Permit No.	Date	DIN
11-07	**April 29, 2014**	**20913**

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Asheville Regional Office

Permit Application

Buncombe County Solid Waste Management Facility

Subtitle D Landfill
Phase IV (Cell 7)
Permit To Construct Application

April 2014

Buncombe County

CDM Smith

CDM Smith
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April 28, 2014

Mr. Allen Gaither
Environmental Engineer
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
2090 US Highway 70
Swannanoa, North Carolina 28778

Subject: Buncombe County Solid Waste Management Facility
Buncombe County, North Carolina
Permit No. 11-07
Subtitle D Landfill – Phase IV (Cell 7)
Permit to Construct Application

Dear Mr. Gaither:

On behalf of Buncombe County, Camp Dresser McKee & Smith (CDM Smith) is pleased to submit one (1) copy of the Permit to Construct Application for Phase IV (Cell 7) of the Buncombe County Subtitle D Landfill. The intent of this submittal is to receive a Permit to Construct.

If you have any questions or comments, or need any additional information during your review, please do not hesitate to contact me at (919) 325-3574.

Very truly yours,

NORTH CAROLINA PROFESSIONAL SEAL 029328 ENGINEER KENTON J. YANG

04/28/2014

Kenton J. Yang, P.E.
CDM Smith

cc: J. Creighton/D. Cottrell/J. Mears/K. Smith, Buncombe County
J. Wiseman, PETRA Engineering
C. Gabel, CDM Smith

Attachments:
Gaither – 1 permit binder
Mears/Smith – 2 permit binders/2 half-size drawing sets/1 full-size drawing set
Wiseman – 1 permit binder/1 half-size drawing set

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Buncombe County, North Carolina

Buncombe County Solid Waste Management Facility Subtitle D Landfill Phase IV (Cell 7) Permit to Construct Application

Part 1 – Introduction

March 2014

Part 1

Introduction

1.1 Purpose of Permit Application

The purpose of this permit application is to obtain a Permit to Construct for Phase IV (Cell 7). The current Permit to Operate (No. 11-07) expires June 15, 2016 and was obtained for operating the Phase III (Cell 6) vertical expansion. Currently, Buncombe County (County) is disposing in Phase III.

The following table provides a summary of the report sections included in this permit application:

Permit Application	Prepared in accordance with
Part 2 – Facility Plan	.1619
Part 3 – Engineering Plan	.1620
Part 4 – Construction Quality Assurance Plan	.1621
Part 5 – Operation Plan	.1625
Part 6 – Closure/Post-Closure Plan	.1629

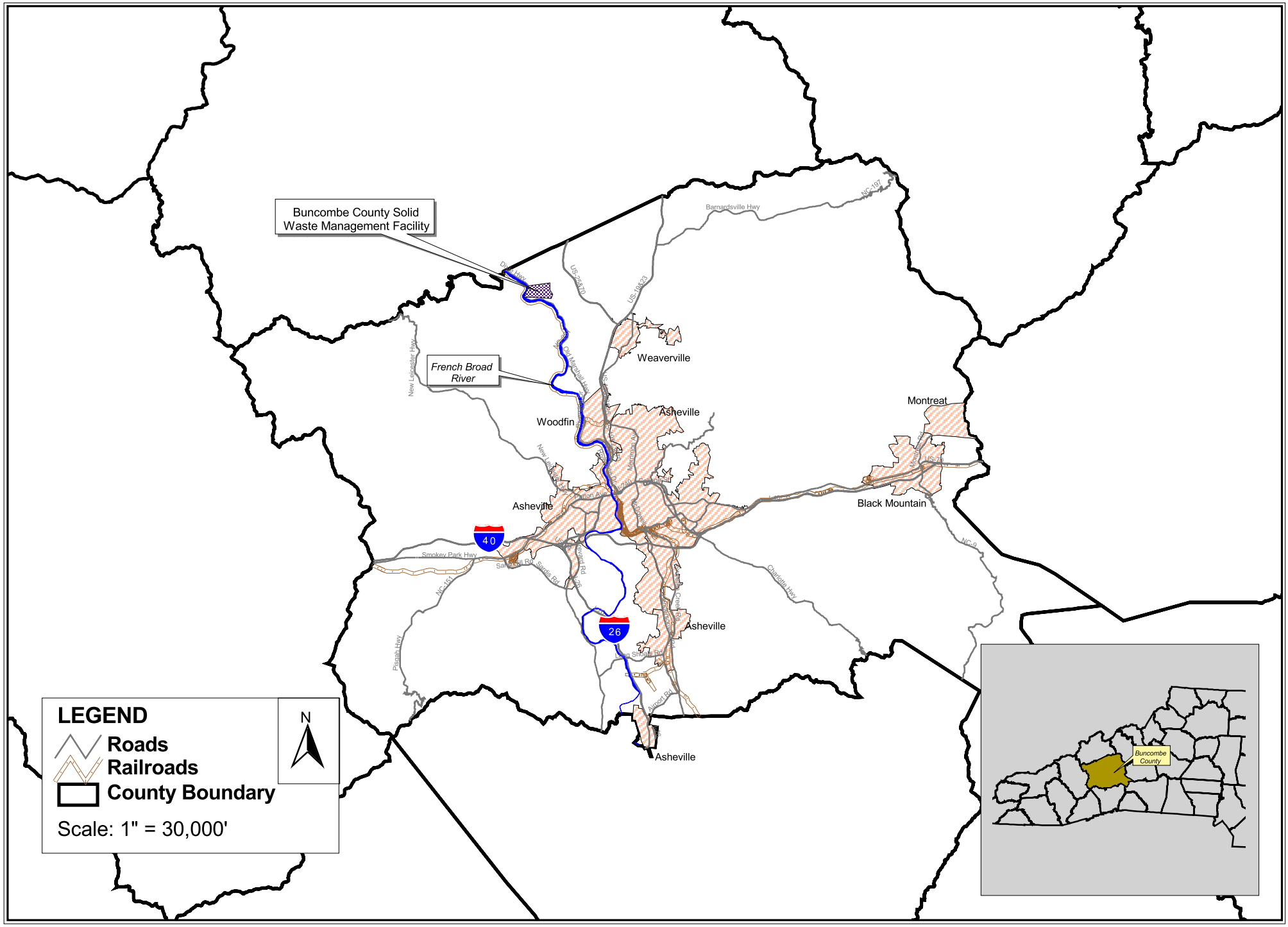
The Facility Plan (Part 2) includes both the Subtitle D and C&D landfills in the report and drawings.

1.2 Facility Location

The Buncombe County Solid Waste Management Facility is located on NC 251 (Dixie Highway) in Alexander, North Carolina approximately 9 miles northwest of Asheville, North Carolina (see Figure 1-1). A construction entrance is located on NC 251. Primary access for landfilling activities is from SR 1745 (Panther Branch Road).

1.3 Solid Waste Management Rule Requirements

The Permit Application criteria and requirements established in Rules .1619, .1620, .1621, .1625, and .1629 of the North Carolina Solid Waste Management Rules, as directly related to municipal solid waste landfills, are presented in Tables 1-1 through 1-6, respectively. Following each criterion, a brief description of the location where the information is contained is provided.



CDM Smith

Figure 1-1
Location Map

Table 1-1. Cross Reference Summary to Rule .1619 Requirements

Rule and Criteria	Location / Comment
15A NCAC 13B .1619 FACILITY PLAN FOR MSWLFS	
(d) Facility Drawings. The facility plan must include the following drawings:	
(1) Site Development. The drawings which plot site development must be prepared on topographic maps representative of existing site conditions; the maps must locate or delineate the following: (A) Delineate the areal limits of all landfill units, and incorporate the buffer requirements set forth in Rule .1624(b)(3); (B) Locate all solid waste management facilities and facility infrastructure, including landfill units.	(A) See Sheet SD-1 in Appendix 2A. (B) See Sheet SD-1 in Appendix 2A.
(2) Landfill Construction. All on-site grading activities related to the construction and operation of the MSWLF shall be illustrated in facility drawings which: (A) Delineate the limits of grading, including borrow and stockpile areas; (B) Define phases of development which do not exceed approximately five years of operating capacity; (C) Propose base grades for the MSWLF unit(s); (D) Delineate the location of access roads, sedimentation basins, leachate pipeline and storage or treatment facilities and other structures related to the operation of the MSWLF unit; and (E) Propose final contours for the MSWLF unit(s) and facility features for closure.	(A) See Sheet SD-1 in Appendix 2A. (B) See Sheet LC-1 in Appendix 2A. (C) See Sheet LC-1 in Appendix 2A. (D) See Sheets LC-1 and LC-2 in Appendix 2A. (E) See Sheet LO-5 and LO-9 in Appendix 2A.
(3) Landfill Operation. The following information related to the long-term operation of the MSWLF units shall be included in facility drawings: (A) General grade and flow direction for the drainage layer component of the leachate collection system; (B) Size, location, and general grade for the leachate piping system, including on-site pipelines to leachate management facilities; (C) Proposed transitional contours for each phase of development, including operational grades for existing phase(s) and construction grading for the new phase; and (D) If included in the design, stormwater segregation features and details for inactive	(A) See LO-1 Sheet in Appendix 2A. (B) See LC-2 Sheet in Appendix 2A. (C) See LO Sheets in Appendix 2A. (D) See EP Sheets in Appendix 3D.

Rule and Criteria	Location / Comment
15A NCAC 13B .1619 FACILITY PLAN FOR MSWLFS	
landfill subcells.	
(e) Facility Report. The facility plan must include the following information:	
(1) Waste stream. A discussion of the characteristics of the wastes received at the facility and facility specific management plans must incorporate: (A) the types of waste specified for disposal; (B) Average monthly disposal rates and estimated variance; (C) the area served by the facility; (D) procedures for segregated management at different on-site facilities; and (E) equipment requirements for operation of the MSWLF unit(s).	• See Section 2 of Part 2: Facility Plan.
(2) Landfill Capacity. An analysis of landfill capacity and soil resources must be performed. (A) The data and assumptions used in the analysis shall be: (i) Consistent with the facility drawings and disposal rates specified in the facility plan; and (ii) Representative of operational requirements and conditions. (B) The conclusions shall provide accurate volumetric estimates of: (i) Total operating capacity; (ii) Operating capacity for each phase of development; (iii) In-place ratio of waste to soil; (iv) Available soil resources from on-site or specific off-site sources; (v) Required quantities of soil for landfill construction, operation, and closure; and (vi) The estimated operating life of all MSWLF units in years.	• See Section 2 of Part 2: Facility Plan.
(3) Containment and environmental control systems. A general description of the systems designed for proper landfill operation, system components, and corresponding functions shall be provided.	• See Section 2 of Part 2: Facility Plan.
(4) Leachate Management. An analysis of the leachate management requirements and plans for the MSWLF facility shall incorporate the information required under this Subparagraph. (A) The performance of and design concepts for the leachate collection system within	• See Section 2 of Part 2: Facility Plan.

Rule and Criteria	Location / Comment
15A NCAC 13B .1619 FACILITY PLAN FOR MSWLFS	
active areas of the MSWLF unit and any storm water segregation included in the engineering design shall be described. (B) Normal operating conditions. Normal operating conditions shall be defined and must consider: (i) Average monthly values for leachate generation representative of the landfill's environment and operation using: (I) Empirically derived estimates; or (II) For landfill expansions, actual leachate generation data from the existing landfill. (ii) Surge volumes generated by storm events. (C) Leachate management system. A description of the leachate management system components and their engineered function shall be provided, including: (i) Leachate pipeline operating capacity; (ii) Capacity of the storage and if applicable, the treatment facilities; and (iii) Final disposal plans and applicable discharge limits, including documented prior approval of the waste water treatment plant which may be designated in the plan. (D) A contingency plan shall be prepared for storm surges or other considerations exceeding design parameters for the storage or treatment facilities.	

Table 1-2. Cross Reference Summary to Rule .1620 Requirements

Rule and Criteria	Location / Comment
15A NCAC 13B .1620 ENGINEERING PLAN FOR MSWLFs	
(d) An engineering report must contain:	
(1) An analysis of the facility design that conforms to: (A) The standards for the foundation and the base liner system set forth in Rule .1624 of this Section; (B) The standards for the cap system set forth in Paragraph (c) of Rule .1627 of this Section; and (C) The standards for the leachate storage facilities set forth in Rule .1680 of this Section.	• See Section 1 of Part 3: Engineering Plan.
(2) A summary of the facility design that includes: (A) a discussion of the analytical methods used to evaluate the design, (B) definition of the critical conditions evaluated and assumptions made, (C) a list of technical references used in the evaluation, and (D) completion of any applicable location restriction demonstrations in accordance with Rule .1622.	• See Part 3: Engineering Plan.
(3) A description of the materials and construction practices that conforms to the requirements set forth in Rule .1624.	• See Part 4: Construction Quality Assurance Plan.
(4) A copy of the Design Hydrogeologic Report prepared in accordance with Paragraph (b) of Rule .1623.	• See Appendix 3C of Part 3: Engineering Plan.
(e) Engineering drawings must illustrate:	
(1) existing conditions: site topography, features, existing disposal areas, roads, and buildings;	• See Sheet EP-1 in Appendix 3D.
(2) grading plans: proposed limits of excavation, subgrade elevations, intermediate grading for partial construction;	• See Sheet EP-2 in Appendix 3D.
(3) base liner system: grades for top of composite liner, slopes, anchor configuration, liner penetration locations and details;	• See EP Sheets in Appendix 3D.
(4) leachate collection system: base elevations, piping system grade and inverts, cleanouts, valves, sumps, top of protective cover elevations, and details;	• See EP-4 Sheet in Appendix 3D.

Rule and Criteria	Location / Comment
15A NCAC 13B .1620 ENGINEERING PLAN FOR MSWLFs	
(4) stormwater segregation system: location and detail of features;	• See EP-4A Sheet in Appendix 3D.
(6) cap system: base and top elevations, landfill gas devices, infiltration barrier, surface water removal, protective and vegetative cover, and details;	• See EP-5 Sheet in Appendix 3D.
(7) temporary and permanent sedimentation and erosion control plans;	• See EP-2 Sheet in Appendix 3D.
(8) Vertical separation requirements incorporating boring locations, cross sections, the maps prepared in accordance with Rule .1623 (b)(2)(E) and (F) of this Section, and the grading plans; and	• See EP-6 through -6D Sheets in Appendix 3D.
(9) Additional engineering features and details.	• See EP Sheets in Appendix 3D.

Table 1-3. Cross Reference Summary to Rule .1623 Requirements

Rule and Criteria	Location / Comment
15A NCAC 13B .1623 GEOLOGIC AND HYDROGEOLOGIC INVESTIGATIONS FOR MSWLF FACILITIES	
(b) Design Hydrogeologic Report	• See Appendix 3C of Part 3: Engineering Plan.
(1) A geological and hydrogeological report must be submitted in the application for the Permit to Construct. This report must contain the information required by Subparagraph (2) of this Paragraph. The number and depths of borings required must be based on the geologic and hydrogeologic characteristics of the landfill facility. At a minimum, there must be an average of one boring for each acre of the investigative area. The area of investigation must, at a minimum, be the area within the unit footprint and unit compliance boundary, unless otherwise authorized by the Division. The scope and purpose of the investigation is as follows: (A) The investigation shall provide adequate information to demonstrate compliance with the vertical separation and foundation standards set forth in Subparagraphs (b)(4) and (b)(7) of Rule .1624 of this Section, and Paragraph (e) of Rule .1680 of this Section. (B) The report shall include an investigation of the hydrogeologic characteristics of the uppermost aquifer for the proposed phase of landfill development and any leachate surface impoundment or leachate disposal facility. The purpose of this investigation is to provide more detailed and localized data on the hydrogeologic regime for this area in order to design an effective water quality monitoring system.	• See Appendix 3C of Part 3: Engineering Plan.
(2) The Design Hydrogeologic Report must provide, at a minimum, the following information: (A) the information required in Subparagraphs (a)(4) through (a)(12) of this Rule; (B) the technical information necessary to determine the design of the monitoring system as required by Paragraph (b) of Rule .1631 of this Section; (C) the technical information necessary to determine the relevant point of compliance as required by Part (a)(2)(B) of Rule .1631 of this Section; (D) rock cores (for sites located in the piedmont or mountain regions) for which the numbers, locations, and depths are adequate to provide an understanding of the fractured bedrock conditions and ground-water flow characteristics of at least the upper 10 feet of the bedrock. Testing for the corings must provide, at a minimum, rock types, recovery values, rock quality designation (RQD) values, saturated hydraulic conductivity and secondary porosity values, and rock descriptions, including fracturing	• See Appendix 3C of Part 3: Engineering Plan.

Rule and Criteria	Location / Comment
15A NCAC 13B .1623 GEOLOGIC AND HYDROGEOLOGIC INVESTIGATIONS FOR MSWLF FACILITIES	
and jointing patterns, etc.; (E) a ground-water contour map based on the estimated long-term seasonal high water table that is superimposed on a topographic map and includes the location of all borings and rock cores and the water table elevations or potentiometric data at each location used to generate the ground-water contours; (F) a bedrock contour map (for sites located in piedmont or mountain regions) illustrating the contours of the upper surface of the bedrock that is superimposed on a topographic map and includes the location of all borings and rock cores and the top of rock elevations used to generate the upper surface of bedrock contours; (G) a three dimensional ground-water flow net or several hydrogeologic cross-sections that characterize the vertical ground-water flow regime for this area; (H) a report on the ground-water flow regime for the area including ground-water flow paths for both horizontal and vertical components of ground-water flow, horizontal and vertical gradients, flow rates, ground-water recharge areas and discharge areas; (I) A certification by a Licensed Geologist that all borings at the site that have not been converted to permanent monitoring wells will be properly abandoned in accordance with the procedures for permanent abandonment of wells, as delineated in 15A NCAC 2C Rule .0113(a)(2).	

Table 1-4. Cross Reference Summary to Rule .1621 Requirements

Rule and Criteria	Location / Comment
15A NCAC 13B .1621 CONSTRUCTION QUALITY ASSURANCE PLAN	
(b) For construction of each cell, the CQA plan must include at a minimum: (1) Responsibilities and authorities. The plan must establish responsibilities and authorities for the construction management organization. A pre-construction meeting must be conducted prior to beginning construction of the initial cell, or as required by the permit. The meeting must include a discussion of the construction management organization, respective duties during construction, and periodic reporting requirements for test results and construction activities; (2) Inspection activities. A description of all field observations, tests and equipment that will be used to ensure that the construction meets or exceeds all design criteria established in accordance with Rules .1620 and .1624; (3) Sampling strategies. A description of all sampling protocols, sample size and frequency of sampling must be presented in the CQA plan; (4) Documentation. A description of reporting requirements for CQA activities. Progress and troubleshooting meetings. A plan for holding daily and monthly troubleshooting meetings. The proceedings of the meetings must be documented.	• See Part 4: Construction Quality Assurance Plan.

Table 1-5. Cross Reference Summary to Rule .1625 Requirements

Rule and Criteria	Location / Comment
15A NCAC 13B .1625 OPERATIONAL PLAN	
(b) Operation Plan. The owner or operator of a MSWLF unit must prepare an operation plan for each phase of landfill development. The plan must include drawings and a report defining the information as identified in this Rule.	
(1) Operation drawings. Drawings must be prepared for each phase of landfill development. The drawings must be consistent with the engineering plan and prepared in a format which is useable for the landfill operator. The operation drawings must illustrate the following: (A) existing conditions including the known limits of existing disposal areas; (B) progression of construction cells for incremental or modular construction; (C) progression of operation, including initial waste placement, daily operations, transition contours, and final contours; (D) leachate and stormwater controls for active and inactive subcells; (E) special waste areas within the MSWLF unit; (F) buffer zones, noting restricted use; and (G) stockpile and borrow operations.	• See Appendix 5A of Part 5: Operation Plan.
(2) Operation report. The report shall provide a narrative discussion of the operation drawings and contain a description of the facility operation that conforms to the requirements of Rule .1626 of this Section.	
(1) Waste Acceptance and Disposal Requirements.	• See Section 2 of Part 5: Operation Plan.
(2) Cover material requirements.	• See Section 3 of Part 5: Operation Plan.
(3) Disease vector control.	• See Section 4 of Part 5: Operation Plan.
(4) Explosive gases control.	• See Section 5 of Part 5: Operation Plan.
(5) Air Criteria.	• See Section 6 of Part 5: Operation Plan.
(6) Access and safety requirements.	• See Section 7 of Part 5: Operation Plan.
(7) Erosion and sedimentation control requirements.	• See Section 8 of Part 5: Operation Plan.

Rule and Criteria	Location / Comment
15A NCAC 13B .1625 OPERATIONAL PLAN	
(8) Drainage control and water protection requirements.	• See Section 9 of Part 5: Operation Plan.
(9) Liquid restrictions.	• See Section 10 of Part 5: Operation Plan.
(10) Recordkeeping requirements.	• See Section 11 of Part 5: Operation Plan.
(11) Spreading and Compacting requirements.	• See Section 12 of Part 5: Operation Plan.
(12) Leachate management plan.	• See Section 13 of Part 5: Operation Plan.

Table 1-6. Cross Reference Summary to Rule .1629 Requirements

Rule and Criteria	Location / Comment
15A NCAC 13B .1629 CLOSURE AND POST-CLOSURE PLAN	
(1) Closure plan contents. The owner and operator must prepare a written closure plan that describes the steps necessary to close all MSWLF units at any point during their active life in accordance with the cap system requirements in Paragraph (c) of this Rule. The closure plan, at a minimum, must include the following information:	
(A) a description of the cap system and the methods and procedures to be used to install the cap that conforms to the requirements set forth in Paragraph (c) of Rule .1627;	• See Section 1 of Part 6: Closure/Post-Closure Plan.
(B) an estimate of the largest area of the MSWLF unit requiring the specified cap system at any time during the active life;	• See Section 1 of Part 6: Closure/Post-Closure Plan.
(C) an estimate of the maximum inventory of wastes on-site over the active life of the landfill facility;	• See Section 1 of Part 6: Closure/Post-Closure Plan.
(D) a schedule for completing all activities necessary to satisfy the closure criteria set forth in Paragraph (c) of Rule .1627.	• See Section 1 of Part 6: Closure/Post-Closure Plan.
(3) Financial assurance: the cost estimate for closure activities as required under Rule .1628.	• See Section 1 of Part 6: Closure/Post-Closure Plan.
(c) Post-closure plan contents. The owner and operator of all MSWLF units must submit a written post-closure plan that includes, at a minimum, the following information:	
(1) a description of the monitoring and maintenance activities required in Paragraph (d) of Rule .1627 for each MSWLF unit, and the frequency at which these activities shall be performed;;	• See Section 2 of Part 6: Closure/Post-Closure Plan.
(2) name, address, and telephone number of the person or office responsible for the facility during the post-closure period;	• See Section 2 of Part 6: Closure/Post-Closure Plan.
(3) a description of the planned uses of the property during the post-closure period; and	• See Section 2 of Part 6: Closure/Post-Closure Plan.
(4) Financial Assurance. The owner or operator shall submit the cost estimate for post-closure required under Rule .1628 of this Section as a component of the plan.	• See Section 2 of Part 6: Closure/Post-Closure Plan.

Buncombe County
North Carolina

Buncombe County Solid Waste Management Facility
Subtitle D Landfill
Phase IV (Cell 7) Permit to Construct Application

Part 2 – Facility Plan

April 2014

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Section 1

Facility Drawings

Facility drawings were prepared in compliance with Rule .1619(d) and include all management units on the property. The drawings address site development, landfill construction and landfill operation and are provided in **Appendix 2A**.

1.1 Site Development

Five drawings were prepared using topographic surveys to provide site development. Sheet SD-1 shows the full extent of the property owned by Buncombe County for the solid waste management facility. Note that an additional parcel along Panther Branch Road was purchased in 2013 that expands the facility boundary to the north. No facilities have been built on the newly purchased parcel. Sheet SD-1a is an enlarged view that shows all existing solid waste management facilities and associated infrastructure and buffer requirements as set forth in Rule .1619(d)(1).

Sheets SD-2 and SD-3 show the phases of development and grading for the C&D and Subtitle D landfills, respectively. Sheet SD-4 shows the landfill gas-to-energy facility including planned expansions.

1.2 Landfill Construction

The following Landfill Construction sheets were prepared per Rule .1619(d)(2):

- Sheet LC-1 provides the cell limits for the Subtitle D cells and shows the active soil borrow area per Rule .1619(d)(2)(A).
- Sheets LC-1 and LC-3 depict development phases for the C&D and Subtitle D landfills per Rule .1619(d)(2)(B).
- Sheets LC-1 and LC-3 depict proposed base grades for the C&D and Subtitle D landfills per Rule .1619(d)(2)(C).
- Sheet LC-2 presents the leachate collection and force main and Sheet LC-1 presents the access roads, sedimentation basins, leachate storage and other structures related to operation of the Subtitle D landfill per Rule .1619(d)(2)(D).
- Sheets LO-5 and LO-9 present the final contours per Rule .1619(d)(2)(E) for the Subtitle D and C&D landfills, respectively.

1.3 Landfill Operation

The following Landfill Operation sheets were prepared in accordance with Rule .1619(d)(3):

- Sheet LC-2 depicts the general grade and flow direction for the drainage layer component of the leachate collection system and the size, location, and general grade for the leachate piping system as required by Rule .1619(d)(3)(A) and (B).

- Sheets LO-1 through LO-5 show the transitional contours for the future phases of development of the Subtitle D landfill in accordance with Rule .1619(d)(3)(C).
- Sheets LO-6 through LO-10 show the transitional contours for the future phases of development of the C&D landfill in accordance with Rule .1619(d)(3)(C).
- Stormwater segregation per Rule .1619(d)(3)(D) is shown on Sheet EP-4A of the Engineering Plan Drawings.

1.4 Steepening of Final Sideslopes

As shown on Sheets LO-2 through LO-5, the final sideslopes for Phase IV through VII have been steepened to a maximum 3 to 1 (horizontal to vertical) to increase capacity. The final sideslopes for those phases were previously permitted in February 2011 at 4 to 1.

Section 2

Facility Report

This report was prepared in accordance with Rule .1619(e). A separate report was prepared for the construction and demolition (C&D) landfill facility in accordance with Rule .0537(e) and is provided in **Appendix 2B**.

2.1 Waste Stream

In accordance with Rule .1619(1), a discussion on waste stream is presented below.

2.1.1 Types of Waste [Rule .1619(e)(1)(A)]

Waste disposed of in the Subtitle D landfill is municipal solid waste (MSW) and consists of residential, commercial, and non-hazardous industrial wastes. Only waste that meets the acceptance criteria as described in the North Carolina Solid Waste Management Rules and as specified in the Permit to Operate is allowed to be disposed of at the facility. C&D waste is disposed in a separate C&D landfill.

The waste screening plan provided in the Operation Plan is used to determine if incoming waste is acceptable for the Subtitle D or C&D facilities.

Waste received at the facility that is not landfilled includes: wood and yard waste which are mulched using a tub grinder, white goods, batteries, motor oil, tires, household hazardous waste (HHW), triple-rinsed pesticide containers, and recyclables.

2.1.2 Disposal Rates [Rule .1619(e)(1)(B)]

Table 2-1 presents yearly disposal rates as recorded at the landfill scale house and includes an average daily rate assuming 284 operating days (365 days - 52 Sundays - 26 Saturdays (half days) - 3 holidays). Assuming a 5% annual increase starting from 2013, it is anticipated that the average annual MSW waste disposed will be approximately 119,000 tons (419 tons per day) over the next 5 years.

Table 2-1 MSW Disposal Rates

FY[1]	Amount Received (tons)	Daily Rate (tons/day)
98-99	109,734	386
99-00	120,143	423
00-01	122,333	431
01-02	146,690	517
02-03	160,863	566
03-04	170,170	599
04-05	173,774	612
05-06	122,034	430
06-07	117,216	413
07-08	143,994	507
08-09	129,551	456
09-10	113,497	400
10-11	116,876	412
11-12	109,317	385
12-13	107,469	378

[1]Fiscal year is from July to June.

2.1.3 Areas Served By Facility [Rule .1619(e)(1)(C)]

The Buncombe County Solid Waste Management Facility serves only Buncombe County. Buncombe County is approximately 659 square miles and, includes the incorporated municipalities of Asheville, Biltmore Forest, Black Mountain, Montreat, Weaverville, and Woodfin.

2.1.4 Waste Segregation Management [Rule .1619(e)(1)(D)]

The waste screening and segregation procedures employed by the Buncombe County Solid Waste Management Facility staff are provided in the Operation Plan.

2.1.5 Equipment Requirements [Rule .1619(e)(1)(E)]

Equipment utilized at the Subtitle D landfill includes the following:

- 2 Dozers (1 Cat D6 and 1 John Deer 850)
- 2 Compactors (Terex 1-390 & 1-TC550)
- 1 Excavator (Volvo 210)
- 1 25-yard Articulated Dump Truck (Volvo A25)
- 1 Rubber Tired Loader (Volvo L70)
- 1 Track Loader (International 250C)
- 1 Farm Tractor (Kubota 8030F)

- 1 Motor Grader (John Deere 570A)
- 1 Skid Loader (CAT 287)
- 1 Tub Grinder (Morbark 1119)
- 1 Roll-off Truck (used to haul convenience center roll-offs to working face)
- 1 Slope Mower (Kut-Kwick)
- 1 Fuel Truck (Chevrolet 1.5 ton)

2.2 Landfill Capacity

Landfill capacity calculations were prepared in accordance with Rule .1619(e)(2) as described below.

2.2.1 Data and Assumptions [Rule .1619(e)(2)(A)]

The following data and assumptions were used in estimating the volumetric capacity and life expectancy of the landfill units:

- 284 landfill operating days per year
- 4:1 waste to soil ratio
- 0.53 in-place waste density (From June 2013 Airspace Analysis Report)
- An average of 119,000 tons/year for the next 5 years (refer to Section 2.1.2.)
- 3:1 final sideslopes for Cells 7-10 and the vertical expansion

2.2.2 Volumetric Estimates [Rule .1619(e)(2)(B)]

2.2.2.1 Total Operating Capacity

AutoCAD Civil 3D 2012 software was used to estimate the total operating capacity, which is defined as the volume between the top of the landfill liner protective cover and the top of the 12-inch intermediate cover layer for the Subtitle D landfill. The total operating capacity is approximately 11.8 million cubic yards (cy) as presented in **Table 2-2.**

2.2.2.2 Operating Capacity per Phase

AutoCAD Civil 3D 2012 software was used to estimate the phased operating capacity and is presented in Table 2-2.

Table 2-2 – Operating Capacity Per Phase

Phase	Operating Capacity (cy)
I (Cells 1-3)	1,371,000
II (Cells 4-5)	974,000
III (Cell 6)	2,434,000
IV (Cell 7)	1,349,000
V (Cells 9-10)	1,580,000
VI (Cell 8)	752,000
VII (Vertical Expansion)	3,345,000
Total	11,805,000

The permanent landfill sideslopes for Phases IV through VII have been increased to 3 to 1 (horizontal to vertical) from 4 to 1 as previously permitted in February 2011 and as presented on Sheets LO-2 through LO-5. The operating capacities presented in Table 2-2 reflect the 3 to 1 sideslopes.

2.2.2.3 Waste-to-Soil Ratio

Based on information from the County regarding use of cover soils, a waste-to-soil ratio of 4:1 was assumed. The County also uses Posi-Shell as alternative daily cover. However, due to the negligible amount of additional volume it contributes, Posi-Shell is not included in the soil ratio.

2.2.2.4 Soil Resources

Current and future soil borrow sources are identified on Sheet SD-1. The amount of remaining borrow material available onsite is estimated to be 645,000 CY for the current area and 753,000 CY for the future areas. The County has purchased an adjacent property as shown on Sheet SD-1 that may be considered for future borrow material.

2.2.2.5 Soil Requirements

Estimated soil quantities for landfill construction, operation, and closure and presented in **Table 2-3**. Operation quantities include daily and intermediate cover.

The following sample calculation shows how the estimates provided in Table 2-3 were generated.

- Construction (Phase IV) = 1.5-foot thick compacted clay liner x area of cell

  = (1.5 foot x 13.3 acres x 43,560 sf/ac)/27 cf/cy

  = <u>32,200 cy</u>

- Operation (Phase IV) = operating capacity (Table 2-2) x 20% (4:1 waste to cover ratio from Section 2.2.2.3)

  = 1,349,000 cy x 20%

  = <u>269,800 cy</u>

The closure soil quantity requirement was calculated for the entire Subtitle D landfill (95-acres):

1. 6-inch erosion layer totaling 76,600 cy

2. 18-inch protective soil layer totaling 229,900 cy

The total final cover material required for the entire Subtitle D landfill is 306,500 cy.

Table 2-3 Required Soil Quantities

		Required Soil Quantities (cy)	
Phase	Area (ac)	Construction	Operation
IV (Cell 7)	13.3	32,200	269,800
V (Cells 9-10)	17.8	43,100	315,900
VI (Cell 8)	8.5	20,600	150,400
VII (Vertical Expansion)	--	--	669,000

2.2.2.6 Operating Life

The following calculations were performed to determine the landfill operating life presented in **Table 2-4**. Based on the June 2013 Airspace Analysis Report, the in-place density is 0.53 tons per cy. From Section 2.1.2, the annual amount of waste disposed will be approximately 119,000 tons of MSW per year over the next 5 years.

The following are the calculations used to complete Table 2-4.

- Operating Life (Phase IV) = (Operating Capacity (Table 2-2) x in-place density)/ annual waste disposed

= (1,349,000 cy x 0.53 ton/cy) / 119,000 ton/yr

= 6.0 yrs

Table 2-4 Operating Life

Phase	Operating Capacity (cy)	Operating Life (yr)
IV (Cell 7)	1,349,000	6.0
V (Cells 9-10)	1,580,000	7.0
VI (Cell 8)	752,000	3.3
VII (Vertical Expansion)	3,345,000	14.9
Total	7,026,000	31.2

If the operating life estimate turns out to be accurate then the County will request a vertical expansion permit amendment for Phase IV when the 5-year operating limit is reached.

2.3 Containment and Environmental Control Systems [Rule .1619(e)(3)]

The design concept for the landfill facility is to maximize the disposal capacity while providing full containment of the disposed waste and leachate. The following narrative provides a description of the containment and environmental control systems for the facility.

2.3.1 Leachate Collection and Storage

A 24-inch rock drainage layer possessing a minimum hydraulic conductivity of 1.0 cm/s will be placed over the liner system. A heavyweight fabric cushion will be used under the drainage layer to protect the geomembrane.

Ten-inch diameter, perforated HDPE collection pipe will be installed in areas of concentrated flow to efficiently route leachate to the sump. Leachate in the collection pipes will flow by gravity to sump areas where a submersible pump will be installed to remove the leachate from the cells.

The collected leachate will be pumped from the cells through an HDPE force main located along the perimeter of the cells to the lined leachate storage pond. From the pond, leachate will be recirculated back into the landfill or hauled to the Metropolitan Sewerage District (MSD) wastewater treatment facility.

2.3.2 Base Composite Liner System

A composite base liner system will be utilized to contain leachate generated in the cells consisting of a compacted, smooth subgrade, 18 inches of compacted soil with a maximum permeability of 1.0×10^{-5} cm/s, a geosynthetic clay liner (GCL) and a 60-mil textured HDPE geomembrane liner. The grades of the base liner system will be designed to retain a minimum post-settlement slope of two percent and a minimum post-settlement vertical separation of four feet above seasonal high ground water table and bedrock.

2.3.3 Final Cover System

A final cover system will be installed after waste filling is complete to minimize infiltration of stormwater and control landfill gas. The composition of the cap system will be a geomembrane overlain by an 18-inch layer of protective soil and 6-inch erosion soil layer with sufficient organic content to sustain vegetative growth. The closure cap will have a maximum grade of 4 to 1 (horizontal to vertical) for Cells 1 through 5 and a maximum grade of 3 to 1 for Cells 6 through 10. A minimum slope of five percent will be used for the final plateau.

2.3.4 Erosion & Sedimentation Control

Stormwater runoff from the landfill will be collected and routed to a series of sedimentation ponds to remove suspended solids prior to discharge. Intermediate cover slopes will be maintained with a good stand of grass to limit erosion and repairs will be made in a timely manner.

2.3.5 Landfill Gas Control

An active gas collection system consisting of vertical and horizontal wells is used to collect landfill gas. The collected gas is combusted onsite in a generator set and a flare.

2.4 Leachate Management [Rule .1619(e)(4)]

The leachate collection system is designed to collect leachate by gravity flow in the cells and convey leachate to an onsite storage pond using pressurized flow. The collected leachate is recirculated back into the landfill or hauled to the MSD wastewater treatment facility.

2.4.1 Stormwater Diversion

During initial fill placement in a cell, temporary diversion berms and tarps will be used to segregate clean stormwater from the waste. The temporary berms will be installed near the midpoint of each cell to capture stormwater in roughly half the area. Stormwater falling upstream of the berms will be collected as clean water and will be pumped to the perimeter drainage channel. Stormwater falling on the active waste fill area that comes into contact with waste or is collected downstream of the diversion berms will be collected as leachate.

2.4.2 Normal Operating Conditions

Normal operating conditions, as defined by typical weather conditions, are used to estimate the average monthly and peak daily values of leachate that will be generated by the landfill. The Hydrological Evaluation of Landfill Performance (HELP) Model program is used to estimate these site-specific leachate quantities and is provided in the Engineering Plan.

2.4.3 System Design

The capacity of the leachate collection pipes is based on the peak daily leachate generation rate for the worst case condition. The design calculations are provided in the Engineering Report. In periods of extreme precipitation, leachate may be temporarily stored in the MSW landfill as necessary to maintain control. This is intended to serve only as a short-term solution until the leachate can be transferred from the storage pond to the MSD wastewater treatment facility.

2.4.4 Contingency Plan

The primary means of leachate disposal will be recirculation. When recirculation is not being performed, the leachate will be hauled to the MSD wastewater treatment facility. Should the MSD wastewater treatment facility experience problems and not be able to accept leachate for a limited time period, the storage pond will be used to store the leachate. As stated in Section 2.4.3, the MSW landfill cells can act as temporary storage if necessary.

2.5 Special Engineering Features [Rule .1619(e)(4)]

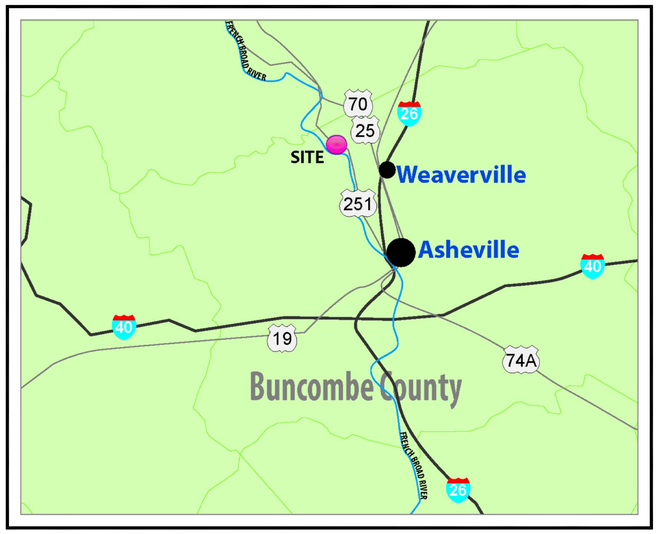
Additional special engineering features have been incorporated into the design of Cell 7:

- No liner penetrations for leachate withdrawal
- Automated pumping stations to minimize storage time for leachate in the landfill cells.
- Leachate recirculation into the waste mass to accelerate decomposition of the MSW and increase landfill capacity and gas generation for the gas-to-energy facility.

Facility Plan
Appendix 2A
Facility Drawings

BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION
SUBTITLE D LANDFILL - PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

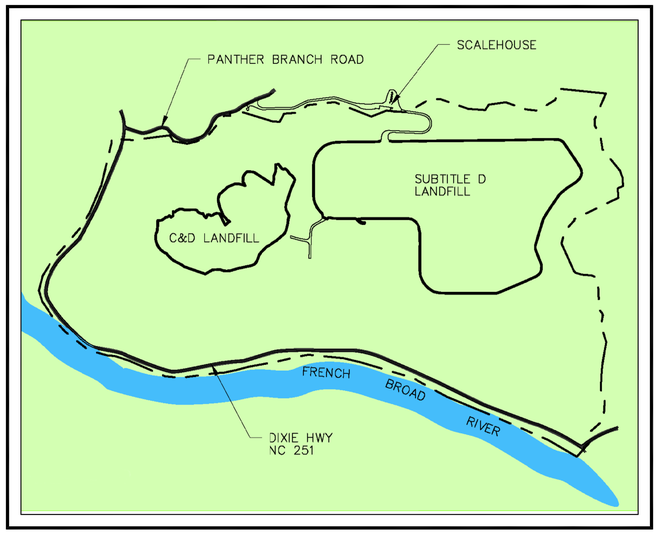


LOCATION MAP

NOT TO SCALE

INDEX OF DRAWINGS

SD-1	SITE DEVELOPMENT EXISTING CONDITIONS
SD-1A	SITE DEVELOPMENT EXISTING CONDITIONS – ENLARGED VIEW
SD-2	SITE DEVELOPMENT C&D LANDFILL
SD-3	SITE DEVELOPMENT SUBTITLE D LANDFILL
SD-4	SITE DEVELOPMENT LANDFILL GAS-TO-ENERGY (LFGTE) FACILITY
LC-1	LANDFILL CONSTRUCTION SUBTITLE D LANDFILL BASE GRADES
LC-2	LANDFILL CONSTRUCTION SUBTITLE D LANDFILL LEACHATE COLLECTION
LC-3	LANDFILL CONSTRUCTION C&D LANDFILL BASE GRADES
LO-1	LANDFILL OPERATION TRANSITION CONTOURS SUBTITLE D LANDFILL – PHASE III CLOSURE GRADES PHASE IV BASE GRADES
LO-2	LANDFILL OPERATION TRANSITION CONTOURS SUBTITLE D LANDFILL – PHASE IV CLOSURE GRADES PHASE V BASE GRADES
LO-3	LANDFILL OPERATION TRANSITION CONTOURS SUBTITLE D LANDFILL – PHASE V CLOSURE GRADES PHASE VI BASE GRADES
LO-4	LANDFILL OPERATION TRANSITION CONTOURS SUBTITLE D LANDFILL – PHASE VI CLOSURE GRADES PHASE VII BASE GRADES (VERTICAL EXPANSION)
LO-5	LANDFILL OPERATION TRANSITION CONTOURS SUBTITLE D LANDFILL – PHASE VII CLOSURE GRADES (VERTICAL EXPANSION)
LO-6	LANDFILL OPERATION TRANSITION CONTOURS C&D LANDFILL – PHASE 5 CLOSURE PHASE 6 BASE GRADES
LO-7	LANDFILL OPERATION TRANSITION CONTOURS C&D LANDFILL – PHASE 6 CLOSURE PHASE 7 BASE GRADES
LO-8	LANDFILL OPERATION TRANSITION CONTOURS C&D LANDFILL – PHASE 7 CLOSURE PHASE 8 BASE GRADES
LO-9	LANDFILL OPERATION TRANSITION CONTOURS C&D LANDFILL – PHASE 8 CLOSURE



VICINITY MAP

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APRIL 2014

PREPARED BY

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6447-97693

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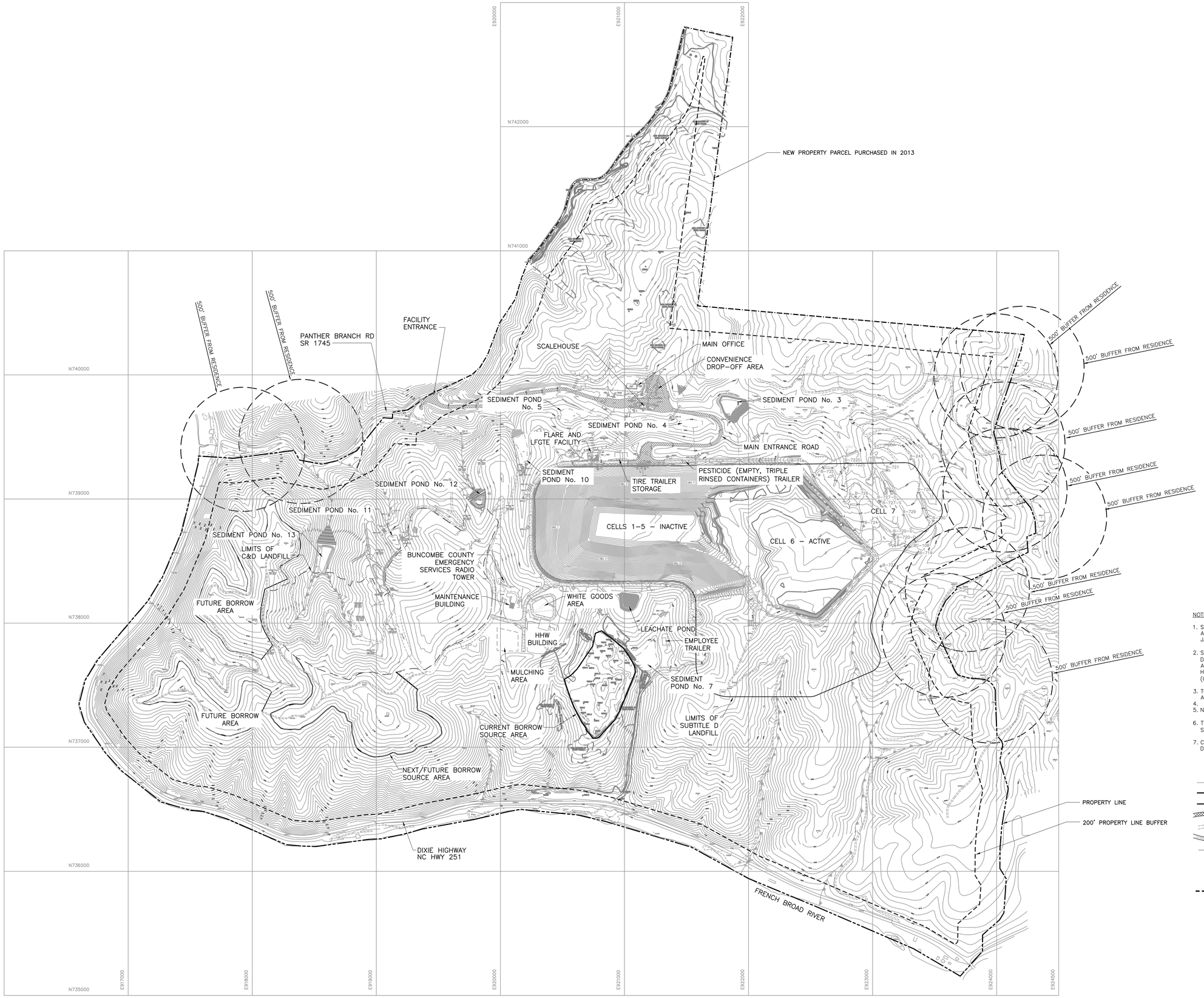

NOTES:

1. SURVEY OF NEW PROPERTY PURCHASE LOCATED NORTH OF ADMINISTRATION BUILDING BY ED HOLMES AND ASSOCIATES DATED JANUARY 2014.
2. SURVEY OF MSW LANDFILL (CELLS 1-5) BY ED HOLMES AND ASSOCIATES DATED APRIL 2008. SURVEY OF MSW LANDFILL (CELL 6) BY ED HOLMES AND ASSOCIATES DATED AUGUST 2010. SURVEY C&D LANDFILL BY ED HOLMES AND ASSOCIATES DATED JUNE 2008. SURVEY OF MSW LANDFILL (CELL 7) BY ED HOLMES AND ASSOCIATES DATED SEPTEMBER 2012.
3. TOPOGRAPHY OUTSIDE OF MSW AND C&D BOUNDARY LIMITS DERIVED FROM AERIAL SURVEY PROVIDED BY AERODYNAMICS, CHARLOTTE, N.C. JULY 1993.
4.
5. NORTH CAROLINA 1983 GRID DATUM.
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7. CONTOURS WITHIN DENSE FOLIAGE AREAS INDICATE DOUBTFUL ACCURACY DUE TO OBSCURED VIEW FROM VEGETATION, SHADOWS, ETC.

LEGEND

2010	INDEX CONTOUR
	PROPERTY LINE
	PARCEL PROPERTY LINE PURCHASED IN 2013
	ASPHALT ROAD (MAIN ACCESS ROAD)
	UNIMPROVED ROAD
	STONE ROAD
	BLEVIN BRANCH (PERENNIAL STREAM)
	TREELINE
	STRUCTURE
	200' PROPERTY LINE BUFFER
MW-10	EXISTING GROUNDWATER MONITORING WELL
M-3	EXISTING METHANE MONITORING WELL
SW-2	SURFACE WATER MONITORING LOCATOIN

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BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

SITE DEVELOPMENT
EXISTING CONDITIONS

PROJECT NO. 6447-97693
FILE NAME: SD-1.DWG
SHEET NO.
SD-1

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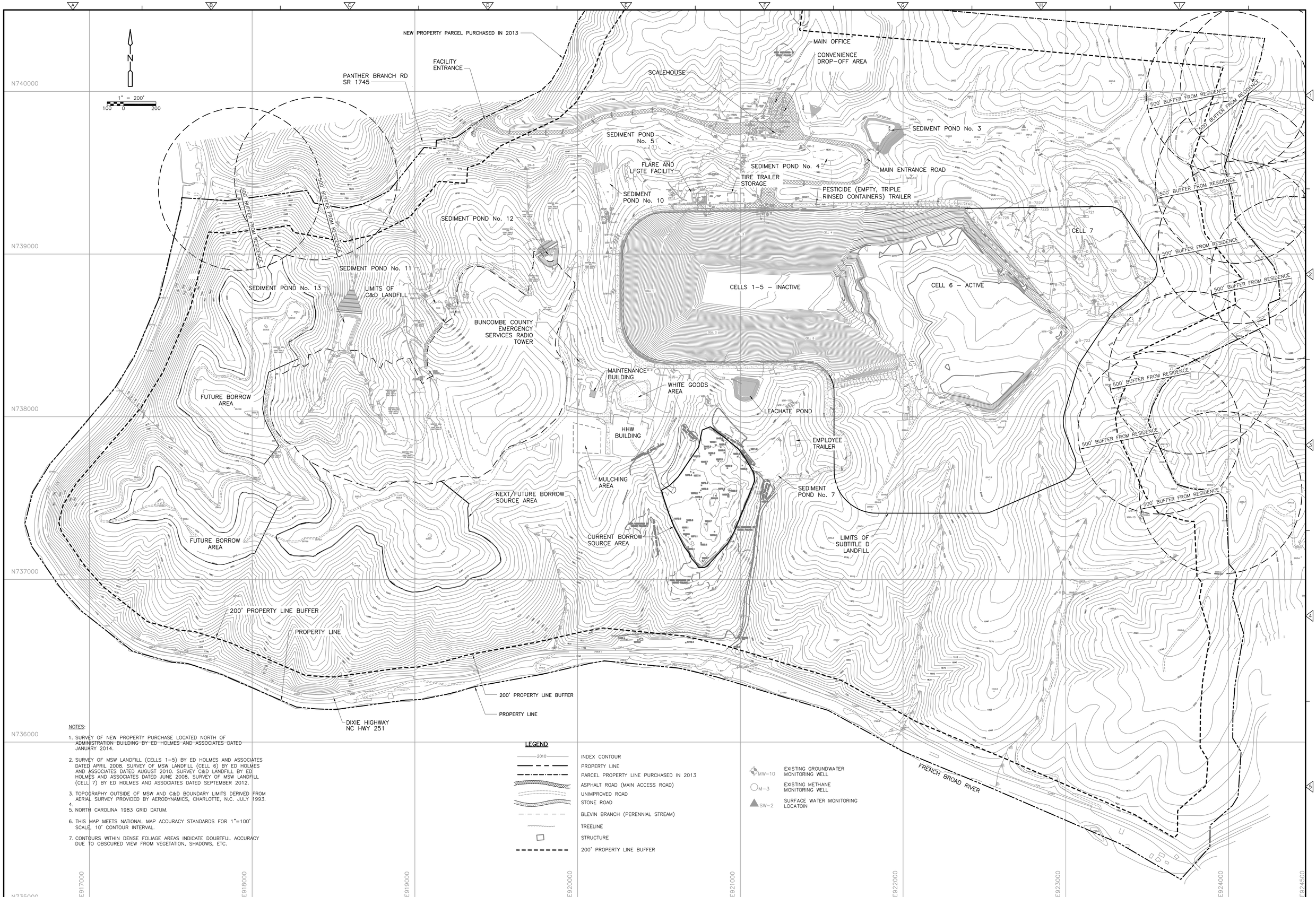

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LEGEND

- 2010 — INDEX CONTOUR
- PROPERTY LINE
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- UNIMPROVED ROAD
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- SW-2 — SURFACE WATER MONITORING LOCATOIN

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PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

SITE DEVELOPMENT
EXISTING CONDITIONS - ENLARGED VIEW

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FACILITY PLAN DRAWINGS

SITE DEVELOPMENT
C&D LANDFILL

PROJECT NO. 6447-97693
FILE NAME: SD-2.DWG
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PHASE I
(CELL 1)

PHASE I
(CELL 2)

PHASE I
(CELL 3)

PHASE II
(CELL 4)

PHASE II
(CELL 5)

ACTIVE MSW AREA
PHASE III (CELL 6)

PHASE IV
(CELL 7)
13.3 ACRES

PHASE V
(CELL 10)
8.7 ACRES

PHASE V
(CELL 9)
9.1 ACRES

PHASE VI
(CELL 8)
8.5 ACRES

PHASE VII
(VERTICAL EXPANSION TO EL. 2236)

N

1" = 100'

50 0 100

LEGEND

- EXISTING CONTOUR
- PROPOSED CONTOUR
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
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SITE DEVELOPMENT
SUBTITLE D LANDFILL

PROJECT NO. 6447-97693
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SHEET NO.
SD-3

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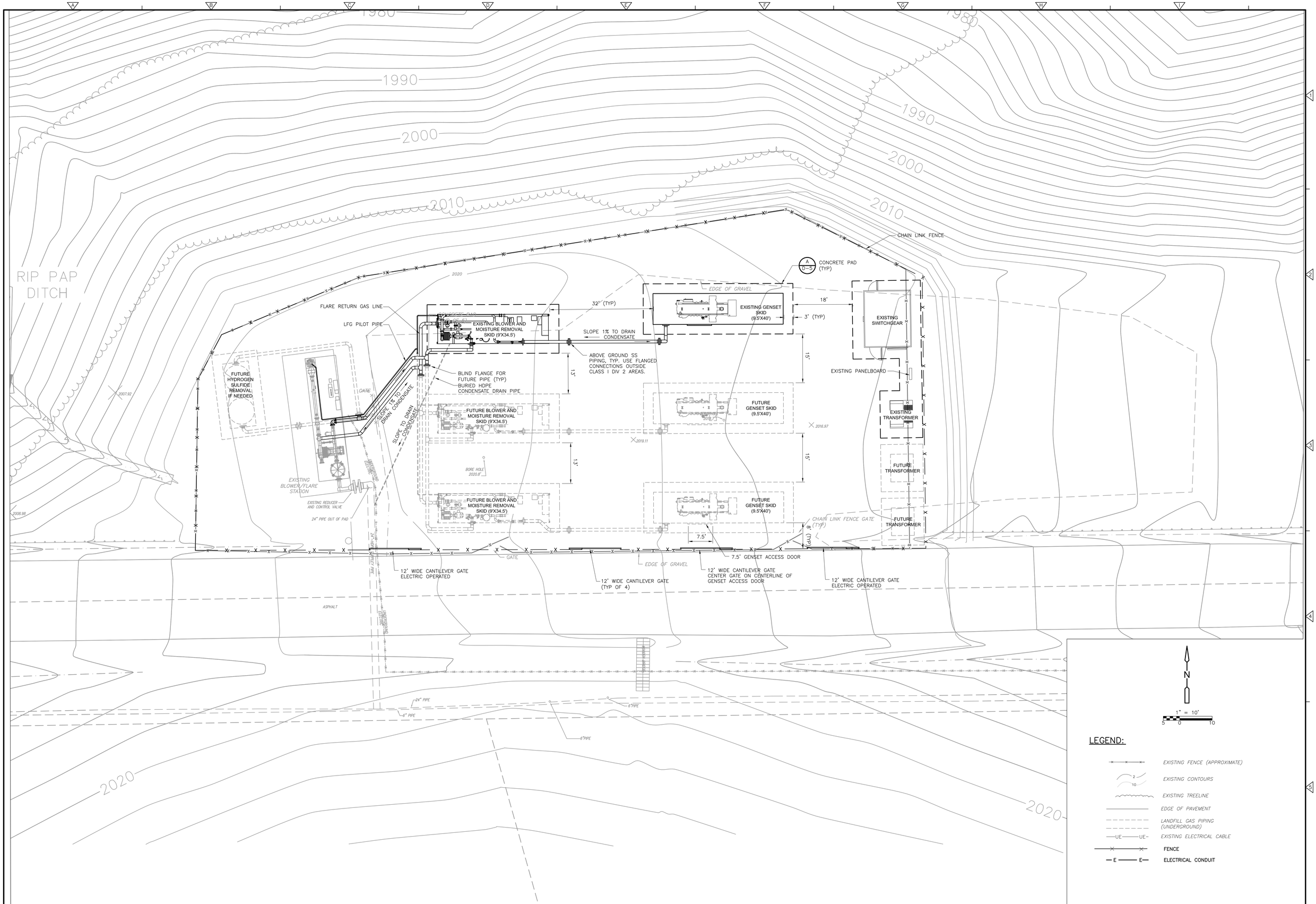

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FACILITY PLAN DRAWINGS

SITE DEVELOPMENT
LANDFILL GAS TO ENERGY FACILITY

PROJECT NO. 6447-97693
FILE NAME: SD-4.DWG
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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

LANDFILL CONSTRUCTION
SUBTITLE D LANDFILL BASE GRADES

PROJECT NO. 6447-97693
FILE NAME: LC-1.DWG
SHEET NO.
LC-1

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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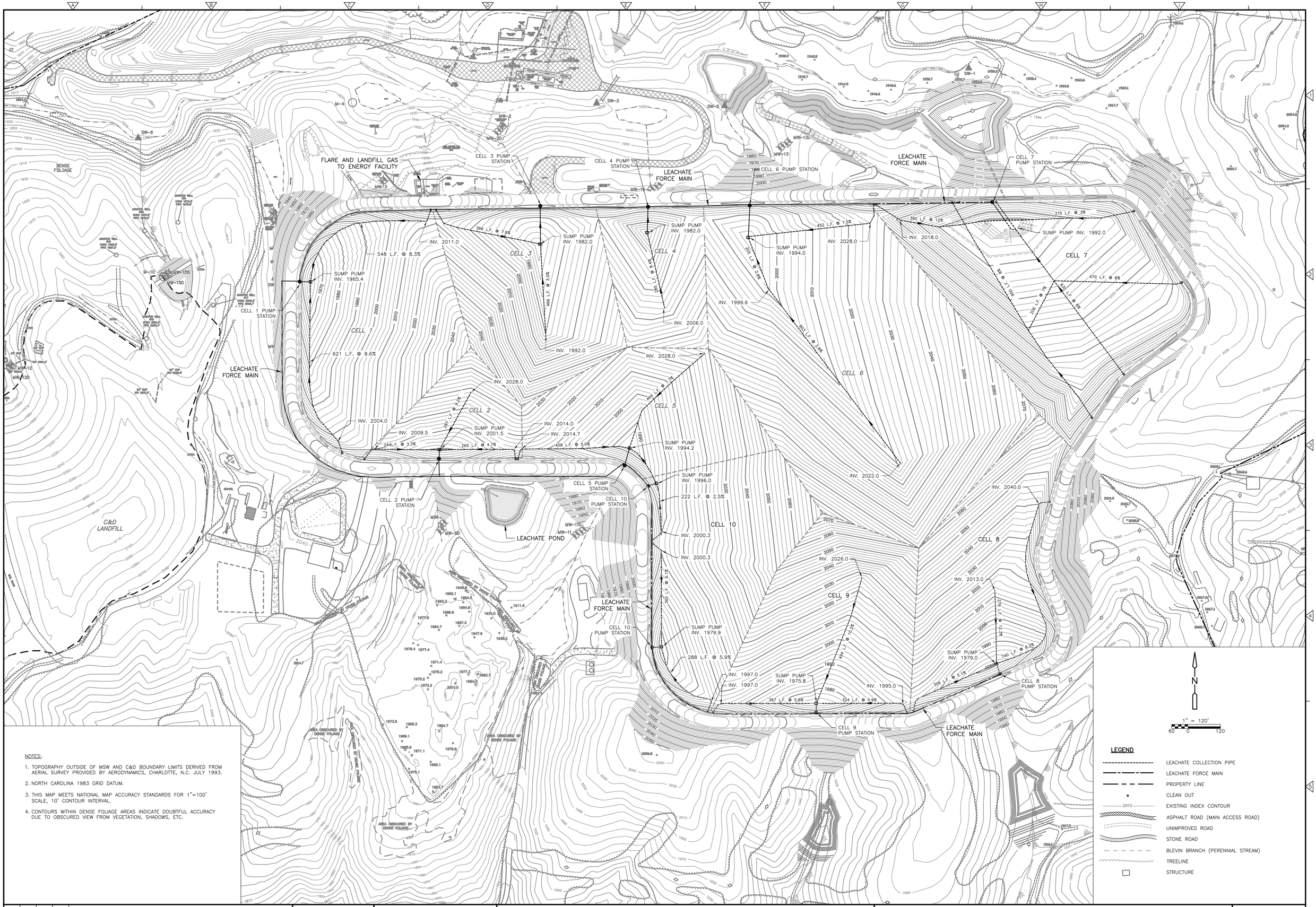

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PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

LANDFILL CONSTRUCTION
SUBTITLE D LANDFILL LEACHATE COLLECTION

PROJECT NO. 6447-97693
FILE NAME: LC-2.DWG
SHEET NO.
LC-2

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SEDIMENT POND No. 13

SEDIMENT POND No. 11

SEDIMENT POND No. 12

EXISTING C&D LANDFILL PERMITTED LIMITS

PHASES 6,7,8 LIMITS

PHASE 5 LIMITS

ACTIVE PHASE 5

MW-6

1" = 60'

30 0 60

LEGEND

- EXISTING INDEX CONTOUR
- PHASE 6, 7, & 8 BASE GRADES
- EXISTING C&D LANDFILL LIMITS
- PHASE 5,6,7,&8 LIMITS
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE

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REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

LANDFILL CONSTRUCTION
C&D LANDFILL BASE GRADES

PROJECT NO. 6447-97693
FILE NAME: LC-3.DWG

SHEET NO.
LC-3

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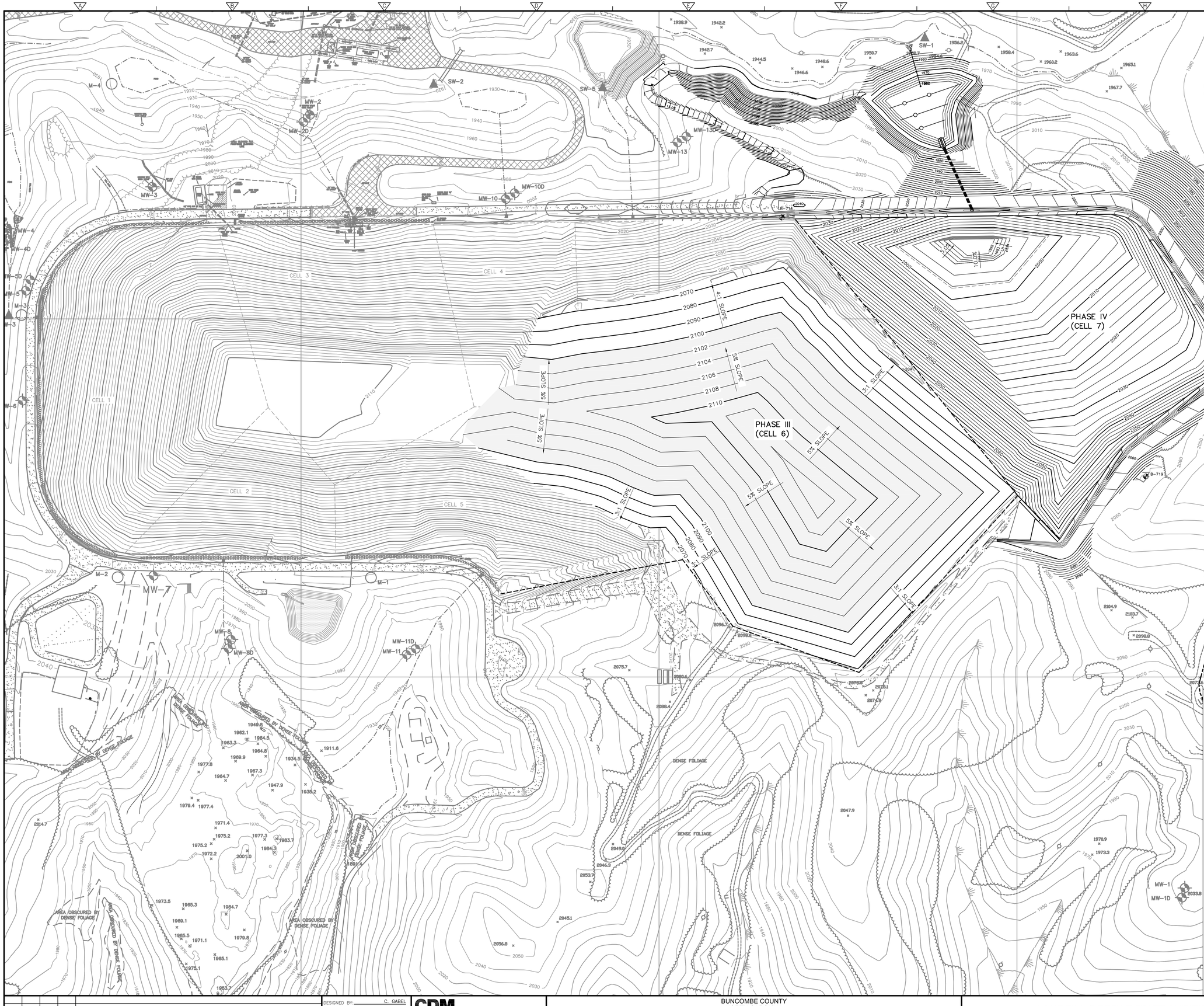

N

1" = 100'

50 0 100

LEGEND

- PROPOSED CONTOUR
- EXISTING INDEX CONTOUR
- PROPERTY LINE
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE

NOTES:

1. BASE GRADES AS SHOWN ARE PREPARED SUBGRADE PRIOR TO PLACEMENT OF COMPACTED CLAY SOIL LINER.
2. CLOSURE GRADES AS SHOWN ARE INTERMEDIATE COVER GRADES AND DO NOT INCLUDE 2 FEET OF FINAL COVER.
3. PHASE III (CELL 6) VOLUME = 2,434,000 CU.YDS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

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APPROVED BY: K. YANG
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FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
SUBTITLE D LANDFILL - PHASE III CLOSURE GRADES
PHASE IV BASE GRADES

PROJECT NO. 6447-97693
FILE NAME: LO-1.DWG
SHEET NO.
LO-1

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NOTES:

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2. CLOSURE GRADES AS SHOWN ARE INTERMEDIATE COVER GRADES AND DO NOT INCLUDE 2 FEET OF FINAL COVER.
2. PHASE IV (CELL 7) VOLUME = 1,424,000 CU.YDS.

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FACILITY PLAN DRAWINGS

LANDFILL OPERATIONS TRANSITION CONTOURS
SUBTITLE D LANDFILL - PHASE IV CLOSURE GRADES
PHASE V BASE GRADES

PROJECT NO. 6447-97693
FILE NAME: LO-2.DWG
SHEET NO.
LO-2

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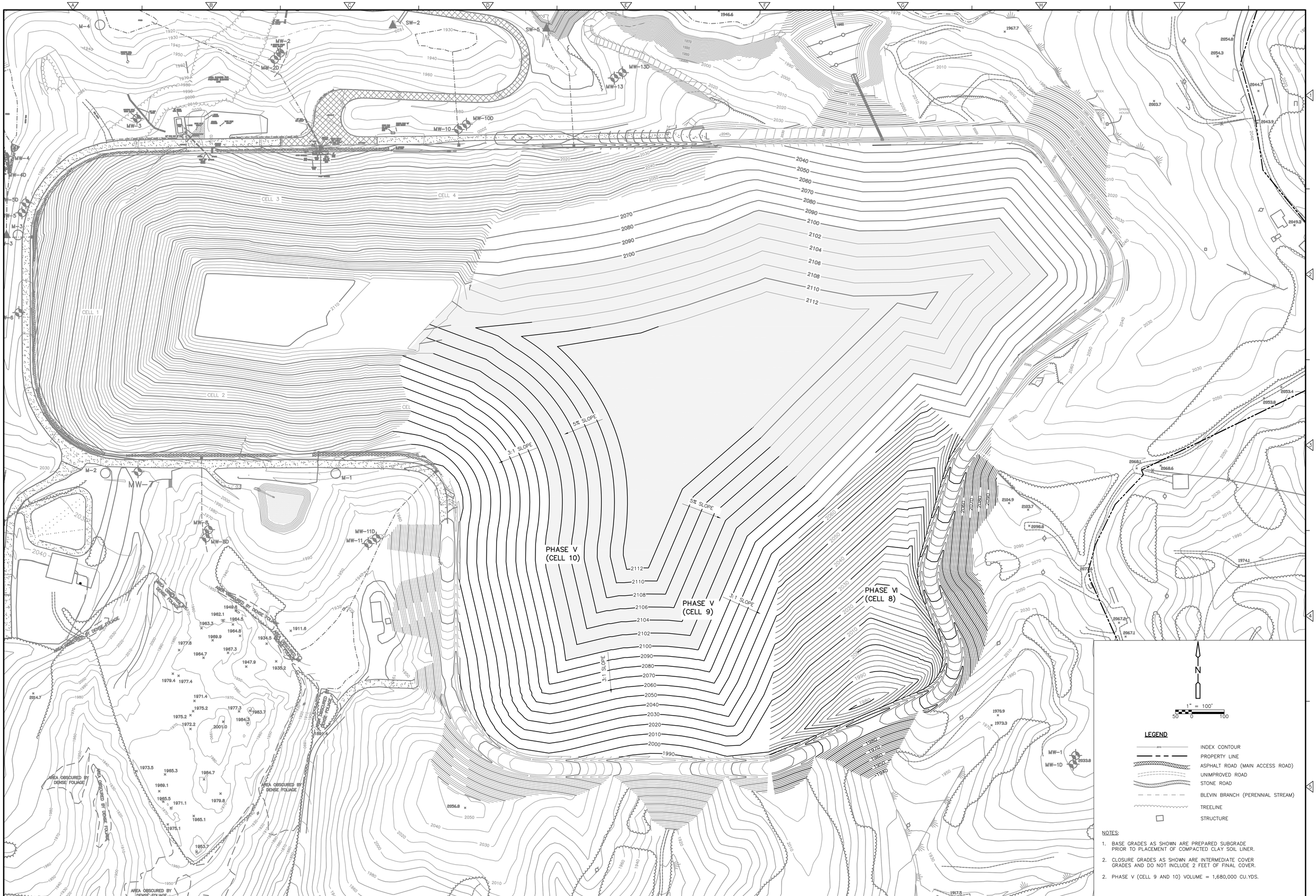

NOTES:

1. BASE GRADES AS SHOWN ARE PREPARED SUBGRADE PRIOR TO PLACEMENT OF COMPACTED CLAY SOIL LINER.
2. CLOSURE GRADES AS SHOWN ARE INTERMEDIATE COVER GRADES AND DO NOT INCLUDE 2 FEET OF FINAL COVER.
2. PHASE V (CELL 9 AND 10) VOLUME = 1,680,000 CU.YDS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

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DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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NORTH CAROLINA
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PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
SUBTITLE D LANDFILL - PHASE V CLOSURE GRADES
PHASE VI BASE GRADES

PROJECT NO. 6447-97693
FILE NAME: LO-3.DWG
SHEET NO.
LO-3

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LEGEND

- INDEX CONTOUR
- PROPERTY LINE
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE

NOTES:

1. CLOSURE GRADES AS SHOWN ARE INTERMEDIATE COVER GRADES AND DO NOT INCLUDE 2 FEET OF FINAL COVER.
2. PHASE VI (CELL 8) VOLUME = 800,000 CU.YDS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

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APPROVED BY: K. YANG
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PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
SUBTITLE D LANDFILL - PHASE VI CLOSURE GRADES
PHASE VII BASE GRADES (VERTICAL EXPANSION)

PROJECT NO. 6447-97693
FILE NAME: LO-4.DWG
SHEET NO.
LO-4

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N

1" = 100'

50 0 100

LEGEND

- INDEX CONTOUR
- PROPERTY LINE
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE

NOTES:

1. CLOSURE GRADES AS SHOWN ARE INTERMEDIATE COVER GRADES AND DO NOT INCLUDE 2 FEET OF FINAL COVER.
2. PHASE VII (VERTICAL EXPANSION) VOLUME = 3,345,000 CU.YDS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

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FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
SUBTITLE D LANDFILL - PHASE VII CLOSURE GRADES
(VERTICAL EXPANSION)

PROJECT NO. 6447-97693
FILE NAME: LO-5.DWG
SHEET NO.
LO-5

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NOTES:

1. GRADES AS SHOWN INCLUDE 3 FT. FINAL COVER CAP.
2. PHASE 5 VOLUME = 285,500 CU.YDS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
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CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
C&D LANDFILL - PHASE 5 CLOSURE PHASE 6 BASEGRADES

PROJECT NO. 6447-97693
FILE NAME: LO-6.DWG
SHEET NO.
LO-6

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SEDIMENT POND No. 13

SEDIMENT POND No. 12

SEDIMENT POND 11

PHASES 6, 7, & 8 LIMITS

PHASE 7
VERTICAL EXPASION
(ELEVATION 2030 TO 2100)

3:1 SLOPE

5% SLOPE

MW-6

N

1" = 60'

30 0 60

LEGEND

- INDEX CONTOUR
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE

NOTES:

1. GRADES AS SHOWN INCLUDE 3 FT. FINAL COVER CAP.
2. PHASE 6 VOLUME = 607,700 CU.YDS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
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FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
C&D LANDFILL - PHASE 6 CLOSURE PHASE 7 BASEGRADES

PROJECT NO. 6447-97693
FILE NAME: LO-7.DWG

SHEET NO.
LO-7

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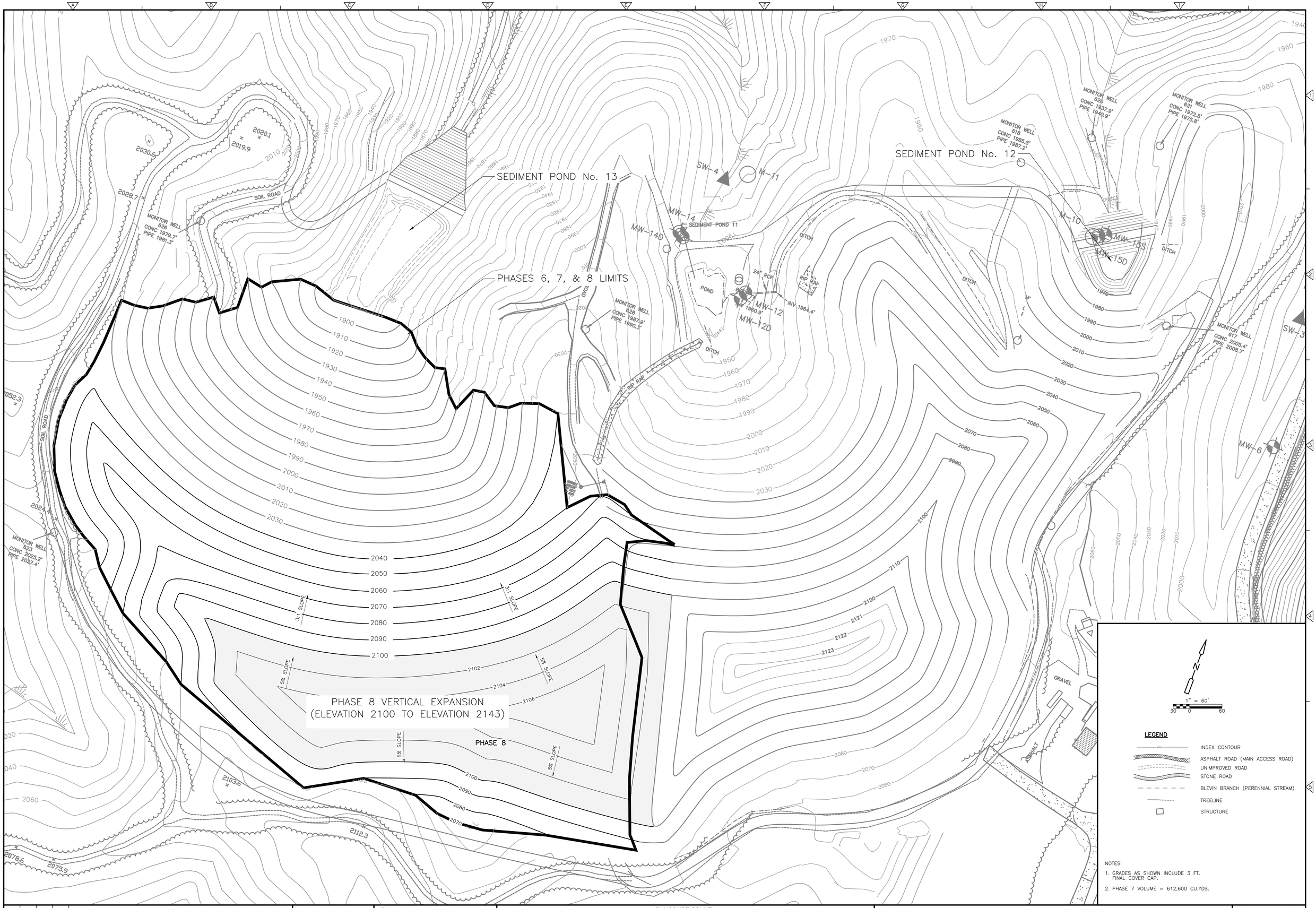

NOTES:

1. GRADES AS SHOWN INCLUDE 3 FT. FINAL COVER CAP.
2. PHASE 7 VOLUME = 612,600 CU.YDS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

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DATE: APRIL 2014

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FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
C&D LANDFILL - PHASE 7 CLOSURE PHASE 8 BASEGRADES

PROJECT NO. 6447-97693
FILE NAME: LO-8.DWG
SHEET NO.
LO-8

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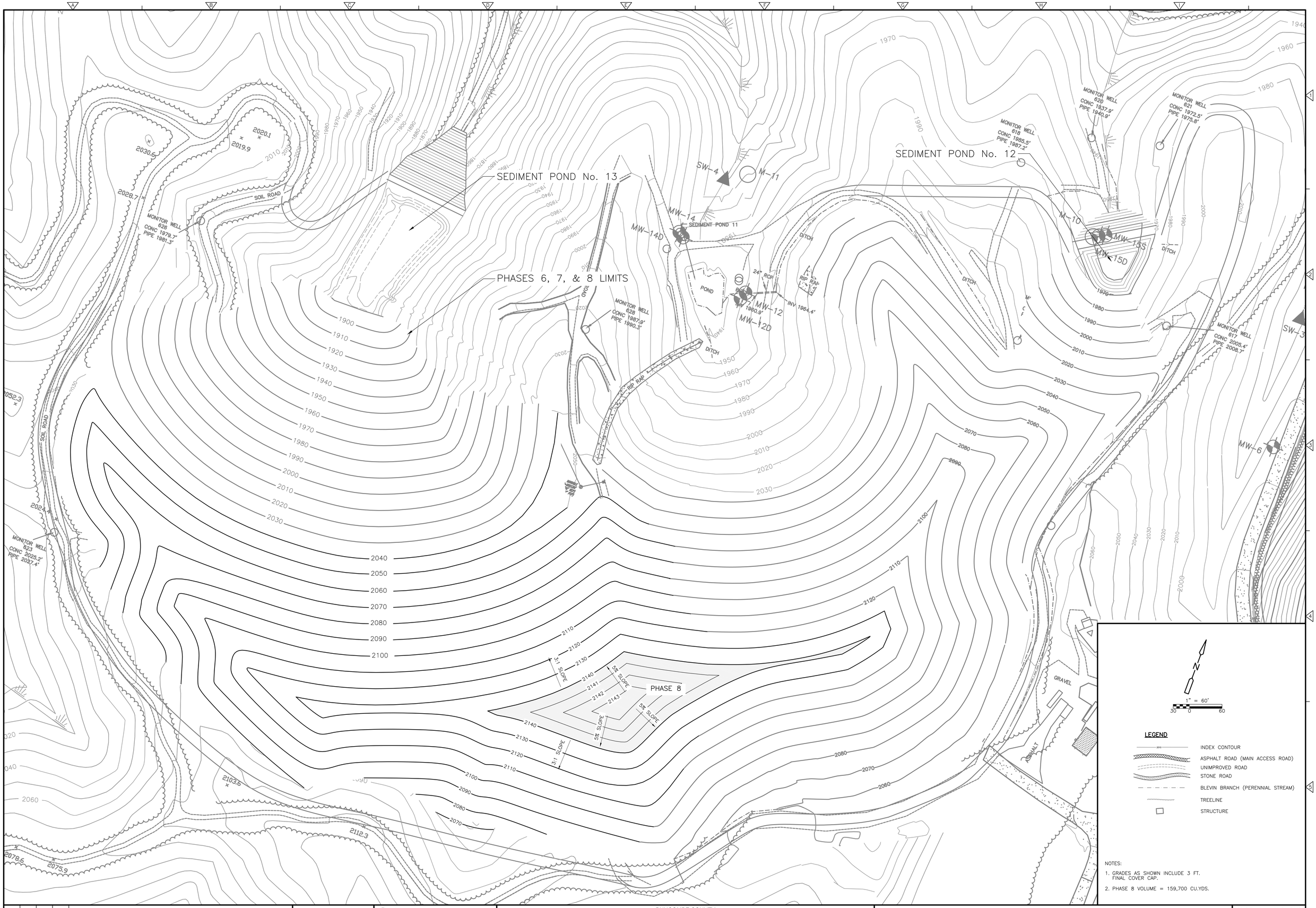

NOTES:

1. GRADES AS SHOWN INCLUDE 3 FT. FINAL COVER CAP.
2. PHASE 8 VOLUME = 159,700 CU.YDS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

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FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
C&D LANDFILL - PHASE 8 CLOSURE

PROJECT NO. 6447-97693
FILE NAME: LO-9.DWG
SHEET NO.
LO-9

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Facility Plan
Appendix 2B
C&D Landfill Facility Report

Buncombe County, North Carolina

Buncombe County Solid Waste Management Facility

C&D Landfill Expansion Part 3: Facility Plan

April 2009

Part 3: Facility Plan
Contents

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1.2 Landfill Operation 1-1

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Appendices

Appendix A Facility Plan Drawings
Appendix B Location Restrictions

Section 1
Facility Drawings

A set of facility drawings have been prepared in compliance with Rule .0537 (d). These drawings include conceptual site development and landfill operation sheets and are included in Appendix A.

1.1 Site Development

Three drawings were prepared on topographic maps representative of existing site conditions. The first drawing, Sheet SD-1, contains a topographical survey of the entire site representative of existing site conditions locating all property boundaries for the proposed landfill facility certified by an individual licensed to practice land surveying in the State of North Carolina. Also included is the following:

- areal limits of all solid waste management facilities and facility infrastructure, including landfill units and buffer requirements set forth in 15A NCAC 13B .0540(1);
- areal limits of borrow and stockpile; and
- any physical features referenced in Rule 15A NCAC 13B .0536 (Location Restrictions).

Sheet SD-2 illustrates the phases of development and areal limits of grading. Sheet SD-3 depicts the proposed final contours for the C&D landfill unit and facility feature for closure.

1.2 Landfill Operation

Landfill Operation Sheets 1-5 show the proposed transitional contours and construction grading for the new phases. Five drawings were prepared detailing the long-term operation of the C&D landfill unit. Proposed transitional contours and final grades for each phase of development (Phases 5 through 8) are shown on Drawings LO-1 through LO-5.

Section 2
Facility Report

This facility report contains characteristics of the waste stream to be received at the landfill facility and of the landfill capacity as required by Rule .0537(e).

2.1 Waste Stream

Per Rule .0537(e)(1), a discussion of the characteristics of the waste received at the facility and facility specific management plans is as follows.

2.1.1 Types of Waste Specified for Disposal

From the Permit to Operate – Asbestos Modification, dated March 5, 2008, the County is permitted to dispose of construction or demolition debris, inert debris, land-clearing debris, and asphalt in accordance with the corresponding General Statute. The C&D landfill is also permitted to dispose of asbestos waste in accordance with Rule .0542(c) and must be managed per 40 CFR 61.

Waste, listed in Rule .0542(e), may not be accepted for disposal including, but not limited to yard trash, municipal solid waste, and liquid or industrial wastes.

The County will continue to dispose of waste types as specified in the current Permit to Operate.

2.1.2 Disposal Rates

Table 2-1 presents yearly disposal rates as provided by the County scale house and includes a representative daily rate assuming 284 operating days (365 days - 52 Sundays - 26 Saturdays (half days) - 3 holidays). It is anticipated that the annual amount of waste to be disposed will be approximately 63,000 tons of C&D waste per year (222 tons per day).

Table 2-1 – Disposal Rates

FY[1]	Tons Disposed	Daily Rate (tons/day)
98-99	30,898	109
99-00	43,147	152
00-01	43,370	153
01-02	24,238	85
02-03	8,209	29
03-04	29,889	105
04-05	39,252	138
05-06	58,730	207
06-07	66,388	234
07-08	62,849	222

[1]Fiscal year is from July to June.

2.1.3 Areas Served by the Facility

The Buncombe County C&D landfill will serve only waste streams originating from Buncombe County. Buncombe County, approximately 659 square miles in area, includes the incorporated municipalities of Asheville, Biltmore Forest, Black Mountain, Montreat, Weaverville, and Woodfin.

2.1.4 Segregated Management

The Buncombe County Solid Waste Management Facility staff place a high priority on proper management of incoming waste. The same level of concern and effort is put forth for the operation of the C&D landfill. Waste screening and segregation procedures are included in the Operation Plan.

2.1.5 Landfill Equipment

Equipment currently owned by the County and utilized at the C&D landfill includes the following:

- 1 – 390-E Trashmaster
- 1 – D-6 CAT Dozer
- 1 – Waste Screening Vehicle (Ford F-150 Truck)

No additional equipment purchases are anticipated as a result of expanding the C&D disposal capacity.

2.2 Landfill Capacity

2.2.1 Gross Capacity

AutoCAD Civil 3D 2008 software was used to estimate the gross capacity between the base grades and the top of the proposed final cover grades for the proposed C&D landfill. The gross capacity (waste and daily, intermediate, and final cover) of the landfill is approximately 1.7 million cubic yards (cy).

2.2.2 Phased Gross Capacity

AutoCAD Civil 3D 2008 software was used to estimate the phased gross capacity and is presented in Table 2-2.

Table 2-2 – Phased Gross Capacity

Phase	Gross Capacity (cy)
5	285,500
6	607,700
7	612,600
8	159,700
Total	1,665,500

2.2.3 Soil Required for Landfill Construction

Soil is required for landfill construction to install access/haul roads, stormwater control measures, and, when necessary, to establish the required minimum four feet separation between the bottom elevation of waste and seasonal high groundwater table and the bedrock datum plane contours. For the Buncombe County C&D landfill, seasonal high groundwater table is below bedrock, so the bedrock contours govern the four feet separation when applicable.

2.2.4 Soil Required for Final Cover

The final cover material volume required to construct the three-foot thick cover system for each phase is determined by delineating final slopes (see Table 3-3).

Required Final Cover = Final Cover Area x 3-foot Thick Cover System

2.2.5 Soil Required for Operations

It is anticipated that the County will use an alternative cover material for the required weekly cover. An intermediate, stabilizing material will be used for areas which will not have additional wastes placed on them for three months or more, but where final termination of disposal operations has not occurred. When the County resumes disposal in these areas, they will scrap off the intermediate cover and use it for the final cover once areas are at final grades.

2.2.6 Net Capacity

Table 3-3 present the net capacity available for C&D debris disposal is calculated as:

Net Capacity = Gross Capacity – Final Cover

2.2.7 C&D Landfill Operating Life

The first step in calculating the operating life of each C&D landfill phase is to convert available net airspace to available C&D debris tonnage. From the July 2008 Airspace Analysis Report, the C&D in-place density is 0.65 tons per cubic yard (cy) (the calculated in-place density includes operational soils). Available tonnage is calculated as:

Available Tonnage = Net Capacity x 0.65 tons/ cy

The approximate average disposal rate for the C&D landfill for the past three fiscal years is 63,000 tons per year from Table 2-1. An average disposal rate of 63,000 tons per year is used in the following calculation. Table 2-3 presents the estimated operating life for the C&D disposal unit is, therefore, calculated as:

Operating Life = Available Tonnage/Average Disposal Rate

Table 2-3 – Operating Life

Phase	Final Cover Area (acre)	Soil Required for Final Cover (cy)	Available Net Airspace (cy)	Operating Life (yrs)
5	10.7	51,800	233,700	2.4
6	5.9	28,600	579,100	6.0
7	7.7	37,300	575,300	5.9
8	5.4	26,200	133,600	1.4
TOTAL			**1,521,700**	**16**

2.2.8 Net Balance of On-site Soils

Earthwork fill volume associated with the construction of each phase of the C&D landfill was estimated based on the proposed base grades and governing four feet of separation. A volume computation, using AutoCAD Civil 3D 2008, resulted in an even cut/fill soil balance for the construction of Phase 5. Phase 6 soil balance during construction was calculated to be a soil surplus of approximately 104,000 cy. Phases 7 and 8 are vertical expansions and will not require soil for construction. Table 2-4 presents the net soil required for construction and closure of each phase and was calculated by the following:

Fill + Final Cover = Net Soil Required

Table 2-4 – Net Soils Balance

Phase	Net Soil Required (yd^3)		
	Construction	Final Cover	TOTAL
5	0	51,800	51,800
6	-104,000	28,600	-75,400
7	0	37,300	37,300
8	0	26,200	26,200

Soil materials for construction of the landfill base and cap will be obtained from the on-site borrow areas as presented on Sheet SD-1. The current borrow source area is being exhausted and the County proposes to move into the proposed borrow source area as delineated on Sheet SD-1 on contingency of North Carolina Department of Environment and Natural Resources, Solid Waste Section (NCDENR SWS) approval. The proposed borrow source area has a potential soil volume of approximately 645,000 cy. Assuming a swell factor of 1.25 the loose soil volume is approximately 806,000 cy. Also, assuming the County using 300 cy of soil a day, working 284 days per year, the proposed borrow source life is approximately 9 to 10 years.

As stated, the proposed borrow source area will provide adequate soil for operations and final cover for the proposed C&D landfill expansion.

2.3 Special Engineering Features

2.3.1 Containment and Environmental Control Systems

2.3.1.1 Closure Cap System

A closure cap will be designed and constructed when portions of the C&D landfill are at closure grades to reduce the infiltration and erosion per Rule .0543 (c)(1). The cap system will be 3-foot thick and be designed and constructed to:

(A) have a permeability less than or equal to soils underlying the landfill, or the permeability specified for the final cover in the effective permit, or a permeability no greater than 1.0×10^{-5} cm/sec, whichever is less;

(B) minimize infiltration through the closed C&DLF unit by the use of a low-permeability barrier that contains a minimum 18 inches of earthen material; and

(C) minimize erosion of the cap system and protect the low-permeability barrier from root penetration by use of an erosion layer that contains a minimum of 18 inches of earthen material that is capable of sustaining native plant growth.

A gas venting or collection system will be installed below the low-permeability barrier to minimize pressures exerted on the barrier.

2.3.1.2 Sedimentation and Erosion Control

A Sedimentation and Erosion Control Plan will be submitted for approval to the NCDENR, Land Quality Section before construction of each phase. Internal stormwater berms will be utilized to minimize the amount of stormwater that comes in contact with waste. Temporary erosion control measures, such as silt fences, fast germinating vegetation, rock check dams, etc. will be installed as necessary to reduce the amount of sedimentation and erosion during construction activities.

2.3.1.3 Landfill Subgrade

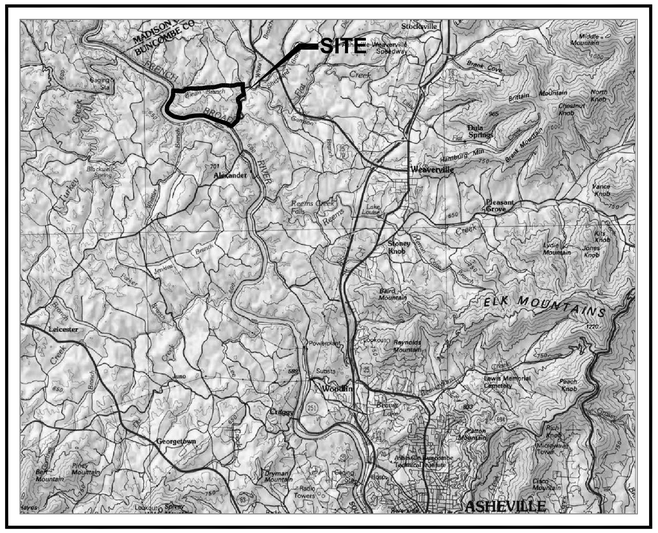
Per Rule .0540 (2), each proposed phase will be constructed so that the post-settlement bottom elevation of waste is a minimum of four feet above the seasonal high groundwater table as established in the Design Hydrogeological Report (see Part 5 of this report). Additionally, per Rule .0540 (2)(b), on-site soils will be used to construct the upper two feet of separation since they meet and/or exceed the required soil classifications.

Part 3
Facility Plan

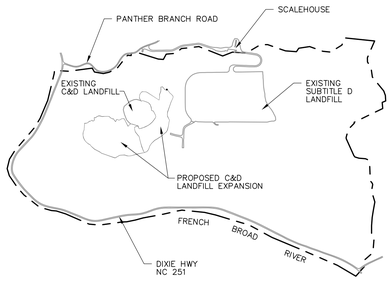
Appendix A
Facility Plan Drawings

BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY C&D LANDFILL
PERMIT DRAWINGS



LOCATION MAP



VICINITY MAP

VICINITY MAP
NOT TO SCALE

INDEX OF DRAWINGS

FACILITY PLAN DRAWINGS

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SD-2 SITE DEVELOPMENT C&D LANDFILL EXPANSION
SD-3 SITE DEVELOPMENT FINAL CLOSURE
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LO-2 LANDFILL OPERATION TRANSITION CONTOURS – PHASE 5 CLOSURE / PHASE 6 BASEGRADES
LO-3 LANDFILL OPERATION TRANSITION CONTOURS – PHASE 6 CLOSURE / PHASE 7 BASEGRADES
LO-4 LANDFILL OPERATION TRANSITION CONTOURS – PHASE 7 CLOSURE / PHASE 8 BASEGRADES
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OP-5 TRANSITION CONTOURS – FINAL CLOSURE

APRIL 2009

PREPARED BY

CDM Camp Dresser & McKee

consulting
engineering
construction
operations

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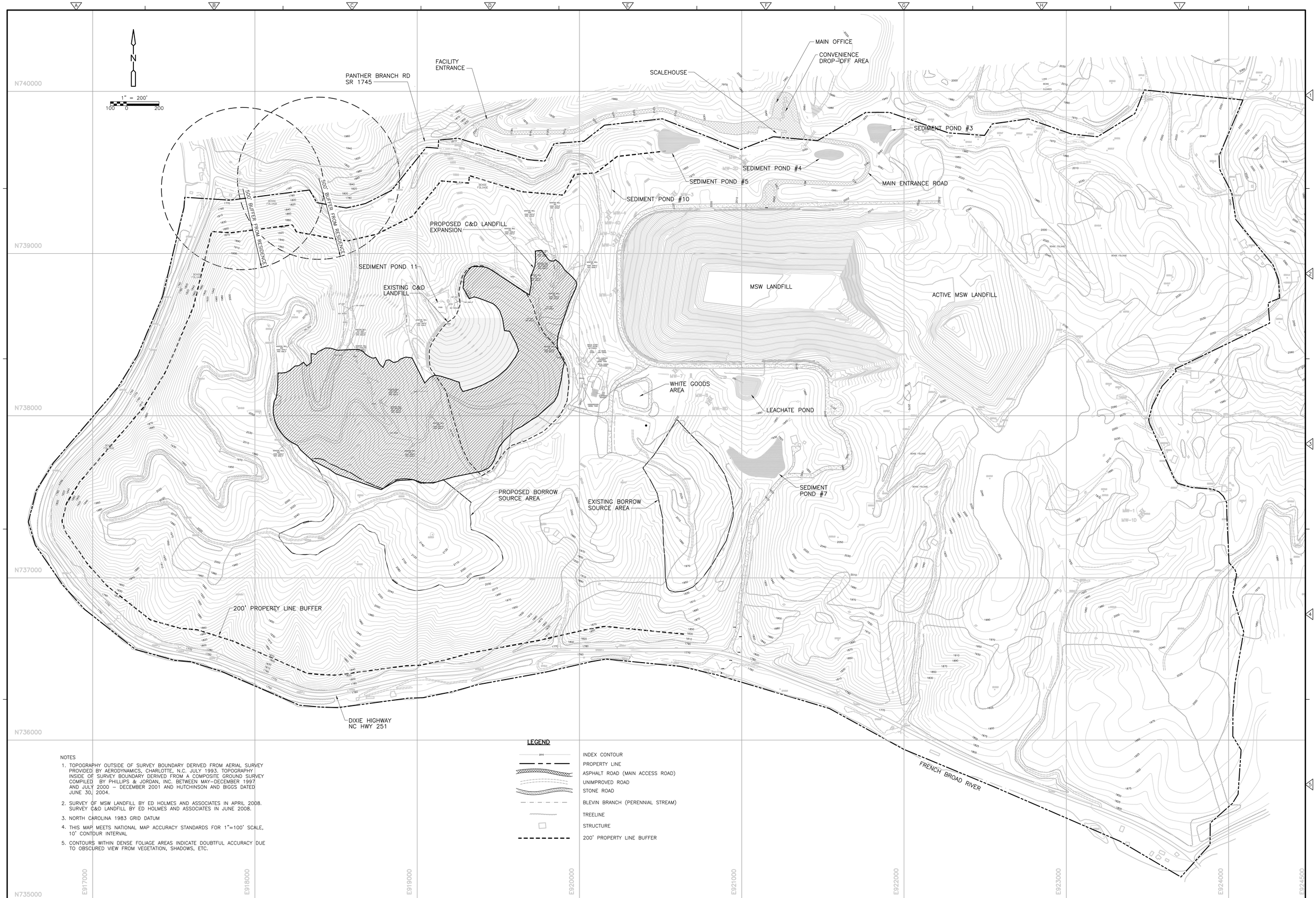
Raleigh, North Carolina 27612
Tel: 919-787-5620 Fax: 919-781-5730

6447-65973



NOTES

1. TOPOGRAPHY OUTSIDE OF SURVEY BOUNDARY DERIVED FROM AERIAL SURVEY PROVIDED BY AERODYNAMICS, CHARLOTTE, N.C. JULY 1993. TOPOGRAPHY INSIDE OF SURVEY BOUNDARY DERIVED FROM A COMPOSITE GROUND SURVEY COMPILED BY PHILLIPS & JORDAN, INC. BETWEEN MAY–DECEMBER 1997 AND JULY 2000 – DECEMBER 2001 AND HUTCHINSON AND BIGGS DATED JUNE 30, 2004.
2. SURVEY OF MSW LANDFILL BY ED HOLMES AND ASSOCIATES IN APRIL 2008. SURVEY C&D LANDFILL BY ED HOLMES AND ASSOCIATES IN JUNE 2008.
3. NORTH CAROLINA 1983 GRID DATUM
4. THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS FOR 1"=100' SCALE, 10' CONTOUR INTERVAL
5. CONTOURS WITHIN DENSE FOLIAGE AREAS INDICATE DOUBTFUL ACCURACY DUE TO OBSCURED VIEW FROM VEGETATION, SHADOWS, ETC.

LEGEND

- INDEX CONTOUR
- PROPERTY LINE
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE
- 200' PROPERTY LINE BUFFER

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2009

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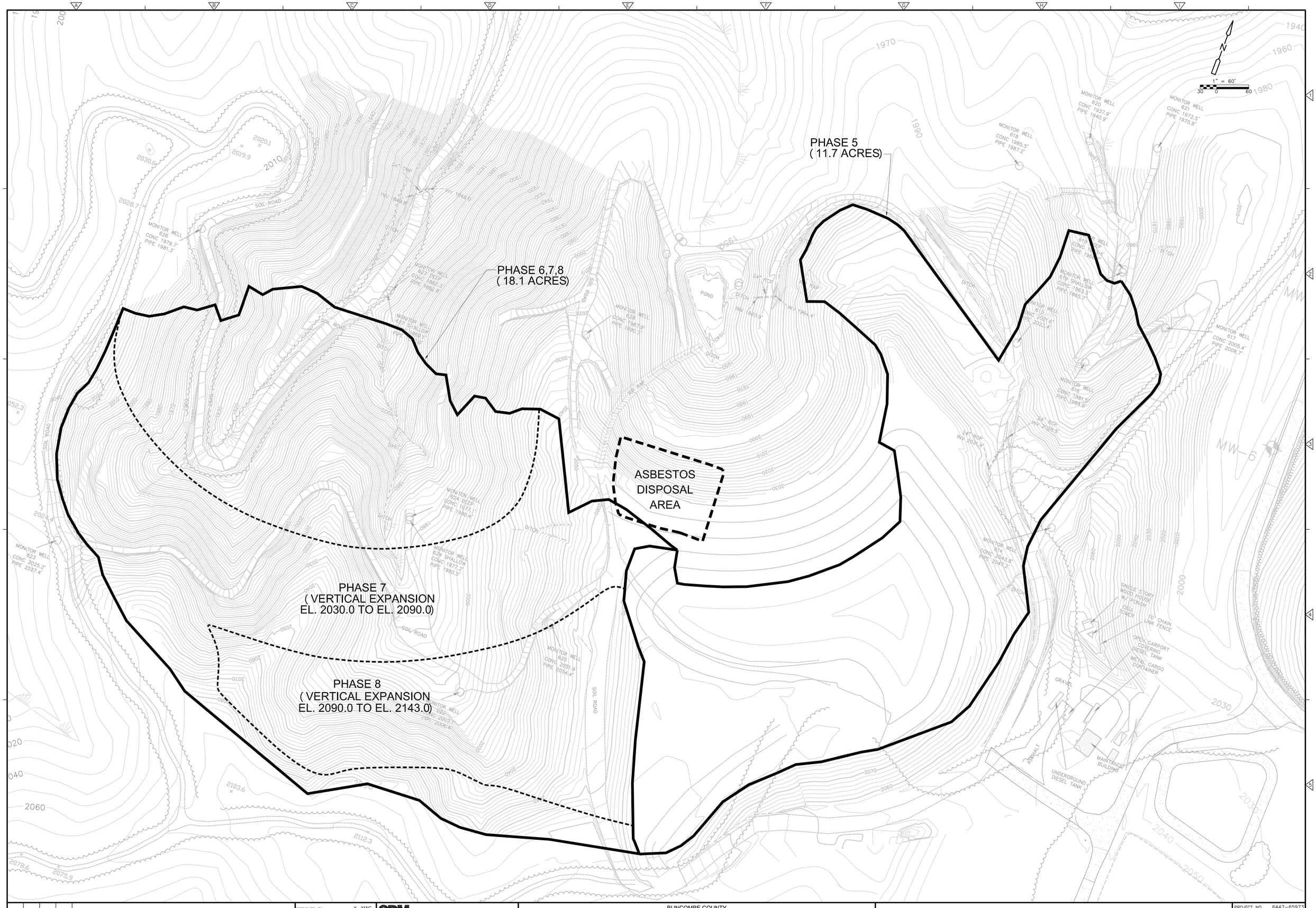
BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY C&D LANDFILL
FACILITY PLAN

SITE DEVELOPMENT
EXISTING CONDITIONS

PROJECT NO. 6447-65973
FILE NAME: SD-1.DWG
SHEET NO.
SD-1

NOT FOR CONSTRUCTION



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BUNCOMBE COUNTY
NORTH CAROLINA

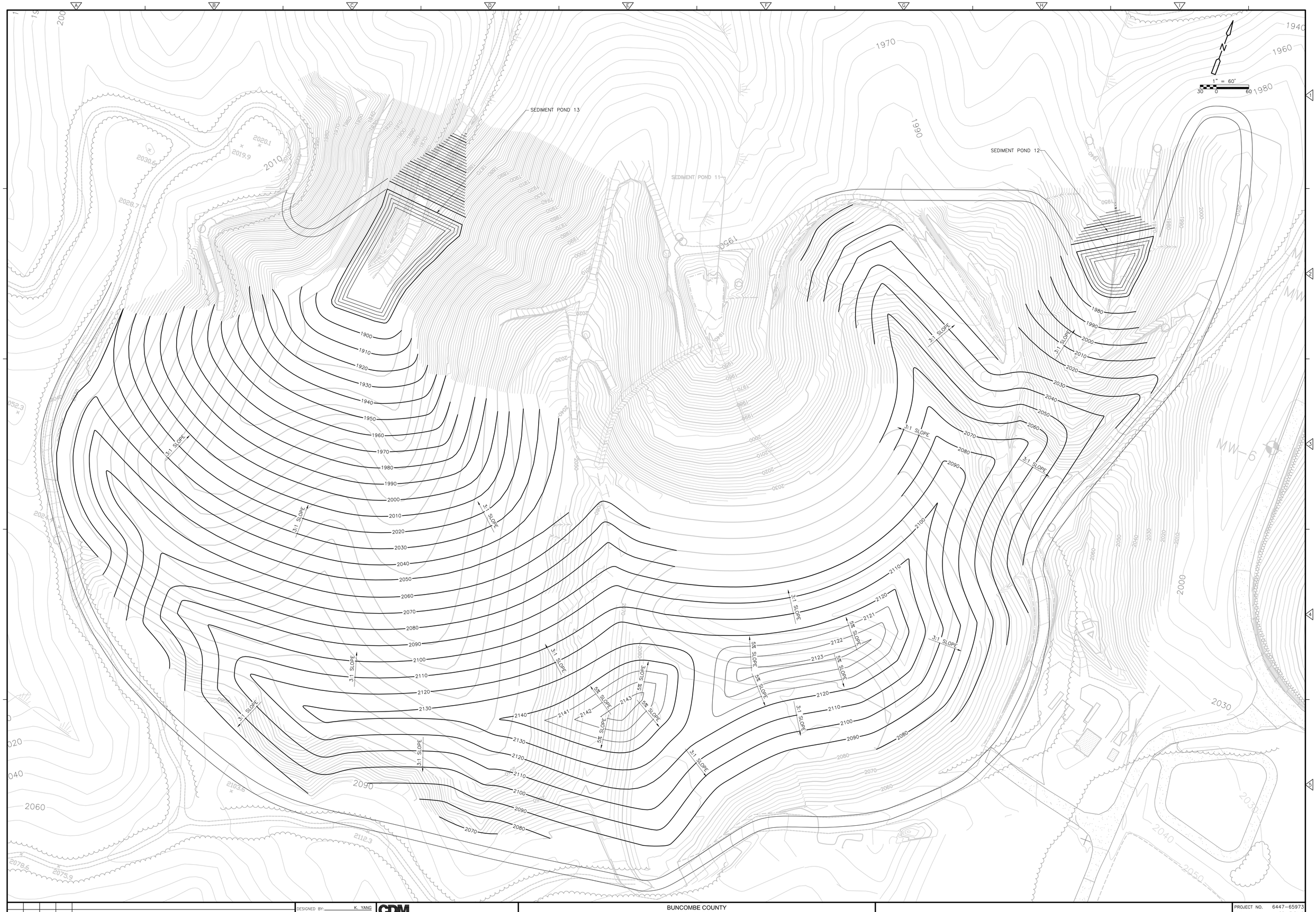
BUNCOMBE COUNTY C&D LANDFILL
FACILITY PLAN

SITE DEVELOPMENT
C&D LANDFILL EXPANSION

PROJECT NO. 6447-65973
FILE NAME: SD-2.DWG

SHEET NO.
SD-2

NOT FOR CONSTRUCTION



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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY C&D LANDFILL
FACILITY PLAN

SITE DEVELOPMENT
FINAL CLOSURE

PROJECT NO. 6447-65973
FILE NAME: SD-3.DWG
SHEET NO.
SD-3

NOT FOR CONSTRUCTION

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
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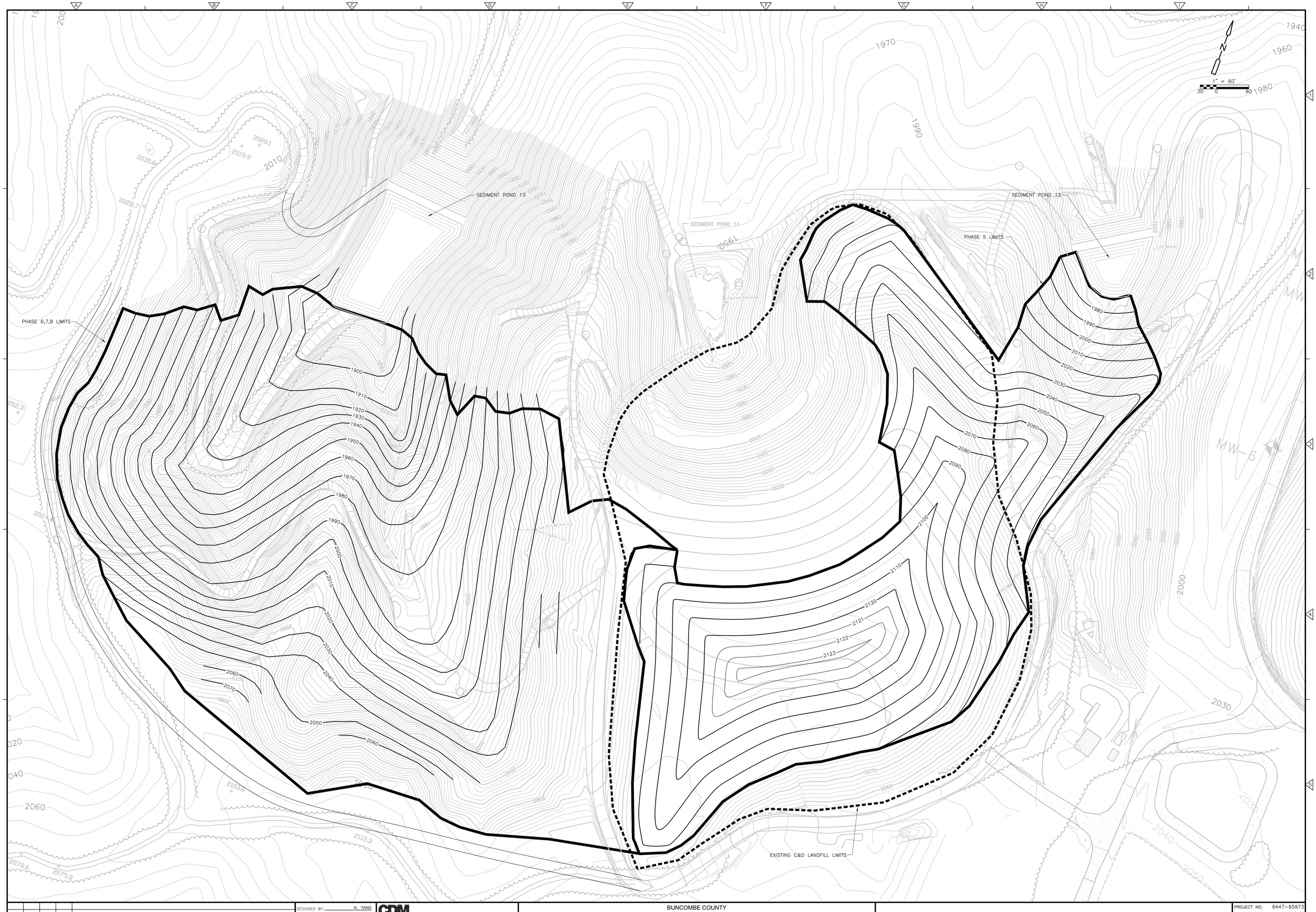
BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY C&D LANDFILL
FACILITY PLAN

LANDFILL OPERATION
TRANSITION CONTOURS - PHASE 5 BASEGRADES

PROJECT NO. 6447-65973
FILE NAME: LO-1.DWG
SHEET NO.
LO-1

NOT FOR CONSTRUCTION



REV. NO.	DATE	DRWN	CHKD	REMARKS

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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY C&D LANDFILL
FACILITY PLAN

LANDFILL OPERATION
TRANSITION CONTOURS - PHASE 5 CLOSURE / PHASE 6 BASEGRADES

PROJECT NO. 6447-65973
FILE NAME: LO-2.DWG
SHEET NO.
LO-2

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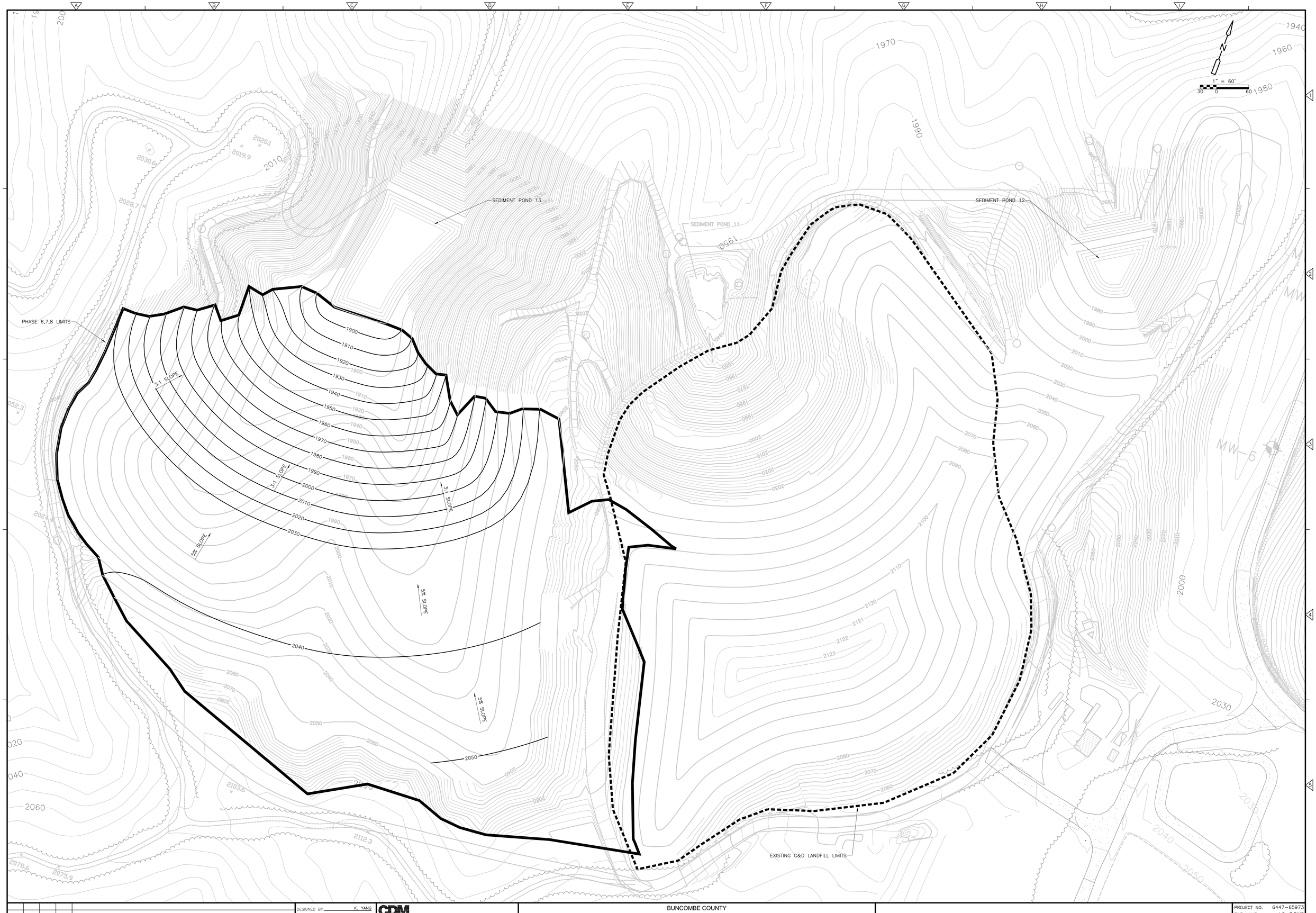

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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY C&D LANDFILL
FACILITY PLAN

LANDFILL OPERATION
TRANSITION CONTOURS - PHASE 6 CLOSURE / PHASE 7 BASEGRADES

PROJECT NO. 6447-65973
FILE NAME: LO-3.DWG
SHEET NO.
LO-3

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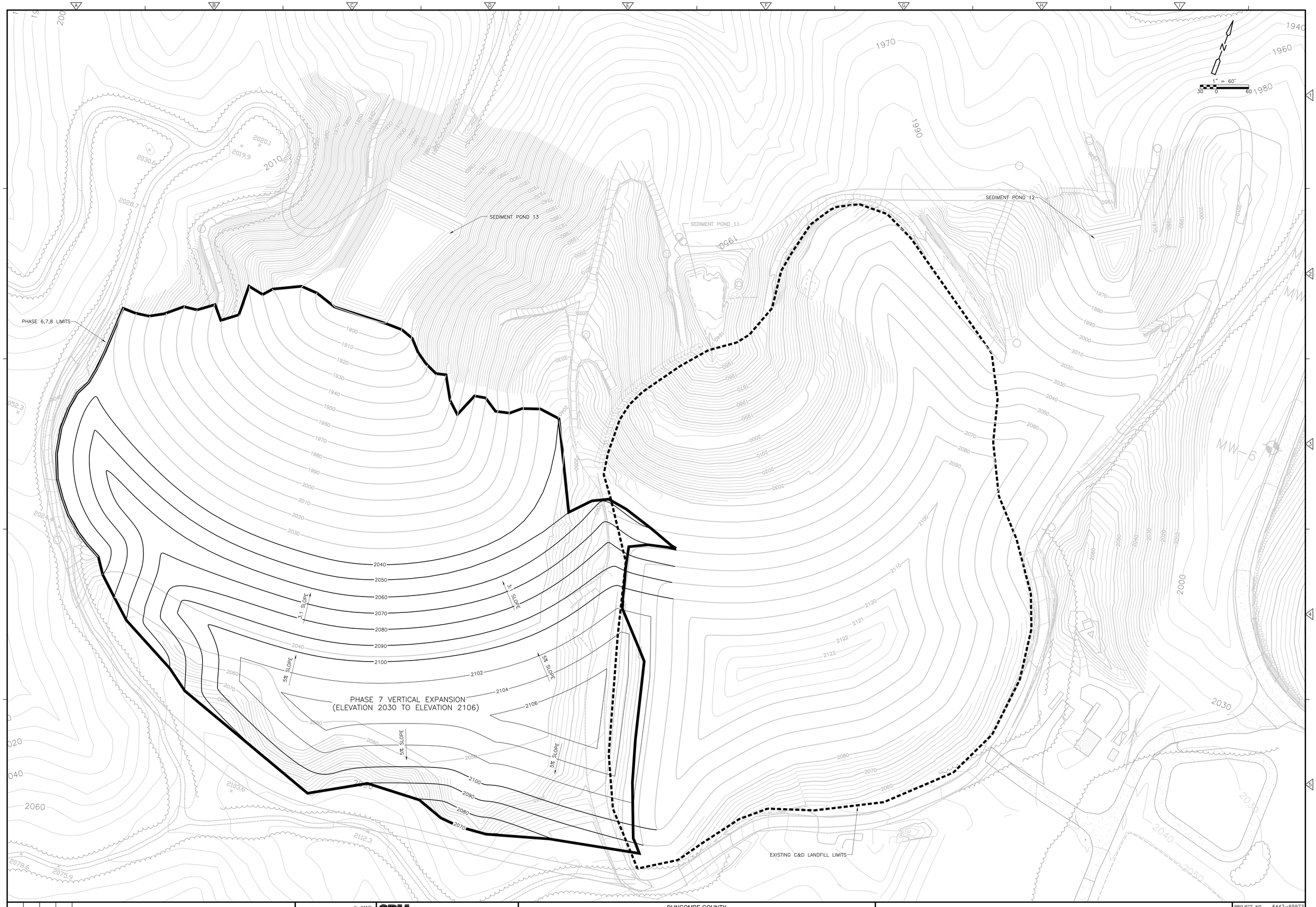

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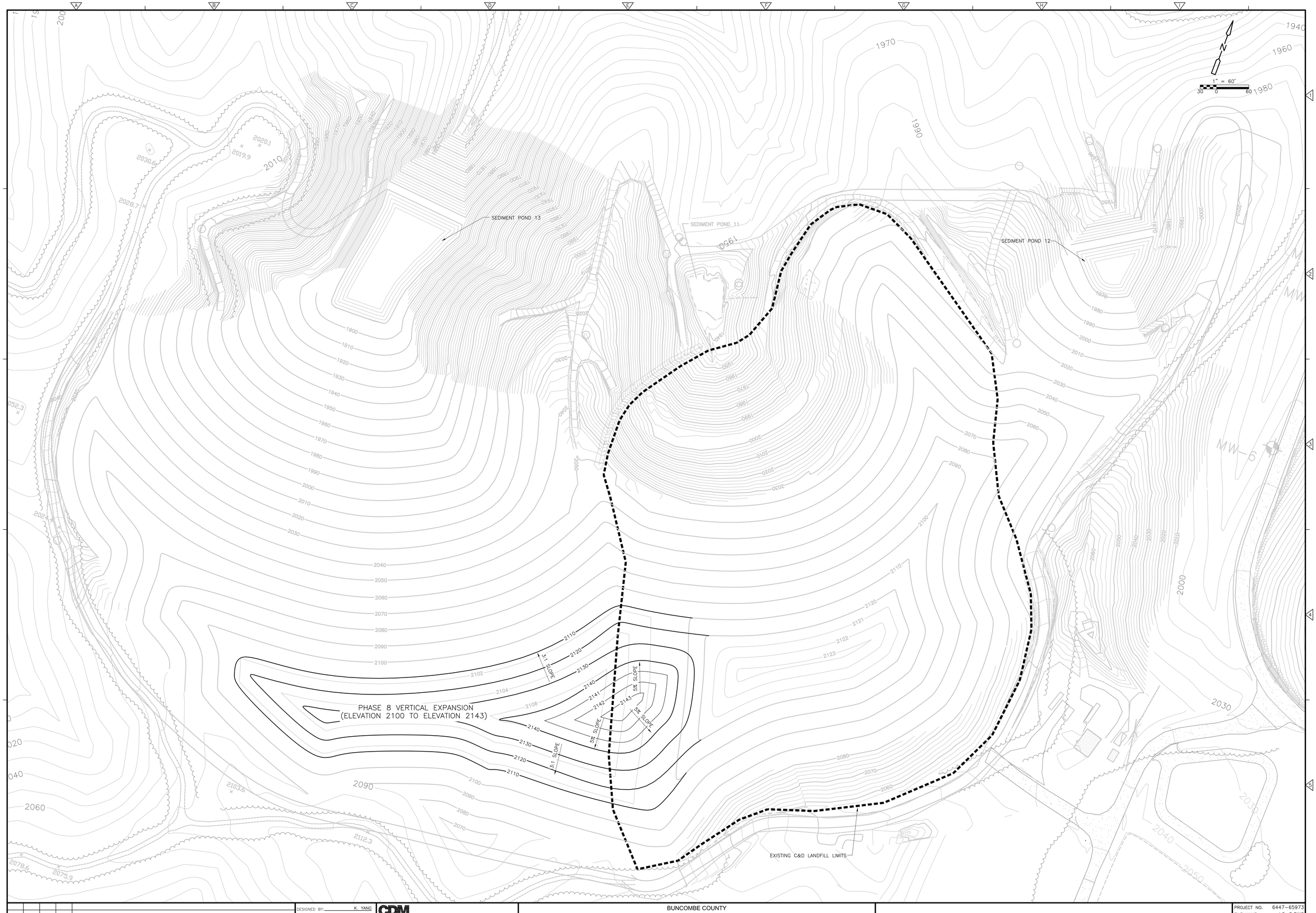
BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY C&D LANDFILL
FACILITY PLAN

LANDFILL OPERATION
TRANSITION CONTOURS - PHASE 7 CLOSURE / PHASE 8 BASEGRADES

PROJECT NO. 6447-65973
FILE NAME: LO-4.DWG
SHEET NO.
LO-4

NOT FOR CONSTRUCTION



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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY C&D LANDFILL
FACILITY PLAN

LANDFILL OPERATION
TRANSITION CONTOURS - PHASE 8 CLOSURE

PROJECT NO. 6447-65973
FILE NAME: LO-5.DWG
SHEET NO.
LO-5

NOT FOR CONSTRUCTION

Part 3
Facility Plan

Appendix B
Location Restrictions

Appendix B – Location Restrictions
Facility Plan – C&D Landfill
Contents

Section 1 – Location Restrictions

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1.3.2 Compliance Issues 1-3
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1.5 State Nature and Historic Preserves 1-4
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1.7 Endangered and Threatened Species 1-5

Attachments

Attachment A – Floodplain Map
Attachment B – PCN Form and Nationwide Permitting Approval Letters
Attachment C – State Historic Preservation Office/
Department of Cultural Resources Correspondence
Attachment D – Natural Heritage Program Correspondence
Attachment E – US Fish and Wildlife Service Correspondence

Section 1
Location Restrictions

Rule .0539 (d)(1)(D) of the North Carolina Solid Waste Management Rules requires that a report be prepared and submitted demonstrating compliance with the location restriction criteria in Rule .0536. Rule .0536 requires documentation or approvals by agencies other than the Division of Waste Management, Solid Waste Section that demonstrate compliance with specific location criteria. It is the intent of this section to provide location restriction demonstration for the C&D landfill facility plan. The location restrictions include:

- Floodplains;
- Wetlands;
- Unstable areas;
- Cultural resources;
- State nature and historic preserve;
- Water supply watersheds; and
- Endangered and threatened species.

CDM has reviewed available information pertaining to location restriction criteria relative to the proposed Buncombe County C&D landfill expansion. The following sections summarize the findings.

1.1 Floodplains

Rule .0536(c)(4), floodplain location restrictions, states:

(A) C&DLF units or constructed embankments used to construct a C&DLF unit must not be located in a 100-year floodplain unless a variance for the facility has been issued in accordance with N.C.G.S. 143-215.54A.

(B) C&DLF units must not be located in floodplains unless the owners or operators demonstrate that the unit will not restrict the flow of the flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human health and the environment.

Based on floodplain maps for the Buncombe County area, no portion of the Buncombe County property resides in the 100-year floodplain (see Attachment A). Areas around the French Broad River and Flat Creek are denoted as AE; area inundated by 100-year flooding, before flood elevation have been determined.

1.2 Wetlands

1.2.1 Regulatory Background

Rule .0536 (c)(5) requires that new C&DLF units or lateral expansions must not be located in wetlands, unless the owner or operator can make the following demonstrations to the Division:

(A) Where applicable under Section 404 of the Clean Water Act or applicable State wetlands laws, the presumption that a practicable alternative to the proposed landfill facility is available which does not involve wetlands is clearly rebutted.

(B) The construction and operation of the C&DLF unit(s) will not cause or contribute to violations of any applicable State water quality standards and will not violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act.

(C) The construction and operation of the C&DLF unit(s) will not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973. The construction and operation of the C&DLF unit(s) will not violate any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.

(D) The construction and operation of the C&DLF unit(s) will not cause or contribute to significant degradation of wetlands.

(E) The owner or operator must demonstrate the integrity of the C&DLF unit(s) and its ability to protect ecological resources by addressing the following factors: (1) erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the C&DLF unit; (2) erosion, stability, and migration potential of dredged and fill materials used to support the C&DLF unit; the volume and chemical nature of the waste managed in the C&DLF unit; (3) impacts on fish, wildlife, and other aquatic resources and their habitat from release of the solid waste; (4) the potential effects of catastrophic release of waste to the wetland and the resulting impacts on the environment; and (5) any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected to the extent required under Section 404 of the Clean Water Act or applicable State wetlands laws.

(F) The owner or operator must demonstrate that 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 Part (c)(5)(A) – (D) 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).

(G) The owner or operator must also demonstrate that sufficient information is available to make a reasonable determination with respect to each of the demonstrations required by this Rule.

1.2.2 Compliance Issues

CDM and the US Army Corps of Engineers (USACE) conducted a site visit on October 28, 2008 to determine if drainage features located north of each expansion site were jurisdictional, as subject to regulations under the Clean Water Act. Jurisdictional waters were determined and the County prepared and submitted a Preconstruction Notification (PCN), which served as a joint application for a Section 404 Permit from USACE and a 401 Water Quality Certification from the North Carolina Division of Water Quality (NCDWQ). Included as Attachment B are the PCN form and the approval letters.

1.3 Unstable Areas

1.3.1 Regulatory Background

Rule .0536 (c)(6) states that owners and operators of new C&DLF unit(s) and lateral expansions proposed for location in an unstable area must demonstrate that engineering measures have been incorporated in the C&DLF unit's design to ensure that the integrity of any structural components of the C&DLF unit will not be disrupted. The owner and operator must consider the following factors, at a minimum, when determining whether an area is unstable:

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

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

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

1.3.2 Compliance Issues

Based on the site and design hydrogeological and geotechnical investigation completed for this report and previously approved reports, the geological and soil conditions that are presumed to be throughout the site are not prone to unstable conditions.

1.4 Cultural Resources

Rule .0536 (c)(7) states that a new C&DLF unit or lateral expansion must not damage or destroy a property of archaeological or historical significance which has been listed or determined eligible for a listing in the National Register of Historic Places.

Correspondence with the State Historic Preservation Office in the Department of Cultural Resources is included in Attachment C.

Based on the correspondence, there is no documentation that significant cultural resources exist within or in the vicinity of the site. No cultural resources are expected to be adversely affected by the C&D landfill development.

1.5 State Nature and Historic Preserves

Rule .0536 (c)(8) states that a new C&DLF unit or lateral expansion must not have an adverse impact, considering the purposes for designation of the Preserve lands and the location, access, size and operation of the landfill, on any lands included in the State Nature and Historic Preserve.

The NC Natural Heritage Program (NHP) was contacted to determine if any state natural preserves exist within or in the vicinity of the proposed C&D landfill expansion (see Attachment D). Based on the NHP correspondence, no state nature or historical preserves would be impacted by development within the facility boundary.

1.6 Water Supply Watersheds

Rule .0536 (c)(9)(A) states that a new C&DLF unit or lateral expansion must not be located in the critical area of a water supply watershed, or in the watershed for a stream segment classified as WS-I, or in watersheds of other water bodies which indicate that no new landfills are allowed in accordance with the rules codified at 15A NCAC 02B Section .0200 entitled "Classifications and Water Quality Standards Applicable To Surface Waters Of North Carolina."

The State has classified all surface waters and watersheds throughout the state as required by 15A NCAC 2B .0311 as referenced by Rule 2B .0200. These classifications are made available by NCDENR Division of Water Quality.

Based on the classification list and NC OneMap program data and on-line map (used on April 2009) from NCDENR, CGIA, the proposed site is not located in an area that will impact or discharge to a WS-1, WS-II, WS-III, or WS-IV watershed. Therefore, the proposed location is in compliance with Water Supply Watershed rules.

Rule .0536 (c)(9)(B) states that any new C&DLF unit or lateral expansion, which proposes to discharge leachate to surface waters 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, must not be located within watersheds classified as WS-II or WS-III, or in watersheds of other

water bodies which indicate that no new discharging landfills are allowed, in accordance with the rules codified at 15A NCAC 02B Section .0200.

The C&D landfill facility is not located within any of these classified watersheds and will not discharge leachate into any surface water locations and therefore is not expected to apply for a NPDES permit.

1.7 Endangered and Threatened Species

Rule .0536 (c)(10) states that a new C&DLF unit or lateral expansion must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973.

CDM contacted US Fish and Wildlife Service (US FWS) office to determine whether there was any documentation that endangered or threatened species existed within the site or its vicinity. Correspondence with the US FWS is included in Attachment E.

Based on the US FWS, there are no federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Endangered Species Act within the proposed facility boundary.

Part 3 - Facility Plan
Appendix B – Location Restrictions

Attachment A
Floodplain Map

Legend

	100 Year Flood		Proposed C + D Landfill Expansion
	500 Year Flood		Proposed C + D Landfill Expansion
			Landfill Property Boundary

Attachment A - Floodplain Map
Buncome County Solid
Waste Management Facility

CDM

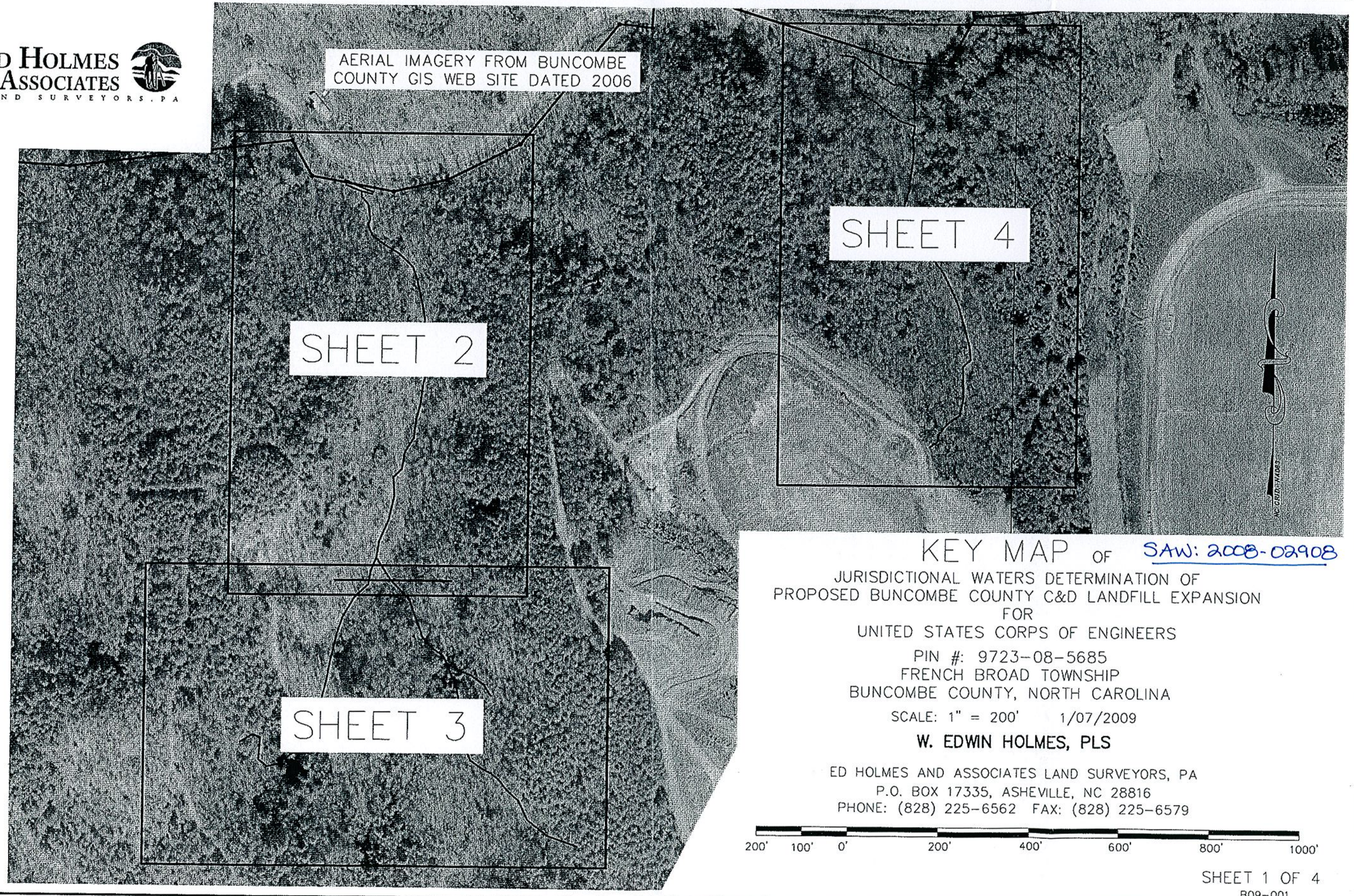
Part 3 - Facility Plan
Appendix B – Location Restrictions

Attachment B
PCN Form and Nationwide Permitting
Approval Letters

Part 3 - Facility Plan
Appendix B – Location Restrictions

Attachment B1
USACE Jurisdictional Determination

ED HOLMES & ASSOCIATES
LAND SURVEYORS, PA



KEY MAP OF

SAW: 2008-02908

JURISDICTIONAL WATERS DETERMINATION OF
PROPOSED BUNCOMBE COUNTY C&D LANDFILL EXPANSION
FOR
UNITED STATES CORPS OF ENGINEERS

PIN #: 9723-08-5685
FRENCH BROAD TOWNSHIP
BUNCOMBE COUNTY, NORTH CAROLINA

SCALE: 1" = 200' 1/07/2009

W. EDWIN HOLMES, PLS

ED HOLMES AND ASSOCIATES LAND SURVEYORS, PA
P.O. BOX 17335, ASHEVILLE, NC 28816
PHONE: (828) 225-6562 FAX: (828) 225-6579

200' 100' 0' 200' 400' 600' 800' 1000'

SHEET 1 OF 4
B09-001

N:\USERS\JOEKANE\DWGS\LANDFILL\STREAMLOCATION.dwg

ED HOLMES & ASSOCIATES
LAND SURVEYORS, PA

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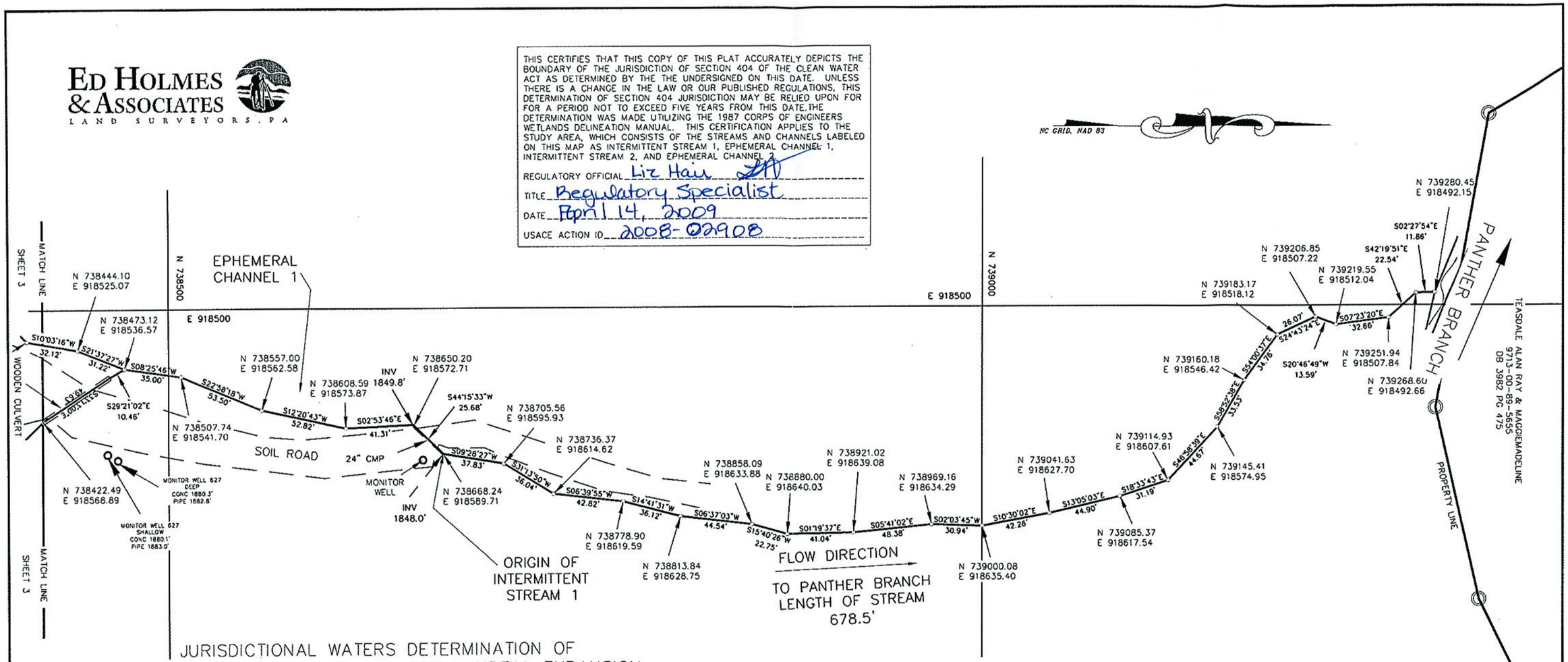
REGULATORY OFFICIAL Liz Hair
TITLE Regulatory Specialist
DATE April 14, 2009
USACE ACTION ID 2008-02908



JURISDICTIONAL WATERS DETERMINATION OF
PROPOSED BUNCOMBE COUNTY C&D LANDFILL EXPANSION
FOR
THE UNITED STATES CORPS OF ENGINEERS

PIN #: 9723-08-5685
FRENCH BROAD TOWNSHIP
BUNCOMBE COUNTY, NORTH CAROLINA
SCALE: 1" = 60' 1/07/2009

W. EDWIN HOLMES, PLS

ED HOLMES AND ASSOCIATES LAND SURVEYORS, PA
P.O. BOX 17335, ASHEVILLE, NC 28816
PHONE: (828) 225-6562 FAX: (828) 225-6579

60' 30' 0' 60' 120' 180' 240' 300'

I, W. EDWIN HOLMES, N.C. P.L.S., CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION (PROPERTY DESCRIPTION RECORDED IN DEED BOOKS AS SHOWN); THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED BY DASHED LINES AS DRAWN FROM INFORMATION FOUND IN DEED BOOKS AS SHOWN; THAT THE RATIO OF PRECISION AS CALCULATED IS 1:10,000 OR GREATER.

WITNESS MY SIGNATURE, LICENSE NUMBER, AND SEAL THIS 13TH DAY OF FEB, A.D., 2009.

N.C. PROFESSIONAL LAND SURVEYOR

L-2755
LICENSE #

NORTH CAROLINA PROFESSIONAL SEAL L-2755 LAND SURVEYOR W. EDWIN HOLMES

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JURISDICTIONAL WATERS DETERMINATION OF PROPOSED BUNCOMBE COUNTY C&D LANDFILL EXPANSION FOR THE UNITED STATES CORPS OF ENGINEERS

PIN#: 9723-08-5685
FRENCH BROAD TOWNSHIP
BUNCOMBE COUNTY, NORTH CAROLINA

SCALE: 1" = 60' 1/07/2009

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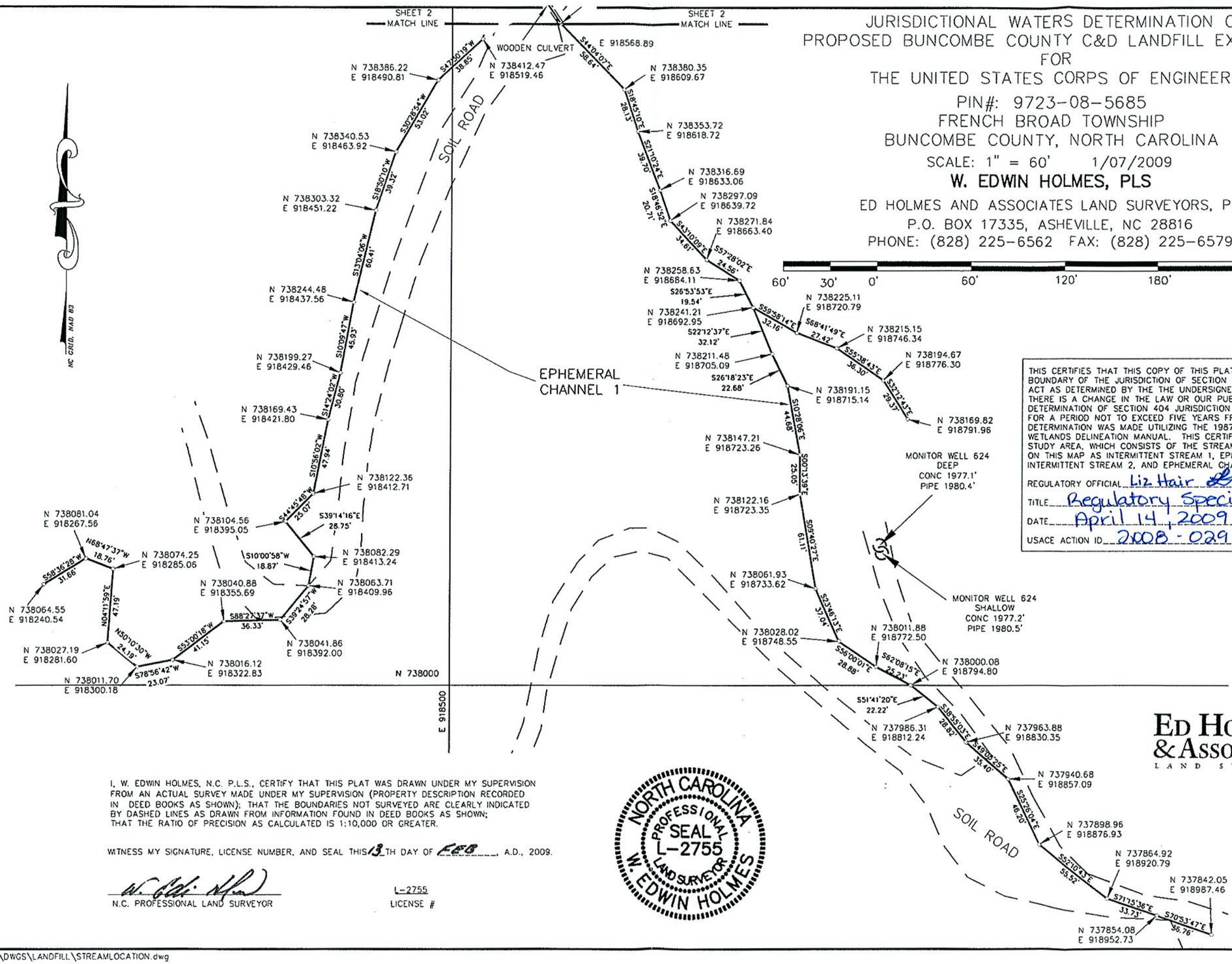

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REGULATORY OFFICIAL Liz Hair
TITLE Regulatory Specialist
DATE April 14, 2009
USACE ACTION ID 2008-02908

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ED HOLMES & ASSOCIATES LAND SURVEYORS, PA

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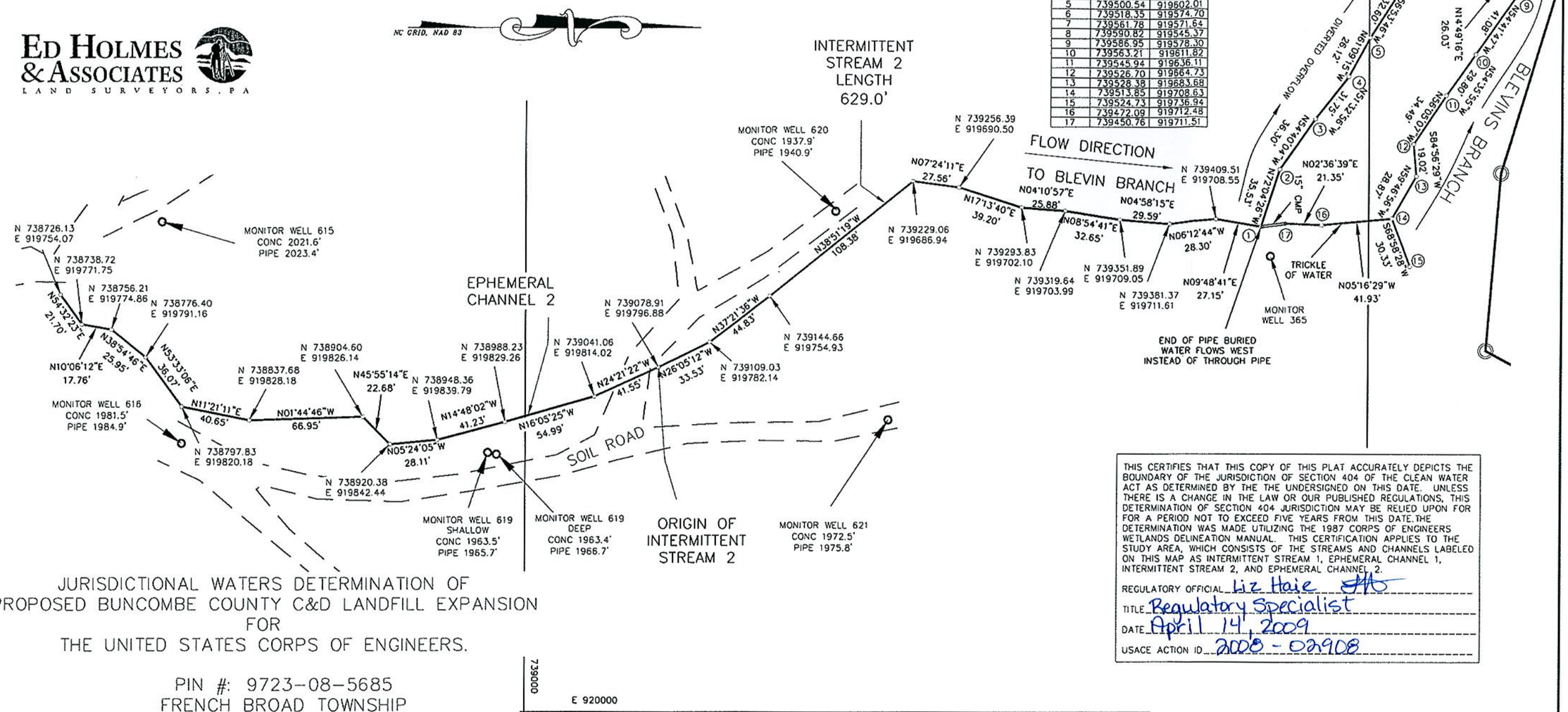
ED HOLMES & ASSOCIATES
LAND SURVEYORS, PA

NC GRID, NAD 83

POINT	NORTHING	EASTING
1	739436.27	919713.18
2	739447.20	919679.37
3	739468.19	919649.76
4	739487.94	919624.89
5	739500.54	919602.01
6	739518.35	919574.70
7	739561.78	919571.64
8	739590.82	919545.37
9	739586.95	919578.30
10	739563.21	919611.82
11	739545.94	919636.11
12	739526.70	919664.73
13	739528.38	919683.68
14	739513.85	919708.63
15	739524.73	919736.94
16	739472.09	919712.48
17	739450.76	919711.51



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REGULATORY OFFICIAL Liz Haie
TITLE Regulatory Specialist
DATE April 14, 2009
USACE ACTION ID 2008-02908

JURISDICTIONAL WATERS DETERMINATION OF PROPOSED BUNCOMBE COUNTY C&D LANDFILL EXPANSION FOR THE UNITED STATES CORPS OF ENGINEERS.

PIN #: 9723-08-5685
FRENCH BROAD TOWNSHIP
BUNCOMBE COUNTY, NORTH CAROLINA

SCALE: 1" = 60' 1/07/2009

W. EDWIN HOLMES, PLS

ED HOLMES AND ASSOCIATES LAND SURVEYORS, PA
P.O. BOX 17335, ASHEVILLE, NC 28816
PHONE: (828) 225-6562 FAX: (828) 225-6579

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WITNESS MY SIGNATURE, LICENSE NUMBER, AND SEAL THIS 13TH DAY OF FEB, A.D., 2009.

W. Edwin Holmes
N.C. PROFESSIONAL LAND SURVEYOR

L-2755
LICENSE #

NORTH CAROLINA PROFESSIONAL SEAL L-2755 LAND SURVEYOR W. EDWIN HOLMES

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Part 3 - Facility Plan
Appendix B – Location Restrictions

Attachment B2
PCN Form

CDM
5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919 787-5620
fax: 919 781-5730

March 9, 2009

Mountain Region Coordinator
20830 Great Smoky Mountain Expressway
Waynesville, North Carolina 28786

Subject: Buncombe County Solid Waste Management Facility
C&D Landfill Expansion
Preconstruction Notification

To Whom it May Concern:

Buncombe County proposes to expand the existing construction and demolition (C&D) landfill at the Buncombe County Solid Waste Management Facility. The project includes an additional 15 years of landfill capacity. The project has been designed to avoid jurisdictional waters where possible and minimize impacts where they are unavoidable. Total impacts will be less than 150 feet of stream (see Figures No. 1 and 2 and Sheets 1 through 4).

Enclosed please find one (1) copy of a Preconstruction Notification (PCN) form for the project with supporting documentation. Please call me at (919) 325-3574 if you have questions. Thank you for your assistance.

Very truly yours,

Kenton J. Yang, P.E.
Camp Dresser & McKee

Enclosure: Preconstruction Notification Form with Attachments A through F (one copy)

cc: J. Creighton/J. Mears/K. Smith, BCSWMF
J. Wiseman/K. Boone, CDM

CDM
5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919 787-5620
fax: 919 781-5730

March 9, 2009

Ms. Liz Hair
US Army Corps of Engineers
Asheville Regulatory Field Office
151 Patton Avenue
Room 208
Asheville, North Carolina 28801-5006

Subject: Buncombe County Solid Waste Management Facility
C&D Landfill Expansion
Preconstruction Notification

Dear Ms. Hair:

Buncombe County proposes to expand the existing construction and demolition (C&D) landfill at the Buncombe County Solid Waste Management Facility. The project includes an additional 15 years of landfill capacity. The project has been designed to avoid jurisdictional waters where possible and minimize impacts where they are unavoidable. Total impacts will be less than 150 feet of stream (see Figures No. 1 and 2 and Sheets 1 through 4). CDM provided you with Sheets 1 through 4 of the stream delineation and requested a certifying signature on February 16, 2009.

Enclosed please find one (1) copy of a Preconstruction Notification (PCN) form for the project with supporting documentation. Please call me at (919) 325-3574 if you have questions. Thank you for your assistance.

Very truly yours,

Kenton J. Yang, P.E.
Camp Dresser & McKee

Enclosure: Preconstruction Notification Form with Attachments A through F (one copy)

cc: J. Creighton/J. Mears/K. Smith, BCSWMF
J. Wiseman/K. Boone, CDM

CDM
5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919 787-5620
fax: 919 781-5730

March 9, 2009

Ms. Cyndi Karoly
North Carolina Division of Water Quality
401 Unit
2321 Crabtree Boulevard
Raleigh, North Carolina 27604

Subject: Buncombe County Solid Waste Management Facility
C&D Landfill Expansion
Preconstruction Notification

Dear Ms. Karoly:

Buncombe County proposes to expand the existing construction and demolition (C&D) landfill at the Buncombe County Solid Waste Management Facility. The project includes an additional 15 years of landfill capacity. The project has been designed to avoid jurisdictional waters where possible and minimize impacts where they are unavoidable. Total impacts will be less than 150 feet of stream (see Figures No. 1 and 2 and Sheets 1 through 4).

Enclosed please find five (5) copies of a Preconstruction Notification (PCN) form for the project with supporting documentation. A check for $240 is also enclosed. Please call me at (919) 325-3574 if you have questions. Thank you for your assistance.

Very truly yours,

Kenton J. Yang, P.E.
Camp Dresser & McKee

Enclosure: Preconstruction Notification Form with Attachments A through F (five copies)
Check for permit fee

cc: J. Creighton/J. Mears/K. Smith, BCSWMF
J. Wiseman/K. Boone, CDM

Office Use Only:
Corps action ID no. _____
DWQ project no. _____
Form Version 1.3 Dec 10 2008

Pre-Construction Notification (PCN) Form

A. Applicant Information

1. Processing

1a. Type(s) of approval sought from the Corps:	☒ Section 404 Permit ☐ Section 10 Permit	
1b. Specify Nationwide Permit (NWP) number: NWP 39 or General Permit (GP) number: GC 3402		
1c. Has the NWP or GP number been verified by the Corps?	☒ Yes ☐ No	
1d. Type(s) of approval sought from the DWQ (check all that apply): ☒ 401 Water Quality Certification – Regular ☐ Non-404 Jurisdictional General Permit ☐ 401 Water Quality Certification – Express ☐ Riparian Buffer Authorization		
1e. Is this notification solely for the record because written approval is not required?	For the record only for DWQ 401 Certification: ☐ Yes ☒ No	For the record only for Corps Permit: ☐ Yes ☒ No
1f. Is payment into a mitigation bank or in-lieu fee program proposed for mitigation of impacts? If so, attach the acceptance letter from mitigation bank or in-lieu fee program.	☐ Yes ☒ No	
1g. Is the project located in any of NC's twenty coastal counties. If yes, answer 1h below.	☐ Yes ☒ No	
1h. Is the project located within a NC DCM Area of Environmental Concern (AEC)?	☐ Yes ☒ No	

2. Project Information

2a. Name of project:	Buncombe County Solid Waste Management Facility - Construction and Demolition (C&D) Debris Landfill Expansion
2b. County:	Buncombe County
2c. Nearest municipality / town:	Alexander
2d. Subdivision name:	N/A
2e. NCDOT only, T.I.P. or state project no:	N/A

3. Owner Information

3a. Name(s) on Recorded Deed:	Buncombe County
3b. Deed Book and Page No.	DB 1851 / PG 0097
3c. Responsible Party (for LLC if applicable):	N/A
3d. Street address:	Buncombe County Solid Waste Management Facility 81 Panther Branch Road
3e. City, state, zip:	Alexander, NC 28701
3f. Telephone no.:	(828) 250-5460 (Mr. Jerry Mears, Landfill Manager)
3g. Fax no.:	(828) 250-5478
3h. Email address:	jerry.mears@buncombecounty.org

4. Applicant Information (if different from owner)	
4a. Applicant is:	☐ Agent ☐ Other, specify:
4b. Name:	
4c. Business name (if applicable):	
4d. Street address:	
4e. City, state, zip:	
4f. Telephone no.:	
4g. Fax no.:	
4h. Email address:	
5. Agent/Consultant Information (if applicable)	
5a. Name:	Kelly Boone / Kenton Yang
5b. Business name (if applicable):	CDM
5c. Street address:	5400 Glenwood Avenue, Suite 300
5d. City, state, zip:	Raleigh, NC 27612
5e. Telephone no.:	(919) 325-3508 / (919) 325-3574
5f. Fax no.:	(919) 781-5730
5g. Email address:	boonekr@cdm.com / yangkj@cdm.com

B. Project Information and Prior Project History	
1. Property Identification	
1a. Property identification no. (tax PIN or parcel ID):	9723-08-5685-00000
1b. Site coordinates (in decimal degrees):	Latitude: 35.7265 (DD.DDDDDD) Longitude: -82.6416 (-DD.DDDDDD)
1c. Property size:	604.5 acres (Buncombe Co. Solid Waste Management Facility site)
2. Surface Waters	
2a. Name of nearest body of water (stream, river, etc.) to proposed project:	Panther Branch
2b. Water Quality Classification of nearest receiving water:	C
2c. River basin:	French Broad
3. Project Description	
3a. Describe the existing conditions on the site and the general land use in the vicinity of the project at the time of this application: The Construction Demolition (C&D) Debris Landfill Expansion is located on the Buncombe County Solid Waste Management Facility site. The site contains an existing Subtitle D Landfill, an existing Construction and Demolition (C&D) Debris Landfill, and associated buildings and facilities.	
3b. List the total estimated acreage of all existing wetlands on the property: The wetlands delineation study that was performed in the 1990s prior to development of the overall Buncombe County Solid Waste Management Facility noted that there are approximately 7 acres of jurisdictional wetlands on the 604.5-acre site.	
3c. List the total estimated linear feet of all existing streams (intermittent and perennial) on the property: The wetlands delineation study that was performed in the 1990s prior to development of the overall Buncombe County Solid Waste Management Facility noted that there are approximately 20,400 linear feet of stream channel on the 604.5-acre site.	
3d. Explain the purpose of the proposed project: The purpose of the project is to expand Buncombe County's existing construction and demolition (C&D) debris landfill, which is located at the site of the Buncombe County Solid Waste Management Facility. The landfill serves Buncombe County. The C&D landfill will provide area for disposal of construction or demolition debris, inert debris, land-clearing debris, asphalt, and asbestos.	
3e. Describe the overall project in detail, including the type of equipment to be used: The project includes an expansion of Buncombe County's existing construction and demolition (C&D) debris landfill, which is located at the Buncombe County Solid Waste Management Facility. The expanded C&D landfill area will be located adjacent to and surrounding and on top of the existing C&D landfill on property that is already part of the Buncombe County Solid Waste Management Facility. Construction of the C&D landfill expansion will involve clearing, grading, and earth moving activities. Sedimentation ponds will be constructed as required by State regulations to remove sediment from stormwater runoff. Equipment to be used during construction will include excavators, trackhoes, dump trucks, and other earth-moving equipment. The C&D landfill expansion will be designed, permitted, and constructed per NC Solid Waste Regulations.	

B. Project Information and Prior Project History

4. Jurisdictional Determinations	
4a. Have jurisdictional wetland or stream determinations by the Corps or State been requested or obtained for this property / project (including all prior phases) in the past? Comments: Determinations were obtained only for portion of property on which water treatment plant and associated facilities will be located.	☒ Yes ☐ No ☐ Unknown
4b. If the Corps made the jurisdictional determination, what type of determination was made?	☐ Preliminary ☒ Final
4c. If yes, who delineated the jurisdictional areas? Name (if known): Kelly Boone, Rob Hopper	Agency/Consultant Company: CDM Other:
4d. If yes, list the dates of the Corps jurisdictional determinations or State determinations and attach documentation. USACE has visited the site to verify the origins of jurisdictional streams in the C&D landfill expansion project area. A JD map has been prepared and was submitted to USACE on 2/16/2009. See attached map (Attachment B).	
5. Project History	
5a. Have permits or certifications been requested or obtained for this project (including all prior phases) in the past?	☒ Yes ☐ No ☐ Unknown
5b. If yes, explain in detail according to "help file" instructions. A Section 404 permit was requested for construction of the original C&D debris and Subtitle D landfill facilities on December 29, 1993. A permit was requested under Nationwide Permit 26 for filling 1.77 acres of jurisdictional waters. The permit was received, and the facilities were constructed in the 1990s.	
6. Future Project Plans	
6a. Is this a phased project?	☒ Yes ☐ No
6b. If yes, explain. The C&D landfill expansion project will be constructed in 4 phases; however, all impacts to Waters of the US will occur in the first phase. This permit covers all impacts for all phases of the C&D landfill expansion project. Future phases of the C&D landfill expansion include vertical expansions and earthwork with no stream or wetland impacts.	

C. Proposed Impacts Inventory

1. Impacts Summary

1a. Which sections were completed below for your project (check all that apply):

☐ Wetlands ☒ Streams - tributaries ☐ Buffers

☐ Open Waters ☐ Pond Construction

2. Wetland Impacts

If there are wetland impacts proposed on the site, then complete this question for each wetland area impacted.

2a. Wetland impact number – Permanent (P) or Temporary (T)	2b. Type of impact	2c. Type of wetland (if known)	2d. Forested	2e. Type of jurisdiction (Corps - 404, 10 DWQ – non-404, other)	2f. Area of impact (acres)
W1 ☐ P ☐ T			☐ Yes ☐ No	☐ Corps ☐ DWQ	
W2 ☐ P ☐ T			☐ Yes ☐ No	☐ Corps ☐ DWQ	
W3 ☐ P ☐ T			☐ Yes ☐ No	☐ Corps ☐ DWQ	
W4 ☐ P ☐ T			☐ Yes ☐ No	☐ Corps ☐ DWQ	
W5 ☐ P ☐ T			☐ Yes ☐ No	☐ Corps ☐ DWQ	
W6 ☐ P ☐ T			☐ Yes ☐ No	☐ Corps ☐ DWQ	
				2g. **Total wetland impacts**	N/A

2h. Comments:

3. Stream Impacts

If there are perennial or intermittent stream impacts (including temporary impacts) proposed on the site, then complete this question for all stream sites impacted.

3a. Stream impact number - Permanent (P) or Temporary (T)	3b. Type of impact	3c. Stream name	3d. Perennial (PER) or intermittent (INT)?	3e. Type of jurisdiction (Corps - 404, 10 DWQ – non-404, other)	3f. Average stream width (feet)	3g. Impact length (linear feet)
S1 ☒ P ☐ T	Clearing, grading, and filling of stream channel for construction of new landfill	UT to Panther Branch	☐ PER ☒ INT	☒ Corps ☐ DWQ	3-5 feet	147
S2 ☐ P ☐ T			☐ PER ☐ INT	☐ Corps ☐ DWQ		
S3 ☐ P ☐ T			☐ PER ☐ INT	☐ Corps ☐ DWQ		
S4 ☐ P ☐ T			☐ PER ☐ INT	☐ Corps ☐ DWQ		

S5 ☐ P ☐ T			☐ PER ☐ INT	☐ Corps ☐ DWQ		
S6 ☐ P ☐ T			☐ PER ☐ INT	☐ Corps ☐ DWQ		
					3h. **Total stream and tributary impacts**	147 ft.

3i. Comments:

4. Open Water Impacts

If there are proposed impacts to lakes, ponds, estuaries, tributaries, sounds, the Atlantic Ocean, or any other open water of the U.S. then individually list all open water impacts below.

4a. Open water impact number – Permanent (P) or Temporary (T)	4b. Name of waterbody (if applicable)	4c. Type of impact	4d. Waterbody type	4e. Area of impact (acres)
O1 ☐ P ☐ T				
O2 ☐ P ☐ T				
O3 ☐ P ☐ T				
O4 ☐ P ☐ T				
			4f. Total open water impacts	N/A

4g. Comments:

5. Pond or Lake Construction

If pond or lake construction proposed, then complete the chart below.

5a. Pond ID number	5b. Proposed use or purpose of pond	5c. Wetland Impacts (acres)			5d. Stream Impacts (feet)			5e. Upland (acres)
		Flooded	Filled	Excavated	Flooded	Filled	Excavated	Flooded
P1								
P2								
	5f. Total							

5g. Comments:

5h. Is a dam high hazard permit required?	☐ Yes ☐ No If yes, permit ID no:
5i. Expected pond surface area (acres):	N/A
5j. Size of pond watershed (acres):	N/A
5k. Method of construction:	N/A

6. Buffer Impacts (for DWQ)

If project will impact a protected riparian buffer, then complete the chart below. If yes, then individually list all buffer impacts below. If any impacts require mitigation, then you **MUST** fill out Section D of this form.

6a. Project is in which protected basin?	☐ Neuse ☐ Catawba	☐ Tar-Pamlico ☐ Randleman	☐ Other:

6b. Buffer impact number – Permanent (P) or Temporary (T)	6c. Reason for impact	6d. Stream name	6e. Buffer mitigation required?	6f. Zone 1 impact (square feet)	6g. Zone 2 impact (square feet)
B1 ☐ P ☐ T			☐ Yes ☐ No		
B2 ☐ P ☐ T			☐ Yes ☐ No		
B3 ☐ P ☐ T			☐ Yes ☐ No		
			6h. **Total buffer impacts**	N/A	N/A

6i. Comments:

D. Impact Justification and Mitigation

1. Avoidance and Minimization

1a. Specifically describe measures taken to avoid or minimize the proposed impacts in designing project.

In designing the footprint of the proposed C&D landfill expansion, jurisdictional waters were avoided to the extent practicable. After delineating jurisdictional waters, the footprint of the landfill was further modified and the landfill capacity decreased to avoid impacts to Intermittent Channel 2 and minimize impacts to Intermittent Channel 1 as much as possible. Impacts to Channel 1 are the minimum necessary to achieve the minimum landfill capacity needed and install a required sediment pond. A detailed grading plan has been developed to establish accurate limits of construction, and side slopes were maximized to minimize fill in jurisdictional waters. Existing topography was used to minimize earthwork. A retaining wall was considered but determined to be impracticable for this application. Expanding the existing C&D landfill rather than construction a new landfill allows the landfill footprint to be minimized by constructing the expansion against the side slopes and on top of the existing landfill. This results in much less impact than siting a C&D landfill in a new location. The overall Solid Waste Management Facility contains no other location that would result in less impact.

1b. Specifically describe measures taken to avoid or minimize the proposed impacts through construction techniques.

Construction will be subject to a sediment and erosion control plan, which will protect downstream surface waters. Construction sequencing will be specified so that all sediment and erosion control measures are in place prior to construction of the landfill. Limits of disturbance will be shown on the construction plans and enforced during construction. All stockpiles of soil will occur in upland areas within the limits of disturbance. Construction access into jurisdictional waters that are not included in the footprint of the landfill and associated sediment pond will be allowed. Excavation during construction will be minimized, because the landfill expansion will be constructed against the side slopes and on top of the existing C&D landfill. This results in less disturbance within the landfill expansion project area. Existing topography was used to minimize earthwork, which will result in less disturbance during construction.

2. Compensatory Mitigation for Impacts to Waters of the U.S. or Waters of the State

2a. Does the project require Compensatory Mitigation for impacts to Waters of the U.S. or Waters of the State?	☐ Yes ☒ No
2b. If yes, mitigation is required by (check all that apply):	☐ DWQ ☐ Corps N/A
2c. If yes, which mitigation option will be used for this project?	☐ Mitigation bank ☐ Payment to in-lieu fee program ☐ Permittee Responsible Mitigation

3. Complete if Using a Mitigation Bank

3a. Name of Mitigation Bank: N/A

3b. Credits Purchased (attach receipt and letter)	Type	Quantity

3c. Comments: N/A	
4. Complete if Making a Payment to In-lieu Fee Program	
4a. Approval letter from in-lieu fee program is attached.	☐ Yes
4b. Stream mitigation requested:	linear feet
4c. If using stream mitigation, stream temperature:	☐ warm ☐ cool ☐ cold
4d. Buffer mitigation requested (DWQ only):	square feet
4e. Riparian wetland mitigation requested:	acres
4f. Non-riparian wetland mitigation requested:	acres
4g. Coastal (tidal) wetland mitigation requested:	acres
4h. Comments:	
5. Complete if Using a Permittee Responsible Mitigation Plan	
5a. If using a permittee responsible mitigation plan, provide a description of the proposed mitigation plan. N/A	
6. Buffer Mitigation (State Regulated Riparian Buffer Rules) – required by DWQ	
6a. Will the project result in an impact within a protected riparian buffer that requires buffer mitigation?	☐ Yes ☒ No
6b. If yes, then identify the square feet of impact to each zone of the riparian buffer that requires mitigation. Calculate the amount of mitigation required.	

Zone	6c. Reason for impact	6d. Total impact (square feet)	Multiplier	6e. Required mitigation (square feet)
Zone 1			3 (2 for Catawba)	N/A
Zone 2			1.5	N/A
			6f. **Total buffer mitigation required:**	N/A

6g. If buffer mitigation is required, discuss what type of mitigation is proposed (e.g., payment to private mitigation bank, permittee responsible riparian buffer restoration, payment into an approved in-lieu fee fund). N/A	
6h. Comments: N/A	

E. Stormwater Management and Diffuse Flow Plan (required by DWQ)	
1. Diffuse Flow Plan	
1a. Does the project include or is it adjacent to protected riparian buffers identified within one of the NC Riparian Buffer Protection Rules?	☐ Yes ☒ No
1b. If yes, then is a diffuse flow plan included? If no, explain why. Comments: N/A	☐ Yes ☐ No
2. Stormwater Management Plan	
2a. What is the overall percent imperviousness of this project?	0%
2b. Does this project require a Stormwater Management Plan?	☐ Yes ☒ No
2c. If this project DOES NOT require a Stormwater Management Plan, explain why: Project results in less than 24% imperviousness.	
2d. If this project DOES require a Stormwater Management Plan, then provide a brief, narrative description of the plan: N/A	
2e. Who will be responsible for the review of the Stormwater Management Plan? N/A	☐ Certified Local Government ☐ DWQ Stormwater Program ☐ DWQ 401 Unit
3. Certified Local Government Stormwater Review	
3a. In which local government's jurisdiction is this project?	Buncombe County
3b. Which of the following locally-implemented stormwater management programs apply (check all that apply): N/A	☐ Phase II ☐ NSW ☐ USMP ☐ Water Supply Watershed ☐ Other:
3c. Has the approved Stormwater Management Plan with proof of approval been attached? N/A	☐ Yes ☐ No N/A
4. DWQ Stormwater Program Review	
4a. Which of the following state-implemented stormwater management programs apply (check all that apply): N/A	☐ Coastal counties ☐ HQW ☐ ORW ☐ Session Law 2006-246 ☐ Other:
4b. Has the approved Stormwater Management Plan with proof of approval been attached? N/A	☐ Yes ☐ No N/A
5. DWQ 401 Unit Stormwater Review	
5a. Does the Stormwater Management Plan meet the appropriate requirements? N/A	☐ Yes ☐ No
5b. Have all of the 401 Unit submittal requirements been met? N/A	☐ Yes ☐ No

F. Supplementary Information		
1. Environmental Documentation (DWQ Requirement)		
1a. Does the project involve an expenditure of public (federal/state/local) funds or the use of public (federal/state) land?	☒ Yes	☐ No
1b. If you answered "yes" to the above, does the project require preparation of an environmental document pursuant to the requirements of the National or State (North Carolina) Environmental Policy Act (NEPA/SEPA)?	☐ Yes	☒ No
1c. If you answered "yes" to the above, has the document review been finalized by the State Clearing House? (If so, attach a copy of the NEPA or SEPA final approval letter.) Comments: N/A	☐ Yes	☐ No
2. Violations (DWQ Requirement)		
2a. Is the site in violation of DWQ Wetland Rules (15A NCAC 2H .0500), Isolated Wetland Rules (15A NCAC 2H .1300), DWQ Surface Water or Wetland Standards, or Riparian Buffer Rules (15A NCAC 2B .0200)?	☐ Yes	☒ No
2b. Is this an after-the-fact permit application?	☐ Yes	☒ No
2c. If you answered "yes" to one or both of the above questions, provide an explanation of the violation(s):		
3. Cumulative Impacts (DWQ Requirement)		
3a. Will this project (based on past and reasonably anticipated future impacts) result in additional development, which could impact nearby downstream water quality?	☐ Yes	☒ No
3b. If you answered "yes" to the above, submit a qualitative or quantitative cumulative impact analysis in accordance with the most recent DWQ policy. If you answered "no," provide a short narrative description. This project will not cause growth or development. This project provides the ability for Buncombe County to dispose of construction and demolition debris at its solid waste facility rather than transporting this waste elsewhere for disposal.		
4. Sewage Disposal (DWQ Requirement)		
4a. Clearly detail the ultimate treatment methods and disposition (non-discharge or discharge) of wastewater generated from the proposed project, or available capacity of the subject facility. This project will not generate any wastewater.		

5. **Endangered Species and Designated Critical Habitat (Corps Requirement)**	
5a. Will this project occur in or near an area with federally protected species or habitat?	☐ Yes ☒ No
5b. Have you checked with the USFWS concerning Endangered Species Act impacts?	☐ Yes ☒ No
5c. If yes, indicate the USFWS Field Office you have contacted.	☐ Raleigh ☐ Asheville

5d. What data sources did you use to determine whether your site would impact Endangered Species or Designated Critical Habitat?

A protected species survey of the entire Buncombe County Solid Waste Management Facility site was conducted in the 1990s when the facility was originally developed (*Protected Species Survey, Buncombe County Landfill, NC*, Robert J. Goldstein and Associates, Inc. Inc., August 18, 1992). The survey was submitted to and reviewed by the NC Natural Heritage Program. The survey noted that potential habitat was found on the overall Solid Waste Management Facility site for 15 state or federally protected plant and animal species, including the federally-protected Virginia spiraea (*Spiraea viginiana*) and spotfin chub (*Erimonax monachus*). However, none of these 15 state or federally protected species was found during on-foot investigations of the potential habitat areas. The survey report concluded that the proposed landfill will have no adverse impacts on state or federally protected species.

6. **Essential Fish Habitat (Corps Requirement)**	
6a. Will this project occur in or near an area designated as essential fish habitat?	☐ Yes ☒ No

6b. What data sources did you use to determine whether your site would impact Essential Fish Habitat?

There are no areas of essential fish habitat in the project area according to the NMFS map website (http://ocean.floridamarine.org/efh_coral/ims/viewer.htm).

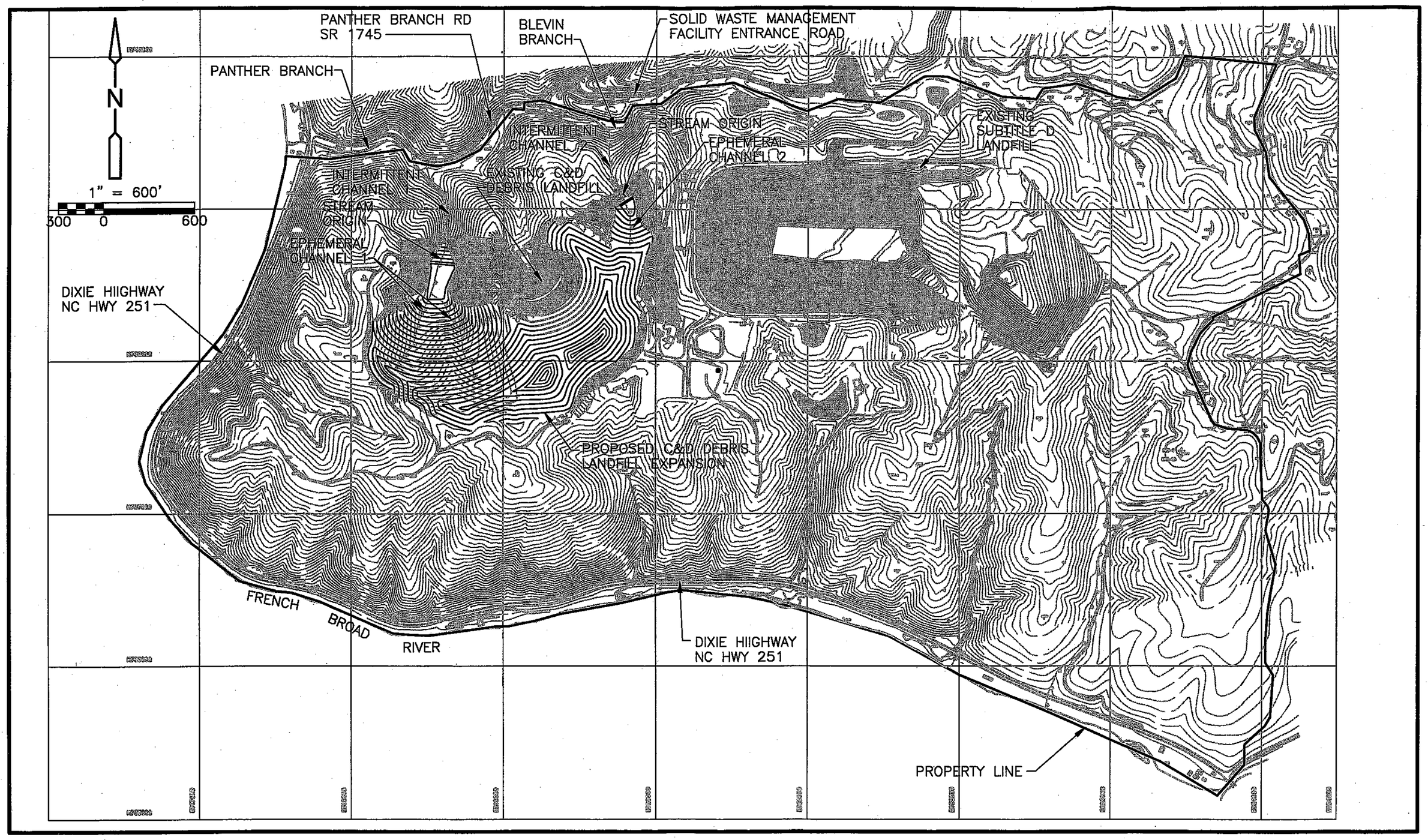
7. **Historic or Prehistoric Cultural Resources (Corps Requirement)**	
7a. Will this project occur in or near an area that the state, federal or tribal governments have designated as having historic or cultural preservation status (e.g., National Historic Trust designation or properties significant in North Carolina history and archaeology)?	☐ Yes ☒ No

7b. What data sources did you use to determine whether your site would impact historic or archeological resources?

An archaeological resources survey of the entire Buncombe County Solid Waste Management Facility site was conducted in the 1990s when the facility was originally developed (*An Archaeological Survey of the Proposed Buncombe County Landfill, Alexander Vicinity, Buncombe County, NC*, Archaeological Research Consultants, Inc., April 1993). The survey was submitted to and reviewed by the State Historic Preservation Office. The survey noted 8 sites in the project area. None of these sites is located in the footprint of the proposed C&D debris landfill expansion that is covered by this Section 404/401 permit.

8. Flood Zone Designation (Corps Requirement)		
8a. Will this project occur in a FEMA-designated 100-year floodplain?	☐ Yes	☒ No
8b. If yes, explain how project meets FEMA requirements: N/A		
8c. What source(s) did you use to make the floodplain determination? NC/FEMA Floodplain Mapping Program website (http://www.ncfloodmaps.com).		

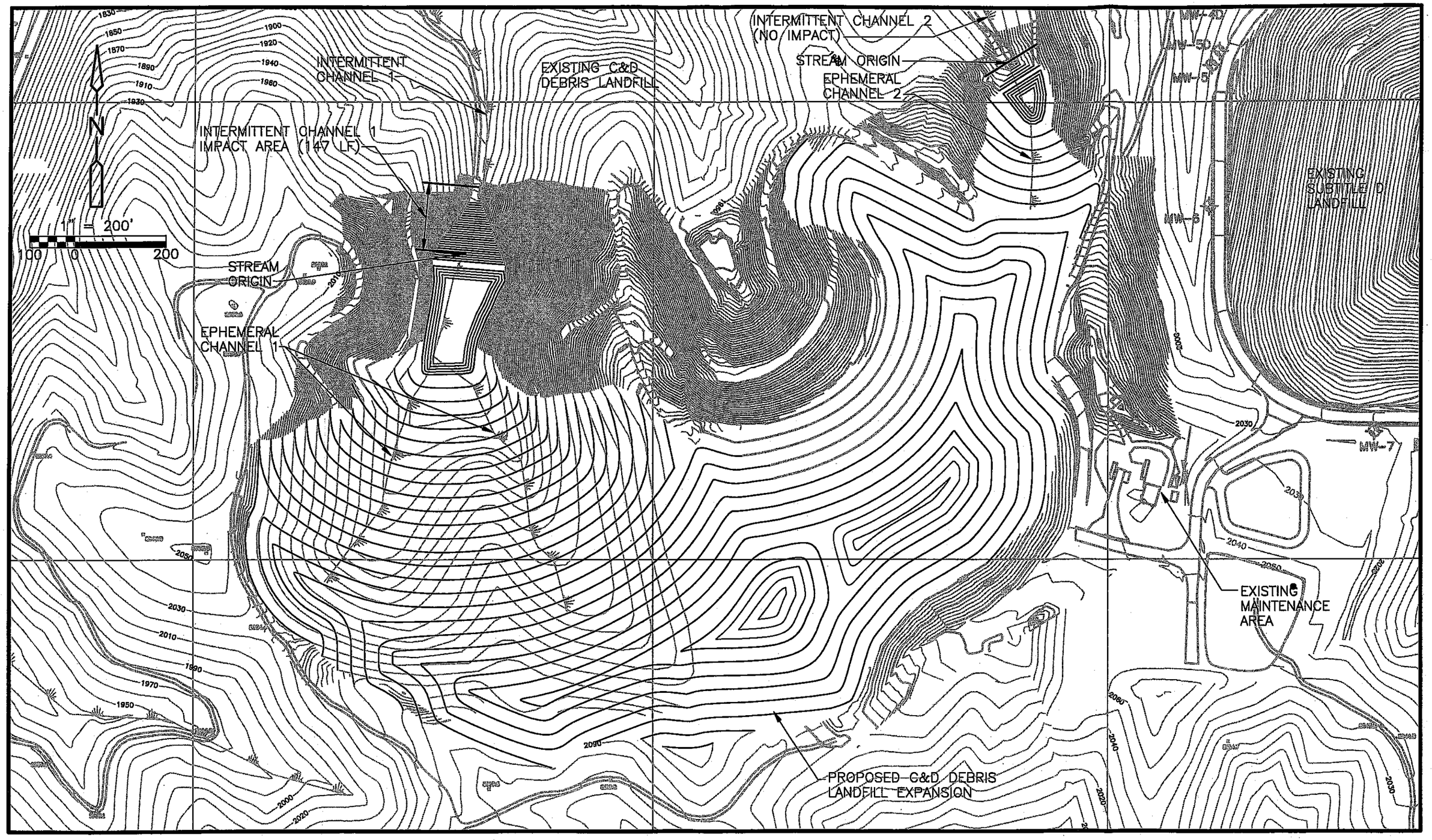
Jon Creighton Applicant/~~Agent~~'s Printed Name	Applicant/~~Agent~~'s Signature (Agent's signature is valid only if an authorization letter from the applicant is provided.)	2-5-09 Date



CDM

consulting • engineering • construction • operations

Figure No. 1
Buncombe County Solid Waste
Management Facility Site Plan



CDM

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Figure No. 2
Buncombe County C&D Debris Landfill Expansion
Jurisdictional Waters Impacts

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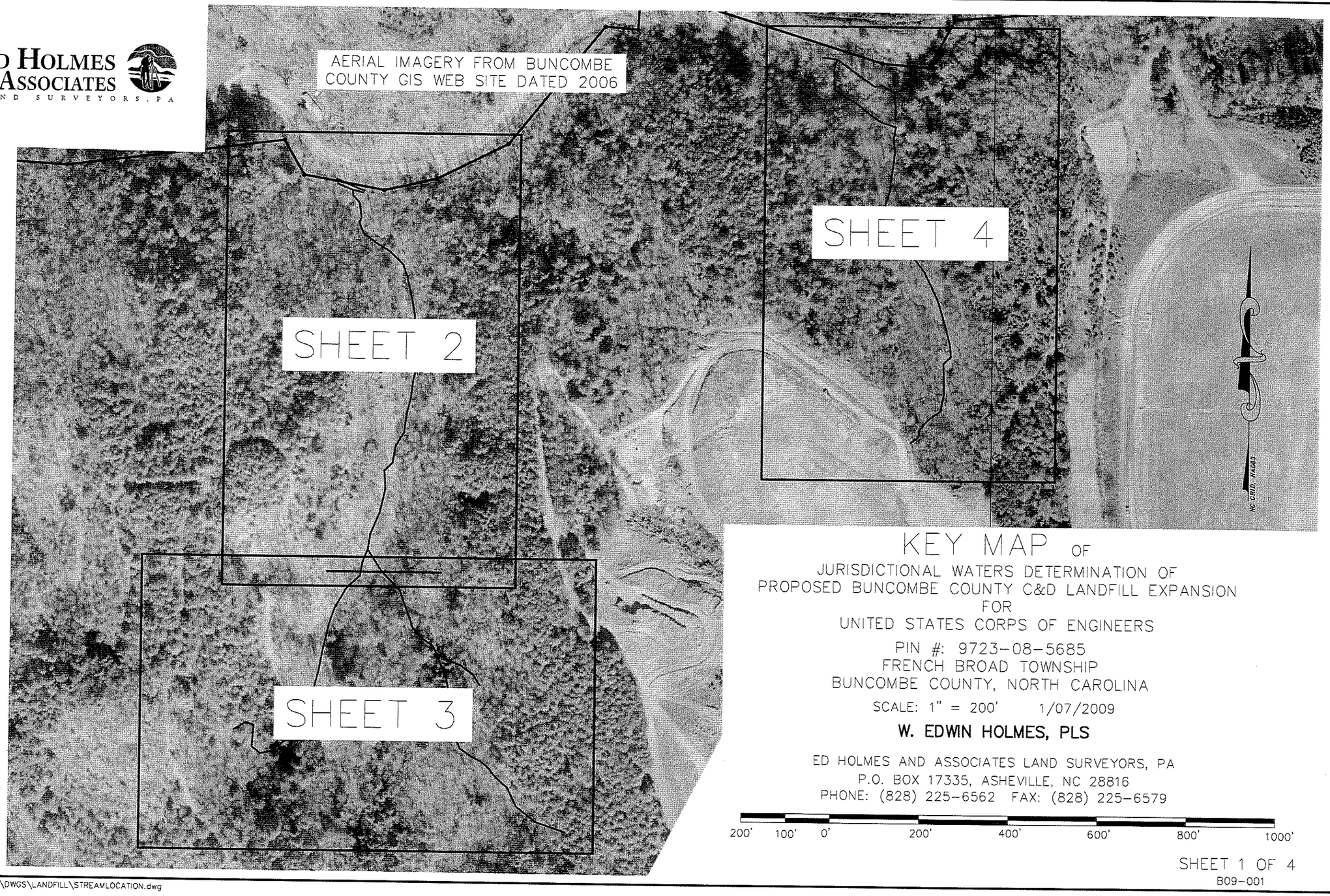
LAND SURVEYORS, PA



KEY MAP OF

JURISDICTIONAL WATERS DETERMINATION OF
PROPOSED BUNCOMBE COUNTY C&D LANDFILL EXPANSION
FOR
UNITED STATES CORPS OF ENGINEERS

PIN #: 9723-08-5685
FRENCH BROAD TOWNSHIP
BUNCOMBE COUNTY, NORTH CAROLINA

SCALE: 1" = 200' 1/07/2009

W. EDWIN HOLMES, PLS

ED HOLMES AND ASSOCIATES LAND SURVEYORS, PA
P.O. BOX 17335, ASHEVILLE, NC 28816
PHONE: (828) 225-6562 FAX: (828) 225-6579

200' 100' 0' 200' 400' 600' 800' 1000'

N:\USERS\JOEKANE\DWGS\LANDFILL\STREAMLOCATION.dwg

ED HOLMES & ASSOCIATES
LAND SURVEYORS, PA

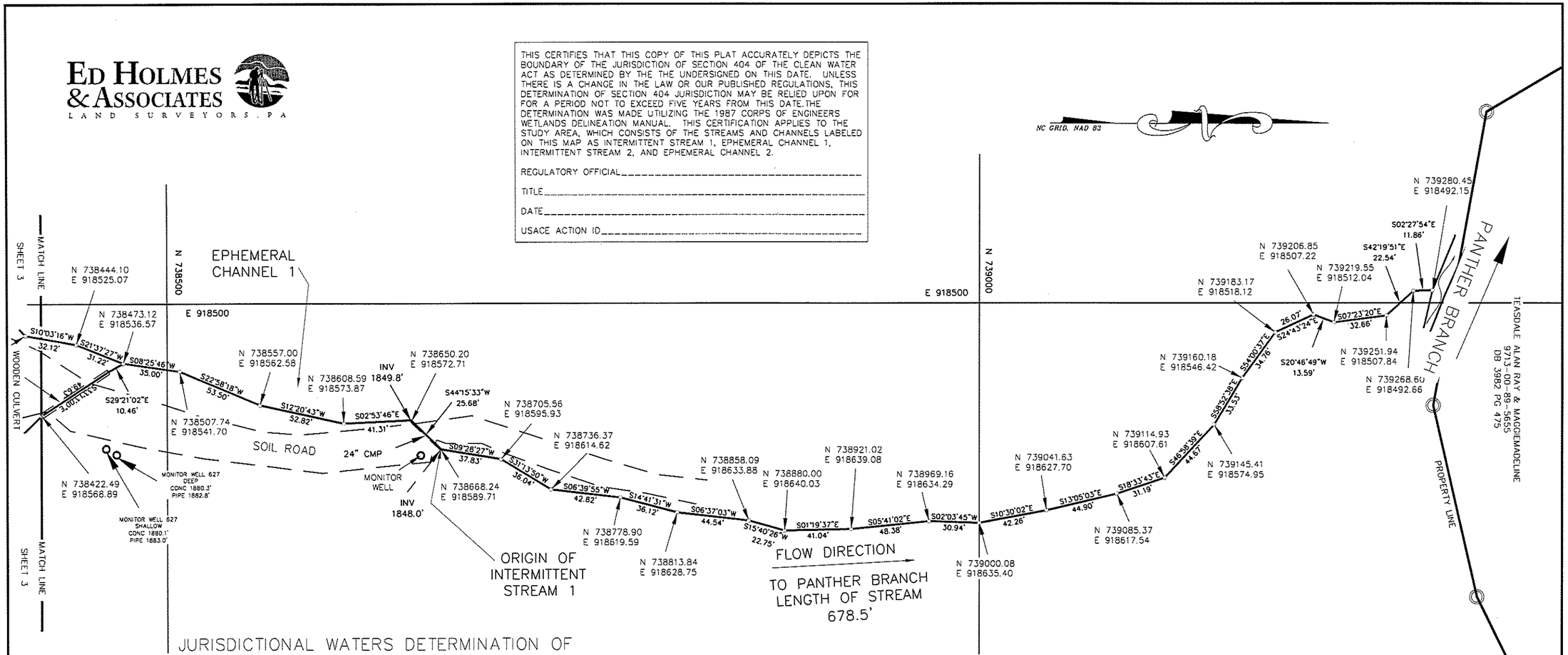
THIS CERTIFIES THAT THIS COPY OF THIS PLAT ACCURATELY DEPICTS THE BOUNDARY OF THE JURISDICTION OF SECTION 404 OF THE CLEAN WATER ACT AS DETERMINED BY THE THE UNDERSIGNED ON THIS DATE. UNLESS THERE IS A CHANGE IN THE LAW OR OUR PUBLISHED REGULATIONS, THIS DETERMINATION OF SECTION 404 JURISDICTION MAY BE RELIED UPON FOR FOR A PERIOD NOT TO EXCEED FIVE YEARS FROM THIS DATE.THE DETERMINATION WAS MADE UTILIZING THE 1987 CORPS OF ENGINEERS WETLANDS DELINEATION MANUAL. THIS CERTIFICATION APPLIES TO THE STUDY AREA, WHICH CONSISTS OF THE STREAMS AND CHANNELS LABELED ON THIS MAP AS INTERMITTENT STREAM 1, EPHEMERAL CHANNEL 1, INTERMITTENT STREAM 2, AND EPHEMERAL CHANNEL 2.

REGULATORY OFFICIAL_____

TITLE_____

DATE_____

USACE ACTION ID_____



JURISDICTIONAL WATERS DETERMINATION OF
PROPOSED BUNCOMBE COUNTY C&D LANDFILL EXPANSION
FOR
THE UNITED STATES CORPS OF ENGINEERS

PIN #: 9723-08-5685
FRENCH BROAD TOWNSHIP
BUNCOMBE COUNTY, NORTH CAROLINA

SCALE: 1" = 60' 1/07/2009

W. EDWIN HOLMES, PLS

ED HOLMES AND ASSOCIATES LAND SURVEYORS, PA
P.O. BOX 17335, ASHEVILLE, NC 28816
PHONE: (828) 225-6562 FAX: (828) 225-6579

60' 30' 0' 60' 120' 180' 240' 300'

I, W. EDWIN HOLMES, N.C. P.L.S., CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION (PROPERTY DESCRIPTION RECORDED IN DEED BOOKS AS SHOWN); THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED BY DASHED LINES AS DRAWN FROM INFORMATION FOUND IN DEED BOOKS AS SHOWN; THAT THE RATIO OF PRECISION AS CALCULATED IS 1:10,000 OR GREATER.

WITNESS MY SIGNATURE, LICENSE NUMBER, AND SEAL THIS 13TH DAY OF FEB, A.D., 2009.

N.C. PROFESSIONAL LAND SURVEYOR

L-2755
LICENSE #

NORTH CAROLINA PROFESSIONAL SEAL L-2755 LAND SURVEYOR W. EDWIN HOLMES

SHEET 2 OF 4

B09-001

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JURISDICTIONAL WATERS DETERMINATION OF PROPOSED BUNCOMBE COUNTY C&D LANDFILL EXPANSION FOR THE UNITED STATES CORPS OF ENGINEERS

PIN#: 9723-08-5685
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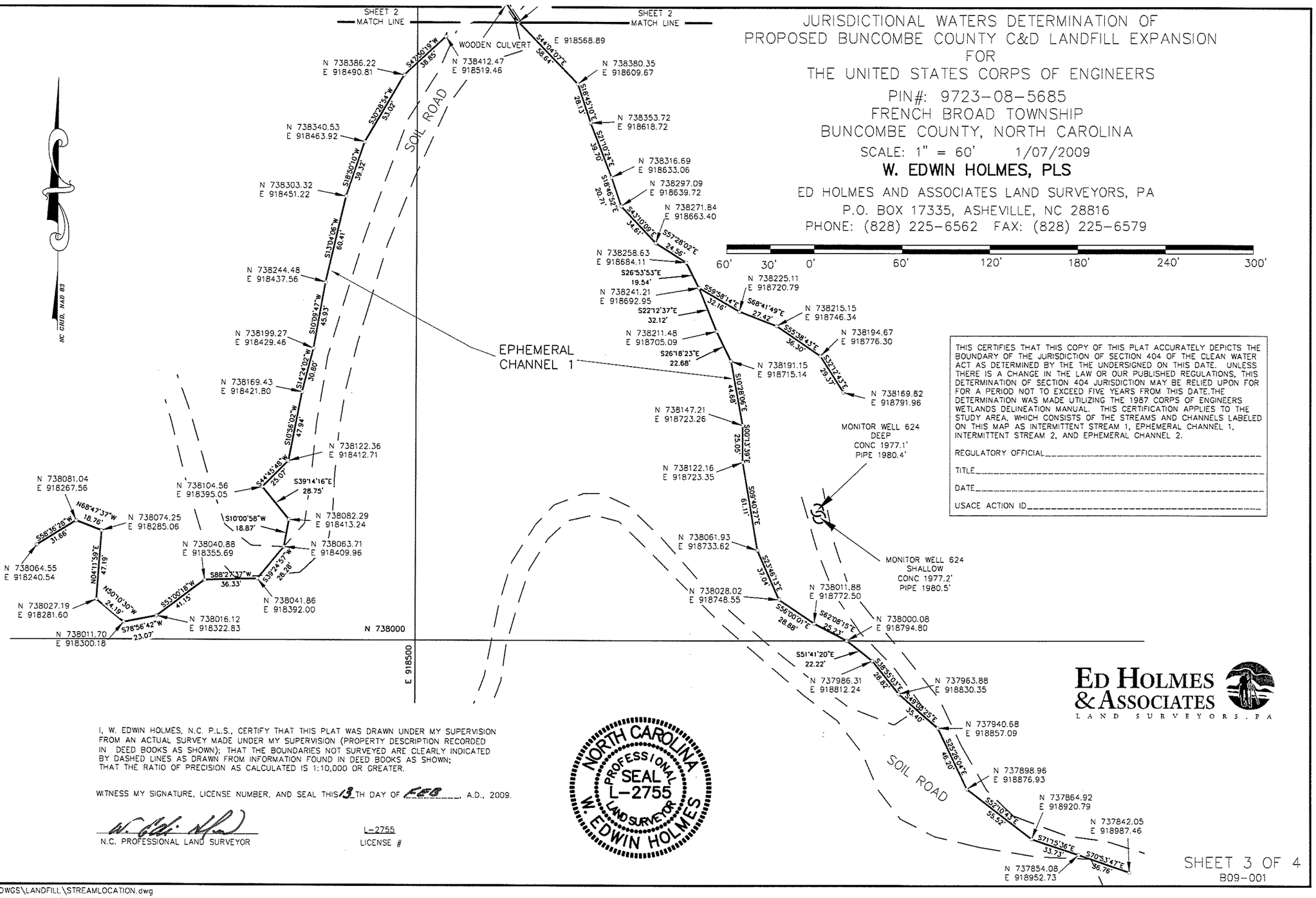

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DATE_____

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ED HOLMES & ASSOCIATES
LAND SURVEYORS, PA

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NORTH CAROLINA PROFESSIONAL SEAL L-2755 LAND SURVEYOR W. EDWIN HOLMES

N.C. PROFESSIONAL LAND SURVEYOR

L-2755
LICENSE #

SHEET 3 OF 4
B09-001

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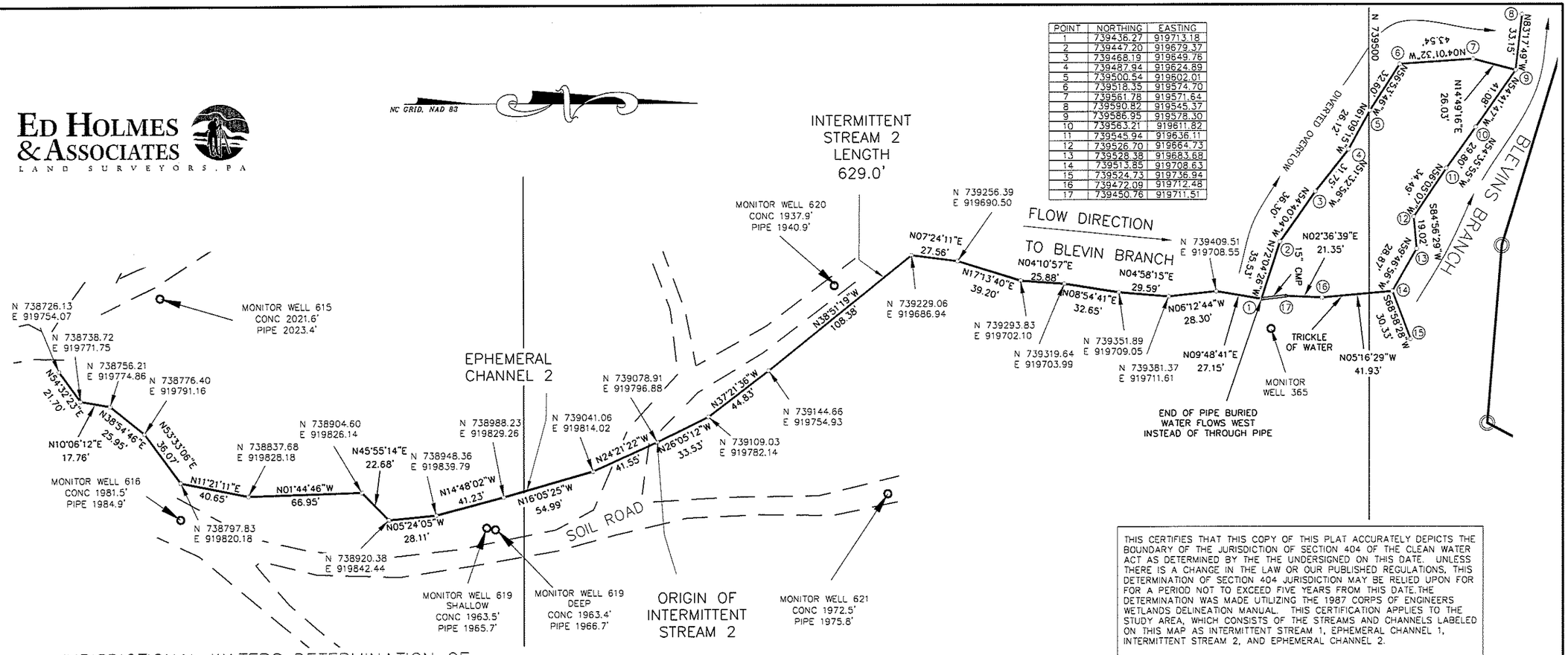
ED HOLMES & ASSOCIATES
LAND SURVEYORS, PA

NC GRID, NAD 83

POINT	NORTHING	EASTING
1	739436.27	919713.18
2	739447.20	919679.37
3	739468.19	919649.76
4	739487.94	919624.89
5	739500.54	919602.01
6	739518.35	919574.70
7	739561.78	919571.64
8	739590.82	919545.37
9	739586.95	919578.30
10	739563.21	919611.82
11	739545.94	919636.11
12	739526.70	919664.73
13	739528.38	919683.68
14	739513.85	919708.63
15	739524.73	919736.94
16	739472.09	919712.48
17	739450.76	919711.51



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PROPOSED BUNCOMBE COUNTY C&D LANDFILL EXPANSION
FOR
THE UNITED STATES CORPS OF ENGINEERS.

PIN #: 9723-08-5685
FRENCH BROAD TOWNSHIP
BUNCOMBE COUNTY, NORTH CAROLINA

SCALE: 1" = 60' 1/07/2009

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NORTH CAROLINA PROFESSIONAL SEAL L-2755 LAND SURVEYOR W. EDWIN HOLMES

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Part 3 - Facility Plan
Appendix B – Location Restrictions

Attachment B3
Nationwide Permitting
Approval Letters

NCDENR

North Carolina Department of Environment and Natural Resources
Division of Water Quality

Beverly Eaves Perdue
Governor

Coleen H. Sullins
Director

Dee Freeman
Secretary

April 23, 2009

RECEIVED

APR 2 - 2009

Mr. Jerry Mears, Landfill Manager
Buncombe County Solid Waste Management Facility
81 Panther Branch Road
Alexander, NC 28701

Subject: **Activities Deemed Certified**
Buncombe County Landfill – Construction and Demolition Debris Landfill Expansion
DWQ Project # 93-1066 ver2
Buncombe County
FRB02 / UT Panther Branch / 6-90 / C

Dear Mr. Mears:

The Division of Water Quality (Division) has completed the review of the 401 Water Quality Certification application associated with the project listed above.

It has been determined that the subject project does not require written concurrence from the Division and has been deemed certified, if the conditions required by Water Quality Certification No. 3705 are followed (attached). In addition, the County should obtain or otherwise comply with any other required federal, state or local permits before proceeding with the project, including (but not limited to) Erosion and Sediment Control regulations.

This letter completes the review of your application by the Division under Section 401 of the Clean Water Act. If you have any questions, please contact Susan A. Wilson in the Asheville Regional Office at 828-296-4665.

Sincerely,

Roger C. Edwards
Regional Office Supervisor, Surface Water Protection Section

CHS/*saw*
w/attachment
cc: USACE Asheville Regulatory Field Office
Wildlife Resources Commission – David McHenry
401 Permitting Unit – Central Office
ARO File Copy

G:\WPDATA\DEMWQ\Buncombe\401s\Buncombe Co Landfill\93-1066 v2 no 401 reqd 4 23 2009.doc

Location: 2090 U.S. Highway 70, Swannanoa, North Carolina 28778
Phone: 828-296-4500\ FAX: 828-299-7043 \ Customer Service: 1-877-623-6748
Internet: www.ncwaterquality.org

One NorthCarolina *Naturally*

An Equal Opportunity \ Affirmative Action Employer

Water Quality Certification N°. 3705

GENERAL CERTIFICATION FOR PROJECTS ELIGIBLE FOR U.S. ARMY CORPS OF ENGINEERS NATIONWIDE PERMIT NUMBERS 18 (MINOR DISCHARGES), 29 (RESIDENTIAL DEVELOPMENT), 39 (COMMERCIAL AND INSTITUTIONAL DEVELOPMENTS), 41 (RESHAPING EXISTING DRAINAGE DITCHES), 42 (RECREATIONAL FACILITIES), 44 (MINING ACTIVITIES), AND 46 (DISCHARGES IN DITCHES), AND RIPARIAN AREA PROTECTION RULES (BUFFER RULES)

Water Quality Certification Number 3705 is issued in conformity with the requirements of Section 401, Public Laws 92-500 and 95-217 of the United States and subject to the North Carolina Division of Water Quality (DWQ) Regulations in 15A NCAC 2H, Section .0500 and 15A NCAC 2B .0200 for the discharge of fill material to waters and adjacent wetland areas or to wetland areas that are not a part of the surface tributary system to interstate waters or navigable waters of the United States () as described in 33 CFR 330 Appendix A (B) (18, 29, 39, 41, 42, 43, 44, and 46) of the Corps of Engineers regulations (i.e., Nationwide Permit No. 39) and for the Riparian Area Protection Rules (Buffer Rules) in 15A NCAC 2B .0200.

The State of North Carolina certifies that the specified categories of activities will not violate the [illegible] if conducted in accordance with the conditions hereinafter set forth.

Activities meeting any one (1) of the following criteria require *written approval* from the Division of Water Quality (the "Division"):

I. Stream and/or buffer impacts:
   a. Any impacts to perennial waters (as depicted on the most recent USGS 1:24000 topographic map or as otherwise determined by the local government,) and their associated riparian buffers in Water Supply (WS), High Quality Water (HQW), or Outstanding Resource Water (ORW) watersheds. Only water-dependent activities, public projects, and structures with diminimus increases in impervious surfaces will be allowed as outlined in those rules [15A NCAC 2B .0212 through .0215]. All other activities require a variance from the delegated local government and/or the NC Environmental Management Commission before the application for the 401 Water Quality Certification can be processed.
   b. Any impacts to streams and buffers in the Neuse, Tar-Pamlico, Randleman and Catawba River Basins (or any other basins with Riparian Area Protection Rules [Buffer Rules] in effect at the time of application [in accordance with 15A NCAC 2B .0200]), *unless* the activities are listed as "EXEMPT" from these Rules.
   c. Any impacts to streams involving excavation or dredging.
   d. Total stream impacts equal to or greater than 150 linear feet of intermittent and/or perennial stream to be filled, culverted, rip rapped, or relocated, including temporary and/or permanent impacts.

II. Impacts (temporary and/or permanent) to waters:
   a. Equal to or greater than one-third (1/3) of an acre East of Interstate 95 (I-95).
   b. Equal to or greater than one-tenth (1/10) acre West of Interstate 95 (I-95).

III. Wetland impacts (temporary and/or permanent):
   a. Equal to or greater than one-third (1/3) acre East of Interstate-95.
   b. Equal to or greater than one-tenth (1/10) acre West of Interstate-95.
   c. Any impacts to wetlands adjacent to waters designated as: ORW, SA, WS-I, WS-II, or Trout, or wetlands contiguous to waters designated as a North Carolina or National Wild and Scenic River.
   d. Any impacts to coastal wetlands [15A NCAC 7H .0205)], or Unique Wetlands (UWL) [15A NCAC 2H .0506].

Water Quality Certification N°. 3705

IV. If the activity is associated with or in response to a Notice of Violation or an enforcement action initiated by the Division and/or the Division of Land Resources.

In accordance with North Carolina General Statute Section 143-215.3D(e), written approval for a 401 Water Quality General Certification must include the appropriate fee. If a project also requires a CAMA Permit, then one payment to both agencies shall be submitted and will be the higher of the two fees.

Activities that are below the thresholds, or otherwise do not meet the criteria listed above in this General Certification do *not* require written approval from the Division of Water Quality as long as they comply with the Conditions of Certification listed below, including the Stormwater Management Plan condition. If the project requires a Stormwater Management Plan, but is otherwise below the written approval thresholds, the applicant may provide a courtesy copy of the Pre-Construction Notification along with a copy of the Stormwater Management Plan (and approval letter from the appropriate locally delegated state program where applicable). If any of these Conditions cannot be met, then written approval from the Division is required.

Conditions of Certification:

1. No Impacts Beyond those Authorized in the Written Approval or Beyond the Threshold of Use of this Certification

   No waste, spoil, solids, or fill of any kind shall occur in wetlands, waters, or riparian areas beyond the footprint of the impacts depicted in the Pre-Construction Notification and authorized in the written approval from the Division, including incidental impacts. All construction activities, including the design, installation, operation, and maintenance of sediment and erosion control Best Management Practices, shall be performed so that no violations of state water quality standards, statutes, or rules occur.

2. Standard Erosion and Sediment Control Practices

   Erosion and sediment control practices must be in full compliance with all specifications governing the proper design, installation and operation and maintenance of such Best Management Practices:

   a. Design, installation, operation, and maintenance of the sediment and erosion control measures must be such that they equal, or exceed, the requirements specified in the most recent version of the *North Carolina Sediment and Erosion Control Manual*. The devices shall be maintained on all construction sites, borrow sites, and waste pile (spoil) projects, including contractor-owned or leased borrow pits associated with the project.
   b. For borrow pit sites, the erosion and sediment control measures must be designed, installed, operated, and maintained in accordance with the most recent version of the *North Carolina Surface Mining Manual*.
   c. Reclamation measures and implementation must comply with the reclamation in accordance with the requirements of the Sedimentation Pollution Control Act and the Mining Act of 1971.
   d. Sufficient materials required for stabilization and/or repair of erosion control measures and stormwater routing and treatment shall be on site at all times.
   e. If the project occurs in waters or watersheds classified as Primary Nursery Areas (PNAs), Trout (Tr), SA, WS-I, WS-II, High Quality (HQW), or Outstanding Resource (ORW) waters, then the sediment and erosion control requirements contained within *Design Standards in Sensitive Watersheds* (15A NCAC 04B .0124) supercede all other sediment and erosion control requirements.

Water Quality Certification N°. 3705

3. No Sediment and Erosion Control Measures in Wetlands or Waters

   Sediment and erosion control measures should not be placed in wetlands or waters without prior approval by the Division. If placement of sediment and erosion control devices in wetlands and waters is unavoidable, then design and placement of temporary erosion control measures shall not be conducted in a manner that may result in dis-equilibrium of wetlands or stream beds or banks, adjacent to or upstream and down stream of the above structures. All sediment and erosion control devices shall be removed and the natural grade restored within two (2) months of the date that the Division of Land Resources or locally delegated program has released the project.

4. Construction Stormwater Permit NCG010000

   Upon the approval of an Erosion and Sedimentation Control Plan issued by the Division of Land Resources (DLR) or a DLR delegated local erosion and sedimentation control program, an NPDES General stormwater permit (NCG010000) administered by the Division is automatically issued to the project. This General Permit allows stormwater to be discharged during land disturbing construction activities as stipulated by conditions in the permit. If your project is covered by this permit [applicable to construction projects that disturb one (1) or more acres], full compliance with permit conditions including the sedimentation control plan, self-monitoring, record keeping and reporting requirements are required. A copy of this permit and monitoring report forms may be found at *http://h2o.enr.state.nc.us/su/Forms_Documents.htm*.

5. Construction Moratoriums and Coordination

   If activities must occur during periods of high biological activity (i.e. sea turtle or bird nesting), then biological monitoring may be required at the request of other state or federal agencies and coordinated with these activities. This condition can be waived through written concurrence on a case by case basis upon reasonable justification.

   All moratoriums on construction activities established by the NC Wildlife Resources Commission (WRC), US Fish and Wildlife Service (USFWS), NC Division of Marine Fisheries (DMF), or National Marine Fisheries Service (NMFS) to lessen impacts on trout, anadromous fish, larval/post-larval fishes and crustaceans, or other aquatic species of concern shall be implemented. This condition can be waived through written concurrence on a case by case basis upon reasonable justification.

   Work within the twenty-five (25) designated trout counties or identified state or federal endangered or threatened species habitat shall be coordinated with the appropriate WRC, USFWS, NMFS, and/or DMF personnel.

6. Work in the Dry

   All work in or adjacent to stream waters shall be conducted in a dry work area. Approved best management practices from the most current version of the NC Sediment and Erosion Control Manual, or the NC DOT Construction and Maintenance Activities Manual, such as sandbags, rock berms, cofferdams, and other diversion structures shall be used to minimize excavation in flowing water. Exceptions to this condition require submittal to, and approval by, the Division of Water Quality.

Water Quality Certification N°. 3705

7. Riparian Area Protection (Buffer) Rules

   Activities located in the protected 50-foot wide riparian areas (whether jurisdictional wetlands or not), within the Neuse, Tar-Pamlico, Catawba, or Randleman (or any other basin with buffer rules), shall be limited to "uses" identified within and constructed in accordance with 15A NCAC 2B .0233, .0259, .0250 and .0243, and shall be located, designed, constructed, and maintained to have minimal disturbance to protect water quality to the maximum extent practicable through the use of best management practices. All buffer rule requirements, including diffuse flow requirements, must be met.

8. Water Supply Watershed Buffers

   The 30-foot wide vegetative buffer (low-density development) or the 100-foot wide vegetative buffer (high-density development) shall be maintained adjacent to all perennial waters except for allowances as provided in the Water Supply Watershed Protection Rules [15A NCAC 2B .0212 through .0215].

9. If concrete is used during the construction, then a dry work area should be maintained to prevent direct contact between curing concrete and stream water. Water that inadvertently contacts uncured concrete should not be discharged to surface waters due to the potential for elevated pH and possible aquatic life/fish kills.

10. Compensatory Mitigation

    In accordance with 15A NCAC 2H .0506 (h), compensatory mitigation may be required for losses of 150 linear feet or more of streams and/or one (1) acre or more of wetlands. For linear, public transportation projects, impacts equal to or exceeding 150 linear feet per stream shall require mitigation.

    Compensatory stream mitigation shall be required at a 1:1 ratio for all perennial and intermittent stream impacts in watersheds classified as ORW, HQW, Trout, WS-I and WS-II.

    Buffer mitigation may be required for any project with Buffer Rules in effect at the time of application for buffer impacts resulting from activities classified as "Allowable with Mitigation" within the "Table of Uses" section of the Buffer Rules or require a variance under the Buffer Rules.

    A determination of buffer, wetland and stream mitigation requirements shall be made for any General Water Quality Certification for this Nationwide Permit. Design and monitoring protocols shall follow the US Army Corps of Engineers Wilmington District *Stream Mitigation Guidelines* (April 2003), or its subsequent updates. Compensatory mitigation plans shall be submitted for written Division approval as required in those protocols. Alternatively, the Division will accept payment into an in-lieu fee program or credit purchase from a mitigation bank.

    Finally, the mitigation plan must be implemented and/or constructed before any permanent building or structure on site is occupied. In the case of public road projects, the mitigation plan must be implemented before the road is opened to the public. Proof of payment to an in-lieu fee program or mitigation bank must be provided to the Division to satisfy this requirement.

Water Quality Certification N°. 3705

11. For all activities requiring re-alignment of streams, a stream relocation plan must be included for written Division approval. Relocated stream designs should include the same dimensions, patterns and profiles as the existing channel (or a stable reference reach if the existing channel is unstable), to the maximum extent practical. The new channel should be constructed in the dry and water shall not be turned into the new channel until the banks are stabilized. Vegetation used for bank stabilization shall be limited to native woody species, and should include establishment of a 30-foot wide wooded and an adjacent 20-foot wide vegetated buffer on both sides of the relocated channel to the maximum extent practical. A transitional phase incorporating appropriate erosion control matting materials and seedling establishment is allowable. Rip-rap, A-Jacks, concrete, gabions or other hard structures may be allowed if it is necessary to maintain the physical integrity of the stream; however, the applicant must provide written justification and any calculations used to determine the extent of rip-rap coverage. Please note that if the stream relocation is conducted as a stream restoration as defined in the US Army Corps of Engineers Wilmington District, April 2003 *Stream Mitigation Guidelines* (or its subsequent updates), the restored length can be used as compensatory mitigation for the impacts resulting from the relocation.

12. Stormwater Management Plan Requirements

    A. For applicants other than the North Carolina Department of Transportation, a Stormwater Management Plan in accordance with the version of *Stormwater Management Plan (SMP) Requirements for Applicants other than the North Caroline Department of Transportation* posted on the Division web site at the time of application shall be provided for any project that meets both of the following two criteria:

    i. Requires a 404 Permit or Isolated Wetlands Permit (regardless of whether written authorization is required by the Division), AND

    ii. Contains one or more drainage areas that are anticipated to have impervious surface cover of equal to or greater than 24 percent. When drainage areas are difficult to delineate or when a pocket of high density exists within a drainage area, the Division shall use best professional judgment to apply the SMP requirement as appropriate.

    B. For the North Carolina Department of Transportation, compliance with NCDOT's Individual NPDES permit NCS000250 shall serve to satisfy this condition.

13. Placement of Culverts and Other Structures in Waters and Wetlands

    Culverts required for this project shall be designed and installed in such a manner that the original stream profiles are not altered and allow for aquatic life movement during low flows. Existing stream dimensions (including the cross section dimensions, pattern, and longitudinal profile) must be maintained above and below locations of each culvert. Placement of culverts and other structures in waters and streams must be placed below the elevation of the streambed by one foot for all culverts with a diameter greater than 48 inches, and 20 percent of the culvert diameter for culverts having a diameter less than or equal to 48 inches, to allow low flow passage of water and aquatic life.

    Installation of culverts in wetlands must ensure continuity of water movement and be designed to adequately accommodate high water or flood conditions. Additionally, when roadways, causeways or other fill projects are constructed across FEMA-designated floodways or wetlands, openings such as culverts or bridges must be provided to maintain the natural hydrology of the system as well as prevent constriction of the floodway that may result in destabilization of streams or wetlands.

Water Quality Certification N°. 3705

If site-specific topographic constraints preclude the ability to bury the culverts as described above and/or the applicant can demonstrate that burying the culvert would result in destabilization of the channel and head-cutting upstream, the Division will consider alternative design proposals.

Any riprap required for normal pipe burial and stabilization shall be buried such that the original stream elevation is restored and maintained.

The establishment of native, woody vegetation and other soft stream bank stabilization techniques must be used where practicable instead of riprap or other bank hardening methods.

14. Additional site-specific conditions may be added to the written approval letter for projects proposed under this Water Quality Certification in order to ensure compliance with all applicable water quality and effluent standards.

15. If an environmental document is required under the National or State Environmental Policy Act (NEPA or SEPA), then this General Certification is not valid until a Finding of No Significant Impact (FONSI) or Record of Decision (ROD) is issued by the State Clearinghouse.

16. If this Water Quality Certification is used to access building sites, then all lots owned by the applicant must be buildable without additional impacts to streams or wetlands. The applicant is required to provide evidence that the lots are buildable without requiring additional impacts to wetlands, waters or buffers if required to do so in writing by the Division. For road construction purposes, this Certification shall only be utilized from natural high ground to natural high ground.

17. Deed notifications or similar mechanisms shall be placed on all retained jurisdictional wetlands, waters and protective buffers in order to assure compliance for future wetland, water and buffer impact. These mechanisms shall be put in place at the time of recording of the property, or of individual lots, whichever is appropriate. A sample deed notification can be downloaded from the 401/Wetlands Unit web site at http://h2o.enr.state.nc.us/ncwetlands. The text of the sample deed notification may be modified as appropriate to suit to a specific project.

18. When written authorization is required for use of this certification, upon completion of all permitted impacts included within the approval and any subsequent modifications, the applicant shall be required to return the certificate of completion attached to the approval. One copy of the certificate shall be sent to the DWQ Central Office in Raleigh at 1650 Mail Service Center, Raleigh, NC, 27699-1650.

19. This General Certification shall expire three (3) years from the date of issuance of the written letter from the Division or on the same day as the expiration date of the corresponding Nationwide Permit The conditions in effect on the date of issuance of Certification for a specific project shall remain in effect for the life of the project, regardless of the expiration date of this Certification. If the construction process for approved activities will overlap the expiration and renewal date of the corresponding 404 Permit and the Corps allows for continued use of the 404 Permit, then the General Certification shall also remain in effect without requiring re-application and re-approval to use this Certification for the specific impacts already approved.

Water Quality Certification N°. 3705

20. The applicant/permittee and their authorized agents shall conduct all activities in a manner consistent with State water quality standards (including any requirements resulting from compliance with §303(d) of the Clean Water Act), and any other appropriate requirements of State and Federal Law. If the Division determines that such standards or laws are not being met, including failure to sustain a designated or achieved use, or that State or Federal law is being violated, or that further conditions are necessary to assure compliance, then the Division may reevaluate and modify this General Water Quality Certification.

Non-compliance with or violation of the conditions herein set forth by a specific fill project may result in revocation of this General Certification for the project and may also result in criminal and/or civil penalties.

The Director of the North Carolina Division of Water Quality may require submission of a formal application for Individual Certification for any project in this category of activity, if it is determined that the project is likely to have a significant adverse effect upon water quality including state or federally listed endangered or threatened aquatic species or degrade the waters so that existing uses of the wetland or downstream waters are precluded.

Public hearings may be held for specific applications or group of applications prior to a Certification decision if deemed in the public's best interest by the Director of the North Carolina Division of Water Quality.

Effective date: November 1, 2007

DIVISION OF WATER QUALITY

By

Coleen H. Sullins

Director

History Note: Water Quality Certification Number 3705 replaces Water Quality Certification Numbers 3106 and 3108 issued on February 11, 1997, Water Quality Certification Number 3287 issued on June 1, 2000, Water Quality Certification Number 3362 issued March 18, 2002, Water Quality Certification Number 3402 issued March, 2003, and Water Quality Certification Number 3631 issued March 19, 2007. This Water Quality Certification is rescinded when the Corps of Engineers re-authorizes Nationwide Permits 18, 29, 39, 41, 42, 43 or 44 or when deemed appropriate by the Director of the Division of Water Quality.

Copy Furnished:
CDM; Attn: Mr. Kenton Yang, 5400 Glenwood Avenue, Suite 300 Raleigh, NC 27612

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action ID. **SAW-2008-02908** County: **Buncombe** USGS Quad: **Leicester**

GENERAL PERMIT (REGIONAL AND NATIONWIDE) VERIFICATION

Property Owner / Authorized Agent: **Buncombe County Solid Waste Management Facility-Construction Demolition and Debris Landfill**
Address: **81 Panther Branch Road**
Alexander, NC 28701

Size and location of property (water body, road name/number, town, etc.): **The proposed project site is located along an unnamed tributary to Panther Branch, within the existing 604.5 acres of the Buncombe County Solid Waste Management Facility on Panther Branch Road, in the town of Alexander, Buncombe County, North Carolina. 35.7265 N and -82.6416 W.**

Description of projects area and activity: **This verification authorizes impacts to jurisdictional waters of the U.S. for the expansion of the existing Construction Demolition and Debris landfill. Impacts authorized total 147 linear feet for the placemen t of fill material into an intermittent unnamed tributary to Panther Branch.**

Applicable Law: ☒ **Section 404 (Clean Water Act, 33 USC 1344)**
☐ Section 10 (Rivers and Harbors Act, 33 USC 403)

Authorization: Regional General Permit Number:
Nationwide Permit Number: 39

Your work is authorized by the above referenced permit provided it is accomplished in strict accordance with the attached conditions and your submitted plans. Any violation of the attached conditions or deviation from your submitted plans may subject the permittee to a stop work order, a restoration order and/or appropriate legal action.

This verification will remain valid until the expiration date identified below unless the nationwide authorization is modified, suspended or revoked. If, prior to the expiration date identified below, the nationwide permit authorization is reissued and/or modified, this verification will remain valid until the expiration date identified below, provided it complies with all requirements of the modified nationwide permit. If the nationwide permit authorization expires or is suspended, revoked, or is modified, such that the activity would no longer comply with the terms and conditions of the nationwide permit, activities which have commenced (i.e., are under construction) or are under contract to commence in reliance upon the nationwide permit, will remain authorized provided the activity is completed within twelve months of the date of the nationwide permit's expiration, modification or revocation, unless discretionary authority has been exercised on a case-by-case basis to modify, suspend or revoke the authorization.

Activities subject to Section 404 (as indicated above) may also require an individual Section 401 Water Quality Certification. You should contact the NC Division of Water Quality (telephone (919) 733-1786) to determine Section 401 requirements.

For activities occurring within the twenty coastal counties subject to regulation under the Coastal Area Management Act (CAMA), prior to beginning work you must contact the N.C. Division of Coastal Management.

This Department of the Army verification does not relieve the permittee of the responsibility to obtain any other required Federal, State or local approvals/permits.

If there are any questions regarding this verification, any of the conditions of the Permit, or the Corps of Engineers regulatory program, please contact Liz Hair at 828-271-7980.

Corps Regulatory Official Liz Hair Date: **April 14, 2009**

Expiration Date of Verification: **April 14, 2011**

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete the attached customer Satisfaction Survey or visit http://www.saw.usace.army.mil/WETLANDS/index.html to complete the survey online.

Determination of Jurisdiction:

A. ☐ Based on preliminary information, there appear to be waters of the US including wetlands within the above described project area. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331).

B. ☐ There are Navigable Waters of the United States within the above described project area subject to the permit requirements of Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

C. ☒ **There are waters of the US and/or wetlands within the above described project area subject to the permit requirements of Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification. This jurisdictional determination applies to the area described as the study area only.**

D. ☐ The jurisdictional areas within the above described project area have been identified under a previous action. Please reference jurisdictional determination issued ___. Action ID

Basis of Jurisdictional Determination: The site contains wetlands as determined by the USACE 1987 Wetland Delineation Manual and is adjacent to stream channels that exhibit indicators of ordinary high water marks. The stream channel on the property is an unnamed tributary to Panther Branch which flows into the French Broad River and ultimately flows to the Gulf of Mexico through the UT to Panther Branch> Panther Branch> French Broad River, a section 10 navigable water of the U.S..

Appeals Information: (This information does not apply to preliminary determinations as indicated by paragraph A. above).

Attached to this verification is an approved jurisdictional determination. If you are not in agreement with that approved jurisdictional determination, you can make an administrative appeal under 33 CFR 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and request for appeal (RFA) form. If you request to appeal this determination you must submit a completed RFA form to the following address:

District Engineer, Wilmington Regulatory Program
Attn: Liz Hair, Project Manager
151 Patton Avenue, Room 208
Asheville, North Carolina 28801

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address within 60 days from the *Issue Date* below.

It is not necessary to submit an RFA form to the Division Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: Liz Hair

Issue Date: **April 14, 2009**

Expiration Date: Five years from *Issue Date*

SURVEY PLATS, FIELD SKETCH, WETLAND DELINEATION FORMS, PROJECT PLANS, ETC., MUST BE ATTACHED TO THE FILE COPY OF THIS FORM, IF REQUIRED OR AVAILABLE.

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

March 13, 2009

Ms. Liz Hair
U.S. Army Corps of Engineers, Regulatory Branch
151 Patton Avenue, Room 208
Asheville, North Carolina 28801-5006

MAR 13 2009

SUBJECT: Nationwide Permit Application for Buncombe County Solid Waste Management Facility Culvert in UT Panther Branch, Buncombe County

Dear Ms. Hair:

The Buncombe County Solid Waste Management Facility requested a letter of concurrence from the North Carolina Wildlife Resources Commission (Commission) for a 404 Permit from the U.S. Army Corps of Engineers. Comments from the Commission are provided under provisions of the Clean Water Act of 1977 (33 U.S.C. 466 et seq.) and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667d).

The project involves putting 147 feet of culvert in a tributary to Panther Branch near Alexander to accommodate a landfill expansion.

The project should not harm trout. The Commission has no major concerns with this project provided the Nationwide and Final Regional conditions are adhered to (except trout moratorium is unnecessary) and if effective sediment and erosion control measures are used and maintained.

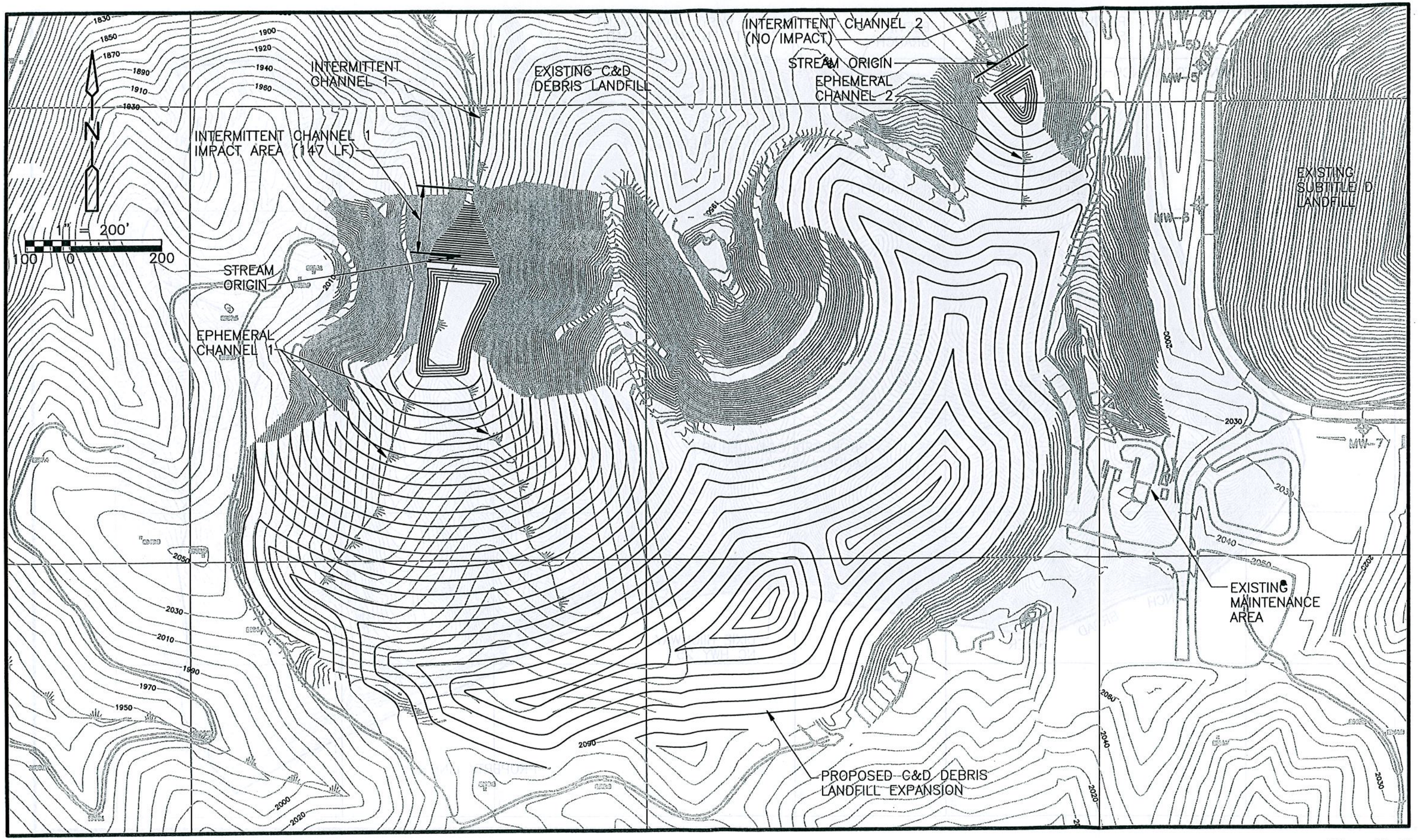
Thank you for the opportunity to review and comment on this project. If there are any questions regarding these comments, please contact me at (828) 452-2546 extension 24.

Sincerely,

Dave McHenry
Mountain Region Coordinator, Habitat Conservation Program

cc: K.J. Yang, Camp Dresser & McKee

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028



CDM
consulting • engineering • construction • operations

Figure No. 2
Buncombe County C&D Debris Landfill Expansion
Jurisdictional Waters Impacts

Part 3 - Facility Plan
Appendix B – Location Restrictions

Attachment C
State Historic Preservation Office/
Department of Cultural Resources Correspondence

North Carolina Department of Cultural Resources

State Historic Preservation Office

Peter B. Sandbeck, Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

March 12, 2009

Kenton Yang
Camp Dresser & McKee
5400 Glenwood Avenue
Suite 300
Raleigh, NC 27612

Re: Buncombe County Solid Waste Management Facility, C&D Landfill Expansion, Buncombe County, ER 08-2378

Dear Mr. Yang:

Thank you for your letter of September 29, 2008, concerning the above project. We apologize for the delay in our response.

We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Peter Sandbeck

Part 3 - Facility Plan
Appendix B – Location Restrictions

Attachment D
Natural Heritage Program Correspondence

NCDENR

North Carolina Department of Environment and Natural Resources

Michael F. Easley, Governor | William G. Ross Jr., Secretary

October 6, 2008

Mr. Kenton J. Yang
CDM
5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612

Reference: Buncombe County, North Carolina
Buncombe County Solid Waste Management Facility
C&D Landfill Expansion
CDM Project Number 6447-65973

Dear Mr. Yang:

The NC Natural Heritage Program has two records of rare species and one Significant Natural Heritage Area within the landfill property boundary and several additional records of rare species and state nature preserves within two miles of the project site shown on your map of September 29, 2008.

The Panther Cliffs Significant Natural Heritage Area is located along the western property boundary, facing the French Broad River. This area supports two rare plant species, Branching Draba (*Draba ramosissima*), NC Significantly Rare, and Carolina Saxifrage (*Micranthes caroliniana* or *Saxifraga caroliniana*), US Federal Species of Concern and NC Significantly Rare.

Additional species reported within two miles of the project site include:

- Piratebush (*Buckleya distichophylla*), US Federal Species of Concern and NC Endangered
- Southern Zigzag Salamander (*Plethodon ventralis*), NC Special Concern
- Striped Shiner (*Luxilus chrysocephalus*), NC Special Concern
- American Barberry (*Berberis canadensis*), NC Significantly Rare
- Bleeding Heart (*Dicentra eximia*), NC Significantly Rare
- Climbing Fumatory (*Adlumia fungosa*), NC Significantly Rare
- Slender Corydalis (*Corydalis micrantha ssp. micrantha*), NC Significantly Rare

The Sandymush Game Land is located on the west bank of the French Broad River, across from the landfill property boundary.

You may wish to consult with the NC Plant Conservation Program or the NC Wildlife Resources Commission if direct or indirect impacts are expected to affect protected species habitat.

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-715-8700 \ Email: misty.buchanan@ncmail.net \ www.ncnhp.org

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NORTH CAROLINA Natural Heritage Program
SCIENCE GUIDING CONSERVATION

use of Natural Heritage Program data should not be substituted for actual field surveys, particularly if the project area contains suitable habitat for rare species, significant natural communities, or priority natural areas. You may wish to check the Natural Heritage Program database website at www.ncnhp.org for a listing of rare plants and animals and significant natural communities in the county and on the quad map.

Our Program also has a website that allows users to obtain information on element occurrences and significant natural heritage areas within two miles of a given location: http://nhpweb.enr.state.nc.us/nhis/public/gmap75_main.phtml. The user name is "public" and the password is "heritage". You may want to click "Help" to download the user's manual before you use the application. This website gives you instant answers to information requests about specific locations, without waiting for NHP staff to respond.

NC OneMap provides digital Natural Heritage data online for free. This service provides site specific information on GIS layers with Natural Heritage Program rare species occurrences and Significant Natural Heritage Areas. The NC OneMap website provides Element Occurrence (EO) ID numbers (instead of species name), and the data user is then encouraged to contact the Natural Heritage Program for detailed information. This service allows the user to quickly and efficiently get site specific NHP data without visiting the NHP workroom or waiting for the Information Request to be answered by NHP staff. For more information about data formats and access, visit www.nconemap.com, then click on "FTP Data Download", and then "nheo.zip" [to the right of "Natural Heritage Element Occurrences"]. You may also e-mail NC OneMap at dataq@ncmail.net for more information.

We appreciate your interest in Natural Heritage Program data. If you have any questions or need additional information, please contact me at (919) 715-8700.

Sincerely,

Misty Buchanan

Misty Buchanan
Botanist

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-715-8700 \ Email: misty.buchanan@ncmail.net \ www.ncnhp.org

NORTH CAROLINA
Natural Heritage Program
SCIENCE GUIDING CONSERVATION

Part 3 - Facility Plan
Appendix B – Location Restrictions

Attachment E
US Fish and Wildlife Service Correspondence

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Asheville Field Office
160 Zillicoa Street
Asheville, North Carolina 28801

October 20, 2008

Mr. Kenton J. Yang, P.E.
Camp Dresser & McKee
5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612

Dear Mr. Yang:

Subject: Buncombe County Solid Waste Management Facility, C&D Landfill Expansion, Buncombe County, North Carolina (CDM Project Number 6447-65973)

In your letter dated September 29, 2008, you requested our comments about the subject project. The following comments are provided in accordance with the provisions of section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1543) (Act).

According to our records and a review of the information you provided, no federally listed species or their habitats occur on the site. Therefore, we believe the requirements under section 7 of the Act are fulfilled. However, obligations under section 7 of the Act must be reconsidered if: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered, (2) this action is subsequently modified in a manner that was not considered in this review, or (3) a new species is listed or critical habitat is determined that may be affected by the identified action.

Thank you for allowing us to comment on this project. Please contact Mr. Allen Ratzlaff of our staff at 828/258-3939, Ext. 229, if you have any questions. In any future correspondence concerning this project, please reference our Log Number 4-2-09-001.

Sincerely,

Amy Pepler for

Brian P. Cole
Field Supervisor

Buncombe County
North Carolina

Buncombe County Solid Waste Management Facility
Subtitle D Landfill
Phase IV (Cell 7) Permit to Construct Application

Part 3 – Engineering Plan

April 2014

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Section 1

Engineering Design

The following sections describe the engineering design of Phase IV (Cell 7). The design is consistent with the original permitted design.

1.1 Liner System

The proposed composite liner system for Phase IV is designed in conformance with Title 15A of the North Carolina Administrative Code, Subchapter 13B, Section .1624 and will be constructed according to the following liner system design:

- A textured 60-mil HDPE geomembrane
- A geosynthetic clay liner (GCL)
- An 18-inch thick low permeability compacted soil liner with a hydraulic conductivity of less than or equal to 1×10^{-5} cm/sec,

The liner system is shown in Detail A on Sheet EP-7.

A heavyweight, non-woven fabric cushion will be installed over the geomembrane to protect it from damage by the 24-inch rock drainage layer. The selected fabric cushion has a minimum mass per unit area of 28 ounces per square yard as supported by the calculation provided in **Appendix A-1**.

The perimeter of the liner system will be anchored by a 5-ft long by 2-ft deep clay plug as shown in Detail B on Sheet EP-7. The anchor trench has been designed to secure the geomembrane but allow pull-out at a tensile force that is less than the tensile force of the geomembrane to avoid rupture as demonstrated in the calculation provided in **Appendix A-2**.

Consistent with the design of the previous cells, a groundwater monitoring system will be installed beneath the liner system in the sump area of Phase IV. The limits of the groundwater monitoring system are shown on Sheets EP-2, EP-3 and EP-4. The monitoring system consists of a 60-mil HDPE geomembrane overlain by a composite drainage net as shown on Sheet EP-10. Three feet of common fill separate the monitoring system from the bottom of the Phase IV liner system. A 10-inch perforated HDPE pipe will route any liquids captured by the system through a liner penetration to a solid 10-inch diameter pipe that connects to a 10-inch diameter stand-pipe. The stand-pipe extends vertically to the top of the perimeter berm. The stand-pipe will be monitored for leakage by the landfill staff. If liquid is detected it will be pumped out and the quantity of liquid will be recorded. A sample of the liquid will be tested for quality to determine if it is leachate.

1.2 Leachate Collection System

In accordance with Title 15A of the North Carolina Administrative Code, Subchapter 13B, Section .1624, the leachate collection system (LCS) will be installed directly above the composite liner system. The proposed LCS is composed of a 24-inch rock drainage layer and French drains as presented on Sheet EP-4. A description of the LCS components is provided below:

- Drainage Layer – The drainage layer consists of 24 inches of NCDOT 57m aggregate with a 28-ounce heavyweight fabric cushion placed underneath it to protect the geomembrane. The highly permeable material and collection piping system will maintain a hydraulic head of less than 12-inches at all times as demonstrated in the USEPA HELP Model runs provided in **Appendix A-3**.

- Collection Pipes – The collection pipes consists of 10-inch diameter perforated HDPE pipes with a standard dimension ratio (SDR) of 17, surrounded by a gravel drainage media (NCDOT No. 4 stone), and wrapped with a woven monofilament geotextile. The selected woven geotextile h an apparent opening size (AOS) of 0.425mm (Propex Geotex 106F or equal).

  The leachate collection pipes are designed to support the maximum static and dynamic loads calculated for the cell and account for the loss of pipe strength resulting from the perforations as demonstrated in **Appendix A-4**.

  Leachate is conveyed to a sump area located in the lowest point of the cell as shown on Sheet EP-4. The leachate pipe conveyance calculation was performed to confirm that sufficient capacity is available to carry peak leachate flow conditions as demonstrated in **Appendix A-5**. The perforations of the leachate conveyance pipe are shown in Detail C of Sheet EP-8 and their flow capacity is demonstrated in **Appendix A-6**.

- Leachate Pump - The leachate is pumped out of the cell by a slope-riser pump system located in the sump area and discharged to the existing lined leachate pond through a 6-inch HDPE force main installed around the perimeter of the landfill. The landfill pumping system, consisting of the existing force main and pumps in Cells 1-6 and the additional force main and pump of Cell 7, was modeled to demonstrate that it can handle the additional flow from Cell 7 as provided in **Appendix A-7**.

1.3 Leachate Recirculation System

The recirculation system consists of a nine (9) horizontal injection trenches installed in the waste of Cell 7 as shown on Sheet EP-15 and EP-16. A 6-inch, perforated, HDPE pipe will be installed in a 3 ft by 3 ft trench to distribute leachate and collect gas when not injecting. The solid pipe sections will be sloped at a minimum 3% to allow condensate and leachate to drain. The injection pipe will be perforated with six rows of 1/2-inch holes spaced evenly around the pipe. The pipe will be covered with washed gravel which will meet the gradation requirements for NCDOT No. 4 stone as shown in Detail A of Sheet EP-17. The trenches will installed at elevations 2060ft and 2090ft. The positioning of the trenches are staggered between adjacent tiers to provide more uniform wetting.

The existing leachate recirculation pumps and the pipe network were evaluated to demonstrate that the leachate can be recirculated in Cell 7 as shown in **Appendix A-8**.

1.4 Stormwater Management System

The Phase IV construction will include expansion of the stormwater management system. The perimeter channel will be extended along the boundary of Phase IV and a new pond will be constructed.

The perimeter channel is designed to convey the 24-hour, 25-year storm event for the build-out condition of the landfill. The channel will be 3-ft deep with a bottom width of 3 feet. The channel will be formed by the outside slope of the containment berm (2:1 slope) and the inside slope of the access

road (2:1 slope) as shown in Detail A on Sheet EP-2. The channel will be protected from erosion by a fabric formed concrete liner. A drop inlet will be located at the low point of the channel to drain stormwater through two, 24-inch diameter reinforced concrete pipes to a stilling structure as shown on Sheet EP-2. Stormwater will be routed from the stilling structure to the new Sediment Pond No. 2 using a fabric filled concrete lined channel. Design calculations for the stormwater control devices were calculated to accommodate the 25-year, 24-hour storm event and are provided in **Appendix A-9**.

Erosion and sediment control devices such as sediment traps and silt fencing will be used during the construction to treat sediment laden stormwater. These devices will remain in use until construction has been completed and all permanent stormwater control devices are operable.

A stormwater segregation system is designed for Cell 7 and presented on Sheet EP-4A. The purpose of the stormwater segregation system is to limit the amount of rainfall that would be considered leachate when the cell is first active. The system will use a scrim reinforced tarp installed over the protective stone layer in the south area of Cell 7 with a stormwater pump located at the low point of the segregated area. Design calculations for the stormwater berm storage and pumping system are provided in **Appendix A-9**.

In addition, diversion berms will be installed on the east sideslope of Cell 6 to divert stormwater away from the construction area as shown in **Appendix A-10**.

Prior to construction, a Sedimentation and Erosion Control Permit Application will be submitted to NCDENR Land Quality Section prepared in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual.

1.5 Final Cover System

The final cover system is designed to resist erosive forces, minimize stormwater infiltration and prevent uplift due to gas pressure. The cover system consists of an erosion layer, drainage layer, synthetic barrier layer and a gas venting as described below:

- A six-inch Erosion Layer consisting of soil capable of supporting native plant growth;
- An 18-inch Protective Soil Layer consisting of common fill;
- A Drainage Layer consisting of a geocomposite constructed of two layers of nonwoven geotextile heat-bonded to both sides of an HDPE drainage net;
- A Barrier Layer consisting of a textured 40-mil Linear Low Density Polyethylene (LLDPE) geomembrane or an equivalent geomembrane; and
- A Gas Venting Layer consisting of a geocomposite constructed of two layers of nonwoven geotextile heat-bonded to both sides of an HDPE drainage net.

The highly elastic nature of the LLDPE geomembrane is designed to accommodate the differential settlement during the post-closure period.

The post-settlement grades of the plateau area will be a minimum of 5 percent. For the sideslopes of Phases IV-VII, a maximum slope angle of 3:1 is proposed.

The geotechnical evaluation of the Cell 7 design is provided in **Appendix B**. The calculations demonstrate that the landfill will be stable using 3:1 sideslopes. Strain in the Cell 7 base liner system due to differential settlement of the foundation was calculated for the worst case scenario based on settlement estimates provided in **Appendix B**. The maximum elongation strain is calculated to be only 0.13%- far below the 12% allowable strain for 60-mil HDPE geomembrane as shown **Appendix A-11**.

1.6 Gas Collection System

Horizontal collection trenches will be installed during the operation phase of Cell 7that will be used for gas collection and leachate recirculation as shown on Sheets EP-15, 16 and 17. Early capture of landfill gas will be achieved by connecting the leachate collection piping to the gas main in seven locations as shown on Sheet EP-4. The connection design is shown in Detail D on Sheet EP-8. After build-out elevations are achieved a vertical gas collection system may be installed if deemed necessary. The condensate in the LFG collection system will be collected at one low point as shown on Sheet EP-4. The design of the condensate recovery system is provided in Detail F on Sheet EP-8. Condensate is pumped from the recovery system to the adjacent Cell 7 leachate riser where it comingles with leachate in the sump and is pumped to the leachate pond. Calculations shown in **Appendix A-12** estimate the amount of condensate generated in Cell 7 from landfill gas, and determine if the pump model AP-4/BL can convey landfill gas condensate from condensate recovery system to Cell 7 riser.

Section 2

Technical References and Location Restrictions

2.1 Technical References

The following references were used for the design of Cell 7.

- Buncombe County Cell 7 Design Hydrogeologic Report (refer to **Appendix C**)
- Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.07 authored by Dr. P.R. Schroeder et al. (1993)
- North Carolina Erosion and Sediment Control Planning and Design Manual
- SoftDesk (AutoCAD) Design Software
- Driscopipe Design Manual
- Designing with Geosynthetics, Third Ed. (1994) by R.M. Koemer

2.2 Location Restrictions

Rule .1620 (d)(2)(D) of the North Carolina Solid Waste Management Rules requires that a report be prepared and submitted demonstrating compliance with the criteria in Rule .1622. Rule .1622 requires documentation or approvals by agencies other than the Division of Solid Waste Management that demonstrate compliance with specific location criteria. The location criteria include:

- Airport safety;
- Floodplains;
- Wetlands;
- Fault areas;
- Seismic impact zones;
- Unstable areas;
- Cultural resources;
- State nature and historic preserve;
- Water supply watersheds; and
- Endangered and threatened species.

2.2.1 Airport Safety

Rule .1622 (1):

Airport safety location restrictions that apply to the Phase IV state that:

(a) A new MSWLF unit shall be located no closer than 5,000 feet from any airport runway used only by piston-powered aircraft and no closer than 10,000 feet from any runway used by turbine-powered aircraft;

(b) Owners and operators proposing to site a new MSWLF unit or lateral expansion within a five mile radius (26,400 feet) of any airport used by turbine-powered or piston-powered aircraft shall notify the affected airport and the Federal Aviation Administration prior to submitting a permit application to the Division.

As shown on **Figure 2-1** (presented after Section 2), the landfill site meets the airport safety location restrictions.

2.2.2 Floodplains

Rule .1622 (2):

Floodplain location restrictions that apply state that new MSWLF units shall not be located in the 100-year floodplains unless the owners or operators demonstrate that the unit:

- Will not restrict the flow of the 100-year flood;
- Will not reduce the temporary water storage capacity of the floodplain; or
- Result in washout of solid waste so as to pose a hazard to human health and the environment.

As presented on Figure 2-1, no portion of the Buncombe County facility resides in the 100-year floodplain.

2.2.3 Wetlands

Rule .1622 (3)(a):

The North Carolina Solid Waste Management Rules 15A NCAC 13 B, Section .1622 (3) require that new MSWLF units and lateral expansions shall not be located in wetlands, unless the owner or operator can make the following demonstrations to the Division:

- .1622 (3)(a)(i) That a practicable alternative to the proposed landfill facility that does not impact wetlands is not available;
- .1622 (3)(a)(ii) That the construction and operation of the MSWLF unit will not

  (A) Cause or contribute to violations of any applicable State water quality standard;

  (B) Violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act;

  (C) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973; and,

(D) Violate any requirements under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.

- .1622 (3)(a)(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 the 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 releases of solid waste;

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

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

- .1622 (3)(a)(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 wetland to the maximum extent practicable as required by Sub item (3)(a)(i) of this Rule, then minimizing unavoidable impacts through all appropriate and practicable compensatory mitigation actions (e.g. restoration of existing degraded wetland or creation of man-made wetlands); and

- .1622 (3)(a)(v) Sufficient information is available to make a reasonable determination with respect to these demonstrations.

As presented on Figure 2-1, the landfill property does not contain any wetlands.

2.2.4 Fault Areas

Rule .1622 (4)

The Subtitle D regulations (Section 258.13) effectively ban the location of new MSW landfill units within 200 feet (60 meters) of faults that have experienced displacement during the Holocene Geologic Epoch. These regulations define a Holocene fault "zone" (HFZ) to include not only the actual primary fracture along which strata on one side have been displaced with respect to the other side, but also, the appropriate zone (or zones) of rock which have been fractured in any geologic material along which there has been an observable amount of displacement of the sides relative to each other.

As referenced, EPA has effectively banned siting and construction of landfills within 200 feet of HFZs unless a demonstration to the director of an approved state program can be made which verifies that the integrity of the landfill will be protective of human health and the environment, and that the landfill structural integrity will not be compromised if built within an HFZ.

The United States Geological Survey (USGS) published a field studies map (Howard, et al. 1978) which illustrates the occurrence of "young" faults throughout the United States. Based on an evaluation of these data, no area of the site is within 200 feet of a fault. Therefore, no impact of this type is expected to occur which might affect the proposed site.

2.2.5 Seismic Impact Zones

Rule .1622 (5)

The Buncombe County Landfill is located within a seismic impact zone with a maximum horizontal acceleration value of 0.226g. The seismic impact zone was taken into consideration during the preparation of the geotechnical design of the Cell 7.

2.2.6 Unstable Areas

Rule .1622 (6)

The North Carolina Solid Waste Management Rules [15A NCAC 13 B, Section .1622 (6) (a)] requires owners or operators of municipal solid waste landfill (MSWLF) units which are located in unstable areas (UAs) to demonstrate that adequate engineering measures have been taken to ensure that the structural integrity of the MSWLF unit will not be disrupted. The rule provides definitions of unstable areas and conditions. At a minimum the following factors should be considered when determining whether an area is unstable:

- On-site or local soil conditions that may result in differential settling
- On-site or local geologic or geomorphologic features
- On-site or local human-made features or events

If the unit is located in an area that is or could become unstable, then the applicant must provide detailed structural engineering and geotechnical analysis.

The demonstration must show that the structural components of the MSWLF can withstand the impacts of potentially unstable areas, such as liquefaction areas, subsidence zones, karst areas, landslides, earth flows, rock slides, debris flows, avalanches, creep zones, slump areas, solifluction areas and other such features. The structural components include liners, leachate collection systems, final cover systems, run-on and run-off control systems, and any other components used in the construction and operation of the MSWLF unit that are necessary for protection of human health and the environment.

The Cell 7 site has no unstable areas or conditions.

2.2.7 Cultural Resources

Rule .1622 (7)

Cultural Resource location restrictions state that new MSWLF units shall not damage or destroy an archeological or historical property.

CDM Smith requested the North Carolina Department of Cultural Resources to identify any archaeological or historical properties, which may be damaged or destroyed as a result of the Subtitle

D landfill. The Department of Cultural Resources correspondence, provided after Section 2, confirms that the project will not impact any archeological or historical properties.

2.2.8 State Nature and Historic Preserves

Rule .1622 (8)

State Nature and Historic Preserve location restrictions state that new MSWLF units shall not have an adverse impact on State Nature and Historic Preserves. There are no State Nature or Historic Preserves in the vicinity of the site.

2.2.9 Water Supply Watersheds

Rule .1622 (9)(a)

Water Supply Watershed location restrictions state that MSWLF units shall not be located in the critical area of a water supply watershed or in the watershed for a stream segment classified as WS-1, in accordance with the rules codified in 15A NCAC 2B .0200 - "Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina."

The State has classified all surface waters and watersheds throughout the state as required by 15A NCAC 2B .0311 as referenced by Rule 2B .0200. These classifications are published in documents available through the Division of Environmental Management. A review of the locations of these state classified Water Supply Watersheds demonstrates that the proposed site is not located in an area that will impact or discharge to a WS-1, WS-II, WS-III, or WS-IV watershed. Therefore, the proposed location is in compliance with Water Supply Watershed rules (see Figure 2-1).

Rule .1622 (9)(b)

Water Supply Watershed location restrictions state that MSWLF units which shall discharge leachate to surface waters at the landfill facility must obtain a National Pollution Discharge Elimination System (NPDES) Permit from the Division of Environmental Management; and the discharge shall not be located within a watershed classified as WS-II or WS-III.

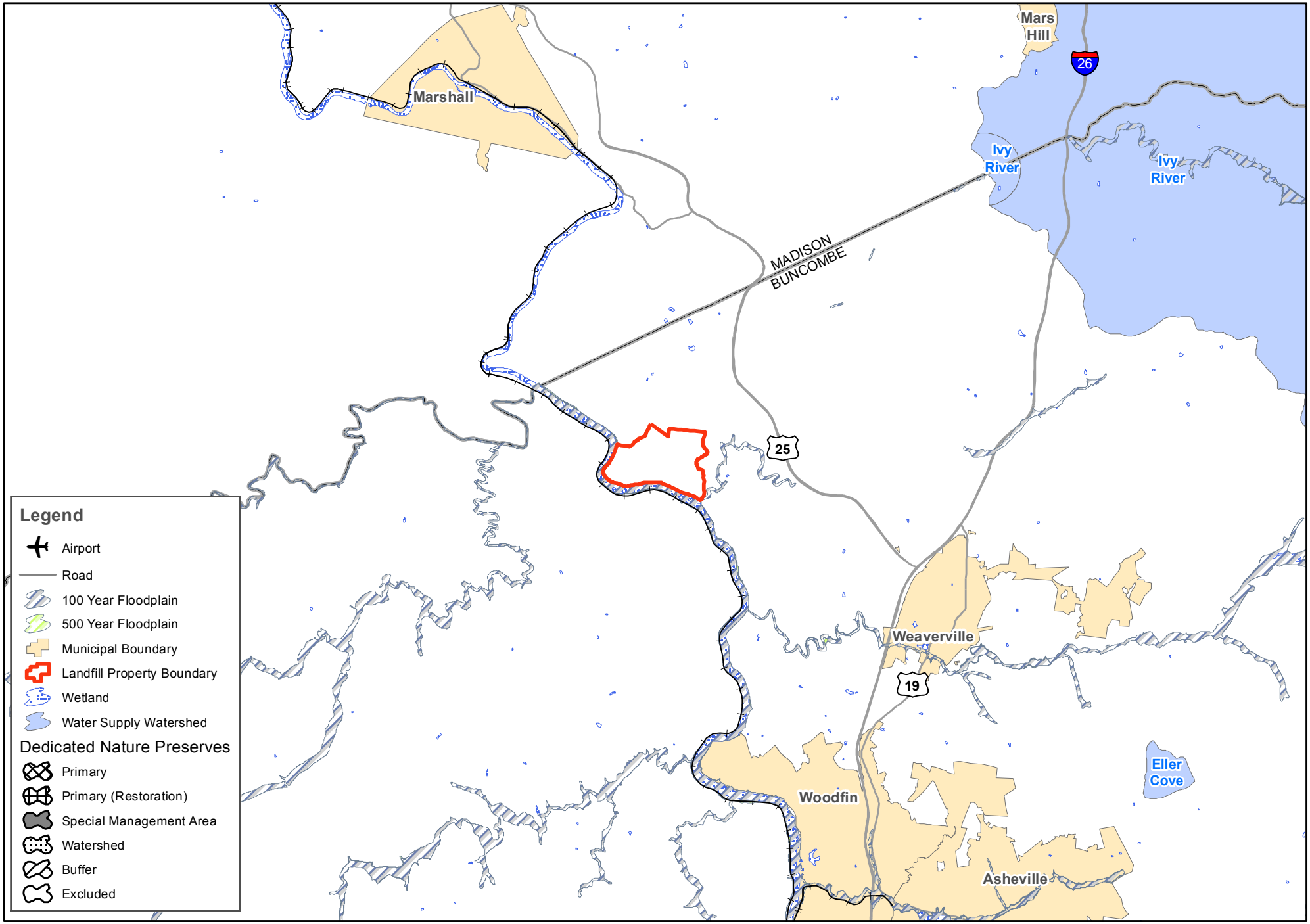
The proposed site is not located within any of the classified watersheds mentioned in Rule .1622(9)(b) and the facility will not discharge leachate into any surface water locations and therefore is not required to apply for an NPDES permit.

2.2.10 Endangered and Threatened Species

Rule .1622 (10)

Endangered and Threatened Species rules state that new MSWLF units shall not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modifications of a critical habitat, protected under the Federal Endangered Species Act of 1973.

The Natural Heritage Program stated during site suitability that there are no endangered or threatened species listed for the site.



CDM Smith

N
W E
S

0 1 2 4 6 Miles

SOURCE: Data is from NCONEMAP, NCDENR, NCDOT, and the North Carolina Floodplain Mapping Program

Figure 2-1
Location Restriction

North Carolina Department of Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Governor Pat McCrory
Secretary Susan Kluttz

Office of Archives and History
Deputy Secretary Kevin Cherry

November 26, 2013

Kenton Yang
CDM Smith
5400 Glenwood Avenue
Suite 300
Raleigh, NC 27612

Re: Buncombe County Landfill Expansion, 85 Panther Branch Road, Alexander, Buncombe County, ER 13-2725

Dear Mr. Yang:

Thank you for your email of November 7, 2013, concerning the above project.

We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579 or renee.gledhill-earley@ncdcr.gov. In all future communication concerning this project, please cite the above referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Ramona M. Bartos

Engineering Plan

Appendix A – Calculations

CDM Smith

Engineering Plan

Appendix A – Calculations

A-1 Fabric Puncture Protection

CDM Smith

CLIENT	Buncombe County	JOB NO.	6447-97693	COMPUTED BY	Ravi Kadambala
PROJECT	Cell 7	DATE CHECKED	KJY	DATE	9/9/2013
DETAIL	GM Puncture	CHECKED BY	1/30/2014		

Purpose:

The composite liner system that will be used for Cell 7 incorporates an aggregate layer, a geotextile, a geomembrane, and GCL. The calculation below was used to determine the required mass per unit area of nonwoven geotextile to protect the HDPE textured geomembrane from being puncture by the aggregate layer.

References:

1. Wilson-Fahmy, R.F., Narejo, D. and Koerner, R.M. (1996), "Puncture Protection of Geomembranes Part I: Theory", Geosynthetics International, Vol. 3, No. 5, pp. 605-628.

2. Narejo, D. and Koerner, R.M. and Wilson-Fahmy, R.F., (1996), "Puncture Protection of Geomembranes Part II: Experimental", Geosynthetics International, Vol. 3, No. 5, pp. 629-653.

3. Koerner, R.M., Wilson-Fahmy, R.F. and Narejo, D. (1996), "Puncture Protection of Geomembranes Part III: Examples", Geosynthetics International, Vol. 3, No. 5 pp. 655-675.

4. Koerner, R.M. (1998), Designing with Geosynthetics, Prentice Hall Publishing Co., Englewood Cliffs, NJ.

5. GSE Environmental (2002), Geomembrane Protection Design Manual, First Edition

Procedure:

The following case was evaluated:
Geomembrane installed below a geotextile with 24" min NCDOT No. 57M crushed stone (<1.5") placed over the geotextile and no live load.

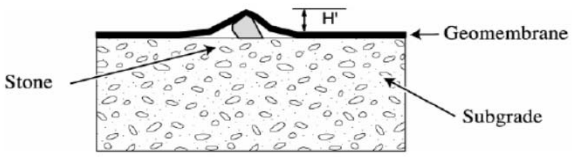


Figure 2.1 Effective Protrusion Height for the Case of Isolated Objects.

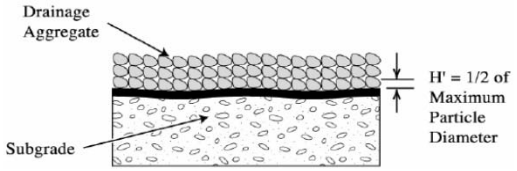


Figure 2.2 Effective Protrusion Height in the Case of Grouped Objects.

NCDOT No. 57M Stone

Std. Size #	% by Weight Passing
1.5"	100
1"	95-100
½"	25-45
#4	0-10
#8	0-5
#200	0-.6

Table 3.2 Mass per Unit Area of Nonwoven Needlepunched Geotextile Recommended for Geomembrane Protection During Installation.

Maximum Stone Size		Mass per Unit Area	
(mm)	(inch)	(g/m^2)	(oz/sq. yard)
≤ 12	≤ 0.5	≥ 335	≥ 10
≤ 25	≤ 1.0	≥ 405	≥ 12
≤ 38	≤ 1.5	≥ 540	≥ 16
≤ 50	≤ 2.0	≥ 1080	≥ 32

Max Size of NCDOT No. 57M Stone =	1.5	inch
Height of Protrusion (H) = 1/2 max diameter of particle =	0.75	inch
	0.019	m
Depth of material (d) on top of geomembrane =	140	feet
	43	meters
Unit weight of material on top of geomembrane =	90	lb/ft^3
	14.14	kN/m^3

Table 2.2 Approximate Unit Weights of Various Materials.

Material	Unit Weight (kN/m^3)	Unit Weight (lb/ft^3)
Soil	15 to 20	100 to 130
Water	9.8	62.5
Municipal Solid Waste	9 to 26	60 to 170
Steel	77	490
Concrete	24	160

$$p_{allow} = \left[450\frac{M}{H'^2}\right]\left[\frac{1}{MF_{PS}xFS_{CR}xFS_{CBD}}\right] \qquad FS = \frac{p_{allow}}{p_{act}}$$

P(act) =	603.3	Hydrostatic pressure applied (kN/m^2 = kPa)
H =	19	Height of maximum protrusion (mm)
FS(cr) =	1.3	Factor of Safety for creep of geotextile and geomembrane (see Table 3.3)
MF(ps) =	0.5	Modification Factor for particle shape (see Table 3.5 below)
FS(cbd) =	1.5	Factor of Safety for chemical and biological degradation (typically 1.5 for landfill leachate)

Calculation: Calculate Factor of Safety against puncture using a 28 oz/sy (950 g/m^2) nonwoven geotextile fabric cushion above the geomembrane

M =	950	Geotextile mass per unit area (g/m^2)
P(allow) =	1208	kPa = kN/m^2
FS =	2.0	Factor of Safety

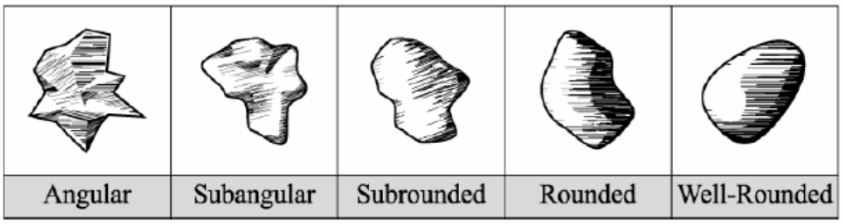
Table 3.3 Factors of Safety for Creep Obtained from Long Term Puncture Testing (Modified from Narejo et. al., 1996).

NW-NP Geotextile Mass		Effective Protrusion Height (mm)		
g/m^2	oz./sq. yard	≤38 (1.5")	≤25 (1.0")	≤12 (0.5")
None	None	N/R	N/R	N/R
270	8	N/R	N/R	>1.5
335	10	N/R	N/R	1.4
405	12	N/R	N/R	1.4
540	16	N/R	1.5	1.3
675	20	N/R	1.4	1.2
810	24	1.5	1.3	1.2
950	28	1.4	1.3	1.1
1100	32	1.3	1.2	1.1
2000	60	1.2	1.1	1.0

Note: Values in shaded rows are extrapolated; NW-NP = Nonwoven Needlepunched; N/R = Not Recommended

Table 3.5 Modification Factors for Shape of Stones.

Stone Shape	Modification Factor MF_{PS}
Angular	1.0
Subangular and subrounded	0.5
Rounded	0.25



Angular	Subangular	Subrounded	Rounded	Well-Rounded

Engineering Plan

Appendix A – Calculations

A-2 Anchor Trench Pull-out

CDM Smith

CDM Smith	CLIENT	Buncombe County	JOB NO.	6447-97693	COMPUTED BY Ravi Kadambala
	PROJECT	Cell 7	DATE CHECKED	2/4/2014	DATE 8/23/2013
	DETAIL	Anchor Trench Pull-Out	CHECKED BY	KJY	PAGE NO. 1 of 2

Task Design the anchor runout such to prevent the geomembrane to break under the applied stress

Reference:

1- *Designing with Geosynthetics* R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

2- *Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments.* G. N. Richardson and R. M. Koerner, 1987

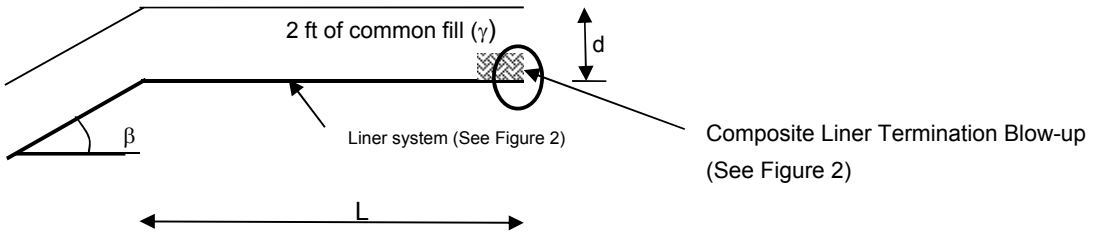


Figure 1: Anchor Trench Detail

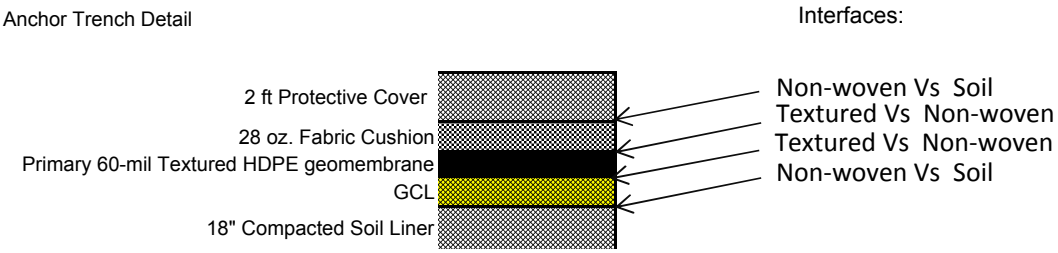


Figure 2: Composite Liner Termination Blow-up

Asumptions and Considerations

1- The top common filll moves along with the geomembrane as it deforms. Therefore , the friction angle between the cover soil and the geomembrane is assumed to be equal to zero ($\delta_U = 0$) (Reference 1, page 487).

2- The GCL has two layers of non-woven geotextile on both sides. The following interfaces shall be considered in the determination of the critical interface as shown on Figure 2.

Interface	Friction Angle	Reference
Textured Vs Non-woven	21. degrees	Attachment 2
Non-woven Vs. Soil	35.5 degrees	Attachment 1

The critical interface is the interface between the GCL (Non-woven) and the textured liner which has a friction angle of 21 degrees.

CDM Smith	CLIENT	Buncombe County	JOB NO.	6447-97693	COMPUTED BY Ravi Kadambala
	PROJECT	Cell 7	DATE CHECKED	2/4/2014	DATE 8/23/2013
	DETAIL	Anchor Trench Pull-Out	CHECKED BY	KJY	PAGE NO. 2 of 2

Procedure:

$$AR = \frac{T_{GMallow}}{T_{ATallow}}$$

where

AR	Anchor ratio
$T_{GMallow}$	Allowable geomembrane trench tension from ASTM D3886
$T_{ATallow}$	Allowable geomembrane trench tension from analytical model

$T_{GMallow}$ for the HDPE Liner geomembrane is 90 lbs/in *(See Attachment 4)*
or 1080 lbs/ft

$$T_{ATallow} = \frac{(\gamma * d * L * (\tan \delta_U + \tan \delta_L)}{\cos \beta - \sin \beta * \tan \delta_L}$$

Where

$T_{ATallow}$	Allowable anchor trench tension		
γ	Common fill unit weight	120	pcf
d	Thickness of the cover soil	2	ft
δ_L	GCL /geomembrane friction angle for the critical interface	21	degree
δ_U	Cover soil / geomembrane friction angle (above geomembrane)	0	degree
Φ	Soil internal friction angle	30	degree
β	Side slope angle (4H:1V)	14	degree

Procedure: Assume a value for the embedment length L and calculate AR.

If AR > 1 Geomembrane pull-out mode controls
AR = 1 Balanced Design.
AR < 1 Geomembrane tension rupture mode controls

Adjust embedment length until AR > 1

L = Embedment length 4 ft

$T_{ATallow}$ = 420 lbs/ft

$$AR = \frac{1080}{420}$$

AR = 2.57

Conclusion: Geomembrane pull-out mode controls OK

ATTACHMENT 1

SUMMARY OF BENTOMAT DIRECT SHEAR TEST DATA
INTERFACE W/ SOIL

Lab[1]	Report Date	Interface Tested[2]	Normal Stresses (psi)	Bentomat Moisture[3]	Shear Rate (in/min)	Peak Friction Angle (deg)	Residual Friction Angle (deg)[4]	Apparent Peak Cohesion (psf)	Comments
GSC	01-08-97	NW/ Soaked Soils	14 - 40 - 70	Hydrated	0.04	18	18	155	
TRI	09-23-97	NW/ Subbase Soil	3.5 – 7 – 14	Hydrated	0.001	24.0	20.7	4	
		NW/ Subbase Soil	.35 - .7 – 1.4	Hydrated	0.001	35.5	37.2	88	
GSC	01-22-98	CLS/ SM soil	5 - 25 - 45	Hydrated	0.04	17	13	70	
Cetco	02-10-98	CLS/ SC Soil	0.5 – 1 – 1.5	Hydrated	0.04	9.5	ND	46	
VE	03-03-98	W/ Cover soil	1 - 2.1 – 4.9	Hydrated	0.04	37	33	50	
Cetco	08-11-98	W/ SC soil	2.1 – 4.2 – 6.3	Hydrated	0.04	33.6	35.2	183	
		NW/ Non-Pag Quartz Monzonite Waste	2.1 – 4.2 – 6.3	Hydrated	0.04	39.8	37.5	190	
TRI	09-22-98	NW/ soil	16 – 32 – 73	Hydrated	0.04	17.5	16.8	505	Residual @ 3"
Cetco	11-3-98	CLS/SM soil	0.5 – 1 – 1.5	Hydrated	0.04	27	27	80	
		CLS/SP soil	0.5 – 1 – 1.5	Hydrated	0.04	15.2	15.2	55	

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ATTACHMENT 2

SUMMARY OF BENTOMAT DIRECT SHEAR TEST DATA
INTERFACE W/ GEOMEMBRANE (Continued)

Lab[1]	Report Date	Interface Tested[2]	Normal Stresses (psi)	Bentomat Moisture[3]	Shear Rate (in/min)	Peak Friction Angle (deg)	Residual Friction Angle (deg)[4]	Apparent Peak Cohesion (psf)	Comments
GSC	06-21-99	NW/ 40mil text. HDPE	14 – 28 – 56 – 112	Hydrated	0.04	18	9	375	
	06-25-99	NW/ 40mil text. HDPE	14 – 28 – 56 – 112	Hydrated	0.04	20	4	590	sheared w/in GCL @ 56, 112 psi
GSC	08-06-99	NW/ 60mil text. HDPE	10 – 25 – 50 – 75	Hydrated	0.04	21	16	150	
STS	10-28-99	NW/ 40mil text LLDPE	0.5 – 1 – 2 – 3	Hydrated	0.04	28.8	21.8	72	
GSC	02-01-00	NW/ 60mil text HDPE	7 – 14 – 35	Hydrated	0.0016	29	18	370	
		NW/ 60mil text. HDPE	35 – 100 - 150	Hydrated	0.0016	21	9	130	
PL	2-5-00	ST/ 40mil text LLDPE	0.35-0.69-1.39	Hydrated	0.04	29	16	196	residual @ 3.2"
PL	6-4-01	NW/60mil text HDPE	1.3-2.6-6.3	Hydrated	0.001	24.8	18.9	230	Hydrated under 72 psf
		NW/60mil text HDPE	1.3-2.6-6.3	Hydrated	0.001	21.4	18.5	225	Hydrated under 216 psf

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ATTACHMENT 3

SUMMARY OF BENTOMAT DIRECT SHEAR TEST DATA
INTERFACE W/ GEOCOMPOSITE

Lab[1]	Report Date	Interface Tested[2]	Normal Stresses (psi)	Bentomat Moisture[3]	Shear Rate (in/min)	Peak Friction Angle (deg)	Residual Friction Angle (deg)[4]	Apparent Peak Cohesion (psf)	Comments
GA	09-04-92	NW/Drainage Composite	0.5 - 1 - 2 - 4 - 10	Hydrated	0.02	21	19	0	
SL	08-02-96	W/Drainage Composite	0.7 - 1.0 - 1.4	Hydrated	0.04	16.8	ND	65.6	
			52 – 69 – 87	Hydrated	0.04	22.8	ND	560	
GSC	02-03-98	NW/Drainage Composite	3.5 - 7 - 10	Hydrated	0.04	14	13	65	
VE	03-03-98	NW/Drainage Composite	1.0 - 2.1 - 4.9	Hydrated	0.04	18	15	50	Residual @ 3"
GSC	04-14-98	W/Drainage Composite	1.4 - 2.8 - 5.6	Hydrated	0.04	19	18	22	
TRI	08-03-98	W/Drainage Composite	0.9 - 1.8 - 3.6-7.2	Hydrated	0.04	22.9	22.2	79	
ATE	01-15-99	CLS/Drainage Composite	1 - 2 - 3	Hydrated	0.0016	14	11.6	72	
TRI	09-14-99	NW/Drainage Composite	0.7 - 1.4 - 2.8	Hydrated	0.04	27.5	17.6	61	Residual @ 3.6"
ATT	09-21-00	CLT/Drainage composite	1.4 – 2.8 – 5.6	Hydrated	0.04	45.9	45.9	10.2	
GTX	10-05-00	NW/Drainage comp	10 - 30 - 70	Hydrated	0.004	22	18	1	
GT	12-6-00	W/Drainage Composite	1.4 – 2.8 – 4.2	Hydrated	0.04	25	20.7	0	Residual @ 2.3"

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MINIMUM PROPERTIES FOR GSE WHITE TEXTURED

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM VALUE			
Product Code			HDT 040C010	HDT 060C010	HDT 080C010	HDT 100C010
Thickness, (minimum average) mil (mm)	ASTM D 5994	every roll	38 (0.96)	57 (1.45)	76 (1.93)	95 (2.41)
Lowest individual for 8 out of 10 values			36 (0.91)	54 (1.40)	72 (1.80)	90 (2.30)
Lowest individual for any of the 10 values			34 (0.86)	51 (1.30)	68 (1.73)	85 (2.16)
Density[H], g/cm³	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94
Tensile Properties (each direction)[F1]	ASTM D 6693, Type IV	20,000 lb				
Strength at Break, lb/in-width (N/mm)	Dumbell, 2 ipm		60 (11)	90 (16)	120 (21)	150 (27)
Strength at Yield, lb/in-width (N/mm)			84 (15)	126 (22)	168 (29)	210 (37)
Elongation at Break, %	G.L. = 2.0 in (51 mm)		100	100	100	100
Elongation at Yield, %	G.L. = 1.3 in (33 mm)		12	12	12	12
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	28 (125)	42 (187)	56 (249)	70 (311)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	60 (267)	90 (400)	120 (534)	150 (667)
Carbon Black Content[H], %	ASTM D 1603	20,000 lb	2.0	2.0	2.0	2.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	+Note 1	+Note 1	+Note 1	+Note 1
Asperity Height	GRI GM 12	second roll	+Note 2	+Note 2	+Note 2	+Note 2
Notched Constant Tensile Load[H], hr	ASTM D 5397, Appendix	200,000 lb	300	300	300	300
REFERENCE PROPERTY	**TEST METHOD**	**FREQUENCY**	**NOMINAL VALUE**			
Oxidative Induction Time[H], min	ASTM D 3895, 200° C; O_2, 1 atm	200,000 lb	>100	>100	>100	>100
Roll Length[R] (approximate), ft (m)			700 (213)	520 (158)	400 (122)	330 (101)
Roll Width[R], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft² (m²)			15,750 (1,463)	11,700 (1,087)	9,000 (836)	7,425 (690)

NOTES:

- +Note 1: Dispersion only applies to near spherical agglomerates. 9 or 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- +Note 2: 10 mil average. 8 of 10 readings ≥7 mils. Lowest individual ≥ 5 mils.
- GSE White Textured is available in rolls weighing about 4,000 lb (1,800 kg).
- [F1]The combination of stress concentrations due to coextrusion texture geometry and the small specimen size results in large variation of test results. Therefore, these tensile properties are minimum average values.
- [H]GSE White Textured may have an overall ash content greater than 3.0% due to the white layer.
- [H]NCTL is conducted on representative smooth membrane samples.
- All GSE geomembranes have dimensional stability of ±2% when tested with ASTM D 1204 and ITB of <-77° C when tested with ASTM D 746.
- [H]The values apply to the black layer only.
- [R]Roll lengths and widths have a tolerance of ± 1%.

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Engineering Plan

Appendix A – Calculations

A-3 HELP Model

CDM Smith

HELP Model Evaluation

1. Introduction

The purpose of this section is to evaluate the performance of the leachate collection system (LCS) that will be constructed in Cell 7 using Hydraulic Evaluation of Landfill Performance (HELP) model.

The leachate collection system consists of a composite liner utilizing a geosynthetic clay liner (GCL) as shown in Figure 1. This composite liner is one liner that consists of three components: a geomembrane liner installed above and in uniform contact with a GCL overlying a compacted clay liner with a minimum thickness of 18 inches (0.46 m) and a permeability of no more than 1.0 X 10^{-5} cm/sec as per the requirements of NCDENR 15A NCAC 13B .1624 (b)(1)(A)(ii). Leachate percolating through the waste will drain vertically through a two foot protective cover rock layer and a fabric cushion residing above the primary liner. The leachate collection system has to be hydraulically designed using HELP model to remove leachate from the landfill and ensure that the leachate head on the composite liner does not exceed one foot. Leachate will travel along the 6-percent slope through the protective cover rock to a leachate collection pipe. These pipes will be 10-inch perforated HDPE pipes placed in a NCDOT No. 4 stone envelope and wrapped with a woven filter fabric as shown in Figure 2. These leachate collection pipes have been designed to meet the 2 percent post-settlement slope requirement of NCDENR 15A NCAC 13B .1624 (b)(7).

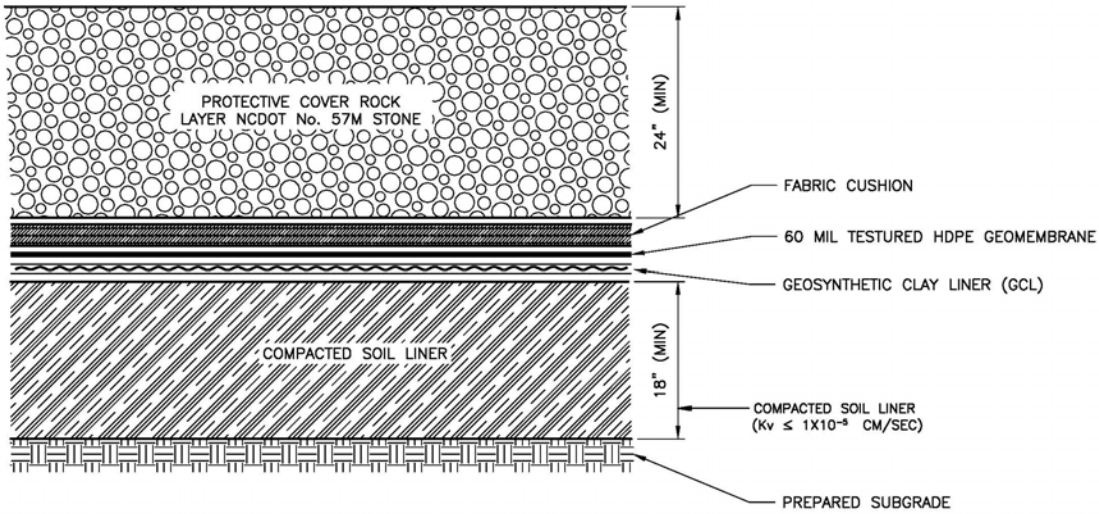

Figure 1. Leachate Collection System of Cell 7

2. Purpose of HELP Model Analyses

The HELP model is a quasi-two dimensional water balance computer program developed by EPA, commonly used to evaluate the performance of landfill liner systems. Using historic rainfall data from January 1998 to December 2012 at the Asheville Airport, leachate production rates, liner leakage, and leachate head were estimated for four phases of operation at the Buncombe Landfill.

3. Operation Conditions

The four cases considered in HELP are described below:

- **Case 1 – First Lift of Waste**
  This scenario considers the initial conditions in a cell after the placement of the first lift, 10 feet of waste and 6 inches of daily cover. No runoff or surface vegetation was assumed.

- **Case 2 – Active Operation**
  This scenario considers an intermediate condition with 30 feet of waste and 6 inches of daily cover. No runoff or surface vegetation was assumed.

- **Case 3 – Intermediate Cover**
  This scenario considers a phase close to full capacity, 90 feet of waste with 12 inches of intermediate cover. A curve number of 93.7 was calculated within HELP for intermediate cover with an estimated 5% slope. 75% of the leachate generated was recirculated in the top 45 ft of waste.

- **Case 4 – Final buildout conditions with a final cap and 90 feet of waste**
  This scenario considers post-closure conditions with 90 ft of waste and final cover installed. The final cap includes 2 feet of soil, drainage net, 40-mil HDPE geomembrane, drainage net, and 12 inches of intermediate cover. A curve number of 79.8 was calculated within HELP for final cover with an estimated 5% slope. 75% of the leachate generated was recirculated in the top 45 ft of waste.

  This case represents the lowest potential for leachate generation, leakage, and head, as the cover system is designed to minimize percolation of rainfall through the waste.

4. Model Setup

Leachate generation for the Buncombe Landfill was modeled using HELP for each of the 4 cases. The maximum drainage length in the leachate collection system was 450 ft, and had a pre-settlement drainage slope of 6.3% as shown in Figure 2. Geotechnical report (found in the Engineering Plan) indicates that the maximum settlement from the center to the perimeter of the landfill is 23.5 inches. The post settlement slope was estimated to be 5.8% and used in HELP modeling. The geomembrane was assumed to have pinhole density of 3 per acre, installation defect of 1 per acre, and placement quality of 3 per acre.

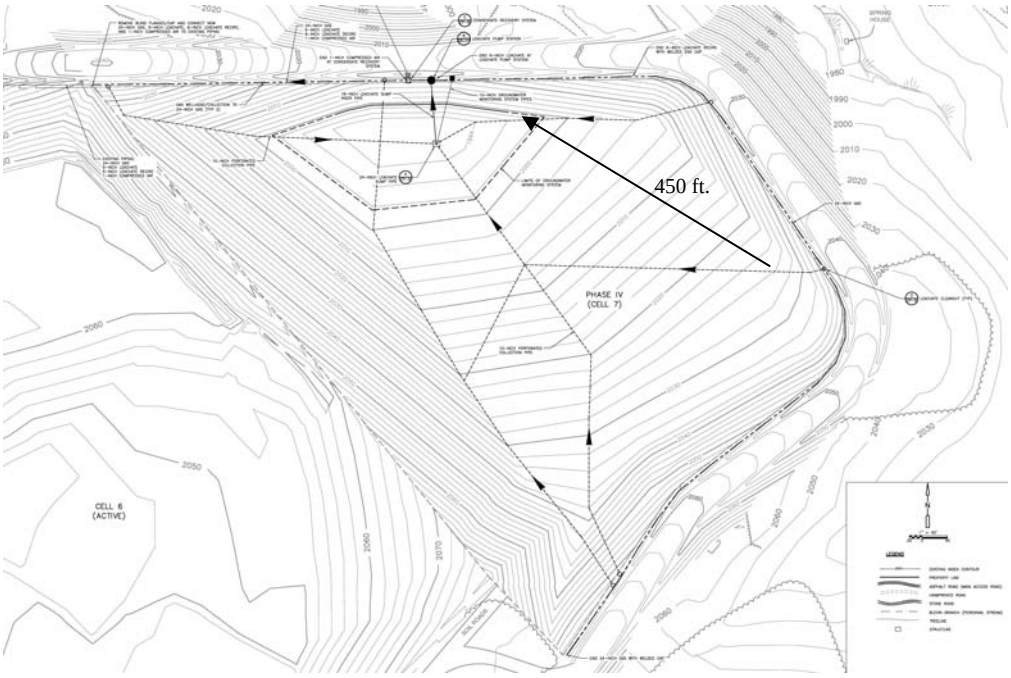

Figure 2. Drainage length and slope of LCS in Cell 7

The surface run-off was based on 5% slope and a drainage length of 750ft as shown in Figure 3.

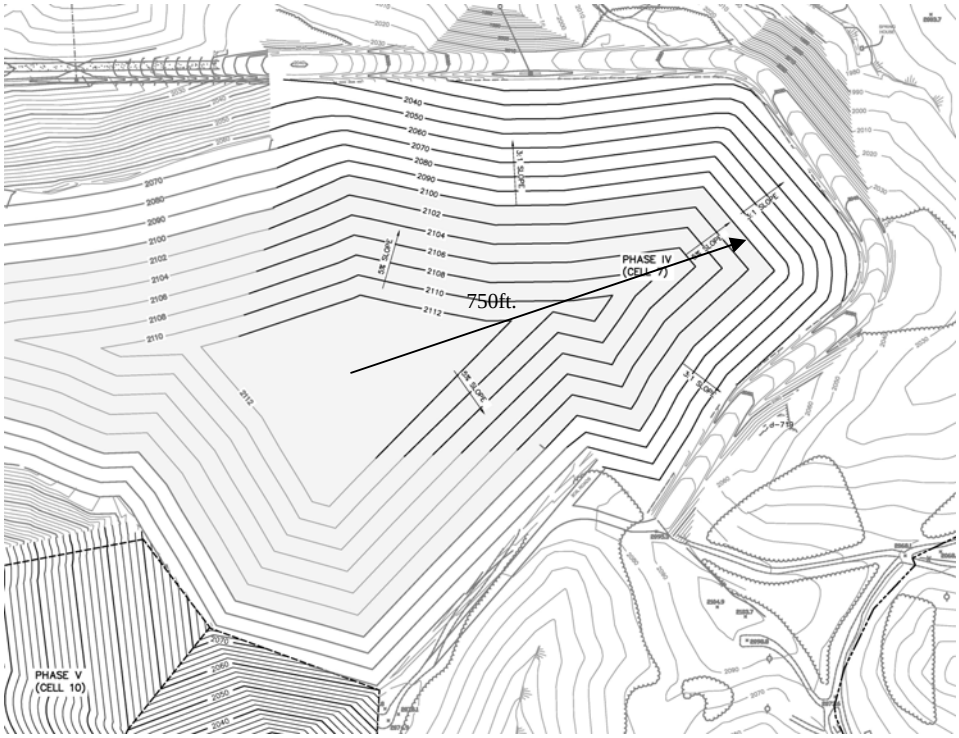

Figure 3. Surface drainage length and slope of Cell 7

5. Results

Table 1 shows the summary of HELP model assumptions for Cases 1 through 4.

Table 1. HELP model assumptions for Cases 1 through 4 for Cell 7

	CASE 1 10ft of waste	CASE 2 30ft of waste	CASE 3 90ft of waste	CASE 4 90ft of waste with final cover
Layer 1	6 inches of common fill 1.0×10^{-4} cm/sec	6 inches of common fill 1.0×10^{-4} cm/sec	12 inches of common fill 1.0×10^{-4} cm/sec	24 inches of soil 1.0×10^{-4} cm/sec
Layer 2	10 ft of waste 1.0×10^{-3} cm/sec	30 ft of waste 1.0×10^{-3} cm/sec	45 ft of waste 1.0×10^{-3} cm/sec	Geonet 39.3 cm/sec
Layer 3	2 ft of Drainage rock 0.3 cm/sec	2 ft of Drainage rock 0.3 cm/sec	45 ft of waste 1.0×10^{-3} cm/sec	40 mil LLDPE Geomembrane 4.0×10^{-13} cm/sec
Layer 4	60 mil HDPE Geomembrane 2.0×10^{-13} cm/sec	60 mil HDPE Geomembrane 2.0×10^{-13} cm/sec	2 ft of Drainage rock 0.3 cm/sec	Geonet 39.3 cm/sec
Layer 5	200 mil GCL 3.0×10^{-9} cm/sec	200 mil GCL 3.0×10^{-9} cm/sec	60 mil HDPE Geomembrane 2.0×10^{-13} cm/sec	12 inches of protective sand 1.0×10^{-4} cm/sec
Layer 6	18 inch Soil Barrier 1.0×10^{-5} cm/sec	18 inch Soil Barrier 1.0×10^{-5} cm/sec	200 mil GCL 3.0×10^{-9} cm/sec	45 ft of waste 1.0×10^{-3} cm/sec
Layer 7			18 inch Soil Barrier 1.0×10^{-5} cm/sec	45 ft of waste 1.0×10^{-3} cm/sec
Layer 8				2 ft of Drainage rock 0.3 cm/sec
Layer 9				60 mil HDPE Geomembrane[1] 2.0×10^{-13} cm/sec
Layer 10				200 mil GCL 3.0×10^{-9} cm/sec
Layer 11				18 inch Soil Barrier 1.0×10^{-5} cm/sec
Surface Drainage Slope (%)				5%
Surface Drainage length (feet)				750
Drainage Slope (%)	5.8%	5.8%	5.8%	5.8%
Drainage length (feet)	450	450	450	450
Evaporative Zone Depth (inch)	12	12	12	12
Percentage of Area Allowing Runoff	0%	0%	100%	100%
Runoff Curve Number			93.7	79.8
Leachate Recirculation	No	No	Yes	Yes
Percentage of Leachate Recirculated			75%	75%
Layer in which Leachate was Recirculated			2	6

Table 2 shows the summary of HELP model results for Cases 1 through 4. The complete HELP runs for all cases are attached.

Table 2. HELP model results for Cases 1 through 4 for Cell 7

	CASE 1 10ft of waste	CASE 2 30ft of waste	CASE 3 90ft of waste	CASE 4 90ft of waste with final cover
Average Annual	**(Inches)**	**(Inches)**	**(Inches)**	**(Inches)**
Precipitation (Ave Annual)	44.07	44.07	44.07	44.07
Runoff (Ave Annual)	0	0	10.384	2.434
Evapotranspiration (Ave Annual)	28.575	28.575	27.279	27.902
Lateral Drainage collected from the drainage rock above the primary geomembrane	15.493	15.487	5.274	0.450
Lateral Drainage recirculated from the drainage rock above the primary geomembrane	NA	NA	15.821	1.351
Leakage through LCS (Ave Annual)	0.000	0.000	0.000	0.000
Average head on LCS geomembrane (Ave Annual)	0.192	0.192	0.260	0.022
Daily Peak	**(Inches)**	**(Inches)**	**(Inches)**	**(Inches)**
Precipitation (Daily Peak)	4.11	4.11	4.11	4.11
Runoff (Daily Peak)	0	0	3.039	1.577
Lateral Drainage collected from the drainage rock above the primary geomembrane	0.5854	0.2823	0.0372	0.0033
Lateral Drainage recirculated from the drainage rock above the primary geomembrane	NA	NA	0.1117	0.0100
Leakage through LCS geomembrane (Daily Peak)	0.00000	0.00000	0.00000	0.00000
Average head on LCS geomembrane (Daily Peak)	2.643	1.275	0.673	0.060
Max head on LCS geomembrane (Daily Peak)	5.008	2.470	1.320	0.120

Results indicate that the maximum head on the liner on leachate collection system geomembrane for all cases is less than 5 inches at daily peak. Hence the leachate collection system meets the requirements of NCDENR 15A NCAC 13B .1624.

Attachment 1

```
WARNING:  TEMPERATURE FOR YEAR    1 USED WITH PRECIPITATION FOR YEAR 1998

WARNING:  SOLAR RADIATION FOR YEAR    1 USED WITH PRECIPITATION FOR YEAR 1998

♀
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************



PRECIPITATION DATA FILE:    C:\HELP\bc\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP\bc\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\help\bc\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\help\bc\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\help\bc\DATA10.D10
OUTPUT DATA FILE:           C:\help\bc\DATA10.OUT


TIME:  17:18     DATE:   8/20/2013



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

     TITLE:  Buncombe County Cell 7 - Case 1

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


     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   0
          THICKNESS                   =      6.00   INCHES
          POROSITY                    =      0.3980 VOL/VOL
          FIELD CAPACITY              =      0.2440 VOL/VOL
          WILTING POINT               =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2842 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-04 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =    120.00   INCHES
POROSITY                    =      0.3980 VOL/VOL
FIELD CAPACITY              =      0.2440 VOL/VOL
WILTING POINT               =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2604 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  21
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0430 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000012000     CM/SEC
SLOPE                       =      5.88   PERCENT
DRAINAGE LENGTH             =    450.0    FEET


                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      3.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  5
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.20   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4750	VOL/VOL
FIELD CAPACITY	=	0.3780	VOL/VOL
WILTING POINT	=	0.2650	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3525	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-05	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	0.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.410	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.776	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.632	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	42.182	INCHES
TOTAL INITIAL WATER	=	42.182	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

NOTE: PRECIPITATION DATA FOR ASHEVILLE NORTH CAROLINA
WAS ENTERED FROM AN ASCII DATA FILE.

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

WARNING: TEMPERATURE FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 1998

WARNING: SOLAR RADIATION FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 1998

****

ANNUAL TOTALS FOR YEAR 1998

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.39	124835.727	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	24.941	90536.867	72.52
DRAINAGE COLLECTED FROM LAYER 3	9.4464	34290.305	27.47
PERC./LEAKAGE THROUGH LAYER 5	0.000013	0.047	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1172		
PERC./LEAKAGE THROUGH LAYER 6	0.157745	572.614	0.46
CHANGE IN WATER STORAGE	-0.155	-564.100	-0.45
SOIL WATER AT START OF YEAR	42.182	153119.266	
SOIL WATER AT END OF YEAR	42.026	152555.172	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.040	0.00

****

WARNING: TEMPERATURE FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 1999

WARNING: SOLAR RADIATION FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 1999

****

ANNUAL TOTALS FOR YEAR 1999

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.91	137613.328	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	24.576	89211.469	64.83
DRAINAGE COLLECTED FROM LAYER 3	14.4132	52319.766	38.02
PERC./LEAKAGE THROUGH LAYER 5	0.000019	0.069	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1807		
PERC./LEAKAGE THROUGH LAYER 6	0.096110	348.879	0.25
CHANGE IN WATER STORAGE	-1.175	-4266.812	-3.10
SOIL WATER AT START OF YEAR	42.026	152555.172	
SOIL WATER AT END OF YEAR	40.851	148288.359	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.026	0.00

****

WARNING: TEMPERATURE FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2000

WARNING: SOLAR RADIATION FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2000

****

ANNUAL TOTALS FOR YEAR 2000

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.35	128320.508	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.558	96403.781	75.13
DRAINAGE COLLECTED FROM LAYER 3	8.6426	31372.490	24.45

PERC./LEAKAGE THROUGH LAYER 5	0.000012	0.042	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1072		
PERC./LEAKAGE THROUGH LAYER 6	0.069058	250.681	0.20
CHANGE IN WATER STORAGE	0.081	293.564	0.23
SOIL WATER AT START OF YEAR	40.851	148288.359	
SOIL WATER AT END OF YEAR	40.932	148581.922	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.010	0.00

****

WARNING: TEMPERATURE FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2001

WARNING: SOLAR RADIATION FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2001

****

ANNUAL TOTALS FOR YEAR 2001

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.695	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.593	96532.344	77.10
DRAINAGE COLLECTED FROM LAYER 3	8.1114	29444.426	23.52
PERC./LEAKAGE THROUGH LAYER 5	0.000011	0.041	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1009		
PERC./LEAKAGE THROUGH LAYER 6	0.053517	194.266	0.16
CHANGE IN WATER STORAGE	-0.268	-972.389	-0.78
SOIL WATER AT START OF YEAR	40.932	148581.922	
SOIL WATER AT END OF YEAR	40.664	147609.531	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.047	0.00

****

WARNING: TEMPERATURE FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2002

WARNING: SOLAR RADIATION FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2002

****

ANNUAL TOTALS FOR YEAR 2002

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.47	161426.094	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.439	95972.086	59.45
DRAINAGE COLLECTED FROM LAYER 3	15.1450	54976.215	34.06
PERC./LEAKAGE THROUGH LAYER 5	0.000019	0.070	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1875		
PERC./LEAKAGE THROUGH LAYER 6	0.043683	158.569	0.10
CHANGE IN WATER STORAGE	2.843	10319.185	6.39
SOIL WATER AT START OF YEAR	40.664	147609.531	
SOIL WATER AT END OF YEAR	43.507	157928.719	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.039	0.00

****

WARNING: TEMPERATURE FOR YEAR 6 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: SOLAR RADIATION FOR YEAR 6 USED WITH PRECIPITATION FOR YEAR 2003

****

ANNUAL TOTALS FOR YEAR 2003

	INCHES	CU. FEET	PERCENT
PRECIPITATION	59.46	215839.781	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	37.197	135026.547	62.56

DRAINAGE COLLECTED FROM LAYER 3	24.5837	89238.672	41.34
PERC./LEAKAGE THROUGH LAYER 5	0.000031	0.111	0.00
AVG. HEAD ON TOP OF LAYER 4	0.3017		
PERC./LEAKAGE THROUGH LAYER 6	0.036848	133.759	0.06
CHANGE IN WATER STORAGE	-2.358	-8559.131	-3.97
SOIL WATER AT START OF YEAR	43.507	157928.719	
SOIL WATER AT END OF YEAR	41.149	149369.594	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.062	0.00

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WARNING: TEMPERATURE FOR YEAR 7 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: SOLAR RADIATION FOR YEAR 7 USED WITH PRECIPITATION FOR YEAR 2004

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ANNUAL TOTALS FOR YEAR 2004

	INCHES	CU. FEET	PERCENT
PRECIPITATION	52.36	190066.766	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	32.530	118084.008	62.13
DRAINAGE COLLECTED FROM LAYER 3	18.9188	68675.422	36.13
PERC./LEAKAGE THROUGH LAYER 5	0.000025	0.091	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2334		
PERC./LEAKAGE THROUGH LAYER 6	0.031921	115.873	0.06
CHANGE IN WATER STORAGE	0.879	3191.454	1.68
SOIL WATER AT START OF YEAR	41.149	149369.594	
SOIL WATER AT END OF YEAR	42.028	152561.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.001	0.00

****

WARNING: TEMPERATURE FOR YEAR 8 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: SOLAR RADIATION FOR YEAR 8 USED WITH PRECIPITATION FOR YEAR 2005

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ANNUAL TOTALS FOR YEAR 2005

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.26	171553.734	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	32.550	118155.016	68.87
DRAINAGE COLLECTED FROM LAYER 3	15.0965	54800.137	31.94
PERC./LEAKAGE THROUGH LAYER 5	0.000020	0.072	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1852		
PERC./LEAKAGE THROUGH LAYER 6	0.027999	101.638	0.06
CHANGE IN WATER STORAGE	-0.414	-1502.991	-0.88
SOIL WATER AT START OF YEAR	42.028	152561.047	
SOIL WATER AT END OF YEAR	41.614	151058.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.061	0.00

****

WARNING: TEMPERATURE FOR YEAR 9 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: SOLAR RADIATION FOR YEAR 9 USED WITH PRECIPITATION FOR YEAR 2006

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ANNUAL TOTALS FOR YEAR 2006

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.29	175292.672	100.00

RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.155	98572.234	56.23
DRAINAGE COLLECTED FROM LAYER 3	19.5606	71005.055	40.51
PERC./LEAKAGE THROUGH LAYER 5	0.000025	0.089	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2434		
PERC./LEAKAGE THROUGH LAYER 6	0.024968	90.635	0.05
CHANGE IN WATER STORAGE	1.550	5624.813	3.21
SOIL WATER AT START OF YEAR	41.614	151058.047	
SOIL WATER AT END OF YEAR	42.458	154123.328	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.705	2559.535	1.46
ANNUAL WATER BUDGET BALANCE	0.0000	-0.065	0.00

****

WARNING: TEMPERATURE FOR YEAR 10 USED WITH PRECIPITATION FOR YEAR 2007

WARNING: SOLAR RADIATION FOR YEAR 10 USED WITH PRECIPITATION FOR YEAR 2007

****

ANNUAL TOTALS FOR YEAR 2007

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.39	124835.727	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	24.298	88201.945	70.65
DRAINAGE COLLECTED FROM LAYER 3	11.0630	40158.660	32.17
PERC./LEAKAGE THROUGH LAYER 5	0.000015	0.055	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1368		
PERC./LEAKAGE THROUGH LAYER 6	0.022530	81.784	0.07
CHANGE IN WATER STORAGE	-0.994	-3606.723	-2.89
SOIL WATER AT START OF YEAR	42.458	154123.328	
SOIL WATER AT END OF YEAR	42.042	152613.172	
SNOW WATER AT START OF YEAR	0.705	2559.535	2.05

SNOW WATER AT END OF YEAR	0.128	462.977	0.37
ANNUAL WATER BUDGET BALANCE	0.0000	0.054	0.00

****

WARNING: TEMPERATURE FOR YEAR 11 USED WITH PRECIPITATION FOR YEAR 2008

WARNING: SOLAR RADIATION FOR YEAR 11 USED WITH PRECIPITATION FOR YEAR 2008

****

ANNUAL TOTALS FOR YEAR 2008

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.63	129336.914	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	22.872	83025.164	64.19
DRAINAGE COLLECTED FROM LAYER 3	13.3095	48313.617	37.35
PERC./LEAKAGE THROUGH LAYER 5	0.000017	0.063	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1656		
PERC./LEAKAGE THROUGH LAYER 6	0.020560	74.633	0.06
CHANGE IN WATER STORAGE	-0.572	-2076.554	-1.61
SOIL WATER AT START OF YEAR	42.042	152613.172	
SOIL WATER AT END OF YEAR	41.598	150999.594	
SNOW WATER AT START OF YEAR	0.128	462.977	0.36
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.055	0.00

****

WARNING: TEMPERATURE FOR YEAR 12 USED WITH PRECIPITATION FOR YEAR 2009

WARNING: SOLAR RADIATION FOR YEAR 12 USED WITH PRECIPITATION FOR YEAR 2009

****

ANNUAL TOTALS FOR YEAR 2009

	INCHES	CU. FEET	PERCENT

PRECIPITATION	62.13	225531.891	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	33.067	120032.258	53.22
DRAINAGE COLLECTED FROM LAYER 3	26.3700	95723.273	42.44
PERC./LEAKAGE THROUGH LAYER 5	0.000034	0.122	0.00
AVG. HEAD ON TOP OF LAYER 4	0.3255		
PERC./LEAKAGE THROUGH LAYER 6	0.018791	68.210	0.03
CHANGE IN WATER STORAGE	2.674	9708.154	4.30
SOIL WATER AT START OF YEAR	41.598	150999.594	
SOIL WATER AT END OF YEAR	44.236	160578.469	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.036	129.277	0.06
ANNUAL WATER BUDGET BALANCE	0.0000	-0.010	0.00

****

WARNING: TEMPERATURE FOR YEAR 13 USED WITH PRECIPITATION FOR YEAR 2010

WARNING: SOLAR RADIATION FOR YEAR 13 USED WITH PRECIPITATION FOR YEAR 2010

****

ANNUAL TOTALS FOR YEAR 2010

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.26	160663.781	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.119	98440.961	61.27
DRAINAGE COLLECTED FROM LAYER 3	21.1984	76950.062	47.90
PERC./LEAKAGE THROUGH LAYER 5	0.000028	0.101	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2622		
PERC./LEAKAGE THROUGH LAYER 6	0.017358	63.009	0.04
CHANGE IN WATER STORAGE	-4.074	-14790.229	-9.21
SOIL WATER AT START OF YEAR	44.236	160578.469	
SOIL WATER AT END OF YEAR	40.198	145917.516	

SNOW WATER AT START OF YEAR	0.036	129.277	0.08
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.019	0.00

****

WARNING: TEMPERATURE FOR YEAR 14 USED WITH PRECIPITATION FOR YEAR 2011

WARNING: SOLAR RADIATION FOR YEAR 14 USED WITH PRECIPITATION FOR YEAR 2011

****

ANNUAL TOTALS FOR YEAR 2011

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.04	167125.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	30.319	110057.711	65.85
DRAINAGE COLLECTED FROM LAYER 3	12.6135	45787.105	27.40
PERC./LEAKAGE THROUGH LAYER 5	0.000016	0.060	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1562		
PERC./LEAKAGE THROUGH LAYER 6	0.016128	58.545	0.04
CHANGE IN WATER STORAGE	3.091	11221.811	6.71
SOIL WATER AT START OF YEAR	40.198	145917.516	
SOIL WATER AT END OF YEAR	43.289	157139.328	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.019	0.00

****

WARNING: TEMPERATURE FOR YEAR 15 USED WITH PRECIPITATION FOR YEAR 2012

WARNING: SOLAR RADIATION FOR YEAR 15 USED WITH PRECIPITATION FOR YEAR 2012

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ANNUAL TOTALS FOR YEAR 2012

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.66	162115.859	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	32.409	117643.578	72.57
DRAINAGE COLLECTED FROM LAYER 3	13.9180	50522.445	31.16
PERC./LEAKAGE THROUGH LAYER 5	0.000018	0.066	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1722		
PERC./LEAKAGE THROUGH LAYER 6	0.015087	54.765	0.03
CHANGE IN WATER STORAGE	-1.682	-6105.013	-3.77
SOIL WATER AT START OF YEAR	43.289	157139.328	
SOIL WATER AT END OF YEAR	41.266	149794.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.342	1239.940	0.76
ANNUAL WATER BUDGET BALANCE	0.0000	0.081	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1998 THROUGH 2012

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.20	2.66	3.84	3.16	3.38	4.34
	4.82	3.96	4.75	2.49	3.46	4.01
STD. DEVIATIONS	1.67	1.02	1.39	1.33	2.60	2.53
	2.56	1.67	3.27	1.39	1.65	1.96
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.200	1.476	2.705	3.189	2.864	3.255

	4.106	3.330	2.425	1.790	1.317	0.919
STD. DEVIATIONS	0.253	0.430	0.595	0.857	1.533	1.458
	0.995	1.076	0.821	0.396	0.388	0.178

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	2.7145	1.8720	1.6547	1.1599	0.6402	0.3238
	1.0170	0.6844	1.1129	1.4590	1.0522	1.8022
STD. DEVIATIONS	1.2385	0.8783	1.4435	0.8474	0.8858	0.5746
	1.2890	1.3022	1.6355	1.3350	1.4155	1.5534

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0043	0.0038	0.0040	0.0038	0.0038	0.0036
	0.0036	0.0035	0.0033	0.0034	0.0032	0.0032
STD. DEVIATIONS	0.0044	0.0038	0.0039	0.0036	0.0035	0.0032
	0.0031	0.0030	0.0028	0.0027	0.0025	0.0025

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.3954	0.2989	0.2410	0.1746	0.0933	0.0487
	0.1481	0.0997	0.1675	0.2125	0.1584	0.2625
STD. DEVIATIONS	0.1804	0.1404	0.2103	0.1275	0.1290	0.0865
	0.1878	0.1897	0.2462	0.1945	0.2130	0.2263

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1998 THROUGH 2012

	INCHES		CU. FEET	PERCENT
PRECIPITATION	44.07	(8.978)	159983.8	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	28.575	(4.1439)	103726.40	64.836
LATERAL DRAINAGE COLLECTED FROM LAYER 3	15.49270	(5.58295)	56238.512	35.15263
PERCOLATION/LEAKAGE THROUGH	0.00002	(0.00001)	0.073	0.00005

```
  LAYER  5

 AVERAGE HEAD ON TOP             0.192 (    0.069)
   OF LAYER  4

 PERCOLATION/LEAKAGE THROUGH     0.04349 (  0.03887)       157.857     0.09867
   LAYER  6

 CHANGE IN WATER STORAGE        -0.038   (  1.9982)       -139.00     -0.087
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               PEAK DAILY VALUES FOR YEARS 1998 THROUGH 2012
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              4.11         14919.301

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  3           0.58539       2124.97998

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000001         0.00321

      AVERAGE HEAD ON TOP OF LAYER  4            2.643

      MAXIMUM HEAD ON TOP OF LAYER  4            5.008

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)               22.2 FEET

      PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000597         2.16749

      SNOW WATER                                 5.58         20250.3086


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3980

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1360

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

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

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                    FINAL WATER STORAGE AT END OF YEAR 2012
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LAYER	(INCHES)	(VOL/VOL)
1	3.4070	0.2839
2	31.0532	0.2588
3	0.9622	0.0401
4	0.0000	0.0000
5	0.1500	0.7500
6	5.6933	0.3163
SNOW WATER	0.342	

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```
WARNING:  TEMPERATURE FOR YEAR    1 USED WITH PRECIPITATION FOR YEAR 1998

WARNING:  SOLAR RADIATION FOR YEAR    1 USED WITH PRECIPITATION FOR YEAR 1998

♀
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************



PRECIPITATION DATA FILE:    C:\HELP\bc\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP\bc\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\help\bc\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\help\bc\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\help\bc\DATA10.D10
OUTPUT DATA FILE:           C:\help\bc\DATA10.OUT


TIME:  13:48     DATE:   8/26/2013



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

     TITLE:  Buncombe County Cell 7 - Case 2

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


     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   0
          THICKNESS                   =      6.00   INCHES
          POROSITY                    =      0.3980 VOL/VOL
          FIELD CAPACITY              =      0.2440 VOL/VOL
          WILTING POINT               =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2842 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-04 CM/SEC
```

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                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =    360.00   INCHES
POROSITY                    =      0.3980 VOL/VOL
FIELD CAPACITY              =      0.2440 VOL/VOL
WILTING POINT               =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2496 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  21
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0416 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000012000     CM/SEC
SLOPE                       =      5.88   PERCENT
DRAINAGE LENGTH             =    450.0    FEET


                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      3.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  5
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.20   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4750	VOL/VOL
FIELD CAPACITY	=	0.3780	VOL/VOL
WILTING POINT	=	0.2650	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3525	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-05	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	0.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.410	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.776	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.632	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	100.742	INCHES
TOTAL INITIAL WATER	=	100.742	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

NOTE: PRECIPITATION DATA FOR ASHEVILLE NORTH CAROLINA
WAS ENTERED FROM AN ASCII DATA FILE.

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

WARNING: TEMPERATURE FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 1998

WARNING: SOLAR RADIATION FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 1998

****

ANNUAL TOTALS FOR YEAR 1998

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.39	124835.727	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	24.941	90536.867	72.52
DRAINAGE COLLECTED FROM LAYER 3	9.4464	34290.305	27.47
PERC./LEAKAGE THROUGH LAYER 5	0.000013	0.046	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1184		
PERC./LEAKAGE THROUGH LAYER 6	0.157744	572.612	0.46
CHANGE IN WATER STORAGE	-0.155	-564.058	-0.45
SOIL WATER AT START OF YEAR	100.743	365695.281	
SOIL WATER AT END OF YEAR	100.587	365131.219	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.004	0.00

****

WARNING: TEMPERATURE FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 1999

WARNING: SOLAR RADIATION FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 1999

****

ANNUAL TOTALS FOR YEAR 1999

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.91	137613.328	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	24.576	89211.469	64.83
DRAINAGE COLLECTED FROM LAYER 3	14.0147	50873.473	36.97
PERC./LEAKAGE THROUGH LAYER 5	0.000018	0.065	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1746		
PERC./LEAKAGE THROUGH LAYER 6	0.096110	348.879	0.25
CHANGE IN WATER STORAGE	-0.777	-2820.511	-2.05
SOIL WATER AT START OF YEAR	100.587	365131.219	
SOIL WATER AT END OF YEAR	99.810	362310.719	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

****

WARNING: TEMPERATURE FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2000

WARNING: SOLAR RADIATION FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2000

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ANNUAL TOTALS FOR YEAR 2000

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.35	128320.508	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.558	96403.781	75.13
DRAINAGE COLLECTED FROM LAYER 3	8.1930	29740.564	23.18

PERC./LEAKAGE THROUGH LAYER 5	0.000011	0.040	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1012		
PERC./LEAKAGE THROUGH LAYER 6	0.069059	250.683	0.20
CHANGE IN WATER STORAGE	0.530	1925.474	1.50
SOIL WATER AT START OF YEAR	99.810	362310.719	
SOIL WATER AT END OF YEAR	100.341	364236.187	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.002	0.00

****

WARNING: TEMPERATURE FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2001

WARNING: SOLAR RADIATION FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2001

****

ANNUAL TOTALS FOR YEAR 2001

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.695	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.593	96532.344	77.10
DRAINAGE COLLECTED FROM LAYER 3	8.9613	32529.484	25.98
PERC./LEAKAGE THROUGH LAYER 5	0.000012	0.043	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1111		
PERC./LEAKAGE THROUGH LAYER 6	0.053516	194.262	0.16
CHANGE IN WATER STORAGE	-1.118	-4057.412	-3.24
SOIL WATER AT START OF YEAR	100.341	364236.187	
SOIL WATER AT END OF YEAR	99.223	360178.781	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.016	0.00

****

WARNING: TEMPERATURE FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2002

WARNING: SOLAR RADIATION FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2002

****

ANNUAL TOTALS FOR YEAR 2002

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.47	161426.094	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.439	95972.086	59.45
DRAINAGE COLLECTED FROM LAYER 3	11.6974	42461.406	26.30
PERC./LEAKAGE THROUGH LAYER 5	0.000015	0.054	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1443		
PERC./LEAKAGE THROUGH LAYER 6	0.043687	158.584	0.10
CHANGE IN WATER STORAGE	6.290	22833.949	14.15
SOIL WATER AT START OF YEAR	99.223	360178.781	
SOIL WATER AT END OF YEAR	105.513	383012.719	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.066	0.00

****

WARNING: TEMPERATURE FOR YEAR 6 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: SOLAR RADIATION FOR YEAR 6 USED WITH PRECIPITATION FOR YEAR 2003

****

ANNUAL TOTALS FOR YEAR 2003

	INCHES	CU. FEET	PERCENT
PRECIPITATION	59.46	215839.781	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	37.197	135026.547	62.56

DRAINAGE COLLECTED FROM LAYER 3	26.3623	95695.227	44.34
PERC./LEAKAGE THROUGH LAYER 5	0.000032	0.117	0.00
AVG. HEAD ON TOP OF LAYER 4	0.3261		
PERC./LEAKAGE THROUGH LAYER 6	0.036845	133.749	0.06
CHANGE IN WATER STORAGE	-4.137	-15015.680	-6.96
SOIL WATER AT START OF YEAR	105.513	383012.719	
SOIL WATER AT END OF YEAR	101.377	367997.031	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.059	0.00

****

WARNING: TEMPERATURE FOR YEAR 7 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: SOLAR RADIATION FOR YEAR 7 USED WITH PRECIPITATION FOR YEAR 2004

****

ANNUAL TOTALS FOR YEAR 2004

	INCHES	CU. FEET	PERCENT
PRECIPITATION	52.36	190066.766	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	32.530	118084.008	62.13
DRAINAGE COLLECTED FROM LAYER 3	16.7787	60906.824	32.04
PERC./LEAKAGE THROUGH LAYER 5	0.000021	0.077	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2062		
PERC./LEAKAGE THROUGH LAYER 6	0.031924	115.885	0.06
CHANGE IN WATER STORAGE	3.019	10960.067	5.77
SOIL WATER AT START OF YEAR	101.377	367997.031	
SOIL WATER AT END OF YEAR	104.396	378957.094	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.024	0.00

****

WARNING: TEMPERATURE FOR YEAR 8 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: SOLAR RADIATION FOR YEAR 8 USED WITH PRECIPITATION FOR YEAR 2005

****

ANNUAL TOTALS FOR YEAR 2005

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.26	171553.734	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	32.550	118155.016	68.87
DRAINAGE COLLECTED FROM LAYER 3	17.1837	62376.660	36.36
PERC./LEAKAGE THROUGH LAYER 5	0.000022	0.078	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2133		
PERC./LEAKAGE THROUGH LAYER 6	0.027997	101.629	0.06
CHANGE IN WATER STORAGE	-2.501	-9079.542	-5.29
SOIL WATER AT START OF YEAR	104.396	378957.094	
SOIL WATER AT END OF YEAR	101.895	369877.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.024	0.00

****

WARNING: TEMPERATURE FOR YEAR 9 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: SOLAR RADIATION FOR YEAR 9 USED WITH PRECIPITATION FOR YEAR 2006

****

ANNUAL TOTALS FOR YEAR 2006

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.29	175292.672	100.00

RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.155	98572.234	56.23
DRAINAGE COLLECTED FROM LAYER 3	18.7952	68226.484	38.92
PERC./LEAKAGE THROUGH LAYER 5	0.000023	0.084	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2331		
PERC./LEAKAGE THROUGH LAYER 6	0.024969	90.638	0.05
CHANGE IN WATER STORAGE	2.315	8403.340	4.79
SOIL WATER AT START OF YEAR	101.895	369877.562	
SOIL WATER AT END OF YEAR	103.505	375721.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.705	2559.535	1.46
ANNUAL WATER BUDGET BALANCE	0.0000	-0.026	0.00

****

WARNING: TEMPERATURE FOR YEAR 10 USED WITH PRECIPITATION FOR YEAR 2007

WARNING: SOLAR RADIATION FOR YEAR 10 USED WITH PRECIPITATION FOR YEAR 2007

****

ANNUAL TOTALS FOR YEAR 2007

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.39	124835.727	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	24.298	88201.945	70.65
DRAINAGE COLLECTED FROM LAYER 3	13.5491	49183.145	39.40
PERC./LEAKAGE THROUGH LAYER 5	0.000017	0.063	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1694		
PERC./LEAKAGE THROUGH LAYER 6	0.022527	81.773	0.07
CHANGE IN WATER STORAGE	-3.480	-12631.180	-10.12
SOIL WATER AT START OF YEAR	103.505	375721.375	
SOIL WATER AT END OF YEAR	100.602	365186.750	
SNOW WATER AT START OF YEAR	0.705	2559.535	2.05

SNOW WATER AT END OF YEAR	0.128	462.977	0.37
ANNUAL WATER BUDGET BALANCE	0.0000	0.037	0.00

****

WARNING: TEMPERATURE FOR YEAR 11 USED WITH PRECIPITATION FOR YEAR 2008

WARNING: SOLAR RADIATION FOR YEAR 11 USED WITH PRECIPITATION FOR YEAR 2008

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ANNUAL TOTALS FOR YEAR 2008

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.63	129336.914	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	22.872	83025.164	64.19
DRAINAGE COLLECTED FROM LAYER 3	12.5265	45471.031	35.16
PERC./LEAKAGE THROUGH LAYER 5	0.000016	0.058	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1553		
PERC./LEAKAGE THROUGH LAYER 6	0.020561	74.635	0.06
CHANGE IN WATER STORAGE	0.211	765.975	0.59
SOIL WATER AT START OF YEAR	100.602	365186.750	
SOIL WATER AT END OF YEAR	100.941	366415.687	
SNOW WATER AT START OF YEAR	0.128	462.977	0.36
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.111	0.00

****

WARNING: TEMPERATURE FOR YEAR 12 USED WITH PRECIPITATION FOR YEAR 2009

WARNING: SOLAR RADIATION FOR YEAR 12 USED WITH PRECIPITATION FOR YEAR 2009

****

ANNUAL TOTALS FOR YEAR 2009

	INCHES	CU. FEET	PERCENT

PRECIPITATION	62.13	225531.891	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	33.067	120032.258	53.22
DRAINAGE COLLECTED FROM LAYER 3	19.8922	72208.555	32.02
PERC./LEAKAGE THROUGH LAYER 5	0.000025	0.089	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2463		
PERC./LEAKAGE THROUGH LAYER 6	0.018799	68.240	0.03
CHANGE IN WATER STORAGE	9.152	33222.840	14.73
SOIL WATER AT START OF YEAR	100.941	366415.687	
SOIL WATER AT END OF YEAR	110.058	399509.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.036	129.277	0.06
ANNUAL WATER BUDGET BALANCE	0.0000	-0.005	0.00

****

WARNING: TEMPERATURE FOR YEAR 13 USED WITH PRECIPITATION FOR YEAR 2010

WARNING: SOLAR RADIATION FOR YEAR 13 USED WITH PRECIPITATION FOR YEAR 2010

****

ANNUAL TOTALS FOR YEAR 2010

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.26	160663.781	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.119	98440.961	61.27
DRAINAGE COLLECTED FROM LAYER 3	26.5751	96467.641	60.04
PERC./LEAKAGE THROUGH LAYER 5	0.000034	0.122	0.00
AVG. HEAD ON TOP OF LAYER 4	0.3291		
PERC./LEAKAGE THROUGH LAYER 6	0.017351	62.984	0.04
CHANGE IN WATER STORAGE	-9.451	-34307.777	-21.35
SOIL WATER AT START OF YEAR	110.058	399509.250	
SOIL WATER AT END OF YEAR	100.642	365330.750	

SNOW WATER AT START OF YEAR	0.036	129.277	0.08
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.022	0.00

****

WARNING: TEMPERATURE FOR YEAR 14 USED WITH PRECIPITATION FOR YEAR 2011

WARNING: SOLAR RADIATION FOR YEAR 14 USED WITH PRECIPITATION FOR YEAR 2011

****

ANNUAL TOTALS FOR YEAR 2011

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.04	167125.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	30.319	110057.711	65.85
DRAINAGE COLLECTED FROM LAYER 3	12.0892	43883.617	26.26
PERC./LEAKAGE THROUGH LAYER 5	0.000015	0.056	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1502		
PERC./LEAKAGE THROUGH LAYER 6	0.016128	58.546	0.04
CHANGE IN WATER STORAGE	3.616	13125.322	7.85
SOIL WATER AT START OF YEAR	100.642	365330.750	
SOIL WATER AT END OF YEAR	104.258	378456.094	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.045	0.00

****

WARNING: TEMPERATURE FOR YEAR 15 USED WITH PRECIPITATION FOR YEAR 2012

WARNING: SOLAR RADIATION FOR YEAR 15 USED WITH PRECIPITATION FOR YEAR 2012

****

ANNUAL TOTALS FOR YEAR 2012

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.66	162115.859	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	32.409	117643.578	72.57
DRAINAGE COLLECTED FROM LAYER 3	16.2414	58956.234	36.37
PERC./LEAKAGE THROUGH LAYER 5	0.000020	0.074	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2014		
PERC./LEAKAGE THROUGH LAYER 6	0.015084	54.755	0.03
CHANGE IN WATER STORAGE	-4.005	-14538.784	-8.97
SOIL WATER AT START OF YEAR	104.258	378456.094	
SOIL WATER AT END OF YEAR	99.911	362677.344	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.342	1239.940	0.76
ANNUAL WATER BUDGET BALANCE	0.0000	0.074	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1998 THROUGH 2012

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.20	2.66	3.84	3.16	3.38	4.34
	4.82	3.96	4.75	2.49	3.46	4.01
STD. DEVIATIONS	1.67	1.02	1.39	1.33	2.60	2.53
	2.56	1.67	3.27	1.39	1.65	1.96
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.200	1.476	2.705	3.189	2.864	3.255

	4.106	3.330	2.425	1.790	1.317	0.919
STD. DEVIATIONS	0.253	0.430	0.595	0.857	1.533	1.458
	0.995	1.076	0.821	0.396	0.388	0.178

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	1.9635	1.9720	2.0416	1.7886	1.4029	0.6540
	0.7392	0.6861	0.7004	1.4120	0.9543	1.1724
STD. DEVIATIONS	1.3678	0.6656	1.1125	0.8151	0.8297	0.7029
	0.6736	0.9330	0.9654	1.0464	0.8161	1.0188

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0043	0.0038	0.0040	0.0038	0.0038	0.0036
	0.0036	0.0035	0.0033	0.0034	0.0032	0.0032
STD. DEVIATIONS	0.0044	0.0038	0.0039	0.0036	0.0035	0.0032
	0.0031	0.0030	0.0027	0.0027	0.0025	0.0025

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.2860	0.3155	0.2974	0.2692	0.2043	0.0984
	0.1077	0.0999	0.1054	0.2057	0.1436	0.1708
STD. DEVIATIONS	0.1992	0.1074	0.1620	0.1227	0.1209	0.1058
	0.0981	0.1359	0.1453	0.1524	0.1228	0.1484

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1998 THROUGH 2012

	INCHES		CU. FEET	PERCENT
PRECIPITATION	44.07	(8.978)	159983.8	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	28.575	(4.1439)	103726.40	64.836
LATERAL DRAINAGE COLLECTED FROM LAYER 3	15.48706	(5.66667)	56218.043	35.13984
PERCOLATION/LEAKAGE THROUGH	0.00002	(0.00001)	0.071	0.00004

```
  LAYER  5

 AVERAGE HEAD ON TOP             0.192 (    0.070)
   OF LAYER  4

 PERCOLATION/LEAKAGE THROUGH     0.04349 (  0.03887)       157.857     0.09867
   LAYER  6

 CHANGE IN WATER STORAGE        -0.033   (  4.5819)       -118.53     -0.074
******************************************************************************


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

              PEAK DAILY VALUES FOR YEARS 1998 THROUGH 2012
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              4.11         14919.301

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  3           0.28228       1024.66943

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000000         0.00135

      AVERAGE HEAD ON TOP OF LAYER  4            1.275

      MAXIMUM HEAD ON TOP OF LAYER  4            2.470

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)               12.5 FEET

      PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000597         2.16749

      SNOW WATER                                 5.58         20250.3086


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3980

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1360

       ***  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.

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


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

                    FINAL WATER STORAGE AT END OF YEAR 2012
```

LAYER	(INCHES)	(VOL/VOL)
1	3.4070	0.2839
2	89.6155	0.2489
3	1.0453	0.0436
4	0.0000	0.0000
5	0.1500	0.7500
6	5.6933	0.3163
SNOW WATER	0.342	

****
****

```
WARNING:  TEMPERATURE FOR YEAR    1 USED WITH PRECIPITATION FOR YEAR 1998

WARNING:  SOLAR RADIATION FOR YEAR    1 USED WITH PRECIPITATION FOR YEAR 1998

♀
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP\bc\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP\bc\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\help\bc\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\help\bc\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\help\bc\DATA10.D10
OUTPUT DATA FILE:           C:\help\bc\DATA10.OUT


TIME:  17:16     DATE:   9/10/2013


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

     TITLE:  Buncombe County Cell 7 - Case 3

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


     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   0
          THICKNESS                   =     12.00   INCHES
          POROSITY                    =      0.3980 VOL/VOL
          FIELD CAPACITY              =      0.2440 VOL/VOL
          WILTING POINT               =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2814 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-04 CM/SEC
```

```
                         LAYER  2
                         --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =    540.00   INCHES
  POROSITY                    =      0.3980 VOL/VOL
  FIELD CAPACITY              =      0.2440 VOL/VOL
  WILTING POINT               =      0.1360 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2467 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
NOTE:   75.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 4
         IS RECIRCULATED INTO THIS LAYER.


                         LAYER  3
                         --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =    540.00   INCHES
  POROSITY                    =      0.3980 VOL/VOL
  FIELD CAPACITY              =      0.2440 VOL/VOL
  WILTING POINT               =      0.1360 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2440 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                         LAYER  4
                         --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER  21
  THICKNESS                   =     24.00   INCHES
  POROSITY                    =      0.3970 VOL/VOL
  FIELD CAPACITY              =      0.0320 VOL/VOL
  WILTING POINT               =      0.0130 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0429 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.300000012000     CM/SEC
  SLOPE                       =      5.88   PERCENT
  DRAINAGE LENGTH             =    450.0    FEET
NOTE:   75.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS
         LAYER IS RECIRCULATED INTO LAYER #  2.


                         LAYER  5
                         --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
  THICKNESS                   =      0.06   INCHES
  POROSITY                    =      0.0000 VOL/VOL
  FIELD CAPACITY              =      0.0000 VOL/VOL
  WILTING POINT               =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
```

```
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      3.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD
```

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

```
THICKNESS                   =      0.20   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                   =     18.00   INCHES
POROSITY                    =      0.4750 VOL/VOL
FIELD CAPACITY              =      0.3780 VOL/VOL
WILTING POINT               =      0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3525 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-05 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 93.6, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 750. FEET.

```
SCS RUNOFF CURVE NUMBER             =     93.60
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      3.377  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.776  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      1.632  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    275.888  INCHES
TOTAL INITIAL WATER                 =    275.888  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26 DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	96
END OF GROWING SEASON (JULIAN DATE)	=	298
EVAPORATIVE ZONE DEPTH	=	12.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00 %

NOTE: PRECIPITATION DATA FOR ASHEVILLE NORTH CAROLINA
WAS ENTERED FROM AN ASCII DATA FILE.

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

WARNING: TEMPERATURE FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 1998

WARNING: SOLAR RADIATION FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 1998

****

ANNUAL TOTALS FOR YEAR 1998

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.39	124835.727	100.00
RUNOFF	7.873	28578.016	22.89
EVAPOTRANSPIRATION	23.003	83502.602	66.89
RECIRCULATION INTO LAYER 2	7.237884	26273.520	21.05
DRAINAGE COLLECTED FROM LAYER 4	2.4126	8757.840	7.02

RECIRCULATION FROM LAYER 4	7.237884	26273.520	21.05
PERC./LEAKAGE THROUGH LAYER 6	0.000012	0.044	0.00
AVG. HEAD ON TOP OF LAYER 5	0.1189		
PERC./LEAKAGE THROUGH LAYER 7	0.157742	572.602	0.46
CHANGE IN WATER STORAGE	0.916	3324.140	2.66
SOIL WATER AT START OF YEAR	275.888	1001473.120	
SOIL WATER AT END OF YEAR	276.804	1004797.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0277	100.527	0.08

****

WARNING: TEMPERATURE FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 1999

WARNING: SOLAR RADIATION FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 1999

****

ANNUAL TOTALS FOR YEAR 1999

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.91	137613.328	100.00
RUNOFF	7.500	27225.852	19.78
EVAPOTRANSPIRATION	23.713	86076.500	62.55
RECIRCULATION INTO LAYER 2	8.355450	30330.283	22.04
DRAINAGE COLLECTED FROM LAYER 4	2.7852	10110.095	7.35
RECIRCULATION FROM LAYER 4	8.355450	30330.283	22.04
PERC./LEAKAGE THROUGH LAYER 6	0.000014	0.051	0.00
AVG. HEAD ON TOP OF LAYER 5	0.1370		
PERC./LEAKAGE THROUGH LAYER 7	0.096111	348.883	0.25
CHANGE IN WATER STORAGE	3.841	13941.070	10.13
SOIL WATER AT START OF YEAR	276.804	1004797.250	
SOIL WATER AT END OF YEAR	280.644	1018738.310	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0245	-89.071	-0.06

****

WARNING: TEMPERATURE FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2000

WARNING: SOLAR RADIATION FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2000

****

ANNUAL TOTALS FOR YEAR 2000

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.35	128320.508	100.00
RUNOFF	5.651	20513.596	15.99
EVAPOTRANSPIRATION	25.638	93064.781	72.53
RECIRCULATION INTO LAYER 2	10.342643	37543.793	29.26
DRAINAGE COLLECTED FROM LAYER 4	3.4475	12514.603	9.75
RECIRCULATION FROM LAYER 4	10.342643	37543.793	29.26
PERC./LEAKAGE THROUGH LAYER 6	0.000017	0.061	0.00
AVG. HEAD ON TOP OF LAYER 5	0.1699		
PERC./LEAKAGE THROUGH LAYER 7	0.069052	250.659	0.20
CHANGE IN WATER STORAGE	0.504	1831.284	1.43
SOIL WATER AT START OF YEAR	280.644	1018738.310	
SOIL WATER AT END OF YEAR	281.149	1020569.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0401	145.588	0.11

****

WARNING: TEMPERATURE FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2001

WARNING: SOLAR RADIATION FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2001

****

ANNUAL TOTALS FOR YEAR 2001

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.695	100.00
RUNOFF	5.111	18553.104	14.82
EVAPOTRANSPIRATION	25.462	92426.258	73.82
RECIRCULATION INTO LAYER 2	10.535724	38244.676	30.55
DRAINAGE COLLECTED FROM LAYER 4	3.5119	12748.222	10.18
RECIRCULATION FROM LAYER 4	10.535724	38244.676	30.55
PERC./LEAKAGE THROUGH LAYER 6	0.000017	0.063	0.00
AVG. HEAD ON TOP OF LAYER 5	0.1732		
PERC./LEAKAGE THROUGH LAYER 7	0.053512	194.249	0.16
CHANGE IN WATER STORAGE	0.343	1244.489	0.99
SOIL WATER AT START OF YEAR	281.149	1020569.620	
SOIL WATER AT END OF YEAR	281.491	1021814.060	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0089	32.373	0.03

****

WARNING: TEMPERATURE FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2002

WARNING: SOLAR RADIATION FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2002

****

ANNUAL TOTALS FOR YEAR 2002

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.47	161426.094	100.00
RUNOFF	10.134	36785.082	22.79
EVAPOTRANSPIRATION	25.664	93158.953	57.71
RECIRCULATION INTO LAYER 2	10.937835	39704.340	24.60
DRAINAGE COLLECTED FROM LAYER 4	3.6459	13234.781	8.20
RECIRCULATION FROM LAYER 4	10.937835	39704.340	24.60

PERC./LEAKAGE THROUGH LAYER 6	0.000018	0.065	0.00
AVG. HEAD ON TOP OF LAYER 5	0.1801		
PERC./LEAKAGE THROUGH LAYER 7	0.043687	158.585	0.10
CHANGE IN WATER STORAGE	5.009	18181.240	11.26
SOIL WATER AT START OF YEAR	281.491	1021814.060	
SOIL WATER AT END OF YEAR	286.500	1039995.310	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0255	-92.553	-0.06

****

WARNING: TEMPERATURE FOR YEAR 6 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: SOLAR RADIATION FOR YEAR 6 USED WITH PRECIPITATION FOR YEAR 2003

****

ANNUAL TOTALS FOR YEAR 2003

	INCHES	CU. FEET	PERCENT
PRECIPITATION	59.46	215839.781	100.00
RUNOFF	14.758	53572.773	24.82
EVAPOTRANSPIRATION	35.933	130436.594	60.43
RECIRCULATION INTO LAYER 2	14.696656	53348.863	24.72
DRAINAGE COLLECTED FROM LAYER 4	4.8989	17782.947	8.24
RECIRCULATION FROM LAYER 4	14.696656	53348.863	24.72
PERC./LEAKAGE THROUGH LAYER 6	0.000024	0.088	0.00
AVG. HEAD ON TOP OF LAYER 5	0.2407		
PERC./LEAKAGE THROUGH LAYER 7	0.036854	133.781	0.06
CHANGE IN WATER STORAGE	3.819	13862.860	6.42
SOIL WATER AT START OF YEAR	286.500	1039995.310	
SOIL WATER AT END OF YEAR	290.319	1053858.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0140	50.831	0.02

****

WARNING: TEMPERATURE FOR YEAR 7 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: SOLAR RADIATION FOR YEAR 7 USED WITH PRECIPITATION FOR YEAR 2004

****

ANNUAL TOTALS FOR YEAR 2004

	INCHES	CU. FEET	PERCENT
PRECIPITATION	52.36	190066.766	100.00
RUNOFF	13.398	48634.883	25.59
EVAPOTRANSPIRATION	31.105	112911.227	59.41
RECIRCULATION INTO LAYER 2	16.604935	60275.914	31.71
DRAINAGE COLLECTED FROM LAYER 4	5.5350	20091.967	10.57
RECIRCULATION FROM LAYER 4	16.604935	60275.914	31.71
PERC./LEAKAGE THROUGH LAYER 6	0.000027	0.099	0.00
AVG. HEAD ON TOP OF LAYER 5	0.2731		
PERC./LEAKAGE THROUGH LAYER 7	0.031920	115.868	0.06
CHANGE IN WATER STORAGE	2.281	8280.494	4.36
SOIL WATER AT START OF YEAR	290.319	1053858.250	
SOIL WATER AT END OF YEAR	292.600	1062138.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0089	32.323	0.02

****

WARNING: TEMPERATURE FOR YEAR 8 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: SOLAR RADIATION FOR YEAR 8 USED WITH PRECIPITATION FOR YEAR 2005

****

ANNUAL TOTALS FOR YEAR 2005

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.26	171553.734	100.00
RUNOFF	10.530	38222.566	22.28
EVAPOTRANSPIRATION	31.019	112597.742	65.63
RECIRCULATION INTO LAYER 2	18.963175	68836.328	40.13
DRAINAGE COLLECTED FROM LAYER 4	6.3211	22945.436	13.38
RECIRCULATION FROM LAYER 4	18.963175	68836.328	40.13
PERC./LEAKAGE THROUGH LAYER 6	0.000031	0.112	0.00
AVG. HEAD ON TOP OF LAYER 5	0.3123		
PERC./LEAKAGE THROUGH LAYER 7	0.027990	101.603	0.06
CHANGE IN WATER STORAGE	-0.652	-2365.792	-1.38
SOIL WATER AT START OF YEAR	292.600	1062138.620	
SOIL WATER AT END OF YEAR	291.948	1059772.870	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0144	52.186	0.03

****

WARNING: TEMPERATURE FOR YEAR 9 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: SOLAR RADIATION FOR YEAR 9 USED WITH PRECIPITATION FOR YEAR 2006

****

ANNUAL TOTALS FOR YEAR 2006

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.29	175292.672	100.00
RUNOFF	13.399	48639.660	27.75
EVAPOTRANSPIRATION	26.386	95779.586	54.64
RECIRCULATION INTO LAYER 2	18.627296	67617.086	38.57
DRAINAGE COLLECTED FROM LAYER 4	6.2091	22539.047	12.86
RECIRCULATION FROM LAYER 4	18.627296	67617.086	38.57

PERC./LEAKAGE THROUGH LAYER 6	0.000030	0.110	0.00
AVG. HEAD ON TOP OF LAYER 5	0.3067		
PERC./LEAKAGE THROUGH LAYER 7	0.024966	90.625	0.05
CHANGE IN WATER STORAGE	2.319	8416.921	4.80
SOIL WATER AT START OF YEAR	291.948	1059772.870	
SOIL WATER AT END OF YEAR	293.637	1065901.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.630	2288.416	1.31
ANNUAL WATER BUDGET BALANCE	-0.0477	-173.161	-0.10

****

WARNING: TEMPERATURE FOR YEAR 10 USED WITH PRECIPITATION FOR YEAR 2007

WARNING: SOLAR RADIATION FOR YEAR 10 USED WITH PRECIPITATION FOR YEAR 2007

****

ANNUAL TOTALS FOR YEAR 2007

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.39	124835.727	100.00
RUNOFF	9.114	33085.629	26.50
EVAPOTRANSPIRATION	22.551	81859.164	65.57
RECIRCULATION INTO LAYER 2	20.068024	72846.930	58.35
DRAINAGE COLLECTED FROM LAYER 4	6.6893	24282.309	19.45
RECIRCULATION FROM LAYER 4	20.068024	72846.930	58.35
PERC./LEAKAGE THROUGH LAYER 6	0.000033	0.118	0.00
AVG. HEAD ON TOP OF LAYER 5	0.3297		
PERC./LEAKAGE THROUGH LAYER 7	0.022517	81.735	0.07
CHANGE IN WATER STORAGE	-4.017	-14580.510	-11.68
SOIL WATER AT START OF YEAR	293.637	1065901.370	
SOIL WATER AT END OF YEAR	290.123	1053146.370	
SNOW WATER AT START OF YEAR	0.630	2288.416	1.83
SNOW WATER AT END OF YEAR	0.128	462.977	0.37

ANNUAL WATER BUDGET BALANCE	0.0296	107.402	0.09

****

WARNING: TEMPERATURE FOR YEAR 11 USED WITH PRECIPITATION FOR YEAR 2008

WARNING: SOLAR RADIATION FOR YEAR 11 USED WITH PRECIPITATION FOR YEAR 2008

****

ANNUAL TOTALS FOR YEAR 2008

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.63	129336.914	100.00
RUNOFF	7.684	27894.285	21.57
EVAPOTRANSPIRATION	22.116	80281.875	62.07
RECIRCULATION INTO LAYER 2	18.569418	67406.984	52.12
DRAINAGE COLLECTED FROM LAYER 4	6.1898	22469.000	17.37
RECIRCULATION FROM LAYER 4	18.569418	67406.984	52.12
PERC./LEAKAGE THROUGH LAYER 6	0.000030	0.109	0.00
AVG. HEAD ON TOP OF LAYER 5	0.3051		
PERC./LEAKAGE THROUGH LAYER 7	0.020553	74.608	0.06
CHANGE IN WATER STORAGE	-0.401	-1455.999	-1.13
SOIL WATER AT START OF YEAR	290.123	1053146.370	
SOIL WATER AT END OF YEAR	289.849	1052153.250	
SNOW WATER AT START OF YEAR	0.128	462.977	0.36
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0202	73.150	0.06

****

WARNING: TEMPERATURE FOR YEAR 12 USED WITH PRECIPITATION FOR YEAR 2009

WARNING: SOLAR RADIATION FOR YEAR 12 USED WITH PRECIPITATION FOR YEAR 2009

****

ANNUAL TOTALS FOR YEAR 2009

	INCHES	CU. FEET	PERCENT
PRECIPITATION	62.13	225531.891	100.00
RUNOFF	17.401	63163.922	28.01
EVAPOTRANSPIRATION	32.589	118297.820	52.45
RECIRCULATION INTO LAYER 2	16.580379	60186.777	26.69
DRAINAGE COLLECTED FROM LAYER 4	5.5268	20062.256	8.90
RECIRCULATION FROM LAYER 4	16.580379	60186.777	26.69
PERC./LEAKAGE THROUGH LAYER 6	0.000027	0.098	0.00
AVG. HEAD ON TOP OF LAYER 5	0.2719		
PERC./LEAKAGE THROUGH LAYER 7	0.018804	68.258	0.03
CHANGE IN WATER STORAGE	6.610	23994.523	10.64
SOIL WATER AT START OF YEAR	289.849	1052153.250	
SOIL WATER AT END OF YEAR	296.423	1076014.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.037	133.654	0.06
ANNUAL WATER BUDGET BALANCE	-0.0151	-54.893	-0.02

****

WARNING: TEMPERATURE FOR YEAR 13 USED WITH PRECIPITATION FOR YEAR 2010

WARNING: SOLAR RADIATION FOR YEAR 13 USED WITH PRECIPITATION FOR YEAR 2010

****

ANNUAL TOTALS FOR YEAR 2010

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.26	160663.781	100.00
RUNOFF	13.242	48069.297	29.92
EVAPOTRANSPIRATION	25.314	91889.656	57.19
RECIRCULATION INTO LAYER 2	24.064257	87353.250	54.37
DRAINAGE COLLECTED FROM LAYER 4	8.0214	29117.750	18.12
RECIRCULATION FROM LAYER 4	24.064257	87353.250	54.37
PERC./LEAKAGE THROUGH LAYER 6	0.000039	0.142	0.00

AVG. HEAD ON TOP OF LAYER 5	0.3974		
PERC./LEAKAGE THROUGH LAYER 7	0.017351	62.985	0.04
CHANGE IN WATER STORAGE	-2.329	-8454.916	-5.26
SOIL WATER AT START OF YEAR	296.423	1076014.120	
SOIL WATER AT END OF YEAR	294.130	1067692.870	
SNOW WATER AT START OF YEAR	0.037	133.654	0.08
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0058	-20.993	-0.01

****

WARNING: TEMPERATURE FOR YEAR 14 USED WITH PRECIPITATION FOR YEAR 2011

WARNING: SOLAR RADIATION FOR YEAR 14 USED WITH PRECIPITATION FOR YEAR 2011

****

ANNUAL TOTALS FOR YEAR 2011

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.04	167125.141	100.00
RUNOFF	10.379	37674.176	22.54
EVAPOTRANSPIRATION	28.289	102688.469	61.44
RECIRCULATION INTO LAYER 2	21.728354	78873.922	47.19
DRAINAGE COLLECTED FROM LAYER 4	7.2428	26291.312	15.73
RECIRCULATION FROM LAYER 4	21.728354	78873.922	47.19
PERC./LEAKAGE THROUGH LAYER 6	0.000035	0.128	0.00
AVG. HEAD ON TOP OF LAYER 5	0.3585		
PERC./LEAKAGE THROUGH LAYER 7	0.016116	58.501	0.04
CHANGE IN WATER STORAGE	0.124	449.430	0.27
SOIL WATER AT START OF YEAR	294.130	1067692.870	
SOIL WATER AT END OF YEAR	294.254	1068142.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0101	-36.738	-0.02

****

WARNING: TEMPERATURE FOR YEAR 15 USED WITH PRECIPITATION FOR YEAR 2012

WARNING: SOLAR RADIATION FOR YEAR 15 USED WITH PRECIPITATION FOR YEAR 2012

****

ANNUAL TOTALS FOR YEAR 2012

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.66	162115.859	100.00
RUNOFF	9.580	34773.922	21.45
EVAPOTRANSPIRATION	30.402	110360.406	68.08
RECIRCULATION INTO LAYER 2	20.008051	72629.227	44.80
DRAINAGE COLLECTED FROM LAYER 4	6.6693	24209.736	14.93
RECIRCULATION FROM LAYER 4	20.008051	72629.227	44.80
PERC./LEAKAGE THROUGH LAYER 6	0.000033	0.118	0.00
AVG. HEAD ON TOP OF LAYER 5	0.3290		
PERC./LEAKAGE THROUGH LAYER 7	0.015080	54.742	0.03
CHANGE IN WATER STORAGE	-2.040	-7403.687	-4.57
SOIL WATER AT START OF YEAR	294.254	1068142.370	
SOIL WATER AT END OF YEAR	291.873	1059498.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.342	1239.940	0.76
ANNUAL WATER BUDGET BALANCE	0.0333	120.739	0.07

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1998 THROUGH 2012

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

```
-------------
  TOTALS                 3.20     2.66     3.84     3.16     3.38     4.34
                         4.82     3.96     4.75     2.49     3.46     4.01

  STD. DEVIATIONS        1.67     1.02     1.39     1.33     2.60     2.53
                         2.56     1.67     3.27     1.39     1.65     1.96

RUNOFF
------
  TOTALS                 0.840    0.873    0.796    0.447    0.543    0.947
                         0.872    0.807    1.693    0.480    1.016    1.071

  STD. DEVIATIONS        0.760    1.266    0.681    0.408    0.855    1.015
                         1.077    0.977    1.915    0.456    0.921    1.012

EVAPOTRANSPIRATION
------------------
  TOTALS                 1.194    1.470    2.691    3.093    2.645    3.085
                         3.800    3.144    2.219    1.738    1.282    0.919

  STD. DEVIATIONS        0.254    0.429    0.580    0.868    1.453    1.439
                         1.057    1.012    0.812    0.398    0.377    0.186

LATERAL DRAINAGE RECIRCULATED INTO LAYER  2
-------------------------------------------
  TOTALS                 0.9663   0.8700   1.3960   1.2407   1.4016   1.5182
                         1.5686   1.4352   1.2934   1.4367   1.2518   1.4429

  STD. DEVIATIONS        0.4901   0.6117   0.8491   0.6388   0.7444   0.4788
                         0.4493   0.4493   0.5837   0.4662   0.5034   0.4993

LATERAL DRAINAGE COLLECTED FROM LAYER  4
----------------------------------------
  TOTALS                 0.3221   0.2900   0.4653   0.4136   0.4672   0.5061
                         0.5229   0.4784   0.4311   0.4789   0.4173   0.4810

  STD. DEVIATIONS        0.1634   0.2039   0.2830   0.2129   0.2481   0.1596
                         0.1498   0.1498   0.1946   0.1554   0.1678   0.1664

LATERAL DRAINAGE RECIRCULATED FROM LAYER  4
-------------------------------------------
  TOTALS                 0.9663   0.8700   1.3960   1.2407   1.4016   1.5182
                         1.5686   1.4352   1.2934   1.4367   1.2518   1.4429

  STD. DEVIATIONS        0.4901   0.6117   0.8491   0.6388   0.7444   0.4788
                         0.4493   0.4493   0.5837   0.4662   0.5034   0.4993

PERCOLATION/LEAKAGE THROUGH LAYER  6
-------------------------------------
  TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

PERCOLATION/LEAKAGE THROUGH LAYER  7
-------------------------------------
  TOTALS                 0.0043   0.0038   0.0040   0.0038   0.0038   0.0036
                         0.0036   0.0035   0.0033   0.0034   0.0032   0.0032

  STD. DEVIATIONS        0.0044   0.0038   0.0039   0.0036   0.0035   0.0032
                         0.0031   0.0030   0.0027   0.0027   0.0025   0.0025
```

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.1877	0.1848	0.2711	0.2490	0.2722	0.3047
	0.3046	0.2787	0.2596	0.2790	0.2512	0.2802
STD. DEVIATIONS	0.0952	0.1301	0.1649	0.1282	0.1446	0.0961
	0.0873	0.0872	0.1171	0.0905	0.1010	0.0970

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1998 THROUGH 2012

	INCHES		CU. FEET	PERCENT
PRECIPITATION	44.07	(8.978)	159983.8	100.00
RUNOFF	10.384	(3.4761)	37692.45	23.560
EVAPOTRANSPIRATION	27.279	(4.1037)	99022.09	61.895
DRAINAGE RECIRCULATED INTO LAYER 2	15.82134	(5.19182)	57431.461	35.89830
LATERAL DRAINAGE COLLECTED FROM LAYER 4	5.27378	(1.73061)	19143.818	11.96610
DRAINAGE RECIRCULATED FROM LAYER 4	15.82134	(5.19182)	57431.461	35.89830
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00003	(0.00001)	0.094	0.00006
AVERAGE HEAD ON TOP OF LAYER 5	0.260	(0.086)		
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.04348	(0.03887)	157.846	0.09866
CHANGE IN WATER STORAGE	1.088	(2.9088)	3951.04	2.470

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PEAK DAILY VALUES FOR YEARS 1998 THROUGH 2012

	(INCHES)	(CU. FT.)
PRECIPITATION	4.11	14919.301

RUNOFF	3.039	11030.4111
DRAINAGE RECIRCULATED INTO LAYER 2	0.11172	405.53305
DRAINAGE COLLECTED FROM LAYER 4	0.03724	135.17769
DRAINAGE RECIRCULATED FROM LAYER 4	0.11172	405.53305
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00067
AVERAGE HEAD ON TOP OF LAYER 5	0.673	
MAXIMUM HEAD ON TOP OF LAYER 5	1.320	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	7.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000597	2.16748
SNOW WATER	5.58	20250.3086

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3549
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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

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

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FINAL WATER STORAGE AT END OF YEAR 2012

LAYER	(INCHES)	(VOL/VOL)
1	3.4042	0.2837
2	140.0798	0.2594
3	141.0146	0.2611
4	1.5309	0.0638
5	0.0000	0.0000
6	0.1500	0.7500
7	5.6934	0.3163
SNOW WATER	0.342	

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****

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WARNING:  TEMPERATURE FOR YEAR    1 USED WITH PRECIPITATION FOR YEAR 1998

WARNING:  SOLAR RADIATION FOR YEAR    1 USED WITH PRECIPITATION FOR YEAR 1998

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************



PRECIPITATION DATA FILE:    C:\HELP\bc\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP\bc\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\help\bc\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\help\bc\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\help\bc\DATA10.D10
OUTPUT DATA FILE:           C:\help\bc\DATA10.OUT


TIME:  17:19     DATE:   9/10/2013



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

     TITLE:  Buncombe County Cell 7 - Case 4

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


     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   0
          THICKNESS                   =     24.00   INCHES
          POROSITY                    =      0.3980 VOL/VOL
          FIELD CAPACITY              =      0.2440 VOL/VOL
          WILTING POINT               =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.3201 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-04 CM/SEC
```

```
                         LAYER  2
                         --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
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  =      0.1125 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   39.2999992000     CM/SEC
SLOPE                       =      5.00   PERCENT
DRAINAGE LENGTH             =    750.0    FEET


                         LAYER  3
                         --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      3.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                         LAYER  4
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
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  =      0.0685 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   39.2999992000     CM/SEC


                         LAYER  5
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.3980 VOL/VOL
FIELD CAPACITY              =      0.2440 VOL/VOL
WILTING POINT               =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2447 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-04 CM/SEC
```

```
                         LAYER  6
                         --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =    540.00   INCHES
  POROSITY                    =      0.3980 VOL/VOL
  FIELD CAPACITY              =      0.2440 VOL/VOL
  WILTING POINT               =      0.1360 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2440 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
NOTE:   75.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 8
         IS RECIRCULATED INTO THIS LAYER.


                         LAYER  7
                         --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =    540.00   INCHES
  POROSITY                    =      0.3980 VOL/VOL
  FIELD CAPACITY              =      0.2440 VOL/VOL
  WILTING POINT               =      0.1360 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2440 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                         LAYER  8
                         --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER  21
  THICKNESS                   =     24.00   INCHES
  POROSITY                    =      0.3970 VOL/VOL
  FIELD CAPACITY              =      0.0320 VOL/VOL
  WILTING POINT               =      0.0130 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0413 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.300000012000     CM/SEC
  SLOPE                       =      5.88   PERCENT
  DRAINAGE LENGTH             =    450.0    FEET
NOTE:   75.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS
         LAYER IS RECIRCULATED INTO LAYER #  6.


                         LAYER  9
                         --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
  THICKNESS                   =      0.06   INCHES
  POROSITY                    =      0.0000 VOL/VOL
  FIELD CAPACITY              =      0.0000 VOL/VOL
```

```
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      3.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD
```

LAYER 10

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

```
THICKNESS                    =      0.20   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
```

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.4750 VOL/VOL
FIELD CAPACITY               =      0.3780 VOL/VOL
WILTING POINT                =      0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3543 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 79.5, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 750. FEET.

```
SCS RUNOFF CURVE NUMBER              =     79.50
FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      3.662  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.776  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.632  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =    283.162  INCHES
TOTAL INITIAL WATER                  =    283.162  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

Cell 7 Case 4.OUT

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	96
END OF GROWING SEASON (JULIAN DATE)	=	298
EVAPORATIVE ZONE DEPTH	=	12.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00 %

NOTE: PRECIPITATION DATA FOR ASHEVILLE NORTH CAROLINA
WAS ENTERED FROM AN ASCII DATA FILE.

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

WARNING: TEMPERATURE FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 1998

WARNING: SOLAR RADIATION FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 1998

****

ANNUAL TOTALS FOR YEAR 1998

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.39	124835.727	100.00
RUNOFF	1.078	3912.031	3.13
EVAPOTRANSPIRATION	24.488	88890.828	71.21
DRAINAGE COLLECTED FROM LAYER 2	8.5012	30859.480	24.72

PERC./LEAKAGE THROUGH LAYER 3	0.320908	1164.895	0.93
AVG. HEAD ON TOP OF LAYER 3	0.0016		
RECIRCULATION INTO LAYER 6	0.846206	3071.727	2.46
DRAINAGE COLLECTED FROM LAYER 8	0.2821	1023.909	0.82
RECIRCULATION FROM LAYER 8	0.846206	3071.727	2.46
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.012	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0140		
PERC./LEAKAGE THROUGH LAYER 11	0.173221	628.793	0.50
CHANGE IN WATER STORAGE	-0.133	-482.663	-0.39
SOIL WATER AT START OF YEAR	283.164	1027886.560	
SOIL WATER AT END OF YEAR	283.031	1027403.870	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0009	3.348	0.00

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WARNING: TEMPERATURE FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 1999

WARNING: SOLAR RADIATION FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 1999

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ANNUAL TOTALS FOR YEAR 1999

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.91	137613.328	100.00
RUNOFF	1.260	4575.194	3.32
EVAPOTRANSPIRATION	23.899	86751.789	63.04
DRAINAGE COLLECTED FROM LAYER 2	13.3300	48387.859	35.16
PERC./LEAKAGE THROUGH LAYER 3	0.433414	1573.294	1.14
AVG. HEAD ON TOP OF LAYER 3	0.0025		
RECIRCULATION INTO LAYER 6	1.151118	4178.557	3.04
DRAINAGE COLLECTED FROM LAYER 8	0.3837	1392.852	1.01
RECIRCULATION FROM LAYER 8	1.151118	4178.557	3.04

PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.014	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0190		
PERC./LEAKAGE THROUGH LAYER 11	0.101688	369.129	0.27
CHANGE IN WATER STORAGE	-1.065	-3866.956	-2.81
SOIL WATER AT START OF YEAR	283.031	1027403.870	
SOIL WATER AT END OF YEAR	281.966	1023536.940	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0010	3.458	0.00

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WARNING: TEMPERATURE FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2000

WARNING: SOLAR RADIATION FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2000

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ANNUAL TOTALS FOR YEAR 2000

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.35	128320.508	100.00
RUNOFF	0.670	2432.037	1.90
EVAPOTRANSPIRATION	26.188	95061.359	74.08
DRAINAGE COLLECTED FROM LAYER 2	8.6649	31453.510	24.51
PERC./LEAKAGE THROUGH LAYER 3	0.374571	1359.692	1.06
AVG. HEAD ON TOP OF LAYER 3	0.0016		
RECIRCULATION INTO LAYER 6	1.164247	4226.217	3.29
DRAINAGE COLLECTED FROM LAYER 8	0.3881	1408.739	1.10
RECIRCULATION FROM LAYER 8	1.164247	4226.217	3.29
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.014	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0192		
PERC./LEAKAGE THROUGH LAYER 11	0.071915	261.053	0.20
CHANGE IN WATER STORAGE	-0.632	-2293.121	-1.79
SOIL WATER AT START OF YEAR	281.966	1023536.940	

SOIL WATER AT END OF YEAR	281.334	1021243.810	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0008	-3.069	0.00

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WARNING: TEMPERATURE FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2001

WARNING: SOLAR RADIATION FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2001

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ANNUAL TOTALS FOR YEAR 2001

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.695	100.00
RUNOFF	0.632	2295.431	1.83
EVAPOTRANSPIRATION	26.785	97229.172	77.66
DRAINAGE COLLECTED FROM LAYER 2	6.4009	23235.121	18.56
PERC./LEAKAGE THROUGH LAYER 3	0.283264	1028.248	0.82
AVG. HEAD ON TOP OF LAYER 3	0.0012		
RECIRCULATION INTO LAYER 6	1.043777	3788.911	3.03
DRAINAGE COLLECTED FROM LAYER 8	0.3479	1262.970	1.01
RECIRCULATION FROM LAYER 8	1.043777	3788.911	3.03
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.013	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0173		
PERC./LEAKAGE THROUGH LAYER 11	0.055240	200.523	0.16
CHANGE IN WATER STORAGE	0.270	981.389	0.78
SOIL WATER AT START OF YEAR	281.334	1021243.810	
SOIL WATER AT END OF YEAR	281.605	1022225.190	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0016	-5.917	0.00

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WARNING: TEMPERATURE FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2002

WARNING: SOLAR RADIATION FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2002

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ANNUAL TOTALS FOR YEAR 2002

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.47	161426.094	100.00
RUNOFF	2.322	8427.380	5.22
EVAPOTRANSPIRATION	25.600	92927.617	57.57
DRAINAGE COLLECTED FROM LAYER 2	15.7048	57008.355	35.32
PERC./LEAKAGE THROUGH LAYER 3	0.511348	1856.195	1.15
AVG. HEAD ON TOP OF LAYER 3	0.0029		
RECIRCULATION INTO LAYER 6	1.092772	3966.763	2.46
DRAINAGE COLLECTED FROM LAYER 8	0.3643	1322.254	0.82
RECIRCULATION FROM LAYER 8	1.092772	3966.763	2.46
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.013	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0180		
PERC./LEAKAGE THROUGH LAYER 11	0.044844	162.784	0.10
CHANGE IN WATER STORAGE	0.431	1563.421	0.97
SOIL WATER AT START OF YEAR	281.605	1022225.190	
SOIL WATER AT END OF YEAR	282.035	1023788.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0039	14.274	0.01

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WARNING: TEMPERATURE FOR YEAR 6 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: SOLAR RADIATION FOR YEAR 6 USED WITH PRECIPITATION FOR YEAR 2003

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ANNUAL TOTALS FOR YEAR 2003

	INCHES	CU. FEET	PERCENT
PRECIPITATION	59.46	215839.781	100.00
RUNOFF	2.804	10179.896	4.72
EVAPOTRANSPIRATION	36.211	131444.984	60.90
DRAINAGE COLLECTED FROM LAYER 2	20.1029	72973.508	33.81
PERC./LEAKAGE THROUGH LAYER 3	0.642398	2331.906	1.08
AVG. HEAD ON TOP OF LAYER 3	0.0037		
RECIRCULATION INTO LAYER 6	2.002903	7270.537	3.37
DRAINAGE COLLECTED FROM LAYER 8	0.6676	2423.513	1.12
RECIRCULATION FROM LAYER 8	2.002903	7270.537	3.37
PERC./LEAKAGE THROUGH LAYER 10	0.000005	0.017	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0331		
PERC./LEAKAGE THROUGH LAYER 11	0.037686	136.801	0.06
CHANGE IN WATER STORAGE	-0.364	-1321.591	-0.61
SOIL WATER AT START OF YEAR	282.035	1023788.620	
SOIL WATER AT END OF YEAR	281.671	1022467.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0007	2.670	0.00

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WARNING: TEMPERATURE FOR YEAR 7 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: SOLAR RADIATION FOR YEAR 7 USED WITH PRECIPITATION FOR YEAR 2004

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ANNUAL TOTALS FOR YEAR 2004

	INCHES	CU. FEET	PERCENT
PRECIPITATION	52.36	190066.766	100.00
RUNOFF	3.495	12688.488	6.68
EVAPOTRANSPIRATION	31.731	115183.141	60.60

DRAINAGE COLLECTED FROM LAYER 2	16.6532	60451.055	31.81
PERC./LEAKAGE THROUGH LAYER 3	0.519371	1885.318	0.99
AVG. HEAD ON TOP OF LAYER 3	0.0031		
RECIRCULATION INTO LAYER 6	1.464964	5317.819	2.80
DRAINAGE COLLECTED FROM LAYER 8	0.4883	1772.606	0.93
RECIRCULATION FROM LAYER 8	1.464964	5317.819	2.80
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0241		
PERC./LEAKAGE THROUGH LAYER 11	0.032547	118.147	0.06
CHANGE IN WATER STORAGE	-0.041	-149.551	-0.08
SOIL WATER AT START OF YEAR	281.671	1022467.000	
SOIL WATER AT END OF YEAR	281.630	1022317.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0008	2.877	0.00

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WARNING: TEMPERATURE FOR YEAR 8 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: SOLAR RADIATION FOR YEAR 8 USED WITH PRECIPITATION FOR YEAR 2005

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ANNUAL TOTALS FOR YEAR 2005

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.26	171553.734	100.00
RUNOFF	1.552	5632.275	3.28
EVAPOTRANSPIRATION	31.937	115930.578	67.58
DRAINAGE COLLECTED FROM LAYER 2	13.1803	47844.602	27.89
PERC./LEAKAGE THROUGH LAYER 3	0.448067	1626.484	0.95
AVG. HEAD ON TOP OF LAYER 3	0.0024		
RECIRCULATION INTO LAYER 6	1.528867	5549.789	3.24
DRAINAGE COLLECTED FROM LAYER 8	0.5096	1849.931	1.08

RECIRCULATION FROM LAYER 8	1.528867	5549.789	3.24
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0253		
PERC./LEAKAGE THROUGH LAYER 11	0.028479	103.380	0.06
CHANGE IN WATER STORAGE	0.057	205.938	0.12
SOIL WATER AT START OF YEAR	281.630	1022317.500	
SOIL WATER AT END OF YEAR	281.687	1022523.440	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0036	-12.964	-0.01

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WARNING: TEMPERATURE FOR YEAR 9 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: SOLAR RADIATION FOR YEAR 9 USED WITH PRECIPITATION FOR YEAR 2006

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ANNUAL TOTALS FOR YEAR 2006

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.29	175292.672	100.00
RUNOFF	2.689	9761.727	5.57
EVAPOTRANSPIRATION	26.077	94660.312	54.00
DRAINAGE COLLECTED FROM LAYER 2	16.4399	59676.781	34.04
PERC./LEAKAGE THROUGH LAYER 3	0.571060	2072.947	1.18
AVG. HEAD ON TOP OF LAYER 3	0.0031		
RECIRCULATION INTO LAYER 6	1.625109	5899.146	3.37
DRAINAGE COLLECTED FROM LAYER 8	0.5417	1966.382	1.12
RECIRCULATION FROM LAYER 8	1.625109	5899.146	3.37
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0268		
PERC./LEAKAGE THROUGH LAYER 11	0.025356	92.041	0.05
CHANGE IN WATER STORAGE	2.514	9124.133	5.21

SOIL WATER AT START OF YEAR	281.687	1022523.440	
SOIL WATER AT END OF YEAR	283.570	1029359.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.630	2288.416	1.31
ANNUAL WATER BUDGET BALANCE	0.0031	11.302	0.01

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WARNING: TEMPERATURE FOR YEAR 10 USED WITH PRECIPITATION FOR YEAR 2007

WARNING: SOLAR RADIATION FOR YEAR 10 USED WITH PRECIPITATION FOR YEAR 2007

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ANNUAL TOTALS FOR YEAR 2007

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.39	124835.727	100.00
RUNOFF	1.799	6529.137	5.23
EVAPOTRANSPIRATION	23.920	86830.945	69.56
DRAINAGE COLLECTED FROM LAYER 2	9.0008	32672.959	26.17
PERC./LEAKAGE THROUGH LAYER 3	0.372090	1350.687	1.08
AVG. HEAD ON TOP OF LAYER 3	0.0061		
RECIRCULATION INTO LAYER 6	1.388344	5039.689	4.04
DRAINAGE COLLECTED FROM LAYER 8	0.4628	1679.896	1.35
RECIRCULATION FROM LAYER 8	1.388344	5039.689	4.04
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.014	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0231		
PERC./LEAKAGE THROUGH LAYER 11	0.022837	82.899	0.07
CHANGE IN WATER STORAGE	-0.812	-2948.514	-2.36
SOIL WATER AT START OF YEAR	283.570	1029359.120	
SOIL WATER AT END OF YEAR	283.261	1028236.060	
SNOW WATER AT START OF YEAR	0.630	2288.416	1.83
SNOW WATER AT END OF YEAR	0.128	462.977	0.37
ANNUAL WATER BUDGET BALANCE	-0.0032	-11.596	-0.01

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WARNING: TEMPERATURE FOR YEAR 11 USED WITH PRECIPITATION FOR YEAR 2008

WARNING: SOLAR RADIATION FOR YEAR 11 USED WITH PRECIPITATION FOR YEAR 2008

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ANNUAL TOTALS FOR YEAR 2008

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.63	129336.914	100.00
RUNOFF	2.076	7536.903	5.83
EVAPOTRANSPIRATION	22.950	83309.328	64.41
DRAINAGE COLLECTED FROM LAYER 2	11.8392	42976.387	33.23
PERC./LEAKAGE THROUGH LAYER 3	0.387934	1408.200	1.09
AVG. HEAD ON TOP OF LAYER 3	0.0022		
RECIRCULATION INTO LAYER 6	1.150523	4176.399	3.23
DRAINAGE COLLECTED FROM LAYER 8	0.3835	1392.134	1.08
RECIRCULATION FROM LAYER 8	1.150523	4176.399	3.23
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.014	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0190		
PERC./LEAKAGE THROUGH LAYER 11	0.020819	75.571	0.06
CHANGE IN WATER STORAGE	-1.639	-5950.073	-4.60
SOIL WATER AT START OF YEAR	283.261	1028236.060	
SOIL WATER AT END OF YEAR	281.749	1022748.940	
SNOW WATER AT START OF YEAR	0.128	462.977	0.36
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0009	-3.330	0.00

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WARNING: TEMPERATURE FOR YEAR 12 USED WITH PRECIPITATION FOR YEAR 2009

WARNING: SOLAR RADIATION FOR YEAR 12 USED WITH PRECIPITATION FOR YEAR 2009

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ANNUAL TOTALS FOR YEAR 2009

	INCHES	CU. FEET	PERCENT
PRECIPITATION	62.13	225531.891	100.00
RUNOFF	4.262	15470.776	6.86
EVAPOTRANSPIRATION	32.063	116387.375	51.61
DRAINAGE COLLECTED FROM LAYER 2	25.1228	91195.680	40.44
PERC./LEAKAGE THROUGH LAYER 3	0.672442	2440.965	1.08
AVG. HEAD ON TOP OF LAYER 3	0.0046		
RECIRCULATION INTO LAYER 6	1.479929	5372.141	2.38
DRAINAGE COLLECTED FROM LAYER 8	0.4933	1790.714	0.79
RECIRCULATION FROM LAYER 8	1.479929	5372.141	2.38
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0244		
PERC./LEAKAGE THROUGH LAYER 11	0.019024	69.057	0.03
CHANGE IN WATER STORAGE	0.166	603.135	0.27
SOIL WATER AT START OF YEAR	281.749	1022748.940	
SOIL WATER AT END OF YEAR	281.878	1023218.440	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.037	133.654	0.06
ANNUAL WATER BUDGET BALANCE	0.0042	15.158	0.01

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WARNING: TEMPERATURE FOR YEAR 13 USED WITH PRECIPITATION FOR YEAR 2010

WARNING: SOLAR RADIATION FOR YEAR 13 USED WITH PRECIPITATION FOR YEAR 2010

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ANNUAL TOTALS FOR YEAR 2010

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.26	160663.781	100.00

RUNOFF	6.329	22975.260	14.30
EVAPOTRANSPIRATION	25.998	94372.758	58.74
DRAINAGE COLLECTED FROM LAYER 2	11.8024	42842.574	26.67
PERC./LEAKAGE THROUGH LAYER 3	0.461316	1674.579	1.04
AVG. HEAD ON TOP OF LAYER 3	0.0054		
RECIRCULATION INTO LAYER 6	1.679775	6097.582	3.80
DRAINAGE COLLECTED FROM LAYER 8	0.5599	2032.527	1.27
RECIRCULATION FROM LAYER 8	1.679775	6097.582	3.80
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0279		
PERC./LEAKAGE THROUGH LAYER 11	0.017551	63.709	0.04
CHANGE IN WATER STORAGE	-0.447	-1624.405	-1.01
SOIL WATER AT START OF YEAR	281.878	1023218.440	
SOIL WATER AT END OF YEAR	281.468	1021727.690	
SNOW WATER AT START OF YEAR	0.037	133.654	0.08
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0004	1.356	0.00

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WARNING: TEMPERATURE FOR YEAR 14 USED WITH PRECIPITATION FOR YEAR 2011

WARNING: SOLAR RADIATION FOR YEAR 14 USED WITH PRECIPITATION FOR YEAR 2011

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ANNUAL TOTALS FOR YEAR 2011

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.04	167125.141	100.00
RUNOFF	2.378	8633.268	5.17
EVAPOTRANSPIRATION	29.397	106709.453	63.85
DRAINAGE COLLECTED FROM LAYER 2	13.3455	48444.121	28.99
PERC./LEAKAGE THROUGH LAYER 3	0.423753	1538.223	0.92
AVG. HEAD ON TOP OF LAYER 3	0.0025		

RECIRCULATION INTO LAYER 6	1.301362	4723.944	2.83
DRAINAGE COLLECTED FROM LAYER 8	0.4338	1574.647	0.94
RECIRCULATION FROM LAYER 8	1.301362	4723.944	2.83
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.014	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0215		
PERC./LEAKAGE THROUGH LAYER 11	0.016285	59.114	0.04
CHANGE IN WATER STORAGE	0.472	1713.194	1.03
SOIL WATER AT START OF YEAR	281.468	1021727.690	
SOIL WATER AT END OF YEAR	281.940	1023440.870	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0024	-8.648	-0.01

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WARNING: TEMPERATURE FOR YEAR 15 USED WITH PRECIPITATION FOR YEAR 2012

WARNING: SOLAR RADIATION FOR YEAR 15 USED WITH PRECIPITATION FOR YEAR 2012

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ANNUAL TOTALS FOR YEAR 2012

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.66	162115.859	100.00
RUNOFF	3.159	11468.899	7.07
EVAPOTRANSPIRATION	31.293	113593.750	70.07
DRAINAGE COLLECTED FROM LAYER 2	8.7271	31679.318	19.54
PERC./LEAKAGE THROUGH LAYER 3	0.384587	1396.049	0.86
AVG. HEAD ON TOP OF LAYER 3	0.0016		
RECIRCULATION INTO LAYER 6	1.338165	4857.540	3.00
DRAINAGE COLLECTED FROM LAYER 8	0.4461	1619.181	1.00
RECIRCULATION FROM LAYER 8	1.338165	4857.540	3.00
PERC./LEAKAGE THROUGH LAYER 10	0.000004	0.014	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0221		

PERC./LEAKAGE THROUGH LAYER 11	0.015225	55.268	0.03
CHANGE IN WATER STORAGE	1.020	3702.553	2.28
SOIL WATER AT START OF YEAR	281.940	1023440.870	
SOIL WATER AT END OF YEAR	282.618	1025903.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.342	1239.940	0.76
ANNUAL WATER BUDGET BALANCE	-0.0009	-3.120	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1998 THROUGH 2012

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.20	2.66	3.84	3.16	3.38	4.34
	4.82	3.96	4.75	2.49	3.46	4.01
STD. DEVIATIONS	1.67	1.02	1.39	1.33	2.60	2.53
	2.56	1.67	3.27	1.39	1.65	1.96
RUNOFF						
TOTALS	0.253	0.492	0.096	0.030	0.072	0.197
	0.101	0.180	0.496	0.066	0.254	0.197
STD. DEVIATIONS	0.364	1.198	0.153	0.058	0.185	0.430
	0.256	0.447	0.763	0.162	0.391	0.267
EVAPOTRANSPIRATION						
TOTALS	1.094	1.420	2.620	3.205	3.049	3.352
	4.181	3.340	2.335	1.353	1.120	0.832
STD. DEVIATIONS	0.222	0.402	0.502	0.819	1.535	1.491
	1.008	1.100	0.755	0.241	0.171	0.154
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	2.1546	1.1752	1.2722	0.6445	0.5100	0.2944
	0.6299	0.4848	1.1431	0.9267	1.5548	2.4642
STD. DEVIATIONS	1.4812	0.7493	0.9115	0.4244	0.8066	0.5397
	1.1617	0.9018	1.6387	0.8905	1.4387	1.6966
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0666	0.0449	0.0492	0.0347	0.0237	0.0123

```
                          0.0237   0.0170   0.0301   0.0384   0.0479   0.0653

  STD. DEVIATIONS         0.0263   0.0160   0.0207   0.0142   0.0206   0.0178
                          0.0294   0.0247   0.0282   0.0225   0.0301   0.0314

LATERAL DRAINAGE RECIRCULATED INTO LAYER  6
-------------------------------------------
  TOTALS                  0.1334   0.1477   0.1596   0.1480   0.1314   0.1061
                          0.0888   0.0839   0.0745   0.0789   0.0894   0.1087

  STD. DEVIATIONS         0.0647   0.0487   0.0430   0.0337   0.0275   0.0281
                          0.0293   0.0356   0.0476   0.0410   0.0424   0.0562

LATERAL DRAINAGE COLLECTED FROM LAYER  8
----------------------------------------
  TOTALS                  0.0445   0.0492   0.0532   0.0493   0.0438   0.0354
                          0.0296   0.0280   0.0248   0.0263   0.0298   0.0362

  STD. DEVIATIONS         0.0216   0.0162   0.0143   0.0112   0.0092   0.0094
                          0.0098   0.0119   0.0159   0.0137   0.0141   0.0187

LATERAL DRAINAGE RECIRCULATED FROM LAYER  8
-------------------------------------------
  TOTALS                  0.1334   0.1477   0.1596   0.1480   0.1314   0.1061
                          0.0888   0.0839   0.0745   0.0789   0.0894   0.1087

  STD. DEVIATIONS         0.0647   0.0487   0.0430   0.0337   0.0275   0.0281
                          0.0293   0.0356   0.0476   0.0410   0.0424   0.0562

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

PERCOLATION/LEAKAGE THROUGH LAYER 11
------------------------------------
  TOTALS                  0.0045   0.0040   0.0042   0.0040   0.0040   0.0037
                          0.0038   0.0037   0.0035   0.0035   0.0033   0.0033

  STD. DEVIATIONS         0.0050   0.0042   0.0044   0.0039   0.0038   0.0035
                          0.0034   0.0032   0.0030   0.0029   0.0027   0.0027


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
  AVERAGES                0.0082   0.0028   0.0028   0.0015   0.0011   0.0007
                          0.0014   0.0011   0.0026   0.0020   0.0035   0.0080

  STD. DEVIATIONS         0.0156   0.0018   0.0020   0.0010   0.0018   0.0012
                          0.0025   0.0020   0.0037   0.0019   0.0032   0.0109

DAILY AVERAGE HEAD ON TOP OF LAYER  9
-------------------------------------
  AVERAGES                0.0259   0.0315   0.0310   0.0297   0.0255   0.0213
                          0.0172   0.0163   0.0149   0.0153   0.0179   0.0211
```

STD. DEVIATIONS	0.0126	0.0105	0.0084	0.0068	0.0053	0.0056
	0.0057	0.0069	0.0095	0.0080	0.0085	0.0109

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1998 THROUGH 2012

	INCHES			CU. FEET	PERCENT
PRECIPITATION	44.07	(	8.978)	159983.8	100.00
RUNOFF	2.434	(	1.4945)	8834.58	5.522
EVAPOTRANSPIRATION	27.902	(	3.9235)	101285.57	63.310
LATERAL DRAINAGE COLLECTED FROM LAYER 2	13.25438	(	4.99150)	48113.418	30.07393
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.45377	(	0.11179)	1647.179	1.02959
AVERAGE HEAD ON TOP OF LAYER 3	0.003	(	0.001)		
DRAINAGE RECIRCULATED INTO LAYER 6	1.35054	(	0.29330)	4902.451	3.06434
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.45018	(	0.09777)	1634.150	1.02145
DRAINAGE RECIRCULATED FROM LAYER 8	1.35054	(	0.29330)	4902.451	3.06434
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000	(	0.00000)	0.014	0.00001
AVERAGE HEAD ON TOP OF LAYER 9	0.022	(	0.005)		
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.04551	(	0.04273)	165.218	0.10327
CHANGE IN WATER STORAGE	-0.014	(	0.9673)	-49.54	-0.031

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PEAK DAILY VALUES FOR YEARS 1998 THROUGH 2012

	(INCHES)	(CU. FT.)
PRECIPITATION	4.11	14919.301
RUNOFF	1.577	5722.9458

DRAINAGE COLLECTED FROM LAYER 2	1.25958	4572.27930
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.038420	139.46419
AVERAGE HEAD ON TOP OF LAYER 3	1.293	
MAXIMUM HEAD ON TOP OF LAYER 3	1.085	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	8.0 FEET	
DRAINAGE RECIRCULATED INTO LAYER 6	0.00996	36.14524
DRAINAGE COLLECTED FROM LAYER 8	0.00332	12.04842
DRAINAGE RECIRCULATED FROM LAYER 8	0.00996	36.14524
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 9	0.060	
MAXIMUM HEAD ON TOP OF LAYER 9	0.120	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000677	2.45577
SNOW WATER	5.58	20250.3086

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3800
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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

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

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FINAL WATER STORAGE AT END OF YEAR 2012

LAYER	(INCHES)	(VOL/VOL)
1	7.7611	0.3234
2	0.0279	0.1397
3	0.0000	0.0000

4	0.0143	0.0716
5	4.3948	0.2442
6	131.7600	0.2440
7	131.7600	0.2440
8	1.0529	0.0439
9	0.0000	0.0000
10	0.1500	0.7500
11	5.6951	0.3164
SNOW WATER	0.342	

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Engineering Plan

Appendix A – Calculations

A-4 Pipe Strength

CDM Smith

Leachate Collection Pipe Strength Calculations

This calculation was performed to check the strength of the HDPE collection pipes.

1.0 Total loading = Static+Dynamic+Vacuum

Static Loading Pressure

Yellow areas are input parameters

Depth of drainage rock above leachate pipe invert	$D_p := 2.0 \cdot ft$
Outside diameter of pipe	$D_{OD} := 10.75 \cdot in$
Depth of final cover material layer above waste	$D_{fc} := 3.5 \cdot ft$
Density of drainage rock and cover material	$\gamma_{soil} := 120 \cdot pcf$
Density of waste	$\gamma_{waste} := 90 \cdot pcf$
Depth of waste above pipe	$D_{waste} := 140 \cdot ft$

Blue areas are calculated based on input parameters

Static load on leachate pipe in empty cell

$$P_{se} := (D_p - D_{OD}) \cdot \gamma_{soil}$$

$$P_{se} = 133 \cdot psf$$

Static load on leachate pipe in full cell

$$P_{sf} := (D_{fc} \cdot \gamma_{soil}) + D_{waste} \cdot \gamma_{waste} + (D_p - D_{OD}) \cdot \gamma_{soil}$$

$$P_{sf} = 13152 \cdot psf$$

Dynamic Loading Pressure

Yellow cells are input parameters

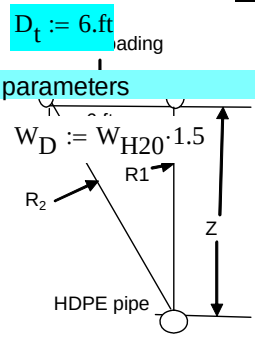
Axle loading	$W_{H20} := 16000 \cdot lbf$	Based on H-20 ASHTTO standard
Distance between Tires	$D_t := 6.ft$	

Blue cells are calculated based on input parameters

Design Axle loading

$$W_D := W_{H20} \cdot 1.5$$

$$W_D = 24000.00\,lbf$$



R1e, R1f, R2e, and R2f as shown on graphic

$R_{1e} := D_p - D_{OD}$ $\quad R_{1e} = 1.1\,ft$

$R_{2e} := \left[D_t^2 + \left(D_p - D_{OD}\right)^2\right]^{0.5}$ $\quad R_{2e} = 6.1\,ft$

$R_{1f} := D_{fc} + D_{waste} + \left(D_p - D_{OD}\right)$ $\quad R_{1f} = 145\,ft$

$R_{2f} := \left(R_{1f}^2 + D_t^2\right)^{0.5}$ $\quad R_{2f} = 145\,ft$

Dynamic Loading on pipe P.L1e, P.L2e, P.L1f, and P.L2f

$Z_e := D_p - D_{OD}$ $\quad Z_f := R_{1f}$ $\quad Z_e = 1.10\,ft$ $\quad Z_f = 144.60\,ft$

$P_{L1e} := \frac{3 \cdot W_D \cdot Z_e^3}{2 \cdot \pi \cdot R_{1e}^5}$ $\quad P_{L1e} = 9399.04 \cdot psf$

$P_{L1f} := \frac{3 \cdot W_D \cdot Z_f^3}{2 \cdot \pi \cdot R_{1f}^5}$ $\quad P_{L1f} = 0.55 \cdot psf$

$P_{L2e} := \frac{3 \cdot W_D \cdot Z_e^3}{2 \cdot \pi \cdot R_{2e}^5}$ $\quad P_{L2e} = 1.83 \cdot psf$

$P_{L2f} := \frac{3 \cdot W_D \cdot Z_f^3}{2 \cdot \pi \cdot R_{2f}^5}$ $\quad P_{L2f} = 0.55 \cdot psf$

Vacuum Pressure

External pressure due to vaccum is 0

Total Loading = Static pressure + Dynamic Pressure + Vacuum Pressure

Total Load on leachate pipe in the empty cell case $\quad P_{te} := P_{se} + P_{L1e} + P_{L2e}$

$P_{te} = 9533 \cdot psf$

Total Load on leachate pipe in the full cell case $\quad P_{tf} := P_{sf} + P_{L1f} + P_{L2f}$

$P_{tf} = 13154 \cdot psf$

Select design load(P_T) as the max of the empty cell and full cell cases plus 10% due to area lost from perforations

$P_T := \max\left(P_{te}, P_{tf}\right)$ $\quad P_T = 13154 \cdot psf$

$P_{Tdesign} := P_T \cdot 1.1$

$P_{Tdesign} = 14468.95 \cdot psf$ $\quad P_{Tdesign} = 100.5\,psi$

2.0 Short-Term Wall Crushing (SA)

$$SA(SDR) := (SDR - 1)\cdot\frac{P_{Tdesign}}{2}$$

Compressive yield strength for Drisco Pipe is equal to 1600 psi

Safety Factor for each SDR case (SF) $\quad SF(SDR) := \frac{1600\cdot psi}{SA(SDR)}$

$SA(11) = 502.4\,psi$	$SA(13.5) = 628\,psi$	$SA(15.5) = 728.5\,psi$
$SF(11) = 3.2$	$SF(13.5) = 2.5$	$SF(15.5) = 2.2$
$SA(17) = 803.8\,psi$	$SA(19) = 904.31\,psi$	$SA(21) = 1.005\times 10^{3}\,psi$
$SF(17) = 2$	$SF(19) = 1.8$	$SF(21) = 1.6$

3.0 Critical Collapse Pressure (Pc)

Modulus of Elasticity (E) for polyethylene pipe vs. stress intensity

$$E(SDR) := 37399\cdot e^{-\left(0.0013\cdot\frac{SA(SDR)}{psi}\right)}$$

This equation is the curve fit for Chart 25of DriscoPipe manual charts at 73.4 deg F and 50 years. Chart is shown below

$$P_c(SDR) := \frac{2.32\cdot E(SDR)}{SDR^{3}}$$

Critical Collapse pressure equation Pc

Pcb is the critical buckling pressure. Assume $\quad P_{cb} := P_{Tdesign}$

$$E'(SDR) := \frac{P_{cb}^{2}}{0.64\cdot P_c(SDR)\cdot psi}$$

E` is the required modulus of elasticity for soil

Minimum E` is for crushed stone (around pipe) $\quad E'_{min} := 3000\cdot psi$

$$SF_2(SDR) := \frac{E'_{min}}{E'(SDR)}$$

$E(11) = 19463.32$	$E(13.5) = 16531.26$	$E(15.5) = 14506.99$
$P_c(11) = 33.9$	$P_c(13.5) = 15.6$	$P_c(15.5) = 9$
$E'(11) = 465\,psi$	$E'(13.5) = 1\times 10^{3}\,psi$	$E'(15.5) = 1.7\times 10^{3}\,psi$
$SF_2(11) = 6.5$	$SF_2(13.5) = 3$	$SF_2(15.5) = 1.7$
$E(17) = 13153.19$	$E(19) = 11542.57$	$E(21) = 10129.17$
$P_c(17) = 6.2$	$P_c(19) = 3.9$	$P_c(21) = 2.5$
$E'(17) = 2.5\times 10^{3}\,psi$	$E'(19) = 4\times 10^{3}\,psi$	$E'(21) = 6.2\times 10^{3}\,psi$
$SF_2(17) = 1.2$	$SF_2(19) = 0.7$	$SF_2(21) = 0.5$

4.0 Ring Deflection (E_s)

$$E_s := \frac{P_{Tdesign} \cdot 100}{E'_{min}}$$

$E_s = 3.3$ Percent

Allowable deflection (AD) is obtained from DriscoPipe manual

$AD(SDR) := 0.2462 \cdot SDR + 0.0359$

This equation is the curve fit for DriscoPipe manual table. Data is shown below

$$SF_3(SDR) := \frac{AD(SDR)}{E_s}$$

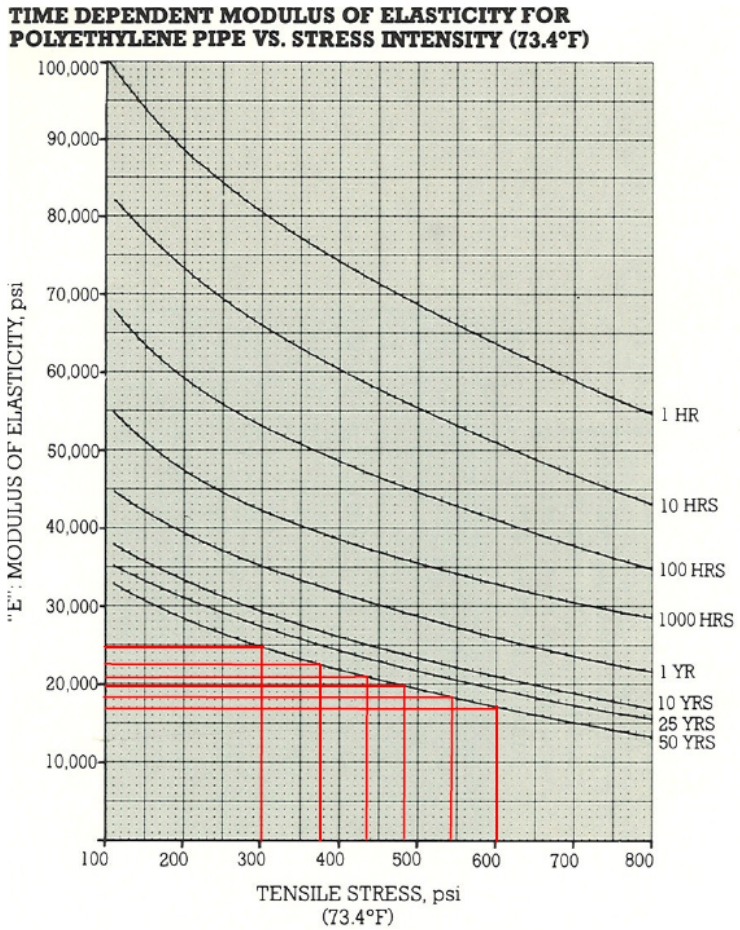
$AD(11) = 2.7$	$AD(13.5) = 3.4$	$AD(15.5) = 3.9$
$SF_3(11) = 0.82$	$SF_3(13.5) = 1.00$	$SF_3(15.5) = 1.15$
$AD(17) = 4.2$	$AD(19) = 4.7$	$AD(21) = 5.2$
$SF_3(17) = 1.26$	$SF_3(19) = 1.41$	$SF_3(21) = 1.55$

5.0 Summary of Safety Facors

	SDR 11	SDR 13.5	SDR 15.5
Short Term Wall Crushing SF	$SF(11) = 3.2$	$SF(13.5) = 2.5$	$SF(15.5) = 2.2$
Critical Collapse Pressure SF	$SF_2(11) = 6.45$	$SF_2(13.5) = 3$	$SF_2(15.5) = 1.72$
Pipe Deflection SF	$SF_3(11) = 0.82$	$SF_3(13.5) = 1.0$	$SF_3(15.5) = 1.15$

	SDR 17	SDR 19	SDR 21
Short Term Wall Crushing SF	$SF(17) = 2.0$	$SF(19) = 1.8$	$SF(21) = 1.6$
Critical Collapse Pressure SF	$SF_2(17) = 1.18$	$SF_2(19) = 0.74$	$SF_2(21) = 0.48$
Pipe Deflection SF	$SF_3(17) = 1.26$	$SF_3(19) = 1.41$	$SF_3(21) = 1.55$

6.0 Data from DriscoPipe Manual used in the calculations



E` Values from DriscoPipe Manual

AD :=

	0	1
0	"SDR"	"AD(%)"
1	11	2.7
2	13.5	3.4
3	15.5	3.9
4	17	4.2
5	19	4.7
6	21	5.2

Allowble Deflection Values from DriscoPipe Manual

Engineering Plan

Appendix A – Calculations

A-5 Pipe Capacity

CDM Smith

Leachate Collection Pipe Conveyance Calculations

This calculation was performed to confirm that the leachate collection pipes have sufficient capacity to handle peak leachate flow conditions.

1.0 Leachate flow and pipe information

Yellow areas are input parameters

Leachate Flow

Area of landfill per leachate collection $A_{perL} := 13.3 \cdot acre$

Design Flow from HELP modeling

$Q_{peak\_per\_acre} := 2125 \cdot \frac{ft^3}{day \cdot acre}$

Select the peak flow as the peak daily value for 15 year

$Q_{peak\_per\_acre} = 0.025 \cdot \frac{ft^3}{sec \cdot acre}$

$cfs := \frac{ft^3}{sec}$

$Q_{avg\_per\_acre} := 154 \cdot \frac{ft^3}{day \cdot acre}$

Select the average flow as the average annual total for 15 yrs divided by 365

$Q_{avg\_per\_acre} = 0.0018 \cdot \frac{ft^3}{sec \cdot acre}$

Calculate the flow per leachate collection

$Q_{peak} := Q_{peak\_per\_acre} \cdot A_{perL}$ $\quad Q_{peak} = 0.327 \cdot cfs$

$Q_{avg} := Q_{avg\_per\_acre} \cdot A_{perL}$ $\quad Q_{avg} = 0.0237 \cdot cfs$

Leachate pipes

Leachate pipe inside diameter $ID := 9.41 \cdot in$

Pipe inside radius $P_r := \frac{ID}{2}$ $\quad P_r = 4.705 \cdot in$

Pre settlement pipe slope $S_{pre} := 0.0063$

Post settlement pipe slope $S_{post} := 0.0058$

Calculate depth of water in pipe at perforations

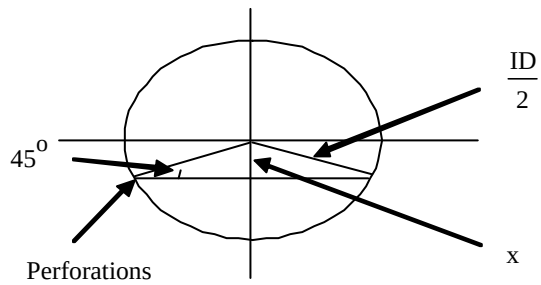
$x := P_r \sin(45 \cdot deg)$

$x = 3.327 \cdot in$

Depth of water at pipe perforations dp

$d_p := P_r - x$

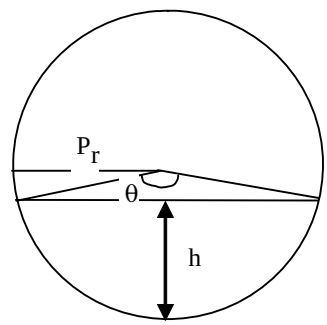
$d_p = 1.378 \cdot in$



Calculate pipe conveyance (flow rate) at different water depths in the pipe

1- Calculate the Central angle θ as a function of depth

$$\theta(d) := \begin{cases} 2 \cdot acos\left(\frac{P_r - d}{P_r}\right) & \text{if } d < P_r \\ 360 \cdot deg - \left[2 \cdot acos\left[\frac{P_r - (ID - d)}{P_r}\right]\right] & \text{if } d \geq P_r \end{cases}$$



$\theta(d_p) = 90 \cdot deg$

2- Calculate the Flow area Af as a function of depth

Area of circular segment K

$$K_f(d) := \begin{cases} \frac{P_r^2}{2} \cdot [\theta(d) - (\sin(\theta(d)))] & \text{if } d < P_r \\ \frac{P_r^2}{2} \cdot [(360 \cdot deg - \theta(d)) - \sin(360 \cdot deg - \theta(d))] & \text{if } d \geq P_r \end{cases}$$

$K_f(d_p) = 6.318 \cdot in^2$

Area of Flow (Af)

$$A_f(d) := \begin{cases} K_f(d) & \text{if } d < P_r \\ \pi \cdot P_r^2 - K_f(d) & \text{if } d \geq P_r \end{cases}$$

$A_f(d_p) = 6.318 \cdot in^2$

3- Calculate the arc length Sl as a function of depth

$$S_l(d) := \begin{cases} P_r \cdot \theta(d) & \text{if } d < P_r \\ P_r \cdot (360 \cdot deg - \theta(d)) & \text{if } d \geq P_r \end{cases}$$

$S_l(d_p) = 7.391 \cdot in$

4- Wetted perimeter Pw as a function of depth

$$P_w(d) := \begin{cases} S_l(d) & \text{if } d < P_r \\ 2 \cdot \pi \cdot P_r - S_l(d) & \text{if } d \geq P_r \end{cases}$$

$P_w(d_p) = 7.391 \cdot in$

5- Hydraulic radius Rh as a function of depth

$$R_h(d) := \frac{A_f(d)}{P_w(d)}$$

$R_h(d_p) = 0.855 \cdot in$

6- Calculate leachate conveyance flow pre and post settlement for flow at perforation level for average flow conditions and full flow for peak flow conditions using Manning's eq.

Manning n for HDPE pipe $n := 0.01 \cdot sec \cdot ft^{\frac{-1}{3}}$

$$Q_{pre}(d) := \frac{1.486\, A_f(d) \cdot R_h(d)^{\frac{2}{3}} \cdot S_{pre}^{\frac{1}{2}}}{n}$$

$Q_{pre}(ID) = 1.922 \cdot cfs$ This is the flow at full capacity pre settlement

$Q_{pre}(d_p) = 0.089 \cdot cfs$ This is the flow when depth is at perforations pre settlement

$$Q_{post}(d) := \frac{1.486\, A_f(d) \cdot R_h(d)^{\frac{2}{3}} \cdot S_{post}^{\frac{1}{2}}}{n}$$

$Q_{post}(ID) = 1.844 \cdot cfs$ This is the flow at full capacity post settlement

$Q_{post}(d_p) = 0.085 \cdot cfs$ This is the flow when depth is at perforations post settlement

7- Safety Factors

At average conditions

Flow at average conditions is assumed to be at perforation level (dp)

$$SF_{1pre} := \frac{Q_{pre}(d_p)}{Q_{avg}}$$

$SF_{1pre} = 3.8$ Pre settlement average flow safety factor

$$SF_{1post} := \frac{Q_{post}(d_p)}{Q_{avg}}$$

$SF_{1post} = 3.6$ Post settlement average flow safety factor

At peak conditions

Flow at peak conditions is assumed to be at the full pipe depth (ID)

$$SF_{2pre} := \frac{Q_{pre}(ID)}{Q_{peak}}$$

$SF_{2pre} = 5.9$ Pre settlement peak flow safety factor

$$SF_{2post} := \frac{Q_{post}(ID)}{Q_{peak}}$$

$SF_{2post} = 5.6$ Post settlement peak flow safety factor

PE 3608/3408 IPS HDPE Pipe Sizes

Pressure Rating	Nominal Size	3/4"	1"	1 1/4"	1 1/2"	2"	3"	4"	5"	5"	6"	7"	8"	10"
	Actual O.D.	1.05"	1.315"	1.66"	1.90"	2.375"	3.50"	4.50"	5.375"	5.563"	6.625"	7.125"	8.625"	10.75"
DR 11 (160psi)	Min. wall	0.095"	0.120"	0.151"	0.173"	0.216"	0.318"	0.409"	0.489"	0.506"	0.602"	0.648"	0.784"	0.977"
	Average I.D.	0.848"	1.062"	1.340"	1.534"	1.917"	2.825"	3.633"	4.339"	4.491"	5.348"	5.752"	6.963"	8.678"
	Weight lb/lf	0.130	0.200	0.312	0.410	0.640	1.387	2.300	3.290	3.520	4.990	5.780	8.460	13.140
DR 13.5 (128psi)	Min. wall	--	--	--	---	0.176"	0.259"	0.333"	0.398"	0.412"	0.491"	0.528"	0.639"	0.796"
	Average I.D.	--	--	--	---	2.002"	2.950"	3.793"	4.531"	4.689"	5.585"	6.006"	7.271"	9.062"
	Weight lb/lf	--	--	--	---	0.531	1.160	1.910	2.730	2.920	4.150	4.800	7.030	10.920
DR 15.5 (110psi)	Min. wall	--	--	--	---	0.153"	0.226"	0.290"	0.347"	0.359"	0.427"	0.460"	0.556"	0.694"
	Average I.D.	--	--	--	---	2.050"	3.021"	3.885"	4.640"	4.802"	5.719"	6.150"	7.445"	9.280"
	Weight lb/lf	--	--	--	---	0.470	1.020	1.680	2.400	2.570	3.637	4.210	6.164	9.580
DR 17 (100psi)	Min. wall	--	--	--	---	0.140"	0.206"	0.265"	0.316"	0.327"	0.390"	0.419"	0.507"	0.632"
	Average I.D.	--	--	--	---	2.079"	3.064"	3.939"	4.705"	4.869"	5.799"	6.236"	7.549"	9.409"
	Weight lb/lf	--	--	--	---	0.430	0.932	1.540	2.200	2.353	3.340	3.860	5.660	8.880

So the DR 17 10 inch IPS HDPE pipe has sufficient capacity to handle peak leachate flow conditions.

Engineering Plan

Appendix A – Calculations

A-6 Perforation Flow Rate

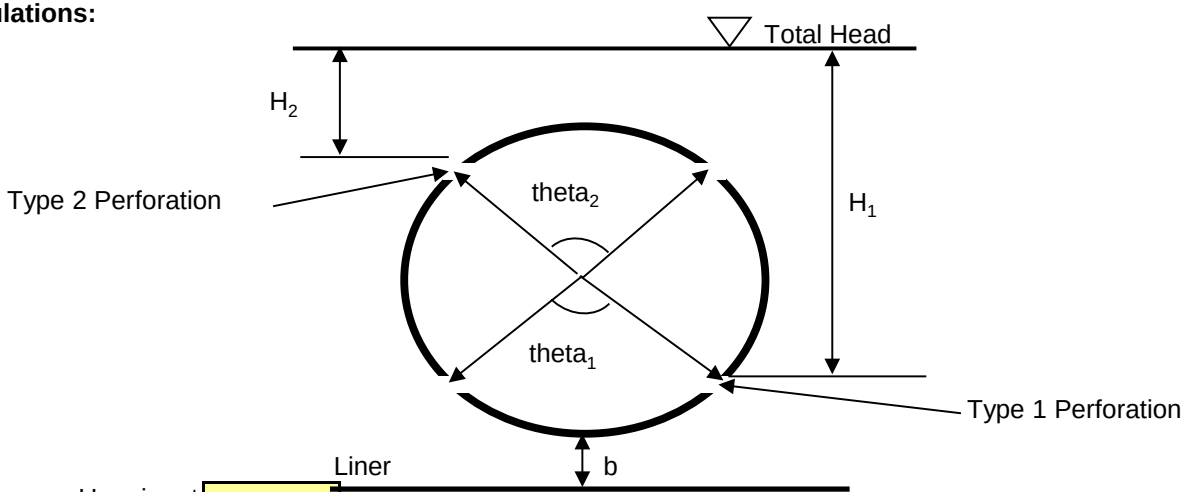
CDM Smith

CLIENT:	Buncombe County	JOB NO.:	6447-97693	COMPUTED BY:	R.K.
PROJECT:	Cell 7 Design	DATE CHECKED:	KJY	DATE:	8/28/2013
DETAIL:	**Perforation Capacity**	CHECKED BY:	2/5/2014		

Task: Calculate the maximum drainage rate through the perforations of the collection pipes with 12" of head on the liner for Cell 7.

Assumptions: 1) Water elevation in pipe is less than height of the orifices.

Calculations:



User input

Given:

D_{pipe} =	9.41	inches	Pipe diameter
b =	2	inches	Pipe bedding depth
Total Head (H_{max}) =	12	inches	Head on the liner
Length of pipe (L) =	1442.5	ft	

Type 1 Perforation

d_{perf} =	0.5	inches
A_{perf} =	0.20	in²
ρ_{perf} =	2	perforations/LF of pipe
$theta_1$ =	120	degress
k =	0.62	head loss orifice coefficient Dally et al. (1993)

Type 2 Perforation

d_{perf} =	0.5	inches	Diameter of perforation
A_{perf} =	0.20	in²	Area of the perforation
ρ_{perf} =	2	perforations/LF of pipe	
$theta_2$ =	120	degress	
k =	0.62	head loss orifice coefficient Dally et al. (1993)	

CLIENT:	Buncombe County	JOB NO.:	6447-97693	COMPUTED BY:	R.K.
PROJECT:	Cell 7 Design	DATE CHECKED:	KJY	DATE:	8/28/2013
DETAIL:	**Perforation Capacity**	CHECKED BY:	2/5/2014		

$$H_1 = H_{max} - \left[b + \left(\frac{D_{pipe}}{2} - \frac{D_{pipe}}{2} \cos\left(\frac{theta_1}{2} \right) \right) \right]$$

$$H_2 = H_{max} - \left[b + \left(\frac{D_{pipe}}{2} + \frac{D_{pipe}}{2} \cos\left(\frac{theta_2}{2} \right) \right) \right]$$

Head at Orifice Equations (Derived Equations)

H_1 = 7.6475 inches, Head on Type 1 Perforation

H_2 = 2.9425 inches, Head on Type 2 Perforation

$$q_x = A_{perf} k \sqrt{2gH_x}$$

Orifice Equation

Streeter et al. (1985)

q_1 = 0.0054 ft³/sec/perforation type 1

q_2 = 0.0034 ft³/sec/perforation type 2

$$Q_x = q_x \rho_{perf} L$$

Flow Through Orifice Type Equation (Derived Equation)

Q_1 = 1,349,990 ft³/day, Flow through Type 1 perforation

Q_2 = 837,390 ft³/day, Flow through Type 2 perforation

Q_{total} = 2,187,380 ft³/day Total flow through both types of perforation

q_{peak} =	2125	ft³/acre/day	Impingement from HELP model simulation for 10ft of waste & steady state moisture content
A_{max} =	7.63	acres	Area of largest subcell
Q_{peak} =	16213.8	ft³/day	Flow rate based on the peak impingement rate and largest subcell

Conclusions:

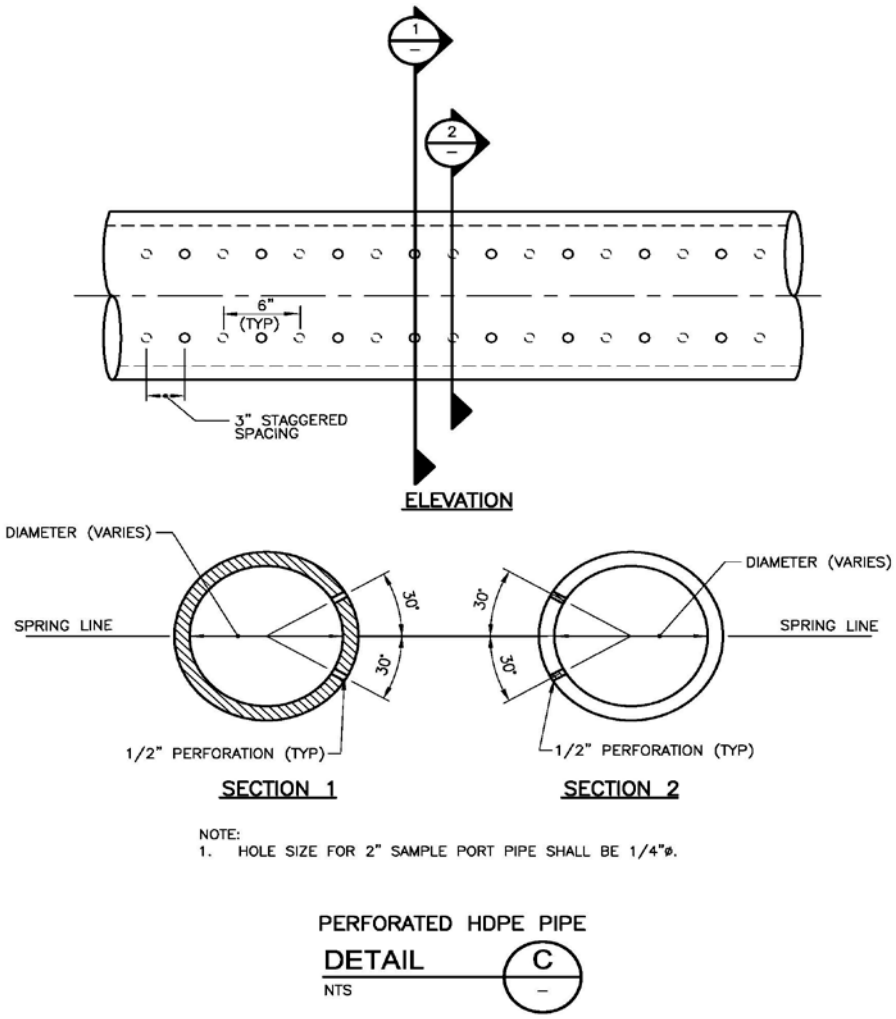
$$\text{Factor of Safety} = \frac{Q_{total}}{Q_{peak}}$$

Factor of Safety = 135

References: Dally, J. W., W. F. Riley, and K. G. McConnell. 1993. Instrumentation for Engineering Measurements. John Wiley and Sons, Inc. 2ed.

Streeter, V. L., E. G. Wylie, and K. W. Bedford. 1985. Fluid Mechanics. McGraw-Hill. 9ed.

Cell 7: Perforated Pipe Detail



NOTE:
1. HOLE SIZE FOR 2" SAMPLE PORT PIPE SHALL BE 1/4"ø.

PERFORATED HDPE PIPE
DETAIL C
NTS –

Engineering Plan

Appendix A – Calculations

A-7 Pump System Model

CDM Smith

Leachate Pump Station Design

1.0 Purpose

The purpose of this section is to select a pump to convey leachate from the leachate collection system of Cell 7 to the leachate pond, and evaluate the effect of operating several pumps at the same time on the existing leachate pipe network at the Buncombe Landfill.

The collected leachate is conveyed by the French drains to a sump area located in the lowest point of the cell as shown on Sheet EP-4. The leachate is pumped out of the cell by a slope-riser pump system located in the sump area and discharged through a pipe network to the existing lined leachate pond as shown in Sheet LC-2.

2.0 Pumps

The following Table 1 shows the pumps are used for existing Cells 1 through 6. The pump curves are presented in **Attachment A.**

Table 1. Pumps used in Cells 1 through 6

EPG - Pumps		
	Model No.	**Horsepower**
Cell 6	30-3	7.5
Cell 5	30-2	5.0
Cell 4	30-2	5.0
Cell 3	30-3	7.5
Cell 2	30-1	2.0
*Cell 1	30-2	5.0

** Pump model for cell 1 has been assumed as information of the pump used is not available*

The pump selected for Cell 7 was EPG 30-3 and is the same as the pump currently being used in cell 3 and Cell 6 to allow ease of maintenance.

3.0 Leachate Generation

Table 2 shows an estimation of average annual and peak daily leachate generation for Cells 1 through 7. Historic leachate generation rates were used to determine the average annual leachate generation estimation for Cell 1 through 6. The average annual leachate generation estimation for Cell 7 is based on HELP model results for Case 1, 10ft of waste. HELP model evaluation is provided in Appendix A. The peak day leachate generation for cells 1 through 7 was calculated by multiplying the annual leachate generation by a peak factor. The peak factor is the ratio of daily impingement rate by annual impingement rate from HELP model for various cases. The peak factor used to determine the peak daily leachate generation for the Cells varied based depth of waste in the cell.

Table 2. Leachate Generation Estimation

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7
	Leachate Generated	Leachate Generated	Leachate Generated	Leachate Generated	Leachate Generated	Leachate Generated	Leachate Generated
	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)
2008	288,526	8,860	94,705	173,647	164,467	8,904,461	NA
2009	101,777	35,102	103,371	333,067	356,580	14,610,720	NA
2010	173,878	34,813	283,867	419,454	124,089	7,097,590	NA
2011	156,900	36,027	44,096	124,478	402,831	6,589,437	NA
2012	191,608	71,821	92,225	355,101	332,049	5,441,508	NA
Average Annual							
gal/year/cell	182,538	37,325	123,653	281,149	276,003	8,528,743	2,781,632
gal/min/cell	0.35	0.07	0.24	0.53	0.53	16.23	5.29
Area (ft2)	422,540	138,822	361,635	181,994	312,718	993,161	576,079
Area (acres)	9.70	3.19	8.30	4.18	7.18	22.80	6.61
gal/min/acre	0.036	0.022	0.028	0.128	0.073	0.712	0.800
Peak day							
gal/min/acre	0.09	0.06	0.07	0.34	0.19	4.73	11.0
gal/min/cell	0.91	0.19	0.62	1.41	1.38	107.95	72.99

5.0 Pump Sizing and Operation

The various scenarios to evaluate pump performance for Cell 7 and existing pipe network are as follows:

- Scenario 1 : Assumes that only one pump is operational at one time.
- Scenario 2 : Assumes Cells 4, 6 and 7 are operational at the same time. This is the most likely scenario. Cells 4 and 6 are active cells and Cell 7 will be an active cell.
- Scenario 3 : Assumes that all pumps are operational at the same time.

WaterGEMS software was used to evaluate the pump performance for Cell 7 and the existing pipe network.
1. Based on the WaterGems Modeling, when the pump in Cell 7 is individually turned "ON", the selected pump accommodates the leachate generation rate of 187 gpm on a peak day which is more than twice the estimated peak daily flow of 73 gpm.

2. Scenario 2 is the most likely scenario during a storm event. All the pumps work and can handle the leachate generated by their respective cells without cavitation.

3. In scenario 3, all the pumps are turned "ON" at the same time. All the pumps work and can handle the leachate generated by their respective cells without cavitation.

Overall the pump selected for cell 7 works well and the existing pipe network can handle the additional leachate generated from cell 7 on a peak day.

Attachment A

CDM Smith	**Client:**	Buncombe County	**Calc By:**	Ravi Kadambala	**Chk'd By:**	Yanni Polematidis
	Project:	Cell 7 Design	**Date:**	8/23/2013	**Date:**	9/19/2013
	Job No.	6447-97693	**Rev. No.**	1	**Cross-Chk By:**	Carl Frizzel
	Detail:	Leachate Pumps Modeling	**Rev. Date**	4/1/2014	**Date:**	9/20/2013

1.0 Purpose / Objective

The purpose of this report is to design the pump for Cell 7 and evaluate the effect of operating several leachate pumps at the same time on the existing leachate pipe network for Buncombe Landfill.

2.0 Data

EPG - Pumps		
	Model No.	**Horsepower**
Cell 6	30-3	7.5
Cell 5	30-2	5.0
Cell 4	30-2	5.0
Cell 3	30-3	7.5
Cell 2	30-1	2.0
*Cell 1	30-2	5.0

** Pump model for cell 1 has been assumed as information of the pump used is not available*

LEACHATE GENERATION ESTIMATION

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7
	Leachate Generated	Leachate Generated	Leachate Generated	Leachate Generated	Leachate Generated	Leachate Generated	
	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)
2008	288,526	8,860	94,705	173,647	164,467	8,904,461	NA
2009	101,777	35,102	103,371	333,067	356,580	14,610,720	NA
2010	173,878	34,813	283,867	419,454	124,089	7,097,590	NA
2011	156,900	36,027	44,096	124,478	402,831	6,589,437	NA
2012	191,608	71,821	92,225	355,101	332,049	5,441,508	NA
Average Annual							
gal/year/cell	182,538	37,325	123,653	281,149	276,003	8,528,743	2,781,632
gal/min/cell	0.35	0.07	0.24	0.53	0.53	16.23	5.29
Area (ft2)	422,540	138,822	361,635	181,994	312,718	993,161	576,079
Area (acres)	9.70	3.19	8.30	4.18	7.18	22.80	6.61
gal/min/acre	0.036	0.022	0.028	0.128	0.073	0.712	0.800
On a Peak day -							
gal/min/acre	0.09	0.06	0.07	0.34	0.19	4.73	11.0
gal/min/cell	0.91	0.19	0.62	1.41	1.38	107.95	72.99

3.0 Assumptions

1. The average annual leachate generation estimation for cell 1 through 6 is based on historic leachate generation data.
   The average annual leachate generation estimation for cell 7 is based on HELP model results for case 1, 10ft of waste.
   The peak day leachate generation for cells 1 through 7 was calculated by multiplying the annual leachate generation by a peak factor.
   The peak factor is the daily impingement rate by annual impingement rate from HELP model for various cases.
   The peak factor used to determine the peak day leachate generation varied based depth of waste in the cell.

2. The various scenarios to evaluate pump performance are as follows:
   1. One Pump On: This scenario reports the modeled flow and head for only one pump per cell in the expansion
   2. All Pumps On: This scenario represents modeled flow and head for a cell when all pumps are "On."

3.

Cell	Model No.	Horsepower
Cell 7	30-3	7.5

4. All the pipes except from Cell 7 to Cell 6 were assumed to be old and had a C value of 120.

5. The pipe from Cell 7 to Cell 6 was assumed to be new and had a C value of 150.

CDM Smith	**Client:**	Buncombe County	**Calc By:**	Ravi Kadambala	**Chk'd By:**	Yanni Polematidis
	Project:	Cell 7 Design	**Date:**	8/23/2013	**Date:**	9/19/2013
	Job No.	6447-97693	**Rev. No.**	1	**Cross-Chk By:**	Carl Frizzel
	Detail:	Leachate Pumps Modeling	**Rev. Date**	4/1/2014	**Date:**	9/20/2013

3.0 Results

The following table provides a summary of output from running the three (3) scenarios using WaterGEM model.
The TDH and flow was calculated by WaterGEM based on the above assumptions.
The pipe network of the model is shown in the figure below.

	Scenario 1		Scenario 2		Scenario 3	
Cell	One Pump "ON"		Pump 4, 6, and 7 "ON"		All Pumps "ON"	
	TDH(ft)	Flow (gpm)	TDH(ft)	Flow (gpm)	TDH(ft)	Flow (gpm)
1	68.2	129			97.35	46
2	30.79	138			39.67	103
3	65.14	179			106.72	128
4	59	148	90.45	71	103.28	6
5	44.55	174			49.93	165
6	58.49	186	90.5	151	102.55	134
7	57.67	187	89.43	151	102.05	135

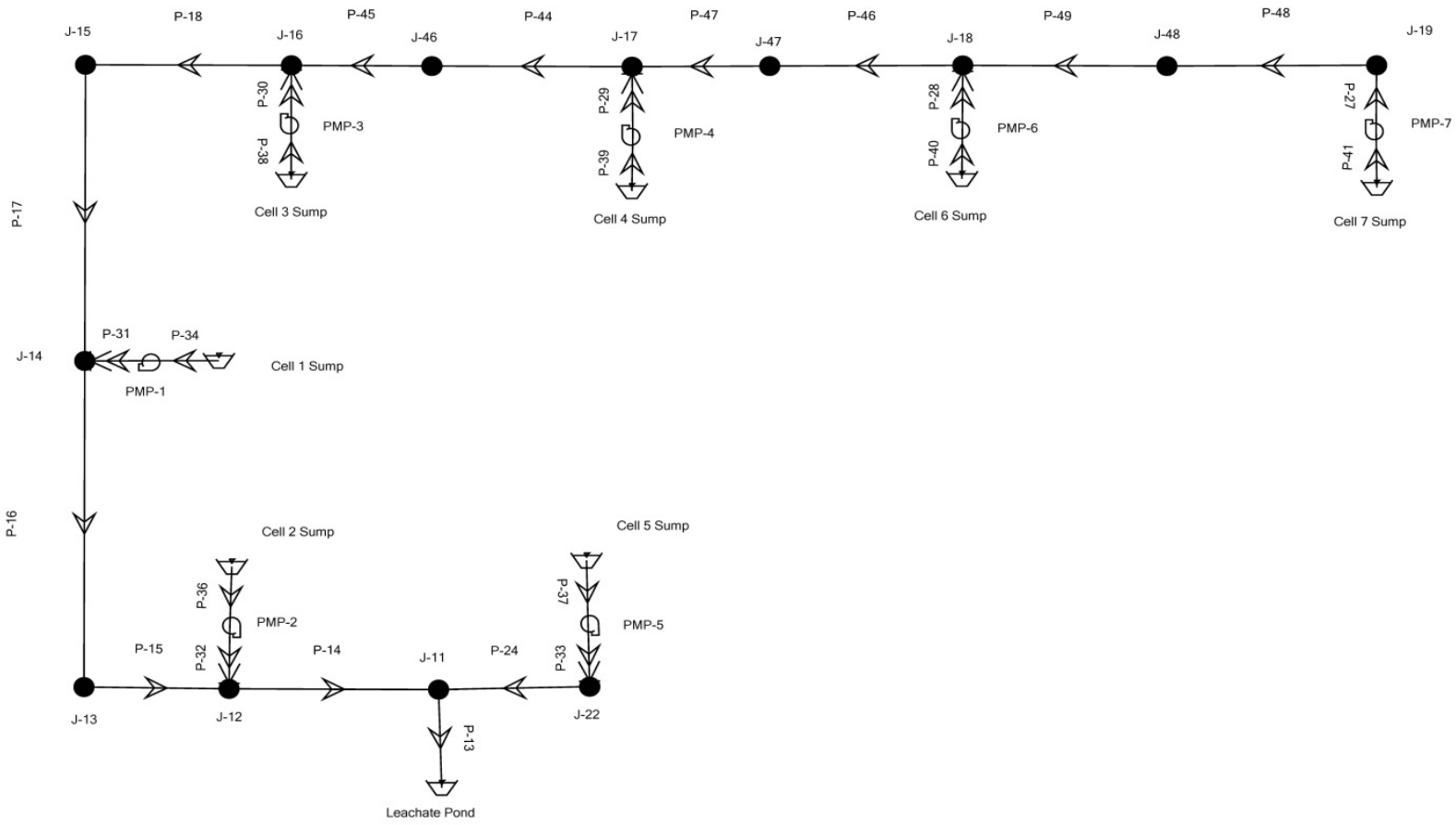
Conclusion:

1. Based on the WaterGems Modeling, when the pump in Cell 7 is individually turned "ON", the selected pump accommodates the leachate generation rate of 187 gpm on a peak day.
2. Scenario 2 is the most likely scenario during a storm event. All the pumps work and can handle the leachate generated by their respective cells without cavitation.

3. In scenario 3, all the pumps are turned "ON" at the same time. All the pumps work and can handle the leachate generated by their respective cells without cavitation.

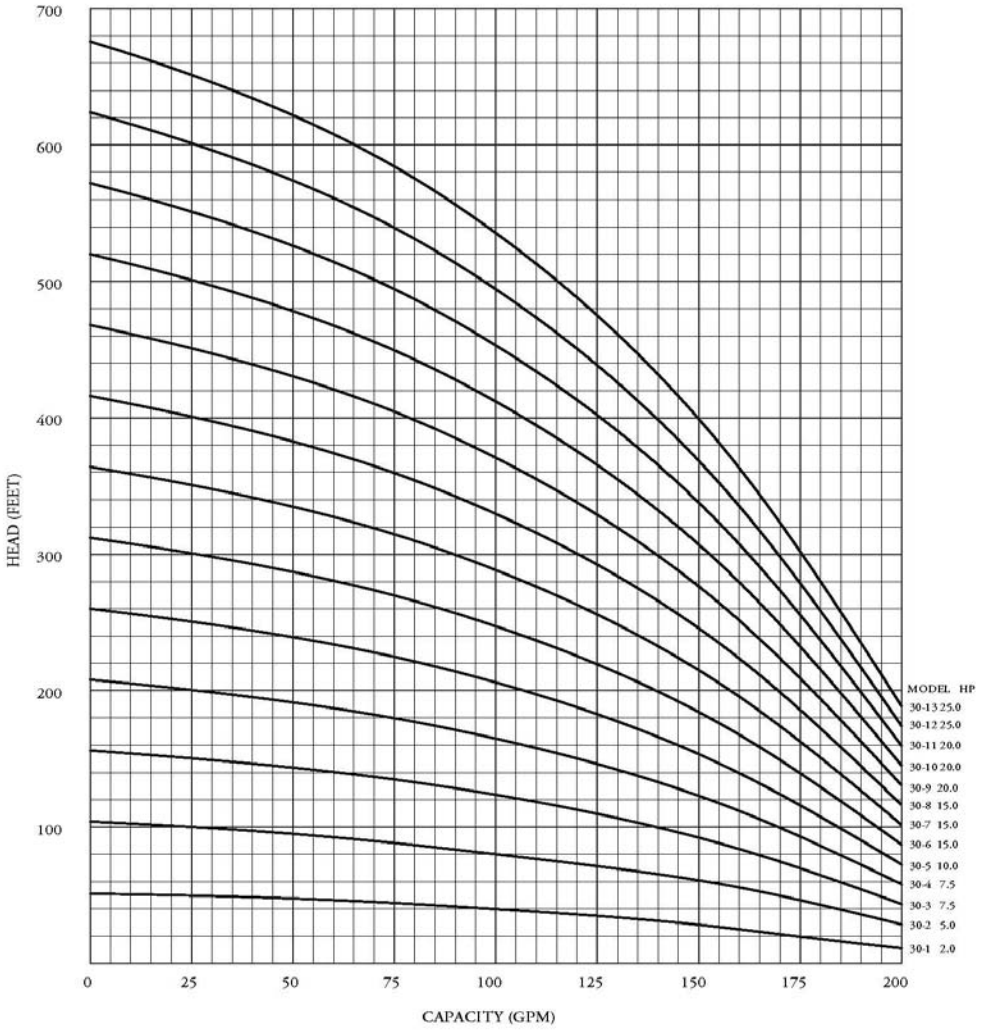
Overall the pump selected for cell 7 works well and the existing pipe network can handle the additional leachate generated from cell 7 on a peak day.

Pipe Network of the Leachate Collection System
Buncombe County



SERIES 30 SurePump™

Flow Range 50-200 GPM
60 Hz



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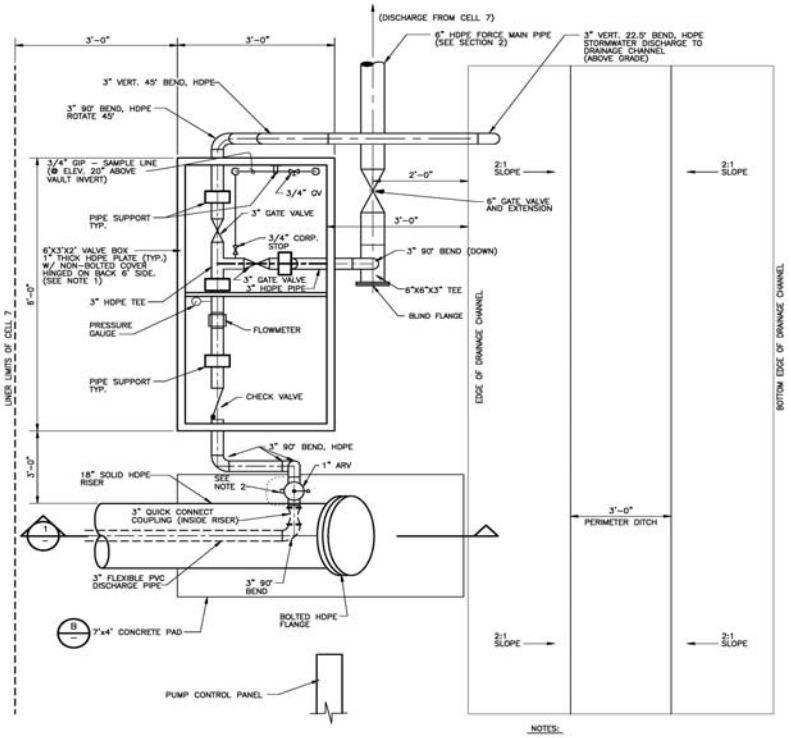


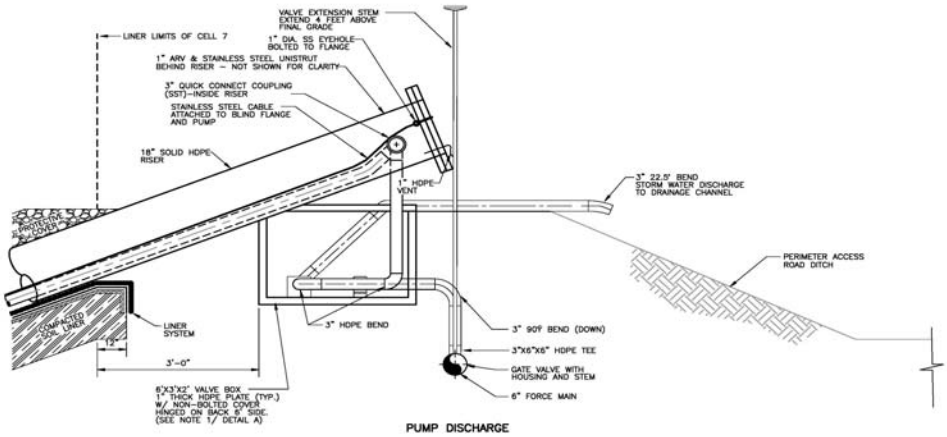
NOTES:

1. PRECAST CONCRETE VAULT WITH DUAL 30"x30" BILCO HATCHES IN TOP SLAB MAY BE USED AS AN ALTERNATE TO HDPE VAULT.
2. SUPPORT ARV AND 3" HDPE FROM 8' LG. STAINLESS STEEL UNISTRUT ANCHORED IN 12" DIA. x 36" DP. CONCRETE BELOW GRADE. INSTALL HEAT TRACING SYSTEM AND INSULATION AROUND EXPOSED PIPE AND ARV.

LEACHATE PUMP STATION

DETAIL A

NTS EP-2



PUMP DISCHARGE

SECTION 1

NTS –

NOTES:

1. TOPOGRAPHY OUTSIDE OF WSW AND C&D BOUNDARY LIMITS DERIVED FROM AERIAL SURVEY PROVIDED BY AEROSYNAMICS, CHARLOTTE, N.C. JULY 1993.
2. NORTH CAROLINA 1983 GRID DATUM.
3. THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS FOR 1"=100' SCALE, 10' CONTOUR INTERVAL.
4. CONTOURS WITHIN DENSE FOLIAGE AREAS INDICATE DOUBTFUL ACCURACY DUE TO OBSCURED VIEW FROM VEGETATION, SHADOWS, ETC.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: E. GABEL
DRAWN BY: M. WOSHI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: J. WISDAHN
APPROVED BY: J. WISDAHN
DATE: DECEMBER 2013

CDM Smith
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5400 Glenwood Avenue, Suite 500
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Fax (919) 787-9700

BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

LANDFILL CONSTRUCTION
SUBTITLE D LANDFILL LEACHATE COLLECTION

PROJECT NO. 6447-97693
FILE NAME: LC-2.DWG
SHEET NO.
LC-2

90% PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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Engineering Plan

Appendix A – Calculations

A-8 Leachate Recirculation System

CDM Smith

Client:	Buncombe County	**Calc By:**	Ravi Kadambala
Project:	Cell 7 Design	**Date:**	11/20/2013
Job No.	6447-97693	**Rev. No.**	checked by CJG
Detail:	Leachate Recirculation Hydraulic Analysis	**Rev. Date**	04/14/14

1.0 Purpose / Objective

The purpose of this calculation is to determine the maximum flowrate at which leachate can be recirculated from the existing pumps in the leachate pond into horizontal injection trenches (HIT) of Cell 7.

2.0 Data

There are two submersible EPG pumps, 30-3 (7.5 hp) in the leachate pond. These pumps are connected in parallel configuration to recirculate leachate in Cells 1 through 6.

The leachate should be injected at a max of 5psi or ~12 ft of water column in the HITs.

The 6 inch HDPE pipe leachate recirculation pipe from the leachate pond to HITs of cell 7 is approximately at 2015ft elevation and ~4500 ft in length.

The HITs in Cell 7 is at 2090 ft elevation.

There are two 45° bends in the 6 inch HDPE pipe.

There are three 90° bends in the 6 inch HDPE pipe.

The pump curve of the EPG pumps, 30-3 is attached in Attachment 1.

3.0 Assumptions

The 6 inch HDPE pipe is assumed to have a Darcy's friction factor of 0.04

4.0 Calculation

The total dynamic head is calculated by adding total static loss, pressure loss, frictional losses and minor losses.

Step 1 - Static Losses

Pumps	Suction level (ft)	Discharge level (ft)	Static Head (ft)
EPG	2015	2090.0	75.0

Step 2 - Pressure Losses

The leachate should be injected at a max of 5psi or ~12 ft of water column.

The total pressure loss = 12 ft

Step 3 - Minor Losses and Friction Losses

Minor Losses (k)

	QTY	
Entrance		0.5
90° Bend	3	0.6
90° Bend	2	0.4
	Σk =	**3.1**

Leachate Line

Length	4500	ft
Diameter	0.50	ft
Area	0.20	ft^2

The friction losses is calculated by using the following equation

$$h_f = f_D \frac{L}{D}\frac{V^2}{2g}$$

The minor losses is calculated by using the following equation

$$h_m = K_L \frac{V^2}{2g}$$

Where

h_f Friction Loss, ft

h_m Minor Loss, ft

f_d Friction factor

L Length of the pipe, ft

D Diamter of the pipe, ft

V Velocity of the leachate, ft/s

g Acceleration due to gravity, ft2/s

K_L Loss Coefficient

Client:	Buncombe County	**Calc By:**	Ravi Kadambala
Project:	Cell 7 Design	**Date:**	11/20/2013
Job No.	6447-97693	**Rev. No.**	checked by CJG
Detail:	Leachate Recirculation Hydraulic Analysis	**Rev. Date**	04/14/14

5.0 Result

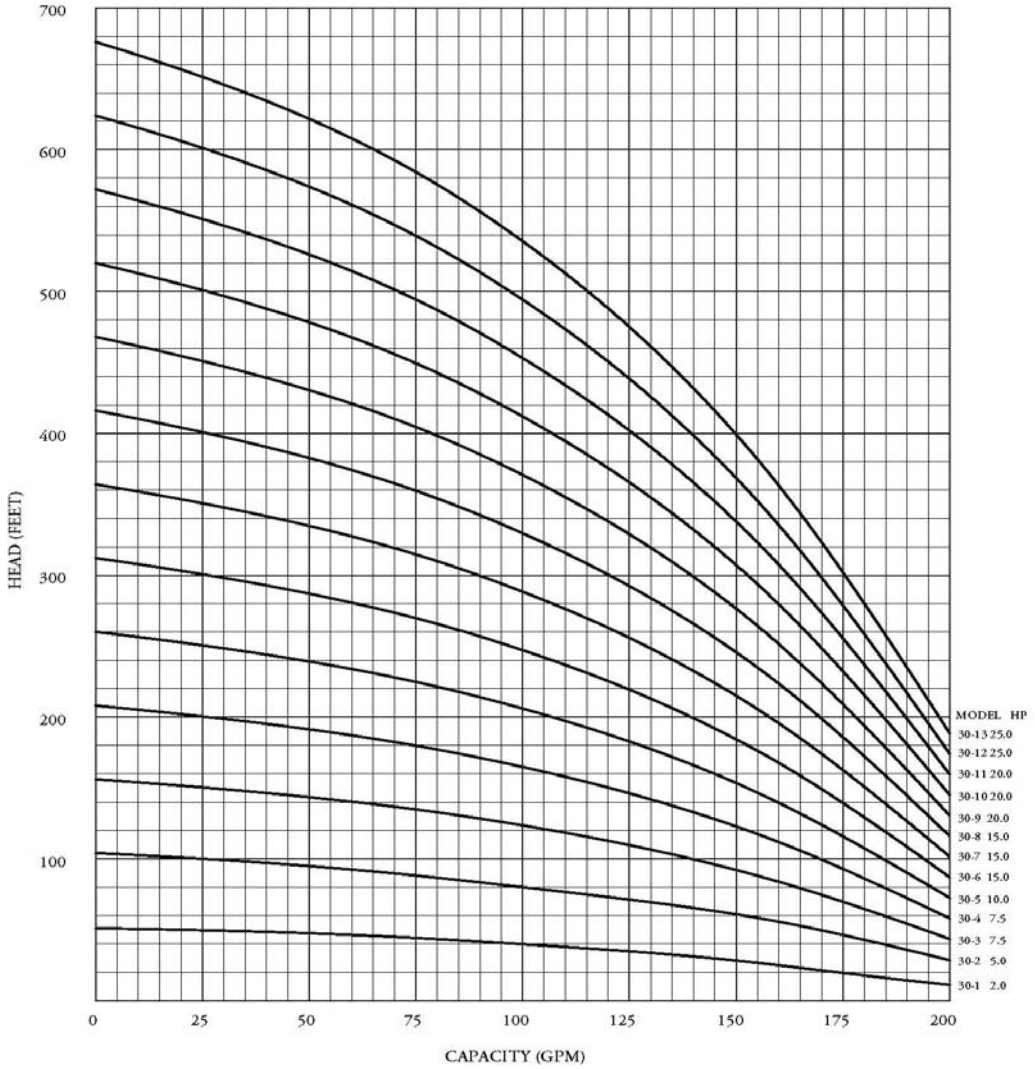
Step 4 Total Dynamic head

Q, gpm	Velocity, ft/s	Vel^2 / 2g	Friction Loss, ft	Minor Losses, ft	Static Loss,ft	Pressure Loss,ft	TDH, ft	EPG Pump Curve, ft
50	0.57	0.0050	1.80	0.02	75.0	12.0	88.8	142
75	0.85	0.0112	4.05	0.03	75.0	12.0	91.1	135
100	1.13	0.0200	7.20	0.06	75.0	12.0	94.3	125
125	1.42	0.0312	11.25	0.10	75.0	12.0	98.3	110
150	1.70	0.0450	16.20	0.14	75.0	12.0	103.3	90
175	1.99	0.0612	22.05	0.19	75.0	12.0	109.2	70
200	2.27	0.0800	28.79	0.25	75.0	12.0	116.0	45

Conclusion:

Each EPG pump can recirculate leachate at max flow rate of 125 gpm from the leachate pond to the HITs of Cell 7.
The total flowrate of leachate that can be pumped using both the EPG pumps is 250 gpm.

SERIES 30 SurePump™
Flow Range 50-200 GPM
60 Hz



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Engineering Plan

Appendix A – Calculations

A-9 Stormwater Management System

CDM Smith

Engineering Plan

Appendix A – Calculations

A-9a Perimeter Channel

CDM Smith

CALCULATION COVER SHEET

Project Title	Buncombe County, NC	
Client	Cell 7 Permit Application	
Project Number	6447-97693	
Calculation Title	Perimeter Channel Calculation	
Calculated By - Date	KJY	2/2/2014
Reviewed By - Date	WMB	2/3/2014
Purpose of the Calculation	Design the stormwater channels that will be used to convey stormwater runoff for the 25-year, 24-hour design storm event per Solid Waste Section regulations.	
Results	See Table 1 on Page 2 for a summary of the recommended channel dimensions and erosion protection	

CLIENT	Buncombe County	COMPUTED BY / DATE	KJY 02/02/14
PROJECT	Cell 7 Permit Application	CHECKED BY / DATE	WMB 2/3/2014
DETAIL	Perimeter Channel Design	REVISION NO. / DATE	- -
PROJECT NO.	6447-97693	REVIEWED BY / DATE	- -

Calculation Brief Title: Summary of Perimeter Channel Calculations

1.0 Objective

The purpose of this spreadsheet is to summarize the recommended channel characteristics and erosion control lining requirements.

2.0 Procedure

1. Summarize the recommended channel dimensions and temporary/permanent erosion protection liners based on the spreadsheet models developed for each channel.

3.0 References / Data Sources

1. Sheet EP-2 presents the locations and associated identifiers for the proposed stormwater channel.
2. See attached channel design calculation spreadsheets for each respective channel design.

4.0 Assumptions / Limitations

1. Channel locations are approximate.

5.0 Calculations

5.1 Recommended Channel Dimension and Erosion Control Liners

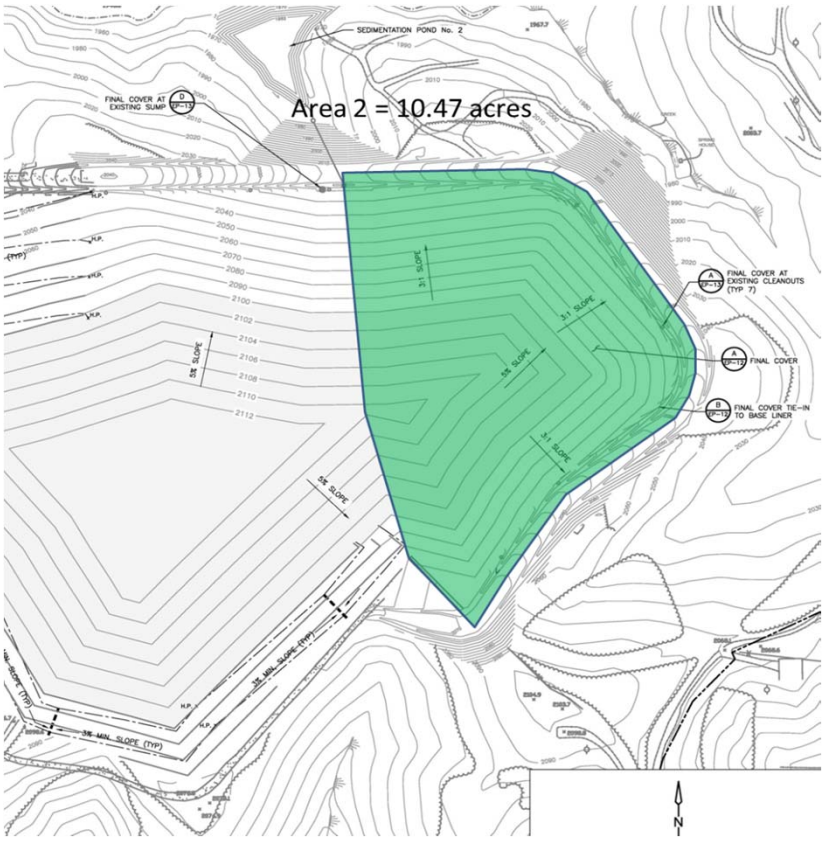
-- See **Table 1** below for a summary of the recommended channel dimensions and temporary/permanent channel linings.

Table 1: Recommended Channel Design

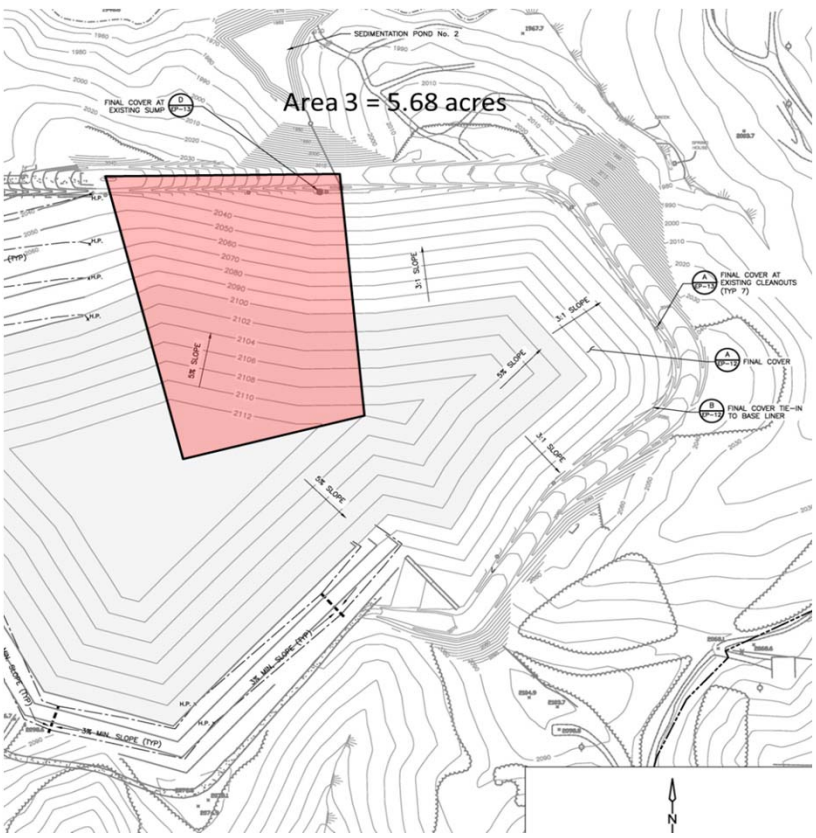
Channel ID	Bottom Width (ft)	Channel Depth (ft)	Side Slopes		Channel Lining	
			M_1	M_2	Temporary	Permanent
2	3	3.0	2	2	N/A	Filter Point FP600
3	3	3.0	2	2	N/A	Filter Point FP600

6.0 Conclusions

Table 1 above summarizes the recommended channel dimenions and erosion control linings.
Filter point is fabric-filled concrete lining.



Start El =	2064
End El =	2008
Run =	1600
Slope =	0.035



Start El =	2036
End El =	2008
Run =	470
Slope =	0.060

CLIENT	Buncombe County	COMPUTED BY / DATE	KJY	02/02/14
PROJECT	Cell 7	CHECKED BY / DATE	WMB	2/3/2014
DETAIL	Perimeter Channel Design	REVISION NO. / DATE	-	
PROJECT NO.	6447-97693	REVIEWED BY / DATE	-	-

Task:
Determine the flow rate for perimeter channel design using TR-55

Conclusion:
See Attachment 1: TR-55 output file

Channel	Drainage Area		Peak Flow - 25 yr (cfs)	
	ID	(ac)		
2	2	10.47	55	Poor Grass
3	3	5.68	30	Poor Grass

CLIENT	Buncombe County	COMPUTED BY / DATE	KJY 02/02/14
PROJECT	Cell 7 Permit Application	CHECKED BY / DATE	WMB 2/3/2014
DETAIL	Perimeter Channel Design	REVISION NO. / DATE	- -
PROJECT NO.	6447-97693	REVIEWED BY / DATE	- -

Calculation Brief Title: Channel Sizing and Lining Calculation **- Channel 2**

1.0 Objective

Determine the appropriate channel dimensions and temporary/permanent erosion control protection for Channel 2.

2.0 Procedure

1. Identify the desired channel characteristics including bottom width, side slopes, longitudinal slope, Manning's 'n', and required flow.
2. Calculate the normal depth and shear stress.

3.0 References / Data Sources

1. Department of Environment and Natural Resources (NCDENR), June 1, 2006, Revised March 2009. Erosion and Sediment Control Planning and Design Manual.

4.0 Assumptions / Limitations

1. Assume unit weight of water is 62.4 lbs/ft^3.
2. Assume unit weight of concrete is 150 lbs/ft^3.

5.0 Calculations

5.1 Input Preliminary Channel Dimensions and Required Flow Capacity

- See Sheet EP-2 for the channel location

Channel Characteristics

B =	3	M_1 =	2	$Q_{25\text{-}YR}$ =	54.5	Inputs
		M_2 =	2	s =	0.035	

B - Channel width (ft)
Q - Design discharge (cfs)
M - Channel sideslope
s - Channel longitudinal slope

5.2 Calculate Shear Stress to Determine Required Temporary Liner

- Input the desired temporary liner

Filter Point FP600

- Identify the permissible shear stress (Hydrotex Specification Guideline)

30 pound per square foot

- Identify the appropriate Manning's n coefficient based on approximate flow depth (provided by Hydrotex specification

0.022

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}	Velocity (ft/s)	V/R
1.062	0.022	5.44	7.75	0.70	4.30	4.30	10.0	14.3

- Calculate shear stress and compare to permissible shear stress for the desired temporary liner

CLIENT	Buncombe County	COMPUTED BY / DATE	KJY	02/02/14
PROJECT	Cell 7 Permit Application	CHECKED BY / DATE	WMB	2/3/2014
DETAIL	Perimeter Channel Design	REVISION NO. / DATE	-	-
PROJECT NO.	6447-97693	REVIEWED BY / DATE	-	-

Shear Stress T = yds

T = shear stress in lb/sf
y = U.W. of H_2O (62.4 lb/cf)
d = flow depth (ft)
s = channel gradient

Calculated		Permissible	
2.3	<	30	**ok**

6.0 Recommendations and Conclusions

- Summarize calculations and recommended channel characteristics

1.1	= Maximum Flow Depth (Y, feet)
3.0	= Channel Bottom Width (B, feet)
2.0	= Channel Side Slope (M_1)
2.0	= Channel Side Slope (M_2)
3.0	= Recommended Channel Depth (feet)
Filter Point FP600	= Recommended Permanent Channel Lining
N/A	= Recommended Temporary Channel Lining

CLIENT	Buncombe County	COMPUTED BY / DATE	KJY 02/02/14
PROJECT	Cell 7 Permit Application	CHECKED BY / DATE	WMB 2/3/2014
DETAIL	Perimeter Channel Design	REVISION NO. / DATE	- -
PROJECT NO.	6447-97693	REVIEWED BY / DATE	- -

Calculation Brief Title: Channel Sizing and Lining Calculation **- Channel 3**

1.0 Objective

Determine the appropriate channel dimensions and temporary/permanent erosion control protection for Channel 3.

2.0 Procedure

1. Identify the desired channel characteristics including bottom width, side slopes, longitudinal slope, Manning's 'n', and required flow.
2. Calculate the normal depth and shear stress.

3.0 References / Data Sources

1. Department of Environment and Natural Resources (NCDENR), June 1, 2006, Revised March 2009. Erosion and Sediment Control Planning and Design Manual.

4.0 Assumptions / Limitations

1. Assume unit weight of water is 62.4 lbs/ft^3.
2. Assume unit weight of concrete is 150 lbs/ft^3.

5.0 Calculations

5.1 Input Preliminary Channel Dimensions and Required Flow Capacity

- See Sheet EP-2 for the channel location

Channel Characteristics

B =	3	M_1 =	2	$Q_{25\text{-}YR}$ =	29.6	Inputs
		M_2 =	2	s =	0.060	

B - Channel width (ft) M - Channel sideslope
Q - Design discharge (cfs) s - Channel longitudinal slope

5.2 Calculate Shear Stress to Determine Required Temporary Liner

- Input the desired temporary liner

Filter Point FP600

- Identify the permissible shear stress (Hydrotex Specification Guideline)

30 pound per square foot

- Identify the appropriate Manning's n coefficient based on approximate flow depth (provided by Hydrotex specification

0.022

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}	Velocity (ft/s)	V/R
0.670	0.022	2.91	6.00	0.48	1.79	1.79	10.2	21.0

- Calculate shear stress and compare to permissible shear stress for the desired temporary liner

CLIENT	Buncombe County	COMPUTED BY / DATE	KJY	02/02/14
PROJECT	Cell 7 Permit Application	CHECKED BY / DATE	WMB	2/3/2014
DETAIL	Perimeter Channel Design	REVISION NO. / DATE	-	-
PROJECT NO.	6447-97693	REVIEWED BY / DATE	-	-

Shear Stress T = yds

T = shear stress in lb/sf
y = U.W. of H_2O (62.4 lb/cf)
d = flow depth (ft)
s = channel gradient

Calculated		Permissible	
2.5	<	30	**ok**

6.0 Recommendations and Conclusions

- Summarize calculations and recommended channel characteristics

0.7	= Maximum Flow Depth (Y, feet)
3.0	= Channel Bottom Width (B, feet)
2.0	= Channel Side Slope (M_1)
2.0	= Channel Side Slope (M_2)
3.0	= Recommended Channel Depth (feet)
Filter Point FP600	= Recommended Permanent Channel Lining
N/A	= Recommended Temporary Channel Lining

Attachment 1

WinTR-55 Current Data Description

--- Identification Data ---

User: Ravi
Project:
SubTitle:
State: North Carolina
County: Buncombe Hillside NOAA
Filename: C:\Users\kadambalar\Documents\Chris Gabel\Cell 7\Calculations\Stormwater Calculations\TR-55 Poor

Date: 11/11/2013
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
C-7 Area 1		Outlet	16.04	86	.165
C-7 Area 2		Outlet	10.47	86	.144
C-7 Area 3		Outlet	5.68	86	.144

Total area: 32.19 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.04	3.81	4.42	5.26	5.93	6.62	2.52

Storm Data Source: Buncombe Hillside NOAA County, NC (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Ravi

Buncombe Hillside NOAA County, North Carolina

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.04	3.81	4.42	5.26	5.93	6.62	2.52

Storm Data Source: Buncombe Hillside NOAA County, NC (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Ravi

Buncombe Hillside NOAA County, North Carolina

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 10-Yr (cfs)	25-Yr (cfs)
SUBAREAS		
C-7 Area 1	64.43	80.88
C-7 Area 2	43.38	54.46
C-7 Area 3	23.54	29.56
REACHES		
OUTLET	130.95	164.37

Ravi

Buncombe Hillside NOAA County, North Carolina

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs)	(hr)	25-Yr (cfs)	(hr)
SUBAREAS				
C-7 Area 1	64.43	11.98	80.88	11.98
C-7 Area 2	43.38	11.96	54.46	11.96
C-7 Area 3	23.54	11.96	29.56	11.96
REACHES				
OUTLET	130.95		164.37	

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
C-7 Area 1	16.04	0.165	86	Outlet	
C-7 Area 2	10.47	0.144	86	Outlet	
C-7 Area 3	5.68	0.144	86	Outlet	

Total Area: 32.19 (ac)

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
C-7 Area 1							
SHEET	90	0.0500	0.150				0.107
SHALLOW	630	0.0500	0.050				0.049
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.165
C-7 Area 2							
SHEET	90	0.0500	0.150				0.107
SHALLOW	360	0.0500	0.050				0.028
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.144
C-7 Area 3							
SHEET	90	0.0500	0.150				0.107
SHALLOW	360	0.0500	0.050				0.028
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.144

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
C-7 Area 1	Open space; grass cover < 50%	(poor)	C	16.04	86
	Total Area / Weighted Curve Number			16.04	86
				=====	==
C-7 Area 2	Open space; grass cover < 50%	(poor)	C	10.47	86
	Total Area / Weighted Curve Number			10.47	86
				=====	==
C-7 Area 3	Open space; grass cover < 50%	(poor)	C	5.68	86
	Total Area / Weighted Curve Number			5.68	86
				====	==

Engineering Plan

Appendix A – Calculations

A-9b Drop-Inlet and Culvert

CDM Smith

CALCULATION COVER SHEET

Project Title	Permit Amendment Application, Subtitle D Landfill - Cell 7
Client	Buncombe County, NC
Project Number	6447-97693
Calculation Title	Stormwater Drop inlet and Culvert Design Calculations for Cell 7
Calculated By - Date	Ravi Kadambala 12/10/2013
Reviewed By - Date	Mike Brinchek
Purpose of the Calculation	The purpose of this calculation is to design the drop inlet and culvert to convey stormwater from Cell 7 to the sedimentaion pond number 2.
Results	Based on the calculations a drop inlet with a minimum opening of 6 sf and two 24-inch-diameter RCP culverts installed at the cross section shown are required to convey the 25-year, 24-hour design storm event from the channel to the sedimentation basin and maintain one-foot of freeboard in the perimeter channel at the inlet. These RCP culverts will function under inlet control.

CDM Smith	**CLIENT** Buncombe County	**JOB NO.** 6447-97693	**COMPUTED BY** Ravi Kadambala
	PROJECT Permit Amendment Application, Subtitle D Landfill - Cell 7		**DATE** 12/10/2013
	DETAIL Drop Inlet Design for Cell 7	**CHECKED BY** Mike Brinchek	**PAGE NO.** 1 of 1

Calculation Discription **Drop inlet of the stormwater culvert adjacent to Cell 7**

Objective

Determine the head on top of the drop inlet to convey the stormwater runoff from a 25-yr, 24-hr storm event to the stormwater culvert adjacent to cell 7.

Background Data

There are two drop inlets and two 24 inch culverts that convey stormwater from Cell 7 to the sedimentaion pond No. 2. The drop inlet has a precast square concrete slab (36 x 36 inches) that sits 6 inches above the surface as shown in detail A and Section 1 of sheet EP-9. This provides four (36 x 6 inches) openings for the stormwater to flow into each culvert as shown in the figure below.

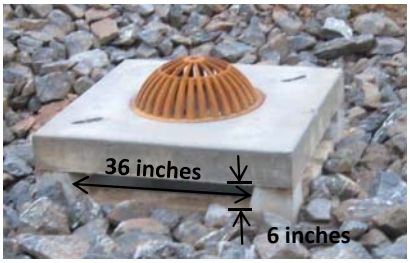
Orifice Equation

$Q = C_D A(2gh)^{1/2}$

Input Variables

C_D =	0.6	
Q_{25} =	40.5	cfs
g =	32.2	ft^2/s
Width of the Drop inlet =	36.0	inch
Height of the drop inlet opening =	6.0	inch
Number of openings in the drop inlet =	4.0	
A =	6.0	ft^2

Stormwater runoff for the 25-yr, 24-hr storm event



Area of the drop inlet opening

Calculations

h =	2.0	ft

Max. head on the drop inlet

CDM Smith	**CLIENT** Buncombe County	**JOB NO.** 6447-97693	**COMPUTED BY** Ravi Kadambala
	PROJECT Permit Amendment Application, Subtitle D Landfill - Cell 7		**DATE** 12/10/2013
	DETAIL Culvert Design for Cell 7	**CHECKED BY** Mike Brinchek	**PAGE NO.** 1 of 2

Calculation Discription **Stormwater culvert adjacent to Cell 7**

Objective

Assuming inlet control, determine the pipe diameter required to convey the stormwater runoff for the 25-yr, 24-hr design storm event for each stormwater culvert adjacent to cell 7.

Background Data

Orifice Equation

$Q = C_D A(2gh)^{1/2}$

There are two 24 inch culverts that convey the stormwater from Cell 7 to the sedimentation pond 2. So the flow in each culvert would be half the total stormwater flow.

Input Variables

C_D =	0.6		
Q_{25} =	40.5	cfs	*Refer to perimeter channel calculation*
g =	32.2	ft^2/s	
El =	1998	ft	*(Pipe invert in. elevation)*
Channel invert =	2008	ft	

Calculations

Using the orifice equation, adjust the pipe diameter value until Q* is tolerably equal to Q

D =	24	in	
A =	3.14	ft^2	
h =	9.0	ft	*available head*

Q_{25}* =	45	=	41	= Q_{25}

Note: if Q is less than Q, proposed pipe diameter is too small.*

Results

Channel Invert =	2008	ft	
Pipe Dia. =	24	in	
HW =	2006.2	ft	[Head water elevation]
FB =	1.8	ft	[Freeboard]

Calculation Discription **Stormwater culvert adjacent to Cell 7**

Objective

Assuming outlet control, determine the pipe diameter required to convey the stormwater runoff for the 25-yr, 24-hr design storm event for each stormwater culvert adjacent to cell 7

There are two 24 inch culverts that convey the stormwater from Cell 7 to the sedimentation pond 2. So the flow in each culvert would be half the total stormwater flow.

Background Data

Energy Balance Eqn. Reformated to:

$Za = Zb + (522Q^2/D^4)[(5096*L*n^2)/D^{1.33}) + K_e)]$ (See H.R. Malcom, P.E. Notes, Pg 5 Culverts)

Variables

Za =	Water surface elevation upstream of the culvert (ft)
Zb =	Water surface elevation downstream of the culvert (ft)
L =	Length of Pipe (ft)
Q =	Discharge (cfs)
D =	Pipe Diameter (in)
Ke =	Aggregate Loss Coefficient
n =	Mannings Roughness Coefficient (in complex units)

Calculations

Using the energy equation, input the following parameters.

Input

Zb=	A + B	
A=	1971.5	ft, Pipe invert at the stilling structure
B=	4.0	ft, Surface of stormwater above the invert, refer to stilling structure calculation
Zb =	1975.5	ft
L =	155.0	ft
Q =	40.5	cfs
D =	24.0	in
Ke =	1.2	
n =	0.0	

Results

Za = 1983.6 ft

Max Water Elevation =	2006.2
Channel Invert =	2008.0
Check Max Water El < Channel Invert	OK

Engineering Plan

Appendix A – Calculations

A-9c Sediment Pond No. 2

CDM Smith

CALCULATION COVER SHEET

Project Title	Permit Amendment Application, Subtitle D Landfill – Cell 7
Client	Buncombe County, North Carolina
Project number	6447-97693
Calculation title	Sedimentation Basin No. 2
Calculated by/date	W. Michael Brinchek, P.E., BCEE – November 19, 2013 Revised February 5, 2014
Reviewed by/date	KJY / 04/22/14
Calculation Summary	The purpose of the calculation was to check the capacity of Sediment Basin No. 2 and size the riser/barrel structure for the 10 and 25-year, 24-hour design storm event.
Results	The capacity of the basin as shown on the plans is sufficient to control the 10 and 25-year, 24-hour storm events. A summary of results are provided below.

Riser Diameter (in)	Barrel Diameter (in)	Riser Crest (ft)	Barrel Invert (ft)	ES Crest (ft)	10-yr Max Discharge (cfs)	25-yr Max Discharge (cfs)
18	**36**	**1965.5**	**1960.0**	**1968**	**42**	**57**

CDM Smith

Sedimentation Pond Design for Cell 7

Objective

The objective of this calculation is size sedimentation pond No. 2 to handle the stormwater run-off from Cell 7 and parts of Cell 6 as shown in Figure 1 below.

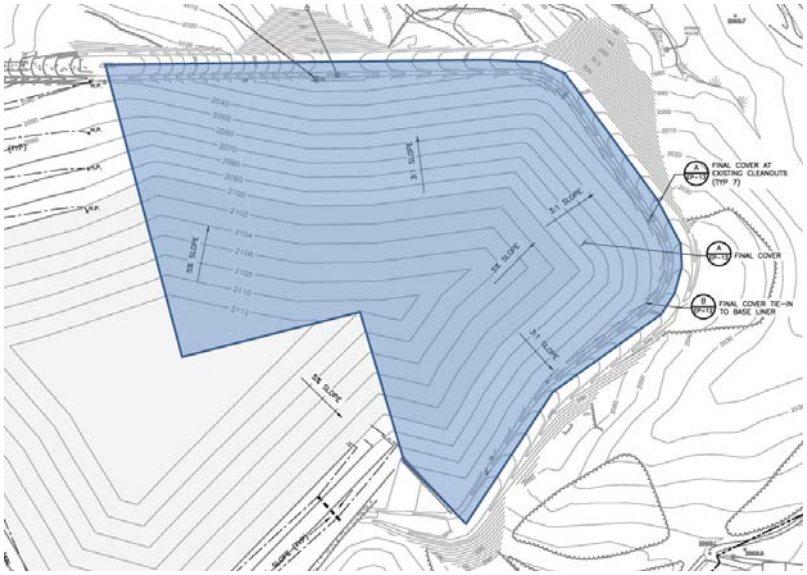


Figure 1. Drainage Area to size the Sedimentation pond

General Overview

The sedimentation pond is designed to capture and treat stormwater runoff from Cell 7 and parts of Cell 6 for 10, and 25-year, 24-hour design storm events based on Cell 7 build out assuming poor grass.

Runoff Computations

The total area draining to the sedimentation pond No. 2 is approximately 16 acres. The curve number (CN) for the drainage area was generated using standard criteria as set forth in Win TR-55. A composite CN of 86 (Type C soil, open space, poor condition) was assumed for the area from landfill sideslopes to the pond. The time of concentration was also computed using Win TR-55 as shown in **Attachment 1.**

Stormwater System Design – Sedimentation Pond No. 2

A desktop, chainsaw routing spreadsheet, developed using procedures outlined by H.R. Malcom, P.E., PhD, North Carolina State University, was used to evaluate the proposed outlet configuration of the Sedimentation Pond to ensure that the pond can handle the peak flow from drainage area. **Attachment 2** provides the hydrograph formulation, stage storage, hydrographs, and outflow calculations for the 10, and 25-year, 24-hour storm events.

Summary of Results

The following Table 1 shows the peak inflow and out flow from the sedimentation pond due to the two storm events.

Table 1. Inflow and Outflow for the Sedimentation Pond No. 2

Flow Location	Peak Flow in CFS	
	10-Year	**25-Year**
Cell 7 RCP Discharge (Inflow)	65	80
Basin Spillway (Outflow)	42	57

As shown in the calculations, the sedimentation pond as proposed can safely pass the 10, and 25-year, 24-hour design storm events.

ATTACHMENT 1

WinTR-55 Current Data Description

--- Identification Data ---

User: Ravi
Project:
SubTitle:
State: North Carolina
County: Buncombe Hillside NOAA
Filename: C:\Users\kadambalar\Documents\Chris Gabel\Cell 7\Calculations\Stormwater Calculations\TR-55 Poor

Date: 11/11/2013
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
C-7 Area 1		Outlet	16.04	86	.165
C-7 Area 2		Outlet	10.47	86	.144
C-7 Area 3		Outlet	5.68	86	.144

Total area: 32.19 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.04	3.81	4.42	5.26	5.93	6.62	2.52

Storm Data Source: Buncombe Hillside NOAA County, NC (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Ravi

Buncombe Hillside NOAA County, North Carolina

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.04	3.81	4.42	5.26	5.93	6.62	2.52

Storm Data Source: Buncombe Hillside NOAA County, NC (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Ravi

Buncombe Hillside NOAA County, North Carolina

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 10-Yr (cfs)	25-Yr (cfs)
SUBAREAS		
C-7 Area 1	64.43	80.88
C-7 Area 2	43.38	54.46
C-7 Area 3	23.54	29.56
REACHES		
OUTLET	130.95	164.37

Ravi

Buncombe Hillside NOAA County, North Carolina

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs)	(hr)	25-Yr (cfs)	(hr)
SUBAREAS				
C-7 Area 1	64.43	11.98	80.88	11.98
C-7 Area 2	43.38	11.96	54.46	11.96
C-7 Area 3	23.54	11.96	29.56	11.96
REACHES				
OUTLET	130.95		164.37	

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
C-7 Area 1	16.04	0.165	86	Outlet	
C-7 Area 2	10.47	0.144	86	Outlet	
C-7 Area 3	5.68	0.144	86	Outlet	

Total Area: 32.19 (ac)

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
C-7 Area 1							
SHEET	90	0.0500	0.150				0.107
SHALLOW	630	0.0500	0.050				0.049
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.165
C-7 Area 2							
SHEET	90	0.0500	0.150				0.107
SHALLOW	360	0.0500	0.050				0.028
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.144
C-7 Area 3							
SHEET	90	0.0500	0.150				0.107
SHALLOW	360	0.0500	0.050				0.028
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.144

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
C-7 Area 1	Open space; grass cover < 50%	(poor)	C	16.04	86
	Total Area / Weighted Curve Number			16.04	86
				=====	==
C-7 Area 2	Open space; grass cover < 50%	(poor)	C	10.47	86
	Total Area / Weighted Curve Number			10.47	86
				=====	==
C-7 Area 3	Open space; grass cover < 50%	(poor)	C	5.68	86
	Total Area / Weighted Curve Number			5.68	86
				====	==

ATTACHMENT 2

Client:	Buncombe County
Project:	Cell 7 Design
Task:	Stage-Storage

Computed By:	WMB
Date:	11.19.2013
Checked By:	KJY 4/22/14

SMALL WATERSHED HYDROGRAPH FORMULATION

Return Period	10	years	NOAA g:	216
Duration	24	hours	NOAA h:	27
Precipitation	4.90	in		
SCS CN	86			

Watershed Flow Characteristics

Watershed Area	16	acres
Hydraulic Length:		feet
Maximum Elevation:		
Minimum Elevation:		
Total Relief	0	feet
Kirpich K:	1	
Time of Concentration	0.0	minutes
Use T_C =	9.0	minutes

Composite C Determination

Land Use	Ci	Ai	Ci*Ai
Wooded			0
Undisturbed			0
Disturbed			0
Pond			0
	Σ	0	0
		Cc	**0.75**

CALCULATED:

				Calculated	Estimated	Use	
Soil Storage	1.63	inches	Intensity	6.0	6.00	6.0	inches/hour
Runoff Depth	3.37	inches	Discharge	72	65	65	cfs
Volume of Runoff	54.0	acre-inches					
Time to Peak	36	minutes	Method of Discharge Estimate:			Other	
Use T_P =	36	minutes					

HYDROGRAPH FORMULATION : By step function developed by H.R. Malcom, Ph.D., P.E., North Carolina State Universit
(Patterned after SCS dimensionless unit hydrograph)

Time (min)	Q (cfs)	Time (min)	Q (cfs)	Time (min)	Q (cfs)	Time (min)	Q (cfs)	Time (min)	Q (cfs)	Time (min)	Q (cfs)
0	0.0	36	65.0	72	21.0	108	5.7	144	1.6	180	0.4
1	0.1	37	64.9	73	20.2	109	5.5	145	1.5	181	0.4
2	0.5	38	64.5	74	19.5	110	5.3	146	1.4	182	0.4
3	1.1	39	63.9	75	18.8	111	5.1	147	1.4	183	0.4
4	2.0	40	63.0	76	18.1	112	4.9	148	1.3	184	0.4
5	3.0	41	62.0	77	17.5	113	4.8	149	1.3	185	0.4
6	4.4	42	60.6	78	16.9	114	4.6	150	1.3	186	0.3
7	5.9	43	59.1	79	16.3	115	4.4	151	1.2	187	0.3
8	7.6	44	57.4	80	15.7	116	4.3	152	1.2	188	0.3
9	9.5	45	55.5	81	15.1	117	4.1	153	1.1	189	0.3
10	11.6	46	53.6	82	14.6	118	4.0	154	1.1	190	0.3
11	13.9	47	51.7	83	14.1	119	3.8	155	1.0	191	0.3
12	16.3	48	49.8	84	13.6	120	3.7	156	1.0	192	0.3
13	18.8	49	48.1	85	13.1	121	3.6	157	1.0	193	0.3
14	21.4	50	46.4	86	12.6	122	3.4	158	0.9	194	0.3
15	24.1	51	44.7	87	12.2	123	3.3	159	0.9	195	0.2
16	26.9	52	43.1	88	11.8	124	3.2	160	0.9	196	0.2
17	29.7	53	41.6	89	11.3	125	3.1	161	0.8	197	0.2
18	32.5	54	40.1	90	10.9	126	3.0	162	0.8	198	0.2
19	35.3	55	38.7	91	10.6	127	2.9	163	0.8	199	0.2
20	38.1	56	37.3	92	10.2	128	2.8	164	0.8	200	0.2
21	40.9	57	36.0	93	9.8	129	2.7	165	0.7		
22	43.6	58	34.7	94	9.5	130	2.6	166	0.7		
23	46.2	59	33.5	95	9.1	131	2.5	167	0.7		
24	48.8	60	32.3	96	8.8	132	2.4	168	0.7		
25	51.1	61	31.2	97	8.5	133	2.3	169	0.6		
26	53.4	62	30.1	98	8.2	134	2.2	170	0.6		
27	55.5	63	29.0	99	7.9	135	2.2	171	0.6		
28	57.4	64	28.0	100	7.6	136	2.1	172	0.6		
29	59.1	65	27.0	101	7.4	137	2.0	173	0.5		
30	60.6	66	26.0	102	7.1	138	1.9	174	0.5		
31	62.0	67	25.1	103	6.8	139	1.9	175	0.5		
32	63.0	68	24.2	104	6.6	140	1.8	176	0.5		
33	63.9	69	23.3	105	6.4	141	1.7	177	0.5		
34	64.5	70	22.5	106	6.1	142	1.7	178	0.5		
35	64.9	71	21.7	107	5.9	143	1.6	179	0.4		

Client:	Buncombe County
Project:	Cell 7 Design
Task:	Stage-Storage

Computed By:	WMB
Date:	11.19.2013
Checked By:	KJY 4/22/14

OBJECTIVE

Determine the stage-storage and associated Ks and b value

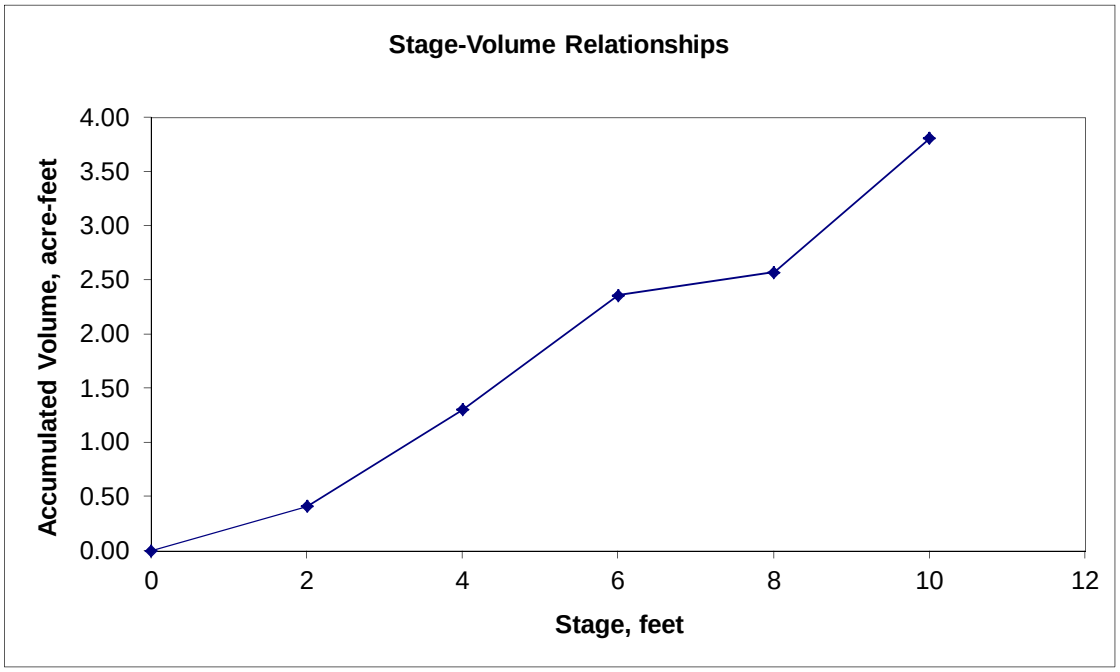
BACKGROUND

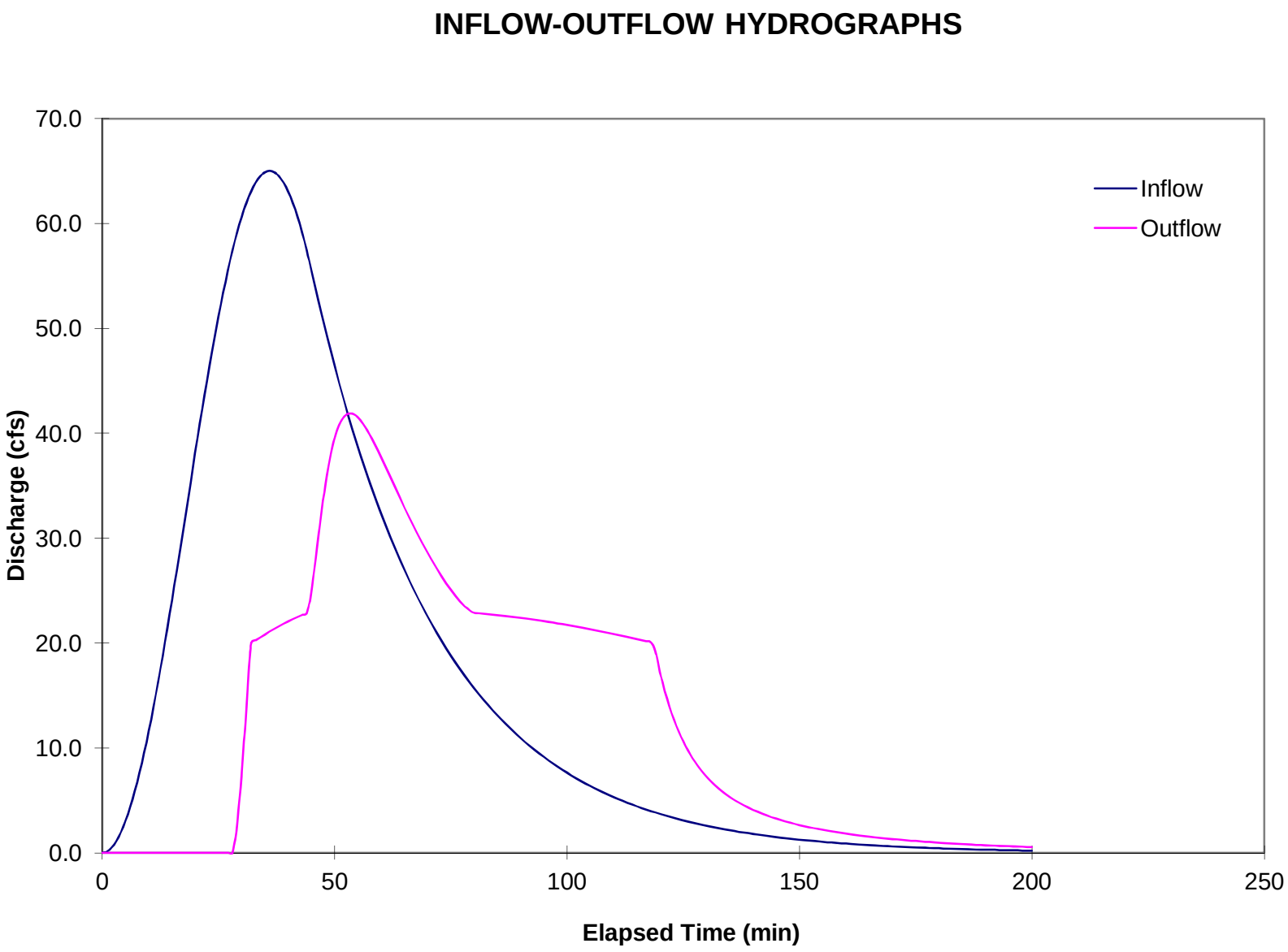
Stage-Storage Function derived from H.R. Malcom CE785 course pac

DEVELOPMENT

Elevation (ft)	Stage (ft)	Area (sf)	Incr. Vol (cf)	Acc. Vol (cf)	LN S	LN Z	Z est (ft)	Acc. Vol (ac-ft)
1960	0	0	0	0	---	---	---	0.00
1962	2	17,860	17,860	17,860	9.8	0.7	2.0	0.41
1964	4	21,000	38,860	56,720	10.9	1.4	4.6	1.30
1966	6	25,000	46,000	102,720	11.5	1.8	7.1	2.36
1968	8	30,240	55,240	111,960	11.6	2.1	7.5	2.57
1970	10	32,868	63,108	165,828	12.0	2.3	10.0	3.81

b=	**1.38**
Ks=	**6840**




INFLOW-OUTFLOW HYDROGRAPHS
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Discharge (cfs)
0
50
100
150
200
250
Elapsed Time (min)
Inflow
Outflow

Client:	Buncombe County
Project:	Cell 7
Task:	Pond Routing

Computed By:	WMB
Date:	11.19.2013
Checked By:	KJY 4/22/14

OBJECTIVE

Check the Pond design for the 10-year, 24-hour design storm event.

BACKGROUND

Routing perfomed by the chainsaw method as outlined by HR Malcom, PE, Ph.D, NCSU

Parameters input by the user.

DEVELOPMENT

SYSTEM PARAMETERS

Time Step (minutes)	1.0

Riser Barrel Spillway

Weir Configuration:	CMP Riser
Weir Diameter (inches):	36
Weir Length (feet):	9.42
Weir Area (square feet):	7.07
Weir Coefficient	3.00
Discharge Coefficient:	0.60
Crest Elevation:	1965.5
Barrel Configuration:	CMP Barrel
Barrel Diameter (inches):	18
Discharge Coefficient	0.6
Number of Barrels	1
Barrel Invert In	1960.0

Emergency Spillway

Weir Configuration:	Vegetative
Weir Length (feet):	20.0
ES Crest Elevation:	1968.00
Weir Coefficient:	3.00

Sharp Crested Weir Spillway

Weir Configuration:	Sharp Crested
Weir Length (feet):	0.0
Crest Elevation:	0.0
Weir Coefficient:	0.00

Circular Culvert / Low Level Outlet

Conduit Configuration:	CMP Barrel
Conduit Diameter (inches):	0
Number of Conduits:	0
Discharge Coefficient:	0
Effective Flow Area (ratio):	0
Conduit Invert In	0

Design Settling Particle

D_{15} (Microns) =	25
Specific Gravity	2.6
Number of effective cells	2
V_{SET} (fps) =	1.57E-03

ROUTING CONTROL & RESULTS

Return Period	10	years	Pond Invert EL	1962.0	feet	Max principal flow	24	cfs
Peak Runoff	65.0	cfs	Pond Crest EL	1970.0	feet	ES Max Discharge	18	cfs
Precipitation	4.90	inches	Initial WS EL	1962.0	feet	ES Depth of Flow	0.30	feet
Drainage Area	16.0	acres	Max Stage EL	1968.5	feet	ES Max Velocity	3.03	fps
Min Sett Eff		percent	Max Storage	2.1	acre-feet			
Ks =	6840		Max Stage	6.45	feet			
b =	1.38							

TIME	INFLOW	STORAGE	STAGE	OUTFLOW	CULVERT/ LOW LEVEL	RISER WEIR	RISER ORIFICE	BARREL ORIFICE	OVERFLOW WEIR	ES WEIR
(min)	(cfs)	(cf)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
0	0.0	0	0.00	0.0	0.0	0.0	0.0	9.5	0.0	0.0
1.0	0.1	0	0.00	0.0	0.0	0.0	0.0	9.5	0.0	0.0
2.0	0.5	7	0.01	0.0	0.0	0.0	0.0	9.5	0.0	0.0
3.0	1.1	37	0.02	0.0	0.0	0.0	0.0	9.6	0.0	0.0
4.0	2.0	103	0.05	0.0	0.0	0.0	0.0	9.7	0.0	0.0
5.0	3.0	221	0.08	0.0	0.0	0.0	0.0	9.8	0.0	0.0
6.0	4.4	404	0.13	0.0	0.0	0.0	0.0	10.0	0.0	0.0
7.0	5.9	665	0.19	0.0	0.0	0.0	0.0	10.2	0.0	0.0
8.0	7.6	1018	0.25	0.0	0.0	0.0	0.0	10.4	0.0	0.0
9.0	9.5	1474	0.33	0.0	0.0	0.0	0.0	10.7	0.0	0.0
10.0	11.6	2045	0.42	0.0	0.0	0.0	0.0	11.0	0.0	0.0
11.0	13.9	2742	0.52	0.0	0.0	0.0	0.0	11.3	0.0	0.0
12.0	16.3	3573	0.63	0.0	0.0	0.0	0.0	11.6	0.0	0.0
13.0	18.8	4548	0.74	0.0	0.0	0.0	0.0	12.0	0.0	0.0
14.0	21.4	5674	0.87	0.0	0.0	0.0	0.0	12.4	0.0	0.0
15.0	24.1	6957	1.01	0.0	0.0	0.0	0.0	12.8	0.0	0.0
16.0	26.9	8402	1.16	0.0	0.0	0.0	0.0	13.2	0.0	0.0
17.0	29.7	10014	1.32	0.0	0.0	0.0	0.0	13.6	0.0	0.0
18.0	32.5	11794	1.48	0.0	0.0	0.0	0.0	14.0	0.0	0.0
19.0	35.3	13744	1.66	0.0	0.0	0.0	0.0	14.5	0.0	0.0

TIME	INFLOW	STORAGE	STAGE	OUTFLOW	CULVERT/ LOW LEVEL	RISER WEIR	RISER ORIFICE	BARREL ORIFICE	OVERFLOW WEIR	ES WEIR
(min)	(cfs)	(cf)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
20.0	38.1	15864	1.84	0.0	0.0	0.0	0.0	14.9	0.0	0.0
21.0	40.9	18152	2.02	0.0	0.0	0.0	0.0	15.4	0.0	0.0
22.0	43.6	20607	2.22	0.0	0.0	0.0	0.0	15.8	0.0	0.0
23.0	46.2	23224	2.42	0.0	0.0	0.0	0.0	16.3	0.0	0.0
24.0	48.8	25998	2.62	0.0	0.0	0.0	0.0	16.7	0.0	0.0
25.0	51.1	28923	2.83	0.0	0.0	0.0	0.0	17.2	0.0	0.0
26.0	53.4	31992	3.05	0.0	0.0	0.0	0.0	17.6	0.0	0.0
27.0	55.5	35195	3.26	0.0	0.0	0.0	0.0	18.1	0.0	0.0
28.0	57.4	38524	3.48	0.0	0.0	0.0	0.0	18.5	0.0	0.0
29.0	59.1	41968	3.71	2.7	0.0	2.7	15.5	18.9	0.0	0.0
30.0	60.6	45355	3.92	7.7	0.0	7.7	22.1	19.3	0.0	0.0
31.0	62.0	48531	4.12	13.7	0.0	13.7	26.7	19.7	0.0	0.0
32.0	63.0	51426	4.29	20.0	0.0	20.0	30.3	20.0	0.0	0.0
33.0	63.9	54011	4.45	20.3	0.0	26.1	33.1	20.3	0.0	0.0
34.0	64.5	56628	4.60	20.6	0.0	32.7	35.7	20.6	0.0	0.0
35.0	64.9	59265	4.76	20.8	0.0	39.8	38.1	20.8	0.0	0.0
36.0	65.0	61908	4.91	21.1	0.0	47.3	40.4	21.1	0.0	0.0
37.0	64.9	64544	5.06	21.3	0.0	55.0	42.5	21.3	0.0	0.0
38.0	64.5	67156	5.21	21.6	0.0	63.0	44.4	21.6	0.0	0.0
39.0	63.9	69731	5.35	21.8	0.0	71.1	46.3	21.8	0.0	0.0
40.0	63.0	72255	5.49	22.1	0.0	79.3	48.0	22.1	0.0	0.0
41.0	62.0	74715	5.62	22.3	0.0	87.4	49.6	22.3	0.0	0.0
42.0	60.6	77096	5.75	22.5	0.0	95.5	51.1	22.5	0.0	0.0
43.0	59.1	79386	5.87	22.7	0.0	103.4	52.4	22.7	0.0	0.0
44.0	57.4	81573	5.99	22.9	0.0	111.1	53.7	22.9	0.0	0.0
45.0	55.5	83645	6.10	24.9	0.0	118.5	54.9	23.0	0.0	1.9
46.0	53.6	85478	6.20	28.4	0.0	125.2	55.9	23.2	0.0	5.2
47.0	51.7	86988	6.28	32.0	0.0	130.7	56.7	23.3	0.0	8.7
48.0	49.8	88171	6.34	35.1	0.0	135.1	57.3	23.4	0.0	11.7
49.0	48.1	89054	6.38	37.7	0.0	138.4	57.8	23.5	0.0	14.2
50.0	46.4	89679	6.41	39.6	0.0	140.7	58.1	23.5	0.0	16.0
51.0	44.7	90088	6.44	40.8	0.0	142.2	58.3	23.6	0.0	17.3
52.0	43.1	90323	6.45	41.6	0.0	143.1	58.4	23.6	0.0	18.0
53.0	41.6	90417	6.45	41.9	0.0	143.5	58.5	23.6	0.0	18.3
54.0	40.1	90402	6.45	41.8	0.0	143.4	58.5	23.6	0.0	18.2
55.0	38.7	90301	6.45	41.5	0.0	143.0	58.4	23.6	0.0	17.9
56.0	37.3	90134	6.44	41.0	0.0	142.4	58.3	23.6	0.0	17.4
57.0	36.0	89916	6.43	40.3	0.0	141.6	58.2	23.5	0.0	16.7
58.0	34.7	89660	6.41	39.5	0.0	140.6	58.1	23.5	0.0	16.0
59.0	33.5	89375	6.40	38.6	0.0	139.6	57.9	23.5	0.0	15.1
60.0	32.3	89068	6.38	37.7	0.0	138.4	57.8	23.5	0.0	14.2
61.0	31.2	88745	6.37	36.8	0.0	137.2	57.6	23.4	0.0	13.3
62.0	30.1	88409	6.35	35.8	0.0	136.0	57.4	23.4	0.0	12.4
63.0	29.0	88066	6.33	34.8	0.0	134.7	57.3	23.4	0.0	11.4
64.0	28.0	87716	6.31	33.9	0.0	133.4	57.1	23.4	0.0	10.5
65.0	27.0	87362	6.29	32.9	0.0	132.1	56.9	23.3	0.0	9.6
66.0	26.0	87004	6.28	32.0	0.0	130.8	56.7	23.3	0.0	8.7
67.0	25.1	86645	6.26	31.1	0.0	129.5	56.5	23.3	0.0	7.8
68.0	24.2	86284	6.24	30.2	0.0	128.1	56.3	23.2	0.0	7.0
69.0	23.3	85923	6.22	29.4	0.0	126.8	56.1	23.2	0.0	6.2
70.0	22.5	85560	6.20	28.6	0.0	125.5	55.9	23.2	0.0	5.4
71.0	21.7	85197	6.18	27.8	0.0	124.2	55.7	23.2	0.0	4.6
72.0	21.0	84832	6.16	27.1	0.0	122.8	55.5	23.1	0.0	3.9
73.0	20.2	84465	6.14	26.4	0.0	121.5	55.3	23.1	0.0	3.3
74.0	19.5	84097	6.12	25.7	0.0	120.2	55.1	23.1	0.0	2.6
75.0	18.8	83725	6.10	25.1	0.0	118.8	54.9	23.0	0.0	2.0
76.0	18.1	83350	6.08	24.5	0.0	117.5	54.7	23.0	0.0	1.5
77.0	17.5	82969	6.06	24.0	0.0	116.1	54.5	23.0	0.0	1.0
78.0	16.9	82581	6.04	23.5	0.0	114.7	54.3	22.9	0.0	0.6
79.0	16.3	82184	6.02	23.1	0.0	113.3	54.1	22.9	0.0	0.2
80.0	15.7	81773	6.00	22.9	0.0	111.8	53.8	22.9	0.0	0.0
81.0	15.1	81342	5.98	22.8	0.0	110.3	53.6	22.8	0.0	0.0
82.0	14.6	80880	5.95	22.8	0.0	108.7	53.3	22.8	0.0	0.0
83.0	14.1	80388	5.93	22.8	0.0	106.9	53.0	22.8	0.0	0.0
84.0	13.6	79867	5.90	22.7	0.0	105.1	52.7	22.7	0.0	0.0
85.0	13.1	79319	5.87	22.7	0.0	103.2	52.4	22.7	0.0	0.0
86.0	12.6	78745	5.84	22.6	0.0	101.2	52.1	22.6	0.0	0.0
87.0	12.2	78146	5.81	22.6	0.0	99.1	51.7	22.6	0.0	0.0
88.0	11.8	77524	5.77	22.5	0.0	97.0	51.3	22.5	0.0	0.0
89.0	11.3	76878	5.74	22.5	0.0	94.8	50.9	22.5	0.0	0.0

TIME	INFLOW	STORAGE	STAGE	OUTFLOW	CULVERT/ LOW LEVEL	RISER WEIR	RISER ORIFICE	BARREL ORIFICE	OVERFLOW WEIR	ES WEIR
(min)	(cfs)	(cf)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
90.0	10.9	76211	5.70	22.4	0.0	92.5	50.5	22.4	0.0	0.0
91.0	10.6	75523	5.67	22.3	0.0	90.1	50.1	22.3	0.0	0.0
92.0	10.2	74816	5.63	22.3	0.0	87.8	49.6	22.3	0.0	0.0
93.0	9.8	74090	5.59	22.2	0.0	85.3	49.2	22.2	0.0	0.0
94.0	9.5	73346	5.55	22.1	0.0	82.9	48.7	22.1	0.0	0.0
95.0	9.1	72585	5.51	22.1	0.0	80.3	48.2	22.1	0.0	0.0
96.0	8.8	71808	5.46	22.0	0.0	77.8	47.7	22.0	0.0	0.0
97.0	8.5	71015	5.42	21.9	0.0	75.2	47.2	21.9	0.0	0.0
98.0	8.2	70209	5.38	21.9	0.0	72.6	46.6	21.9	0.0	0.0
99.0	7.9	69388	5.33	21.8	0.0	70.0	46.0	21.8	0.0	0.0
100.0	7.6	68555	5.28	21.7	0.0	67.4	45.5	21.7	0.0	0.0
101.0	7.4	67709	5.24	21.6	0.0	64.7	44.8	21.6	0.0	0.0
102.0	7.1	66852	5.19	21.6	0.0	62.0	44.2	21.6	0.0	0.0
103.0	6.8	65985	5.14	21.5	0.0	59.4	43.6	21.5	0.0	0.0
104.0	6.6	65106	5.09	21.4	0.0	56.7	42.9	21.4	0.0	0.0
105.0	6.4	64219	5.04	21.3	0.0	54.0	42.2	21.3	0.0	0.0
106.0	6.1	63322	4.99	21.2	0.0	51.4	41.5	21.2	0.0	0.0
107.0	5.9	62417	4.94	21.1	0.0	48.7	40.8	21.1	0.0	0.0
108.0	5.7	61505	4.89	21.0	0.0	46.1	40.1	21.0	0.0	0.0
109.0	5.5	60585	4.83	21.0	0.0	43.5	39.3	21.0	0.0	0.0
110.0	5.3	59658	4.78	20.9	0.0	40.9	38.5	20.9	0.0	0.0
111.0	5.1	58725	4.72	20.8	0.0	38.3	37.7	20.8	0.0	0.0
112.0	4.9	57787	4.67	20.7	0.0	35.8	36.8	20.7	0.0	0.0
113.0	4.8	56843	4.61	20.6	0.0	33.3	35.9	20.6	0.0	0.0
114.0	4.6	55895	4.56	20.5	0.0	30.8	35.0	20.5	0.0	0.0
115.0	4.4	54942	4.50	20.4	0.0	28.4	34.1	20.4	0.0	0.0
116.0	4.3	53986	4.45	20.3	0.0	26.0	33.1	20.3	0.0	0.0
117.0	4.1	53026	4.39	20.2	0.0	23.7	32.1	20.2	0.0	0.0
118.0	4.0	52063	4.33	20.1	0.0	21.4	31.0	20.1	0.0	0.0
119.0	3.8	51097	4.27	19.2	0.0	19.2	29.9	20.0	0.0	0.0
120.0	3.7	50174	4.22	17.2	0.0	17.2	28.8	19.9	0.0	0.0
121.0	3.6	49366	4.17	15.4	0.0	15.4	27.8	19.8	0.0	0.0
122.0	3.4	48654	4.12	14.0	0.0	14.0	26.9	19.7	0.0	0.0
123.0	3.3	48023	4.09	12.7	0.0	12.7	26.1	19.6	0.0	0.0
124.0	3.2	47462	4.05	11.6	0.0	11.6	25.3	19.6	0.0	0.0
125.0	3.1	46960	4.02	10.6	0.0	10.6	24.5	19.5	0.0	0.0
126.0	3.0	46509	3.99	9.8	0.0	9.8	23.9	19.5	0.0	0.0
127.0	2.9	46101	3.97	9.0	0.0	9.0	23.3	19.4	0.0	0.0
128.0	2.8	45732	3.94	8.4	0.0	8.4	22.7	19.4	0.0	0.0
129.0	2.7	45397	3.92	7.8	0.0	7.8	22.1	19.3	0.0	0.0
130.0	2.6	45090	3.90	7.3	0.0	7.3	21.6	19.3	0.0	0.0
131.0	2.5	44809	3.89	6.8	0.0	6.8	21.2	19.3	0.0	0.0
132.0	2.4	44551	3.87	6.4	0.0	6.4	20.7	19.2	0.0	0.0
133.0	2.3	44313	3.86	6.0	0.0	6.0	20.3	19.2	0.0	0.0
134.0	2.2	44092	3.84	5.6	0.0	5.6	19.9	19.2	0.0	0.0
135.0	2.2	43888	3.83	5.3	0.0	5.3	19.5	19.1	0.0	0.0
136.0	2.1	43697	3.82	5.0	0.0	5.0	19.1	19.1	0.0	0.0
137.0	2.0	43520	3.81	4.8	0.0	4.8	18.8	19.1	0.0	0.0
138.0	1.9	43354	3.79	4.5	0.0	4.5	18.5	19.1	0.0	0.0
139.0	1.9	43198	3.79	4.3	0.0	4.3	18.2	19.1	0.0	0.0
140.0	1.8	43052	3.78	4.1	0.0	4.1	17.9	19.0	0.0	0.0
141.0	1.7	42914	3.77	3.9	0.0	3.9	17.6	19.0	0.0	0.0
142.0	1.7	42784	3.76	3.7	0.0	3.7	17.3	19.0	0.0	0.0
143.0	1.6	42661	3.75	3.6	0.0	3.6	17.1	19.0	0.0	0.0
144.0	1.6	42545	3.74	3.4	0.0	3.4	16.8	19.0	0.0	0.0
145.0	1.5	42434	3.74	3.3	0.0	3.3	16.6	19.0	0.0	0.0
146.0	1.4	42329	3.73	3.1	0.0	3.1	16.3	19.0	0.0	0.0
147.0	1.4	42229	3.72	3.0	0.0	3.0	16.1	18.9	0.0	0.0
148.0	1.3	42133	3.72	2.9	0.0	2.9	15.9	18.9	0.0	0.0
149.0	1.3	42042	3.71	2.8	0.0	2.8	15.7	18.9	0.0	0.0
150.0	1.3	41955	3.71	2.6	0.0	2.6	15.4	18.9	0.0	0.0
151.0	1.2	41871	3.70	2.5	0.0	2.5	15.2	18.9	0.0	0.0
152.0	1.2	41791	3.70	2.4	0.0	2.4	15.1	18.9	0.0	0.0
153.0	1.1	41715	3.69	2.4	0.0	2.4	14.9	18.9	0.0	0.0
154.0	1.1	41641	3.69	2.3	0.0	2.3	14.7	18.9	0.0	0.0
155.0	1.0	41570	3.68	2.2	0.0	2.2	14.5	18.9	0.0	0.0
156.0	1.0	41501	3.68	2.1	0.0	2.1	14.3	18.9	0.0	0.0
157.0	1.0	41436	3.67	2.0	0.0	2.0	14.2	18.8	0.0	0.0
158.0	0.9	41372	3.67	2.0	0.0	2.0	14.0	18.8	0.0	0.0
159.0	0.9	41311	3.66	1.9	0.0	1.9	13.8	18.8	0.0	0.0

TIME	INFLOW	STORAGE	STAGE	OUTFLOW	CULVERT/ LOW LEVEL	RISER WEIR	RISER ORIFICE	BARREL ORIFICE	OVERFLOW WEIR	ES WEIR
(min)	(cfs)	(cf)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
160.0	0.9	41251	3.66	1.8	0.0	1.8	13.7	18.8	0.0	0.0
161.0	0.8	41194	3.66	1.8	0.0	1.8	13.5	18.8	0.0	0.0
162.0	0.8	41139	3.65	1.7	0.0	1.7	13.3	18.8	0.0	0.0
163.0	0.8	41085	3.65	1.6	0.0	1.6	13.2	18.8	0.0	0.0
164.0	0.8	41033	3.65	1.6	0.0	1.6	13.1	18.8	0.0	0.0
165.0	0.7	40983	3.64	1.5	0.0	1.5	12.9	18.8	0.0	0.0
166.0	0.7	40934	3.64	1.5	0.0	1.5	12.8	18.8	0.0	0.0
167.0	0.7	40887	3.64	1.4	0.0	1.4	12.6	18.8	0.0	0.0
168.0	0.7	40841	3.63	1.4	0.0	1.4	12.5	18.8	0.0	0.0
169.0	0.6	40796	3.63	1.4	0.0	1.4	12.4	18.8	0.0	0.0
170.0	0.6	40753	3.63	1.3	0.0	1.3	12.2	18.8	0.0	0.0
171.0	0.6	40711	3.63	1.3	0.0	1.3	12.1	18.8	0.0	0.0
172.0	0.6	40670	3.62	1.2	0.0	1.2	12.0	18.8	0.0	0.0
173.0	0.5	40630	3.62	1.2	0.0	1.2	11.8	18.7	0.0	0.0
174.0	0.5	40591	3.62	1.2	0.0	1.2	11.7	18.7	0.0	0.0
175.0	0.5	40553	3.62	1.1	0.0	1.1	11.6	18.7	0.0	0.0
176.0	0.5	40517	3.61	1.1	0.0	1.1	11.5	18.7	0.0	0.0
177.0	0.5	40481	3.61	1.1	0.0	1.1	11.4	18.7	0.0	0.0
178.0	0.5	40446	3.61	1.0	0.0	1.0	11.3	18.7	0.0	0.0
179.0	0.4	40412	3.61	1.0	0.0	1.0	11.1	18.7	0.0	0.0
180.0	0.4	40379	3.60	1.0	0.0	1.0	11.0	18.7	0.0	0.0
181.0	0.4	40347	3.60	0.9	0.0	0.9	10.9	18.7	0.0	0.0
182.0	0.4	40315	3.60	0.9	0.0	0.9	10.8	18.7	0.0	0.0
183.0	0.4	40285	3.60	0.9	0.0	0.9	10.7	18.7	0.0	0.0
184.0	0.4	40255	3.60	0.9	0.0	0.9	10.6	18.7	0.0	0.0
185.0	0.4	40226	3.60	0.8	0.0	0.8	10.5	18.7	0.0	0.0
186.0	0.3	40197	3.59	0.8	0.0	0.8	10.4	18.7	0.0	0.0
187.0	0.3	40169	3.59	0.8	0.0	0.8	10.3	18.7	0.0	0.0
188.0	0.3	40142	3.59	0.8	0.0	0.8	10.2	18.7	0.0	0.0
189.0	0.3	40116	3.59	0.7	0.0	0.7	10.1	18.7	0.0	0.0
190.0	0.3	40090	3.59	0.7	0.0	0.7	10.0	18.7	0.0	0.0
191.0	0.3	40064	3.58	0.7	0.0	0.7	9.9	18.7	0.0	0.0
192.0	0.3	40040	3.58	0.7	0.0	0.7	9.8	18.7	0.0	0.0
193.0	0.3	40016	3.58	0.7	0.0	0.7	9.7	18.7	0.0	0.0
194.0	0.3	39992	3.58	0.6	0.0	0.6	9.6	18.7	0.0	0.0
195.0	0.2	39969	3.58	0.6	0.0	0.6	9.5	18.7	0.0	0.0
196.0	0.2	39947	3.58	0.6	0.0	0.6	9.4	18.7	0.0	0.0
197.0	0.2	39925	3.58	0.6	0.0	0.6	9.4	18.7	0.0	0.0
198.0	0.2	39903	3.57	0.6	0.0	0.6	9.3	18.7	0.0	0.0
199.0	0.2	39882	3.57	0.6	0.0	0.6	9.2	18.7	0.0	0.0
200.0	0.2	39861	3.57	0.5	0.0	0.5	9.1	18.7	0.0	0.0

Client:	Buncombe County
Project:	Cell 7 Design
Task:	Stage-Storage

Computed By:	WMB
Date:	11.19.2013
Checked By:	

SMALL WATERSHED HYDROGRAPH FORMULATION

Return Period	25	years	NOAA g:	257
Duration	24	hours	NOAA h:	28
Precipitation	5.26	in		
SCS CN	86			

Watershed Flow Characteristics

Watershed Area	16	acres
Hydraulic Length:		feet
Maximum Elevation:		
Minimum Elevation:		
Total Relief:	0	feet
Kirpich K:	1	
Time of Concentration	0.0	minutes
Use T_C =	9.0	minutes

Composite C Determination

Land Use	Ci	Ai	Ci*Ai
Wooded			0
Undisturbed			0
Disturbed			0
Pond			0
	Σ	0	0
		Cc	**0.75**

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CALCULATED:

				Calculated	Estimated	Use	
Soil Storage	1.63	inches	Intensity	6.9	6.90	6.9	inches/hour
Runoff Depth	3.71	inches	Discharge	83	80	80	cfs
Volume of Runoff	59.4	acre-inches					
Time to Peak	32	minutes	Method of Discharge Estimate:			Other	
Use T_P =	32	minutes					

HYDROGRAPH FORMULATION : By step function developed by H.R. Malcom, Ph.D., P.E., North Carolina State University
(Patterned after SCS dimensionless unit hydrograph)

Time (min)	Q (cfs)	Time (min)	Q (cfs)	Time (min)	Q (cfs)	Time (min)	Q (cfs)	Time (min)	Q (cfs)	Time (min)	Q (cfs)
0	0.0	36	77.0	72	18.6	108	4.3	144	1.0	180	0.2
1	0.2	37	75.3	73	17.9	109	4.1	145	1.0	181	0.2
2	0.8	38	73.3	74	17.2	110	4.0	146	0.9	182	0.2
3	1.7	39	70.9	75	16.5	111	3.8	147	0.9	183	0.2
4	3.0	40	68.3	76	15.8	112	3.7	148	0.8	184	0.2
5	4.7	41	65.6	77	15.2	113	3.5	149	0.8	185	0.2
6	6.7	42	63.0	78	14.6	114	3.4	150	0.8	186	0.2
7	9.1	43	60.5	79	14.0	115	3.2	151	0.8	187	0.2
8	11.7	44	58.1	80	13.5	116	3.1	152	0.7	188	0.2
9	14.6	45	55.8	81	12.9	117	3.0	153	0.7	189	0.2
10	17.8	46	53.6	82	12.4	118	2.9	154	0.7	190	0.2
11	21.1	47	51.4	83	11.9	119	2.8	155	0.6	191	0.1
12	24.7	48	49.4	84	11.4	120	2.7	156	0.6	192	0.1
13	28.4	49	47.4	85	11.0	121	2.5	157	0.6	193	0.1
14	32.2	50	45.5	86	10.6	122	2.4	158	0.6	194	0.1
15	36.1	51	43.7	87	10.1	123	2.3	159	0.5	195	0.1
16	40.0	52	42.0	88	9.7	124	2.3	160	0.5	196	0.1
17	43.9	53	40.3	89	9.3	125	2.2	161	0.5	197	0.1
18	47.8	54	38.7	90	9.0	126	2.1	162	0.5	198	0.1
19	51.6	55	37.2	91	8.6	127	2.0	163	0.5	199	0.1
20	55.3	56	35.7	92	8.3	128	1.9	164	0.4	200	0.1
21	58.9	57	34.3	93	7.9	129	1.8	165	0.4		
22	62.2	58	32.9	94	7.6	130	1.8	166	0.4		
23	65.4	59	31.6	95	7.3	131	1.7	167	0.4		
24	68.3	60	30.3	96	7.0	132	1.6	168	0.4		
25	70.9	61	29.1	97	6.7	133	1.6	169	0.4		
26	73.3	62	28.0	98	6.5	134	1.5	170	0.3		
27	75.3	63	26.9	99	6.2	135	1.4	171	0.3		
28	77.0	64	25.8	100	6.0	136	1.4	172	0.3		
29	78.3	65	24.8	101	5.7	137	1.3	173	0.3		
30	79.2	66	23.8	102	5.5	138	1.3	174	0.3		
31	79.8	67	22.8	103	5.3	139	1.2	175	0.3		
32	80.0	68	21.9	104	5.1	140	1.2	176	0.3		
33	79.8	69	21.0	105	4.9	141	1.1	177	0.3		
34	79.2	70	20.2	106	4.7	142	1.1	178	0.3		
35	78.3	71	19.4	107	4.5	143	1.0	179	0.2		

Client:	Buncombe County
Project:	Cell 7 Design
Task:	Stage-Storage

Computed By:	WMB
Date:	11.19.2013
Checked By:	

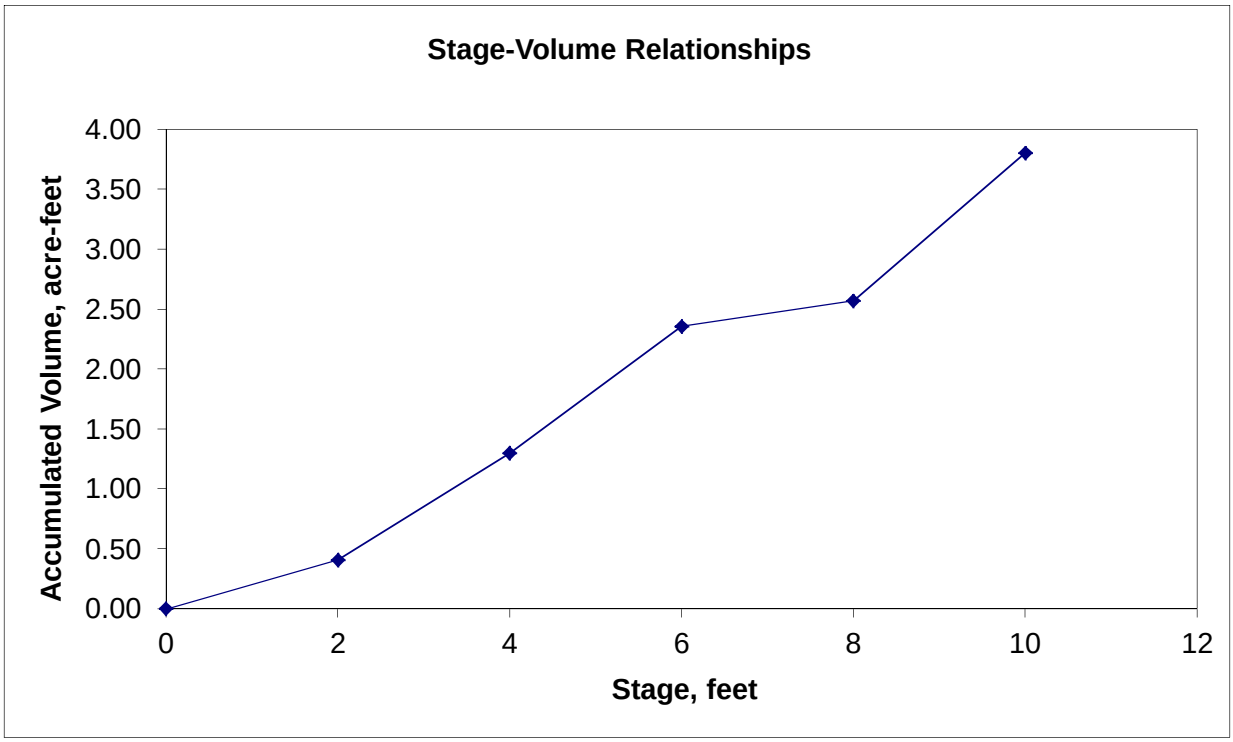
OBJECTIVE
Determine the stage-storage and associated Ks and b values

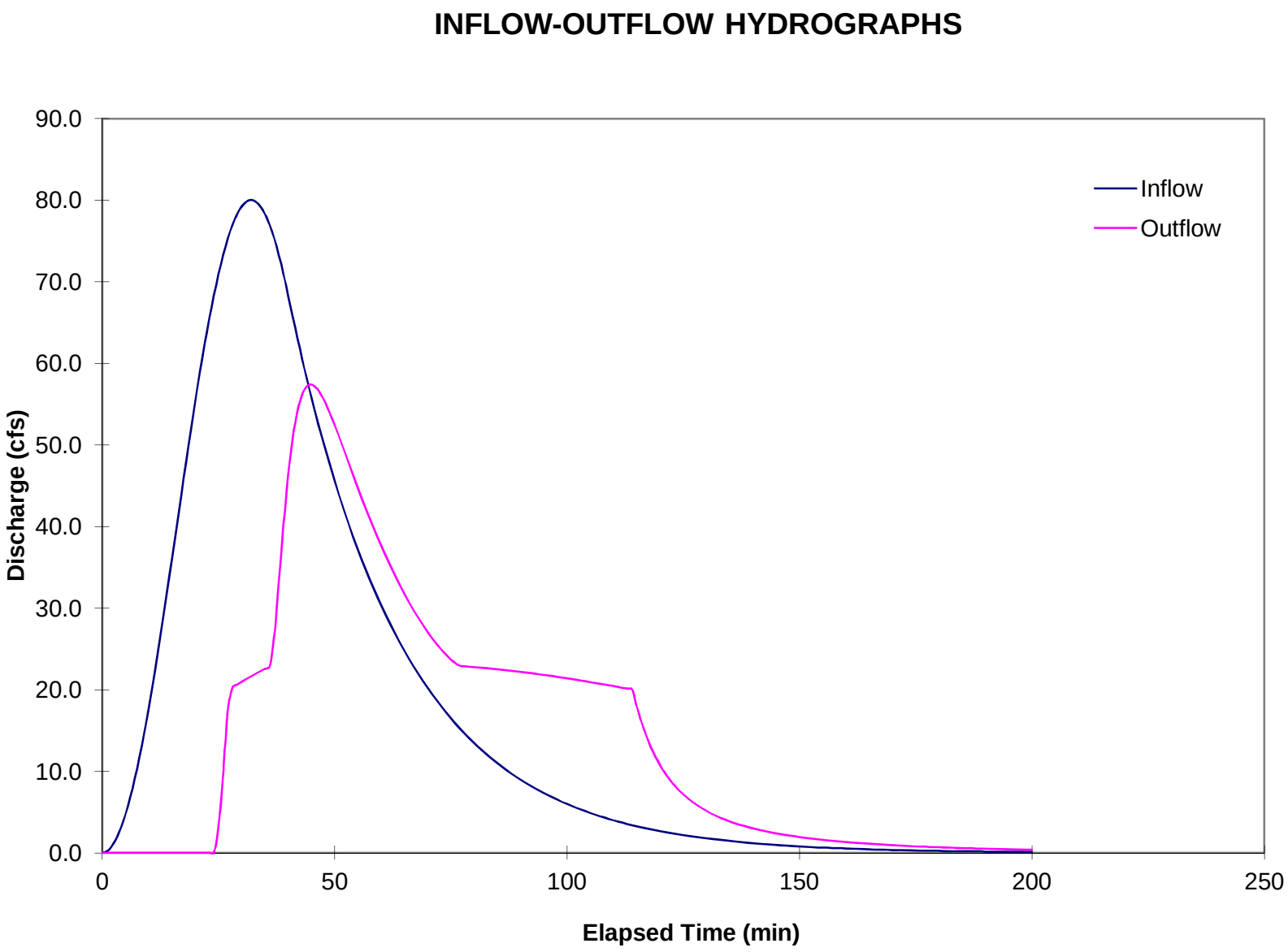
BACKGROUND
Stage-Storage Function derived from H.R. Malcom CE785 course pack.

DEVELOPMENT

Elevation (ft)	Stage (ft)	Area (sf)	Incr. Vol (cf)	Acc. Vol (cf)	LN S	LN Z	Z est (ft)	Acc. Vol (ac-ft)
1960	0	0	0	0	---	---	---	0.00
1962	2	17,860	17,860	17,860	9.8	0.7	2.0	0.41
1964	4	21,000	38,860	56,720	10.9	1.4	4.6	1.30
1966	6	25,000	46,000	102,720	11.5	1.8	7.1	2.36
1968	8	30,240	55,240	111,960	11.6	2.1	7.5	2.57
1970	10	32,868	63,108	165,828	12.0	2.3	10.0	3.81

b=	**1.38**
Ks=	**6840**




INFLOW-OUTFLOW HYDROGRAPHS
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Discharge (cfs)
0
50
100
150
200
250
Elapsed Time (min)
Inflow
Outflow

Client:	Buncombe County
Project:	Cell 7
Task:	Pond Routing

Computed By:	WMB
Date:	11.19.2013
Checked By:	

OBJECTIVE

Check the Pond design for the 25-year, 24-hour design storm event.

BACKGROUND

Routing perfomed by the chainsaw method as outlined by HR Malcom, PE, Ph.D, NCSU

Parameters input by the user.

DEVELOPMENT

SYSTEM PARAMETERS

Time Step (minutes)	1.0

Riser Barrel Spillway

Weir Configuration:	CMP Riser
Weir Diameter (inches):	36
Weir Length (feet):	9.42
Weir Area (square feet):	7.07
Weir Coefficient	3.00
Discharge Coefficient:	0.60
Crest Elevation:	1965.5
Barrel Configuration:	CMP Barrel
Barrel Diameter (inches):	18
Discharge Coefficient	0.6
Number of Barrels	1
Barrel Invert In	1960.0

Emergency Spillway

Weir Configuration:	Vegetative
Weir Length (feet):	20.0
ES Crest Elevation:	1968.00
Weir Coefficient:	3.00

Sharp Crested Weir Spillway

Weir Configuration:	Sharp Crested
Weir Length (feet):	0.0
Crest Elevation:	0.0
Weir Coefficient:	0.00

Circular Culvert / Low Level Outlet

Conduit Configuration:	CMP Barrel
Conduit Diameter (inches):	0
Number of Conduits:	0
Discharge Coefficient:	0
Effective Flow Area (ratio):	0
Conduit Invert In	0

Design Settling Particle

D_{15} (Microns) =	
Specific Gravity	
Number of effective cells	
V_{SET} (fps) =	0.00E+00

ROUTING CONTROL & RESULTS

Return Period	25	years	Pond Invert EL	1962.0	feet	Max principal flow	24	cfs
Peak Runoff	80.0	cfs	Pond Crest EL	1970.0	feet	ES Max Discharge	33	cfs
Precipitation	5.26	inches	Initial WS EL	1962.0	feet	ES Depth of Flow	0.45	feet
Drainage Area	16.0	acres	Max Stage EL	1968.7	feet	ES Max Velocity	3.70	fps
Min Sett Eff		percent	Max Storage	2.2	acre-feet			
Ks =	6840		Max Stage	6.68	feet			
b =	1.38							

TIME	INFLOW	STORAGE	STAGE	OUTFLOW	CULVERT/ LOW LEVEL	RISER WEIR	RISER ORIFICE	BARREL ORIFICE	OVERFLOW WEIR	ES WEIR
(min)	(cfs)	(cf)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
0	0.0	0	0.00	0.0	0.0	0.0	0.0	9.5	0.0	0.0
1.0	0.2	0	0.00	0.0	0.0	0.0	0.0	9.5	0.0	0.0
2.0	0.8	12	0.01	0.0	0.0	0.0	0.0	9.5	0.0	0.0
3.0	1.7	58	0.03	0.0	0.0	0.0	0.0	9.6	0.0	0.0
4.0	3.0	161	0.07	0.0	0.0	0.0	0.0	9.7	0.0	0.0
5.0	4.7	344	0.12	0.0	0.0	0.0	0.0	9.9	0.0	0.0
6.0	6.7	627	0.18	0.0	0.0	0.0	0.0	10.2	0.0	0.0
7.0	9.1	1032	0.26	0.0	0.0	0.0	0.0	10.4	0.0	0.0
8.0	11.7	1576	0.35	0.0	0.0	0.0	0.0	10.7	0.0	0.0
9.0	14.6	2279	0.45	0.0	0.0	0.0	0.0	11.1	0.0	0.0
10.0	17.8	3157	0.57	0.0	0.0	0.0	0.0	11.5	0.0	0.0
11.0	21.1	4223	0.71	0.0	0.0	0.0	0.0	11.9	0.0	0.0
12.0	24.7	5492	0.85	0.0	0.0	0.0	0.0	12.3	0.0	0.0
13.0	28.4	6974	1.01	0.0	0.0	0.0	0.0	12.8	0.0	0.0
14.0	32.2	8677	1.19	0.0	0.0	0.0	0.0	13.3	0.0	0.0

TIME	INFLOW	STORAGE	STAGE	OUTFLOW	CULVERT/ LOW LEVEL	RISER WEIR	RISER ORIFICE	BARREL ORIFICE	OVERFLOW WEIR	ES WEIR
(min)	(cfs)	(cf)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
15.0	36.1	10609	1.37	0.0	0.0	0.0	0.0	13.8	0.0	0.0
16.0	40.0	12773	1.57	0.0	0.0	0.0	0.0	14.3	0.0	0.0
17.0	43.9	15173	1.78	0.0	0.0	0.0	0.0	14.8	0.0	0.0
18.0	47.8	17809	2.00	0.0	0.0	0.0	0.0	15.3	0.0	0.0
19.0	51.6	20677	2.22	0.0	0.0	0.0	0.0	15.8	0.0	0.0
20.0	55.3	23774	2.46	0.0	0.0	0.0	0.0	16.4	0.0	0.0
21.0	58.9	27092	2.70	0.0	0.0	0.0	0.0	16.9	0.0	0.0
22.0	62.2	30623	2.95	0.0	0.0	0.0	0.0	17.4	0.0	0.0
23.0	65.4	34357	3.21	0.0	0.0	0.0	0.0	17.9	0.0	0.0
24.0	68.3	38279	3.47	0.0	0.0	0.0	0.0	18.5	0.0	0.0
25.0	70.9	42376	3.73	3.2	0.0	3.2	16.4	19.0	0.0	0.0
26.0	73.3	46441	3.99	9.6	0.0	9.6	23.8	19.4	0.0	0.0
27.0	75.3	50258	4.22	17.4	0.0	17.4	28.9	19.9	0.0	0.0
28.0	77.0	53733	4.43	20.2	0.0	25.4	32.8	20.2	0.0	0.0
29.0	78.3	57135	4.63	20.6	0.0	34.1	36.2	20.6	0.0	0.0
30.0	79.2	60596	4.83	21.0	0.0	43.5	39.3	21.0	0.0	0.0
31.0	79.8	64093	5.03	21.3	0.0	53.7	42.1	21.3	0.0	0.0
32.0	80.0	67603	5.23	21.6	0.0	64.4	44.8	21.6	0.0	0.0
33.0	79.8	71106	5.42	21.9	0.0	75.5	47.2	21.9	0.0	0.0
34.0	79.2	74577	5.61	22.3	0.0	87.0	49.5	22.3	0.0	0.0
35.0	78.3	77996	5.80	22.6	0.0	98.6	51.6	22.6	0.0	0.0
36.0	77.0	81339	5.98	22.8	0.0	110.3	53.6	22.8	0.0	0.0
37.0	75.3	84586	6.15	26.6	0.0	121.9	55.4	23.1	0.0	3.5
38.0	73.3	87508	6.30	33.3	0.0	132.6	57.0	23.3	0.0	10.0
39.0	70.9	89904	6.43	40.2	0.0	141.5	58.2	23.5	0.0	16.7
40.0	68.3	91745	6.52	46.3	0.0	148.5	59.2	23.7	0.0	22.6
41.0	65.6	93066	6.59	50.9	0.0	153.5	59.8	23.8	0.0	27.1
42.0	63.0	93951	6.63	54.1	0.0	156.9	60.3	23.9	0.0	30.3
43.0	60.5	94484	6.66	56.2	0.0	158.9	60.5	23.9	0.0	32.3
44.0	58.1	94746	6.67	57.2	0.0	159.9	60.6	23.9	0.0	33.2
45.0	55.8	94803	6.68	57.4	0.0	160.1	60.7	23.9	0.0	33.5
46.0	53.6	94708	6.67	57.0	0.0	159.8	60.6	23.9	0.0	33.1
47.0	51.4	94502	6.66	56.2	0.0	159.0	60.5	23.9	0.0	32.3
48.0	49.4	94215	6.65	55.1	0.0	157.9	60.4	23.9	0.0	31.3
49.0	47.4	93871	6.63	53.9	0.0	156.6	60.2	23.8	0.0	30.0
50.0	45.5	93486	6.61	52.4	0.0	155.1	60.0	23.8	0.0	28.6
51.0	43.7	93073	6.59	50.9	0.0	153.5	59.8	23.8	0.0	27.1
52.0	42.0	92641	6.57	49.4	0.0	151.9	59.6	23.8	0.0	25.6
53.0	40.3	92197	6.54	47.8	0.0	150.2	59.4	23.7	0.0	24.1
54.0	38.7	91747	6.52	46.3	0.0	148.5	59.2	23.7	0.0	22.6
55.0	37.2	91294	6.50	44.7	0.0	146.8	58.9	23.6	0.0	21.1
56.0	35.7	90840	6.47	43.2	0.0	145.1	58.7	23.6	0.0	19.6
57.0	34.3	90387	6.45	41.8	0.0	143.4	58.5	23.6	0.0	18.2
58.0	32.9	89937	6.43	40.3	0.0	141.7	58.2	23.5	0.0	16.8
59.0	31.6	89491	6.41	39.0	0.0	140.0	58.0	23.5	0.0	15.5
60.0	30.3	89048	6.38	37.6	0.0	138.3	57.8	23.5	0.0	14.2
61.0	29.1	88609	6.36	36.4	0.0	136.7	57.6	23.4	0.0	12.9
62.0	28.0	88175	6.34	35.1	0.0	135.1	57.3	23.4	0.0	11.7
63.0	26.9	87745	6.31	34.0	0.0	133.5	57.1	23.4	0.0	10.6
64.0	25.8	87320	6.29	32.8	0.0	131.9	56.9	23.3	0.0	9.5
65.0	24.8	86898	6.27	31.7	0.0	130.4	56.6	23.3	0.0	8.4
66.0	23.8	86479	6.25	30.7	0.0	128.8	56.4	23.3	0.0	7.4
67.0	22.8	86063	6.23	29.7	0.0	127.3	56.2	23.2	0.0	6.5
68.0	21.9	85650	6.21	28.8	0.0	125.8	56.0	23.2	0.0	5.6
69.0	21.0	85238	6.18	27.9	0.0	124.3	55.8	23.2	0.0	4.7
70.0	20.2	84828	6.16	27.1	0.0	122.8	55.5	23.1	0.0	3.9
71.0	19.4	84417	6.14	26.3	0.0	121.3	55.3	23.1	0.0	3.2
72.0	18.6	84006	6.12	25.5	0.0	119.8	55.1	23.1	0.0	2.5
73.0	17.9	83592	6.10	24.8	0.0	118.3	54.8	23.0	0.0	1.8
74.0	17.2	83175	6.08	24.2	0.0	116.8	54.6	23.0	0.0	1.2
75.0	16.5	82751	6.05	23.7	0.0	115.3	54.4	23.0	0.0	0.7
76.0	15.8	82320	6.03	23.2	0.0	113.8	54.1	22.9	0.0	0.3
77.0	15.2	81876	6.01	22.9	0.0	112.2	53.9	22.9	0.0	0.0
78.0	14.6	81413	5.98	22.8	0.0	110.6	53.6	22.8	0.0	0.0
79.0	14.0	80919	5.96	22.8	0.0	108.8	53.3	22.8	0.0	0.0

TIME	INFLOW	STORAGE	STAGE	OUTFLOW	CULVERT/ LOW LEVEL	RISER WEIR	RISER ORIFICE	BARREL ORIFICE	OVERFLOW WEIR	ES WEIR
(min)	(cfs)	(cf)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
80.0	13.5	80392	5.93	22.8	0.0	107.0	53.0	22.8	0.0	0.0
81.0	12.9	79834	5.90	22.7	0.0	105.0	52.7	22.7	0.0	0.0
82.0	12.4	79247	5.87	22.7	0.0	102.9	52.4	22.7	0.0	0.0
83.0	11.9	78632	5.83	22.6	0.0	100.8	52.0	22.6	0.0	0.0
84.0	11.4	77990	5.80	22.6	0.0	98.6	51.6	22.6	0.0	0.0
85.0	11.0	77323	5.76	22.5	0.0	96.3	51.2	22.5	0.0	0.0
86.0	10.6	76633	5.73	22.4	0.0	93.9	50.8	22.4	0.0	0.0
87.0	10.1	75919	5.69	22.4	0.0	91.5	50.3	22.4	0.0	0.0
88.0	9.7	75185	5.65	22.3	0.0	89.0	49.9	22.3	0.0	0.0
89.0	9.3	74430	5.61	22.2	0.0	86.5	49.4	22.2	0.0	0.0
90.0	9.0	73655	5.56	22.2	0.0	83.9	48.9	22.2	0.0	0.0
91.0	8.6	72863	5.52	22.1	0.0	81.3	48.4	22.1	0.0	0.0
92.0	8.3	72053	5.48	22.0	0.0	78.6	47.9	22.0	0.0	0.0
93.0	7.9	71227	5.43	22.0	0.0	75.9	47.3	22.0	0.0	0.0
94.0	7.6	70386	5.39	21.9	0.0	73.2	46.7	21.9	0.0	0.0
95.0	7.3	69530	5.34	21.8	0.0	70.4	46.1	21.8	0.0	0.0
96.0	7.0	68661	5.29	21.7	0.0	67.7	45.5	21.7	0.0	0.0
97.0	6.7	67779	5.24	21.6	0.0	64.9	44.9	21.6	0.0	0.0
98.0	6.5	66886	5.19	21.6	0.0	62.1	44.2	21.6	0.0	0.0
99.0	6.2	65981	5.14	21.5	0.0	59.4	43.6	21.5	0.0	0.0
100.0	6.0	65066	5.09	21.4	0.0	56.6	42.9	21.4	0.0	0.0
101.0	5.7	64141	5.04	21.3	0.0	53.8	42.2	21.3	0.0	0.0
102.0	5.5	63207	4.98	21.2	0.0	51.0	41.4	21.2	0.0	0.0
103.0	5.3	62265	4.93	21.1	0.0	48.3	40.7	21.1	0.0	0.0
104.0	5.1	61315	4.87	21.0	0.0	45.6	39.9	21.0	0.0	0.0
105.0	4.9	60359	4.82	20.9	0.0	42.8	39.1	20.9	0.0	0.0
106.0	4.7	59395	4.76	20.8	0.0	40.2	38.3	20.8	0.0	0.0
107.0	4.5	58426	4.71	20.7	0.0	37.5	37.4	20.7	0.0	0.0
108.0	4.3	57452	4.65	20.6	0.0	34.9	36.5	20.6	0.0	0.0
109.0	4.1	56473	4.59	20.5	0.0	32.3	35.6	20.5	0.0	0.0
110.0	4.0	55489	4.54	20.4	0.0	29.8	34.6	20.4	0.0	0.0
111.0	3.8	54502	4.48	20.3	0.0	27.3	33.6	20.3	0.0	0.0
112.0	3.7	53511	4.42	20.2	0.0	24.9	32.6	20.2	0.0	0.0
113.0	3.5	52518	4.36	20.1	0.0	22.5	31.5	20.1	0.0	0.0
114.0	3.4	51522	4.30	20.0	0.0	20.2	30.4	20.0	0.0	0.0
115.0	3.2	50525	4.24	17.9	0.0	17.9	29.2	19.9	0.0	0.0
116.0	3.1	49643	4.18	16.0	0.0	16.0	28.2	19.8	0.0	0.0
117.0	3.0	48868	4.14	14.4	0.0	14.4	27.2	19.7	0.0	0.0
118.0	2.9	48184	4.10	13.0	0.0	13.0	26.3	19.6	0.0	0.0
119.0	2.8	47577	4.06	11.8	0.0	11.8	25.4	19.6	0.0	0.0
120.0	2.7	47034	4.02	10.8	0.0	10.8	24.7	19.5	0.0	0.0
121.0	2.5	46548	3.99	9.8	0.0	9.8	23.9	19.5	0.0	0.0
122.0	2.4	46111	3.97	9.0	0.0	9.0	23.3	19.4	0.0	0.0
123.0	2.3	45715	3.94	8.3	0.0	8.3	22.7	19.4	0.0	0.0
124.0	2.3	45355	3.92	7.7	0.0	7.7	22.1	19.3	0.0	0.0
125.0	2.2	45028	3.90	7.2	0.0	7.2	21.5	19.3	0.0	0.0
126.0	2.1	44728	3.88	6.7	0.0	6.7	21.0	19.2	0.0	0.0
127.0	2.0	44453	3.86	6.2	0.0	6.2	20.5	19.2	0.0	0.0
128.0	1.9	44200	3.85	5.8	0.0	5.8	20.1	19.2	0.0	0.0
129.0	1.8	43966	3.83	5.4	0.0	5.4	19.7	19.2	0.0	0.0
130.0	1.8	43750	3.82	5.1	0.0	5.1	19.2	19.1	0.0	0.0
131.0	1.7	43549	3.81	4.8	0.0	4.8	18.9	19.1	0.0	0.0
132.0	1.6	43362	3.80	4.5	0.0	4.5	18.5	19.1	0.0	0.0
133.0	1.6	43187	3.78	4.3	0.0	4.3	18.1	19.1	0.0	0.0
134.0	1.5	43024	3.77	4.1	0.0	4.1	17.8	19.0	0.0	0.0
135.0	1.4	42870	3.76	3.8	0.0	3.8	17.5	19.0	0.0	0.0
136.0	1.4	42726	3.76	3.6	0.0	3.6	17.2	19.0	0.0	0.0
137.0	1.3	42591	3.75	3.5	0.0	3.5	16.9	19.0	0.0	0.0
138.0	1.3	42463	3.74	3.3	0.0	3.3	16.6	19.0	0.0	0.0
139.0	1.2	42342	3.73	3.1	0.0	3.1	16.3	19.0	0.0	0.0
140.0	1.2	42228	3.72	3.0	0.0	3.0	16.1	18.9	0.0	0.0
141.0	1.1	42119	3.72	2.8	0.0	2.8	15.8	18.9	0.0	0.0
142.0	1.1	42016	3.71	2.7	0.0	2.7	15.6	18.9	0.0	0.0
143.0	1.0	41918	3.70	2.6	0.0	2.6	15.4	18.9	0.0	0.0
144.0	1.0	41824	3.70	2.5	0.0	2.5	15.1	18.9	0.0	0.0

TIME	INFLOW	STORAGE	STAGE	OUTFLOW	CULVERT/ LOW LEVEL	RISER WEIR	RISER ORIFICE	BARREL ORIFICE	OVERFLOW WEIR	ES WEIR
(min)	(cfs)	(cf)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
145.0	1.0	41735	3.69	2.4	0.0	2.4	14.9	18.9	0.0	0.0
146.0	0.9	41650	3.69	2.3	0.0	2.3	14.7	18.9	0.0	0.0
147.0	0.9	41569	3.68	2.2	0.0	2.2	14.5	18.9	0.0	0.0
148.0	0.8	41491	3.68	2.1	0.0	2.1	14.3	18.9	0.0	0.0
149.0	0.8	41416	3.67	2.0	0.0	2.0	14.1	18.8	0.0	0.0
150.0	0.8	41344	3.67	1.9	0.0	1.9	13.9	18.8	0.0	0.0
151.0	0.8	41276	3.66	1.9	0.0	1.9	13.7	18.8	0.0	0.0
152.0	0.7	41210	3.66	1.8	0.0	1.8	13.5	18.8	0.0	0.0
153.0	0.7	41146	3.65	1.7	0.0	1.7	13.4	18.8	0.0	0.0
154.0	0.7	41085	3.65	1.6	0.0	1.6	13.2	18.8	0.0	0.0
155.0	0.6	41026	3.65	1.6	0.0	1.6	13.0	18.8	0.0	0.0
156.0	0.6	40969	3.64	1.5	0.0	1.5	12.9	18.8	0.0	0.0
157.0	0.6	40914	3.64	1.5	0.0	1.5	12.7	18.8	0.0	0.0
158.0	0.6	40861	3.64	1.4	0.0	1.4	12.6	18.8	0.0	0.0
159.0	0.5	40810	3.63	1.4	0.0	1.4	12.4	18.8	0.0	0.0
160.0	0.5	40761	3.63	1.3	0.0	1.3	12.2	18.8	0.0	0.0
161.0	0.5	40713	3.63	1.3	0.0	1.3	12.1	18.8	0.0	0.0
162.0	0.5	40667	3.62	1.2	0.0	1.2	12.0	18.8	0.0	0.0
163.0	0.5	40622	3.62	1.2	0.0	1.2	11.8	18.7	0.0	0.0
164.0	0.4	40579	3.62	1.1	0.0	1.1	11.7	18.7	0.0	0.0
165.0	0.4	40537	3.62	1.1	0.0	1.1	11.5	18.7	0.0	0.0
166.0	0.4	40496	3.61	1.1	0.0	1.1	11.4	18.7	0.0	0.0
167.0	0.4	40456	3.61	1.0	0.0	1.0	11.3	18.7	0.0	0.0
168.0	0.4	40418	3.61	1.0	0.0	1.0	11.2	18.7	0.0	0.0
169.0	0.4	40381	3.61	1.0	0.0	1.0	11.0	18.7	0.0	0.0
170.0	0.3	40345	3.60	0.9	0.0	0.9	10.9	18.7	0.0	0.0
171.0	0.3	40310	3.60	0.9	0.0	0.9	10.8	18.7	0.0	0.0
172.0	0.3	40276	3.60	0.9	0.0	0.9	10.7	18.7	0.0	0.0
173.0	0.3	40243	3.60	0.8	0.0	0.8	10.6	18.7	0.0	0.0
174.0	0.3	40211	3.59	0.8	0.0	0.8	10.4	18.7	0.0	0.0
175.0	0.3	40179	3.59	0.8	0.0	0.8	10.3	18.7	0.0	0.0
176.0	0.3	40149	3.59	0.8	0.0	0.8	10.2	18.7	0.0	0.0
177.0	0.3	40119	3.59	0.7	0.0	0.7	10.1	18.7	0.0	0.0
178.0	0.3	40091	3.59	0.7	0.0	0.7	10.0	18.7	0.0	0.0
179.0	0.2	40063	3.58	0.7	0.0	0.7	9.9	18.7	0.0	0.0
180.0	0.2	40035	3.58	0.7	0.0	0.7	9.8	18.7	0.0	0.0
181.0	0.2	40009	3.58	0.7	0.0	0.7	9.7	18.7	0.0	0.0
182.0	0.2	39983	3.58	0.6	0.0	0.6	9.6	18.7	0.0	0.0
183.0	0.2	39958	3.58	0.6	0.0	0.6	9.5	18.7	0.0	0.0
184.0	0.2	39933	3.58	0.6	0.0	0.6	9.4	18.7	0.0	0.0
185.0	0.2	39910	3.57	0.6	0.0	0.6	9.3	18.7	0.0	0.0
186.0	0.2	39886	3.57	0.6	0.0	0.6	9.2	18.7	0.0	0.0
187.0	0.2	39864	3.57	0.5	0.0	0.5	9.1	18.7	0.0	0.0
188.0	0.2	39842	3.57	0.5	0.0	0.5	9.0	18.7	0.0	0.0
189.0	0.2	39820	3.57	0.5	0.0	0.5	8.9	18.6	0.0	0.0
190.0	0.2	39799	3.57	0.5	0.0	0.5	8.8	18.6	0.0	0.0
191.0	0.1	39779	3.57	0.5	0.0	0.5	8.8	18.6	0.0	0.0
192.0	0.1	39759	3.56	0.5	0.0	0.5	8.7	18.6	0.0	0.0
193.0	0.1	39739	3.56	0.5	0.0	0.5	8.6	18.6	0.0	0.0
194.0	0.1	39720	3.56	0.4	0.0	0.4	8.5	18.6	0.0	0.0
195.0	0.1	39701	3.56	0.4	0.0	0.4	8.4	18.6	0.0	0.0
196.0	0.1	39683	3.56	0.4	0.0	0.4	8.3	18.6	0.0	0.0
197.0	0.1	39666	3.56	0.4	0.0	0.4	8.3	18.6	0.0	0.0
198.0	0.1	39648	3.56	0.4	0.0	0.4	8.2	18.6	0.0	0.0
199.0	0.1	39632	3.56	0.4	0.0	0.4	8.1	18.6	0.0	0.0
200.0	0.1	39615	3.56	0.4	0.0	0.4	8.0	18.6	0.0	0.0

Engineering Plan

Appendix A – Calculations

A-9d Skimmer Device

CDM Smith

TASK: DESIGN THE SKIMMER DEVICE FOR SEDIMENT POND #2, IN ACCORDANCE W/ NCDENR PRACTICE.

APPROACH: - DETERMINE THE DESIRED DEWATERING TIME

t_d = 3 DAYS (RECOMMENDED PER NCDENR STANDARDS)

- DETERMINE FLOW RATE FOR DEWATERING

$Q_d = \forall / t_d$ (CF/DAY)

WHERE $\forall$ = POND VOLUME

$\forall$ = 102,720 CF (APPROXIMATE VOLUME OF BASIN BELOW RISER OUTLET - SEE BASIN SIZING CALCULATION - VOLUME @ EL. 1966)

$Q = \forall / t_d = 102{,}720 / 3 = 34{,}240$ CF/DAY

- SELECT SKIMMER SIZE:

START W/ 8" SKIMMER

- CALCULATE THE ORIFICE DIAMETER USING THE FOLLOWING EQUATION

$$D = \sqrt{Q_d / (2310 \cdot \sqrt{H})}$$

WHERE D = ORIFICE DIAMETER

H = HEAD ON ORIFICE = 0.5 (REFERENCE TABLE 6.64a)

- D = 4.5" FOR t_d = 3.1 DAYS

Client:	Buncombe County	**Rev. No.**		**Calc By:**	Mike Brinchek
Project:	Cell 7 Design	**Rev. Date**		**Date:**	2/28/2013
Job No.	6447-97693	**Rev. No.**		**Chk'd By:**	KJY 4/22/14
Detail:	Sediment Skimmer	**Rev. Date**		**Date:**	

Task: Design the sediment skimmer device for Sediment Pond No. 2 in accordance with NCDENR guidelines.

Sediment Basin Volume @ Primary Spillway Discharge 102,720 cf

Orifice sizing

Skimmer Size	8	inches
Head on Skimmer	0.5	feet
Orifice Size (1/4 inch increments)	4.5	inches
Dewatering Time (~3 days)	3.11	days

Table 6.64a Head on orifice of various skimmer sizes

Skimmer Size (in.)	Head on Orifice (ft.)
1.5	0.125
2	0.167
2.5	0.208
3	0.25
4	0.333
5	0.333
6	0.417
8	0.5

Engineering Plan

Appendix A – Calculations

A-9e Discharge Apron

CDM Smith

CDM Smith		Job #	6447-97693	Calc By:	RK
Client:	BUNCOMBE COUNTY	Checked By:	Mike Brinchek	Date:	11/13/13
Project:	Permit Amendment Application	Date:	2/28/13	Calc.No.	1/1
	Subtitle D Landfill - Phase IV (Cell7)	Reviewed By:		Revision#	
		Date:	___/___/___	Date:	___/___/___

RIPRAP OUTLET PROTECTION CALCULATIONS

1.0 Purpose/Objective

- Design the riprap apron outlet protection devices using the NCDENR Erosion and Sedimentation Control Manual. Design the riprap apron for each sediment basin/trap discharge pipe. The riprap apron should be designed to provide sufficent energy dissipation at each discharge location.

2.0 Procedure

- Determine the tailwater depth

- If the tailwater depth is less than half the outlet pipe diameter, it is classified minimum tailwater condition. If it is greater than half the pipe diameter, it is classified maximum condition.

- Based on the tailwater conditions determined in step 1, enter figure 8.06a or figure 8.06b and determine the d_{50} riprap size and minimum apron length (L_a).

- Determine apron width at the pipe outlet, the apron shape, and the apron width at the outlet end from figure 8.06a or 8.06b.

- Determine the maximum stone diameter (d_{max})
- Determine the apron thickness

- Fit the riprap apron to the site by making it level for the minimum length, La, from figure 8.06a or figure 8.06b. Extend the apron farther downstream and along the channel banks until stability is assured. Keep the apron as a straight as possible and align it with the flow of the receiving stream.

3.0 References/Data Sources

- NCDENR Erosion and Sedimentation and Control Manual.
- NCDOT Standard Specifications for Roads and Structures.
- Design curves are attached, Figure 8.06 (b)
- Pipe network outfall information for each calculation is attached as shown on plans.

4.0 Assumptions and Limitations

- Assume design curves cannot be extrapolated, and use minimum riprap class of NCDOT Class B.
- The final dimensions of the energy dissapators may be altered to fit the existing channel configuration

- The riprap apron length was assumed to be at least 20' or less if there was a structure interfering with the apron length. Otherwise the length is depictive of what is required based on the design charts.

5.0 Calculations

CDM Smith		Job #	6447-97693	Calc By:	RK
Client:	BUNCOMBE COUNTY	Checked By:	Mike Brinchek	Date:	11/13/13
Project:	Permit Amendment Application	Date:	2/28/13	Calc.No.	1/1
	Subtitle D Landfill - Phase IV (Cell7)	Reviewed By:		Revision#	
		Date:	___/___/___	Date:	___/___/___

RIPRAP OUTLET PROTECTION CALCULATIONS

- See attached calculation

6.0 Conclusions/Results

- Dimensions for each energy dissipator are attached and each dissipator is designed based upon the assumptions and limitations listed above. Each dissipator should be constructed based upon the practice standards and specifications listed in the NCDENR Erosion Sedimentation Control Planning and Design Manual.

CDM Smith		Job # 6447-97693	Calc By: RK
Client:	BUNCOMBE COUNTY	Checked By: Mike Brinchek	Date: 11/13/13
Project:	Permit Amendment Application	Date: 2/28/13	Calc.No. 1/1
	Subtitle D Landfill - Phase IV (Cell7)	Reviewed By:	Revision#
		Date: ___/___/___	Date: ___/___/___

RIPRAP OUTLET PROTECTION CALCULATIONS

Calculations:

Riprap Aprons

Task:

Calulate the size of riprap and dimensions of the riprap apron for Sedimentation Pond 2 pipe discharge on sheet EP-2

Approach:
- Use the NCDENR erosion and sedimentation control manual practice 6.41 to design the apron
- Use the NCDOT standard specifications for roads and structures to determine the appropriate riprap size

Indicates input by user.

Design Parameters:

- Design Storm =	25	year	
- Discharge =	24	cfs	(see pond calculations)
- Number of pipes =	1		
- Discharge per pipe =	24.00	cfs	
- Discharge pipe dia D_o =	18	in	
- Tailwater Depth Elev. =	1	Feet	
- Tailwater Condition =	Max	(Min use figure 8.06a; Max use figure 8.06b)	

Calculation

Using figure 8.06a or 8.06b determine the d_{50} stone size.

d50 Riprap size (ft): d_{50} = 0.7 ft (Use a min NCDOT class I riprap)

Using figure 8.06a or 8.06b determine the apron length (La)

Riprap Apron Length: La = 18 ft

Using figure 8.06a or 8.06b determine the apron width at the pipe outlet.

Apron Upstream width (pipe outlet):	=	3 x D_o	=	4.5	ft
Apron Downstream width:	=	$D_o + L_a$	=	19.5	ft

Calculate the thickness of riprap.

d_{max} = 1.5 X d_{50}
Thickness of riprap = 1.5 X d_{max}

Class B riprap d_{50}	=	8.4	inches	Reference: NCDOT Standard Specifications for Roads and Structures
d_{max} = 1.5 X 6 in	=	12.6	inches	
Thickness of riprap = 1.5 X d_{max}	=	18.9	inches	

Apron Final Dimension .

Apron Upstream width (pipe outlet):	4.5	ft
Apron Downstream width:	19.5	ft
Apron length:	18	ft
Apron thickness:	18.9	in

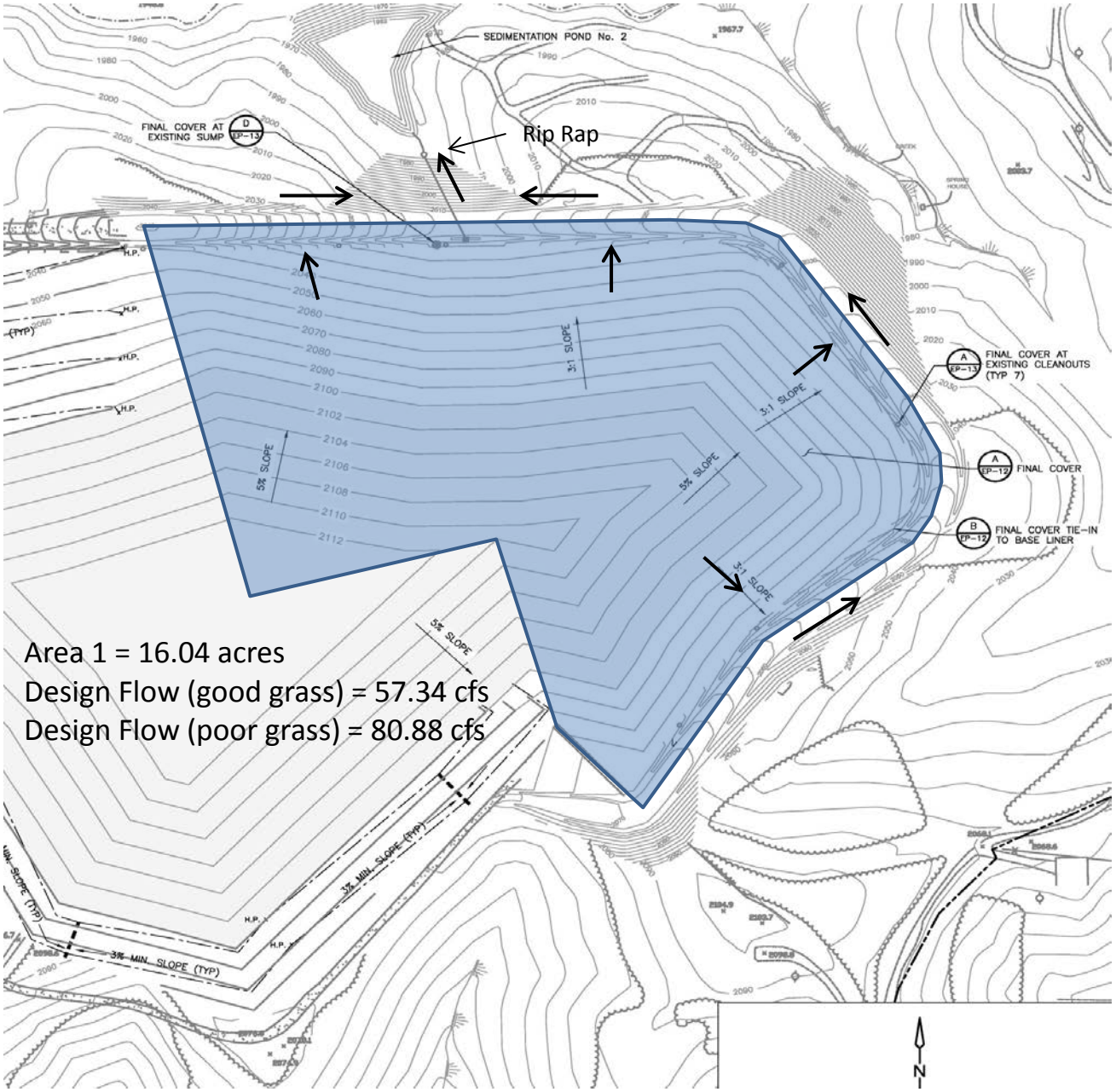
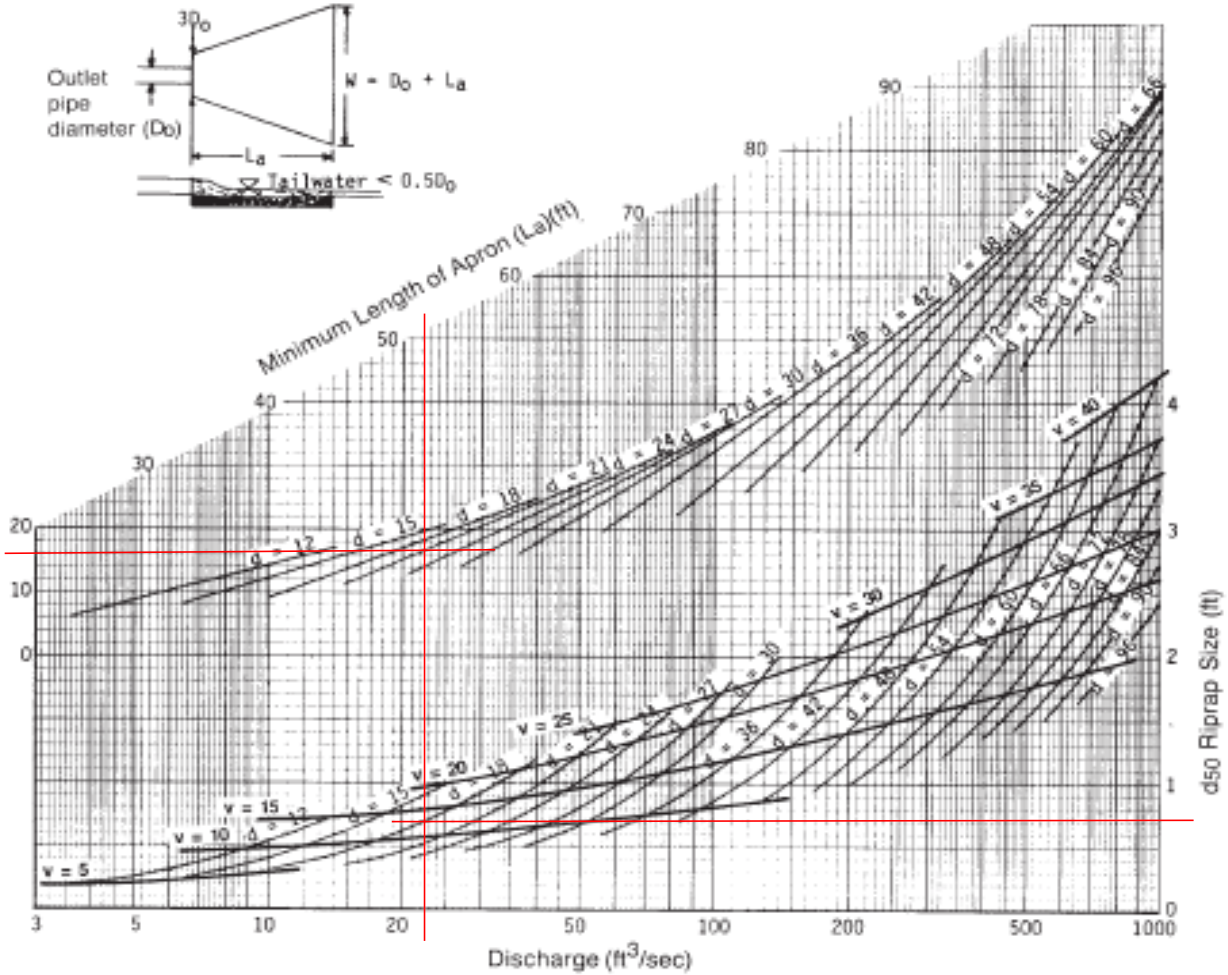

SEDIMENTATION POND No. 2
Rip Rap
FINAL COVER AT EXISTING SUMP
FINAL COVER AT EXISTING CLEANOUTS (TYP 7)
FINAL COVER
FINAL COVER TIE-IN TO BASE LINER
3:1 SLOPE
5% SLOPE
3% MIN. SLOPE (TYP)
Area 1 = 16.04 acres
Design Flow (good grass) = 57.34 cfs
Design Flow (poor grass) = 80.88 cfs
N

Table used to populate detail for Riprap Apron Detail D on sheet EP-9

Outlet Structure	Plan Sheet	Flow in (cfs)	Pipe Dia (in)	Length (ft)	Riprap Thickness (ft)	Upstream Width (ft)	Downstream Width (ft)	NCDOT Riprap Class
Riprap	EP-2	24.00	18	18	1.58	4.5	19.5	1

Notes:
Length of riprap apron (La) from Chart 8.06b
Riprap thickness from Chart 8.06b
Upstream width = 3 x Do (discharge pipe diameter)
Downstream width = Do + La (riprap apron length)



Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter).

WinTR-55 Current Data Description

--- Identification Data ---

User: Ravi
Project:
SubTitle:
State: North Carolina
County: Buncombe Hillside NOAA
Filename: C:\Users\kadambalar\Documents\Chris Gabel\Cell 7\Calculations\Stormwater Calculations\TR-55 Good

Date: 11/11/2013
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
C-7 Area 1		Outlet	16.04	74	.165
C-7 Area 2		Outlet	10.47	74	.144
C-7 Area 3		Outlet	5.68	74	.144

Total area: 32.19 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.04	3.81	4.42	5.26	5.93	6.62	2.52

Storm Data Source: Buncombe Hillside NOAA County, NC (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Ravi

Buncombe Hillside NOAA County, North Carolina

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.04	3.81	4.42	5.26	5.93	6.62	2.52

Storm Data Source: Buncombe Hillside NOAA County, NC (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Ravi

Buncombe Hillside NOAA County, North Carolina

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 10-Yr (cfs)	25-Yr (cfs)
SUBAREAS		
C-7 Area 1	42.46	57.34
C-7 Area 2	28.46	38.51
C-7 Area 3	15.45	20.91
REACHES		
OUTLET	86.09	116.45

Ravi

Buncombe Hillside NOAA County, North Carolina

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs)	(hr)	25-Yr (cfs)	(hr)
SUBAREAS				
C-7 Area 1	42.46	12.00	57.34	11.99
C-7 Area 2	28.46	11.98	38.51	11.97
C-7 Area 3	15.45	11.98	20.91	11.97
REACHES				
OUTLET	86.09		116.45	

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
C-7 Area 1	16.04	0.165	74	Outlet	
C-7 Area 2	10.47	0.144	74	Outlet	
C-7 Area 3	5.68	0.144	74	Outlet	

Total Area: 32.19 (ac)

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
C-7 Area 1							
SHEET	90	0.0500	0.150				0.107
SHALLOW	630	0.0500	0.050				0.049
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.165
C-7 Area 2							
SHEET	90	0.0500	0.150				0.107
SHALLOW	360	0.0500	0.050				0.028
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.144
C-7 Area 3							
SHEET	90	0.0500	0.150				0.107
SHALLOW	360	0.0500	0.050				0.028
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.144

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
C-7 Area 1	Open space; grass cover > 75%	(good)	C	16.04	74
	Total Area / Weighted Curve Number			16.04	74
				=====	==
C-7 Area 2	Open space; grass cover > 75%	(good)	C	10.47	74
	Total Area / Weighted Curve Number			10.47	74
				=====	==
C-7 Area 3	Open space; grass cover > 75%	(good)	C	5.68	74
	Total Area / Weighted Curve Number			5.68	74
				====	==

WinTR-55 Current Data Description

--- Identification Data ---

User: Ravi
Project:
SubTitle:
State: North Carolina
County: Buncombe Hillside NOAA
Filename: C:\Users\kadambalar\Documents\Chris Gabel\Cell 7\Calculations\Stormwater Calculations\TR-55 Poor

Date: 11/11/2013
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
C-7 Area 1		Outlet	16.04	86	.165
C-7 Area 2		Outlet	10.47	86	.144
C-7 Area 3		Outlet	5.68	86	.144

Total area: 32.19 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.04	3.81	4.42	5.26	5.93	6.62	2.52

Storm Data Source: Buncombe Hillside NOAA County, NC (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Ravi

Buncombe Hillside NOAA County, North Carolina

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.04	3.81	4.42	5.26	5.93	6.62	2.52

Storm Data Source: Buncombe Hillside NOAA County, NC (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Ravi

Buncombe Hillside NOAA County, North Carolina

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 10-Yr (cfs)	25-Yr (cfs)
SUBAREAS		
C-7 Area 1	64.43	80.88
C-7 Area 2	43.38	54.46
C-7 Area 3	23.54	29.56
REACHES		
OUTLET	130.95	164.37

Ravi

Buncombe Hillside NOAA County, North Carolina

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs)	(hr)	25-Yr (cfs)	(hr)
SUBAREAS				
C-7 Area 1	64.43	11.98	80.88	11.98
C-7 Area 2	43.38	11.96	54.46	11.96
C-7 Area 3	23.54	11.96	29.56	11.96
REACHES				
OUTLET	130.95		164.37	

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
C-7 Area 1	16.04	0.165	86	Outlet	
C-7 Area 2	10.47	0.144	86	Outlet	
C-7 Area 3	5.68	0.144	86	Outlet	

Total Area: 32.19 (ac)

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
C-7 Area 1							
SHEET	90	0.0500	0.150				0.107
SHALLOW	630	0.0500	0.050				0.049
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.165
C-7 Area 2							
SHEET	90	0.0500	0.150				0.107
SHALLOW	360	0.0500	0.050				0.028
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.144
C-7 Area 3							
SHEET	90	0.0500	0.150				0.107
SHALLOW	360	0.0500	0.050				0.028
SHALLOW	295	0.3333	0.050				0.009
					Time of Concentration		.144

Ravi

Buncombe Hillside NOAA County, North Carolina

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
C-7 Area 1	Open space; grass cover < 50%	(poor)	C	16.04	86
	Total Area / Weighted Curve Number			16.04	86
				=====	==
C-7 Area 2	Open space; grass cover < 50%	(poor)	C	10.47	86
	Total Area / Weighted Curve Number			10.47	86
				=====	==
C-7 Area 3	Open space; grass cover < 50%	(poor)	C	5.68	86
	Total Area / Weighted Curve Number			5.68	86
				====	==

Engineering Plan

Appendix A – Calculations

A-9f Angled Pipe Connection to Dual Drop Inlet Box

CDM Smith

Memorandum

To: *Files*

From: *Ravi Kadambala*

Date: *February 2014*

Subject: *Buncombe County*
Cell 7 – Angle between the concrete reinforced pipe and the drop inlet

The purpose of this memorandum is to make sure that the width of the drop inlet pipe is enough to accommodate the 24 inch concrete reinforced pipe at an angle. The inside width of the drop inlet is 36 inches. The outside diameter of a 24 inch concrete reinforced pipe is 30 inches. **Figure 1** shows that the angle between the pipe and the drop inlet is 25°.

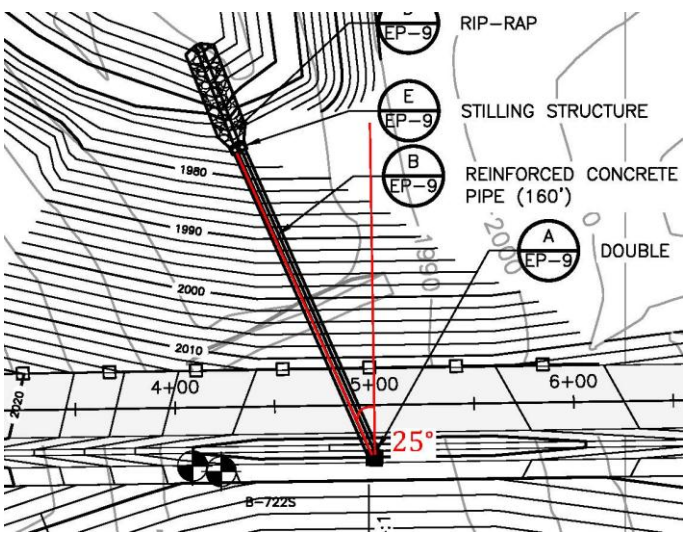


Figure 1 Angle between the concrete reinforced pipe and the drop inlet

So the outside diameter of the pipe will be larger at the point where the pipe attaches the drop inlet at an angle. This outside diameter of the pipe is calculated as follows.

$$\cos \emptyset = \frac{OD\ of\ the\ pipe}{OD\ of\ the\ pipe\ at\ an\ angle}$$

$$\cos 25° = \frac{30}{OD\ of\ the\ pipe\ at\ an\ angle}$$

$$OD\ of\ the\ pipe\ at\ an\ angle = \frac{30}{\cos 25°}$$

$$OD\ of\ the\ pipe\ at\ an\ angle = 33.1"$$

So, the outside diameter of the pipe is 33.10 inches at the point where the pipe attaches the drop inlet at 25° angle. Even though the inside width of the outlet structure is 36 inches, the minimum leeway on either sides of the pipe needs to be 6 inches. So the required width of the drop inlet is 33.10 + 12 = 45.1 inches. So the inside width of the drop inlet needs to be 48 inches, and the total width of the drop inlet needs to be 60 inches to accommodate the 24" concrete reinforced pipe at 25° angle.

Engineering Plan

Appendix A – Calculations

A-9g Stormwater Segregation System

CDM Smith

CDM Smith	**Client:**	Buncombe County	**Calc By:**	Ravi Kadambala	**Chk'd By:**	CJG
	Project:	Cell 7 Design	**Date:**	11/20/2013	**Date:**	4/17/2014
	Job No.	6447-97693	**Rev. No.**			
	Detail:	Stormwater segregation system	**Rev. Date**			

1.0 Purpose / Objective

The purpose of the stormwater segregation system is to divert clean stormwater collected from the south end of cell 7 to the perimeter channel.

2.0 Data

The table below shows the amount of rainfall for various storm events based on intensity duration frequency curves [1].

Storm Event	Rainfall	Rainfall	Area of the Cell Covered with Tarp (6 acres)	Volume	Volume
	inches	ft	ft^2	ft^3	gallons
1 year 24 hr	3.5	0.29	261,360	76,230	570,240
2 year 24 hr	4	0.33	261,360	87,120	651,703
5 year 24 hr	5	0.42	261,360	109,771	821,146
10 year 24 hr	6	0.50	261,360	130,680	977,554
25 year 24 hr	7	0.58	261,360	151,589	1,133,963
50 year 24 hr	8	0.67	261,360	175,111	1,309,923

3.0 Assumptions

It would approximately take 2 years for the waste to get filled on the north side of Cell 7 before moving disposal operations south. So, a 2 year 24 hour storm event was selected to design the stormwater segregation system capable of handling a 4 inches of rain.

3.0 Design

A stormwater segregation berm, tarp, and slope-riser pump has been designed to divert clean stormwater collected from the south end of the cell and pumped to the perimeter channel as shown in Sheet EP-4A. The stormwater tarp will cover 6 acres in the south end of the cell. The maximum height of the berm is approximately 10 feet at the lowest point of the cell along the berm. This stormwater segregation system will be removed once the County is close to moving disposal operations south.

The berm has been designed to contain approximately 400,000 gallons of stormwater with a one foot of free board.

The slope riser pump EPG 30-3 has been selected and can pump 180 gpm of storm water at 60ft of head. In 24 hours, this pump can divert approximately 259,200 gallons of stormwater to the perimeter channel.

Conclusion:

Overall the stormwater segregation system in Cell 7 can handle a 2 year 24 hours storm event or 4 inches of rain.

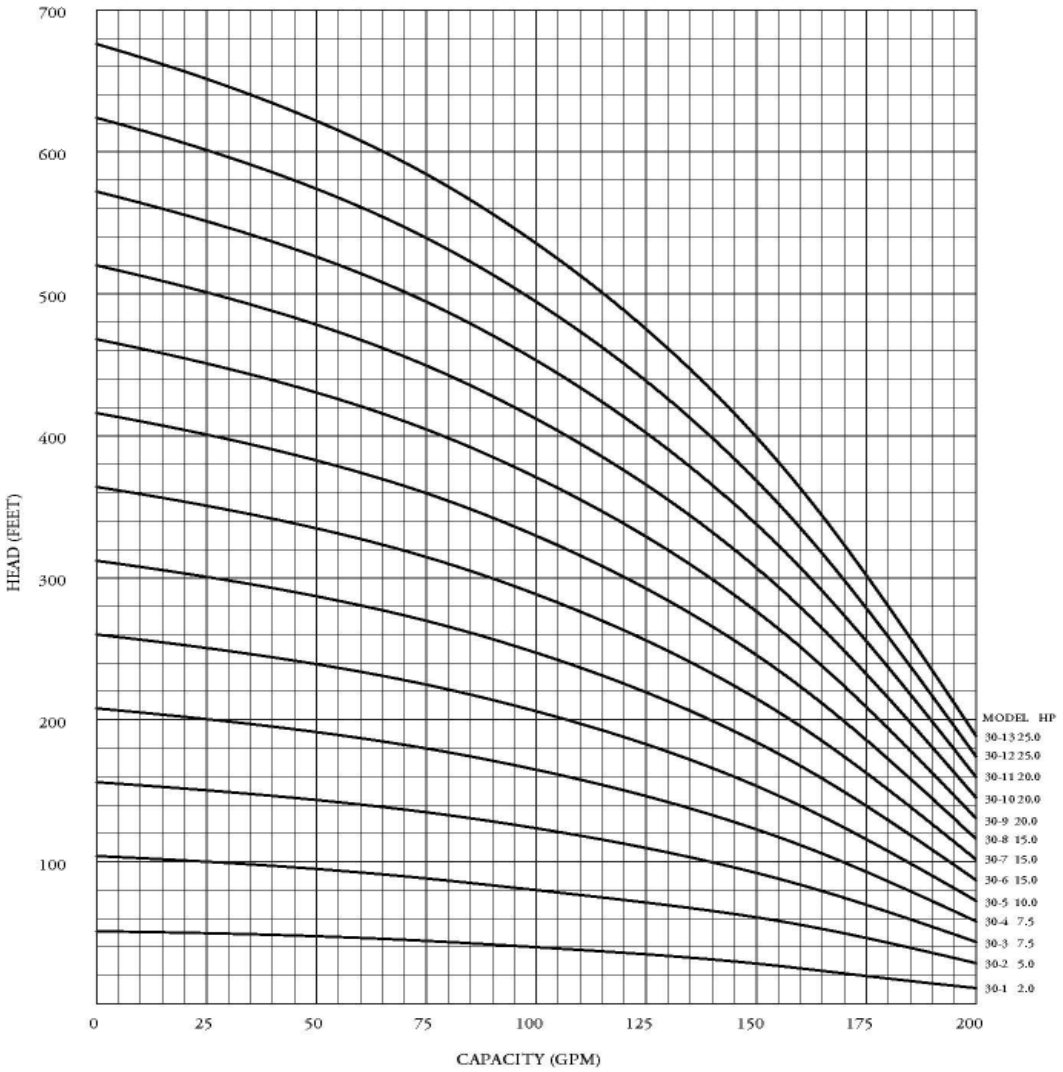
Reference:

1. David M Hershfield, "Rainfall Frequency Atlas for the United States", Technical paper no. 40, U.S. Department of Commerce, Washington D.C. 1963

SERIES 30 SurePump™

Flow Range 50-200 GPM

60 Hz



DATA SUBJECT TO CHANGE WITHOUT NOTICE

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Client:	Buncombe County	**Calc By:**	Ravi Kadambala
Project:	Cell 7 Design	**Date:**	11/20/2013
Job No.	6447-97693	**Checked:**	CJG
Detail:	Stormwater Pump Hydraulic Analysis	**Date:**	4/17/2014

1.0 Purpose / Objective

The purpose of this calculation is to determine the maximum flowrate at which stormwater can be conveyed from cell 7 to the adjacent perimeter channel using EPG pump, 30-3 and 3 inch HDPE pipe.

2.0 Data

The pump curve of the EPG pump, 30-3 is attached in Attachment 1.
The 3 inch HDPE pipe conveys stormwater from elevation 2014 ft to the top of the berm at elevation 2024 ft and then to the adjacent perimeter channel.
The length of the pipe is ~430ft
There are two 45° bends in the 3 inch HDPE pipe.
There are two 90° bends in the 3 inch HDPE pipe.

3.0 Assumptions

The 3 inch HDPE pipe is assumed to have a Darcy's friction factor of = 0.04

4.0 Calculation

The total dynamic head is calculated by adding total static loss, frictional losses and minor losses.

Step 1 - Static Losses

Pumps	Suction level (ft)	Discharge level (ft)	Static Head (ft)
EPG	2014	2024	10.0

Step 2 - Minor Losses and Friction Losses

Minor Losses (k)

	QTY	
Entrance		0.5
90° Bend	2	0.6
45° Bend	2	0.4
	Σk =	**2.5**

Leachate Line

Length	430	ft
Diameter	0.25	ft
Area	0.05	ft^2

The friction losses is calculated by using the following equation

$$h_f = f_D \frac{L}{D}\frac{V^2}{2g}$$

The minor losses is calculated by using the following equation

$$h_m = K_L \frac{V^2}{2g}$$

Where

h_f Friction Loss, ft
h_m Minor Loss, ft
f_d Friction factor
L Length of the pipe, ft
D Diamter of the pipe, ft
V Velocity of the leachate, ft/s
g Acceleration due to gravity, ft2/s
K_L Loss Coefficient

Client:	Buncombe County	**Calc By:**	Ravi Kadambala
Project:	Cell 7 Design	**Date:**	11/20/2013
Job No.	6447-97693	**Checked:**	CJG
Detail:	Stormwater Pump Hydraulic Analysis	**Date:**	4/17/2014

5.0 Result

Step 4 Total Dynamic head

Q, gpm	Velocity, ft/s	$Vel^2 / 2g$	Friction Loss, ft	Minor Losses, ft	Static Loss,ft	TDH, ft	EPG Pump Curve, ft
50	2.27	0.0800	5.50	0.20	10.0	15.7	142
75	3.40	0.1800	12.38	0.45	10.0	22.8	135
100	4.54	0.3199	22.01	0.80	10.0	32.8	125
125	5.67	0.4999	34.39	1.25	10.0	45.6	110
150	6.81	0.7199	49.53	1.80	10.0	61.3	90
175	7.94	0.9798	67.41	2.45	10.0	79.9	70
200	9.08	1.2798	88.05	3.20	10.0	101.2	45

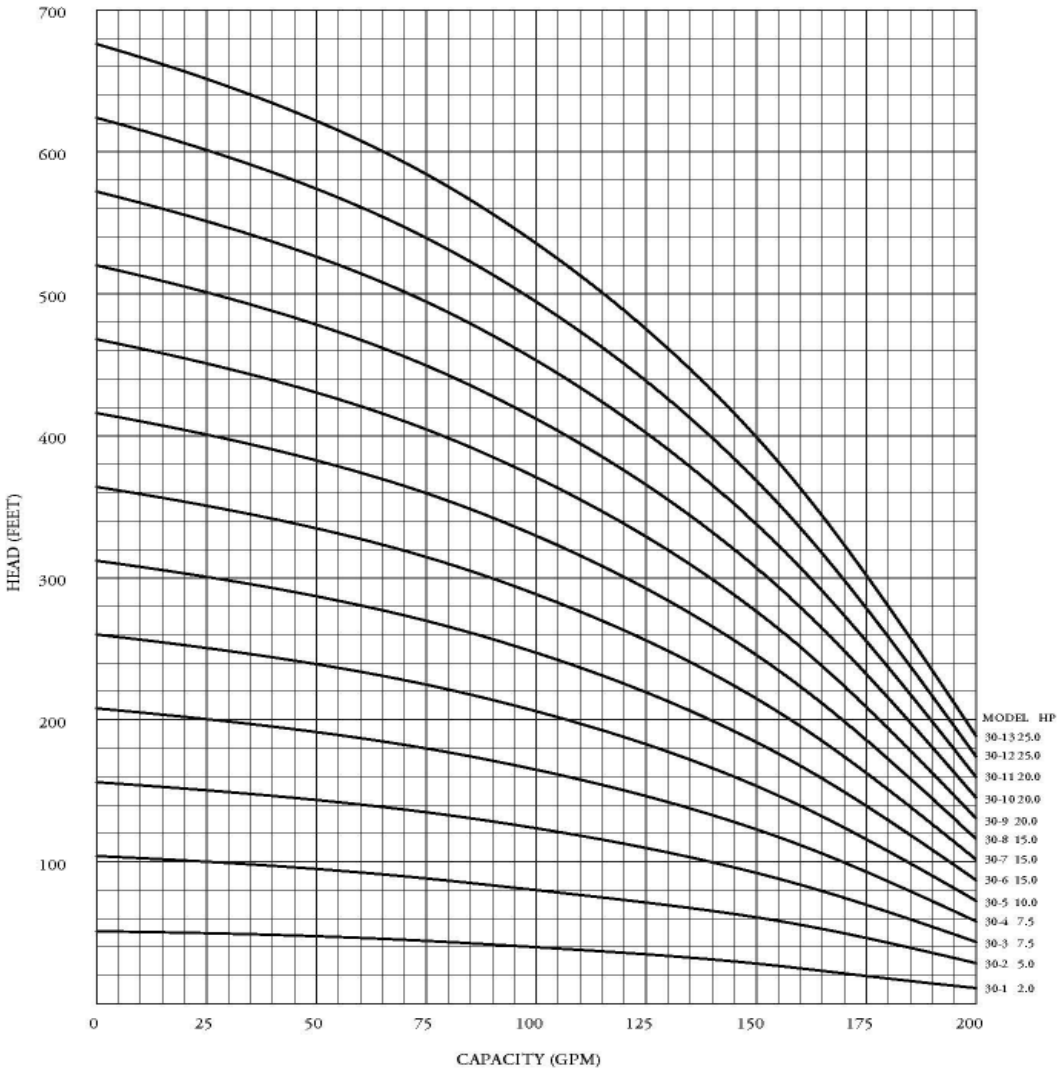
Conclusion:

The maximum flowrate at which stormwater can be conveyed from cell 7 to the adjacent perimeter channel using EPG pump, 30-3 and 3 inch HDPE pipe is between 150-175 gpm.

SERIES 30 SurePump™

Flow Range 50-200 GPM

60 Hz



DATA SUBJECT TO CHANGE WITHOUT NOTICE

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Engineering Plan

Appendix A – Calculations

A-10 Cell 6 Diversion Berms

CDM Smith

CDM Smith

CALCULATION COVER SHEET

Project Title	Permit Amendment Application, Subtitle D Landfill - Cell 7	
Client	Buncombe County	
Project Number	6447-97693	
Calculation Title	Cell 6 Sideslope Diversion Berm Calculation	
Calculated By - Date	Ravi Kadambala	1/12/2014
Reviewed By - Date	W. Michael Brinchek, P.E.	1/15/2014
Purpose of the Calculation	Design the Cell 6 sideslope diversion berms and downcomer that will be used to convey stormwater runoff for the 10-year, 24-hour design storm event for erosion and sediment control purposes.	
Results	See Table 1 on Page 2 for a summary of the recommended berm dimensions and erosion protection	

CLIENT	Buncombe County	COMPUTED BY / DATE	RK 01/12/14
PROJECT	Permit Amendment Application, Subtitle D Landfill - Cell 7	CHECKED BY / DATE	MB 01/15/14
DETAIL	Cell 6 Sideslope Diversion Berm Calculation	REVISION NO. / DATE	- -
PROJECT NO.	6447-97693	REVIEWED BY / DATE	- -

Calculation Brief Title: Cell 6 Sideslope Diversion Berm Calculations

1.0 Objective

The purpose of this spreadsheet is to summarize the recommended diversion characteristics and erosion control lining requirements.

2.0 Procedure

Summarize the recommended diversion berms dimensions and temporary/permanent erosion protection liners based on the spreadsheet models developed for each diversion berm.

3.0 References / Data Sources

1. See **Sheet LO-1** for the locations and associated information for the proposed diversion berms.
2. See attached channel design calculation spreadsheets for each respective channel design.

4.0 Assumptions / Limitations

1. Diversion berm locations are approximate.
2. Assume a minmum 6-inch freeboard

5.0 Calculations

5.1 Recommended Diversion Berm Dimension and Erosion Control Liners

Table 1: Recommended Diversion Berm Design

Diversion Berm ID	Bottom Width (ft)	Channel Depth (ft)	Side Slopes		Channel Lining	
			M_1	M_2	Temporary	Permanent
1	0	2.0	2	3	Curlex I	Grass
2	0	2.0	2	3	Curlex I	Grass
3	0	2.0	2	3	Curlex I	Grass

6.0 Conclusions

Table 1 above summarizes the recommended channel dimenions and erosion control linings.

CLIENT	Buncombe County	COMPUTED BY / DATE	RK 01/12/14
PROJECT	Permit Amendment Application, Subtitle D Landfill - Ce	CHECKED BY / DATE	MB 01/15/14
DETAIL	Cell 6 Sideslope Diversion Berm Calculation	REVISION NO. / DATE	- -
PROJECT NO.	6447-97693	REVIEWED BY / DATE	- -

Task:
Determine the flow rate for diversion berm design using TR-55

Inputs:

10-yr event, 24 hr (in/hr) = 4.42

Berm	Drainage Area		Elevation		Length (ft)	Slope
	ID	(ac)	High	Low		
1	1	2.8	2105	2100	651	0.01
2	2	1.7	2100	2075	890	0.03
3	3	1.6	2060	2040	662	0.03

Conclusion:
See Attachment 1: TR-55 output file

Berm	Peak Flow (cfs)
1	8
2	5
3	5

Berm 3:
From elevation 2060' to perimeter channel 2040'
Length = 662'

DA3 = 1.6 acres

DA2 = 1.7 acres

DA1 = 2.8 acres

Berm 2:
From elevation 2100' to downcomer 2075'
Length = 890'

Berm 1:
From elevation 2105' to downcomer 2100'
Length = 651'

PHASE IV
(CELL 7)

PHASE III
(CELL 6)

DENSE FOLIAGE

N

1" = 100'

50 0 100

LEGEND

- PROPOSED CONTOUR
- EXISTING INDEX CONTOUR
- PROPERTY LINE
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE

NOTES:

1. BASE GRADES AS SHOWN ARE PREPARED SUBGRADE PRIOR TO PLACEMENT OF COMPACTED CLAY SOIL LINER.
2. CLOSURE GRADES AS SHOWN ARE INTERMEDIATE COVER GRADES AND DO NOT INCLUDE 2 FEET OF FINAL COVER.
3. PHASE III (CELL 6) VOLUME = 2,434,000 CU.YDS.

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REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: J. WISEMAN
APPROVED BY: J. WISEMAN
DATE: DECEMBER 2013

CDM Smith
Camp Dresser McKee & Smith
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Raleigh, NC 27612 | Tel: (919) 787-5620
NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
FACILITY PLAN DRAWINGS

LANDFILL OPERATION TRANSITION CONTOURS
SUBTITLE D LANDFILL - PHASE III CLOSURE GRADES
PHASE IV BASE GRADES

PROJECT NO. 6447-97693
FILE NAME: LO-1.DWG
SHEET NO.
LO-1

90% PERMIT DRAWINGS - NOT FOR CONSTRUCTION

CLIENT	Buncombe County	COMPUTED BY / DATE	RK	01/12/14
PROJECT	Permit Amendment Application, Subtitle D Landfill - Cell 7	CHECKED BY / DATE	MB	01/15/14
DETAIL	Ph I Sideslope Diversion - DB1	REVISION NO. / DATE	-	-
PROJECT NO.	6447-97693	REVIEWED BY / DATE	-	-

Calculation Brief Title: Diversion Berm Sizing and Lining Calculation - Diversion Berm 1

1.0 Objective

Determine the appropriate channel dimensions and temporary/permanent erosion control protection for Diversion Berm 1.

2.0 Procedure

1. Identify the desired berm characteristics including bottom width, side slopes, longitudinal slope, Manning's 'n', and required flow.
2. Calculate the normal depth and velocity for the pre- and post-vegetative conditions by adjusting the flow depth.
3. Calculate the shear stress.
4. Determine the need for pre- and post-vegetation erosion control measures.

3.0 References / Data Sources

1. Department of Environment and Natural Resources (NCDENR), June 1, 2006, Revised March 2009. Erosion and Sediment Control Planning and Design Manual.

4.0 Assumptions / Limitations

1. Assume unit weight of water is 62.4 lbs/ft^3.
2. Assume unit weight of concrete is 150 lbs/ft^3.

5.0 Calculations

5.1 Input Preliminary Berm Dimensions and Required Flow Capacity

- See **Sheet FP-2** for the location

Channel Characteristics

B =	0	M_1 =	2	$Q_{25\text{-}YR}$ =	8	Inputs
		M_2 =	3	s =	0.01	

B - Channel width (ft) M - Channel sideslope
Q - Design discharge (cfs) s - Channel longitudinal slope

5.2 Determine Permissible Velocity for Established Grass-Lined Channel

- Input the desired grass seed mix for slope and silt/sand

Tall fescue Desired Grass Lining

- Identify the permissible velocity (NCDENR, Table 8.05a)

4.5 feet/second

5.0 Calculations [continued]

5.3 Calculate Normal Depth and Check Channel Velocity for Established Grass-Lined Channel - Maintained

- Identify vegetation retardness classification for a well maintained condition (NCDENR, Table 8.05c)

D Vegetation Retardance Classification - Maintained Condition

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y - Depth of flow (ft) A - Channel area (sf) n - Manning's Coefficient
R - Hydraulic radius (ft) P - Wetted perimeter (ft)

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}	Velocity (ft/s)	VR
1.085	0.03	2.94	5.86	0.50	1.86	1.86	2.8	1.4
1.333	0.052	4.44	7.20	0.62	3.22	3.22	1.8	1.1
1.371	0.056	4.70	7.40	0.63	3.47	3.47	1.7	1.1
1.375	0.056	4.73	7.42	0.64	3.50	3.50	1.7	1.1

1.38 = Calculated normal depth (ft)
1.7 = Calculated velocity at normal depth (ft/s)

- Check that calculated velocity does not exceed permissible velocity

Actual		Permissible	
1.7	<	4.5	ok

5.4 Calculate Normal Depth and Check Channel Velocity for Established Grass-Lined Channel - Unmaintained

- Identify vegetation retardness classification for an unmaintained condition (NCDENR, Table 8.05c)

C Vegetation Retardance Classification - Unmaintained Condition

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}	Velocity (ft/s)	VR
1.407	0.06	4.95	7.60	0.65	3.72	3.72	1.6	1.1
1.568	0.080	6.15	8.46	0.73	4.96	4.97	1.3	1.0
1.598	0.084	6.38	8.63	0.74	5.22	5.22	1.3	0.9
1.606	0.085	6.45	8.67	0.74	5.29	5.29	1.3	0.9

1.61 = Calculated normal depth (ft)
1.3 = Calculated velocity at normal depth (ft/s)

- Check that calculated velocity does not exceed permissible velocity

Calculated		Permissible	
1.3	<	4.5	ok

5.0 Calculations [continued]

5.5 Calculate Normal Depth and Check Channel Velocity to Determine Need for Temporary Liner

- Input soil type

Graded, Silt to Cobbles (colloidal) Uprotected soils

- Identify the permissible velocity (NCDENR, Table 8.05d)

5.5 feet/second

- Identify the appropriate Manning's n coefficient (NCDENR, Table 8.05f)

0.02

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}
0.933	0.02	2.18	5.04	0.43	1.24	1.24

Velocity (ft/s)	V/R
3.7	8.6

- Check that calculated velocity does not exceed permissible velocity

Calculated		Permissible	
3.7	<	5.5	ok

- Even if a temporary liner may not be required, it is suggested to move to Step 5.6 to add a safety factor

5.6 Calculate Shear Stress to Determine Required Temporary Liner

- Input the desired temporary liner

Curlex I

- Identify the permissible shear stress (NCDENR, Table 8.05g)

1.75 pound per square foot (Manufacturers Specifications)

- Identify the appropriate Manning's n coefficient based on approximate flow depth (NCDENR, Table 8.05e)

0.035

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}
1.150	0.035	3.31	6.21	0.53	2.17	2.17

Velocity (ft/s)	V/R
2.4	4.6

- Calculate shear stress and compare to permissible shear stress for the desired temporary liner

Shear Stress T = yds T = shear stress in lb/sf; y = U.W. of H_2O (62.4 lb/cf); d = flow depth (ft); s = channel gradient

Calculated		Permissible	
0.6	<	1.75	ok

6.0 Recommendations and Conclusions

- Summarize calculations and recommended channel characteristics

1.6	= Maximum Flow Depth (Y, feet)
3.7	= Maximum Velocity (feet per second)
0.0	= Channel Bottom Width (B, feet)
2.0	= Channel Side Slope (M_1)
3.0	= Channel Side Slope (M_2)
2.0	= Recommended Channel Depth (feet)
Grass	= Recommended Permanent Channel Lining
Curlex I	= Recommended Temporary Channel Lining

Calculation Brief Title: Diversion Berm Sizing and Lining Calculation - Diversion Berm 2

1.0 Objective

Determine the appropriate channel dimensions and temporary/permanent erosion control protection for Diversion Berm 2.

2.0 Procedure

1. Identify the desired berm characteristics including bottom width, side slopes, longitudinal slope, Manning's 'n', and required flow.
2. Calculate the normal depth and velocity for the pre- and post-vegetative conditions by adjusting the flow depth.
3. Calculate the shear stress.
4. Determine the need for pre- and post-vegetation erosion control measures.

3.0 References / Data Sources

1. Department of Environment and Natural Resources (NCDENR), June 1, 2006, Revised March 2009. Erosion and Sediment Control Planning and Design Manual.

4.0 Assumptions / Limitations

1. Assume unit weight of water is 62.4 lbs/ft^3.
2. Assume unit weight of concrete is 150 lbs/ft^3.

5.0 Calculations

5.1 Input Preliminary Berm Dimensions and Required Flow Capacity

- See **Sheet FP-2** for the location

Channel Characteristics

B =	0	M_1 =	2	$Q_{25\text{-}YR}$ =	5
		M_2 =	3	s =	0.03

Inputs

B - Channel width (ft) M - Channel sideslope
Q - Design discharge (cfs) s - Channel longitudinal slope

5.2 Determine Permissible Velocity for Established Grass-Lined Channel

- Input the desired grass seed mix

Tall fescue Desired Grass Lining

- Identify the permissible velocity (NCDENR, Table 8.05a)

4.5 feet/second

5.0 Calculations [continued]

5.3 Calculate Normal Depth and Check Channel Velocity for Established Grass-Lined Channel - Maintained

- Identify vegetation retardness classification for a well maintained condition (NCDENR, Table 8.05c)

D Vegetation Retardance Classification - Maintained Condition

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y - Depth of flow (ft) A - Channel area (sf) n - Manning's Coefficient
R - Hydraulic radius (ft) P - Wetted perimeter (ft)

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}	Velocity (ft/s)	VR
0.705	0.03	1.24	3.81	0.33	0.59	0.59	3.9	1.3
0.875	0.053	1.91	4.72	0.41	1.05	1.05	2.6	1.0
0.900	0.058	2.03	4.86	0.42	1.13	1.13	2.4	1.0
0.902	0.058	2.03	4.87	0.42	1.14	1.14	2.4	1.0

0.90 = Calculated normal depth (ft)
2.4 = Calculated velocity at normal depth (ft/s)

- Check that calculated velocity does not exceed permissible velocity

Actual		Permissible	
2.4	<	4.5	ok

5.4 Calculate Normal Depth and Check Channel Velocity for Established Grass-Lined Channel - Unmaintained

- Identify vegetation retardness classification for an unmaintained condition (NCDENR, Table 8.05c)

C Vegetation Retardance Classification - Unmaintained Condition

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}	Velocity (ft/s)	VR
0.915	0.06	2.09	4.94	0.42	1.18	1.18	2.3	1.0
1.028	0.082	2.64	5.55	0.48	1.61	1.61	1.9	0.9
1.060	0.089	2.81	5.72	0.49	1.75	1.75	1.7	0.9
1.070	0.091	2.86	5.78	0.50	1.79	1.79	1.7	0.8

1.07 = Calculated normal depth (ft)
1.7 = Calculated velocity at normal depth (ft/s)

- Check that calculated velocity does not exceed permissible velocity

Calculated		Permissible	
1.7	<	4.5	ok

5.0 Calculations [continued]

5.5 Calculate Normal Depth and Check Channel Velocity to Determine Need for Temporary Liner

- Input soil type

Graded, Silt to Cobbles (colloidal) Uprotected soils

- Identify the permissible velocity (NCDENR, Table 8.05d)

5.5 feet/second

- Identify the appropriate Manning's n coefficient (NCDENR, Table 8.05f)

0.02

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}
0.605	0.02	0.92	3.27	0.28	0.39	0.39

Velocity (ft/s)	V/R
5.4	19.1

- Check that calculated velocity does not exceed permissible velocity

Calculated		Permissible	
5.4	<	5.5	ok

- Even if a temporary liner may not be required, it is suggested to move to Step 5.6 to add a safety factor

5.6 Calculate Shear Stress to Determine Required Temporary Liner

- Input the desired temporary liner

Curlex I

- Identify the permissible shear stress (NCDENR, Table 8.05g)

1.75 pound per square foot (Manufacturers Specifications)

- Identify the appropriate Manning's n coefficient based on approximate flow depth (NCDENR, Table 8.05e)

0.035

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}
0.746	0.035	1.39	4.03	0.35	0.69	0.69

Velocity (ft/s)	V/R
3.5	10.2

- Calculate shear stress and compare to permissible shear stress for the desired temporary liner

Shear Stress T = yds T = shear stress in lb/sf; y = U.W. of H_2O (62.4 lb/cf); d = flow depth (ft); s = channel gradient

Calculated		Permissible	
1.3	<	1.75	ok

6.0 Recommendations and Conclusions

- Summarize calculations and recommended channel characteristics

1.1	= Maximum Flow Depth (Y, feet)
5.4	= Maximum Velocity (feet per second)
0.0	= Channel Bottom Width (B, feet)
2.0	= Channel Side Slope (M_1)
3.0	= Channel Side Slope (M_2)
2.0	= Recommended Channel Depth (feet)
Grass	= Recommended Permanent Channel Lining
Curlex I	= Recommended Temporary Channel Lining

CLIENT	Buncombe County	COMPUTED BY / DATE	RK	01/12/14
PROJECT	Permit Amendment Application, Subtitle D Landfill - Cell 7	CHECKED BY / DATE	MB	01/15/14
DETAIL	Ph I Sideslope Diversion - DB3	REVISION NO. / DATE	-	-
PROJECT NO.	6447-97693	REVIEWED BY / DATE	-	-

Calculation Brief Title: Diversion Berm Sizing and Lining Calculation - Diversion Berm 3

1.0 Objective

Determine the appropriate channel dimensions and temporary/permanent erosion control protection for Diversion Berm 3.

2.0 Procedure

1. Identify the desired berm characteristics including bottom width, side slopes, longitudinal slope, Manning's 'n', and required flow.
2. Calculate the normal depth and velocity for the pre- and post-vegetative conditions by adjusting the flow depth.
3. Calculate the shear stress.
4. Determine the need for pre- and post-vegetation erosion control measures.

3.0 References / Data Sources

1. Department of Environment and Natural Resources (NCDENR), June 1, 2006, Revised March 2009. Erosion and Sediment Control Planning and Design Manual.

4.0 Assumptions / Limitations

1. Assume unit weight of water is 62.4 lbs/ft^3.
2. Assume unit weight of concrete is 150 lbs/ft^3.

5.0 Calculations

5.1 Input Preliminary Berm Dimensions and Required Flow Capacity

- See **Sheet FP-2** for the location

Channel Characteristics

B =	0	M_1 =	2	$Q_{25\text{-}YR}$ =	5	Inputs
		M_2 =	3	s =	0.03	

B - Channel width (ft) M - Channel sideslope
Q - Design discharge (cfs) s - Channel longitudinal slope

5.2 Determine Permissible Velocity for Established Grass-Lined Channel

- Input the desired grass seed mix

Tall fescue Desired Grass Lining

- Identify the permissible velocity (NCDENR, Table 8.05a)

4.5 feet/second

5.0 Calculations [continued]

5.3 Calculate Normal Depth and Check Channel Velocity for Established Grass-Lined Channel - Maintained

- Identify vegetation retardness classification for a well maintained condition (NCDENR, Table 8.05c)

D Vegetation Retardance Classification - Maintained Condition

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y - Depth of flow (ft) A - Channel area (sf) n - Manning's Coefficient
R - Hydraulic radius (ft) P - Wetted perimeter (ft)

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}	Velocity (ft/s)	VR
0.680	0.03	1.16	3.67	0.31	0.54	0.54	4.1	1.3
0.850	0.053	1.81	4.59	0.39	0.97	0.97	2.6	1.0
0.875	0.058	1.91	4.72	0.41	1.05	1.05	2.5	1.0
0.870	0.057	1.89	4.70	0.40	1.03	1.03	2.5	1.0

0.87 = Calculated normal depth (ft)
2.5 = Calculated velocity at normal depth (ft/s)

- Check that calculated velocity does not exceed permissible velocity

Actual		Permissible	
2.5	<	4.5	ok

5.4 Calculate Normal Depth and Check Channel Velocity for Established Grass-Lined Channel - Unmaintained

- Identify vegetation retardness classification for an unmaintained condition (NCDENR, Table 8.05c)

C Vegetation Retardance Classification - Unmaintained Condition

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}	Velocity (ft/s)	VR
0.886	0.06	1.96	4.78	0.41	1.09	1.08	2.4	1.0
1.000	0.083	2.50	5.40	0.46	1.50	1.50	1.9	0.9
1.033	0.090	2.67	5.58	0.48	1.63	1.63	1.8	0.8
1.042	0.092	2.71	5.63	0.48	1.67	1.67	1.7	0.8

1.04 = Calculated normal depth (ft)
1.7 = Calculated velocity at normal depth (ft/s)

- Check that calculated velocity does not exceed permissible velocity

Calculated		Permissible	
1.7	<	4.5	ok

5.0 Calculations [continued]

5.5 Calculate Normal Depth and Check Channel Velocity to Determine Need for Temporary Liner

- Input soil type

Graded, Silt to Cobbles (colloidal) Uprotected soils

- Identify the permissible velocity (NCDENR, Table 8.05d)

5.5 feet/second

- Identify the appropriate Manning's n coefficient (NCDENR, Table 8.05f)

0.02

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}
0.585	0.02	0.86	3.16	0.27	0.36	0.36

Velocity (ft/s)	V/R
5.5	20.3

- Check that calculated velocity does not exceed permissible velocity

Calculated		Permissible	
5.5	<	5.5	ok

- Even if a temporary liner may not be required, it is suggested to move to Step 5.6 to add a safety factor

5.6 Calculate Shear Stress to Determine Required Temporary Liner

- Input the desired temporary liner

Curlex I — curled wood excelsior, fibers

- Identify the permissible shear stress (NCDENR, Table 8.05g)

1.75 pound per square foot (Manufacturers Specifications)

- Identify the appropriate Manning's n coefficient based on approximate flow depth (NCDENR, Table 8.05e)

0.035

- Calculate the normal depth and velocity (adjust depth [Y] so that Z_{REQ} and Z_{AV} are equal).

Y	Manning's n	A	P	R	Z_{REQ}	Z_{AV}
0.726	0.035	1.32	3.92	0.34	0.64	0.64

Velocity (ft/s)	V/R
3.6	10.6

- Calculate shear stress and compare to permissible shear stress for the desired temporary liner

Shear Stress T = yds T = shear stress in lb/sf; y = U.W. of H_2O (62.4 lb/cf); d = flow depth (ft); s = channel gradient

Calculated		Permissible	
1.4	<	1.75	ok

6.0 Recommendations and Conclusions

- Summarize calculations and recommended channel characteristics

1.0	= Maximum Flow Depth (Y, feet)
5.5	= Maximum Velocity (feet per second)
0.0	= Channel Bottom Width (B, feet)
2.0	= Channel Side Slope (M_1)
3.0	= Channel Side Slope (M_2)
2.0	= Recommended Channel Depth (feet)
Grass	= Recommended Permanent Channel Lining
Curlex I	= Recommended Temporary Channel Lining

Engineering Plan

Appendix A – Calculations

A-11 Geomembrane Elongation Strain

CDM Smith

CLIENT	Buncombe County	JOB NO.	6447-97693	COMPUTED BY	Ravi Kadambala
PROJECT	Cell 7	DATE CHECKED	KJY	DATE	11/2/2013
DETAIL	GM Elongation	CHECKED BY	1/30/2014	PAGE NO.	1 of 3

Task:

Calculate the geomembrane liner strain due to differential settlement.

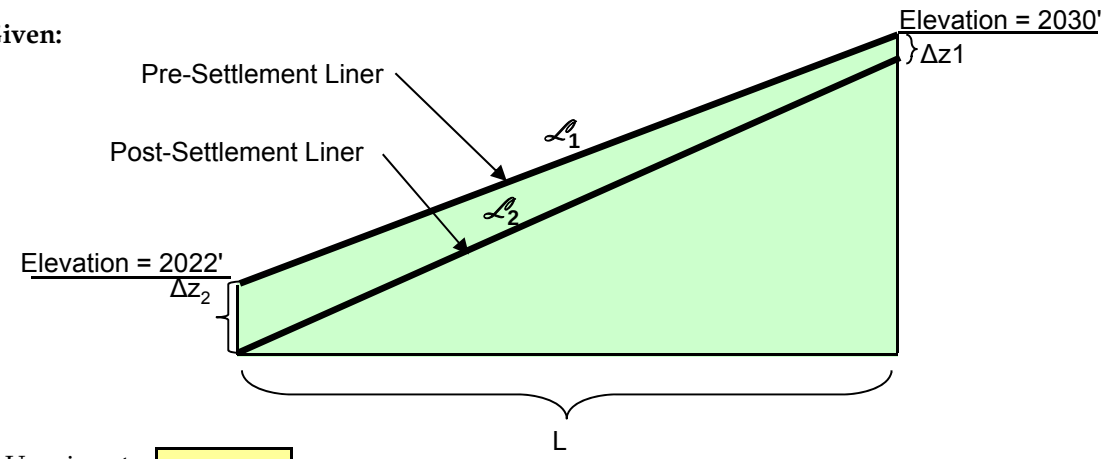
Assumptions:

1) The area between maximum and minimum settlement is flat with no undulations.

2) The elevation at minimum settlement was taken at the toe and not the pullout.

3) Liner elongation is greatest between points of maximum differiential settlement over the shortest linear distance where pre-settlement elevations are similar or where pre-settlement elevations are lower at the point of maximum settlement.

Given:



User input =

Pre-Settlement Elevation at Point 1:	2030	ft See attached Figure for reference
Pre-Settlement Elevation at Point 2:	2022	ft See attached Figure for reference
Minimum Settlement (Δz_1):	0	ft See attached Figure for reference
Maximum Settlement (Δz_2):	1.83	ft See attached Figure for reference
Shortest Length Between Max. and Min. Settlement (L):	155	ft See attached Figure for reference
Pre-Settlement Liner Length ($\mathscr{L}_1$):	155.21	ft
Post-Settlement Liner Length ($\mathscr{L}_2$):	155.31	ft
Geomembrane Liner Strain (ε):	0.10	ft
% Strain (Elongation):	0.07%	

Yield Elongation for 60 mil textured HDPE: 12% See attached table from GRI GM13

Conclusion: 0.07% <<12% therefore liner elongation is well within acceptable limits.

CLIENT	Buncombe County	JOB NO.	6447-97693	COMPUTED BY	Ravi Kadambala
PROJECT	Cell 7	DATE CHECKED	KJY	DATE	11/2/2013
DETAIL	GM Elongation	CHECKED BY	1/30/2014	PAGE NO.	2 of 3

Task:

Calculate the geomembrane liner strain due to differential settlement.

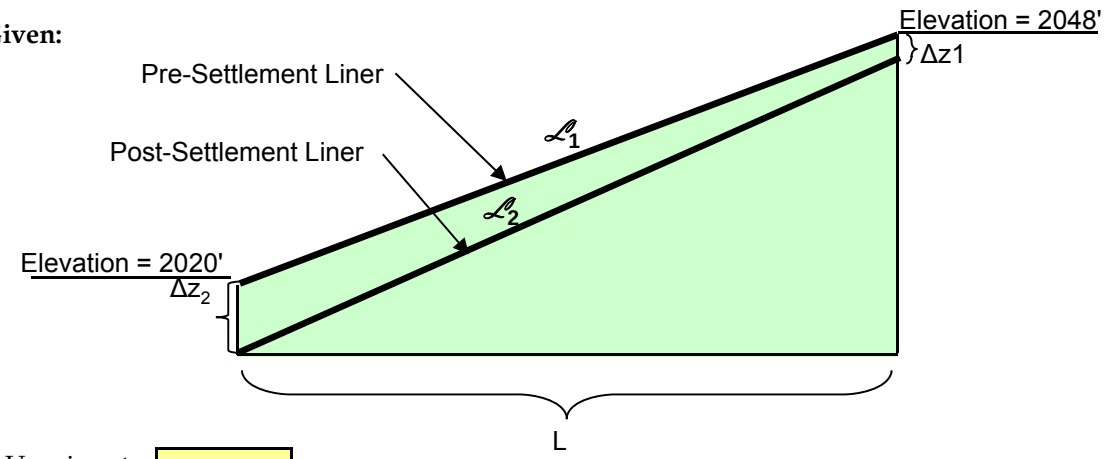
Assumptions:

1) The area between maximum and minimum settlement is flat with no undulations.

2) The elevation at minimum settlement was taken at the toe and not the pullout.

3) Liner elongation is greatest between points of maximum differiential settlement over the shortest linear distance where pre-settlement elevations are similar or where pre-settlement elevations are lower at the point of maximum settlement.

Given:



User input =

Pre-Settlement Elevation at Point 1:	2048	ft See attached Figure for reference
Pre-Settlement Elevation at Point 2:	2020	ft See attached Figure for reference
Minimum Settlement (Δz_1):	0.25	ft See attached Figure for reference
Maximum Settlement (Δz_2):	2.92	ft See attached Figure for reference
Shortest Length Between Max. and Min. Settlement (L):	246	ft See attached Figure for reference
Pre-Settlement Liner Length ($\mathscr{L}_1$):	247.59	ft
Post-Settlement Liner Length ($\mathscr{L}_2$):	247.90	ft
Geomembrane Liner Strain (ε):	0.31	ft
% Strain (Elongation):	0.13%	

Yield Elongation for 60 mil textured HDPE: 12% See attached table from GRI GM13

Conclusion: 0.13% <<12% therefore liner elongation is well within acceptable limits.

CLIENT	Buncombe County	JOB NO.	6447-97693	COMPUTED BY	Ravi Kadambala
PROJECT	Cell 7	DATE CHECKED	KJY	DATE	11/2/2013
DETAIL	GM Elongation	CHECKED BY	1/30/2014	PAGE NO.	3of 3

Task:

Calculate the geomembrane liner strain due to differential settlement.

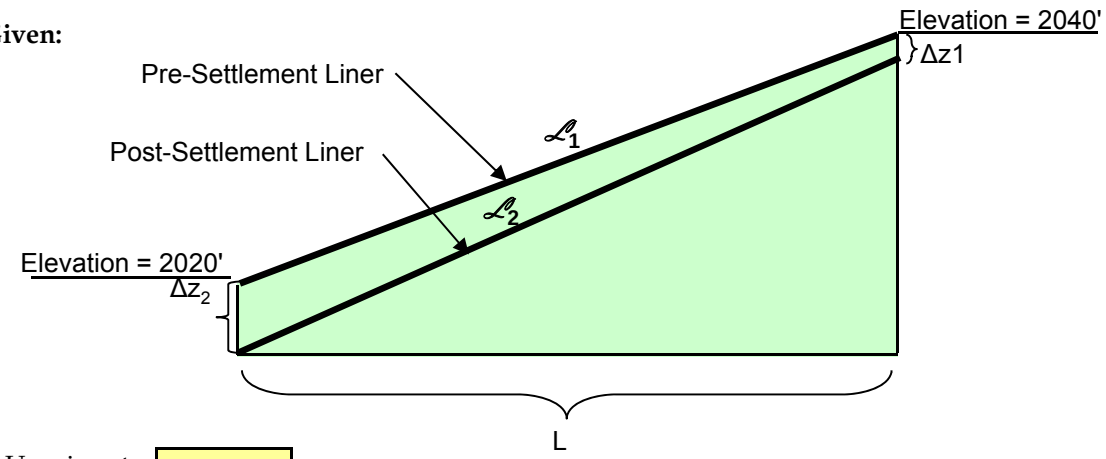
Assumptions:

1) The area between maximum and minimum settlement is flat with no undulations.

2) The elevation at minimum settlement was taken at the toe and not the pullout.

3) Liner elongation is greatest between points of maximum differiential settlement over the shortest linear distance where pre-settlement elevations are similar or where pre-settlement elevations are lower at the point of maximum settlement.

Given:



User input =

Pre-Settlement Elevation at Point 1:	2040	ft See attached Figure for reference
Pre-Settlement Elevation at Point 2:	2020	ft See attached Figure for reference
Minimum Settlement (Δz_1):	1	ft See attached Figure for reference
Maximum Settlement (Δz_2):	2.92	ft See attached Figure for reference
Shortest Length Between Max. and Min. Settlement (L):	189	ft See attached Figure for reference
Pre-Settlement Liner Length ($\mathscr{L}_1$):	190.06	ft
Post-Settlement Liner Length ($\mathscr{L}_2$):	190.27	ft
Geomembrane Liner Strain (ε):	0.21	ft
% Strain (Elongation):	0.11%	

Yield Elongation for 60 mil textured HDPE: 12% See attached table from GRI GM13

Conclusion: 0.11% <<12% therefore liner elongation is well within acceptable limits.

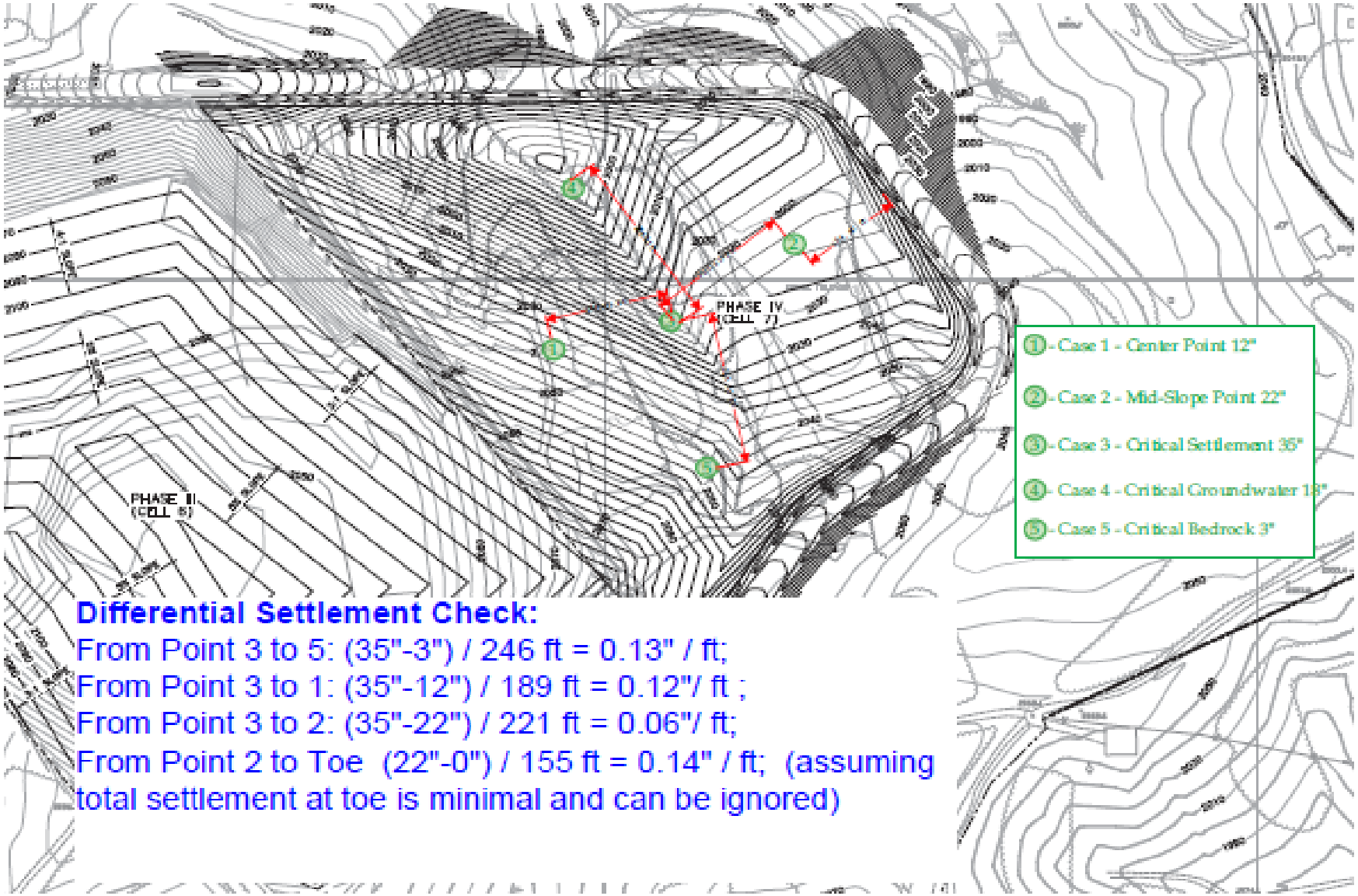
ENGLISH UNITS

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.

Source: GRI GM13



Differential Settlement Check:

From Point 3 to 5: (35"-3") / 246 ft = 0.13" / ft;

From Point 3 to 1: (35"-12") / 189 ft = 0.12"/ ft ;

From Point 3 to 2: (35"-22") / 221 ft = 0.06"/ ft;

From Point 2 to Toe (22"-0") / 155 ft = 0.14" / ft; (assuming total settlement at toe is minimal and can be ignored)

Engineering Plan

Appendix A – Calculations

A-12 Landfill Gas Condensate Volume and Hydraulic Analysis

CDM Smith

Client:	Buncombe County	**Calc By:**	RK
Project:	Cell 7 Design	**Date:**	12/27/2013
Job No.	6447-97693	**Rev. No.**	KJY
Detail:	Condensate Volume of Landfill Gas	**Rev. Date**	2/4/2014

OBJECTIVES:

Determine the LFG condensate volume expected to be generated.

GIVEN:

USER INPUTS

LFG flow rate (scfm) = 1500
(L/s) = 708
highest flow rate from KYPipe Model

System vacuum (in of H2O) = 40
(atm) = 0.10
(abs atm) = 0.90

ASSUMPTIONS:

Average gas temperature expected at the wellhead (F) = 90
(C) = 32
Average gas temperature expected in header piping system (F) = 70
(C) = 21
(K) = 294
Consider lowest winter temperature

- The partial pressure of condensate is saturation pressure at the wellhead or 100% humidity.-

- The condensate vapor content of LFG is similar to that of water vapor in air at the same temperature and pressure.

CALCULATIONS:

1. Determine the potential condensate.

WV = Water Vapor Concentration

Determined from the attached psychrometric chart

WV_{90} (grain/lb) = 210
(kg water/kg LFG) = 0.030

WV_{70} (grain/lb) = 110
(kg water/kg LFG) = 0.016

Potential condensate = WV_{90} - WV_{70}

(kg water/kg LFG) = 0.014

Client:	Buncombe County	**Calc By:**	RK
Project:	Cell 7 Design	**Date:**	12/27/2013
Job No.	6447-97693	**Rev. No.**	KJY
Detail:	Condensate Volume of Landfill Gas	**Rev. Date**	2/4/2014

2. Use ideal gas law to determine density of LFG

LFG density = P M / R_U T

P (atm) = abs pressure in header
M (kg/kg-mole) = molecular weight of LFG
= 0.5 (methane) + 0.5 (carbon dioxide) = (0.5 * 16) + (0.5 * 44)
(kg/kg-mole) = 30
R_U = universal gas constant
(L-atm/g-mole K) = 0.0821
T (K) = temperature

Density = [(0.9 atm) x (30 kg/kg-mole)] / [(0.0821 L-atm/g-mole K) x (294 K) x 1,000]

LFG density (kg/L) = 1.12E-03

3. Determine condensate generation rate

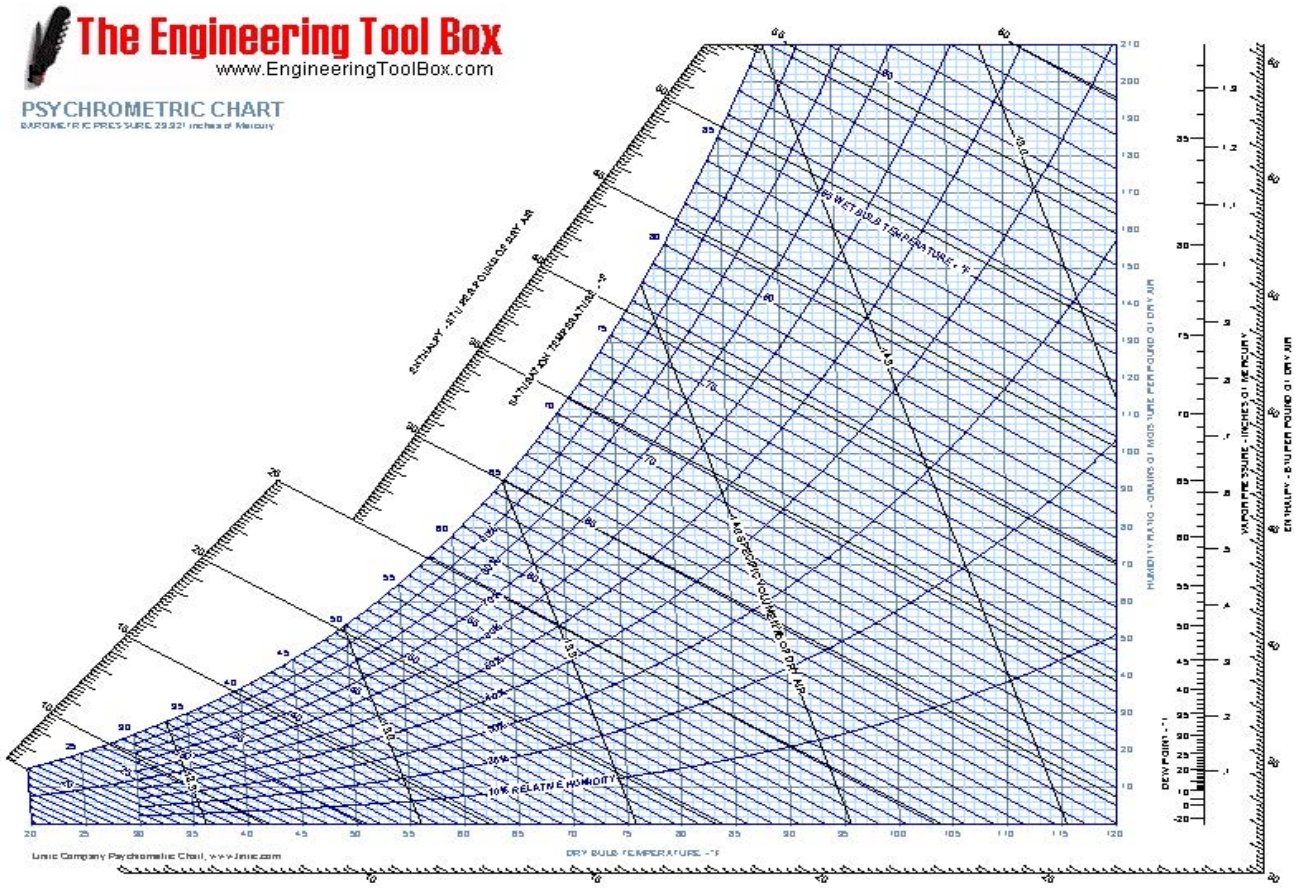
LFG flow rate * LFG density * potential condensate

(0.014 kg water/kg LFG) * (1.12x-3 kg/L) x (236 L/s) * (86,400 s/d) * (1 L/kg)

Condensate generation rate (L/day) = 982

(gpm) = 0.18

Client:	Buncombe County	**Calc By:**	RK
Project:	Cell 7 Design	**Date:**	12/27/2013
Job No.	6447-97693	**Rev. No.**	KJY
Detail:	Condensate Volume of Landfill Gas	**Rev. Date**	2/4/2014



Client:	Buncombe County	**Calc By:**	Ravi Kadambala
Project:	Cell 7 Design	**Date:**	12/27/2013
Job No.	6447-97693	Checked by: CJG / 04/14/14	
Detail:	Condensate Volume Hydraulic Analysis		

1.0 Purpose / Objective

The purpose of this calculation is to determine if the pump AP-4/BL can convey landfill gas condensate from condensate recovery system to Cell 7 riser.

2.0 Data

The condensate recovery system generates 260 gallons of condensate in a day. The flow rate is 0.18 gpm.
The performance curve of the pump AP-4/BL is in Attachment 1.
There is 3/4 inch HDPE pipe that is approximately 12 feet long attached to the condensate recovery system. This pipe is connected to the Cell 7 riser by a 50 ft long 1 inch HDPE pipe.
There are three 90° bends in the 3/4 inch HDPE pipe.
There is a ball valve in the 3/4 inch HDPE pipe.
There is a check valve in the 3/4 inch HDPE pipe.
There are three 90° bends in the 1 inch HDPE pipe.
The elevation from the condensate recovery system to the Cell 7 riser is 10 ft.

3.0 Assumptions

The 1 inch HDPE pipe is assumed to have a Darcy's friction factor of 0.023
The 3/4 inch HDPE pipe is assumed to have a Darcy's friction factor of 0.025

4.0 Calculation

The total dynamic head is calculated by adding total static loss, frictional losses and minor losses.

Step 1 - Static Losses

Pumps	Suction level (ft)	Discharge level (ft)	Static Head (ft)
EPG	2015	2025	10.0

Step 2 - Minor Losses and Friction Losses

Minor Losses (k) on the 3/4 inch pipe

	QTY	
Entrance		0.5
90° Bend	3	1.7
Ball valve	1	1
Check valve	1	4
	Σk =	**10.6**

Minor Losses (k) on the 1 inch pipe

	QTY	
Entrance		0.5
90° Bend	3	1.5
Ball valve	0	
Check valve	0	
	Σk =	**5**

3/4 inch pipe

Length	12 ft
Diameter	0.06 ft
Area	0.003 ft^2

1 inch pipe

Length	50 ft
Diameter	0.08 ft
Area	0.005 ft^2

The friction losses is calculated by using the following equation

$$h_f = f_D \frac{L}{D} \frac{V^2}{2g}$$

The minor losses is calculated by using the following equation

$$h_m = K_L \frac{V^2}{2g}$$

Where

h_f Friction Loss, ft
h_m Minor Loss, ft
f_d Friction factor
L Length of the pipe, ft
D Diamter of the pipe, ft
V Velocity of the leachate, ft/s
g Acceleration due to gravity, ft2/s
K_L Loss Coefficient

CDM Smith	**Client:**	Buncombe County	**Calc By:** Ravi Kadambala
	Project:	Cell 7 Design	**Date:** 12/27/2013
	Job No.	6447-97693	Checked by: CJG / 04/14/14
	Detail:	Condensate Volume Hydraulic Analysis	

5.0 Result

Step 3 Total Dynamic head, TDH

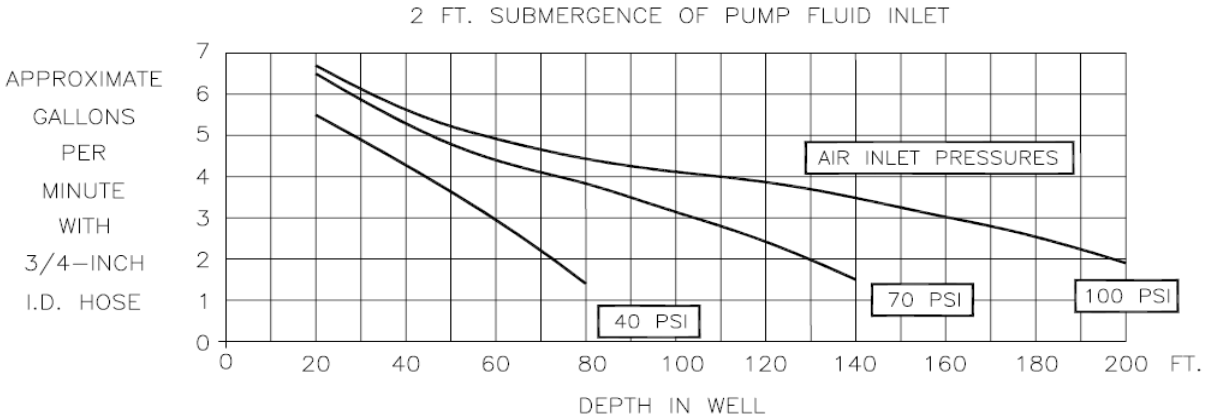
Q, gpm	3/4 inch pipe				1 inch pipe				Static Loss,ft	TDH, ft	Performance Curve, ft (Attachment 1)
	Velocity, ft/s	$Vel^2 / 2g$	Friction Loss, ft	Minor Losses, ft	Velocity, ft/s	$Vel^2 / 2g$	Friction Loss, ft	Minor Losses, ft			
2	1.45	0.0328	0.16	0.35	0.82	0.0104	0.16	0.05	10.0	10.7	200
3	2.18	0.0737	0.57	0.78	1.23	0.0233	0.35	0.12	10.0	11.8	160
4	2.91	0.1310	1.01	1.39	1.63	0.0415	0.62	0.21	10.0	13.2	110

6.0 Conclusion

The pump AP-4/BL can pump upto 5760 gallons of condensate from the condensate recovery system to the Cell 7 riser in a day, however the leachate recovery system generates only 260 gallons of leachate in day.

So, the pump AP-4/BL can convey landfill gas condensate from condensate recovery system to Cell 7 riser.

Attachment 1



Engineering Plan

Appendix B – Geotechnical Evaluation

CDM Smith

CDM Smith

Memorandum

To: *Christopher Gabel, P.E.*

From: *Danielle K. Neamtu, P.E.*
Rob Lawrence, E.I.T.

Date: *April 11, 2014*

Subject: *Buncombe County – MSW Bioreactor Landfill*
Phase IV – Cell 7 Permit Renewal
Geotechnical Design Memorandum

NORTH CAROLINA PROFESSIONAL SEAL 029677 ENGINEER DANIELLE K. NEAMTU
04/11/14

Introduction

CDM Smith has been retained to design and permit Cell 7, which is called Phase IV, of the Municipal Solid Waste (MSW) bioreactor landfill at the Buncombe County Solid Waste Management Facility in Alexander, North Carolina. CDM Smith prepared the permit-to-construct application package for Cell 6 in December 2004 for 4 horizontal to 1 vertical (4H:1V) side slopes. The closure side slopes are now proposed to range 3H:1V to 4H:1V, rather than having 4H:1V for the entire landfill. The proposed closure side slopes for Cells 7, 8, 9, and 10 and the vertical expansion (Phase IV through VII) will be 3 horizontal to 1 vertical (3H:1V). The purpose of this memorandum is to evaluate the slope stability for the final proposed landfill geometry (Phase VII) and the geotechnical aspects of the proposed Cell 7.

Project Information and Site Conditions

The Buncombe County Solid Waste Disposal Facility serves as the disposal site for all solid waste in Buncombe County, North Carolina. The existing disposal facility is located off Panther Branch Road in Alexander, North Carolina. The facility property is bordered by the French Broad River along the south and west boundaries of the site. Site location is shown on **Figure 1**.

The total area of the site is approximately 557 acres. Six of the proposed 10 landfill cells (Cells 1 through 6) have been constructed and are currently utilized as an MSW bioreactor landfill.

Figure 2 shows the proposed maximum closure grading of Cell 7. Elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88) in feet. The top of the Cell 7 slope will be at EL. 2230 at the completion of MSW placement in the vertical expansion Phase VII. The maximum slope height (crest to toe) will be 210 feet and side slopes will be graded no steeper than 3H: 1V.

The topography of the site can be characterized as upland terrain with rock outcrops and ridge and valley topographic features. At the location of the borings within the Cell 7 footprint, the ground surface elevation ranged from about EL. 1986 to EL. 2077.

Four cross sections were considered for the slope stability analyses presented in this memorandum. The cross section locations are shown on Figure 2. Section 1 (north-south) and Section 2 (east-west) were cut through Cell 7 and Section 3 (north-south) and Section 4 (east-west) were cut through Cells 8, 9, and 10. Sections 1 and 2 represent the critical cross sections for Cell 7 and Sections 3 and 4 represent the critical cross sections for the final proposed landfill geometry. The cross sections are presented on **Figures 3A, 3B, 3C** and **3D**, respectively.

Subsurface Conditions

A total of seven (7) site exploration programs were performed at the landfill site between 1991 and 2012. Data and analyses from the first five exploration programs are available in the "Buncombe County Solid Waste Management Facility – Buncombe Project XL – Geotechnical Stability Evaluation" prepared by CDM in 2002. The data related to the most-recent exploration programs conducted in 2004 and 2012 are contained in "Permit to Construct Application Package - Appendix E Hydrogeologic Report and Appendix F Geotechnical Report" prepared by CDM Smith in December 2004 and "Buncombe County Cell 7 Design Hydrogeologic Report" prepared by CDM Smith in 2013. The borings performed in 2004 and 2012 were designated as B-700-series. A summary of subsurface conditions encountered in the Cell 7 borings (2012) and borings adjacent to Cell 7 from previous exploration programs is included in **Table 1**. Boring locations are shown on **Figure 4**. Boring logs and laboratory testing data are available in the previous reports referenced in this section.

Design Considerations

The Buncombe County MSW landfill is operated as a bioreactor facility to maximize air-space by recirculation of leachate into the waste mass for more efficient degradation. Leachate recirulation will be accomplished through horizontal injection trenches with a minimum setback of 100 feet from the face of the landfill slopes. The first level of horizontal injection trenches for the bioreactor will be installed at EL. 2060 and subsequently at 30-foot vertical intervals as the MSW height increases. The analyses contained herein have considered the effect of leachate recirculation on the waste mass properties, as discussed below.

MSW properties for the waste mass were selected based upon a literature search. In general, MSW unit weight increases with leachate recirculation and a value of 90 pcf was selected for the analyses. Two types of studies were considered in selection of the MSW strength properties with recirculation; (1) Strength testing of actual waste and (2) Back-calculated waste properties based upon documented failures. Key examples of the range of effective strength properties were as follows:

- Reddy, et al. (2009) – Based upon direct shear tests on fresh MSW and 1.5-year-old MSW with leachate recirculation, effective friction angle increased from 26-30 degrees (fresh) to 31-35 degrees (degraded).

- Landva and Clark (1986 and 1990) - Based upon large-scale direct shear tests on 10- to 15-year-old MSW effective friction angle ranged from 24–42 degrees (degraded).

- Kavazanjian et al. (1995) – Recommended bilinear envelope with effective cohesion of 24 kPa (500 psf) and effective friction angle of 0 degrees for effective normal stresses less than 30 kPa (625 psf) , and effective cohesion of 0 kPa and effective friction angle of 33 degrees for effective normal stresses more than 30 kPa (625 psf).

Based upon our literature search, we concluded that the effective strength parameters for the bioreactor MSW should not be reduced due to leachate recirculation. Although the leachate recirculation will provide for more efficient degradation, the effective strength properties will be similar to MSW in a non-bioreactor landfill. Therefore, an effective friction angle of 27.5 degrees was selected for our analyses. This value is the same as we have typically used for MSW without leachate recirculation.

Analyses were performed under the assumption that the introduction of liquids into the landfill waste for the bioreactor would not result in complete saturation of the waste and no phreatic surface would develop. This is a reasonable assumption given the target moisture contents, operational controls, and leachate collection system design for the Buncombe facility. Although the presence of the bioreactor tends to increase the moisture content of the landfill material, a continuous phreatic surface is not likely to develop across the MSW when operational practices are executed correctly (Isenberg, Kavazanjian, et al. 2004).

Design Parameters

The landfill will consist of the following components in order of their occurrence below final closure grade:

- 6 inches Vegetative Cover Layer,

- 18 inches Protective Cover Layer,

- Geocomposite Drainage Net for stormwater drainage,

- 40-mil Textured LLDPE,

- Geocomposite Drainage Net for gas venting,

- 18 inches Intermediate Cover Layer,

- MSW,

- 24 inches Crushed Stone,
- Geotextile Fabric Cushion,
- 60-mil Textured HDPE Liner,
- Geocomposite Clay Liner, and
- 18 inches Compacted Soil Layer.

A summary of design properties for each of these components is presented in **Table 2**.

Table 2: Summary of Landfill Component Design Properties

Layer No.	Materials	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	Basis for Parameter Selection
1	Closure Cap System	120	30	0	Literature Search
2	MSW	90	27.5	0	Literature Search
3	Liner/Leachate System	110	23	0	Contract documents shall specify a minimum interface friction angle of 23° between adjacent liner system components

The subsurface strata and design properties assumed for the geotechnical analyses are shown in Figures 3A, 3B, 3C, and 3D and are summarized in **Table 3.**

Table 3: Summary of Subsurface Design Properties

Layer No.	Materials	Layer Thickness (ft)	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	Basis for Parameter Selection
1	Fill (Only Section 1)	0-22	115	34	0	SPT N-Values and Previous CDM/CDM Smith Reports
2	Clay/Silt	0-38.5	118	30	0	
3	Silty/Clayey Sand	0-41.5	118	32	0	

4	PWR [1]	0-24.5	135	35	500	
5	Bedrock	-	150	-	10,000	Literature Search

Note 1: Partially weathered rock (PWR) is defined as in-place weathered bedrock that results in greater than 50 blows for 6 inches of penetration of a 2-inch-diameter split-spoon sampler driven by blows from a 140-pound hammer falling freely for a 30-inch drop.

Depth from the ground surface to the top of bedrock within the Cell 7 Phase IV footprint ranged from 31 feet in boring B-722D to 64 feet in B-726. The top-of-bedrock elevation generally increased to the southwest; however, the bedrock elevation approached EL. 1953 near the center existing valley of Cell 7 running southeast to northwest.

Slope Stability Analyses – Static Conditions

Analyses for overall (global) stability were performed using the SLOPE/W version 2007 modeling software package distributed by GEO-SLOPE International, Ltd. While several stability methods are available for SLOPE/W software, the Spencer method was selected for the analyses presented in this report.

Slope stability analyses for Cell 7, 8, 9, 10, and vertical expansion, Phase IV through Phase VII, were performed for the four cross sections shown on Figures 3A, 3B, 3C, and 3D. The SLOPE/W computer program calculates factors of safety against circular and block failures of the global landfill mass based upon the input values for slope geometry and soil and waste properties. The minimum acceptable factor of safety for overall global stability is 1.5 under static loading conditions.

The computed minimum factors of safety for circular and block failure surfaces are presented in **Table 4**. All factors of safety are greater than 1.5. Results of the SLOPE/W analyses are included in **Attachment A**.

Table 4: Results of Slope Stability Analyses – Static Condition

Cross Section	Factor of Safety	
	Circular Failure	Block Failure
Section 1: North-South – Cell 7	1.56	1.51
Section 2: East-West – Cell 7	1.57	2.04
Section 3: North-South - Cells 8,9, &10	1.56	1.52
Section 4: East-West - Cells 8,9, &10	1.56	1.55

Slope Stability Analyses – Seismic Loading Conditions

All four cross sections were evaluated for seismic loading conditions. A deformation analysis was performed based upon EPA's guidance document "Seismic Design Guidance for Municipal Solid Waste Landfill Facilities" dated April 1995.

Generally, the dynamic forces acting on a landfill during a seismic event do not result in large-scale slides. The seismic forces that increase the driving forces to exceed resisting forces are of a limited duration and usually only result in limited displacement. Based on the design guidance document, displacements under earthquake loading of up to 12 inches are considered acceptable for geosynthetic liner systems. In his review letter for CDM's September 2002 report, Professor Timothy Stark stated that a geomembrane or GCL will have difficulty withstanding 12 inches of rapid shear displacement. Based upon his recommendations, CDM Smith has adopted 4 inches of displacement across the liner system as the limiting criteria under seismic loading conditions.

The method used to estimate potential displacements during an earthquake event is based on Makdisi and Seed, 1978. In order to estimate the displacements, the yield acceleration (ky) that results in a factor of safety of 1.0 was determined. The ratio between the yield acceleration and the maximum average acceleration of a failure mass serves as the input value to estimate the displacements from the design charts.

U.S. Geological Survey (USGS) Probabilistic Seismic Hazard Deaggregation chart for this site indicates that the Buncombe County Landfill has a mean earthquake magnitude of 5.89 and a peak ground acceleration of 0.226g for an earthquake with a 2% probability of exceedance in 50 years. This peak acceleration was used to estimate the maximum average acceleration for liner interface failure mode. Based on the EPA's guidance document, the peak ground acceleration provides a conservative estimate of the landfill mass above the liner. The yield acceleration of potential sliding masses along the liner interface and through the waste mass was computed for all cross sections.

The results of the analyses indicate that the computed displacements are less than four inches for all cases. The seismic deformation analyses, reference material, and graphical output are included in **Attachment B**.

Veneer Stability Analysis

A two-part wedge analysis was used to calculate the factor of safety against veneer sliding for the cap materials on the side slopes using the critical cross section. A two-part wedge analysis is essentially the ratio of the resisting forces to the driving forces. The minimum acceptable factor of safety against veneer sliding is generally considered to be 1.5 for static loading conditions.

Based upon a maximum slope height of 216 feet at 3H:1V (north-south cross section) slopes, a minimum interface friction angle of 26.5 degrees is required within the cap system to provide a factor of safety higher than 1.5. Veneer stability analyses indicate that the protective soils on the side slopes must be kept in a drained condition to satisfy the minimum factor of safety requirements.

The veneer stability calculations for the closure cap materials are included in **Attachment C.**

Geocomposite Drainage Net

Based on the veneer stability analysis presented above, the cap materials on the side slopes must be kept in a drained condition. The lateral drainage system must be designed such that water cannot accumulate in the cap materials overlying the synthetic cap. If water does build up in this layer, the resulting excess water pressures could cause veneer slope instability on the side slopes.

Assuming the protective soil layer above the geonet has a hydraulic conductivity of 1×10^{-4} cm/sec or lower, the analysis results indicate that a geocomposite drainage net system with a transmissivity of 3.5 x 10-3 m^2/sec will provide adequate lateral drainage for side slopes with a maximum vertical height of 216 feet. The calculations for the geocomposite drainage net are included in **Attachment D**.

The Contract Documents should jointly address both the cover soils and geocomposite drainage net and should specify a geocomposite transmissivity that is appropriate for the hydraulic conductivity of the protective cover soils.

A compatibility analysis of the geocomposite drainage net to the cap materials should be performed to determine the properties of the geotextile fabric that will be used as the top layer of the drainage net. The geotextile fabric must have an opening size compatible with the proposed soil such that the opening is not so large as to allow soil to enter into the fabric and cause clogging of the fabric. This analysis should be performed after the proposed cap materials have been identified or the grain-size specified.

Settlement Analyses

CDM Smith performed settlement analyses for the proposed final geometry of the Cell 7 Phase IV landfill to estimate the settlement of foundation soils under the load from the waste and final cap materials proposed in Phase VII. The purpose of the foundation settlement analyses is to assure that the leachate collection and liner system grades meet or exceed minimum specified slope requirements and maintain the minimum bedrock/groundwater separation requirements. Although some foundation settlement will occur during construction, all calculated settlements are assumed to occur after landfill construction is complete.

The Schmertmann method was used for the settlement analyses with vertical stress influence factors based upon Boussinesq stress distribution (for homogeneous isotropic elastic material). The foundation settlement analyses were calculated in the center (Case 1), at the mid-slope (Case 2), and for the most critical settlement point (Case 3). The most critical point for settlement occurred in the valley feature, where the maximum thickness of compressible soil was encountered in the borings. Settlement was also checked at the locations of minimum separation between base grades and seasonal high groundwater (Case 4) and top of bedrock (Case 5). The location of Cases 1 through 3 are shown on Figure 3-B. The locations of all cases, including Case 4 and Case 5 are shown in **Attachment E**.

The soil profile was assumed based on test boring information and the elevation of the liner from the design plans. The bedrock underlying the residual soils is assumed to be incompressible. Design soil properties for the soil layers are based upon SPT N-values from borings located in the Cell 7 footprint area as shown in Table 1.

A summary of the total waste and residual soil thicknesses and anticipated settlement at each point is provided in **Table 5**. The analyses results are included in Attachment E.

Table 5: Results of Settlement Analyses

Case	Location	Layer Thickness (ft)		Foundation Settlement (inches)
		MSW	Compressible Soil	
1	Center	140	38.5	12
2	Mid-Slope	75	48.5	22
3	Critical Settlement	130	63.5	35
4	Critical Groundwater	70	58.5	18
5	Critical Bedrock	100	8.5	3

The foundation soils will tend to settle differentially with the maximum settlement occurring near the center of the Cell 7 at the critical settlement location and almost zero settlement at the toe. Settlement of foundation soils is expected to result in flatter cross-slopes along the liner bottom and a reduction in leachate pipe grades. However, post-settlement pipe grades for the leachate collection system should be no less than 0.5% and should be adequate to maintain drainage of the leachate collection system. Based upon the estimated settlements, the current design base grades should provide a minimum of 4-foot separation post-settlement above groundwater and bedrock.

Limitations

This memorandum has been prepared for specific application to the subject project in accordance with generally accepted geotechnical engineering practices. No other warranty, express or implied, is made. In the event that any changes in the nature, design, or location of the proposed landfill cell are planned, the conclusions and recommendations presented in this report should not be considered valid, unless changes are reviewed and conclusions of this memorandum are modified or verified in writing.

The recommendations submitted in this report are based in part upon the data obtained from the referenced borings. The nature and extent of variations between the explorations may not become evident until construction. If variations then appear evident, it may be necessary to re-evaluate the recommendations of the memorandum.

Attachments

Figure 1 – Site Location Map
Figure 2 – Maximum Closure Grades
Figure 3A – Typical North-South Cross Section – Cell 7
Figure 3B – Typical East-West Cross Section – Cell 7
Figure 3C – Typical North-South Cross Section – Cells 8, 9, &10
Figure 3D – Typical East-West Cross Section – Cells 8, 9, & 10
Figure 4 – Exploration Location Plan
Table 1 – Summary of Subsurface Explorations
Attachment A – SLOPE/W Analysis
Attachment B – Seismic Slope Stability Analysis
Attachment C – Veneer Stability Analysis
Attachment D – Geocomposite Drainage Net Analysis
Attachment E – Settlement Analyses

References

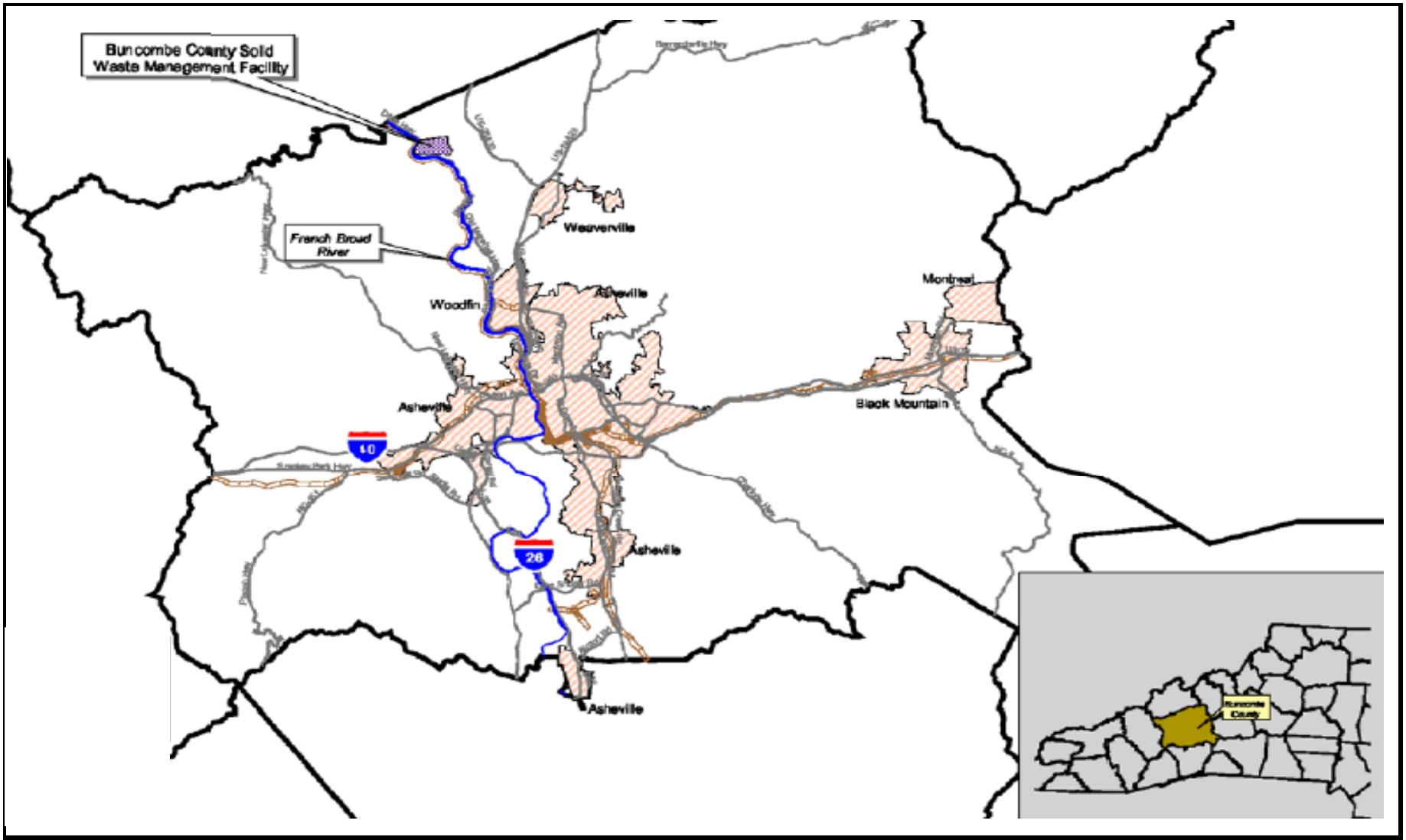
1. Isenberg, B., Kavazanjian, E., Beech, J., Houlihan, M., Bachus, R.. (1995) "Bioreactor Landfill Stability: Key Considerations" MSW Management, September – October 2004.

2. Kavazanjian, E., Matasovic, N., Bonaparte, R., Schmertmann, G.R. (1995) "Evaluation of MSW properties for seismic analysis, "Geoenvironment 2000, ASCE Geotechnical Special Publication #46.

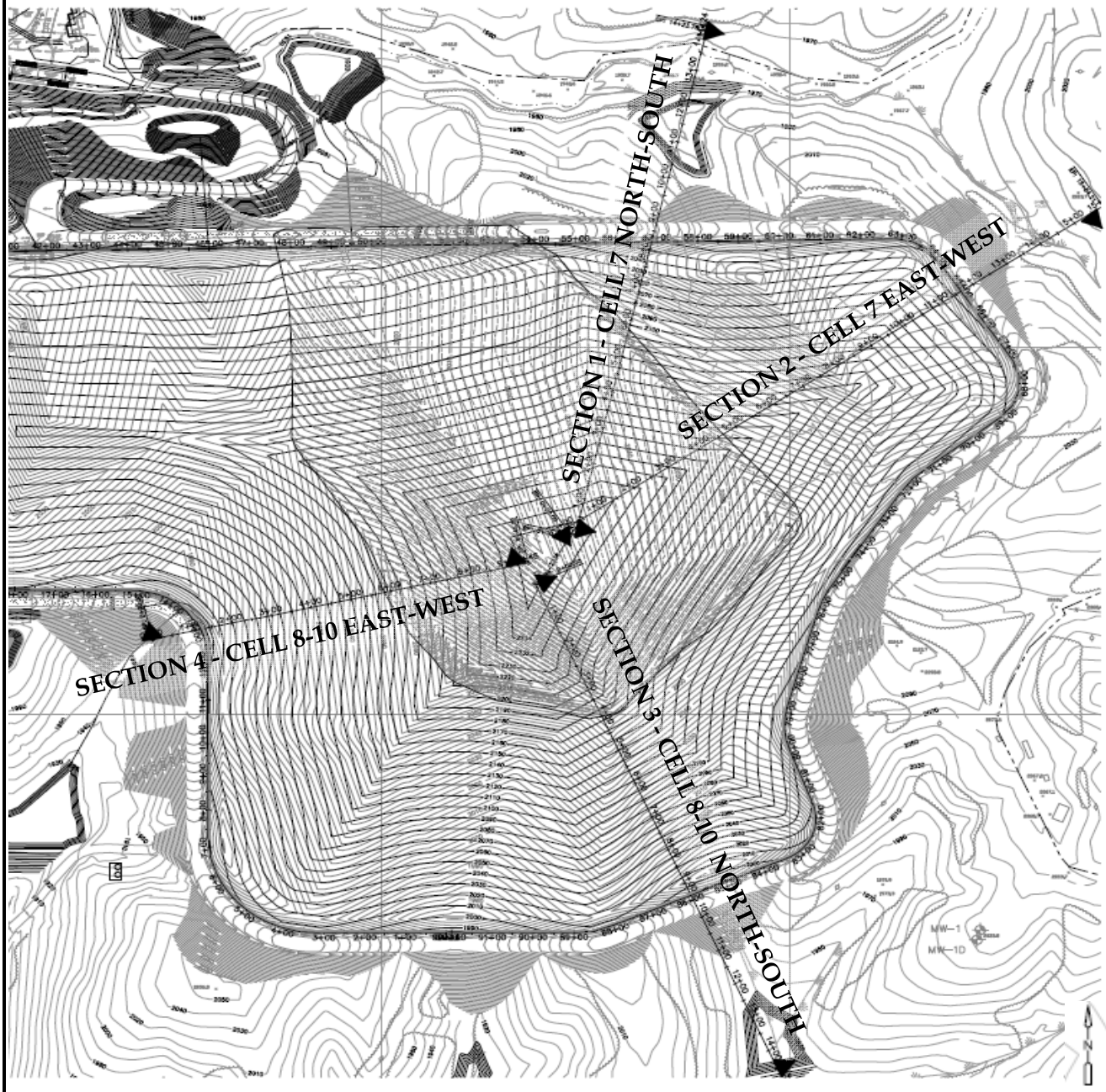
3. Landva, A.O. & Clark, J.I. (1986) Geotechnical testing of wastefill, Proceedings, 39th Canadian Geotechnical Conference. Ottawa, Ontario.

4. Landva, A.O. & Clark, J.I. (1990) Geotechnics of Waste Fill. Geotechnics of Waste fills – Theory and Practice, ASTM STP 1070, ASTM, Philadephia, PA

5. Reddy, K.R., Hettiarachchi, H., Bogner, J.E., Lagier, T. (2009) "Compressibility and shear strength of municipal solid waste under short-term leachate recirculation operations." Waste Management & Research.



CDM Smith	BUNCOMBE COUNTY SUBTITLE D LANDFILL CELL 7 PHASE IV PERMIT	SITE LOCATION MAP	PROJECT NO. 6447-97693 DATE 7/25/2013 Figure No. 1

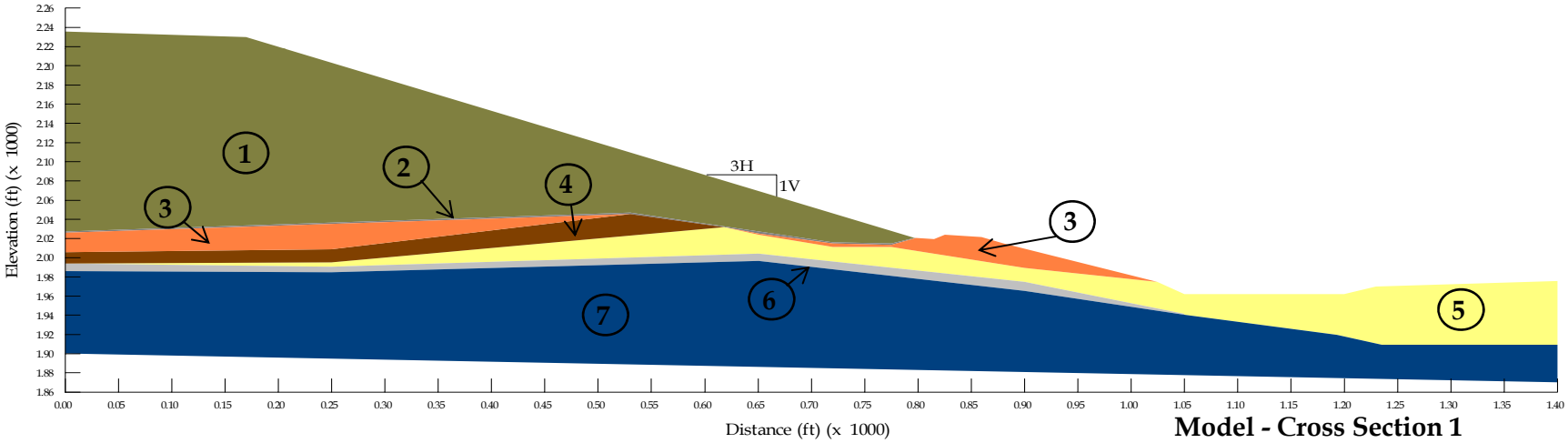


CDM Smith	BUNCOMBE COUNTY SUBTITLE D LANDFILL CELL 7 PHASE IV - VII PERMIT	MAXIMUM CLOSURE GRADES	PROJECT NO. 6447-97693 DATE 7/25/2013 Figure No. **2**

Buncombe County
Cell 7 Phase IV
Permit

Strength Parameters:

Material	Unit Weight	Friction Angle	Cohesion
1- MSW	90 pcf	27.5 degrees	-
2- Liner/Leachate System	110 pcf	23 degrees	-
3- Fill	120 pcf	32 degrees	-
4- Clay/Silt	118 pcf	30 degrees	-
5- Silty/Clayey Sand	118 pcf	32 degrees	-
6- PWR	135 pcf	35 degrees	500 psf
7- Bedrock	150 pcf	-	10,000 psf



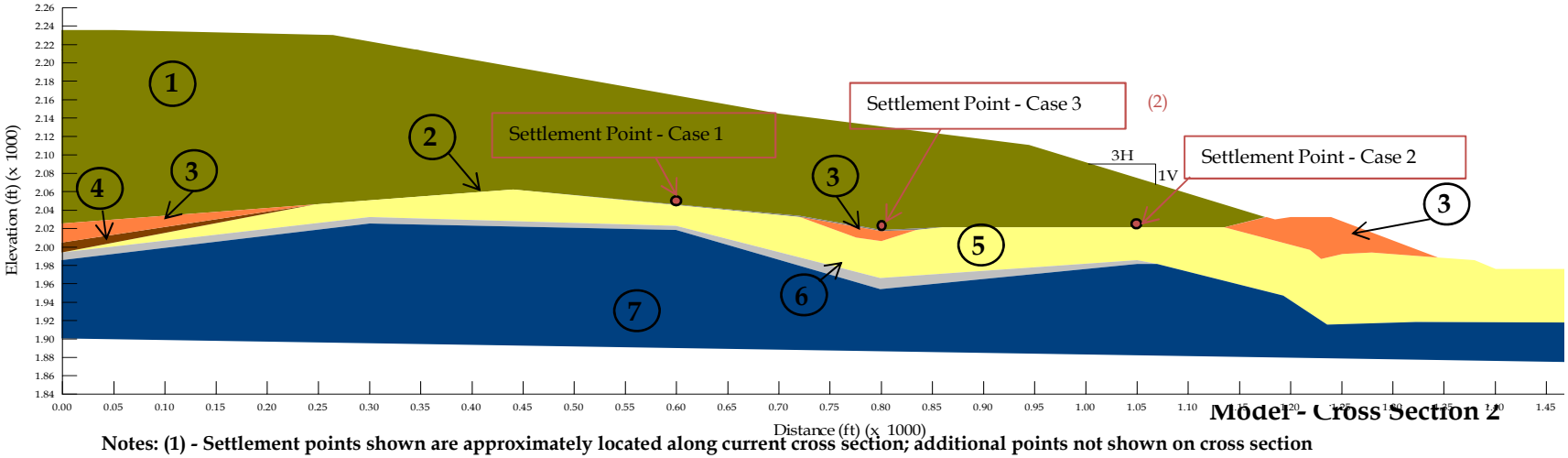
Model - Cross Section 1

CDM Smith	BUNCOMBE COUNTY SUBTITLE D LANDFILL CELL 7 PHASE IV - VII PERMIT	TYPICAL NORTH-SOUTH CROSS SECTION - CELL 7	PROJECT NO. 6447-97693 DATE 7/25/2013 Figure No. **3A**

Buncombe County
Cell 7 Phase IV
Permit

Strength Parameters:

Material	Unit Weight	Friction Angle	Cohesion
1- MSW	90 pcf	27.5 degrees	-
2- Liner/Leachate System	110 pcf	23 degrees	-
3- Fill	120 pcf	32 degrees	-
4- Clay/Silt	118 pcf	30 degrees	-
5- Silty/Clayey Sand	118 pcf	32 degrees	-
6- PWR	135 pcf	35 degrees	500 psf
7- Bedrock	150 pcf	-	10,000 psf



Model - Cross Section 2

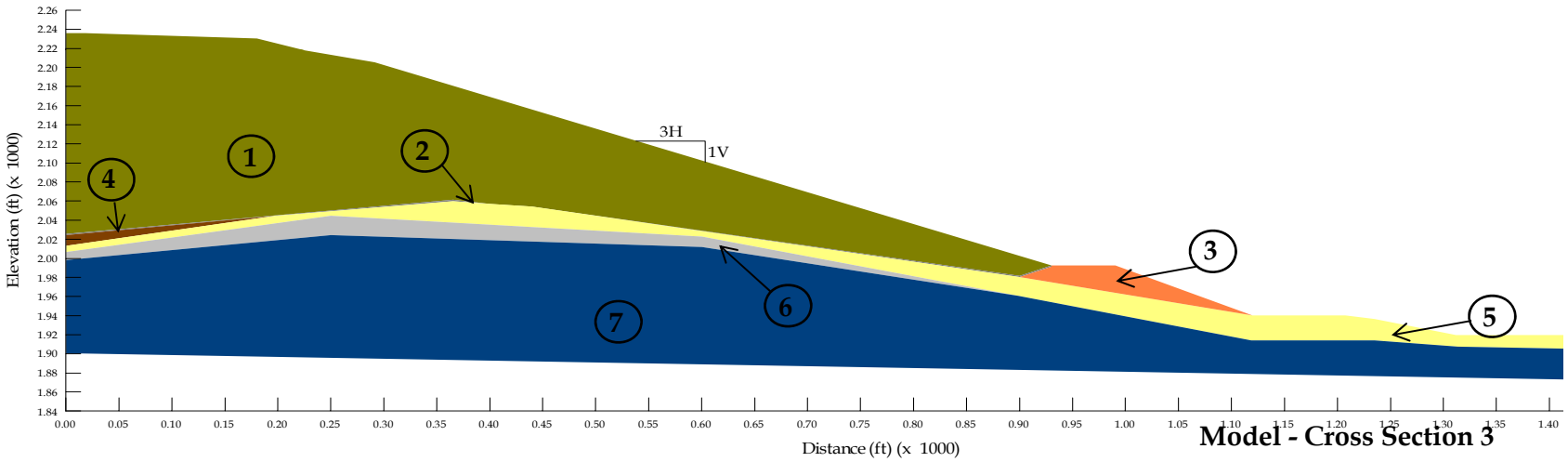
Notes: (1) - Settlement points shown are approximately located along current cross section; additional points not shown on cross section

CDM Smith	BUNCOMBE COUNTY SUBTITLE D LANDFILL CELL 7 PHASE IV - VII PERMIT	TYPICAL EAST-WEST CROSS SECTION - CELL 7	PROJECT NO. 6447-97693 DATE 7/25/2013 Figure No. **3B**

Buncombe County
Cells 7,8,9, & 10 and Vertical Expansion Phase VII
Permit

Strength Parameters:

Material	Unit Weight	Friction Angle	Cohesion
1- MSW	90 pcf	27.5 degrees	-
2- Liner/Leachate System	110 pcf	23 degrees	-
3- Fill	120 pcf	32 degrees	-
4- Clay/Silt	118 pcf	30 degrees	-
5- Silty/Clayey Sand	118 pcf	32 degrees	-
6- PWR	135 pcf	35 degrees	500 psf
7- Bedrock	150 pcf	-	10,000 psf



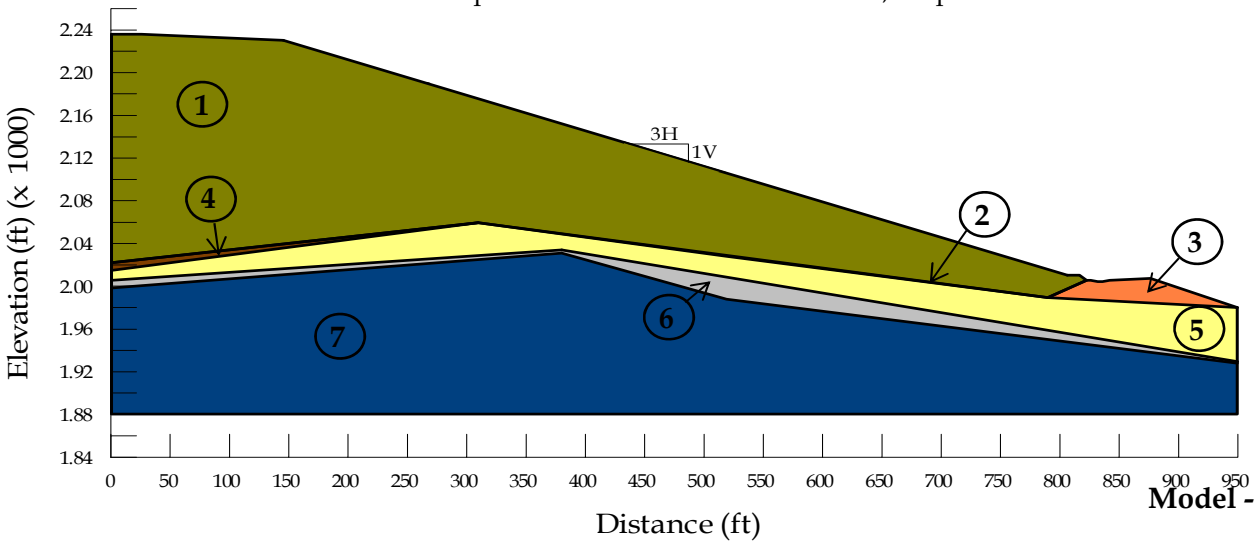
Model - Cross Section 3

CDM Smith	BUNCOMBE COUNTY SUBTITLE D LANDFILL CELL 7 PHASE IV - VII PERMIT	TYPICAL NORTH-SOUTH CROSS SECTION - CELLS 8, 9, & 10	PROJECT NO. 6447-97693 DATE 7/1/2013 Figure No. **3C**

Buncombe County
Cells 7,8,9, & 10 and Vertical Expansion Phase VII
Permit

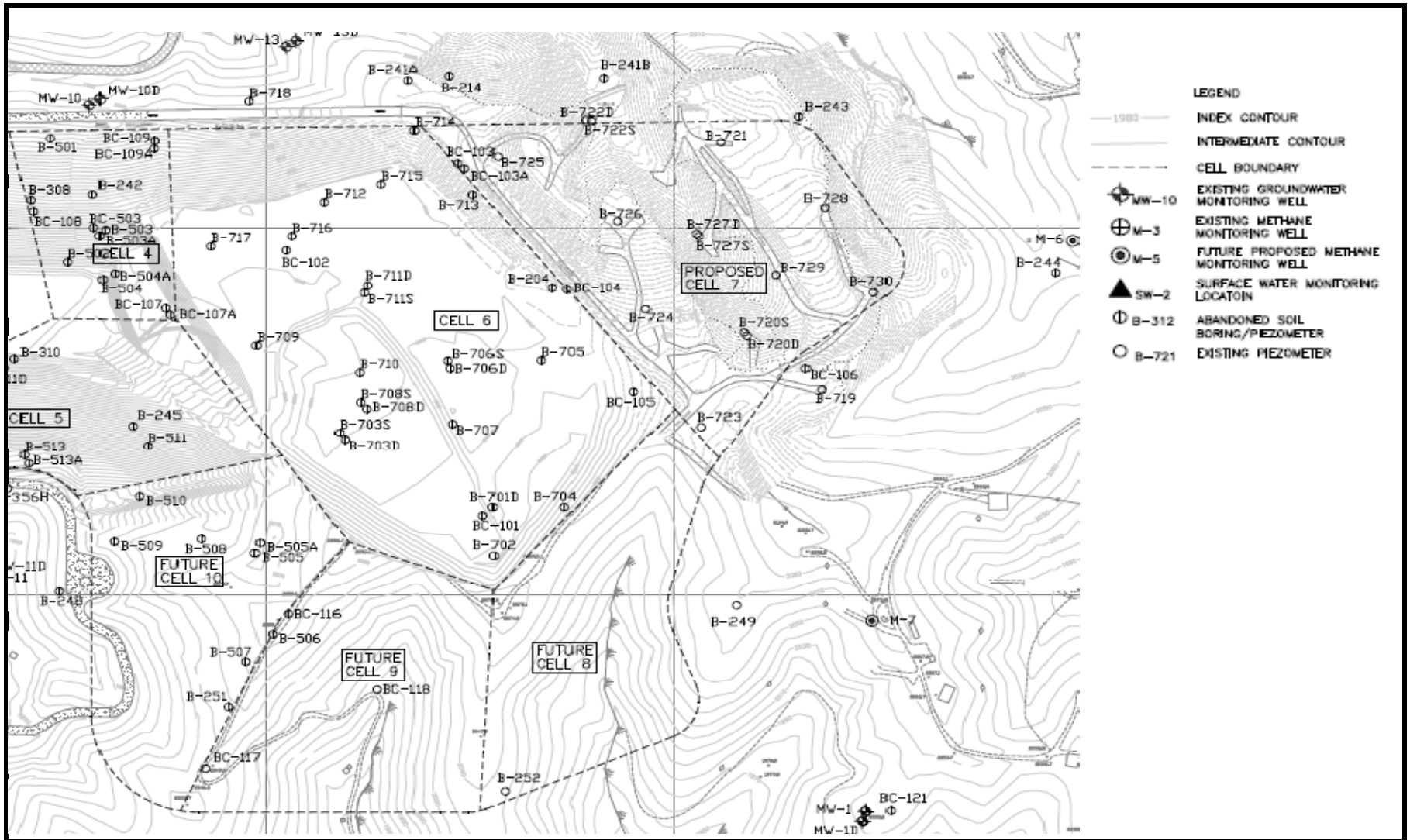
Strength Parameters:

Material	Unit Weight	Friction Angle	Cohesion
1- MSW	90 pcf	27.5 degrees	-
2- Liner/Leachate System	110 pcf	23 degrees	-
3- Fill	120 pcf	32 degrees	-
4- Clay/Silt	118 pcf	30 degrees	-
5- Silty/Clayey Sand	118 pcf	32 degrees	-
6- PWR	135 pcf	35 degrees	500 psf
7- Bedrock	150 pcf	-	10,000 psf



Model - Cross Section 4

CDM Smith	BUNCOMBE COUNTY SUBTITLE D LANDFILL CELL 7 PHASE IV - VII PERMIT	TYPICAL EAST-WEST CROSS SECTION - CELLS 8, 9, & 10	PROJECT NO. 6447-97693 DATE 7/25/2013 Figure No. **3D**



CDM Smith

BUNCOMBE COUNTY

SUBTITLE D LANDFILL
CELL 7 PHASE IV
PERMIT

EXPLORATION LOCATION PLAN

PROJECT NO.	6447-97693
DATE	7/25/2013

Figure No.

4

Buncombe County Landfill
Cell 7 Phase IV
Alexander, NC

Table 1
Summary of Subsurface Explorations

Boring No.	Approximate Ground Surface Elevation (ft-NAVD) [1]	Total Drilling Depth (ft)	Approximate Depth to Groundwater (ft)	Strata Thickness (ft)					Depth to Top of PWR	Depth to Top of Bedrock	Approximate PWR Surface Elevation (ft-NAVD)	Approximate Bedrock Surface Elevation (ft-NAVD)	Average N-value [2]
				Fill	Residual		PWR	Bedrock					
					Sand	Clay/ Silt							
B-719	2070.4	62.0	46.8	-	49.0	-	3.0	>10	49.0	52.0	2021.4	2018.4	15
B-720D	2056.8	80.0	41.5	-	5.0	-	54.0	>21	5.0	59.0	2051.8	1997.8	16
B-721	2011.4	34.0	24.4	-	21.0	-	13.0	-	21.0	34.0	1990.4	1977.4	23
B-722D	1986.1	41.0	7.4	-	18.0	-	13.0	>10	18.0	31.0	1968.1	1955.1	19
B-723	2077.0	62.0	41.7	-	29.0	-	18.0	>15	29.0	47.0	2048.0	2030.0	12
B-724	2055.6	50.0	43.5	-	33.0	-	5.5	>11.5	33.0	38.5	2022.6	2017.1	48
B-725	2028.6	58.0	49.4	-	10.0	-	31.0	>17	10.0	41.0	2018.6	1987.6	14
B-726	2021.8	67.0	28.1	-	20.0	-	44.0	>3	20.0	64.0	2001.8	1957.8	36
B-727D	2006.5	63.0	11.3	-	41.0	-	12.5	>9.5	41.0	53.5	1965.5	1953.0	22
B-728	2030.1	48.5	38.2	-	44.0	-	4.5	-	44.0	48.5	1986.1	1981.6	27
B-729	2040.7	36.0	23.5	-	22.0	-	11.5	>2.5	22.0	33.5	2018.7	2007.2	12
B-730	2055.1	42.5	36.8	-	23.0	-	19.5	-	23.0	42.5	2032.1	2012.6	18
Historical Data - Borings Adjacent to Cell 7 (Cell 6 and Future Cells 8, 9, and 10)													
B-506	2085.6	57.0	N/A	-	44.5		12.5	-	44.5	57.0	2041.1	2028.6	24
B-507	2076.4	30.0	N/A	-	19.0		11.0	-	19.0	30.0	2057.4	2046.4	12
B-508	2082.4	23.0	N/A	-	20.0		3.0	-	20.0	23.0	2062.4	2059.4	30
B-509	2031.0	43.5	N/A	-	21.5		22.0	-	21.5	43.5	2009.5	1987.5	40
B-510	2037.2	44.0	N/A	-	28.5		15.5	-	28.5	44.0	2008.7	1993.2	35
B-514	1946.6	38.0	21.1	-	17.5		0.5	>20	17.5	18.0	1929.1	1928.6	29
B-701D	2024.4	55.0	53.0	-	8.3	9.7	6.5	>30.5	18.0	24.5	2006.4	1999.9	14
B-702	2054.5	75.0	75.0	-	8.0	-	22.0	>45.0	8.0	30.0	2046.5	2024.5	74
B-703D	2054.3	73.0	70.0	-	40.0	18.0	4.0	>11.0	58.0	62.0	1996.3	1992.3	23
B-704	2060.1	85.0	80.0	-	-	-	39.0	>46.0	0.0	39.0	2060.1	2021.1	N/A
B-705	2066.1	64.0	61.0	-	23.3	9.7	8.0	>23.0	33.0	41.0	2033.1	2025.1	24
B-706D	2009.1	41.0	39.0	-	9.4	8.6	7.5	>15.5	18.0	25.5	1991.1	1983.6	19
B-707	2004.6	29.0	20.0	-	-	9.5	9.5	>10.0	9.5	19.0	1995.1	1985.6	14
B-708D	2026.8	46.0	42.0	-	25.0	8.0	6.0	>7.0	33.0	39.0	1993.8	1987.8	13
B-713	2031.7	83.0	79.0	-	22.0	5.0	11.0	>45.0	27.0	38.0	2004.7	1993.7	33
												Average=	**26**

Notes:

1. Elevations are based on the North American Vertical Datum (NAVD) of 1988 and are reported in feet.
2. Average N-value within the Sand and Silt/Clay layer for settlement analysis.
   The number of blows required to drive the split-spoon sampler each 6-inch increment was recorded and the Standard Penetration Resistance (N-value) was determined as the sum of the blows over the 2nd and 3rd 6-inch increments.

Abbreviations:

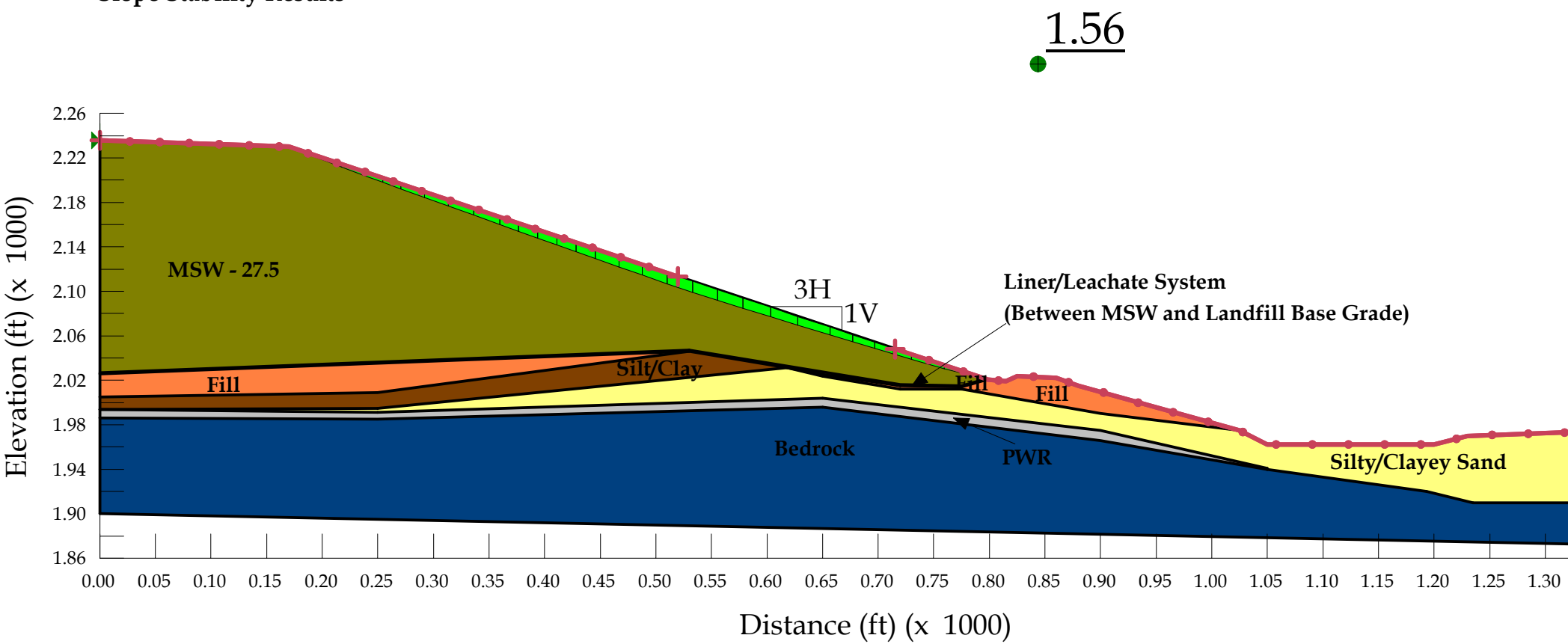
PWR	Partially Weathered Rock
-	Not Encountered
>	Indicates strata not fully penetrated

Attachment A

SLOPE/W Analysis

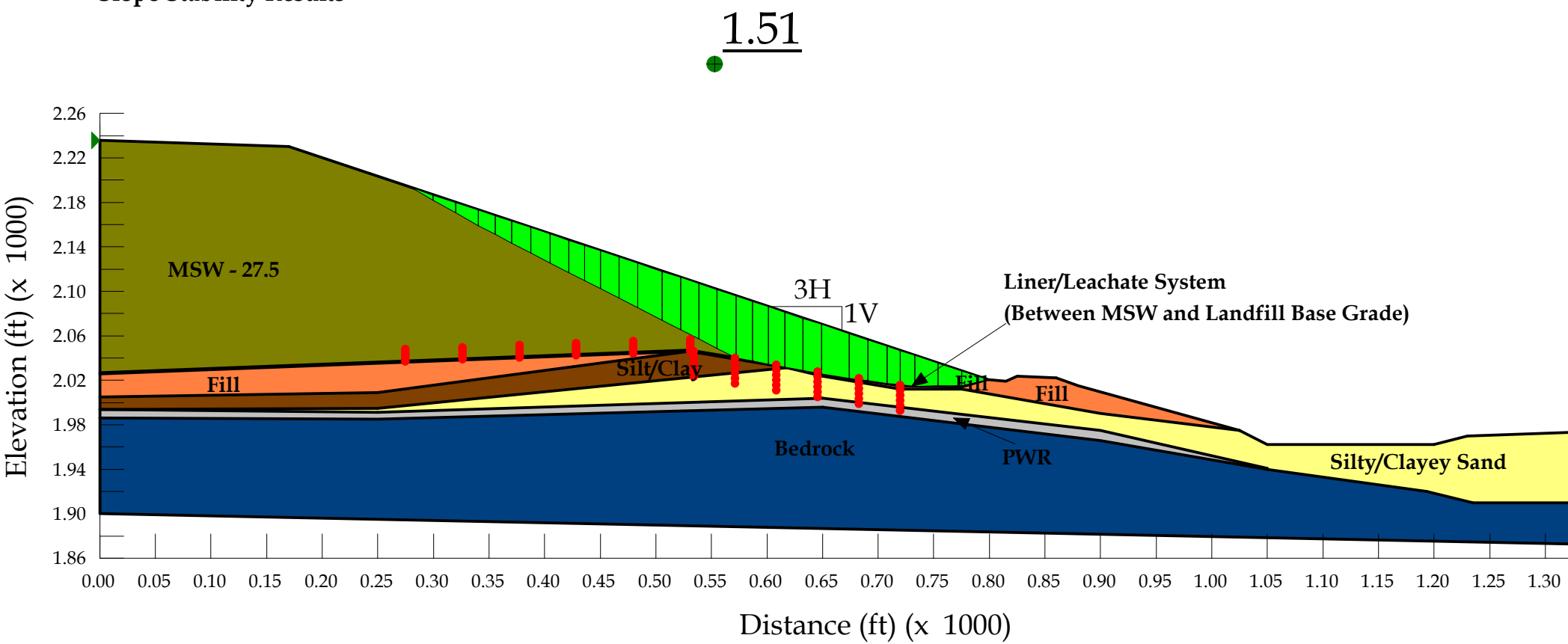
North-South Section Cell 7
Circular Slip Surface
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cell 7
Permitting
Slope Stability Results



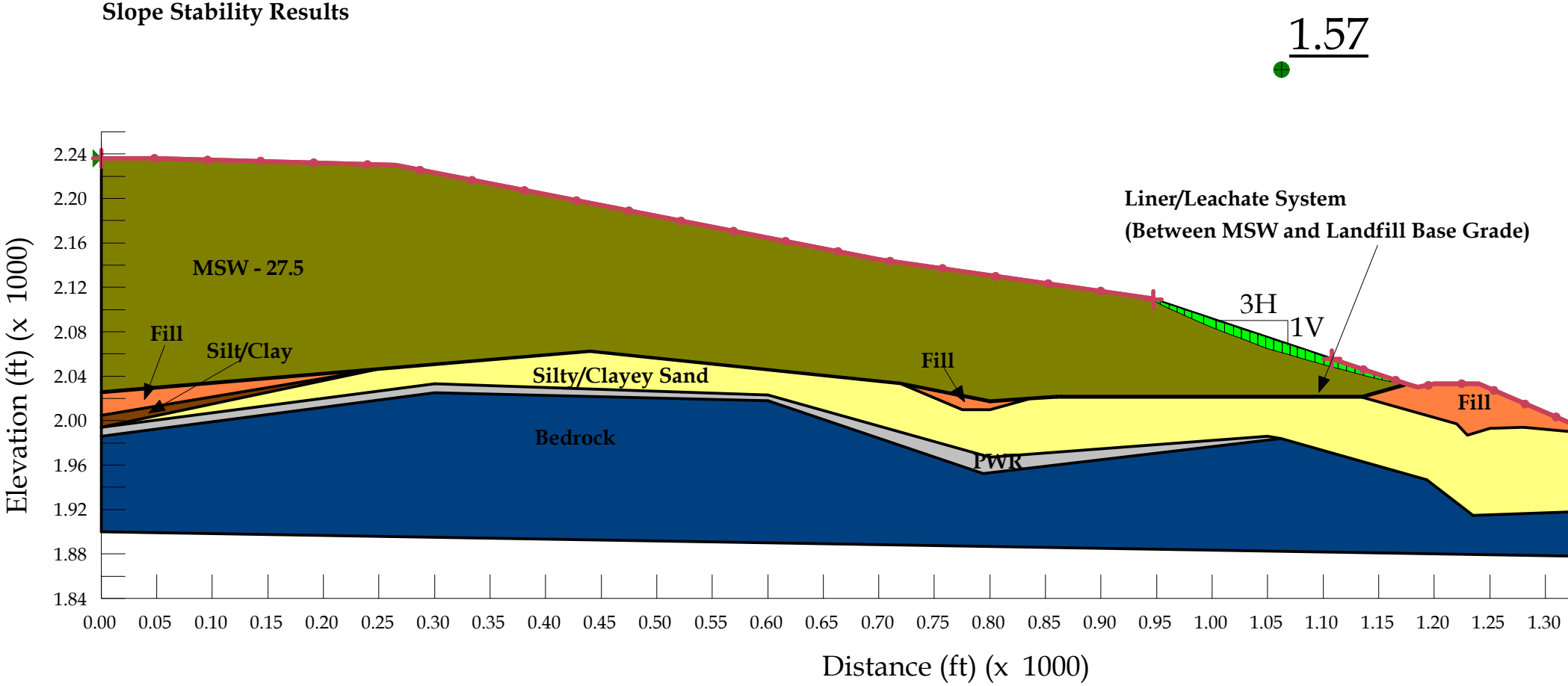
North-South Section Cell 7
Block Slip Surface
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cell 7
Permitting
Slope Stability Results



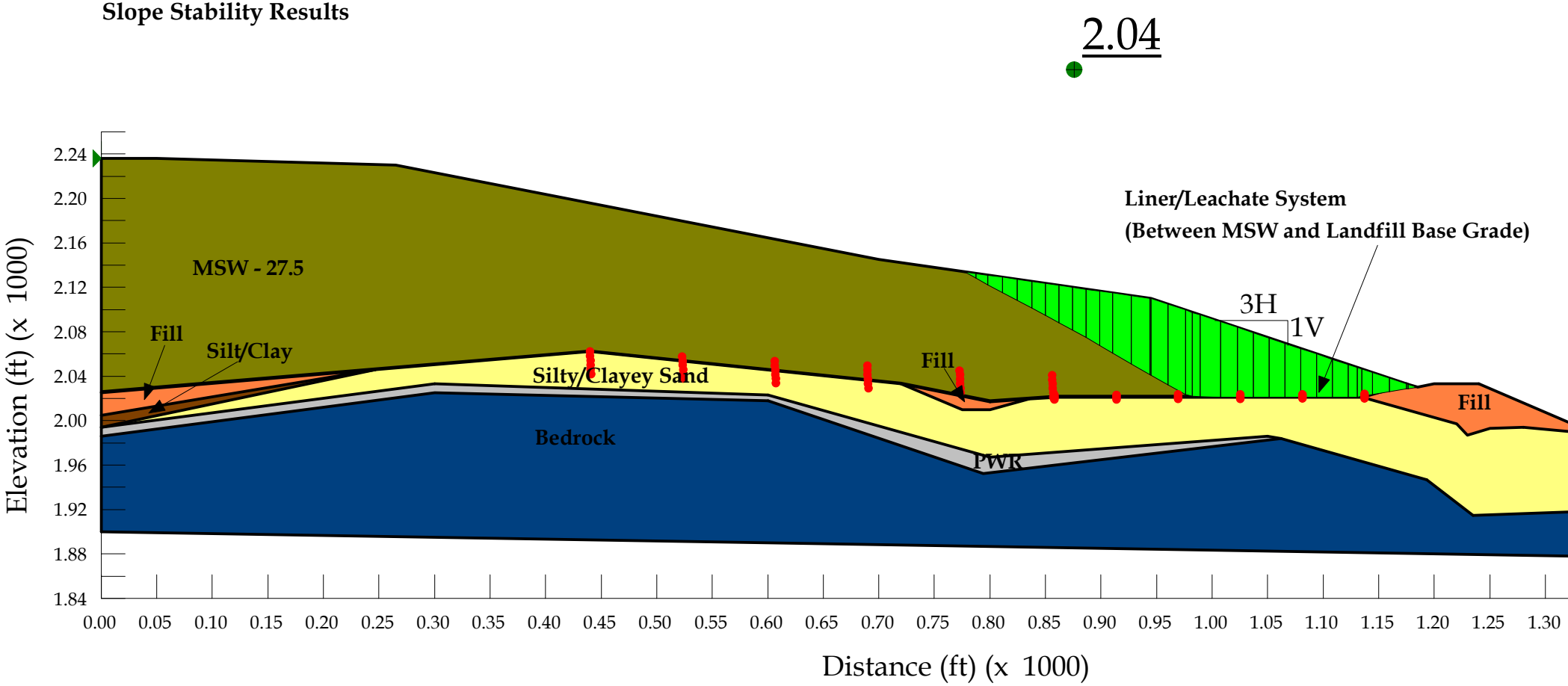
East-West Section Cell 7
Circular Slip Surface
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cell 7
Permitting
Slope Stability Results



East-West Section Cell 7
Block Slip Surface
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cell 7
Permitting
Slope Stability Results



North-South Section Cells 8,9,10

Circular Slip Surface

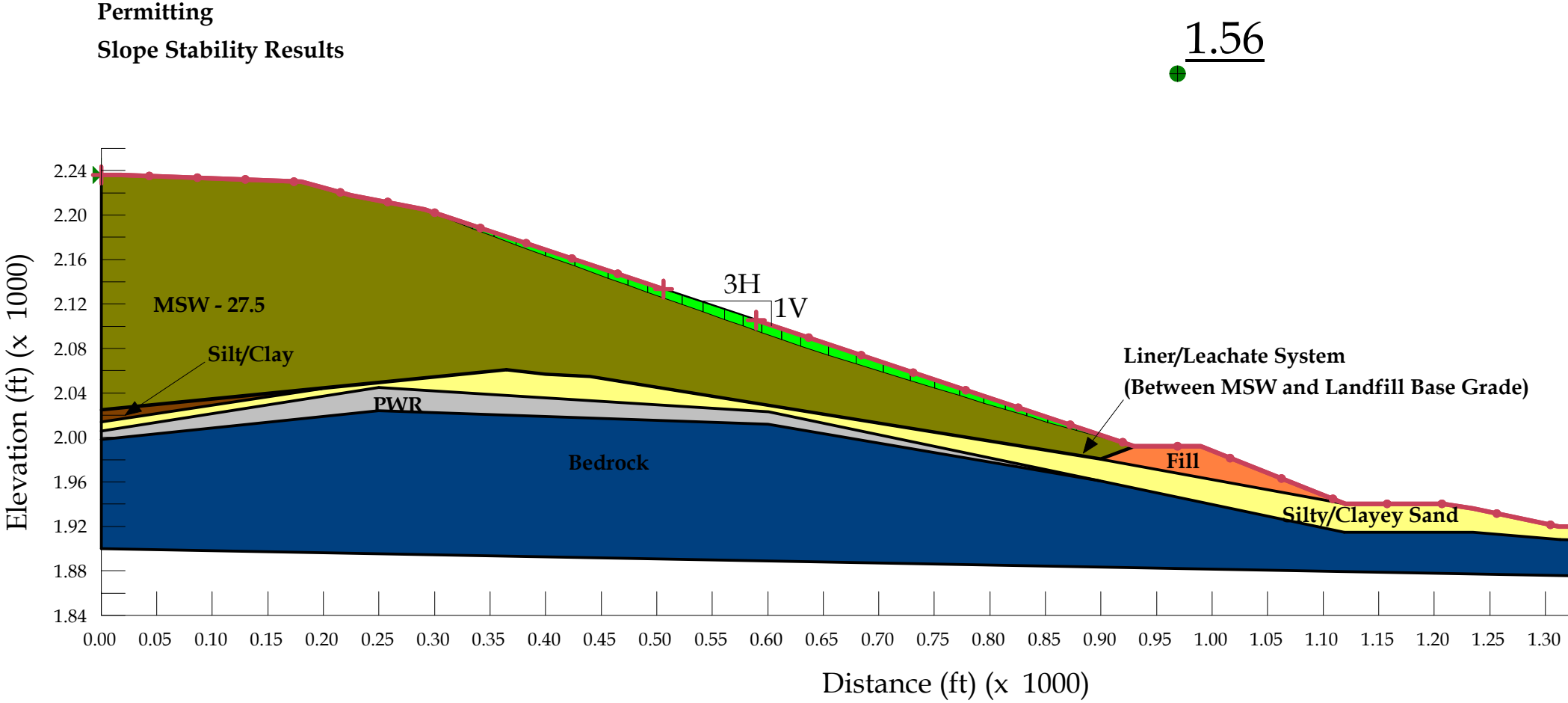
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County

Cells 8 to 10 and Vertical Expansion

Permitting

Slope Stability Results



North-South Section Cells 8,9,10

Block Slip Surface

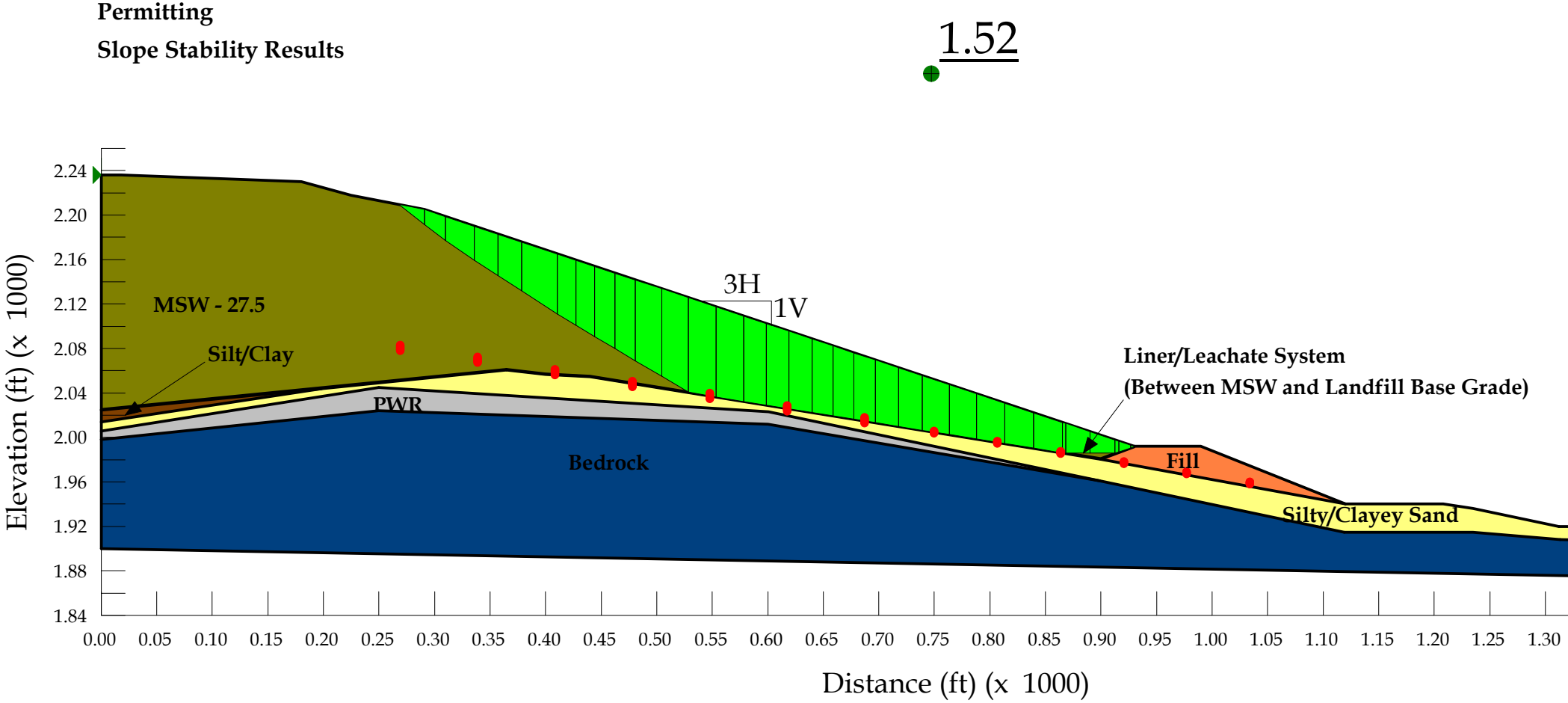
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County

Cells 8 to 10 and Vertical Expansion

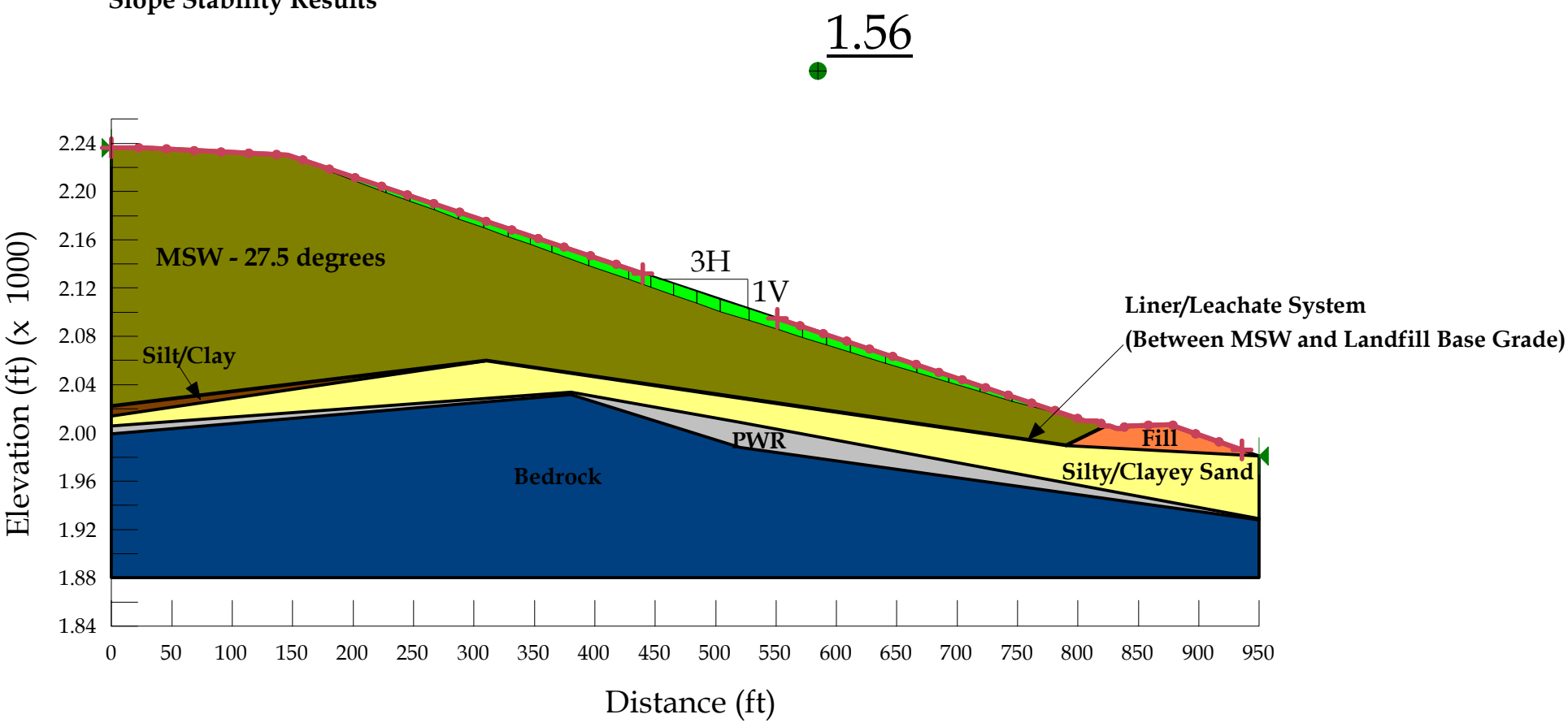
Permitting

Slope Stability Results



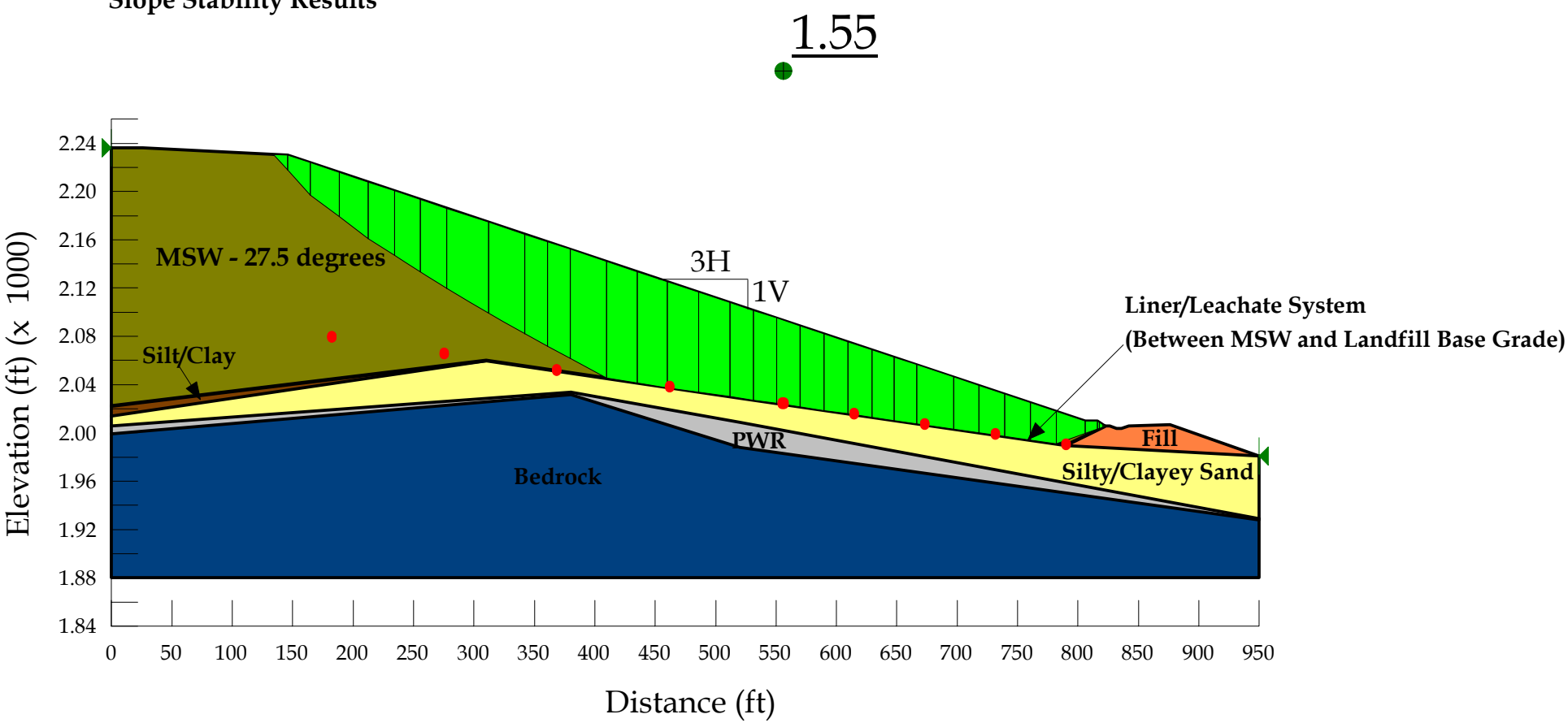
East-West Section Cells 8,9,10
Circular Slip Surface
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cells 8 to 10 and Vertical Expansion
Permitting
Slope Stability Results



East-West Section Cells 8,9,10
Block Slip Surface
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cells 8 to 10 and Vertical Expansion
Permitting
Slope Stability Results



Attachment B

Seismic Slope Stability Analysis

Seismic Slope Stability Analyses Summary

Cross Section	Failure Mode	k_y/g (1)	k_{max}/g (2)	k_y/k_{max}	$U_{6.5}$ (3) (cm)	$U_{6.5}$ (3) (in)
North-South Cells 8,9,10	Circular	0.16	0.226	0.71	3.1	1.2
	Block	0.145	0.226	0.64	5.2	2.0
East-West Cells 8,9,10	Circular	0.16	0.226	0.71	3.1	1.2
	Block	0.16	0.226	0.71	3.1	1.2
North-South Cell 7	Circular	0.16	0.226	0.71	3.1	1.2
	Block	0.145	0.226	0.64	5.2	2.0
East-West Cell 7	Circular	>0.226	0.226	N/A	-	-
	Block	0.16	0.226	0.71	3.1	1.2

Notes:

1- k_y = yield acceleration (Factor of Safety = 1)

2- k_{max} = peak ground acceleration from USGS

3- $U_{6.5}$ = displacement based on an earthquake magnitude of 6.5 from Makdisi and Seed (1978)

4 - For seismic slope stability analysis the MSW strength properties = cohesion 0 psf; friction angle 27.5 degrees

Prob. Seismic Hazard Deaggregation

Alexander,_NC 82.636° W, 35.725 N.

Peak Horiz. Ground Accel.>=0.2263 g

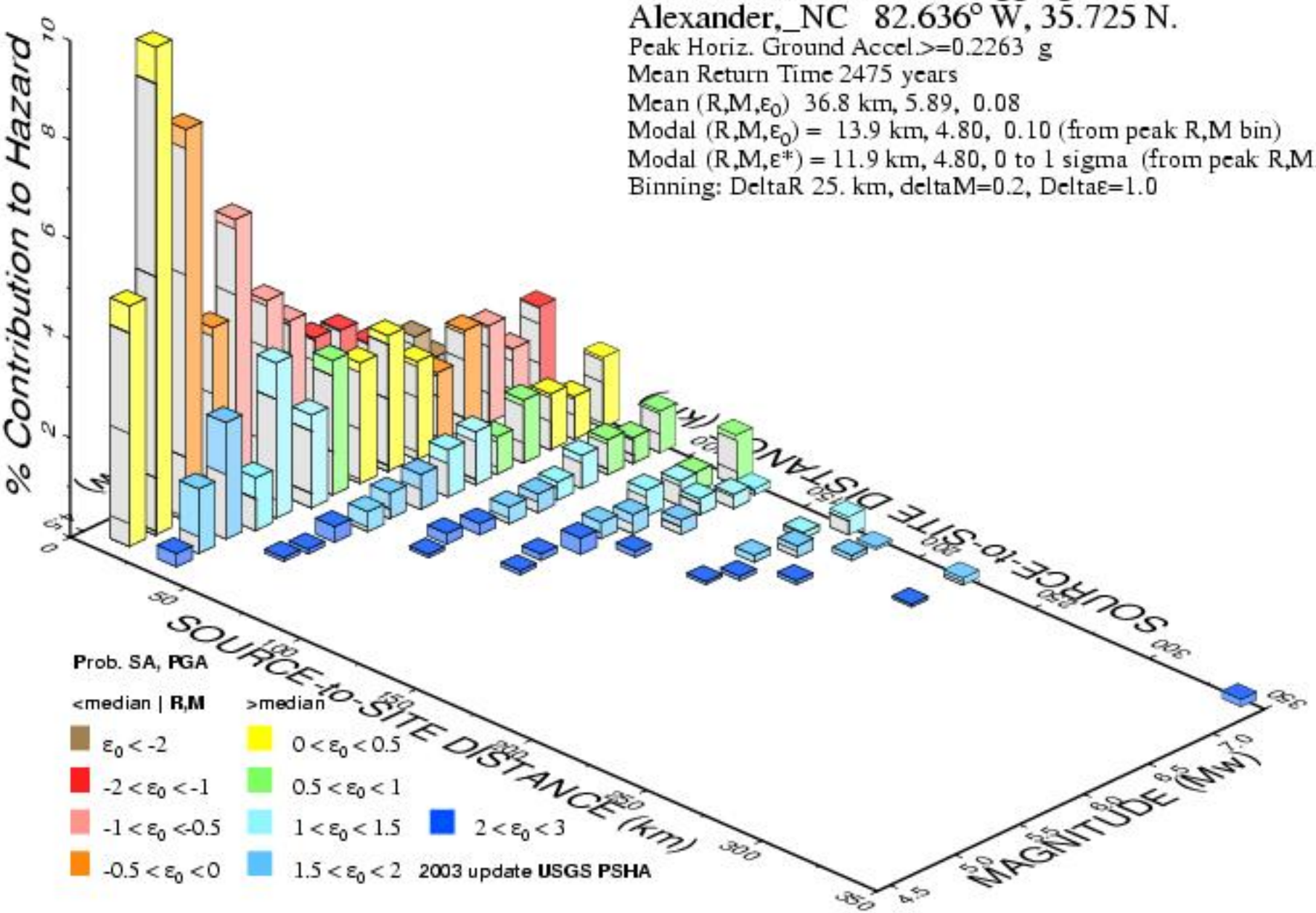
Mean Return Time 2475 years

Mean (R,M,ε_0) 36.8 km, 5.89, 0.08

Modal (R,M,ε_0) = 13.9 km, 4.80, 0.10 (from peak R,M bin)

Modal (R,M,ε^*) = 11.9 km, 4.80, 0 to 1 sigma (from peak R,M,ε bin)

Binning: DeltaR 25. km, deltaM=0.2, Deltaε=1.0



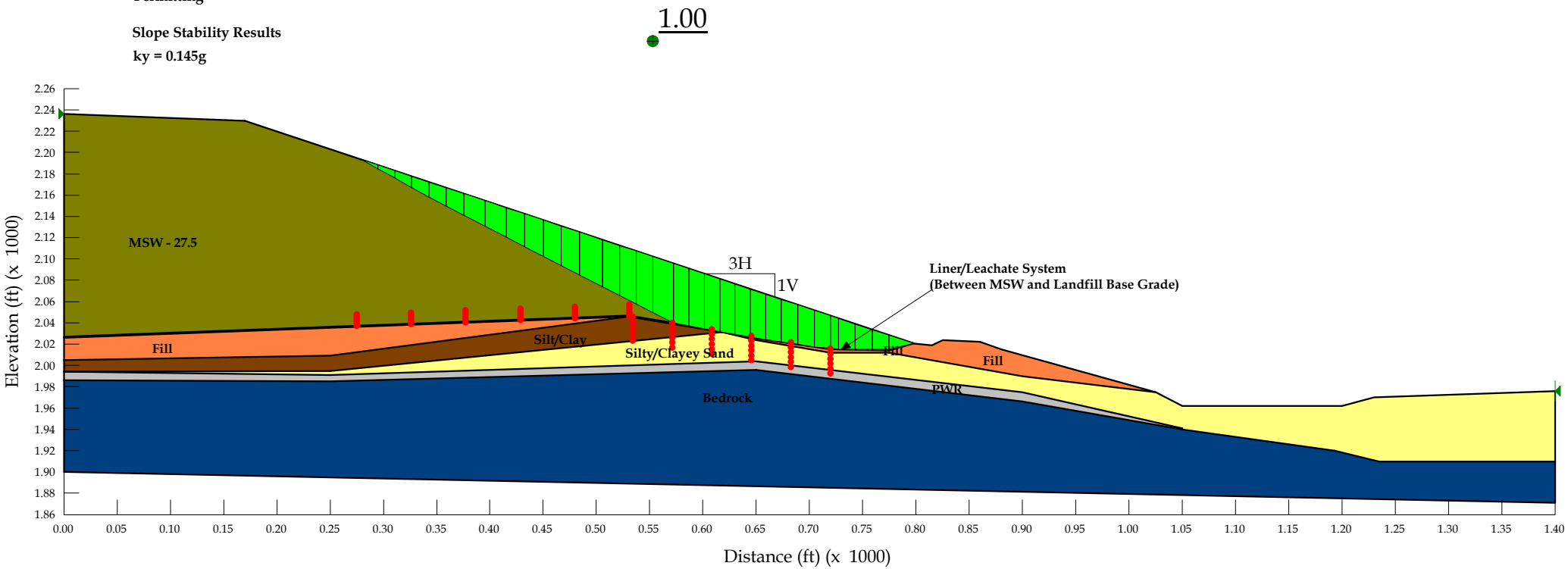
GMT 2011 Jan 10 21:57:04 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on ROCK avg Vs=760 m/s top 30 m USGS CGHT PSHA2002v3 UPDATE Bins with lt 0.05% contrib. omitted

North-South Section Cell 7

Block Slip Surface - Seismic Analysis
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cell 7
Permitting

Slope Stability Results
ky = 0.145g



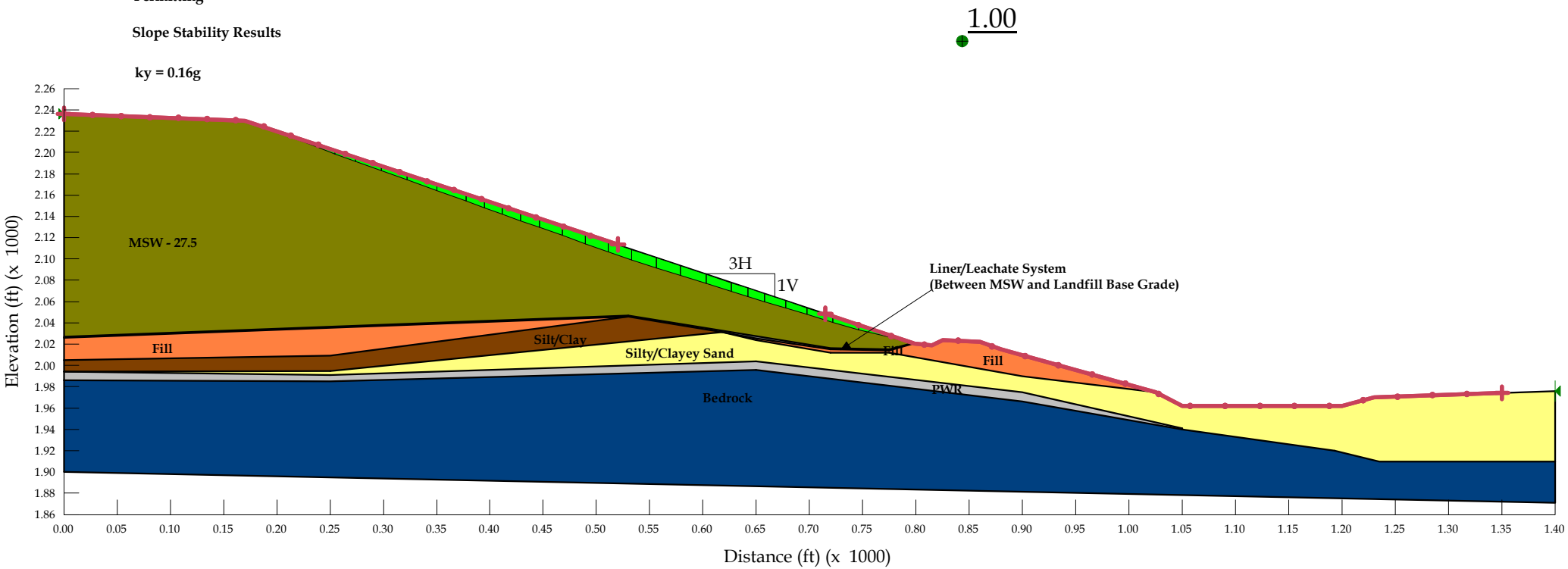
North-South Section Cell 7

Circular Slip Surface - Seismic Analysis
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cell 7
Permitting

Slope Stability Results

ky = 0.16g



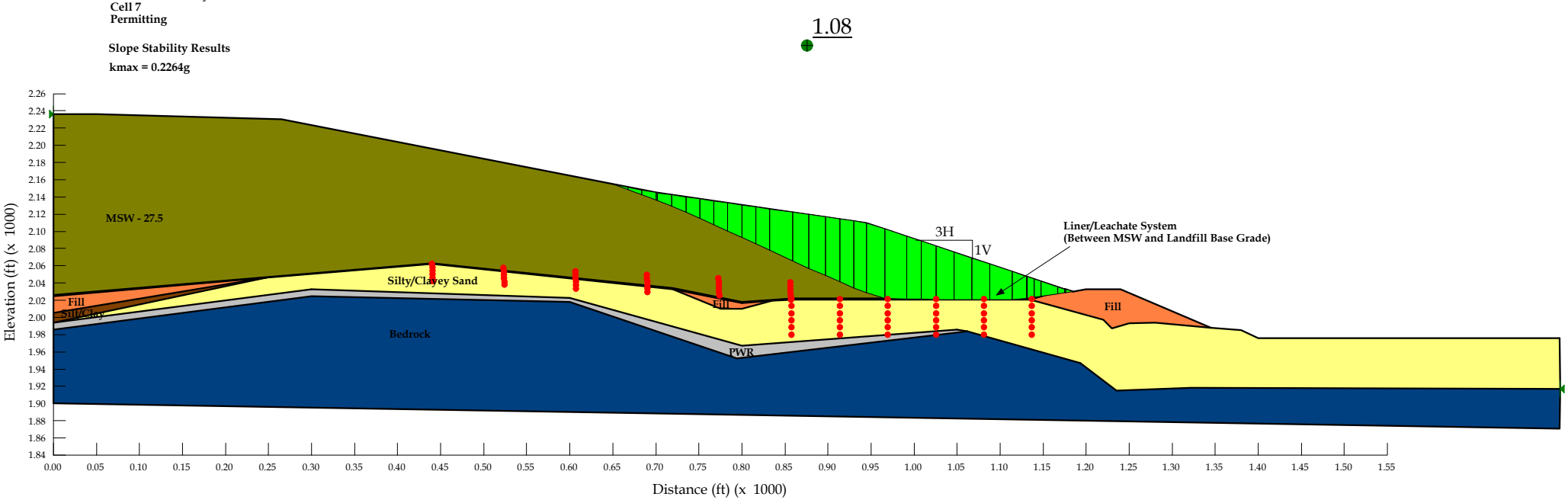
East-West Section Cell 7

Block Slip Surface - Seismic Analysis
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cell 7
Permitting

Slope Stability Results

kmax = 0.2264g



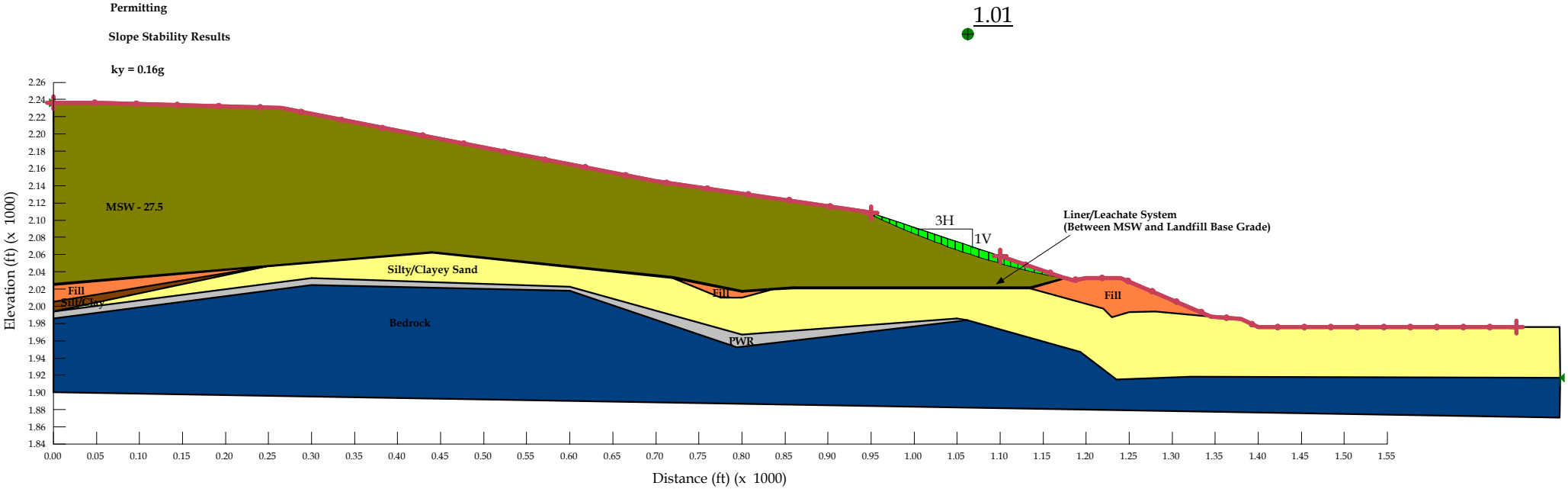
East-West Section Cell 7

Circular Slip Surface - Seismic Analysis
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cell 7
Permitting

Slope Stability Results

ky = 0.16g



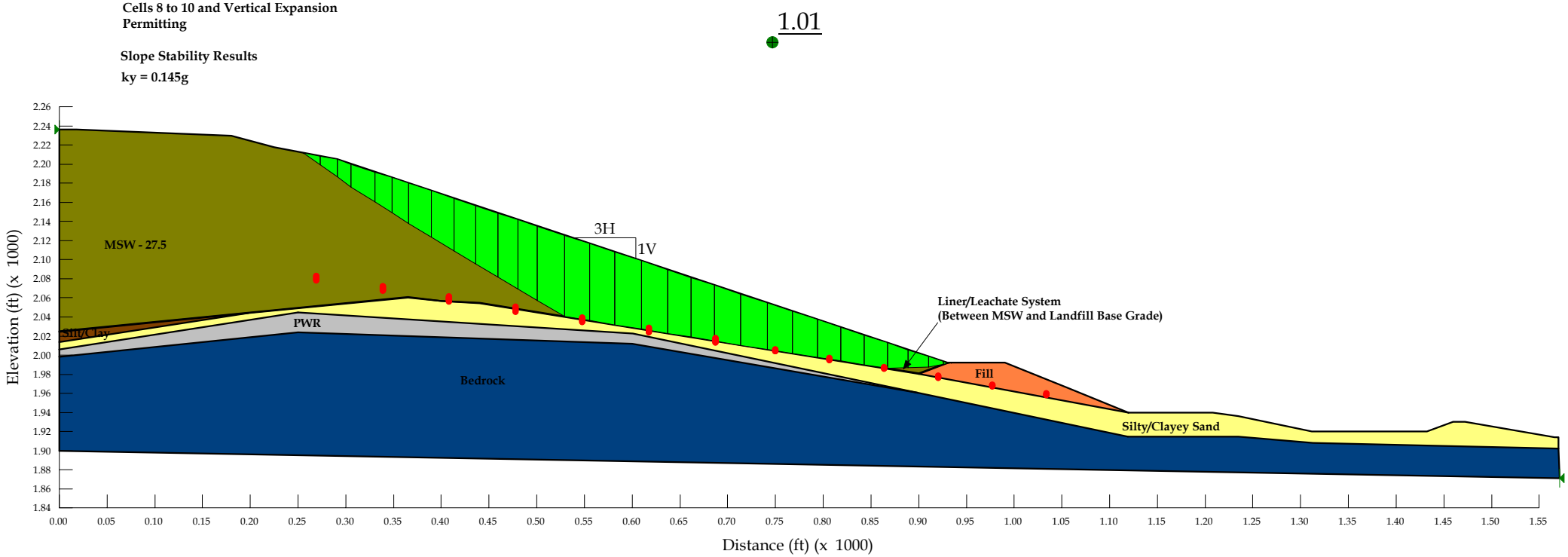
North-South Section Cells 8,9,10

Block Slip Surface - Seismic Analysis
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cells 8 to 10 and Vertical Expansion
Permitting

Slope Stability Results

ky = 0.145g



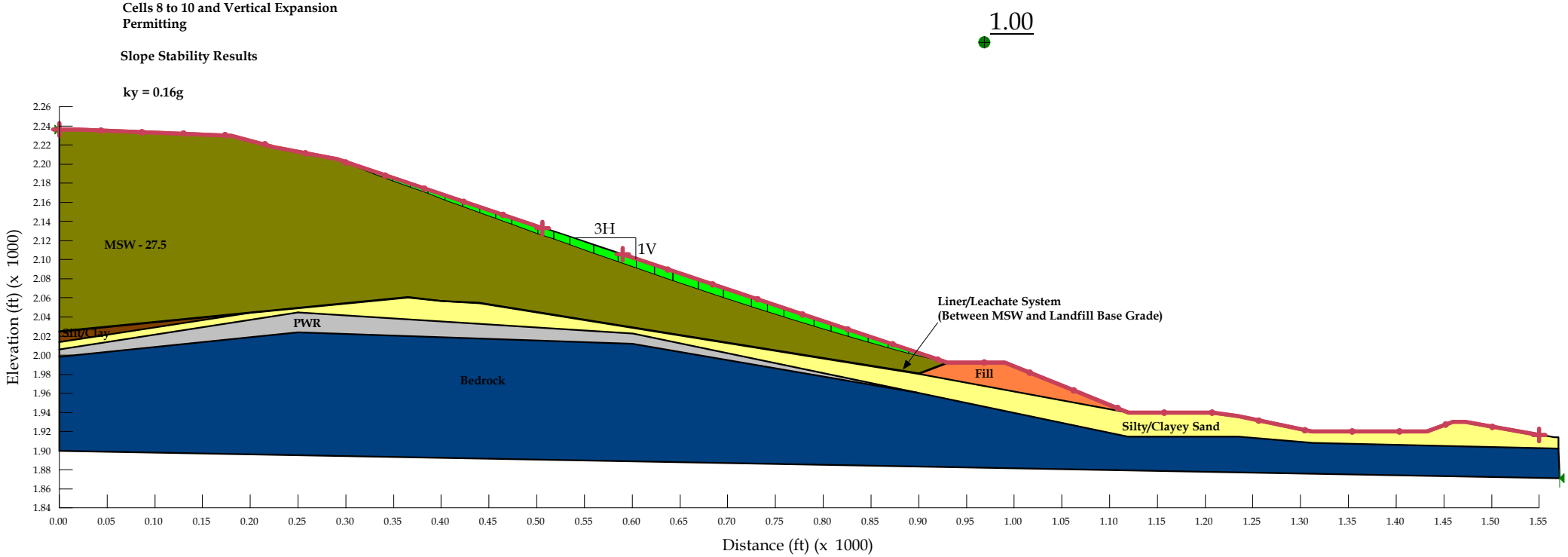
North-South Section Cells 8,9,10

Circular Slip Surface - Seismic Analysis
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °

Buncombe County
Cells 8 to 10 and Vertical Expansion
Permitting

Slope Stability Results

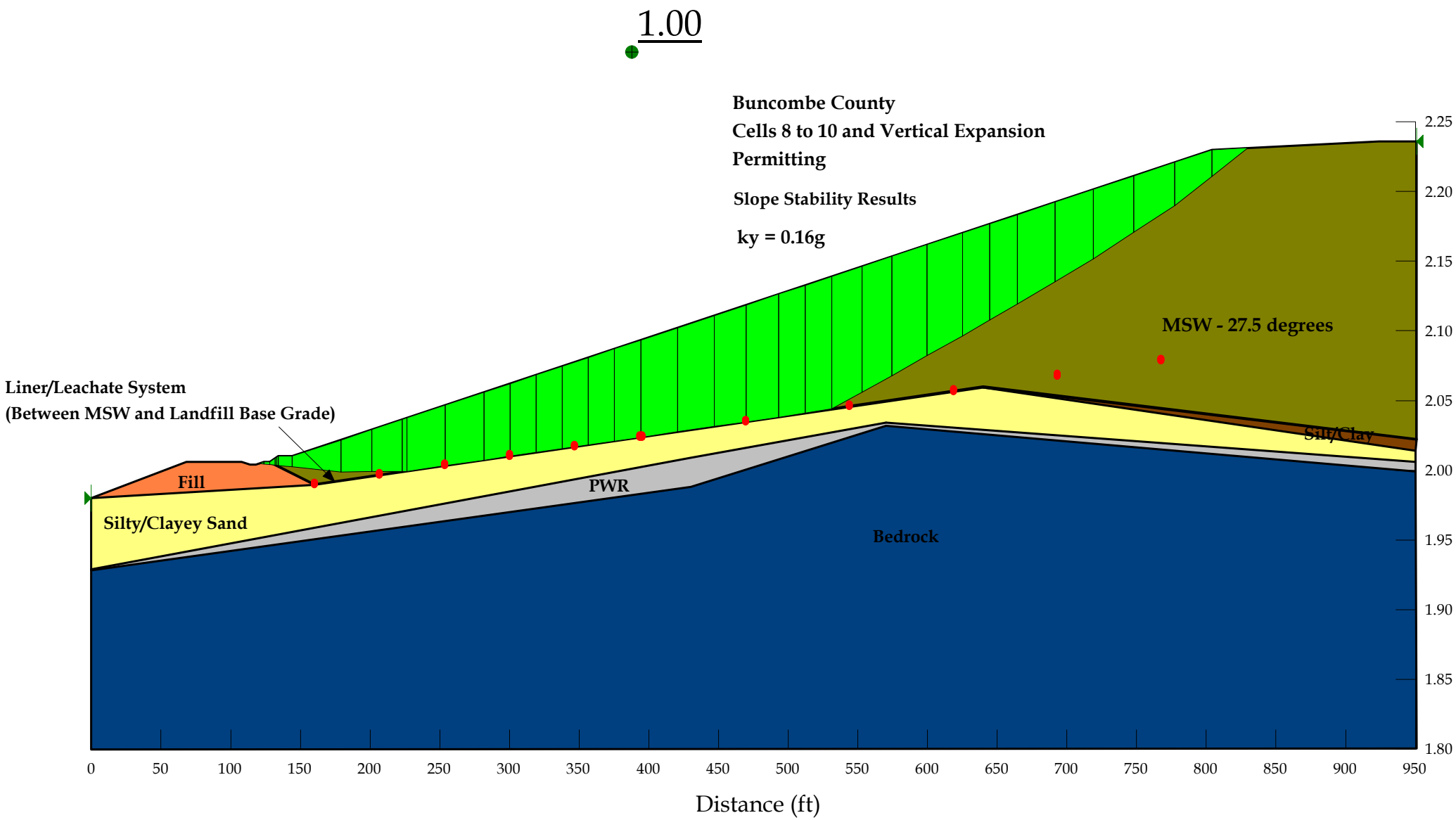
ky = 0.16g



East-West Section Cells 8,9,10

Block Slip Surface - Seismic Analysis

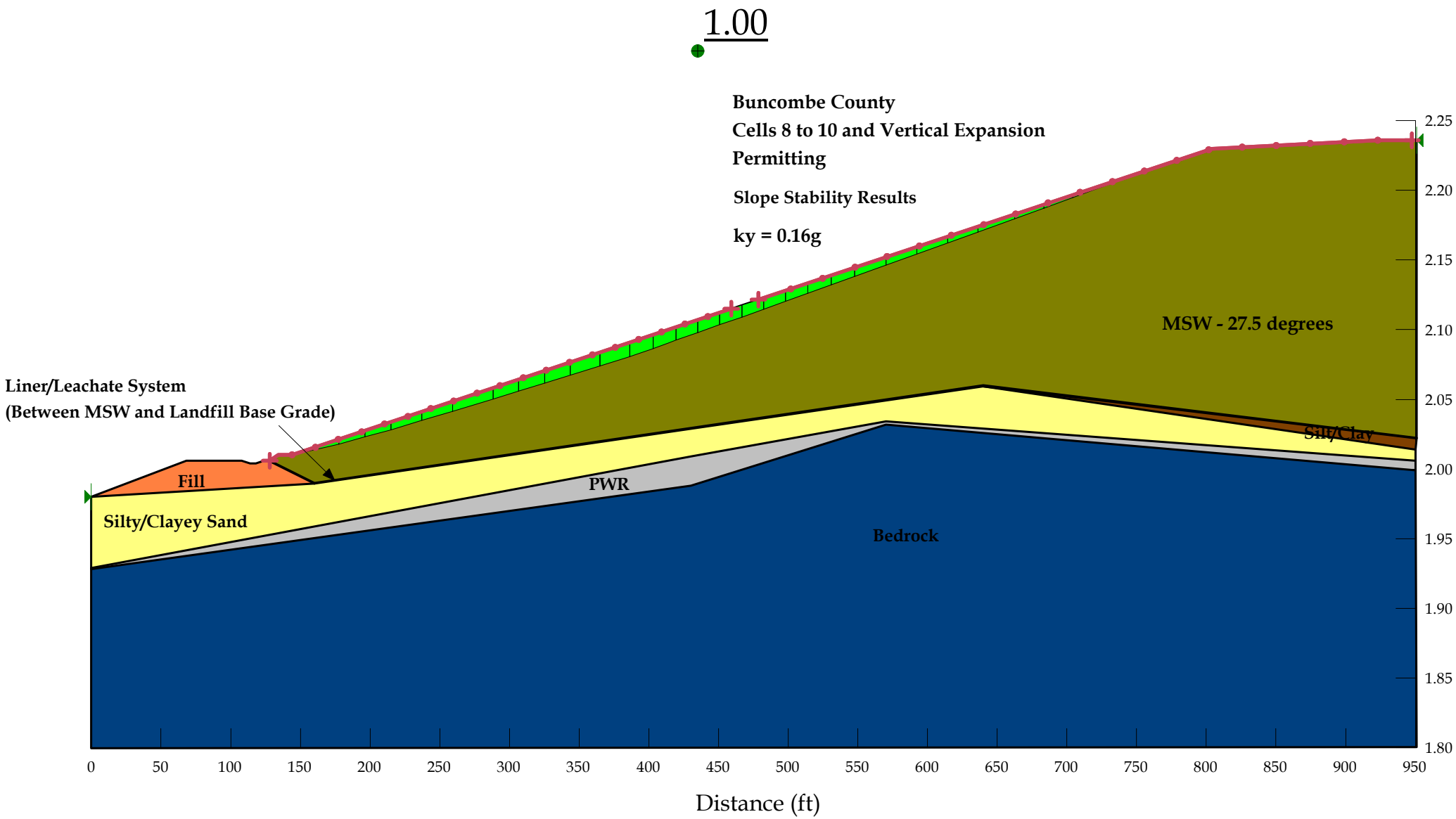
MSW Strength: Cohesion: 0 psf & Phi: 27.5 °



East-West Section

Circular Slip Surface - Seismic Analysis

MSW Strength: Cohesion: 0 psf & Phi: 27.5 °



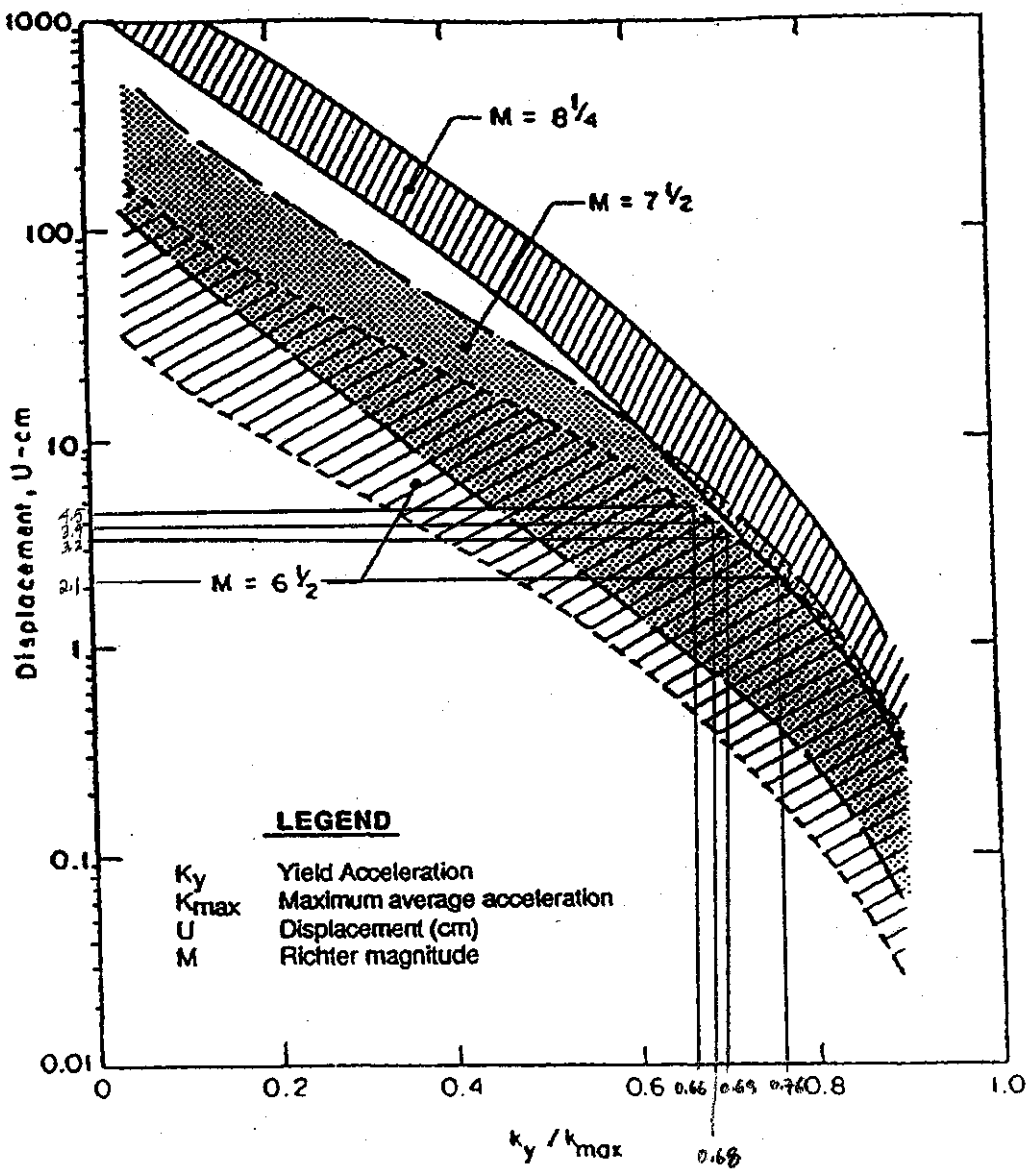


Figure 6.6 Makdisi and Seed Permanent Displacement Chart (Makdisi and Seed, 1978).

Attachment C

Veneer Stability Analysis

Client:	Buncombe County	Computed By: RHL
Project:	Cell 7,8,9,10 Permit	Date: 7/1/2013
Project No.:	6447-37693	Checked by: JW
		Date: 7/8/2013

Veneer Slope Stability Analysis

Maximum Slope Height = 216 feet Cross Section (3H:1V)
Parallel Seepage Over a Finite Slope

Input Parameter	Value	Unit	Definition
h	2	ft	Thickness of Cover Layer
H	216	ft	Height of Slope
h_w	0	ft	Depth of Water
γ_{total}	120	lb/ft^3	Total Unit Weight
γ_{dry}	110	lb/ft^3	Dry Unit Weight
ϕ_{soil}	30	Degrees	Friction Angle of Soil (Drained) or (Undrained)
ϕ_{soil}	0.52	Radians	
δ	26.5	Degrees	Interfacial Friction Angle
δ	0.46	Radians	
Slope (H:V)	3	1	Slope Ratio
β	18.44	Degrees	Slope Angle
β	0.32	Radians	

Ouput Terms	Value	Unit	Definition
W_A	149,538	lbs/ft	Total Weight of Active Wedge
U_N	0.00	lbs/ft	Resultant of Pore Pressures Acting Perpendicular to Slope including Gas Pressure
U_H	0.00	lbs/ft	Resultant of Pore Pressures Acting Between Wedges
N_A	141,864	lbs/ft	Effective Force Normal to Failure Plane of Active Wedge
W_P	733.33	lbs/ft	Total Weight of Passive Wedge
U_V	0.00	lbs/ft	Resultant of Pore Pressures Acting on Passive Wedge Base

Quadratic Terms	
a	44,861
b	-76,158
c	12,914
FS	**1.51**

Reference: Koerner, Robert M. and Daniel, David E. (1997) Final Covers for Solid Waste Landfills and Abandoned Dumps, American Society of Civil Engineers, pp.190-193.

Attachment D

Geocomposite Drainage Net Calculation

Client:	Buncombe County	Computed By:	RHL
Project:	Cell 7,8,9,10 Permit	Date:	7/1/2013
Poject No.:	6447-97693	Checked By:	JW
		Date:	7/8/2013

Task: **Check geocomposite Drainage Net for Cap Side Slopes**

Given:

- Protective cover soils with hydraulic conductivities of $k \leq 1X\ 10^{-4}$ cm/ sec
- 24-inches protective soil layer
- Tri-axial geocomposite drainage net

Calculation:

$$\phi_{required} = \frac{I \times L_p}{i}$$

$$i = \frac{\Delta H}{L}$$

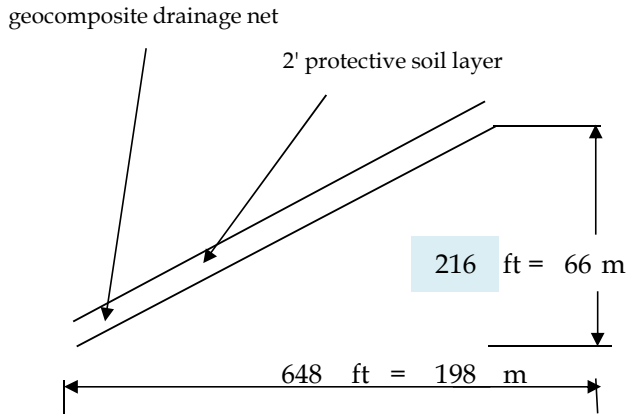
where:

$\phi_{required}$ = required transmissivity of the geocomposite drainage net

I = $k_{required\ soil}$ = 1.0E-04 cm/sec = 1.0E-06 m/sec

i = gradient = sin (3 H: 1 V slope) = 0.32

L_p = horizontal slope length



L_p= 198 m

Note: Not to scale

Client:	Buncombe County	Computed By:	RHL
Project:	Cell 7,8,9,10 Permit	Date:	7/1/2013
Poject No.:	6447-97693	Checked By:	JW
		Date:	7/8/2013

* $$\phi_{required} = \frac{I \times L_p}{i}$$

$$= \frac{0.000001 \text{ m/sec} \times 197.5104 \text{ m}}{0.32}$$

$$= \mathbf{6.2E\text{-}04} \quad \mathbf{m^2/s}$$

* $$\phi_{allowable} = \phi_{required} \times FS$$

where:

$\phi_{allowable}$ = allowable transmissivity of the geocomposite drainage net.

FS = Overall Factor of Safety for Drainage = 2.0

$$\phi_{allowable} = \mathbf{1.25E\text{-}03} \quad \mathbf{m^2/s}$$

* $$\phi_{ultimate} = \phi_{allowable} \times RF_{CR} \times RF_{CC} \times RF_{BC} \times RF_{IN}$$

where:

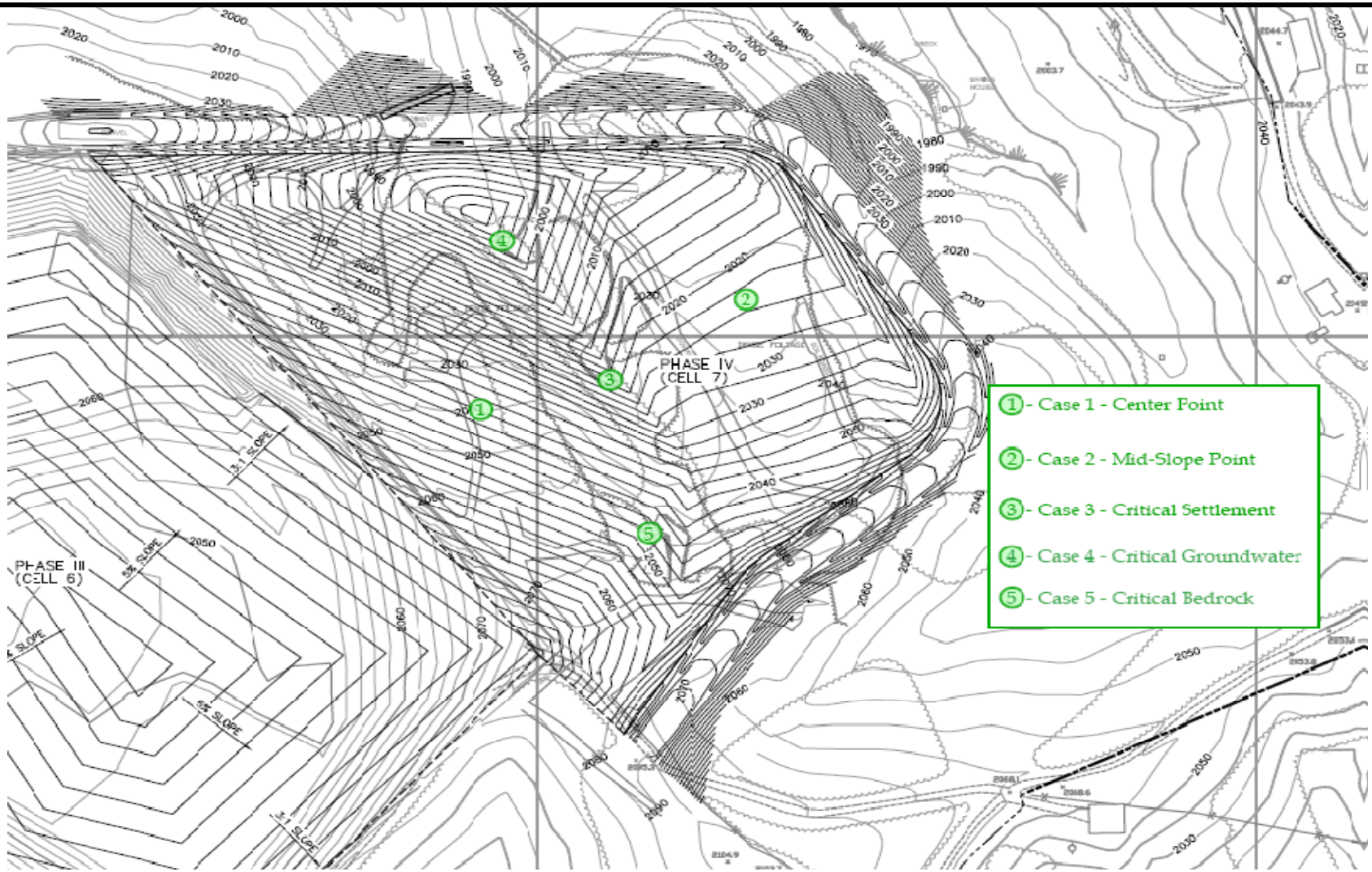
$\phi_{allowable}$ = ultimate transmissivity of the geocomposite drainage net.

RF_{CR}	=	Reduction factor of creep =	1.2	Range: 1.2 to 1.4
RF_{CC}	=	Reduction factor of chemical clogging =	1.2	Range: 1.0 to 1.2
RF_{BC}	=	Reduction factor of biological clogging =	1.5	Range: 1.2 to 1.5
RF_{IN}	=	Reduction factor of geotextile intrusion =	1.3	Range: 1.3 to 1.5

$$\phi_{ultimate} = \mathbf{3.5E\text{-}03} \quad \mathbf{m^2/s}$$

Appendix E

Settlement Analyses



CDM Smith

BUNCOMBE COUNTY

SUBTITLE D LANDFILL
CELL 7 PHASE IV
PERMIT

LOCATIONS OF CALCULATED
SETTLEMENT ESTIMATES

PROJECT NO.	6447-97693
DATE	7/25/2013

Figure No.

E1

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Center Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	1 of 6
FILE NAME:	Assume 140-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 38.5 feet residual soil.				

Purpose: To estimate the amount of settlement at the site under MSW Waste and Cap Material.

Problem: Model foundation settlement due to increase in load on foundation soils

Reference: 1. Schmertmann, John "Static Cone To Compare Static Settlement Over Sands", Journal of the Soil Mechanics and Foundations Division, ASCE, May 1970.

2. Boussinesq Stress Influence Diagrams.

3. USACE, "Engineering Design - Settlement Analysis", EM 1110-1-1904, September 30, 1990.

Soil Information: Borings underneath the Cell 7 footprint

Assumptions:
- Vertical stress increases are based on Boussinesq stress distribution.
- MSW Waste unit weight is 90 pcf.
- All split spoon sampling was carried out according to ASTM D1556.
- Loading occurs instantaneously.
- Soils below the foundation are cohesionless.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/13
DETAIL:	Settlement @ Center Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	2 of 6

FILE NAME: Assume 140-foot-thick MSW Waste and 2-foot-thick Cap Material
Assume compressible profile includes 0 feet of fill and 38.5 feet residual soil.

Depth (ft)	B-724	
	N SPT Value	SOIL TYPE
1	17	SM
5	32	SW
10	33	SM
15	66	SM
20	49	SM
25	53	SW
30	50	SW
35	100	PWR
38.5	100	ROCK

Note:
1. Depth relative to borehole ground surface (EL 2056)
2. Design SPT N-values and layer thicknesses are based on the borings provided in 2012 Cell 7 Hydrogeologic Report.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Center Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	3 of 6
FILE NAME:	Assume 140-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 38.5 feet residual soil.				

Soil Type:	Silty Sand	
Depth of Water Table (d) ft.	0	
Depth of Foundation (D) ft.	0	
Length of Foundation (L) ft.	800	
Width of Foundation (B) ft.	800	
L/B	1.00	
Z/B	2.00	
Compressible Layer Thickness (H) ft.	0	(From Model Profile)
Amount of Placed Fill	0	feet
Existing overburden pressure (tsf)	0.00	(At Foundation Level)
Additional Loading (tsf)	6.42	(Based on Additional Load @ Foundation Level)
MSW Waste Unit Weight	90.00	pcf
MSW Thickness	140.00	feet
Cap Material Thickness	2.00	feet
Foundation Load	12,840	psf

CDM Smith

CLIENT:	Buncombe County	JOB NO:	6447-97693	COMP BY:	R. Lawrence
PROJECT:	Cell 7	DATE CHK:	D. Neamtu	DATE:	6/25/2013
DETAIL:	Settlement @ Center Point	CHECK BY:	7/22/2013	PAGE NO:	4 of 6
FILE NAME:	Assume 140-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 38.5 feet residual soil.				

Boussinesq- Vertical Stress Below the center of a Uniformly Loaded Square Area

B= 800 ft

Simplified Method

$$Iz = [1-(\frac{1}{1+(B/2z)^2})^{1.76}]$$

Increments	Depth (ft.)	Strain Influence
1	2.50	1.000
2	7.50	1.000
3	12.50	1.000
4	17.50	1.000
5	22.50	1.000
6	27.50	1.000
7	32.50	1.000
8	36.75	1.000

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Center Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	5 of 6
FILE NAME:	Assume 140-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 38.5 feet residual soil.				

Soil Type:		
Soil	*q_c/N*	*Descrpition*
Silt	2	Combination of silts, sandy silts, slightly cohesive sand-silts.
Silty Sand	2.75	Silty sands
Sand	3.5	Clean to slightly silty sands.

Where: q_c = Average Dutch Cone Resistance
N = SPT N value

Strain Condition:		
Strain	*Es/qc*	*Descrpition*
Axisymmetric	2.5	L/B = 1
Plane	3.5	L/B > 10

CDM Smith

CLIENT:	Buncombe County	JOB NO:	6447-97693	COMP BY:	R. Lawrence
PROJECT:	Cell 7	DATE CHK:	D. Neamtu	DATE:	6/25/2013
DETAIL:	Settlement @ Center Point	CHECK BY:	7/22/2013	PAGE NO:	6 of 6
FILE NAME:	Assume 140-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 38.5 feet residual soil.				

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)
1	5	17	46.8	116.9	2.50	1.000	0.0428
2	5	32	88.0	220.0	7.50	1.000	0.0227
3	5	33	90.8	226.9	12.50	1.000	0.0220
4	5	66	181.5	453.8	17.50	1.000	0.0110
5	5	49	134.8	336.9	22.50	1.000	0.0148
6	5	53	145.8	364.4	27.50	1.000	0.0137
7	5	50	137.5	343.8	32.50	1.000	0.0145
8	3.5	100	275.0	687.5	36.75	1.000	0.0051

Total Settlement/tsf 0.1468 ft/tsf

Notes:

1 Refer to Boring Information for average N values (not corrected).
2 Refer to reference page for values.
3 Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4 Strain influence is based on Boussinesq distribution.
5 Represents the settlement attributed to each layer assuming C_1 equal to 1.
6 Layer 0 represents the presence of fill placed for grading to landfill base grade (assumed SPT of 25).

Settlement

t = 0 year e = **11.3** Inches at Center

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Midslope Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	1 of 6
FILE NAME:	Assume 75-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 48.5 feet residual soil.				

Purpose: To estimate the amount of settlement at the site under MSW Waste and Cap Material.

Problem: Model foundation settlement due to increase in load on foundation soils

Reference: 1. Schmertmann, John "Static Cone To Compare Static Settlement Over Sands", Journal of the Soil Mechanics and Foundations Division, ASCE, May 1970.

2. Boussinesq Stress Influence Diagrams.

3. USACE, "Engineering Design - Settlement Analysis", EM 1110-1-1904, September 30, 1990.

Soil Information: Borings underneath the Cell 7 footprint

Assumptions:
- Vertical stress increases are based on Boussinesq stress distribution.
- MSW Waste unit weight is 90 pcf.
- All split spoon sampling was carried out according to ASTM D1556.
- Loading occurs instantaneously.
- Soils below the foundation are cohesionless.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/13
DETAIL:	Settlement @ Midslope Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	2 of 6
FILE NAME:	Assume 75-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 48.5 feet residual soil.				

Depth (ft)	B-728	
	N SPT Value	SOIL TYPE
1	7	SM
6	14	SM
11	6	SM
16	8	SM
21	22	SM
26	51	SM
31	18	SM
36	24	SM
41	71	SM
46	100	PWR
48.5	100	ROCK

Note:
1. Depth relative to borehole ground surface (EL 2030)
2. Design SPT N-values and layer thicknesses are based on the borings provided in 2012 Cell 7 Hydrogeologic Report.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Midslope Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	3 of 6
FILE NAME:	Assume 75-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 48.5 feet residual soil.				

Soil Type:	Silty Sand	
Depth of Water Table (d) ft.	0	
Depth of Foundation (D) ft.	0	
Length of Foundation (L) ft.	800	
Width of Foundation (B) ft.	800	
L/B	1.00	
Z/B	2.00	
Compressible Layer Thickness (H) ft.	0	(From Model Profile)
Amount of Placed Fill	0	feet
Existing overburden pressure (tsf)	0.00	(At Foundation Level)
Additional Loading (tsf)	3.50	(Based on Additional Load @ Foundation Level)
MSW Waste Unit Weight	90.00	pcf
MSW Thickness	75.00	feet
Cap Material Thickness	2.00	feet
Foundation Load	6,990	psf

CLIENT:	Buncombe County	JOB NO:	6447-97693	COMP BY:	R. Lawrence
PROJECT:	Cell 7	DATE CHK:	D. Neamtu	DATE:	6/25/2013
DETAIL:	Settlement @ Midslope Point	CHECK BY:	7/22/2013	PAGE NO:	4 of 6
FILE NAME:	Assume 75-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 48.5 feet residual soil.				

Boussinesq- Vertical Stress Below the center of a Uniformly Loaded Square Area

B= 800 ft

Simplified Method

$$Iz = [1 - (\frac{1}{1 + (B/2z)^2})^{1.76}]$$

Increments	Depth (ft.)	Strain Influence
1	3.00	1.000
2	8.50	1.000
3	13.50	1.000
4	18.50	1.000
5	23.50	1.000
6	28.50	1.000
7	33.50	1.000
8	38.50	1.000

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Midslope Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	5 of 6
FILE NAME:	Assume 75-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 48.5 feet residual soil.				

Soil Type:		
Soil	*q_c/N*	*Descrpition*
Silt	2	Combination of silts, sandy silts, slightly cohesive sand-silts.
Silty Sand	2.75	Silty sands
Sand	3.5	Clean to slightly silty sands.

Where: q_c = Average Dutch Cone Resistance
N = SPT N value

Strain Condition:		
Strain	*Es/qc*	*Descrpition*
Axisymmetric	2.5	L/B = 1
Plane	3.5	L/B > 10

CDM Smith

CLIENT:	Buncombe County	JOB NO:	6447-97693	COMP BY:	R. Lawrence
PROJECT:	Cell 7	DATE CHK:	D. Neamtu	DATE:	6/25/2013
DETAIL:	Settlement @ Midslope Point	CHECK BY:	7/22/2013	PAGE NO:	6 of 6
FILE NAME:	Assume 75-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 0 feet of fill and 48.5 feet residual soil.				

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)
1	6	7	19.3	48.1	3.00	1.000	0.1247
2	5	14	38.5	96.3	8.50	1.000	0.0519
3	5	6	16.5	41.3	13.50	1.000	0.1212
4	5	8	22.0	55.0	18.50	1.000	0.0909
5	5	22	60.5	151.3	23.50	1.000	0.0331
6	5	51	140.3	350.6	28.50	1.000	0.0143
7	5	18	49.5	123.8	33.50	1.000	0.0404
8	5	24	66.0	165.0	38.50	1.000	0.0303
9	5	71	195.3	488.1	43.50	1.000	0.0102
10	2.5	100	275.0	687.5	47.25	0.999	0.0036

Total Settlement/tsf 0.5206 ft/tsf

Notes:

1. Refer to Boring Information for average N values (not corrected).
2. Refer to reference page for values.
3. Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4. Strain influence is based on Boussinesq distribution.
5. Represents the settlement attributed to each layer assuming C_1 equal to 1.
6. Layer 0 represents the presence of fill placed for grading to landfill base grade (assumed SPT of 25).

Settlement

t = 0 year e = **21.8** Inches at Center

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical Set Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	1 of 6
FILE NAME:	Assume 130-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 10 feet of fill and 53.5 feet residual soil.				

Purpose: To estimate the amount of settlement at the site under MSW Waste and Cap Material.

Problem: Model foundation settlement due to increase in load on foundation soils

Reference: 1. Schmertmann, John "Static Cone To Compare Static Settlement Over Sands", Journal of the Soil Mechanics and Foundations Division, ASCE, May 1970.

2. Boussinesq Stress Influence Diagrams.

3. USACE, "Engineering Design - Settlement Analysis", EM 1110-1-1904, September 30, 1990.

Soil Information: Borings underneath the Cell 7 footprint

Assumptions:
- Vertical stress increases are based on Boussinesq stress distribution.
- MSW Waste unit weight is 90 pcf.
- All split spoon sampling was carried out according to ASTM D1556.
- Loading occurs instantaneously.
- Soils below the foundation are cohesionless.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/13
DETAIL:	Settlement @ Critical Set Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	2 of 6
FILE NAME:	Assume 130-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 10 feet of fill and 53.5 feet residual soil.				

Depth (ft)	B-727d	
	N SPT Value	SOIL TYPE
1	8	SM
6	8	SM
11	16	SM
16	14	SP
21	39	SW
26	22	SW
31	22	SW
36	27	SW
41	100	PWR
46	100	PWR
51	100	PWR
53.5	100	ROCK

Note:
1. Depth relative to borehole ground surface (EL 2007)
2. Design SPT N-values and layer thicknesses are based on the borings provided in 2012 Cell 7 Hydrogeologic Report.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical Set Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	3 of 6
FILE NAME:	Assume 130-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 10 feet of fill and 53.5 feet residual soil.				

Soil Type:	Silty Sand	
Depth of Water Table (d) ft.	0	
Depth of Foundation (D) ft.	0	
Length of Foundation (L) ft.	800	
Width of Foundation (B) ft.	800	
L/B	1.00	
Z/B	2.00	
Compressible Layer Thickness (H) ft.	53.5	(From Model Profile)
Amount of Placed Fill	10	feet
Existing overburden pressure (tsf)	0.00	(At Foundation Level)
Additional Loading (tsf)	5.97	(Based on Additional Load @ Foundation Level)
MSW Waste Unit Weight	90.00	pcf
MSW Thickness	130.00	feet
Cap Material Thickness	2.00	feet
Foundation Load	11,940	psf

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical Set Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	4 of 6
FILE NAME:	Assume 130-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 10 feet of fill and 53.5 feet residual soil.				

Boussinesq- Vertical Stress Below the center of a Uniformly Loaded Square Area

B= 800 ft

Simplified Method

$$Iz = [1 - (\frac{1}{1 + (B/2z)^2})^{1.76}]$$

Increments	Depth (ft.)	Strain Influence
0(6)	5.00	1.000
1	13.00	1.000
2	18.50	1.000
3	23.50	1.000
4	28.50	1.000
5	33.50	1.000
6	38.50	1.000
7	43.50	1.000
8	48.50	0.999

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical Set Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	5 of 6
FILE NAME:	Assume 130-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 10 feet of fill and 53.5 feet residual soil.				

Soil Type:		
Soil	*q_c/N*	*Descrpition*
Silt	2	Combination of silts, sandy silts, slightly cohesive sand-silts.
Silty Sand	2.75	Silty sands
Sand	3.5	Clean to slightly silty sands.

Where: q_c = Average Dutch Cone Resistance
N = SPT N value

Strain Condition:		
Strain	*Es/qc*	*Descrpition*
Axisymmetric	2.5	L/B = 1
Plane	3.5	L/B > 10

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical Set Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	6 of 6
FILE NAME:	Assume 130-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 10 feet of fill and 53.5 feet residual soil.				

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)
0(6)	10	25	68.8	171.9	5	1.000	0.0582
1	6	8	22.0	55.0	13.00	1.000	0.1091
2	5	8	22.0	55.0	18.50	1.000	0.0909
3	5	16	44.0	110.0	23.50	1.000	0.0455
4	5	14	38.5	96.3	28.50	1.000	0.0519
5	5	39	107.3	268.1	33.50	1.000	0.0186
6	5	22	60.5	151.3	38.50	1.000	0.0330
7	5	22	60.5	151.3	43.50	1.000	0.0330
8	5	27	74.3	185.6	48.50	0.999	0.0269
9	5	100	275.0	687.5	53.50	0.999	0.0073
10	5	100	275.0	687.5	58.50	0.999	0.0073
11	2.5	100	275.0	687.5	62.25	0.999	0.0036

Total Settlement/tsf 0.4854 ft/tsf

Notes:

1. Refer to Boring Information for average N values (not corrected).
2. Refer to reference page for values.
3. Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4. Strain influence is based on Boussinesq distribution.
5. Represents the settlement attributed to each layer assuming C_1 equal to 1.
6. Layer 0 represents the presence of fill placed for grading to landfill base grade (assumed SPT of 25).

Settlement

t = 0 year e = **34.8** Inches at Center

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical GW Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	1 of 6
FILE NAME:	Assume 70-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of fill and 53.5 feet residual soil.				

Purpose: To estimate the amount of settlement at the site under MSW Waste and Cap Material.

Problem: Model foundation settlement due to increase in load on foundation soils

Reference: 1. Schmertmann, John "Static Cone To Compare Static Settlement Over Sands", Journal of the Soil Mechanics and Foundations Division, ASCE, May 1970.

2. Boussinesq Stress Influence Diagrams.

3. USACE, "Engineering Design - Settlement Analysis", EM 1110-1-1904, September 30, 1990.

Soil Information: Borings underneath the Cell 7 footprint

Assumptions:
- Vertical stress increases are based on Boussinesq stress distribution.
- MSW Waste unit weight is 90 pcf.
- All split spoon sampling was carried out according to ASTM D1556.
- Loading occurs instantaneously.
- Soils below the foundation are cohesionless.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/13
DETAIL:	Settlement @ Critical GW Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	2 of 6
FILE NAME:	Assume 70-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of fill and 53.5 feet residual soil.				

Depth (ft)	B-724	
	N SPT Value	SOIL TYPE
1	8	SM
6	8	SM
11	16	SM
16	14	SP
21	39	SW
26	22	SW
31	22	SW
36	27	SW
41	100	PWR
46	100	PWR
51	100	PWR
53.5	100	ROCK

Note:
1. Depth relative to borehole ground surface (EL 2007)
2. Design SPT N-values and layer thicknesses are based on the borings provided in 2012 Cell 7 Hydrogeologic Report.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical GW Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	3 of 6
FILE NAME:	Assume 70-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of fill and 53.5 feet residual soil.				

Soil Type:	Silty Sand	
Depth of Water Table (d) ft.	0	
Depth of Foundation (D) ft.	0	
Length of Foundation (L) ft.	800	
Width of Foundation (B) ft.	800	
L/B	1.00	
Z/B	2.00	
Compressible Layer Thickness (H) ft.	53.5	(From Model Profile)
Amount of Placed Fill	5	feet
Existing overburden pressure (tsf)	0.00	(At Foundation Level)
Additional Loading (tsf)	3.27	(Based on Additional Load @ Foundation Level)
MSW Waste Unit Weight	90.00	pcf
MSW Thickness	70.00	feet
Cap Material Thickness	2.00	feet
Foundation Load	6,540	psf

CDM Smith

CLIENT:	Buncombe County	JOB NO:	6447-97693	COMP BY:	R. Lawrence
PROJECT:	Cell 7	DATE CHK:	D. Neamtu	DATE:	6/25/2013
DETAIL:	Settlement @ Critical GW Point	CHECK BY:	7/22/2013	PAGE NO:	4 of 6
FILE NAME:	Assume 70-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of fill and 53.5 feet residual soil.				

Boussinesq- Vertical Stress Below the center of a Uniformly Loaded Square Area

B= 800 ft

Simplified Method

$$Iz = [1 - (\frac{1}{1 + (B/2z)^2})^{1.76}]$$

Increments	Depth (ft.)	Strain Influence
0(6)	2.50	1.000
1	8.00	1.000
2	13.50	1.000
3	18.50	1.000
4	23.50	1.000
5	28.50	1.000
6	33.50	1.000
7	38.50	1.000
8	43.50	1.000

CDM Smith

CLIENT:	Buncombe County	JOB NO:	6447-97693	COMP BY:	R. Lawrence
PROJECT:	Cell 7	DATE CHK:	D. Neamtu	DATE:	6/25/2013
DETAIL:	Settlement @ Critical GW Point	CHECK BY:	7/22/2013	PAGE NO:	5 of 6
FILE NAME:	Assume 70-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of fill and 53.5 feet residual soil.				

Soil Type:		
Soil	*q_c/N*	*Descrpition*
Silt	2	Combination of silts, sandy silts, slightly cohesive sand-silts.
Silty Sand	2.75	Silty sands
Sand	3.5	Clean to slightly silty sands.

Where: q_c = Average Dutch Cone Resistance
N = SPT N value

Strain Condition:		
Strain	*Es/qc*	*Descrpition*
Axisymmetric	2.5	L/B = 1
Plane	3.5	L/B > 10

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical GW Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	6 of 6
FILE NAME:	Assume 70-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of fill and 53.5 feet residual soil.				

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)
0(6)	5	25	68.8	171.9	2.5	1.000	0.0291
1	6	8	22.0	55.0	8.00	1.000	0.1091
2	5	8	22.0	55.0	13.50	1.000	0.0909
3	5	16	44.0	110.0	18.50	1.000	0.0455
4	5	14	38.5	96.3	23.50	1.000	0.0519
5	5	39	107.3	268.1	28.50	1.000	0.0186
6	5	22	60.5	151.3	33.50	1.000	0.0331
7	5	22	60.5	151.3	38.50	1.000	0.0330
8	5	27	74.3	185.6	43.50	1.000	0.0269
9	5	100	275.0	687.5	48.50	0.999	0.0073
10	5	100	275.0	687.5	53.50	0.999	0.0073
11	2.5	100	275.0	687.5	57.25	0.999	0.0036

Total Settlement/tsf 0.4563 ft/tsf

Notes:

1 Refer to Boring Information for average N values (not corrected).
2 Refer to reference page for values.
3 Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4 Strain influence is based on Boussinesq distribution.
5 Represents the settlement attributed to each layer assuming C_1 equal to 1.
6 Layer 0 represents the presence of fill placed for grading to landfill base grade (assumed SPT of 25).

Settlement

t = 0 year e = **17.9** Inches at Center

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical Bedrock Poi	**CHECK BY:**	7/22/2013	**PAGE NO:**	1 of 6
FILE NAME:	Assume 100-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of cut and 8.5 feet residual soil.				

Purpose: To estimate the amount of settlement at the site under MSW Waste and Cap Material.

Problem: Model foundation settlement due to increase in load on foundation soils

Reference: 1. Schmertmann, John "Static Cone To Compare Static Settlement Over Sands", Journal of the Soil Mechanics and Foundations Division, ASCE, May 1970.

2. Boussinesq Stress Influence Diagrams.

3. USACE, "Engineering Design - Settlement Analysis", EM 1110-1-1904, September 30, 1990.

Soil Information: Borings underneath the Cell 7 footprint

Assumptions:
- Vertical stress increases are based on Boussinesq stress distribution.
- MSW Waste unit weight is 90 pcf.
- All split spoon sampling was carried out according to ASTM D1556.
- Loading occurs instantaneously.
- Soils below the foundation are cohesionless.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/13
DETAIL:	Settlement @ Critical Bedrock Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	2 of 6
FILE NAME:	Assume 100-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of cut and 8.5 feet residual soil.				

Depth (ft)	B-724	
	N SPT Value	SOIL TYPE
1	16	SM
5	100	PWR
8.5	100	ROCK

Note:
1. Depth relative to borehole ground surface - 5 feet of cut (EL 2051)
2. Design SPT N-values and layer thicknesses are based on the borings provided in 2012 Cell 7 Hydrogeologic Report.

CDM Smith

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical Bedrock Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	3 of 6
FILE NAME:	Assume 100-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of cut and 8.5 feet residual soil.				

Soil Type:	Silty Sand	
Depth of Water Table (d) ft.	0	
Depth of Foundation (D) ft.	0	
Length of Foundation (L) ft.	800	
Width of Foundation (B) ft.	800	
L/B	1.00	
Z/B	2.00	
Compressible Layer Thickness (H) ft.	0	(From Model Profile)
Amount of Placed Fill	0	feet
Existing overburden pressure (tsf)	0.00	(At Foundation Level)
Additional Loading (tsf)	4.62	(Based on Additional Load @ Foundation Level)
MSW Waste Unit Weight	90.00	pcf
MSW Thickness	100.00	feet
Cap Material Thickness	2.00	feet
Foundation Load	9,240	psf

CDM Smith

CLIENT:	Buncombe County	JOB NO:	6447-97693	COMP BY:	R. Lawrence
PROJECT:	Cell 7	DATE CHK:	D. Neamtu	DATE:	6/25/2013
DETAIL:	Settlement @ Critical Bedrock Point	CHECK BY:	7/22/2013	PAGE NO:	4 of 6
FILE NAME:	Assume 100-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of cut and 8.5 feet residual soil.				

Boussinesq- Vertical Stress Below the center of a Uniformly Loaded Square Area

B= 800 ft

Simplified Method

$$Iz = [1 - (\frac{1}{1+(B/2z)^2})^{1.76}]$$

Increments	Depth (ft.)	Strain Influence
1	2.50	1.000
2	6.75	1.000
3	8.50	1.000
4	8.50	1.000
5	8.50	1.000
6	8.50	1.000
7	8.50	1.000
8	8.50	1.000

CLIENT:	Buncombe County	**JOB NO:**	6447-97693	**COMP BY:**	R. Lawrence
PROJECT:	Cell 7	**DATE CHK:**	D. Neamtu	**DATE:**	6/25/2013
DETAIL:	Settlement @ Critical Bedrock Point	**CHECK BY:**	7/22/2013	**PAGE NO:**	5 of 6
FILE NAME:	Assume 100-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of cut and 8.5 feet residual soil.				

Soil Type:		
Soil	*q_c/N*	*Descrpition*
Silt	2	Combination of silts, sandy silts, slightly cohesive sand-silts.
Silty Sand	2.75	Silty sands
Sand	3.5	Clean to slightly silty sands.

Where: q_c = Average Dutch Cone Resistance
N = SPT N value

Strain Condition:		
Strain	*Es/qc*	*Descrpition*
Axisymmetric	2.5	L/B = 1
Plane	3.5	L/B > 10

CDM Smith

CLIENT:	Buncombe County	JOB NO:	6447-97693	COMP BY:	R. Lawrence
PROJECT:	Cell 7	DATE CHK:	D. Neamtu	DATE:	6/25/2013
DETAIL:	Settlement @ Critical Bedrock Point	CHECK BY:	7/22/2013	PAGE NO:	6 of 6
FILE NAME:	Assume 100-foot-thick MSW Waste and 2-foot-thick Cap Material				
	Assume compressible profile includes 5 feet of cut and 8.5 feet residual soil.				

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)
1	5	16	44.0	110.0	2.50	1.000	0.0455
2	3.5	100	275.0	687.5	6.75	1.000	0.0051

Total Settlement/tsf 0.0505 ft/tsf

Notes:

1. Refer to Boring Information for average N values (not corrected).
2. Refer to reference page for values.
3. Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4. Strain influence is based on Boussinesq distribution.
5. Represents the settlement attributed to each layer assuming C_1 equal to 1.
6. Layer 0 represents the presence of fill placed for grading to landfill base grade (assumed SPT of 25).

Settlement

t = 0 year e = 2.8 Inches at Center

CDM Smith

Engineering Plan

Appendix C – Design Hydrogeological Report

CDM Smith

Buncombe County
North Carolina

Buncombe County Solid Waste Management Facility
Subtitle D Landfill
Phase IV (Cell 7) Permit to Construct Application

NORTH CAROLINA
LICENSED
SEAL
1851
GEOLOGIST
MATHEW F. COLONE

4/28/2014

Part 3 – Engineering Plan
Appendix D – Design Hydrogeological Report

BUNCOMBE COUNTY
PEOPLE TO MATCH OUR MOUNTAINS
NORTH CAROLINA

April 2014

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Section 1
Introduction

Rule .1620(b)(4) of the North Carolina Solid Waste Management Rules requires that a Design Hydrogeologic Report be prepared in accordance with the requirements set forth in Rule .1623(b). This document is intended to fulfill all of the specified criteria delineated in this rule.

1.1 Purpose and Scope

The Design Hydrogeologic Report presented herein is designed to address the applicable Solid Waste Management Rules for the Permit to Construct for Cell 7 of the Buncombe County Solid Waste Management Facility. The report compiles information from all field activities that have been conducted to date, summarizing data from previously-submitted documents, as well as subsequent investigation activities, to provide a comprehensive characterization of the geology and hydrogeology at the landfill site. The goal of this investigation is to provide sufficient technical information to design a Water Quality Monitoring Plan for Cell 7 as specified in Rule .1623(b)(3).

1.2 Report Contents

Section 1 of the Design Hydrogeologic Report discusses the purpose and scope of the report, summarizes previous and current investigation activities, and provides a cross-reference between each applicable regulatory requirement set forth in Rule .1623(b) and corresponding sections of this report. Section 2 presents a summary of the methodologies used in this field investigation, as well as data collection and evaluation activities. Section 3 presents the results of this field investigation and data analysis activities. Conclusions derived from this and previous investigations are presented in Section 4, along with a discussion of hydrogeologic factors affecting the landfill design and development of the Water Quality Monitoring Plan.

1.3 Previous Investigations

The site was initially investigated in 1990 by Law Environmental, Inc. (Law 1991). The investigation consisted of 17 exploratory soil test borings using hollow-stem augers at 12 locations. Split spoon samples were collected at regular intervals using standard penetration test methods (ASTM D - 1586). Groundwater was not encountered in any of the borings during drilling. Two borings that were left open overnight also did not accumulate groundwater. No permanent piezometers or monitoring wells were constructed. The report cited an absence of perennial surface water features and a small drainage area entering the site as advantages for landfill development, but identified limited excavation depth, scarcity of low permeability soils, and soil workability problems as potential constraints.

1.3.1 Phase I Investigation

In November 1992, a Site Plan Application (CDM 1992) was submitted on behalf of Buncombe County to the North Carolina Division of Waste Management - Solid Waste Section (SWS). A Geologic and Hydrogeologic Evaluation per SWS Rule .1632(a) was included as Section 4 of that report. The evaluation presented results of a Phase I investigation encompassing the 557-acre proposed Buncombe County Landfill site (the Site). During the Phase I investigation, three 20-foot cores and 38 hollow-stem auger borings were drilled and 19 piezometers were installed. Split spoon soil samples were collected at 5-foot

intervals while the auger borings were drilled. Blow counts required to accomplish sample collection were also recorded. Collected soil samples were analyzed for geotechnical properties, including soil classification (25 samples), grain size distribution (25 samples), Atterberg Limits (10 samples), standard proctor compaction (7 samples), natural moisture content (7 samples), porosity (14 samples), and hydraulic conductivity (7 undisturbed samples, 7 remolded samples). The rock cores were examined and descriptions recorded for fracture frequency and orientation, general mineralogy, rock quality designation, and other properties.

Water level measurements were taken in the piezometers at the time of completion, at 24 hours and at least seven days after installation, and on October 14, 1994. Piezometer measuring points were surveyed to state plane coordinates and mean sea level elevation. Falling head permeability tests (slug tests) were performed in five piezometers to obtain hydraulic conductivity data. Most of the piezometers installed were dry due to auger refusal encountered before reaching groundwater. A comprehensive literature search was also conducted during the Phase I evaluation. This search identified reference materials and mapping done by others to characterize the geology and hydrogeology of the site, as well as the surrounding region. The report concluded that the Site appeared to be suitable for landfill development.

1.3.2 Phase II Investigation

In 1993, additional field activities were conducted to address SWS comments provided by letter on April 29, 1993 concerning the Site Hydrogeologic Report. The results of these additional field activities were presented in the Response to Completeness Review (RCR) Site Plan Application dated December 1993 (CDM 1993). As part of that document, GEI Consultants, Inc. (GEI) conducted a Lineament/Fracture Trace Analysis, a Geophysical Investigation, and a Phase II Geologic/Hydrogeologic Site Evaluation. The Lineament/Fracture Trace Analysis and Geophysical Investigation included lineament analysis on maps and aerial photographs, a fracture trace analysis of rock outcroppings within the Site, and a very low frequency (VLF) geophysical survey of the Site.

The Phase II Geologic/Hydrogeologic Site Evaluation was subsequently conducted and included the drilling of boreholes at 27 locations. Some of the boring locations were selected based on the results of the VLF survey. Multiple drilling techniques were often used at each location. Thirteen locations were investigated using hollow-stem augers (HSA) with split spoon sampling as well as air rotary/hammer drilling, four locations by HSA with split spoon sampling and rock coring, nine locations by air rotary/hammer drilling only, and one location by all three methods. One permanent piezometer was installed at each of the 27 locations.

Water levels were measured in each piezometer at the time of installation, at 24 hours and at least seven days after installation. Eight of the piezometers were installed adjacent to borings drilled during the Phase I investigation that yielded no water. Piezometer measuring points were surveyed to state plane coordinates and mean sea level elevation. Water levels were also measured in the piezometers installed during the Phase I investigation. Six slug tests and/or recovery tests were performed in five piezometers to obtain additional hydraulic conductivity recovery data. A monthly piezometer water level measurement program was subsequently initiated on both the Phase I and Phase II piezometers.

The Geologic and Hydrogeologic Evaluations required under Rule .1623(a), consisting of Section 4 of the Site Plan Application (CDM 1992) and the Response to Completeness Review, Site Plan Application (CDM 1993) have been previously submitted to the SWS. Also, CDM submitted a Design Hydrogeologic Report

(Appendix G in Section 2 Engineering Plan, CDM 1995) for landfill Cells 1-3 that characterized the geology and hydrogeology as required by Rule .1623.

1.3.3 Phase III Investigation

The Phase III investigation focused on the area within and surrounding the Cells 1-3 and was completed from October to December 1994. During the Cell 1-3 Area investigation over 71 boreholes were drilled at 39 locations. Air rotary/ hammer drilling was used for 44 borings, three boreholes were cored, and 24 boreholes were drilled using hollow-stem auger drilling techniques. Geotechnical samples were collected during hollow-stem auger drilling at nine locations within the Cell 1-3 Area, and blow counts were taken at all 24 auger locations.

Piezometers were installed in 39 boreholes at 29 locations, making a total of nine nested well pairs. Observation wells were installed in eight boreholes, and two pumping wells were constructed. Water level measurements were taken at each of the piezometers at time of boring, and at 24 hours at least 7 days after boring. Piezometer measuring points were surveyed to state plane coordinates and mean sea level elevation. Slug testing was performed in 10 piezometers to obtain additional hydraulic conductivity data. Two pumping tests were performed in two hollows within the Cell 1-3 Area to further characterize the groundwater system.

1.3.4 Cells 4 and 5 Investigation

The Cells 4 and 5 investigation focused on the area within and surrounding the proposed landfill Cells 4 and 5 and was completed in April 1999. Thirty-two boreholes were drilled at 14 locations during the Cell 4-5 Area hydrogeologic investigation. Air rotary drilling was used for 18 borings and the remaining 14 boreholes were drilled using HSA. Twenty foot core samples were also collected at two HSA borehole locations. Geotechnical samples were collected during HSA drilling at four locations within the Cell 4-5 Area and blow counts were taken at all HSA boring locations.

Piezometers were installed in 19 boreholes at 14 locations, making a total of three nested well pairs. Also, three piezometers were installed at one location. Water level measurements were taken at each of the piezometers 24-hours after installation, approximately seven days after installation, on May 5, 1999 and on September 13, 1999. Piezometer measuring points were surveyed to state plane coordinates and mean sea level elevation. Slug testing was performed in seven piezometers to obtain additional hydraulic conductivity data.

1.3.5 Cell 6 Investigation

The Cell 6 investigation was completed in September and October 2004 and focused on the Cell 6 area. The Cell 6 Area extended beyond the cell boundaries and along the adjacent topographic divides in order to sufficiently characterize the hydrogeologic regime beneath Cell 6.

Thirty-five boreholes were drilled at 18 locations during the Cell 6 Area hydrogeologic investigation. Air rotary drilling was used for 17 borings and the remaining 18 boreholes were drilled using HSA. Ten foot core samples were also collected at three HSA borehole locations, B-702, B-704, and B-707. Undisturbed (Shelby Tube) samples were collected for geotechnical analysis during HSA drilling at 2 locations within the Cell 6 Area (B-709 and B-714). Blow counts and SPT samples were taken at all HSA boring locations. Several split spoon (jar) samples were submitted for grain size and Atterberg Limit analysis.

Piezometers were installed in 22 boreholes at 18 locations, making a total of 5 nested well pairs (BC-101/B-701d, B-703s/703d, B-706s/706d, B-708s/708d, and B-711s/711d). Water level measurements were taken at each of the piezometers 24-hours after installation, approximately seven days after installation, and on October 14, 2004. Piezometer measuring points were surveyed to state plane coordinates and mean sea level elevation.

1.4 Current Investigation

The current investigation was completed from July through October 2012 and focused on the proposed Cell 7 area. Similar to the adjacent Cell 6 area, the Cell 7 area extended beyond the cell boundaries and along the adjacent topographic divides in order to sufficiently characterize the hydrogeologic regime beneath Cell 7. **Sheet 1** (in Section 2) delineates this area of focused investigation as well as the existing Cells 1-6, proposed Cell 7, and future Cells 8 through 10 areas.

Twenty-one boreholes were drilled at 12 locations during the Cell 7 hydrogeologic investigation. Air rotary drilling was used for 8 borings and the remaining 13 boreholes were drilled using HSA. Ten foot core samples were also collected at two locations, B-724 and B-727. Undisturbed (Shelby Tube) samples were collected for geotechnical analysis during HSA drilling at 3 locations within the Cell 7 Area (B-722, 726, and B-727). Blow counts and SPT samples were taken at all HSA boring locations. Two bulk samples were submitted for remolded permeability analysis and several split spoon (jar) samples were submitted for grain size and Atterberg Limit analysis.

Piezometers were installed in 15 boreholes at 12 locations, making a total of 3 nested well pairs (B-720s/B-720d, B722s/B-722d, and B-727s/727d). Water level measurements were taken at each of the piezometers 24-hours after installation, approximately seven days after installation, on September 6, 2012, and again on October 10, 2012. Piezometer measuring points were surveyed to state plane coordinates and mean sea level elevation.

In addition to the drilling work completed in the proposed Cell 7, 9 test pits were excavated. The test pits were generally excavated to depths of about 16 feet in order to estimate the amount of rock that may be encountered during construction. Test pit locations and field descriptions of each location are provided in **Appendix C**.

1.5 Regulatory Cross Reference

The requirements of the Design Hydrogeologic Report are detailed in North Carolina Solid Waste Management Rule .1623(b). In order to facilitate the review of this document and to ensure completeness as required under this rule, a regulatory cross reference is provided in **Table 1-1**. This table lists all of the pertinent requirements under Rule .1623(b), and references corresponding sections of this report.

As previously noted, some of the required information under Rule .1623(b)(2)(A) has already been presented in detail as part of the previous investigation reports. This information has been summarized only to the extent necessary to provide sufficient technical information needed to support design of the monitoring system and determine the relevant point of compliance.

Table 1-1
Cross Reference to Regulations
Buncombe County Subtitle D Landfill - Cell 7
Design Hydrogeologic Report

Rule	*Requirements*	*Report Section(s)*
.1623(b)(2)(A)	Information required in subparagraphs (a)(4) through (a)(12) of Rule .1623	
	.1623(a)(4) Testing program for borings describing the frequency, distribution, and type of samples and methods of analyses	2
	-Standard Penetration-Resistance (A)	2.1, 3.1.7
	-Particle Size Analysis (B)	3.1.6, Table 3-3
	-Soil Classification (C)	3.1.6, Table 3-3
	-Formation Descriptions (D)	3.1
	-Saturated hydraulic conductivity, porosity, and effective porosity (E)	3.1.6, Table 3-3
	.1623(a)(5) Additional Investigation Techniques	2
	.1623(a)(6) Stratigraphic Cross-Sections	3.1
	.1623(a)(7) Tabulations of Water Table Elevations (A,B)	Table 3-4, Table 3-4a
	-Estimate of Seasonal High Water Table (C)	3.2.1.2
	-Potential Water Table Fluctuations	3.2.1.2
	.1623(a)(8) Horizontal and Vertical Dimensions of Groundwater Flow	3.2.1.1
	-Flow Direction	3.2.1.1
	-Flow Rate	3.3.2
	-Gradients	3.2.1.1
	.1623(a)(9) Groundwater Contour Map	Figure 3-5
	.1623(a)(10) Site Topographic Map	Sheet 1
	.1623(a)(11) Boring Logs	Appendix A
	-Well and Piezometer Construction Records	Appendix A, Table 2-1
	.1623(a)(12) Other geologic and hydrogeologic considerations	3.2, 3.3, 4
.1623(b)(2)(B)	Technical information needed to design the monitoring system	3.2, 3.3, 4
.1623(b)(2)(C)	Technical information needed to determine the relative point of compliance	3.2, 3.3, 4
.1623(b)(2)(D)	The number, location, and depths or rock corings to provide and understand fractured bedrock conditions including:	
	-Rock Types	2.1.4, 3.1.5, Table 3-2
	-Recovery Values	3.1.5, Table 3-2
	-Rock Quality Designation (RQD)	3.1.5, Table 3-2
	-Saturated Hydraulic and Secondary Porosity Values	3.1.5
	-Rock descriptions including Fracturing and Jointing Patterns	3.1.5
.1623(b)(2)(E)	Groundwater Contour Map of the Long-Term Seasonal High Water Table	Figure 3-6
.1623(b)(2)(F)	Bedrock Contour Map	Figure 3-4
.1623(b)(2)(G)	Three Dimensional Groundwater Flow Net or Several Hydrogeologic Cross-Sections	Figures 3-1, 3-2, 3-3
.1623(b)(2)(H)	Report on the Groundwater Flow Regime	3.2, 3.3
	-Horizontal Flow Paths and Gradients	3.3.2
	-Vertical Flow Paths and Gradients	3.3.2
	-Flow Rates	3.3.2
	-Groundwater Recharge Areas	3.3.3
	-Groundwater Discharge Rates	3.3.3
.1623(b)(2)(I)	Certification that all borings that have not been converted to permanent monitoring wells will be properly abandoned.	4.2
.1623(3)	Water Quality Monitoring Plan	Separate Report

NR - Not Required

Section 2
Methodology

This section presents the methodology and data reduction used during the Cell 7 hydrogeologic field investigation. As described in Section 1.4, the current investigation included borehole drilling, piezometer installation, water level measurements, and well surveying.

2.1 Drilling Methods

The following section details the drilling methods used to install borings and piezometers and collect geologic and hydrogeologic data for the Cell 7 landfill expansion.

2.1.1 Borehole Drilling

Borehole drilling methods included air rotary, hollow-stem auger, and rock coring. During the field investigation, two drill rigs (one air rotary and one hollow-stem) were utilized to complete the borings and piezometers. Boring logs from previous and current borings in the Cell 7 investigation area are provided in **Appendix A**. Only logs for borings from previous investigations relevant to the Cell 7 area are included in **Appendix A**.

2.1.2 Air Rotary Drilling

Air rotary/hammer drilling utilized a Schramm T450 Rota-Drill truck-mounted rig. The air rotary boreholes were drilled only for bedrock piezometer installation. Lithologic samples were collected approximately every 10 feet, using a shovel to collect cuttings blown from the borehole bottom. Bedrock drill cuttings were described and noted for color, mineralogy, and moisture content. Occasionally, potable water was added to suppress drilling dust, so sample moisture content was not always noted. The rate of drill bit penetration, which is a function of rock hardness, was also noted.

During drilling, fractures or soft spots were identified by a decrease in drill chatter, a faster advance or sudden drop of the drill rods, and a change in lithology and color of the drill cuttings. Clay or the presence of more coarse drill cuttings were often observed when a fracture zone was encountered.

The bedrock boreholes targeted water-bearing fracture zones appropriate for piezometer installation in locations where groundwater was either not encountered in the overburden or a nested pair of wells was being installed. Often when a substantial fracture or fracture zone was encountered, water would be observed in the blow-out cuttings. This was interpreted to indicate the presence of a water-bearing fracture or weathered zone, and the borehole was advanced until competent rock was encountered.

Air lift yield aquifer tests were periodically performed as described below to determine whether groundwater had been encountered. Upon reaching the desired depth (i.e., a suspected fracture zone), the drill string was retracted 10-20 feet from the borehole bottom. After waiting 10 to 15 minutes, the string was lowered to the bottom of the hole and the drill rig's air compressor was used to blow cuttings and water, if present, out of the borehole. If a borehole produced enough water to support a piezometer following the blow down test, the borehole was developed by blowing water out of the annulus until the boring was substantially free of cuttings.

2.1.3 Hollow-Stem Auger (HSA) Drilling

Hollow-stem auger (HSA) drilling was conducted at all locations in which air rotary drilling was performed to obtain lithological information and geotechnical samples, and to install piezometers at locations where groundwater was encountered above bedrock. HSA drilling was completed using a CME 750 track-mounted drill rig with 4 ¼-inch inner diameter augers. Lithologic information was obtained through split spoon sampling at 5-foot intervals as outlined in ASTM D-1586. Blow counts were noted during split spoon sampling and the depth of the first encountered blow count of 50 within a 6-inch interval was used to define the top of partially weathered rock (PWR). The depth of auger refusal was generally used to define the top of bedrock, but in some instances the top of bedrock elevation was refined based on the air rotary drilling. Split spoon samples were examined by CDM's field geologist and described for color, grain size, texture, mineralogy, and moisture content.

Geotechnical samples collected during HSA drilling included bag samples, undisturbed (Shelby tubes) samples, and bulk samples. Jar samples were collected by placing split spoon samples in plastic bags. Bag samples were analyzed as described in Section 2.6. The laboratory results are discussed in Section 3.1.6 and the laboratory data reports are provided in **Appendix B**.

Shelby tubes were collected as specified in ASTM D-1587 by attaching an empty 2-foot long, 3-inch diameter galvanized steel tube to the drilling rods, lowering it to the bottom of the auger hole and hydraulically pushing the tube into the undisturbed formation below the borehole bottom. After the tube was retrieved, the ends were sealed with melted paraffin wax and capped. The sample tubes were maintained in an upright position and protected from shock and temperature extremes until delivered to the laboratory. Shelby tubes were analyzed for geotechnical analysis only and are not discussed in this report. The laboratory results are discussed in Section 3.1.6 and the data are provided in **Appendix B**.

2.1.4 Rock Coring

The CME 750 rig used for HSA drilling was also used for rock coring. Two locations, B-724 and B-727d, within the Cell 7 area were cored. Conventional rock coring techniques were utilized as described below. An NX size double tube core barrel was attached to the bottom of the drill rods and lowered to the bottom of the borehole. The desired coring interval was drilled using a carbide-toothed bit and clear, potable water. When the desired interval had been penetrated, the core barrel and drill rods were retrieved from the borehole. The core sample was then extruded and placed into a box labeled with the core ID and depth intervals.

The rock core was described in the field and the percent recovery, rock quality designation (RQD), orientation and frequency of fractures, observed fracture infilling or coatings, gross mineralogy, and other notable characteristics were recorded. The RQD was determined by dividing the total length of rock fragment longer than four inches over the total length cored. Logs of the core borings are contained in **Appendix A** and described in Section 3.1.5.

2.2 Piezometer Installations

As discussed in Section 1.4, 15 piezometers were installed at 12 locations during the current investigation in the Cell 7 area. The piezometer locations are shown on **Sheet 1** along with those installed in and around the Cell 7 area during previous investigations. **Table 2-1** provides a summary of piezometer completion data for the recently installed piezometers and piezometers installed during previous investigations that were relevant to the Cell 7 investigation.

Table 2-1
Piezometer and Monitoring Well Construction Summary
Buncombe County Subtitle D Landfill Expansion
Cell 7

Piezometer I.D.	Construction Date	Top of Casing Elevation (feet AMSL)	Ground Elevation (feet AMSL)	Screen Interval Lithology	Drilling Method	Depths (feet bls)				Borehole Diameter (inches)	Casing Diameter (inches)	Elevation (feet AMSL)	
						Borehole Depth	Screen Interval	Top of Sand Filter	Top of Bentonite Seal			Top of Screen Interval	Bottom of Screen Interval
B-719	7/31/2012	2073.27	2070.37	Bedrock	HSA/Air	62	57-62	55	52.5	6/8	2	2013.37	2008.37
B-720s	7/25/2012	2059.39	2055.85	Saprolite/PWR	HSA/Air	58	48-58	46	42	6/8	2	2007.85	1997.85
B-720d	8/3/2012	2059.56	2056.82	Bedrock	Air	80	70-80	68	65.5	6	2	1986.82	1976.82
B-721	7/31/2012	2014.44	2011.39	Saprolite/PWR	HSA	34	24-34	22	19.5	8	2	1987.39	1977.39
B-722s	7/30/2012	1987.95	1985.17	Saprolite/PWR	HSA	24	14-24	12	9.5	8	2	1971.17	1961.17
B-722d	8/2/2012	1989.03	1986.13	Bedrock	Air	41	36-41	34	31.5	6	2	1950.13	1945.13
B-723	7/25/2012	2079.93	2077.04	Bedrock	HSA/Air	62	57-62	55	51	6/8	2	2020.04	2015.04
B-724	8/1/2012	2058.15	2055.59	Bedrock	HSA/Core	50	45-50	43	40.5	6/8	2	2010.59	2005.59
B-725	8/3/2012	2031.41	2028.60	Bedrock	HSA/Air	58	53-58	51	48.5	6/8	2	1975.60	1970.60
B-726	8/2/2012	2024.29	2021.78	Saprolite/PWR/ Bedrock	HSA/Air	67	57-67	55	52.5	6/8	2	1964.78	1954.78
B-727s	7/26/2012	2009.82	2007.26	Saprolite	HSA	22	12-22	10	7.5		2	1995.26	1985.26
B-727d	7/25/2012	2008.99	2006.46	Saprolite/PWR	HSA	63	43-53	41	38.5/53.5	8	2	1963.46	1953.46
B-728	7/26/2012	2032.61	2030.06	Saprolite/PWR	HSA	48.5	38.5-48.5	36.5	34	8	2	1991.56	1981.56
B-729	7/30/2012	2043.81	2040.66	Saprolite/PWR/ Bedrock	HSA/Air	36	26-36	24	21.5	6/8	2	2014.66	2004.66
B-730	7/27/2012	2057.77	2055.05	Saprolite/PWR	HSA	42.5	32.5-42.5	30.5	28	8	2	2022.55	2012.55
Historical Data - Piezometers Adjacent to Expansion Area													
BC-106	*8/11/1992*	*2076.28*	*2074.2*	*Saprolite*	*HSA*	*29.5*	*24.5-29.5*	*22.5*	*21.5*	*6*	*2*	*2049.70*	*2044.70*
B-204	*11/8/1993*	*2061.18*	*2059.3*	*Bedrock*	*Air*	*68*	*58-68*	*53*	*51*	*6*	*2*	*2001.30*	*1991.30*
B-241B	*11/13/1993*	*1977.94*	*1975.7*	*Bedrock*	*HSA/Core*	*30*	*20-30*	*18*	*16*	*3*	*2*	*1955.70*	*1945.70*
B-243	*11/18/1993*	*2024.90*	*2023.3*	*Bedrock*	*HSA/Core*	*87*	*72-87*	*70*	*66*	*6*	*2*	*1951.30*	*1936.30*
B-244	*11/12/1993*	*2006.09*	*2003.3*	*Bedrock*	*HSA/Core*	*40*	*29.5-39.5*	*26.5*	*24.5*	*3*	*2*	*1973.80*	*1963.80*
B-249	*11/9/1993*	*2077.57*	*2076.0*	*Bedrock*	*Air*	*81*	*60-80*	*58*	*56*	*6*	*2*	*2016.00*	*1996.00*
B-714	*9/28/2004*	*2038.22*	*2035.18*	*Bedrock*	*Air*	*76.5*	*66.5-76.5*	*63*	*59*	*6*	*2*	*1968.68*	*1958.68*
Subtitle D Landfill Monitoring Wells													
MW-1	1990'S	2021.22	2019.28	Saprolite/PWR	Air	76	61-76	59	57	8	2	1958.28	1943.28
MW-1d	1990'S	2021.57	2019.97	Bedrock	Air	200	85-95	81	78	8	2	1934.97	1924.97
MW-2	1990'S	1920.86	1918.54	Saprolite/PWR	Air	20	5-20	3	1	8	2	1913.54	1898.54
MW-2d	1990'S	1920.51	1918.63	Bedrock	Air	55	45-55	42	39	8	2	1873.63	1863.63
MW-3	1990'S	1987.66	1985.48	Saprolite/PWR	Air	38	23-38	21	18.5	8	2	1962.48	1947.48
MW-4	1990'S	1944.35	1942.48	Saprolite/PWR	Air	25	9-24	7	5	8	2	1933.48	1918.48
MW-4d	1990'S	1944.64	1942.79	Bedrock	Air	55	45-55	43	40	8	2	1897.79	1887.79
MW-5	1990'S	1977.12	1975.39	Saprolite/PWR	Air	50	35-50	33	31	8	2	1940.39	1925.39
MW-5d	1990'S	1976.92	1975.31	Bedrock	Air	81	71-81	68.5	66.5	8	2	1904.31	1894.31
MW-6	1990'S	1987.34	1985.39	Saprolite/PWR	Air	50	35-50	27	24.5	8	2	1950.39	1935.39
MW-7	1990'S	2022.83	2020.72	Saprolite/PWR	Air	61	42-57	40	38	8	2	1978.72	1963.72
MW-8	1990'S	1962.06	1959.85	Saprolite/PWR	Air	70	55-70	53	51	8	2	1904.85	1889.85
MW-8d	1990'S	1962.47	1960.57	Bedrock	Air	95	85-95	82.5	79	8	2	1875.57	1865.57
MW-10	3/6/2002	2010.54	2007.5	Saprolite/PWR	Air	73	58-73	56	54	6	2	1949.50	1934.50
MW-10d	3/6/2002	2010.56	2007.5	Bedrock	Air	117	102-117	100	98	6	2	1905.50	1890.50
MW-11	3/5/2002	1966.71	1963.7	Bedrock	Air	50	35-50	33	31	6	2	1928.70	1913.70
MW-11d	3/5/2002	1966.15	1963.2	Bedrock	Air	70	60-70	58	56	6	2	1903.20	1893.20
MW-13	6/24/2012	1953.92	1951.3	Bedrock	Air	16	6-16	4	2	6	2	1945.30	1935.30
MW-13d	6/23/2005	1953.82	1951.4	Bedrock	Air	44	39-44	37	35	6	2	1912.40	1907.40
C&D Landfill Monitoring Wells													
MW-9	*1990'S*	*1966.54*	*1963.70*	*Bedrock*	*HSA/Core*	*26*	*11-26*	*8*	*6*	*6*	*2*	*1952.70*	*1937.70*
MW-9d	*1990'S*	*1966.34*	*1963.70*	*Bedrock*	*HSA/Core*	*40*	*35-40*	*32*	*29*	*6*	*2*	*1928.70*	*1923.70*
MW-12	6/25/2002	1947.39	1944.7	Saprolite/PWR/ Bedrock	Air	17	7-17	5	3	6	2	1937.70	1927.70
MW-12d	6/25/2002	1947.1	1944.3	Bedrock	Air	37	27-37	25	23	6	2	1917.30	1907.30
MW-14	4/5/2006	1952.77	1949.8	Bedrock	Air	49	39-49	36	33	6	2	1910.80	1900.80
MW-14d	4/6/2006	1953.76	1950.7	Bedrock	Air	88	78-88	74	71	6	2	1872.70	1862.70
MW-15	6/27/2012	1973.29	1970.21	Saprolite/PWR	Air	26	16-26	14	12	6	2	1954.21	1944.21
MW-15d	6/27/2012	1973.51	1970.25	Bedrock	Air	43	33-43	31	27	6	2	1937.25	1927.25

Notes:

1. AMSL - Above Mean Sea Level
2. PWR - Partially Weathered Rock
3. bls - Below Land Surface
4. HSA - Hollow-Stem Auger
5. Bold - Piezometers installed during the Cell 7 design hydrogeologic investigation
6. Italic - Abandoned piezometers/monitoring wells
7. Monitoring wells MW-9/9d were abandoned to accomodate the Phase I and II C&D Landfill expansions.
8. (cd) - C&D Landfill monitoring wells
9. Horizontal Control - NAD 83
10. Vertical Control - NAVD 29 and 88

During this investigation, bedrock piezometers were installed in 6 air rotary boreholes. Six saprolite or partially weathered rock (i.e., overburden) piezometers were installed in HSA boreholes. Two piezometers were installed at the PWR/bedrock interface in air rotary boreholes.

The piezometers were constructed of 10-foot sections of 2-inch diameter PVC casing, with a 5 to 10-foot, 0.010-inch slot screen and bottom cap. A filter pack consisting of #2 silica sand was placed around the well screen to a minimum of 2 feet above the top of screen. The piezometer annulus above the filter pack was then sealed with a minimum of 2 feet of 3/8-inch hydrated bentonite pellets. The bentonite was allowed to set-up for at least several hours prior to grouting. The remainder of the annulus was then filled with a Portland cement/bentonite grout poured from the surface. A locking steel protective cover was installed over all piezometers.

2.3 Water Level Measurements

Water level measurements were taken using an electronic water level meter with an accuracy of 0.01 feet. Water level measurements were taken relative to the top of each PVC well casing (TOC = top of casing). Water levels were monitored both during and after the piezometer completion. Water levels were collected after piezometer completion, when possible, 24 hours after completion, and at least seven days after completion. Water level measurements are presented in Section 3.3.1.

2.4 Piezometer Surveying

Surveying was conducted by Ed Holmes and Associates Land Surveyors. The piezometers were surveyed to the TOC measuring point and the ground surface elevation was also measured. Northing and easting coordinates were reported in the State Plane coordinate system, and elevations were surveyed to mean sea level (msl).

2.5 Slug Tests

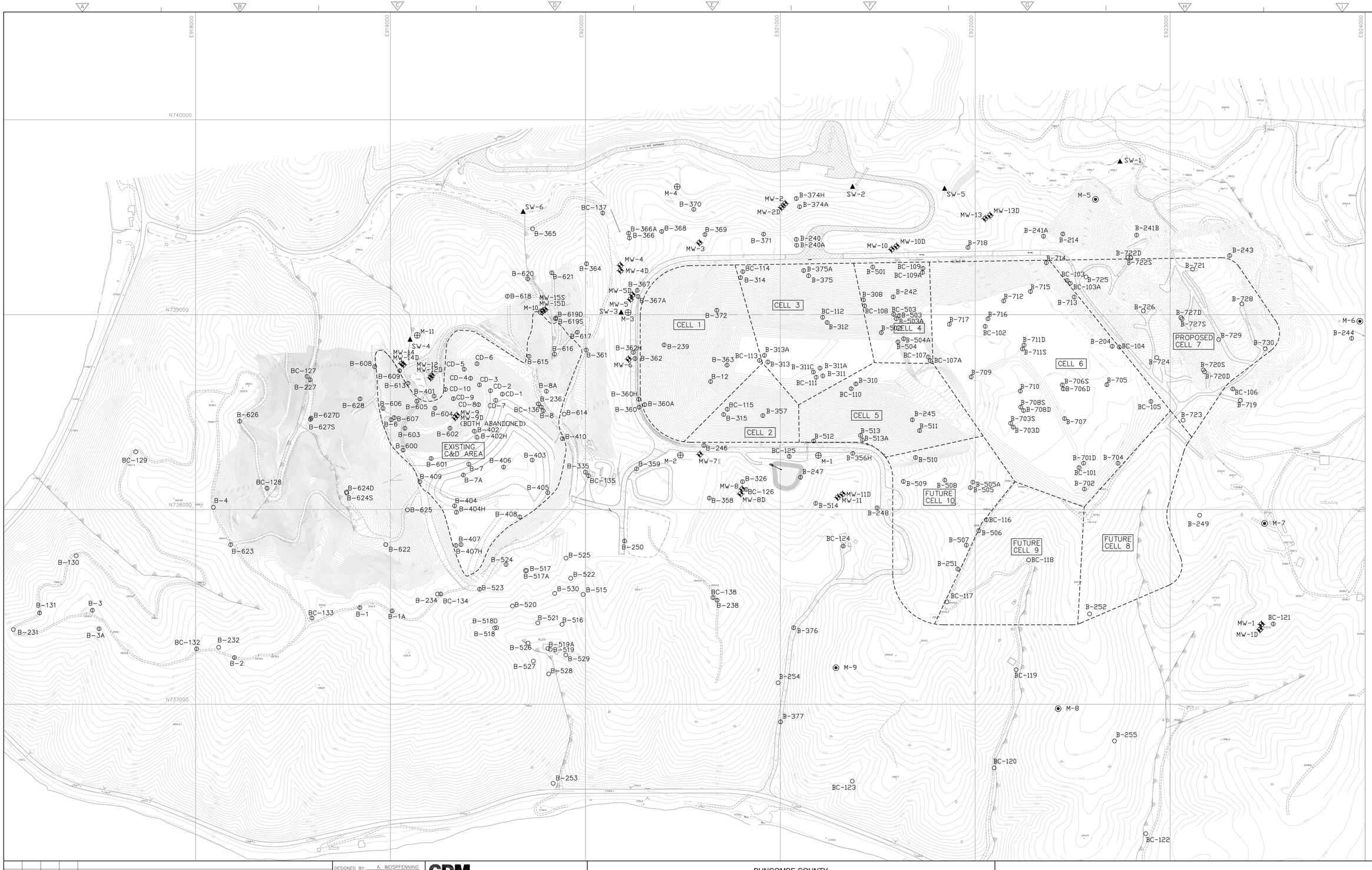
Slug testing was performed on six newly installed piezometers within the Cell 7 area (B-720s, B-720d, B-722s, B-722d, B-727s, and B-727d). Both slug-in (displacement) and slug-out (recovery) tests were conducted at each piezometer using a stainless steel solid slug and a transducer/data logger. The transducer/data logger was lowered to approximately 10 to 15 feet below the water level in the piezometer, taped into place, and a reference water level was collected. Immediately after starting the data logger, the slug was lowered to approximately 1.5 feet below the water surface and taped into place. The data logger was then monitored until water levels stabilized. The data logger was then re-started for the slug-out test and the slug was immediately withdrawn from the piezometer. The data logger was monitored until the water level stabilized.

The data was then analyzed using the Bouwer and Rice method (Bouwer, 1989) to estimate horizontal hydraulic conductivity. The results of the field permeability (slug) tests are summarized in **Table 3-6** and discussed in Section 3.3. Slug test raw data is provided in **Appendix E**.

2.6 Geotechnical Testing

Soil samples collected during this investigation were analyzed for various geotechnical properties by Geotechnics geotechnical laboratory in Raleigh, North Carolina. The testing program consisted of analyses

for grain size distribution, USCS classification, Atterberg limits, and remolded hydraulic conductivity. Laboratory geotechnical data from the samples collected during this investigation in the Cell 7 area are presented in **Appendix B**. Geotechnical data for samples collected during this and previous investigations is summarized on **Table 3-3** and discussed in Section 3.1.6.



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: A. WEISPFENNING
DRAWN BY: A. WEISPFENNING
SHEET CHK'D BY: M. COLONE
CROSS CHK'D BY:
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North Carolina State License Number: F-1255

BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY

SITE MAP

PROJECT NO. 6447-93318
FILE NAME: BUNC-PIEZO.DWG
SHEET NO.
1

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Section 3

Cell 7 Investigation Results

This section presents the results of the Cell 7 area investigation which included borehole drilling, rock coring, geotechnical testing, piezometer installations, water level measurements, and aquifer characterization (i.e., slug testing). The regional geology and hydrogeology have been previously discussed (CDM 1995), and, therefore, will not be re-iterated in this report. The site geology and geotechnical results are discussed in Section 3.1. The site hydrogeology is evaluated in detail in Section 3.2 and includes water level results, potentiometric surface mapping, and slug test analysis.

3.1 Site Geology

The area around the Buncombe County landfill had been preliminarily mapped by the North Carolina Geological Survey (Weiner 1970; Merschat and Wiener 1990). The geologic map of North Carolina indicates that the area is underlain by a northeast-trending sequence of migmatitic biotite hornblende gneiss, which includes layered mafic and felsic rocks that are interlayered and gradational at all scales (North Carolina Geological Survey 1985; Merschat and Wiener 1990). Amphibolite is commonly interlayered with the gneiss, and occurs as discontinuous layers, lenses, and pods, with thickness ranging from inches to tens or hundreds of feet (Merschat and Wiener 1990). Locally occurring lithologies include calcium-silicate metamorphic rocks, granitic rocks, and metasedimentary rocks.

Further site-specific mapping conducted by GEI Consultants Inc. showed that the 557-acre landfill footprint is underlain primarily by granitic and undifferentiated gneiss with smaller areas of biotite gneiss, hornblende-biotite gneiss, calc-silicates, and marble (CDM 1993). According to GEI mapping and bedrock lithologies observed in this and previous investigations, the area occupied by the eastern section of Cell 3 and all of Cell 4 was underlain by undifferentiated gneiss. Geologic mapping and bedrock drilling confirmed that the east/southeast section of Cell 5 was underlain by granitic gneiss and the north and west area of Cell 5 was comprised of undifferentiated gneiss. Rock core drilling observations made in the two core-holes within the Cell 7 area found the bedrock to be undifferentiated gneiss with inter-layers of granitic gneiss.

In late November 1998, CDM contracted Gram, Inc. to further characterize the geologically complex west/northwest portion of the landfill. The results of the Gram geologic mapping were provided in the Permit Amendment Application Cells 4 and 5 – Design Hydrogeologic Report (CDM February 2000). The study concentrated on the two large road-cut outcrops exposed along the east-west trending entrance road to the landfill at the northern margin.

The Gram mapping made four major conclusions. First, the bedrock exposed at the road-cut and within the C&D landfill is dominated by migmatitic biotite hornblende gneiss that is interlayered with amphibolite. This common Blue Ridge sequence is present over an area tens of miles in length and width (Merschat and Wiener 1990). Second, a metamorphic isograd was not present at the landfill and the different lithologies observed (interlayered gneiss and amphibolite) result from chemical differences between the parent rocks. A metamorphic isograd requires the identification of specific index minerals, and the formation of these index minerals requires more silica and aluminum (and water during metamorphism) than is present in the rocks at

the landfill. Third, the fractured bedrock at the landfill occurred following metamorphism (approximately 1 billion years ago) as a result of tectonics. The dominant direction of fracturing is N30E to N60E, 70 to 90 degrees SE and the uniformity of fracture directions through the bedrock suggest a consistent set of pathways for groundwater movement (i.e., fractures are secondary permeability for groundwater movement). And fourth, although several possible faults were observed in one outcrop along the landfill entrance, they are likely of limited displacement and extent and were not observed within the landfill. According to Gram, Inc., "these possible faults provide no evidence of enhanced porosity from dissolution or brecciated material and are expected to be equivalent to fractures in the bedrock."

The directions of fracturing interpreted from fractures measured on the outcrops correlate well with the larger scale lineations identified by GEI (CDM 1993). GEI lineament/fracture analysis showed a dominance of northeast trending lineations, with secondary northwest trending and east-west trending lineations. The correlation between fracture orientations and lineation orientations suggests that the fractures exert a significant control on weathering and, by implication, water movement.

Drilling Observations - During drilling at the site, five distinct units were observed: alluvium/colluvium, residuum, saprolite, partially weathered rock (PWR), and bedrock. The units observed during this investigation are consistent with observations from previous investigations. Detailed descriptions of each material encountered at specific boring locations are provided in the boring logs contained in **Appendix A**. **Table 3-1** presents a summary of lithologic data encountered at each boring in the Cell 7 area and the depths at which the PWR and bedrock surfaces were encountered. **Sheet 1** is an index map indicating the locations of the borings from this and previous investigations. Cross sections A-A', B-B', and C-C' (**Figures 3-1 through 3-3**) are show lateral and vertical extent of these materials in the subsurface, intervals of exploratory boring and piezometer completion, groundwater elevation, and proposed landfill base-grades.

3.1.1 Alluvium

Alluvium/colluvium was present in small localized areas within or adjacent to the drainage features. Where present, the alluvium was found to be of limited thickness and overlaid saprolite, PWR or bedrock. The alluvium ranged in grain size from clayey silt to poorly sorted sands.

3.1.2 Residuum

Where present, residuum comprises the upper-most unit at the site. Residuum is derived from in-place chemical weathering. Residuum typically is higher in clay content and iron than the underlying saprolite. Residuum was present in small areas along the southern ridge that had not been impacted during previous borrow activities.

3.1.3 Saprolite

Saprolite (saprolitic soils) usually comprise the uppermost unit at the site and is present at all locations except small areas where partially weathered rock is exposed at the ground surface from previous borrow activities in the area. These soils are derived from the in-place chemical weathering of bedrock, and are characterized by the presence of relict mineral fabric from the original rock mass. These soils are typically finer near the surface where weathering is more advanced, and become more dense and coarser in texture as weathering decreases with depth. Near the surface, they are generally comprised of fine sandy silt or sandy silt with clay. Silty clays or silty sands are present at some locations and most on-site saprolitic soils grade to a silty sand or very sandy silt with depth.

Hard rock fragments are commonly present in the lower portion of the saprolite and become larger and more frequent with depth. The contact between the saprolite and underlying PWR (or bedrock) is gradational. These soils are typically red/brown or light to dark brown in color and often micaceous with some areas being very micaceous. Locally, gray, dark gray or green/gray colors are present, and appear to correlate with an abundance of mafic minerals (hornblende and biotite) in the rock mass from which they were derived. Thin zones of light brown or orange/tan lean clay are also present locally. The base of the saprolite unit has been defined as the depth at which soil penetration using a split spoon sampler is greater than 50 blows per 6 inches. This definition is used to permit consistent identification of the soil/PWR contact.

In the Cell 7 area, saprolite was observed to range in thickness from 2 feet at B-720s to 49 feet at B-719, and averaged about 25 feet thick. The saprolite unit was generally thicker on the hills and ridges than on the side slopes and bottom of drainage features, however, previous borrow activities along the ridges have reduced the saprolite thickness.

3.1.4 Partially Weathered Rock (PWR)

The PWR elevation and depth below ground surface for each boring in the Cell 7 area investigation is presented in **Table 3-1**. At most locations, the saprolite transitionally grades into the parent bedrock from which it is derived. This transition zone has been designated the PWR unit. It is characterized by deeply weathered bedrock material that can be penetrated by hollow-stem augers but requires more than 50 blows to advance a split spoon sampler 6 inches. The PWR in the Cell 7 area consists primarily of tan to brown and gray/green to green/white silty sands with some intervals of sandy silt. The local areas of gray/green to green/white coloration represent PWR derived from mafic rich bedrock.

Within the Cell 7 area, the PWR unit ranged in thickness from 3 feet (B-719) to 52 feet (B-720s), and averaged about 19 feet in thickness. The PWR was observed to be dry or slightly moist at some locations; however, at some locations the PWR was saturated.

3.1.5 Bedrock

As previously noted in Section 3.1, the 557-acre landfill footprint is underlain primarily by granitic and undifferentiated gneiss with smaller areas of biotite gneiss, hornblende-biotite gneiss, quartz veins, and amphibolite. Geologic mapping and bedrock drilling confirmed that the Cell 7 is underlain by interlayered granitic and undifferentiated gneiss.

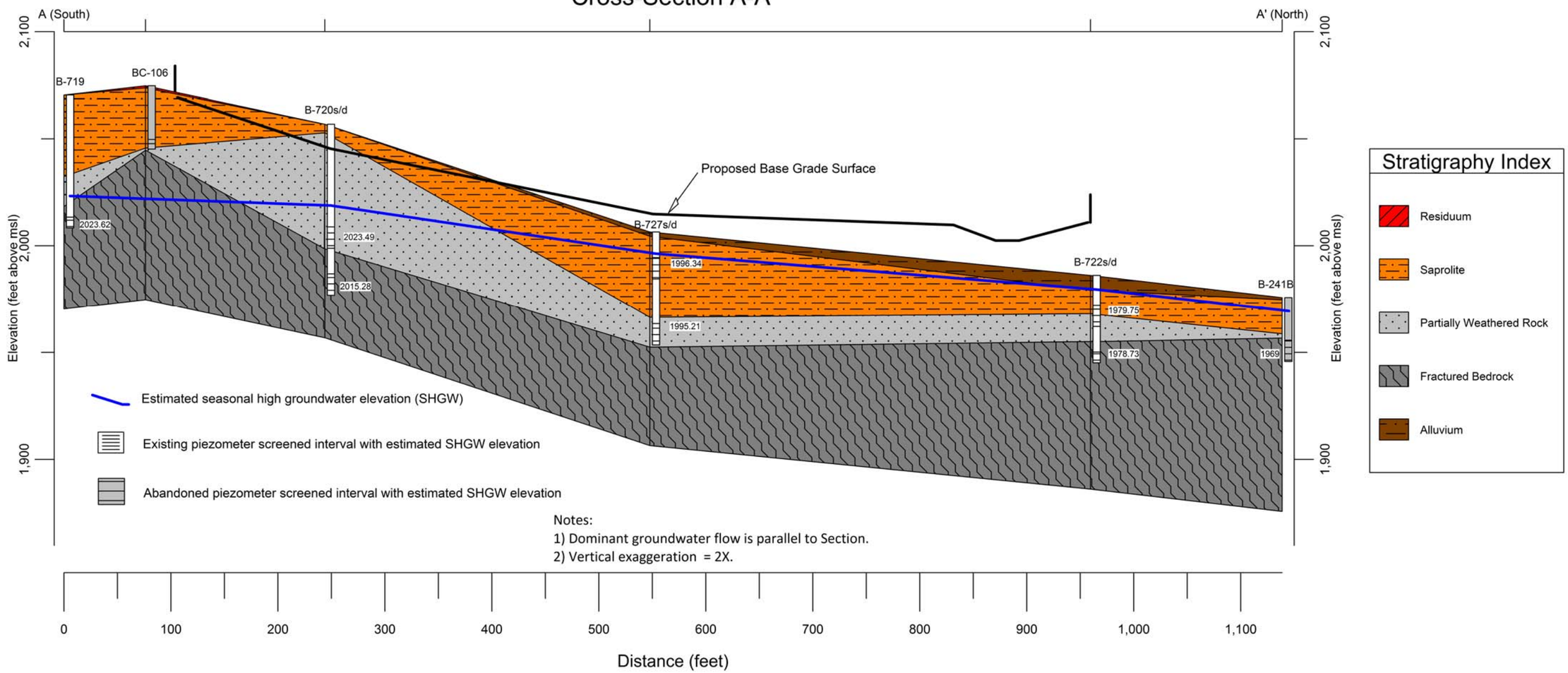
The granitic gneiss is light gray where unweathered and generally comprises 60 to 95 percent of the rock mass. The more mafic foliation planes and bands consist of hornblende or other amphibole minerals and/or biotite, are dark gray/green to black, and are generally more strongly foliated especially where biotite is present. Locally, these minerals compose most of the rock mass, and are only interbanded with granitic minerals. Quartz veins were occasionally observed in some of the exploratory borings throughout the site. Bedrock weathering is highly variable but generally decreases with depth. Bedrock lithology in the Cell 7 Area was consistent with the drilling observations and geologic mapping in the previous site investigations.

Table 3-1
Summary of Lithologic Data
Buncombe County Subtitle D Landfill Expansion
Cell 7

Piezometer I.D.	Ground Elevation (feet AMSL)	Depth to PWR (feet bgs)	PWR Elevation (feet AMSL)	Depth to Bedrock (feet bgs)	Bedrock Elevation (feet AMSL)
B-719	2070.37	49	2021.37	52	2018.37
B-720s	2055.85	5	2050.85	57	1998.85
B-720d	2056.82	5	2051.82	59	1997.82
B-721	2011.39	21	1990.39	34	1977.39
B-722s	1985.17	18	1967.17	31	1954.17
B-722d	1986.13	18	1968.13	31	1955.13
B-723	2077.04	29	2048.04	47	2030.04
B-724	2055.59	33	2022.59	38.5	2017.09
B-725	2028.60	10	2018.60	41	1987.60
B-726	2021.78	20	2001.78	64	1957.78
B-727s	2007.26	41	1966.26	53.5	1953.76
B-727d	2006.46	41	1965.46	53.5	1952.96
B-728	2030.06	44	1986.06	48.5	1981.56
B-729	2040.66	22	2018.66	33.5	2007.16
B-730	2055.05	23	2032.05	42.5	2012.55
Historical Data - Piezometers Adjacent to Expansion Area					
B-204	*2059.7*	*38.5*	*2021.2*	*38.5*	*2021.2*
B-241B	*1975.7*	*17*	*1958.7*	*19*	*1956.7*
B-714	*2035.18*	*29*	*2006.18*	*44*	*1991.18*

Notes:
1. AMSL - Above Mean Sea Level
2. bgs - below ground surface
3. PWR - Partially Weathered Rock
4. Italic - Abandoned piezometer
5. Horizontal Control - NAD 83
6. Vertical Control - NAVD 29

Cross-Section A-A'



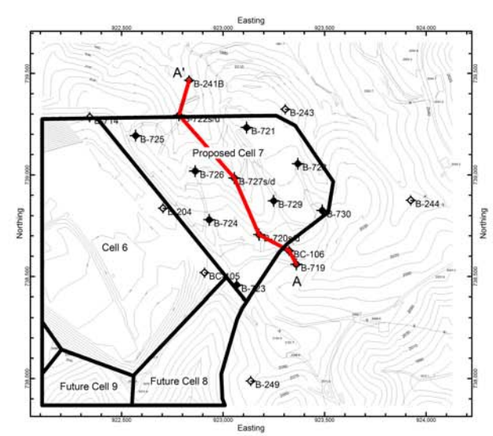
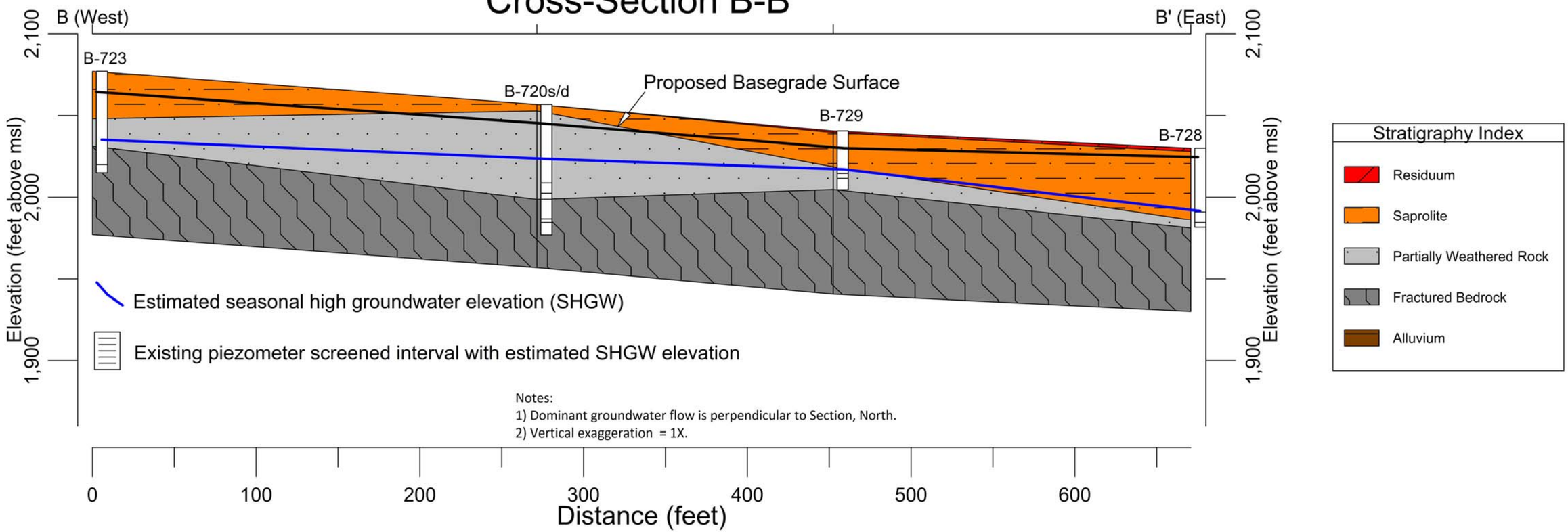


Figure 3-1
Cross Section A-A'
Buncombe County Subtitle D Landfill Expansion
Cell 7 Area

Cross-Section B-B'



Notes:
1) Dominant groundwater flow is perpendicular to Section, North.
2) Vertical exaggeration = 1X.

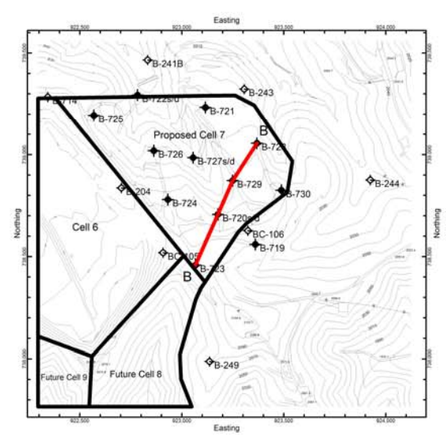
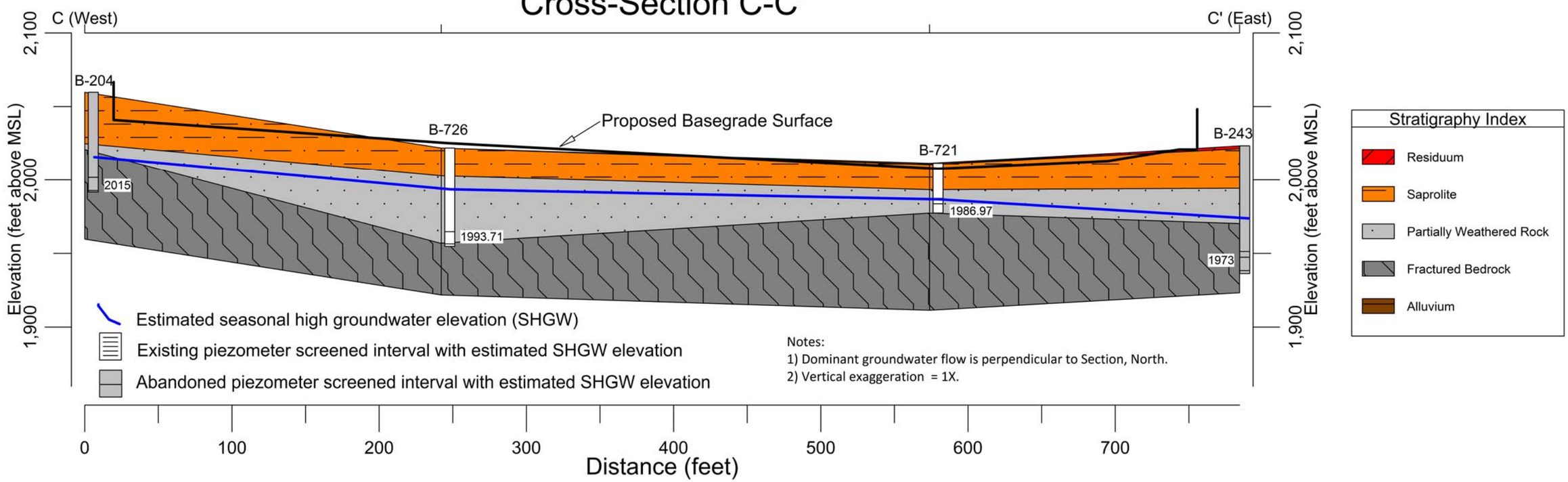


Figure 3-2
Cross Section B-B'
Buncombe County Subtitle D Landfill Expansion
Cell 7 Area

Cross-Section C-C'



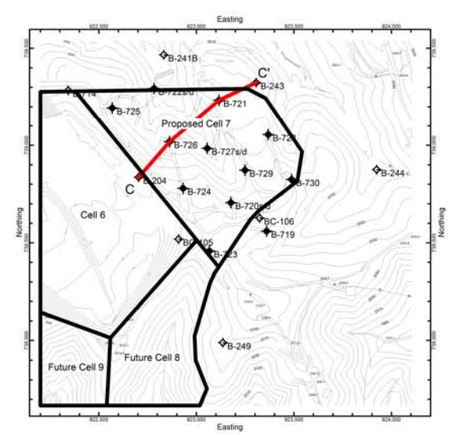


Figure 3-3
Cross Section C-C'
Buncombe County Subtitle D Landfill Expansion
Cell 7 Area

Table 3-2 summarizes observations from rock core samples collected during the Cell 7 Area investigation, along with some rock core samples collected during previous investigations. Inspection of rock cores from this investigation (B-724 and B-727d) and previous coring in the vicinity of the Cell 7 area indicate that the bedrock is variably fractured. RQD values from the cores in the Cell 7 area ranged from 18 percent (B-727d) to 52 percent (B-724). Previous investigation results at the site ranged from 0 percent (BC-107A) up to 90 percent (B-503B), and averaged 42 percent. Based on observation of the cores, an effective porosity of about 1 to 5 percent has been estimated for the competent bedrock material. This estimated effective porosity is higher than the 0.1 percent value estimated by Heath (1980) for bedrock aquifers in granitic gneiss in the Blue Ridge Province. Fracture density in bedrock generally decreases with depth. Site estimates were made from shallow bedrock cores, and Heath's estimate was for bedrock aquifer systems as a whole, thus, the site estimate for effective porosity is correspondingly higher than Heath's 0.1 percent value.

Although oxidation was observed to parallel foliation planes, fractures were not generally observed to be closely oriented with the foliation, except in the upper portions of the core samples. This is consistent with fracture orientation measurements made in surface outcroppings as previously discussed (CDM 1993 and 2000).

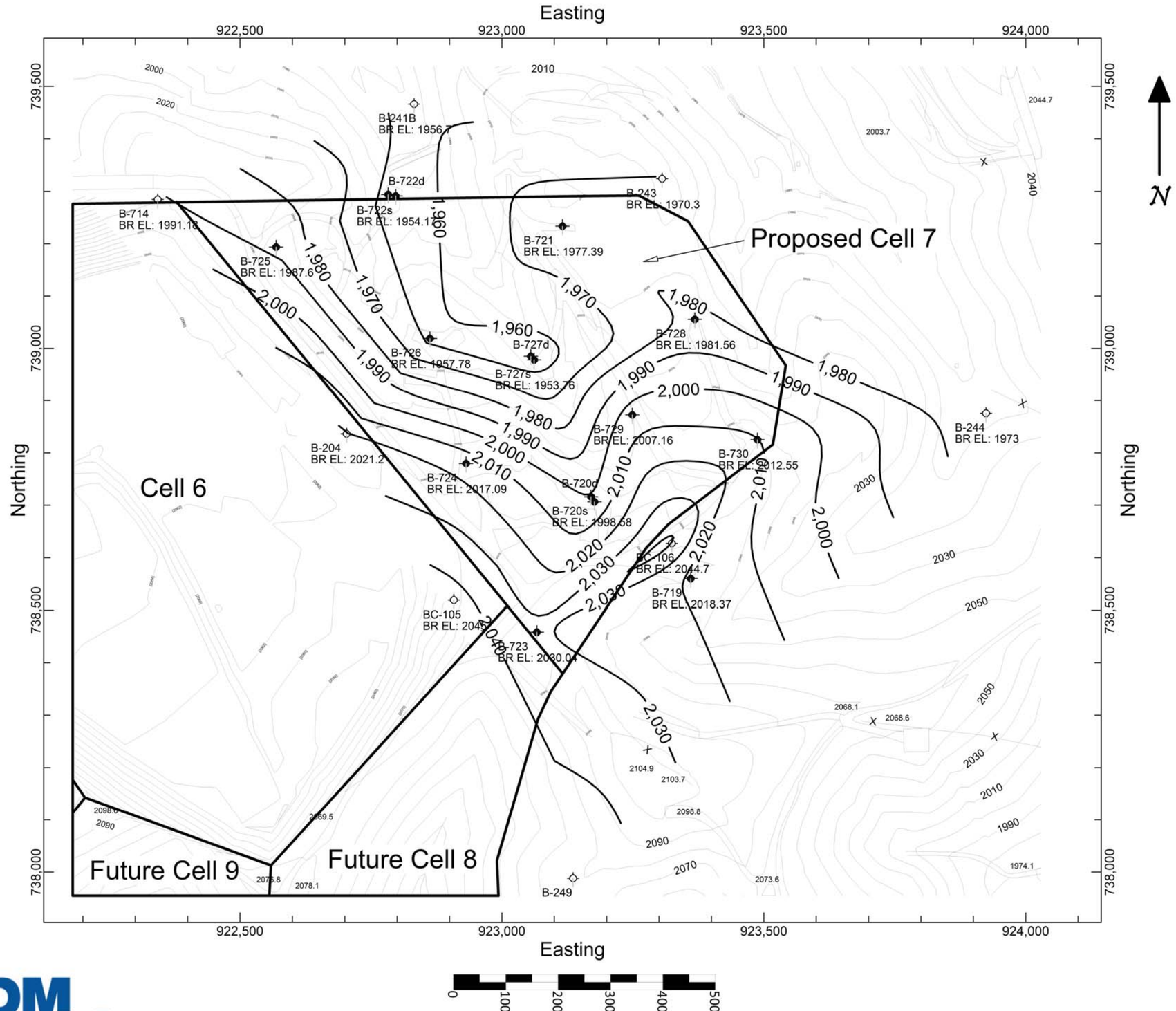
Within the Cell 7 area, depth from ground surface to top of bedrock ranged between 31 feet (B-722) to 64 feet at B-726. The average bedrock depth was about 45 feet across the area, which is deeper than the bedrock depth in the adjacent Cell 6. The depth to bedrock is generally shallow in drainage features and significantly deeper in the upland areas. **Figure 3-4** is a contour map of the bedrock surface developed from depth to bedrock measurements observed in the exploratory borings drilled in and around the Cell 6 Area from this and previous investigations.

Within the Cell 7 area, the association between surface topography and bedrock surface is very distinct and similar to the relationship exhibited in the Cell 1-6 areas. This high degree of correlation between bedrock and ground surface topography shows the major influence bedrock exerts on surficial features.

Figure 3-4 shows the base grade elevations and the top of bedrock elevations for the Cell 7 area. In most areas, the saturated zone lies above the bedrock and the separation of the seasonal high groundwater and base grades is the limiting factor. The vertical separation between the landfill base grades and the bedrock is greater than 4 feet, as required by (b)(7) of Rule .1624. **Figure 3-4** shows that the bedrock surface over the area is a subdued reflection of surficial topography, similar to the rest of the site.

Table 3-2
Summary of Rock Core Observations
Buncombe County Subtitle D Landfill Expansion
Cell 7

Boring	Core Run Depth (feet)	Recovery (%)	RQD (%)	Material Description
Cell 7 Area				
B-724	38.8-48.8	100	52	Undifferentiated Gneiss. Granitic with biotite, feldspar and quartz. Small quartz veins (~6") at 31.5' and 35.5'.
B-727d	54-64	100	18	Undifferentiated Gneiss. Granitic with biotite, feldspar and quartz, soft, very fractured.
B-241B	19-29	17	11	Undifferentiated Gneiss. Soft, very fractured.
	29-30	0	0	No recovery.
B-243	53-60	0	0	No recovery. Very soft.
	60-68	25	10	Undifferentiated Gneiss. Weathered.
	68-74	67	42	Undifferentiated Gneiss. Moderately weathered.
B-244	30-35	54	0	Undifferentiated Gneiss. Granitic. Moderately weathered, highly fractured.
	35-40	82	36	Undifferentiated Gneiss. Granitic. Moderately weathered, highly fractured.
Cell 6 Area				
B-702	30-40	94	NC	Granitic Gneiss with biotite, feldspar and quartz. Small quartz veins (~6") at 31.5' and 35.5'.
B-704	39-49	46	NC	Granitic Gneiss with biotite, feldspar and quartz, soft, very fractured.
B-707	19-29	83	NC	Granitic Gneiss with biotite, feldspar and quartz, increasing RQD with depth.
Cell 4/5 Area				
B-503B	48.5-53.5	40	58	Undifferentiated Gneiss with biotite, feldspar and some quartz, migmatic, fractured 50'-58.5'
	53.5-58.5	98	24	Undifferentiated Gneiss, fractured 50'-58.5'
	58.5-63.5	100	90	Undifferentiated Gneiss
	63.5-68.5	100	70	Undifferentiated Gneiss
B-107A	56.4-61.4	15	0	Undifferentiated Gneiss. Micaceous. Highly weathered.
	61.4-66.4	20	0	Undifferentiated Gneiss. Micaceous. Highly weathered.
	66.4-71.4	25	0	66.4' - 67.5' Undifferentiated Gneiss, micaceous, 67.5' - 71.4' Amphibolite
	71.4-76.4	15	0	Undifferentiated Gneiss. Micaceous. Highly weathered.



Notes:

Existing piezometer with bedrock elevation

B-726
BR EL: 1957.78

Abandoned piezometer with bedrock elevation

B-244
BR EL: 1973

1970 Bedrock contour (feet above MSL)

CDM Smith

Figure 3-4
Bedrock Contour Map
Buncombe County Subtitle D Landfill Expansion
Cell 7

3.1.6 Geotechnical Testing Results

Table 3-3 summarizes the results of the geotechnical testing performed on samples in and around the Cell 7 area during this and previous investigations. Two bulk samples (B-726 and B-729) and 16 bag samples were collected during this investigation. As most of the cell will be excavated, no undisturbed samples were analyzed. Because the excavated material will be used for berm and subgrade construction, the bulk samples were analyzed for specific gravity, porosity, and remolded permeability. Bag samples from the residuum, saprolite, and PWR were submitted for moisture content, grain-size, Attergerg limit analysis, and USCS Classification.

Grain size determinations indicate that the overburden in the Cell 7 area is comprised mostly of silty sand (SM) with some sandy silt (ML) and sandy clay (CL). Natural moisture content ranged between 5.5% (B-724) and 17.0% (B-727d). Porosity of the remolded samples was 31 and 32 percent, respectively. Remolded vertical hydraulic conductivity ranged from 2.1 x 10-6 cm/sec in the B-726 sample to 6.3 x 10-7 cm/sec in B-729. The porosity and vertical hydraulic conductivity values from the samples in the area correlate well with samples from previous investigations.

Porosity was calculated from the initial void ratio by using the equation:

n=e/1+e.

Where n = porosity and e = initial void ratio.

3.1.7 Standard Penetration Testing

Standard Penetration Testing (SPT), in accordance with ASTM Standard D1586, was conducted at all boring locations during this investigation. SPT's were conducted over 2-foot intervals, typically every 5-feet from ground surface to the termination of the boring. Blow counts were recorded for every 6-inches and recorded. The split spoon sample was placed in sealable plastic bags and labeled by boring number, sample number, depth interval, and blow count. Blow counts are presented on the boring logs in Appendix A.

3.1.8 Formation Descriptions

Formation descriptions were made in the field during drilling by an on-site geologist or geotechnical engineer. Formation descriptions were made according to moisture content, consistency, color, and grain size. Alterations to the field descriptions, where necessary, were made according to the geotechnical laboratory results. Boring logs are provided in **Appendix A**. Copies of the field notes for the current investigation are provided in **Appendix C**.

Table 3-3
Summary of Geotechnical Testing Results
Buncombe County Subtitle D Landfill Expansion
Cell 7

Borehole	Depth (feet bgs)	Lithology	Sample Type	USCS Classification	Natural Moisture Content	Porosity (%)	Estimated Porosity (%)	Estimated Effective Porosity (%)	Atterberg Limits		Specific Gravity	Hydraulic Conductivity (cm/sec)
									Liquid Limit	Plasticity Index		
Cell 7 Area												
B-719	28.0-30.0	Saprolite	Bag	ML	14.9	--	35-50	20	42	5	--	--
B-721	19.0-21.0	PWR	Bag	SM	8.4	--	25-40	24	31	3	--	--
B-722s	14.0-16.0	Saprolite	Bag	SM	14.3	--	25-40	25	37	3	--	--
B-724	4.0-6.0	Saprolite	Bag	SM	6.0	--	25-40	25	NP	NP	--	--
B-724	24.0-26.0	Saprolite	Bag	SM	5.5	--	25-40	28	NP	NP	--	--
B-725	3.0-5.0	Saprolite	Bag	ML	8.5	--	35-50	20	36	2	--	--
B-726	0.5-26.0	Saprolite/PWR	Bulk	ML	8.2	32	NA	--	--	--	2.66	2.1×10^{-6} (remolded)
B-726	9.0-11.0	Saprolite	Bag	SM	4.7	--	25-40	26	NP	NP	--	--
B-727d	5.0-7.0	Residuum	Bag	CL	17.0	--	40-50	5	41	17	--	--
B-727d	30.0-32.0	Saprolite	Bag	SM	17.0	--	25-40	25	NP	NP	--	--
B-727d	40.0-42.0	PWR	Bag	SM	14.6	--	25-40	25	41	9	--	--
B-727d	50.0-52.0	PWR	Bag	SM	9.6	--	25-40	25	32	5	--	--
B-728	10.0-12.0	Saprolite	Bag	SM	14.5	--	25-40	22	33	4	--	--
B-728	35.0-37.0	Saprolite	Bag	SM	11.7	--	25-40	26	35	4	--	--
B-729	0.5-26.0	Saprolite/PWR	Bulk	SM	13.6	31	NA	--	--	--	2.67	6.3×10^{-7} (remolded)
B-729	3.0-5.0	Residuum/Saprolite	Bag	SM	14.9	--	25-40	15	46	9	--	--
B-729	18.0-20.0	Saprolite	Bag	SM	13.8	--	25-40	26	34	3	--	--
B-730	14.0-16.0	Saprolite	Bag	SM	10.7	--	25-40	25	NP	NP	--	--
Cell 6 Area												
B-105	18.5-20.0	Saprolite	UD	SM	10.8	32	NA		--	--	--	2.7×10^{-4}
B-701	13.5-15.0	Saprolite	Jar	SM	7.3	--	25-40	25	--	--	--	--
B-705	18.5-20.0	Saprolite	Jar	SM	24.4	--	25-40	28	--	--	--	--
B-705	33.5-35.0	PWR	Jar	SM	6.6	--	25-40	32	--	--	--	--
B-708	8.5-10.0	Saprolite	Jar	SM	19.9	--	25-40	18	--	--	--	--
B-709	3.5-5.0	Saprolite	Jar	SM	18.9	--	25-40	20	--	--	--	--
B-709	10.0-12.0	Saprolite	UD	MH	33.2	--	35-50	4	79	42	2.69	--
B-710	8.5-10.0	Saprolite	Jar	ML	25.3	--	35-50	4	--	--	--	--
B-713	13.5-15.0	Saprolite	Jar	SM	11.0	--	25-40	26	--	--	--	--
B-714	8.0-10.0	Saprolite	UD	SC	48.5	53	NA	18	87	49	2.64	3.7×10^{-7}
Cell 4-5 Area												
B-109	19.0-21.0	Saprolite	UD	SM	24.6	44						1.3×10^{-4}
B-502A	18.5-20.0	Saprolite	UD	SM	19.5	51.8			45	NA	2.83	2.0×10^{-4}
B-509A	7.0-9.0	Saprolite	UD	ML	15.2	48.9			47	2	2.82	9.9×10^{-6}
B-513A	12.0-14.0	Saprolite	UD	CL	21.5	22.2			35	12	2.67	1.5×10^{-7}
B-514A	10.0-12.0	Saprolite	UD	ML	20	65.7			35	5	2.7	1.2×10^{-7}

UD - Undisturbed Sample (Shelby Tube)
USCS - Unified Soil Classification System
NP - non-plastic
Estimated Porosity Values from Driscoll, 1986
Estimated Effective Porosity Values from Johnson, 1967

3.2 Site Hydrogeology

Results of investigation activities designed to characterize the hydrogeology beneath the site are presented in this section. These activities included water level measurements and aquifer slug testing.

3.2.1 Water Level Measurements

Water level measurements collected from the piezometers installed during the Cell 7 investigation are provided in **Table 3-4**. These include initial measurements, measurements at 24 hours after installation, and measurements for August 16, 2012, September 6, 2012, and October 11, 2012. Historic groundwater level measurements from the site groundwater monitoring wells dating back to the spring 2008 semi-annual groundwater sampling event are also included for information purposes (**Table 3-4a**). Water level elevations from the site monitoring wells were used to estimate long-term seasonal high water levels for base-grade design. A discussion of the seasonal high groundwater levels is provided in Section 3.2.1.2.

Water levels in most piezometers installed during the Cell 7 investigation are above the top of bedrock. Saturated conditions were generally encountered in piezometers located in low-lying topographic areas such as the main drainage feature running through the Cell 7 area, while the groundwater in the piezometers along the ridge separating Cell 6 and proposed Cell 7 was generally encountered within the fractured bedrock.

Horizontal and vertical gradients of groundwater beneath the site and temporal trends based on the water level monitoring results are discussed in the following sections.

3.2.1.1 Horizontal and Vertical Gradients

Horizontal Gradients

Figure 3-5 presents a potentiometric surface contour map for the Cell 7 area. The map was constructed from water level data collected on October 11, 2012. The potentiometric surface is interpolated from data from piezometers screened at various monitoring interval depths. Because the groundwater beneath the Cell 7 area was generally encountered above bedrock, the potentiometric surface maps represent an idealized thin surficial aquifer system, with influence and correlation with the shallow fractured bedrock aquifer.

Historic contour maps for the Buncombe County Subtitle D Landfill site showed that the potentiometric surface generally was a subdued reflection of surface topography. Topographic divides are typically groundwater divides and groundwater flow converges into the main surficial drainage features. Groundwater flows radially away from topographically high areas, north toward Blevin Branch, or to the south (or west in the western part of the site) toward the French Broad River. On the steep slopes adjacent to Blevin Branch and the French Broad River, the hydraulic gradient steepens.

In the Cell 7 area, groundwater flow follows the drainage morphology which trends south (topographic high) to north (topographic low) toward Blevin Branch. The drainage feature running through the proposed Cell 7 acts as the dominant drainage control feature for the area. The average hydraulic gradient within the Cell 7 hollow is about 0.06 ft/ft in the surficial aquifer and 0.05 ft/ft in the shallow fractured bedrock. These values are similar to those observed in the Cell 6 area, but are slightly higher than the hydraulic gradient calculated within the Cell 4 hollow at 0.02 ft/ft and 0.03 ft/ft in the Cell 1-3 Area (Hollow A) during previous investigations. Because topography influences groundwater flow, it follows that steeper hydraulic gradients

would occur in areas where relief is greatest and lower gradients would occur where relief is less exaggerated.

Vertical Gradients

Vertical gradient data is evaluated by comparing water levels from nested piezometer sets. Nested piezometer pairs are present at 3 locations in the Cell 7 area: B-720s/B-720d, B-722s/B-722d, and B-727s/B-727d. Vertical gradients are calculated as the difference in water level elevation between two nested piezometers, divided by the vertical distance from the saturated screen midpoint of the shallow piezometer to the screen midpoint of the deeper piezometer. The distance between screen midpoint intervals of nested piezometers ranged from 19 feet at nest B-722s/B-722d to 32 feet at nest B-727s/B-727d.

In the Cell 7 area, all of the nested piezometer pairs exhibited a downward gradient which is indicated by a negative gradient value. The vertical gradient values from the shallow piezometers in the saprolite/PWR to the bedrock ranged from -0.391 ft/ft at nest B-720s/B-720d to -0.04 ft/ft at nest B-722s/B-722d. The vertical gradient in the B-727 well nest showed a negative vertical gradient similar to the B-722 nest, however the shallow well (B-727s) is screened in saturated saprolite and the deep well (B-727d) is screened in saturated saprolite/PWR.

The downward vertical hydraulic gradient decreases further down the drainage feature (from the high point in the south at B-720 to the lower portion to the north at B-722) and eventually becomes an upward gradient near Blevin Branch, as seen in piezometers installed during previous investigations.

Historic, site-wide water level data from nested monitoring well pairs indicate that upward gradients exist near and within drainage features (CDM, 2004). MW-2/2D and MW-8/8D, located in or near a drainage feature, have typically shown an upward vertical gradient. Although nested pair MW-2/2D displays a very weak downward vertical gradient at times, it is expected that just north of this location, and approaching Blevin Branch, an upward vertical gradient exists. The occurrence of upward vertical gradients in the drainage features provide evidence that Blevin Branch and the unamed creeks feeding it and the French Broad River serve as discharge points for the saprolite, PWR, and shallow bedrock aquifer.

3.2.1.2 Temporal Trends

Table 3-4a summarizes water level measurements collected on a semi-annual basis from all of the existing groundwater monitoring wells at the site. Because almost all of the piezometers installed during previous investigations have been abandoned, the water levels from the monitoring wells provide the best long-term assessment of temporal trends at the site.

Historically, the lowest water levels usually occur during the winter months. During previous discussions, eighty percent of the site piezometers exhibited the seasonal low during this period. All of the piezometers in which the low was at another time of the year were less than 30 feet in depth, and could be more sensitive to specific precipitation events or other effects such as evapotranspiration. Seasonal high water levels were most commonly observed in the late spring, and many of the piezometers peaking at another time of the year also exhibited a marked increase during this period.

In the majority of the Cell 7 area the elevation of the water table is the limiting factor in determining the landfill base grades. In addition to the existing data from the site monitoring wells, CDM Smith also reviewed historic groundwater levels from several inactive and active wells in the USGS and NCDENR Division of Water

Resources groundwater level monitoring networks in the vicinity of the landfill or similar terrain and depth. Well names, locations, depths and monitoring zones are provided in the table below.

NCDENR – Division of Water Resources Inactive Groundwater Level Monitoring Network

Quad	Name	County	Total Depth	Monitoring Zone
M 84P1 (inactive)	Swannanoa	Buncombe	99	Bedrock
M 83O1 (inactive)	Black Mountain	Buncombe	26	Saprolite
O 87D1 (active)	Bent Creek (DWQ Research Station)	Buncombe	25	Saprolite/PWR
Q 85N1 (inactive)	Hendersonville	Henderson	48	Bedrock
P 84G2 (inactive)	Hendersonville	Henderson	44	Saprolite
M 90T1 (inactive)	Canton Watershed RS 1	Haywood	35	Saprolite

Hydrographs and well statistics were compared for the applicable active and inactive NCDENR DWQ wells; particularly maximum water levels compared to minimum water levels. The average difference between the maximum recorded highs and the maximum recorded lows for all of the wells with long-term data were about 8 feet. In this case, the maximum value would be 4 feet above the mean.

In the case of the newly installed Buncombe County Cell 7 piezometers, there is insufficient data to determine an average groundwater level; however, based on the groundwater elevations recorded since installation, the groundwater data collected at the site in August 2012 are most likely the closest representative of average levels. In order to construct an estimated seasonal high potentiometric contour map, a conservative value of 4 feet was added to the highest recorded elevation (in most cases the August 16, 2012 data).

The Estimated Seasonal High values for the existing monitoring wells and piezometers are included on **Table 3-4** and **3-4a**. Copies of the hydrographs and well statistical data for the USGS and NCDENR wells are included in **Appendix D**. A seasonal high groundwater contour map is provided on **Figure 3-6**.

Table 3-5 and **Figure 3-7** present monthly precipitation totals from January 1995 to September 2012 at the Asheville Airport. Monthly average precipitation ranges between a low of 4.40 inches in October up to 7.71 inches in July. Monthly averages are typically above 7 inches from June to September. Further discussion of annual precipitation is provided in Section 3.3.1.

Table 3-4
Groundwater Elevation Summary
Buncombe County Subtitle D Landfill Expansion
Cell 7 Area

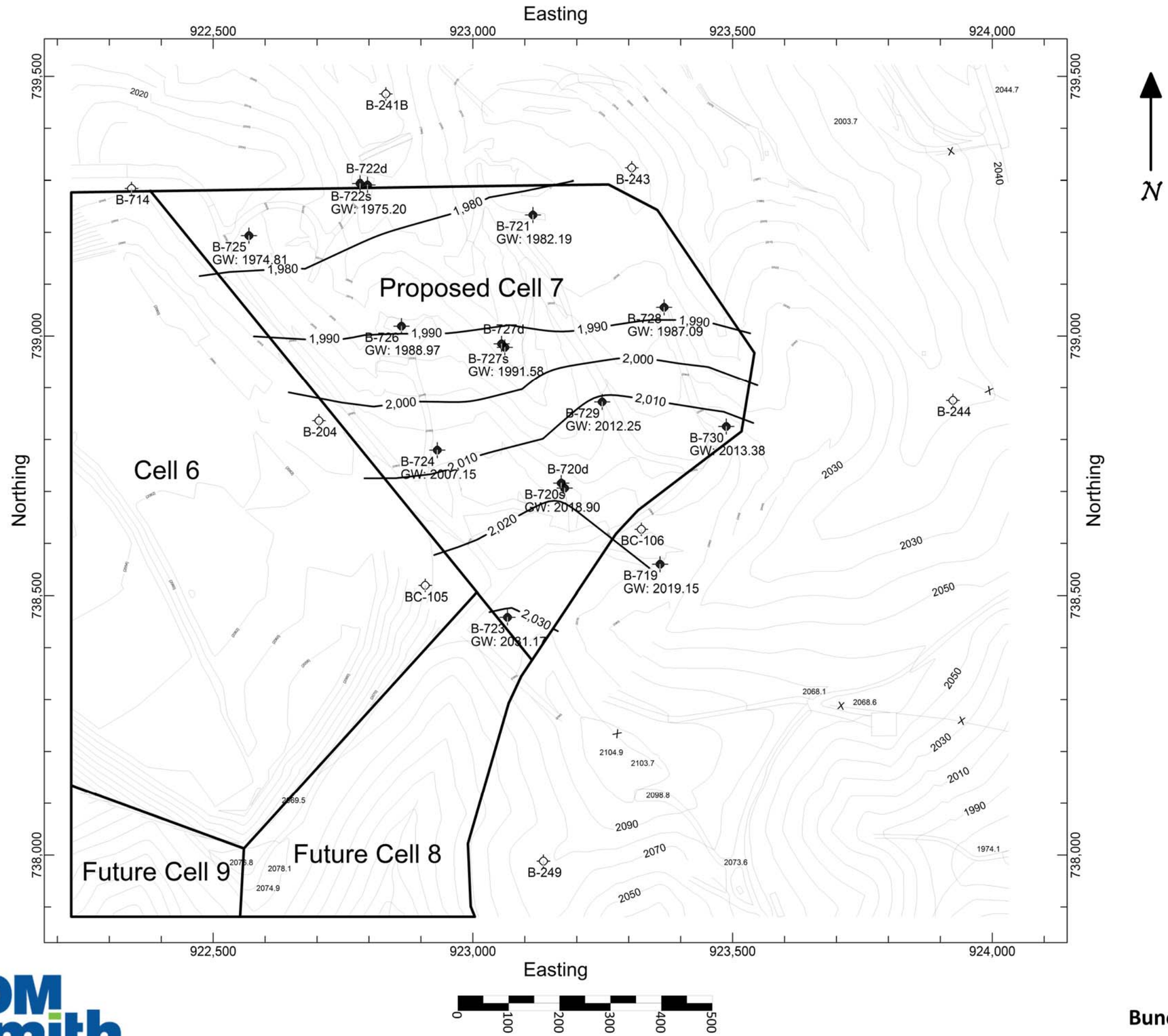
Piezometer I.D.	Top of Casing Elevation (feet AMSL)	Ground Elevation (feet AMSL)	Initial Groundwater Elevation (feet AMSL)	8/16/12 Groundwater Elevation (feet AMSL)	9/6/12 Groundwater Elevation (feet AMSL)	10/11/12 Groundwater Elevation (feet AMSL)	Estimated Seasonal High Elevation (feet AMSL)	Estimated Base Grade Elevation (feet AMSL)	Vertical Separation from Seasonal High[4] (feet)
B-719	2073.27	2070.37	2019.82	2019.62	2019.37	2019.15	2023.62	NA	NA
B-720s	2059.39	2055.85	2021.78	2019.49	2019.11	2018.90	2023.49	2046	22
B-720d	2059.56	2056.82	2011.38	2011.28	2010.88	2010.50	2015.28	2046	31
B-721	2014.44	2011.39	1983.2	1982.87	1982.97	1982.19	1986.97	2008	21
B-722s	1987.95	1985.17	1975.25	1975.75	1974.91	1975.20	1979.75	NA	NA
B-722d	1989.03	1986.13	1974.82	1974.73	1974.06	1974.32	1978.73	NA	NA
B-723	2079.93	2077.04	2031.75	2031.38	2031.27	2031.17	2035.38	2064	29
B-724	2058.15	2055.59	2009.56	2008.05	2007.67	2007.15	2012.05	2050	38
B-725	2031.41	2028.60	1974.88	1975.16	1974.76	1974.81	1979.16	2021	42
B-726	2024.29	2021.78	1989.8	1989.71	1989.3	1988.97	1993.71	2026	33
B-727s	2009.82	2007.26	1993.66	1992.34	1992.00	1991.58	1996.34	2016	19
B-727d	2008.99	2006.46	1991.97	1991.21	1990.88	1990.48	1995.21	2016	21
B-728	2032.61	2030.06	1988.19	1987.90	1987.55	1987.09	1991.90	2020	28
B-729	2043.81	2040.66	2012.95	2013.16	2012.62	2012.25	2017.16	2030	13
B-730	2057.77	2055.05	2014.44	2014.25	2013.87	2013.38	2018.25	2041	22
								Average Separation:	27

Notes:

1. Horizontal Control - NAD 83
2. Vertical Control - NAVD 29
3. AMSL - Above Mean Sea Level
4. Vertical Separation from base grades to estimated seasonal high groundwater table.

Table 3-4a
Groundwater Elevation Summary
Buncombe County Subtitle D Landfill
Existing Monitoring Well Network

Well	Top of Casing Elevation (MSL)	Spring 2008 Elevation (MSL)	Fall 2008 Elevation (MSL)	Spring 2009 Elevation (MSL)	Fall 2009 Elevation (MSL)	Spring 2010 Elevation (MSL)	Fall 2010 Elevation (MSL)	Spring 2011 Elevation (MSL)	Fall 2011 Elevation (MSL)	Spring 2012 Elevation (MSL)	Estimated Seasonal High Elevation
MW-1	2021.22	1953.46	1950.13	1949.04	1948.39	1951.47	1951.03	1951.15	1950.20	1949.91	1957.46
MW-1D	2021.57	1952.26	1948.94	1947.89	1946.22	1949.24	1949.29	1949.36	1948.45	1948.15	1956.26
MW-2	1920.86	1912.76	1912.19	1912.40	1911.96	1912.66	1912.03	1912.36	1911.84	1912.07	1916.76
MW-2D	1920.51	1912.23	1911.85	1912.04	1912.02	1912.60	1912.09	1912.38	1912.14	1912.20	1916.60
MW-3	1987.66	1953.36	1952.04	1951.33	1952.56	1956.54	1954.95	1953.85	1955.00	1955.75	1960.54
MW-4	1944.35	1929.85	1929.80	1930.73	1930.35	1931.15	1929.87	1931.46	1930.14	1931.26	1935.46
MW-4D	1944.64	1929.50	1929.02	1930.13	1929.72	1930.74	1929.82	1931.03	1930.38	1931.19	1935.19
MW-5	1977.12	1940.65	1939.74	1940.27	1940.88	1942.38	1941.42	1942.26	1941.35	1942.37	1946.38
MW-5D	1976.92	1938.42	1937.73	1938.34	1938.81	1940.53	1939.12	1940.21	1939.04	1940.25	1944.53
MW-6	1987.34	1957.93	1955.86	1957.84	1958.86	1961.02	1959.53	1960.45	1959.05	1960.30	1965.02
MW-7	2022.83	1972.21	1969.69	1970.41	NM	1977.30	1975.91	1976.24	1974.38	1974.99	1981.30
MW-8	1962.06	1926.09	1924.75	1924.28	NM	1928.12	1927.34	1927.18	1926.25	1926.70	1932.12
MW-8D	1962.47	1927.77	1926.22	1924.73	1925.95	1929.29	1928.72	1928.56	1927.76	1928.13	1933.29
MW-10	2010.54	1940.28	1939.27	1939.37	NM	1941.10	1939.84	1940.73	1939.24	1940.66	1945.10
MW-10D	2010.56	1941.48	1939.29	1939.13	1939.71	1940.81	1939.39	1940.34	1938.69	1940.23	1945.48
MW-11	1966.71	1932.14	1933.18	1933.36	1934.32	1935.70	1933.46	1933.50	1933.10	1934.45	1939.70
MW-11D	1966.15	1930.95	1932.18	1932.34	1933.36	1934.95	1932.12	1932.32	1931.86	1933.33	1938.95
MW-13	1953.92	1944.92	1946.39	1946.60	1947.51	1950.05	1947.43	1948.63	1946.91	1948.38	1954.05
MW-13D	1953.82	1946.82	1945.34	1942.23	NM	1948.14	1946.33	NM	NM	1946.69	1952.14



Notes:

Groundwater elevations measured October 11, 2012

Existing piezometer with groundwater elevation

B-726
GW: 1988.97

Abandoned piezometer (GW not measured)

B-244

Groundwater contour (feet above MSL)

1970

0 100 200 300 400 500

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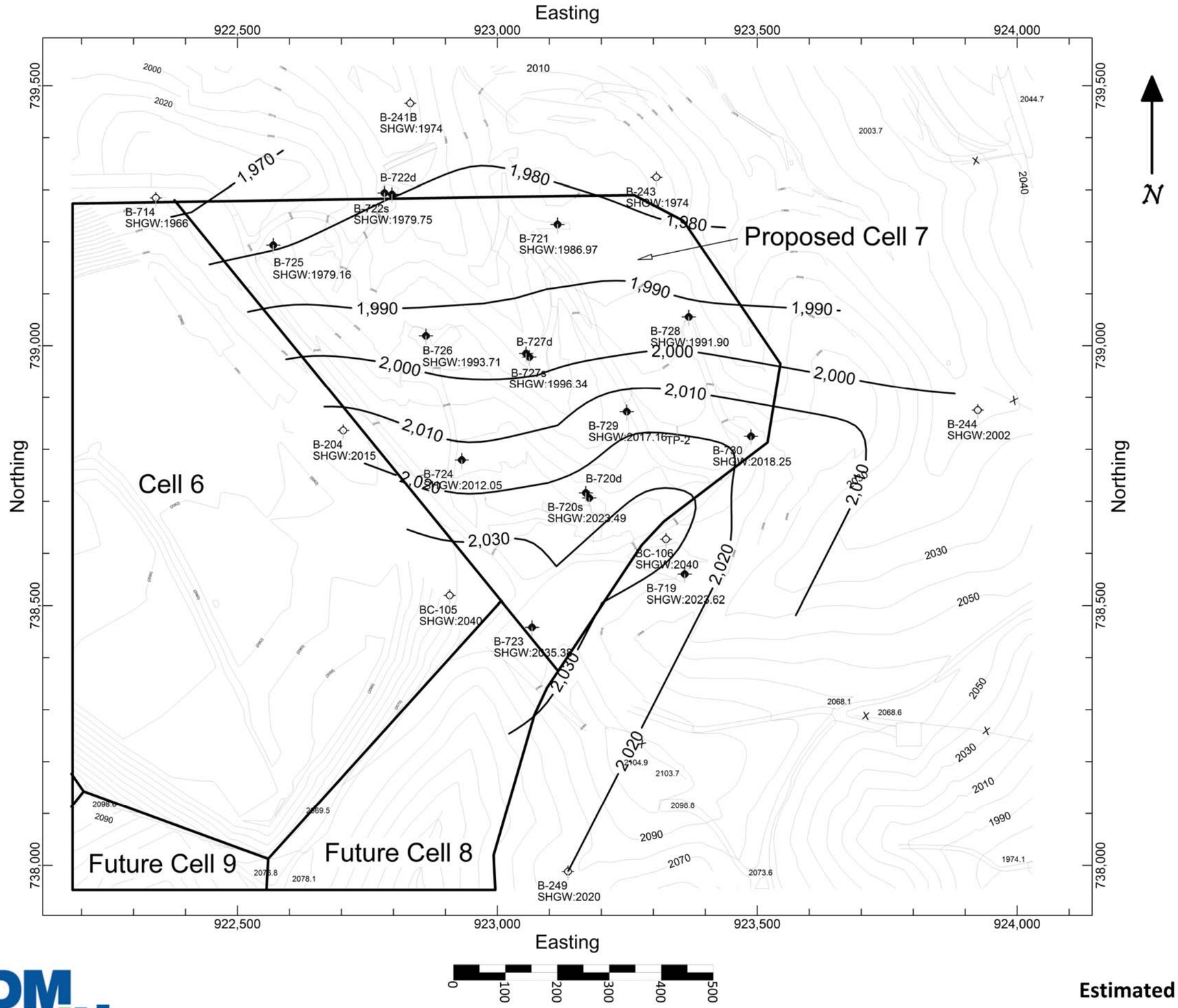
Figure 3-5
Groundwater Contour Map
Buncombe County Subtitle D Landfill Expansion
Cell 7

Table 3-5
Annual Precipitation Data - Asheville Airport
Buncombe County Subtitle D Landfill Expansion
Cell 7

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
1995	7.09	2.93	2.46	1.01	6.05	8.91	3.66	9.27	2	7.26	3.69	1.55	55.88
1996	7.29	2.78	3.43	2.01	2.59	3.57	4.88	6.73	5.26	0.7	4.48	3.98	47.70
1997	4.49	5.29	5.49	5.32	2.94	8.37	3	1.38	4.92	3.94	1.65	3.02	49.81
1998	10	6.4	3.77	8.73	2.28	3.68	2.02	2.3	1.66	1.8	2.8	3.12	48.56
1999	6.43	3.37	2.85	2.45	2.54	4.44	3.89	3.4	2.22	3.34	3.34	2.02	40.29
2000	3.19	2.37	3.87	5.17	1.31	2.81	2.88	4.46	3.33	0	4.29	2.44	36.12
2001	2.68	2.75	5.02	1.35	2.54	2.97	5.54	3.24	4.37	0.63	1.43	2.35	34.87
2002	3.66	1.33	4.38	1.77	3.43	6.19	2.05	2.12	6.09	3.17	4.28	6.41	44.88
2003	1.25	4.5	4.41	5.26	8.37	6.16	10.88	6.86	3.03	2.36	3.93	2.8	59.81
2004	0.83	4.2	2.02	2.95	3.23	7.39	4.68	3.79	13.71	1.11	5.02	3.44	52.37
2005	5.11	6.52	8.47	7.27	4.2	25.63	26.08	14.53	0.87	3.06	9.5	8.92	120.16
2006	9.09	6.48	2.31	11.66	4.29	13.1	7.16	18.09	19.83	7.46	11.63	11.81	122.91
2007	8.51	3.69	10.91	4.51	2.44	7.39	12.33	7.22	8.64	7.67	3.79	10.35	87.45
2008	6.51	9.62	11.45	7.23	3.37	2.17	10.22	14.84	4.33	4.67	4.1	12.07	90.58
2009	6.11	4.74	10.36	8.98	23.32	16.3	7.32	9.36	20.8	14.07	13.68	23.26	158.30
2010	17.81	8.51	10.62	5.69	12.48	4.45	9.01	8.82	10.54	7.47	13.93	3.21	112.54
2011	5.39	7.54	17.64	10.99	7.49	9.74	8.45	7.64	9.51	6.09	13.51	12.98	116.97
2012	9.79	4.05	6.93	11.84	14.79	4.26	14.68	8.62	15.07	4.01	0.85	4.39	99.28
Average	6.40	4.84	6.47	5.79	5.98	7.64	7.71	7.37	7.57	4.38	5.88	6.56	76.58

Source - Climatological Data - Annual Summary North Carolina



Notes:

SHGW = Estimated Seasonal High Groundwater Elevation

Existing piezometer with SHGW elevation

B-726
SHGW: 1993.71

Abandoned piezometer with SHGW elevation

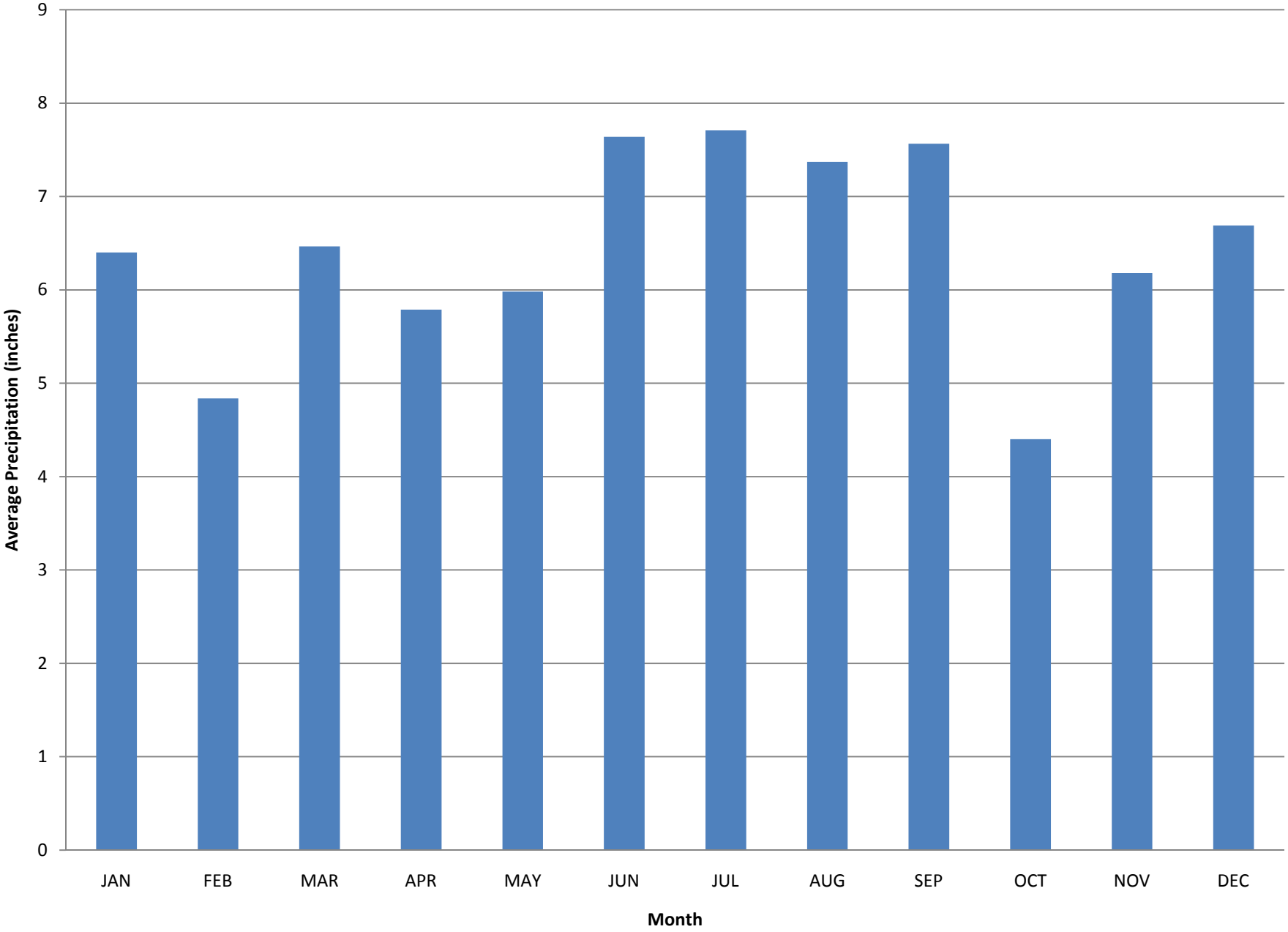
B-244
SHGW: 2002

1970 SHGW contour (feet above MSL)

CDM Smith

Figure 3-6
Estimated Seasonal High Groundwater Contour Map
Buncombe County Subtitle D Landfill Expansion
Cell 7

Figure 3-7
Average Monthly Precipitation
Asheville Regional Airport



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Data From January 1995 to September 2012

3.2.2 Slug Test Results

Hydraulic conductivity (K) values are provided in cm/sec, m/sec, ft/sec, and ft/min. Both displacement (slug-in or falling head) and recovery (slug-out) type slug tests were performed. Hydraulic conductivity results from falling head and recovery tests compared well.

The calculated bedrock hydraulic conductivity within Cell 7 ranged from 0.63 ft/day (B-727d) to 3.03 ft/day (B-720d). Historic average hydraulic conductivities within the bedrock unit around Cell 7 ranged from 0.14 ft/day (B-241B) to 15.96 ft/day (B-503A).

The calculated hydraulic conductivity within the saprolite/PWR within Cell 7 ranged from 0.14 ft/day (B-720s) to 2.99 ft/day (B-727s). Historical average hydraulic conductivity in piezometers from the Cell 4 - 6 area screened in the saprolite/PWR unit ranged from 0.07 ft/day (BC-102) and 0.9 ft/day (BC-101) in Cell 6 to 1.28 ft/day (B-513) in Cell 4-5 Area. A summary of the slug test results from piezometers within the Cell 7 area is provided on **Table 3-6**.

It should be noted that hydraulic conductivities from slug testing in bedrock represent vertically averaged values, as the actual hydraulic conductivity will vary throughout the well monitoring interval with variable fracturing of the bedrock. Slug test raw data and sample calculations are provided in **Appendix E**.

3.3 Hydrogeologic Conceptual Model

3.3.1 Precipitation and Groundwater Recharge

Primarily downward vertical gradients have been observed in nested wells throughout the Cell 7 area. Factors affecting infiltration of precipitation include the rate of precipitation, slope, soil texture, and vegetative cover. Much of the Site is comprised of steep slopes and fine grained soils that inhibit infiltration, however, some of the finer-grained materials have been removed during borrow activities in some areas. Areas of lower relief such as flat hilltops and drainage bottoms are expected to be the locations of greatest recharge (less so in the drainage bottoms due to the higher observed fine content of soils). Areas covered by pasture or forest litter would also be expected to enhance infiltration. Most of the Site has been developed or cleared for borrow or is covered forest, particularly to the south and east. The areas used for borrow would most likely enhance infiltration, especially on the flat hilltops, but would also increase run-off on the sloped areas.

As previously discussed in Section 3.2, the average monthly precipitation at the Site does not vary greatly over the year. However, precipitation during the summer months typically occurs as sporadic high intensity events of short duration, which leads to runoff. In addition, plant evapotranspiration in the summer leads to higher removal of soil moisture and decreases the potential for deep infiltration. Winter precipitation occurs as events of longer duration and lesser intensity; consequently infiltration and groundwater recharge should be greater in the winter months than in the summer. Approximately 5 to 10 inches per year of precipitation (13 to 26 percent of average annual precipitation) are expected to result in groundwater recharge, based on typical regional recharge values.

Table 3-6
Slug Tests Summary
Buncombe County Subtitle D Landfill Expansion
Cell 7

Piezometer I.D.	Screen Depth (feet)	Screen Depth (inches)	Lw	r_w	A	B	C	H	Le	1.1/ln(Lw/rw)	A+B	ln((H-lw)/rw) or C	L_e/r_w	$\ln(R_e/r_w)$	r_c	t	y_o	y_t	K (in/sec)	K (ft/min)	K (ft/day)	K (cm/sec)
B-720s Fall	58	696	217	3	2.8	0.43	2.34	217	120	0.256876928	3.21	2.336	40	3.1718	1.034	1,000	3	0.0001	1.5E-04	7.28E-04	1.05	3.7E-04
B-720s Recovery	58	696	217	3	2.8	0.43	2.34	217	120	0.256876928	3.21	2.336	40	3.1718	1.034	2,190	2	0.1	1.9E-05	9.7E-05	0.14	4.9E-05
B-720d Fall	80	960	381	3	2.8	0.43	2.34	621	120	0.227120605	3.21	4.382026635	40	2.9093	1.034	130	0.68	0.01	4.2E-04	2.10E-03	3.03	1.1E-03
B-720d Recovery	80	960	381	3	2.8	0.43	2.34	621	120	0.227120605	3.21	4.382026635	40	2.9093	1.034	160	0.5	0.01	3.2E-04	1.6E-03	2.28	8.0E-04
B-722s Fall	24	288	142	4	2.5	0.37	2	226	120	0.308407311	2.85	3.044522438	30	2.3318	1.034	585	3.75	1	2.3E-05	1.17E-04	0.17	6.0E-05
B-722s Recovery	24	288	142	4	2.5	0.37	2	226	120	0.308407311	2.85	3.044522438	30	2.3318	1.034	600	0.2	0.0001	1.3E-04	6.57E-04	0.95	3.3E-04
B-722d Fall	41	492	320	3	2.2	0.31	1.61	728	60	0.235497732	2.47	4.912654886	20	2.3788	1.034	285	0.18	0.01	2.1E-04	1.07E-03	1.55	5.5E-04
B-722d Recovery	41	492	320	3	2.2	0.31	1.61	728	60	0.235497732	2.47	4.912654886	20	2.3788	1.034	400	0.2	0.01	1.6E-04	7.9E-04	1.14	4.0E-04
B-727s Fall	22	264	142	4	2.5	0.37	2	226	120	0.308407311	2.85	3.044522438	30	2.3318	1.034	160	0.6	0.001	4.1E-04	2.07E-03	2.99	1.1E-03
B-727s Recovery	22	264	142	4	2.5	0.37	2	226	120	0.308407311	2.85	3.044522438	30	2.3318	1.034	140	2.4	0.01	4.1E-04	2.03E-03	2.93	1.0E-03
B-727d Fall	53	636	423	4	2.5	0.37	2	423	120	0.236040035	2.85	2.001	30	3.3032	1.034	1,140	3.8	0.001	1.1E-04	5.3E-04	0.77	2.7E-04
B-727d Recovery	53	636	423	4	2.5	0.37	2	423	120	0.236040035	2.85	2.001	30	3.3032	1.034	1,240	1.7	0.001	8.8E-05	4.4E-04	0.63	2.2E-04

Notes:

Equation used for partially penetrating piezometers:

$$\ln R_e/r_w = [1.1/\ln (Lw/r_w) + (A+B \ln[(H-Lw)/r_w]/(L_e/r_w]^{-1}$$

$$K = (r_c^2 \ln(R_e/r_w)/2Le) (1/t) (\ln y_o/y_t)$$

Equation used for fully penetrating deep piezometers:

$$\ln Re/rw = [1.1/\ln (Lw/rw) + C/(Le/rw]-1$$

$$K = (rc2 \ln(Re/rw)/2Le) (1/t) (\ln yo/yt)$$

Where:

r_c = radius of the unscreened part of the well where the head is rising
r_w = horizontal distance from well center to undisturbed aquifer
R_e = radial distance over which the difference in head, ho, is dissipated in the flow system of the aquifer
L_e = length of the saturated gravel pack or open section of the well
y_o = displacement in the well at time to = 0
y_t = dispacement in the well at time t > to
Lw = head in the well before slug test
A = dimensionless parameter which is a function of d/rw
B = dimensionless parameter which is a function of d/rw
C = dimensionless parameter which is a function of d/rw
H = saturated thickness of the aquifer
t = time (seconds)
K = hydraulic conductivity (units given above)

All measurements of length (e.g., radius, distance, head, thickness) are in inches unless specified otherwise.

Precipitation that infiltrates into the ground will seep downward as wetting fronts following precipitation. These wetting fronts will follow the path of least resistance through zones of relatively higher conductivity in the saprolite and PWR. Upon reaching a less permeable surface such as the top of hard, unfractured bedrock, the water will spread laterally until it finds another relatively higher conductivity pathway downward such as a weathered zone or a fracture, or until it is discharged to the surface water system. These discharges are generally intermittent, and occur in the secondary drainage features following precipitation events. As saturation is not generally observed within the overburden, the fractured bedrock material is apparently capable of transmitting water at a rate exceeding infiltration except in local areas. The slug test and previous pumping tests results indicated that the fractured bedrock materials were often more permeable than the saprolite and PWR units.

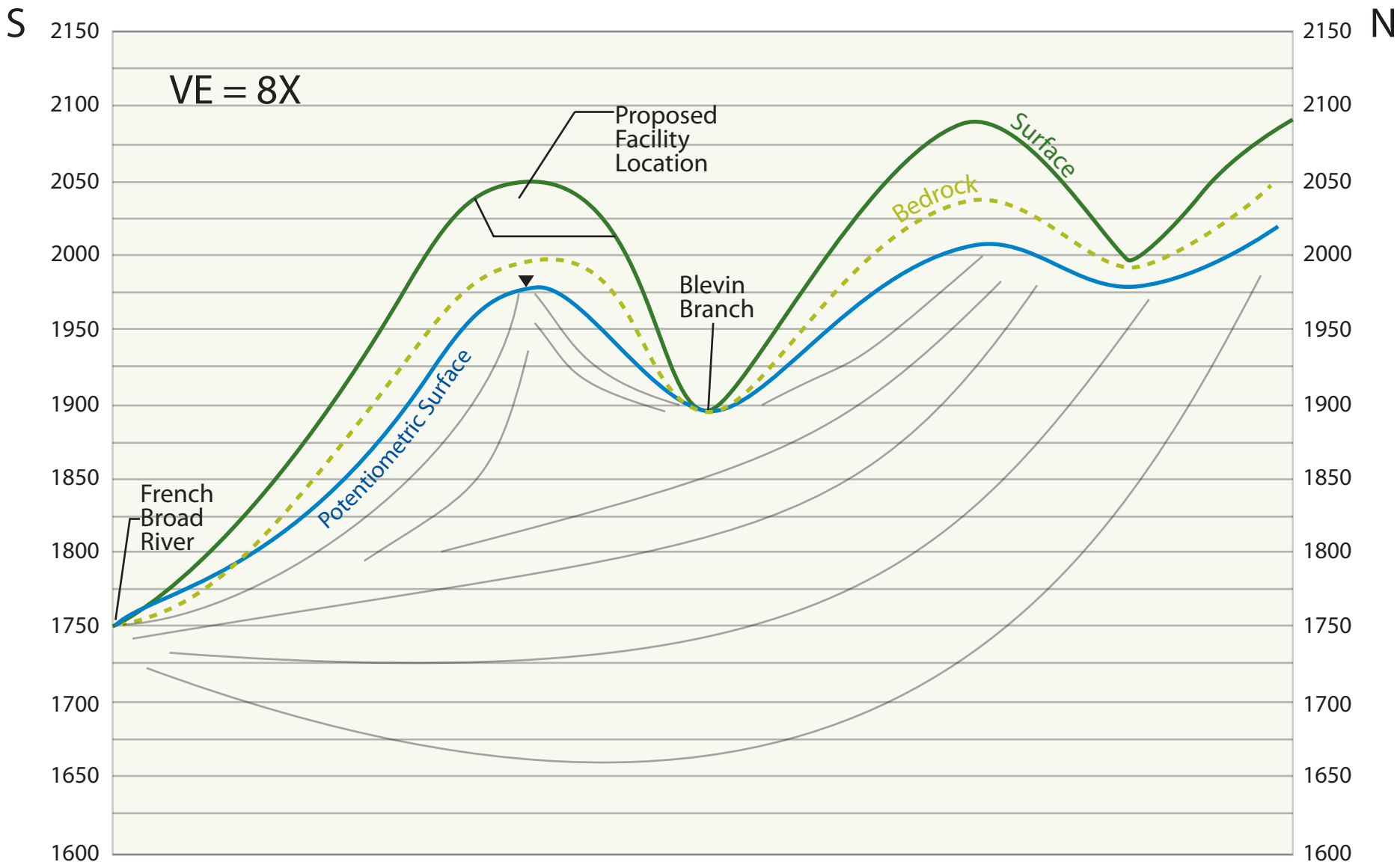
Infiltration following lining of a landfill cell is expected to be greatly reduced. Cells 1-6 have been lined and infiltration is expected to have been almost completely eliminated in these areas. Precipitation which falls on the Cells 1-6 area is collected and redirected to retention ponds, where it is slowly released to surface drainage features and streams ultimately connecting to the French Broad River.

3.3.2 Groundwater Flow

Across the site and within the south-western portions of the Cell 7 area, the saturated zone lies primarily within the bedrock beneath the saprolite and PWR hydrogeologic units, with the exception of the topographic low areas associated with the secondary drainage features where saturated zone occurs within the saprolite and/or PWR. The saturation found in these areas near the bottom of secondary drainage features likely represents water that has infiltrated in surrounding areas and moved laterally possibly on the bedrock surface until it accumulated in the lower elevation area, or as groundwater discharge locations. However, within most of the Cell 7 area, groundwater was encountered above the fractured bedrock in the PWR, and in some areas the saprolite. Within the overburden materials, the zone of highest conductance is immediately above the bedrock surface, due to the presence of lesser amounts of clay minerals in this interval than at the ground surface.

The downward hydraulic gradients between the PWR and bedrock in the Cell 7 piezometers indicates water within the saturated zone of the overburden moves laterally or downward in the higher areas of the hollow; indicating an area of recharge. The upward gradient historically found near the bottom of the drainage features indicates that groundwater is discharging from the fractured bedrock to the surficial water table and ultimately to the perennial surface water features. Sometimes, if laterally moving water intersects the ground surface before it finds a path permitting further downward migration, it will be discharged as springs.

Figure 3-8 (from previous Design reports) is a conceptual groundwater flow diagram for the landfill area showing groundwater flow vectors beneath the site. The diagram is a generalized cross section running north-south from the French Broad River, through the center of the landfill area, and extending several thousand feet north of the site. This figure illustrates that groundwater, originating from recharge areas off-site, travels at deeper intervals than on-site groundwater but still discharges to the French Broad River. Therefore, the depth of groundwater circulation beneath the site is limited by flow from more distant recharge areas. The bulk of groundwater flow within the Blue Ridge Province is in the upper several hundred feet due to the decrease in fracturing and lower bedrock permeability with depth (Freeze and Cherry 1979).


S
N
VE = 8X
2150
2100
2050
2000
1950
1900
1850
1800
1750
1700
1650
1600
Proposed
Facility
Location
Surface
Bedrock
Blevin
Branch
Potentiometric Surface
French
Broad
River

CDM Smith

Within a majority of the Cell 7 area, the groundwater occurs just above the fractured bedrock in the PWR, with the surficial aquifer thickness increasing down the slopes toward Blevin Branch. The secondary drainage feature acts as a discharge point for both the bedrock and saprolite/PWR closer to Blevin Branch. On a large scale, the groundwater regime acts as a single homogeneous unit. Shallow lateral flow within the fractured bedrock unit will be consistent with the potentiometric surface (Figure 3-5). However, local (i.e., small scale) hydrogeologic conditions may cause groundwater to flow in different directions than large scale flow.

Bedrock fracture flow is very complex and is dependent upon fracture size, orientation, degree of infilling, and connection with other fractures. Localized weathered zones will also affect bedrock fracture flow. Because bedrock fracture flow systems cannot be characterized by direct observation, indirect methods must be used. Data concerning the fracture flow system at the site were obtained through drilling observations, rock core samples, water level measurements, aquifer slug tests, and pump tests (previous investigations).

Cell 7 area hydraulic conductivities obtained from slug tests within the bedrock unit ranged from 0.63 ft/day (B-727d) to 3.03 ft/day (B-720d). Hydraulic conductivity values from previous pumping tests ranged from 0.7 to 52 ft/day in Hollow A and 0.015 to 12 ft/day in Hollow B. Slug test k values from the Phase III investigation ranged from 0.08 to 47 ft/day. This wide range in hydraulic conductivity values is due primarily to the heterogeneous nature of the bedrock fractures. At locations where a major fracture was encountered, hydraulic conductivities were very high, and conversely, in areas where only minor or no fractures were encountered, hydraulic conductivities were comparatively low. Based on previous pump tests, the fractures appear to be sufficiently interconnected beneath the site, such that drawdown was observed in all directions.

3.3.2.1 Groundwater Velocity

Groundwater flow in a saturated porous media is characterized by Darcy's Law:

$$\mathbf{Q = K*A*\ dh/dl}$$

Where:	Q	=	groundwater discharge rate
	K	=	hydraulic conductivity
	A	=	cross sectional area of flow
	dh/dl	=	hydraulic gradient

Darcy's law can also be expressed as follows:

$$\mathbf{v = K * dh/dl}$$

Where:	v	=	Darcy groundwater velocity

As the actual groundwater velocity will be a function of the effective porosity of the media (n_e), the seepage velocity is calculated as follows:

$$\mathbf{v_e = \frac{K*dh/dl}{n_e}}$$

Where:	v_e	=	effective groundwater velocity (seepage velocity)
	n_e	=	effective media porosity

Table 3-7 presents site effective groundwater velocity estimates. These estimates were made using hydraulic conductivity values from Cell 7 area aquifer slug testing. The effective porosity range of 1 to 10 percent was used for bedrock wells based on core observations as previously discussed. These estimates represent best and worst case scenarios. An average hydraulic gradient of 0.05 ft/ft was used. These calculations result in average seepage velocities ranging from 0.16 to 0.49 ft/day in the saprolite/PWR and 0.28 to 1.43 ft/day in the fractured bedrock.

The time to travel 250 feet averages 2.1 years in the saprolite/PWR and 0.8 years in the fractured bedrock. These values suggest that a release of a conservative (nonretarded) contaminant from the edge of the landfill would likely take several months to approximately 2 years to reach a monitoring system, after the release had reached groundwater. It should be noted that the estimated velocity rates are for average aquifer conditions and that actual velocity rates within bedrock fractures may vary significantly, as discussed previously.

3.3.3 Surface Water Interactions and Groundwater Discharge

One groundwater discharge location (seep) was identified north of the Cell 7 area. The seep occurs north of the B-722 nested pair near the base of the drainage feature bisecting the Cell. This seep represents a saprolite discharge and likely only discharges during periods of higher water table. The seep may also periodically act as a bedrock discharge point. The drainage feature flows north and discharges directly to Blevin Branch.

The discharge of groundwater from the bedrock system in the Cell 7 area and across the remainder of the site to the surface has not been directly observed; however, shallow bedrock groundwater in the Cell 7 area discharges north to Blevin Branch and may discharge to the secondary feature prior to discharge at Blevin Branch.

Table 3-7
Summary of Calculated Groundwater Flow Velocities
Buncombe County Subtitle D Landfill Expansion
Cell 7

Piezometer Designation	Horizontal Gradient [1] (feet/foot)	Estimated Effective Porosity [2]	Hydraulic Conductivity [3] (feet/day)			Average Linear Velocity (feet/day)		
			Maximum	*Minimum*	*Average*	*Maximum*	*Minimum*	*Average*
B-720s	0.066	0.25	1.05	0.14	0.60	0.28	0.04	0.16
B-727s	0.041	0.25	2.99	2.93	2.96	0.49	0.48	0.49
B-720d	0.054	0.10	3.03	2.28	2.66	1.64	1.23	1.43
B-727d	0.040	0.10	0.77	0.63	0.70	0.31	0.25	0.28

Notes:

[1] Horizontal gradients were calculated using the October 11, 2012 groundwater elevations provided in Table 3-4. Distances were calculated from Figure 3-5.

[2] An effective porosity value of 25% was used for the shallow wells. This value is based on estimated effective porosity values provided in Table 3-3 for similar lithologies. A 10% effective porosity value was used for the bedrock wells.

[3] Values are from the calculated Hydraulic Conductivity calculations provided in Table 3-6.

Section 4
Conclusions

This section presents conclusions based upon site investigation activities to date. These conclusions include considerations regarding the landfill design and considerations for the water quality monitoring plan.

4.1 Landfill Construction Considerations

Based on the findings of presented in this report and previous reports, the Cell 7 area is considered to be well suited for expansion of the Buncombe County Solid Waste Management Facility. Similar to previous investigations for Cells 1-6, the following issues should be considered in the landfill design.

- The separation between the base of the landfill and the seasonal high water table surface is a site concern since the base of the landfill will be limited by the depth to seasonal high groundwater. The depth to seasonal high groundwater below the expansion site, with the exception of a few areas of higher elevation in the south-western portion of the site elevation is above the bedrock. A minimum 4-foot separation above the seasonal high groundwater elevations and bedrock, where applicable, has been observed in the Cell 7 design.

- After construction of the landfill, groundwater recharge will decrease due to the placement of a liner system and the later placement of the landfill cap. This reduction in groundwater recharge will cause a lowering in the water table surface; however, no change of direction of groundwater flow is anticipated. With the decrease in the water table surface, a decrease in the hydraulic gradient beneath the landfill will likely occur. This will likely decrease the groundwater flow velocity and therefore increase travel times to downgradient monitoring and discharge points.

4.2 Water Quality Monitoring Plan Considerations

The Site groundwater system is largely composed of an interaction between the surficial water table and the shallow fractured bedrock aquifer system. Based on observed groundwater levels, potentiometric contour maps, slug tests and pumping tests, this system is on a large-scale equivalent to a homogenous, anisotropic porous media, but on a small-scale may be heterogeneous and locally variable.

Groundwater flows from areas of higher topography to areas of lower topography, with convergent flows into the hollows. This convergent flow can be monitored with wells completed near or within the features at the base of the hollows, downgradient of the landfill.

Due to the downward gradients found throughout the site, shallow fractured bedrock groundwater should be monitored along with the surficial system. The shallow fractured bedrock can be monitored by the installation of wells in zones in which water bearing fractures are found. Installation of nested well pairs screened in the saturated PWR and the shallow fractured bedrock, coupled with surface water monitoring in Blevin Branch, will serve to effectively monitor the site.

4.3 Piezometer Abandonment

Rule .1623(b)(2)(I) requires that all borings at the site not converted to permanent monitoring wells shall be properly abandoned. Because the majority of the Cell 7 area will be excavated, all of the recently installed piezometers within the Cell 7 footprint will be over-drilled and abandoned. Well abandonment records will be submitted following abandonment of the piezometers.

Section 5
References

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Appendix A

Bore Logs and Well Construction Diagrams

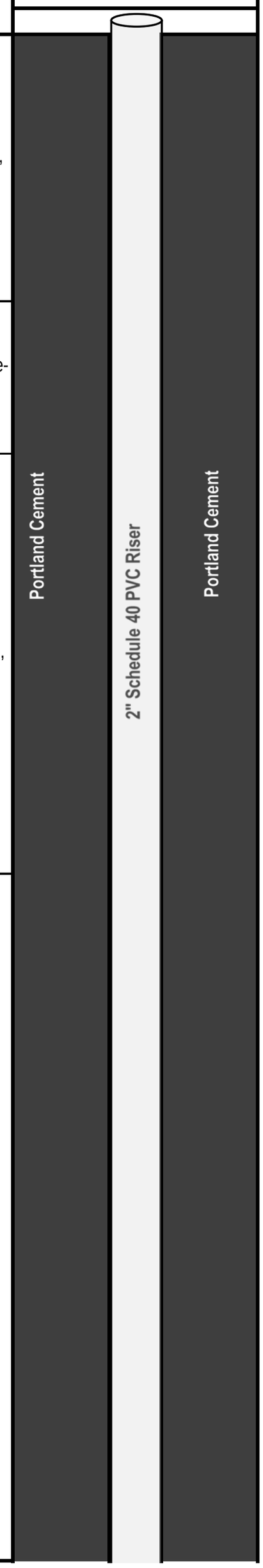
B-719 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/30/2012
Project No.:	6447-93318	End Date:	7/31/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	62'
Location Code:	B-719	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 57'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 57'-62', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	58	4-4-5-4	SAND, silty, weathered rock, brown, light and orangish brown, light to dark gray and black, fine-to coarse-grained, loose, micaceous, dry
3			
4, 5	75	2-3-2-2	
6, 7, 8			
9, 10	79	3-3-4-6	SAND, silty, trace clay and weathered rock, orangish brown, and light brown, fine-to coarse-grained, loose, micaceous, moist
11, 12, 13			
14, 15	88	3-3-3-4	SAND, silty, trace weathered rock, brown, light and orangish brown, fine-to coarse-grained, loose, micaceous, moist
16, 17, 18			
19, 20	92	2-4-3-6	
21, 22, 23			
24, 25	83	5-6-9-9	SAND, silty, trace weathered rock, brown, light and orangish brown, light to dark gray and white, fine-to coarse-grained, loose to dense, micaceous, moist
26, 27, 28			
29, 30	83	2-5-4-6	
31, 32, 33			
34, 35	79	5-4-6-11	
36, 37, 38			
39, 40	88	15-16-20-50/3	

Well Construction
Above Grade Completion



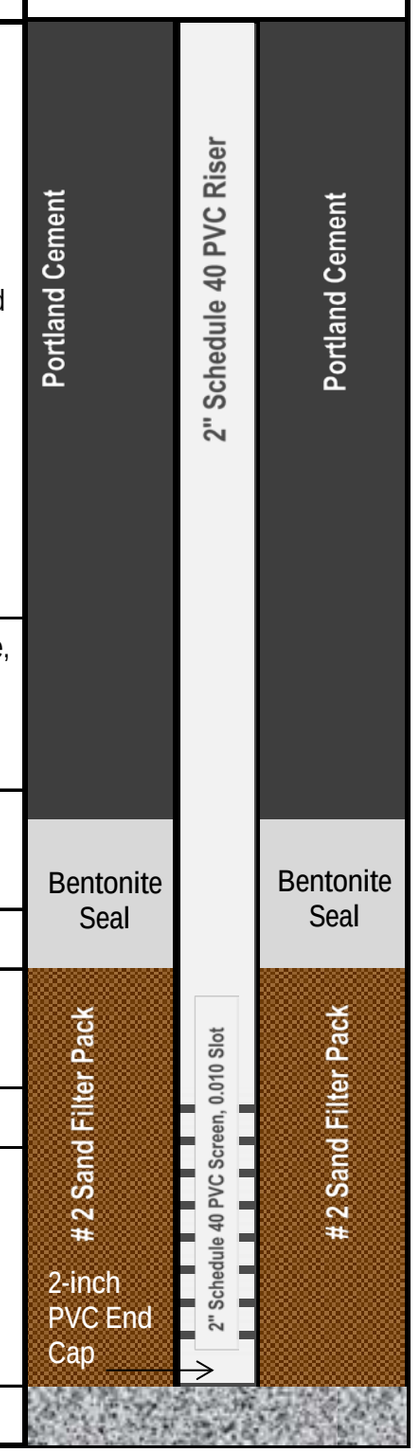
B-719 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/30/2012
Project No.:	6447-93318	End Date:	7/31/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	62'
Location Code:	B-719	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 57'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 57'-62', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
41			SAND, silty, trace weathered rock, brown, light and orangish brown, light to dark gray and white, fine-to coarse-grained, medium dense to dense, micaceous, moist
42			
43			
44	92	7-10-13-16	
45			
46			
47			
48			
49	79	15-16-20-50/3	
50			
51			SAND, silty, weathered rock, brown, light and orangish brown, light to dark gray and white, fine-to coarse-grained, micaceous, moist (Partially Weathered Rock) Auger refusal at 52 feet.
52			
53	Air Drilling		GNEISS, undifferentiated, dense
54			
55			GNEISS, undifferentiated, soft
56			GNEISS, undifferentiated, dense
57			
58			FRACTURE, water producing
59			GNEISS, undifferentiated, dense
60			
61			
62			
63			Boring terminated at 62 feet.

Well Construction
Above Grade Completion



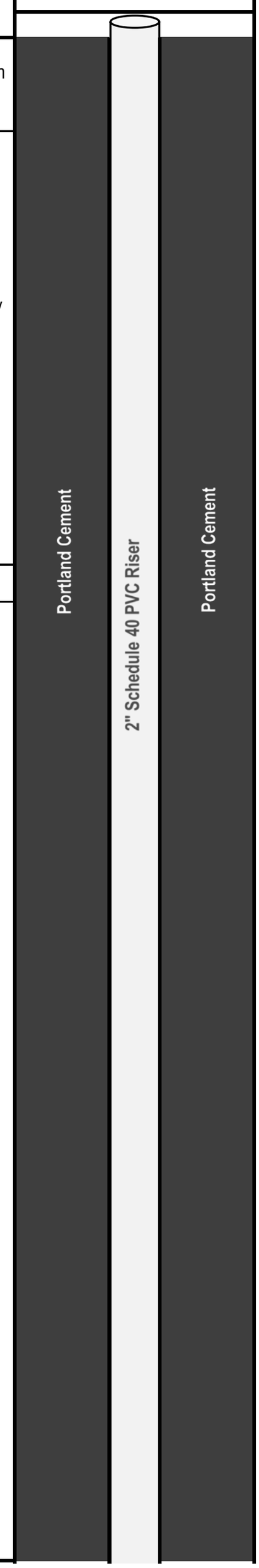
B-720s Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/24/2012
Project No.:	6447-93318	End Date:	7/25/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	58'
Location Code:	B-720s	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 48'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 48'-58', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	46	3-6-10-22	SAND, silty, clayey, trace organics and weathered rock, light brown to brown, orangish and reddish brown, fine-grained, medium dense, dry
3, 4			
5, 6	42	4-22-50/3	
7, 8, 9			SAND, silty, trace weathered rock, light brown, and orangish brown, fine-grained, very dense, dry (Partially Weathered Rock)
10, 11	33	3-25-50/2	
12, 13			Auger refusal at 13.5 feet.
14			WEATHERED ROCK
15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40	Air Drilling		SAND, silty, weathered rock, brown, orangish brown and dark gray, fine-to coarse-grained, micaceous, dry to wet (Partially Weathered Rock)

Well Construction
Above Grade Completion



B-720s Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/24/2012
Project No.:	6447-93318	End Date:	7/25/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	58'
Location Code:	B-720s	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 48'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 48'-58', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description	Well Construction Above Grade Completion
41	Air Drilling		SAND, silty, trace weathered rock, brown, orangish brown and dark gray, fine-to medium-grained, micaceous, wet (Partially Weathered Rock)	Bentonite Seal; 2" Schedule 40 PVC Riser; Bentonite Seal
42				
43				
44				
45				
46			SAND, silty, weathered rock, light to dark gray, brown and orangish brown, fine-grained, micaceous, wet (Partially Weathered Rock)	# 2 Sand Filter Pack; 2" Schedule 40 PVC Screen, 0.010 Slot; # 2 Sand Filter Pack
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58			GNEISS, undifferentiated, dense	2-inch PVC End Cap
59			Boring terminated at 58 feet.	

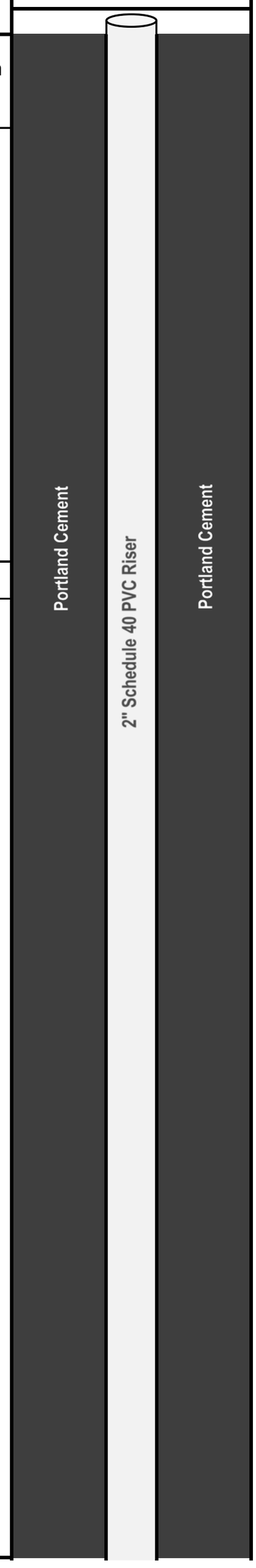
B-720d Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	8/3/2012
Project No.:	6447-93318	End Date:	8/3/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	80'
Location Code:	B-720d	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 70'
Driller:	Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 70'-80', 0.01"

Drilling Method: Air (Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	46	3-6-10-22	SAND, silty, clayey, trace organics and weathered rock, light brown to brown, orangish and reddish brown, fine-grained, medium dense, dry
3, 4			
5, 6	42	4-22-50/3	
7, 8, 9			SAND, silty, trace weathered rock, light brown, and orangish brown, fine-grained, very dense, dry (Partially Weathered Rock)
10, 11	33	3-25-50/2	
12, 13			Auger refusal at 13.5 feet.
14			WEATHERED ROCK
15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40	Air Drilling		SAND, silty, weathered rock, brown, orangish brown and dark gray, fine-to coarse-grained, micaceous, dry to wet (Partially Weathered Rock)

Well Construction
Above Grade Completion



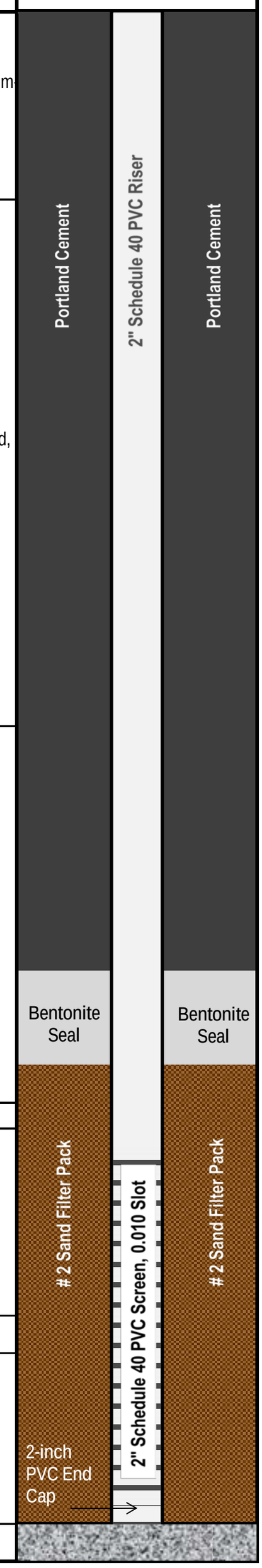
B-720d Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	8/3/2012
Project No.:	6447-93318	End Date:	8/3/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	80'
Location Code:	B-720d	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 70'
Driller:	Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 70'-80', 0.01"

Drilling Method: Air (Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
41			SAND, silty, trace weathered rock, brown, orangish brown and dark gray, fine-to medium-grained, micaceous, wet (Partially Weathered Rock)
42			
43			
44			
45			
46			SAND, silty, weathered rock, light to dark gray, brown and orangish brown, fine-grained, micaceous, wet (Partially Weathered Rock)
47			
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			GNEISS, undifferentiated, dense
61		Air Drilling	
62			
63			
64			
65			
66			
67			
68			
69			
70			FRACTURE
71			GNEISS, undifferentiated, dense
72			
73			
74			
75			GNEISS, undifferentiated, soft
76			GNEISS, undifferentiated, dense
77			
78			
79			
80			
81			Boring terminated at 80 feet.

Well Construction
Above Grade Completion



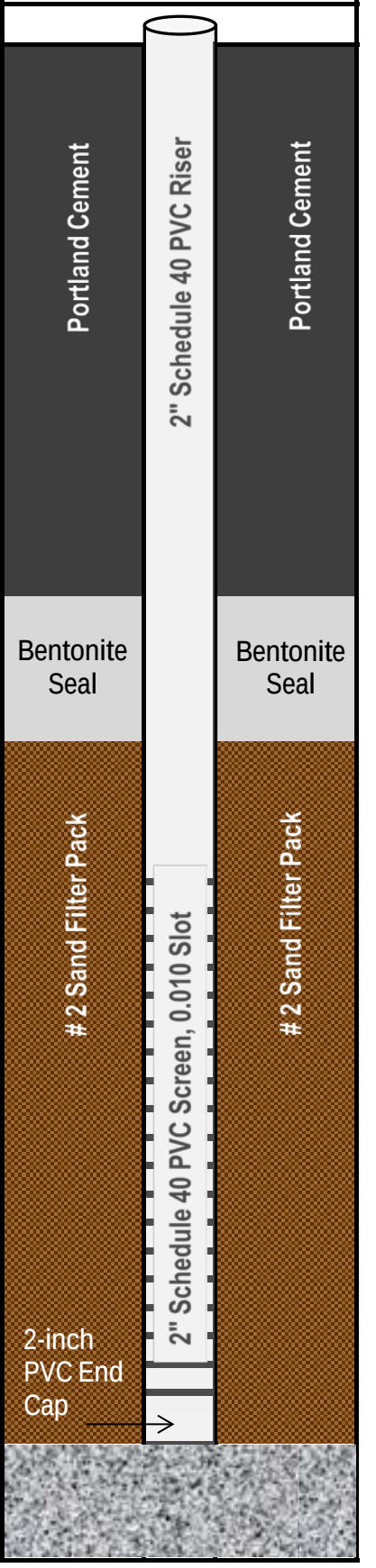
B-722s Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/30/2012
Project No.:	6447-93318	End Date:	7/30/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	24'
Location Code:	B-722s	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 14'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 14'-24', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1			The first foot of soil was disturbed while clearing access to this boring location.
2			
3			SAND, clayey, silty, trace weathered rock, brown to orangish brown, fine-to coarse-grained, loose, micaceous, moist
4			
5	100	3-3-6-9	
6			Shelby tube collected from 4 to 6 feet.
7			
8			
9			
10	75	3-5-10-14	
11			
12			SAND, silty, weathered rock, brown to dark brown, light and orangish brown, and black, fine-to coarse-grained, medium dense, micaceous, moist to wet
13			
14			
15	83	6-8-15-18	
16			
17			
18			
19			
20	42	18-50/4	SAND, silty, trace weathered rock, dark grayish brown, light and orangish brown, fine-to coarse-grained, very dense, micaceous, wet (Partially Weathered Rock)
21			
22			
23			
24			
25	17	50/1	Auger refusal at 24 feet.
26			

Well Construction Above Grade Completion



B-722d Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	8/2/2012
Project No.:	6447-93318	End Date:	8/2/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	41'
Location Code:	B-722d	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 36'
Driller:	Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 36'-41', 0.01"

Drilling Method: Air (Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1			The first foot of soil was disturbed while clearing access to this boring location.
2			
3			
4			SAND, clayey, silty, trace weathered rock, brown to orangish brown, fine-to coarse-grained, loose, micaceous, moist
5	100	3-3-6-9	
6			
7			
8			
9			
10	75	3-5-10-14	
11			
12			SAND, silty, weathered rock, brown to dark brown, light and orangish brown, and black, fine-to coarse-grained, medium dense, micaceous, moist to wet
13			
14			
15	83	6-8-15-18	
16			
17			
18			
19			
20	42	18-50/4	SAND, silty, weathered rock, dark grayish brown, light and orangish brown, fine-to coarse-grained, very dense, micaceous, wet (Partially Weathered Rock)
21			
22			
23			
24			Auger refusal at 24 feet.
25	17	50/1	WEATHERED ROCK
26			
27			SAND, silty, weathered rock, dark grayish brown, light and orangish brown, fine-to coarse-grained, micaceous, wet (Partially Weathered Rock)
28			
29			
30			
31			
32			GNEISS, undifferentiated, hard
33			
34			
35			
36			
37			FRACTURE
38			
39			GNEISS, undifferentiated, hard
40			
41			
42	Air Drilling		Boring terminated at 41 feet.

Well Construction
Above Grade Completion

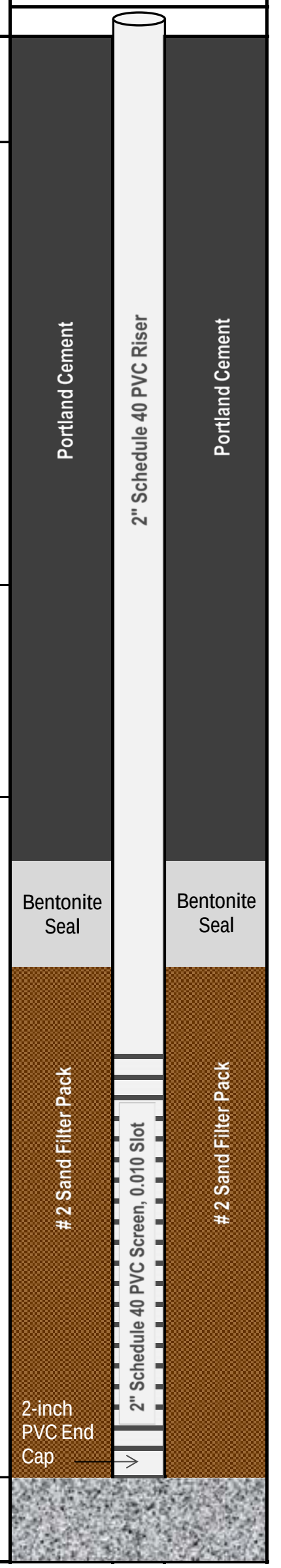
B-721 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/31/2012
Project No.:	6447-93318	End Date:	7/31/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	34'
Location Code:	B-721	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 24'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 24'-34', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	50	WOH-WOH-3-4	SAND, silty, trace organics, brown, light and orangish brown, fine-to coarse-grained, very loose, micaceous, wet The first foot of soil was disturbed while clearing access to this boring location.
3, 4			SAND, silty, trace weathered rock, brown and orangish brown, light brown and light gray, white and black, fine-to coarse-grained, loose to medium dense, micaceous, moist
5, 6	100	3-3-6-10	
7, 8, 9			
10, 11	96	3-4-7-10	
12, 13, 14			
15, 16	100	15-19-30-46	SAND, silty, dark brown to dark grayish brown, light brown and dark orangish brown, and black, fine-to medium-grained, dense, micaceous, moist
17, 18, 19			
20, 21	92	15-25-40-50/4	SAND, silty, weathered rock, grayish brown, light to dark gray and orangish brown, light brown and white, fine-to coarse-grained, very dense, micaceous, moist to wet (Partially Weathered Rock)
22, 23, 24			
25, 26	50	46-50/5	
27, 28, 29			
30, 31	58	11-50/6	
32, 33, 34			
35, 36	13	50/2	Auger refusal at 34 feet.

Well Construction
Above Grade Completion



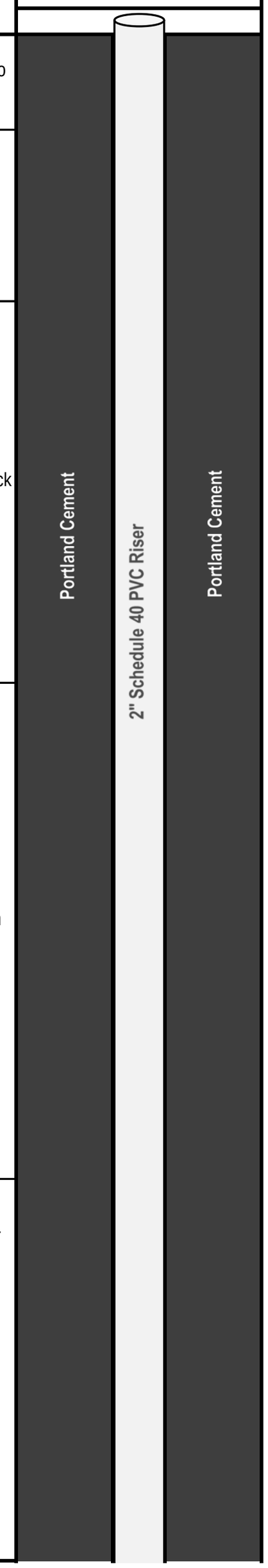
B-723 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/24/2012
Project No.:	6447-93318	End Date:	7/25/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	62'
Location Code:	B-723	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 57'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 57'-62', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	83	1-2-2-5	SILT, organics, trace fine-grained sand, brown, orangish brown and gray, very loose to loose, micaceous, dry
3			SAND, silty, brown, light and orangish brown, fine-grained, loose, micaceous, dry
4, 5	50	WOH-2-3-4	
6, 7, 8			
9, 10	75	WOH-2-3-6	SAND, silty, brown, very light and orangish brown, fine-grained, loose, micaceous, black mineralization, dry to moist
11, 12, 13			
14, 15	83	1-2-5-7	
16, 17, 18			
19, 20	92	2-6-10-11	SAND, silty, light to dark gray, brown, light and orangish brown, fine-grained, medium dense to very dense, micaceous, black mineralization, moist
21, 22, 23			
24, 25	83	4-9-15-25	
26, 27, 28			
29, 30	88	5-16-50/4	
31, 32, 33			SAND, silty, weathered rock, light to dark gray, brown, light and orangish brown, fine-grained, very dense, micaceous, black mineralization, moist (Partially Weathered Rock)
34, 35	38	10-50/5	Auger refusal at 35 feet.
36, 37, 38, 39, 40	Air Drilling		

Well Construction
Above Grade Completion



B-723 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/24/2012
Project No.:	6447-93318	End Date:	7/25/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	62'
Location Code:	B-723	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 57'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 57'-62', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description	Well Construction Above Grade Completion
41	Air Drilling		SAND, silty, weathered rock, light to dark gray, brown, light and orangish brown, fine-grained, micaceous, moist (Partially Weathered Rock)	Portland Cement; 2" Schedule 40 PVC Riser
42				
43				
44				
45				
46				
47				
48			GNEISS, undifferentiated, dense	
49				
50				
51				
52				Bentonite Seal
53				
54				
55				
56				# 2 Sand Filter Pack; 2" Schedule 40 PVC Screen, 0.010 Slot
57				
58				
59			FRACTURE, water producing	
60			GNEISS, undifferentiated, dense	
61				
62				2-inch PVC End Cap
63			Boring terminated at 62 feet.	

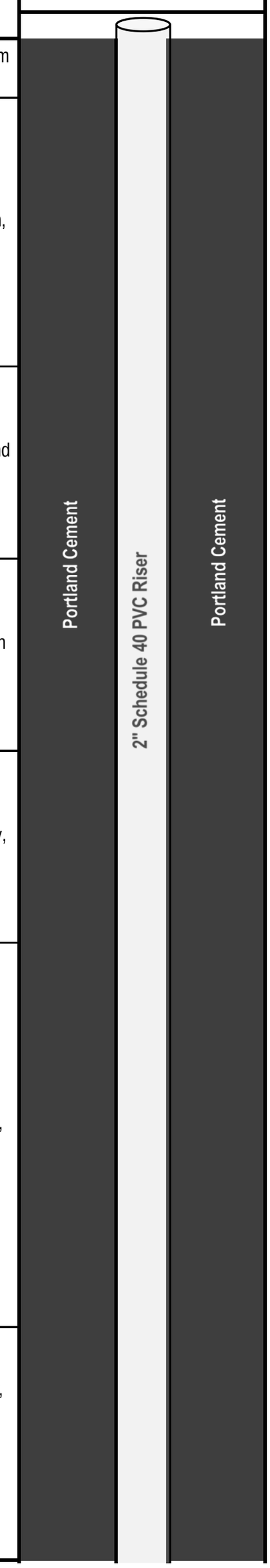
B-724 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/31/2012
Project No.:	6447-93318	End Date:	8/1/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	50'
Location Code:	B-724	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 45'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 45'-50', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	83	2-7-10-12	SAND, silty, trace organics, orangish brown to brown, fine-to medium-grained, medium dense, micaceous, moist to wet
3, 4, 5, 6, 7, 8, 9	79	9-13-19-13	SAND, trace silt and trace weathered rock, very light brown, and light orangish brown, fine-to coarse-grained, medium dense to dense, dry
10, 11, 12, 13, 14	100	7-14-19-18	SAND, silty, trace weathered rock, brown, light and orangish brown, grayish brown and black, fine-to coarse-grained, dense, micaceous, dry
15, 16, 17, 18, 19	100	17-21-45-50/5	SAND, silty, trace weathered rock, grayish brown, light to dark gray and light orangish brown, fine-to coarse-grained, very dense, micaceous, dry
20, 21, 22, 23, 24	83	9-16-33-41	SAND, little silt, trace weathered rock, light brown, light orangish brown and light gray, fine-to coarse-grained, dense, micaceous, moist
25, 26, 27, 28, 29, 30, 31, 32, 33, 34	92	23-26-27-44	SAND, trace silt and weathered rock, light brown, light orangish brown and light gray, and black, fine-to coarse-grained, very dense, micaceous, moist
35, 36, 37, 38, 38.5	25	50/6	SAND, trace silt and weathered rock, light brown, light orangish brown and light gray, and black, fine-to coarse-grained, very dense, micaceous, moist (Partially Weathered Rock) Auger refusal at 38.5 feet.

Well Construction
Above Grade Completion



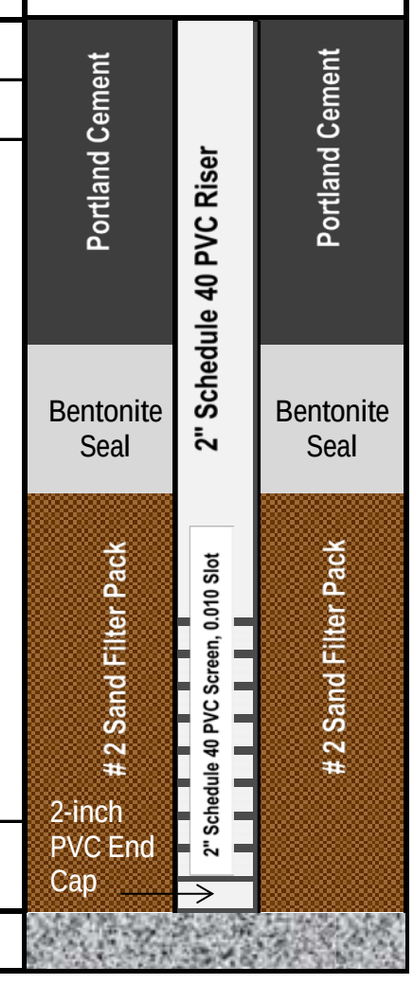
B-724 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/31/2012
Project No.:	6447-93318	End Date:	8/1/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	50'
Location Code:	B-724	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 45'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 45'-50', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
	Rock Coring Summary (NQ Core Size)		
	Fractures	Core Description	Recovery / Rock Quality Designation
38.5		GNEISS	
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49	Reamed with roller cone bit	GNEISS, undifferentiated, hard	
50			
51		Boring terminated at 50 feet.	

Well Construction
Above Grade Completion



B-725 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	8/2/2012
Project No.:	6447-93318	End Date:	8/3/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	58'
Location Code:	B-725	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 53'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 53'-58', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1	100	3-3-5-6	SAND, silty, trace organics, brown, light and orangish brown, fine-grained, loose, micaceous, moist
2			
3			SAND, silty, brown, light and orangish brown, fine-to medium-grained, medium dense, dry
4	75	3-5-9-11	
5			
6			
7			
8			
9	100	20-27-34-50/5	SAND, silty, trace weathered rock, grayish brown, light and orangish brown, and light to dark gray, fine-to medium-grained, very dense, dry (Partially Weathered Rock)
10			
11			
12			
13			
14	0	50/3	Auger refusal at 14 feet.
15	Air Drilling		SAND, silty, trace weathered rock, brown, orangish brown and dark gray, fine-to medium-grained, micaceous, dry to moist (Partially Weathered Rock)
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
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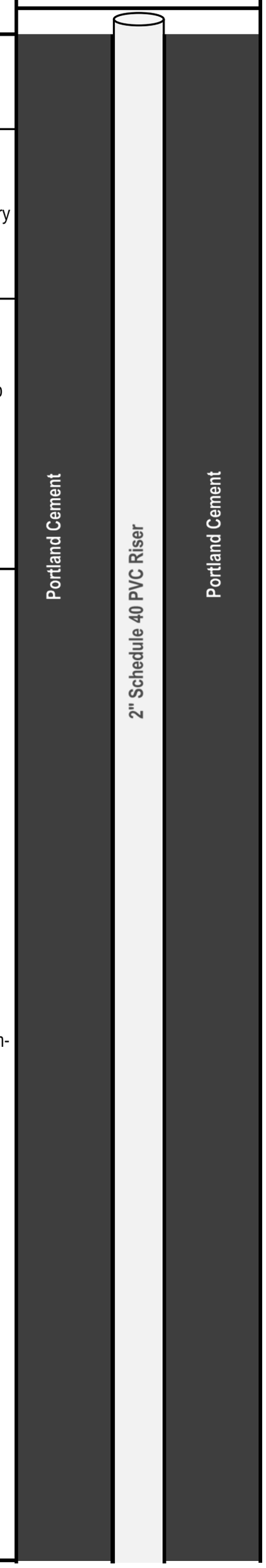
Well Construction
Above Grade Completion



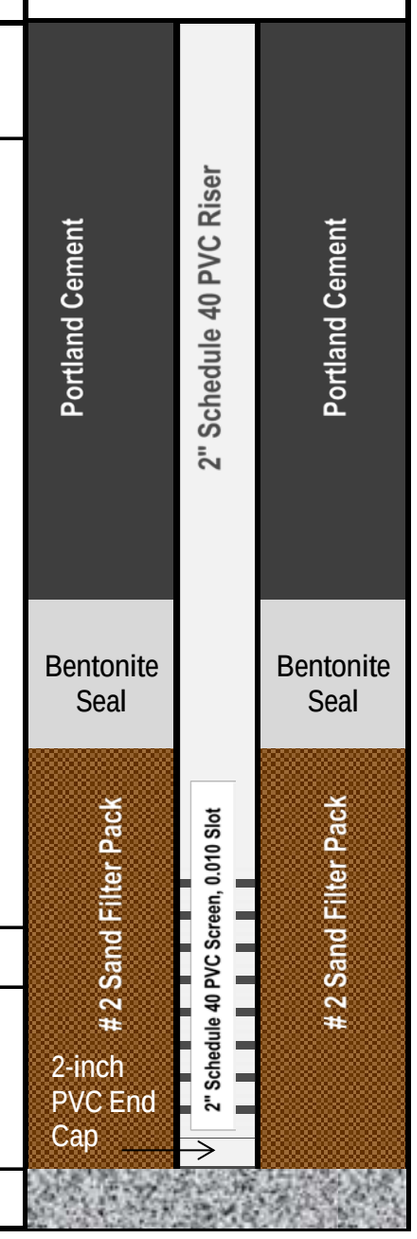
B-725 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	8/2/2012
Project No.:	6447-93318	End Date:	8/3/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	58'
Location Code:	B-725	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 53'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 53'-58', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
41	Air Drilling		SAND, silty, weathered rock, brown, orangish brown and dark gray, fine-to medium-grained, micaceous, moist (Partially Weathered Rock)
42			GNEISS, undifferentiated, dense
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			
55			FRACTURE
56			GNEISS, undifferentiated, dense
57			
58			
59			Boring terminated at 58 feet.

Well Construction
Above Grade Completion



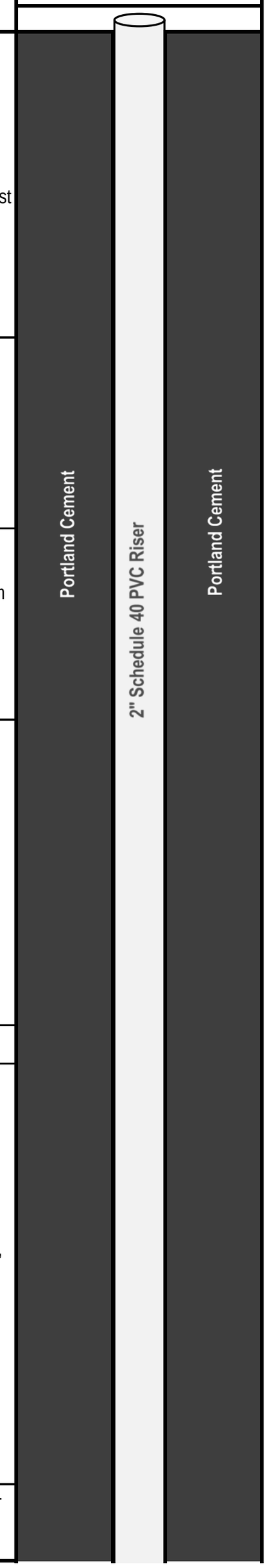
B-726 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	8/2/2012
Project No.:	6447-93318	End Date:	8/2/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	67'
Location Code:	B-726	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 57'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 57'-67', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	100	3-3-3-5	SAND, silty, trace weathered rock, light to dark brown, light orangish brown and light gray, and white, fine-to coarse-grained, loose to medium dense, micaceous, dry to moist
3, 4			
5, 6	83	6-10-9-8	
7, 8, 9			
10, 11	92	13-28-39-50/4	SAND, little silt, light brown and light gray, light orangish brown and white, fine-to medium-grained, very dense, micaceous, dry
12, 13, 14			
15, 16	100	5-9-13-12	SAND, silty, brown to orangish brown, and dark gray, fine-to medium-grained, medium dense, black mineralization, micaceous, moist Shelby Tube collected from 16 to 18 feet.
17, 18, 19			
20, 21	75	10-19-50/5	SAND, silty, trace weathered rock, light gray to light brown, light orangish brown and dark brown, fine-to coarse-grained, very dense, micaceous, moist (Partially Weathered Rock)
22, 23, 24			
25, 26	17	50/2	Auger refusal at 26 feet.
27	Air Drilling		WEATHERED ROCK
28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38			SAND, silty, trace weathered rock, orangish brown and brown, fine-to coarse-grained, micaceous, moist (Partially Weathered Rock)
39, 40			SAND, silty, trace weathered rock, light to dark gray, and light brown, fine-to medium-grained, micaceous, moist (Partially Weathered Rock)

Well Construction
Above Grade Completion



B-726 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	8/2/2012
Project No.:	6447-93318	End Date:	8/2/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	67'
Location Code:	B-726	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 57'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 57'-67', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description	Well Construction Above Grade Completion
41, 42, 43, 44	Air Drilling		SAND, silty, trace weathered rock, light to dark gray, and light brown, fine-to medium-grained, micaceous, moist (Partially Weathered Rock)	Portland Cement; 2" Schedule 40 PVC Riser; Portland Cement
45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55			SAND, silty, trace weathered rock, light to dark brown, and dark gray, fine-to coarse-grained, micaceous, moist (Partially Weathered Rock)	Bentonite Seal; Bentonite Seal
56, 57, 58, 59, 60, 61, 62, 63, 64			SAND, silty, weathered rock, light to dark gray, and light brown, fine-to coarse-grained, micaceous, moist (Partially Weathered Rock)	# 2 Sand Filter Pack; 2" Schedule 40 PVC Screen, 0.010 Slot; # 2 Sand Filter Pack
65, 66, 67			GNEISS, undifferentiated, dense	2-inch PVC End Cap
68, 69			Boring terminated at 67 feet.	

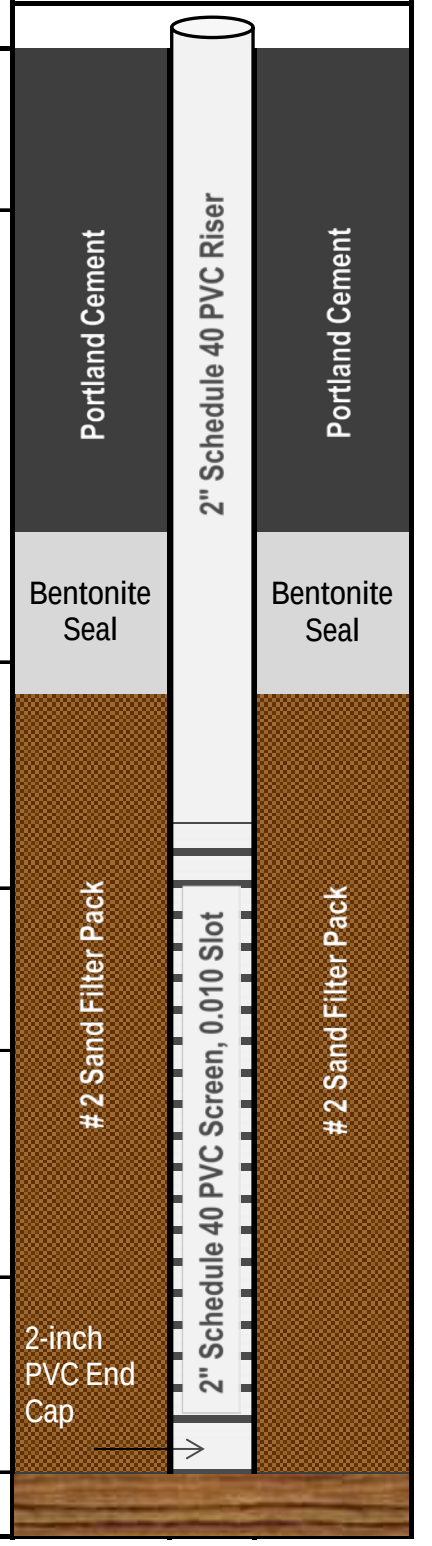
B-727s Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/26/2012
Project No.:	6447-93318	End Date:	7/26/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	22'
Location Code:	B-727s	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 12'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 12'-22', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1	79	1-1-3-3	SAND, silty, trace clay and organics, dark brown, orangish and reddish brown, fine-grained, very loose to loose, micaceous, dry to moist
2			
3			SAND, clayey, silty, trace weathered rock and mica, dark brown, fine-grained, loose, moist sandy clay at 7 feet Shelby Tube collected from 7 to 9.5 feet.
4			
5			
6	100	2-3-5-6	
7			
8			
9			
10			
11	100	3-6-10-9	SAND, clayey, silty, trace weathered rock, brown, and orangish brown, fine-grained, medium dense, micaceous, moist
12			
13			
14			SAND, trace silt and clay, olive brown, and orangish brown, fine-grained, medium dense, micaceous, moist to wet
15			
16	100	3-4-10-13	
17			SAND, trace silt and weathered rock, grayish brown, light to dark gray and dark reddish brown, and white, fine-grained, medium dense, micaceous, wet
18			
19			
20			SAND, grayish brown, light gray and light brown, white and black, fine-to medium-grained, medium dense to dense, micaceous, wet
21	71	10-18-21-38	
22			
23			Boring terminated at 22 feet.

Well Construction
Above Grade Completion



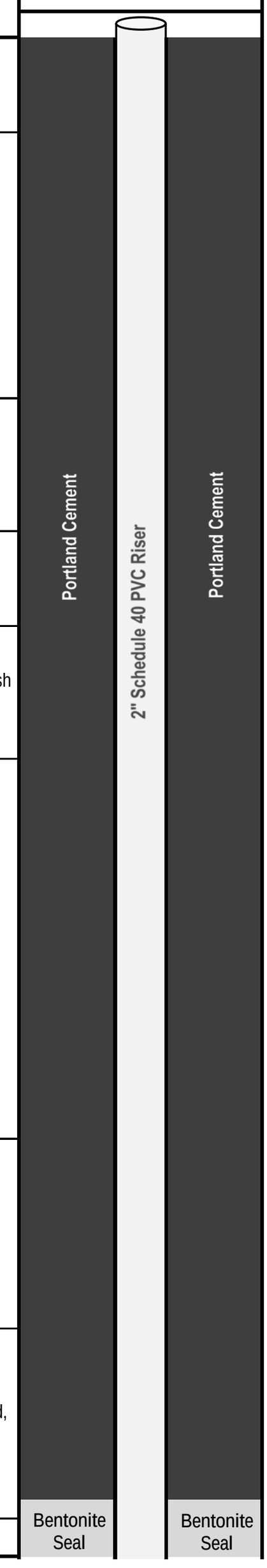
B-727d Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/24/2012
Project No.:	6447-93318	End Date:	7/25/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	63'
Location Code:	B-727d	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 43'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 43'-53', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	79	1-1-3-3	SAND, silty, trace clay and organics, dark brown, orangish and reddish brown, fine-grained, very loose to loose, micaceous, dry to moist
3, 4, 5			SAND, clayey, silty, trace weathered rock and mica, dark brown, fine-grained, loose, moist sandy clay at 7 feet
6, 7	100	2-3-5-6	
8, 9, 10			
11, 12	100	3-6-10-9	SAND, clayey, silty, trace weathered rock, brown, and orangish brown, fine-grained, medium dense, micaceous, moist
13, 14, 15			SAND, trace silt and clay, olive brown, and orangish brown, fine-grained, medium dense, micaceous, moist to wet
16, 17	100	3-4-10-13	SAND, trace silt and weathered rock, grayish brown, light to dark gray and dark reddish brown, and white, fine-grained, medium dense, micaceous, wet
18, 19, 20			
21, 22	71	10-18-21-38	SAND, grayish brown, light gray and light brown, white and black, fine-to medium-grained, medium dense to dense, micaceous, wet
23, 24, 25			
26, 27	54	7-10-12-16	
28, 29, 30			
31, 32	66	4-8-14-17	SAND, grayish brown, light to dark gray and orangish brown, fine-to coarse-grained, medium dense, micaceous, wet
33, 34, 35			
36, 37	92	4-10-17-25	SAND, trace clay, olive brown, orangish brown and dark gray, fine-to medium-grained, medium dense, micaceous, wet
38, 39, 40			

Well Construction
Above Grade Completion



B-727d Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/24/2012
Project No.:	6447-93318	End Date:	7/25/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	63'
Location Code:	B-727d	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 43'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 43'-53', 0.01"

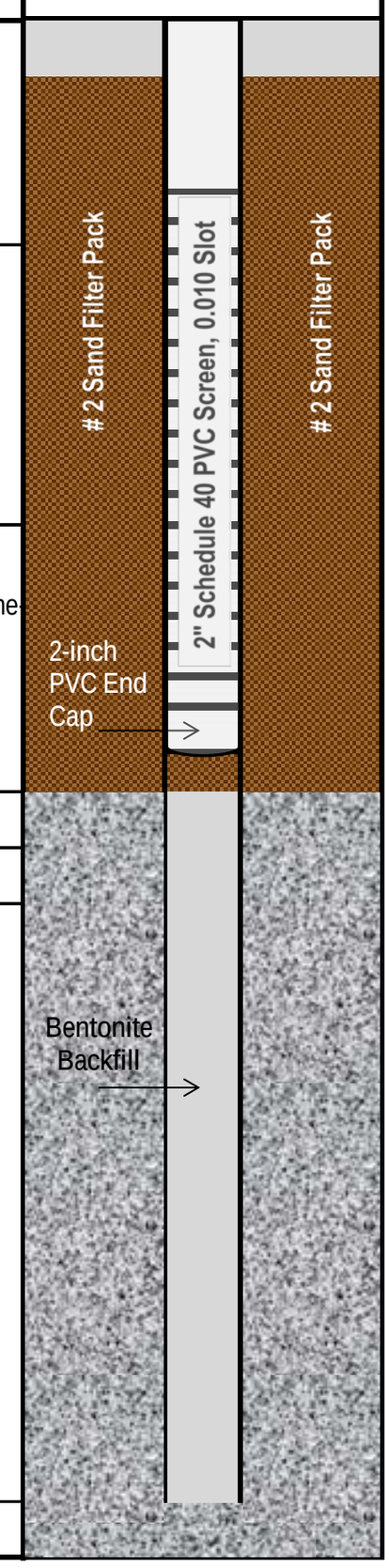
Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
41	71	12-19-50/5.5	SAND, trace weathered rock, olive brown, orangish brown and dark gray, fine-to medium-grained, very dense, micaceous, wet (Partially Weathered Rock)
42			
43			
44			
45			
46	50	43-50/3	SAND, trace weathered rock, dark pale brown, orangish brown and dark gray, fine-to coarse-grained, very dense, micaceous, wet (Partially Weathered Rock)
47			
48			
49			
50			
51	50	38-36-50/5	SAND, weathered rock, dark pale brown, orangish brown and very light to dark gray, fine to coarse-grained, very dense, micaceous, wet Auger refusal at 53.5 feet. (Partially Weathered Rock)
52			
53			
53.5			

Rock Coring Summary (NQ Core Size)

	Fractures	Core Description	Recovery	Rock Quality Designation
54		GNEISS		
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65		Boring terminated at 64 feet.		

Well Construction
Above Grade Completion



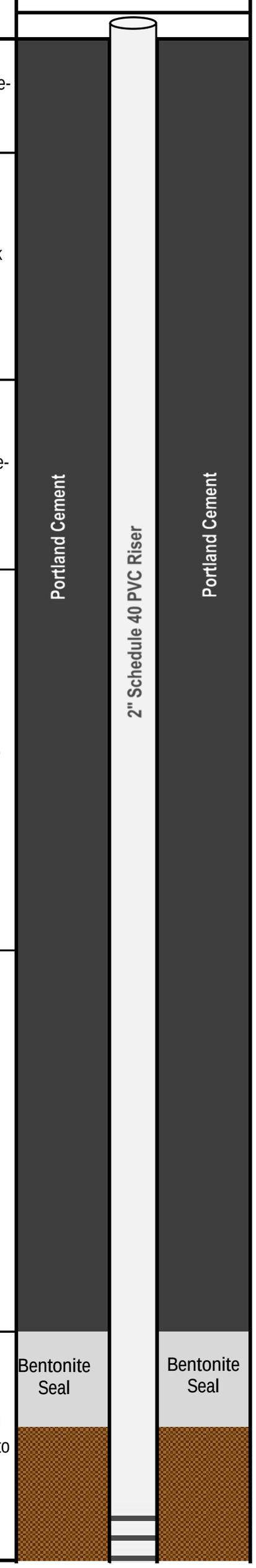
B-728 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/26/2012
Project No.:	6447-93318	End Date:	7/26/2012
Logged/Checked By	Daniel Forbes/Mathew Colone	Total Depth:	48.5'
Location Code:	B-728	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 38.5'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 38.5'-48.5', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	83	6-1-6-3	SAND, silty, trace clay and organics, light to dark orangish brown, and light brown, fine- to medium-grained, loose, dry
3, 4, 5			
6, 7	42	4-7-7-11	SAND, silty, trace weathered rock, dark brown, light to dark orangish brown and dark gray, fine-grained, medium dense, black mineralization, micaceous, dry
8, 9, 10			
11, 12	88	3-3-3-4	SAND, silty, trace clay and weathered rock, brown, light gray and white, fine-to coarse-grained, loose, micaceous, moist
13, 14, 15			
16, 17	79	5-3-5-10	SAND, silty, trace weathered rock, brown to dark brown, light to dark gray and white, and orangish brown, fine-to coarse-grained, loose to dense, micaceous, moist
18, 19, 20			
21, 22	83	7-15-17-29	
23, 24, 25			
26, 27	71	14-21-30-27	
28, 29, 30			SAND, silty, trace weathered rock, dark gray and light to dark orangish brown, light brown and white, fine-to medium-grained, medium dense to very dense, black mineralization, micaceous, moist
31, 32	83	4-6-12-13	
33, 34, 35			
36, 37	83	8-11-13-15	SAND, silty, trace weathered rock, light to dark gray and orangish brown, brown and white, fine-to coarse-grained, medium dense, black mineralization, micaceous, moist to wet
38, 39, 40			

Well Construction
Above Grade Completion



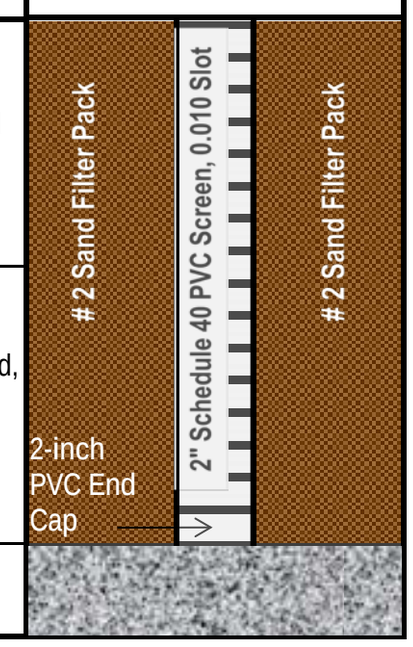
B-728 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/26/2012
Project No.:	6447-93318	End Date:	7/26/2012
Logged/Checked By	Daniel Forbes/Mathew Colone	Total Depth:	48.5'
Location Code:	B-728	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 38.5'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 38.5'-48.5', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
41	75	14-35-36-30	SAND, silty, trace weathered rock, light to dark gray and orangish brown, brown and white, fine-to coarse-grained, very dense, black mineralization, micaceous, wet
42			
43			
44			
45			
46	21	50/5	SAND, weathered rock, light brown, light to dark gray and white, fine-to coarse-grained, very dense, micaceous, wet (Partially Weathered Rock)
47			
48			
49			
50			Auger refusal at 48.5 feet.

Well Construction
Above Grade Completion



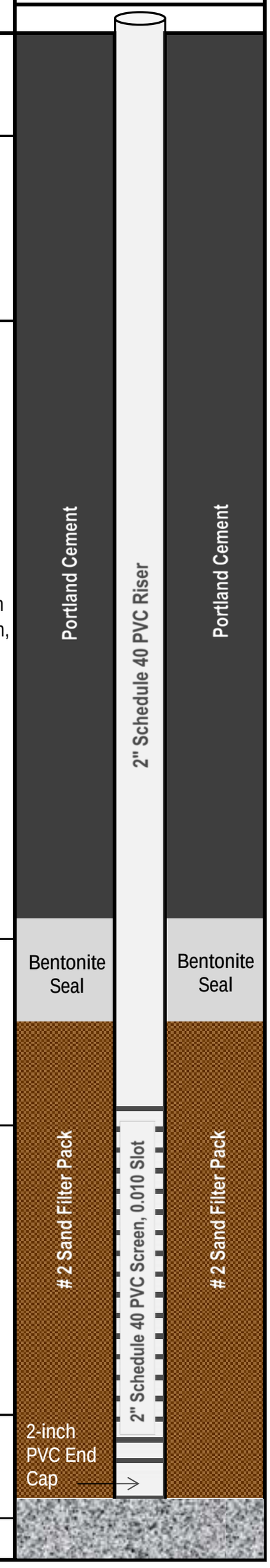
B-729 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/27/2012
Project No.:	6447-93318	End Date:	7/30/2012
Logged/Checked By:	Daniel Forbes/Mathew Colone	Total Depth:	36'
Location Code:	B-729	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 26'
Driller:	AE Drilling Services, LLC/Reuben Caldwell Drilling, Inc.	Screen Dia./Depth/Slot:	2" PVC: 26'-36', 0.01"

Drilling Method: Hollow-Stem Auger/Air (CME Model 750 and Schramm Model T450 Rotadrill)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2	83	3-4-4-7	SAND, silty, trace organics, orangish brown, fine-grained, loose, micaceous, dry
3			SAND, silty, trace weathered rock, orangish brown, and light brown, fine-to coarse-grained, medium dense, black mineralization, micaceous, dry
4, 5	100	4-5-6-7	
6, 7, 8			
9, 10	75	2-2-4-5	SAND, silty, trace weathered rock, light to dark brown, light to dark gray and orangish brown, and white, fine-to coarse-grained, loose to medium dense, black mineralization, micaceous, dry to moist
11, 12, 13			
14, 15	83	5-5-7-9	
16, 17, 18			
19, 20	92	6-6-12-16	
21, 22, 23			
24, 25	25	50/4	SAND, silty, weathered rock, light to dark brown, white and light to dark gray, fine-to coarse-grained, very dense, micaceous, moist (Partially Weathered Rock)
26			Auger refusal at 26.5 feet.
27, 28, 29, 30, 31, 32, 33	Air Drilling		SAND, silty, weathered rock, brown, white and light to dark gray, fine-to coarse-grained, very dense, micaceous, moist to wet (Partially Weathered Rock)
34, 35, 36			GNEISS, undifferentiated, hard
37			Boring terminated at 36 feet.

Well Construction Above Grade Completion



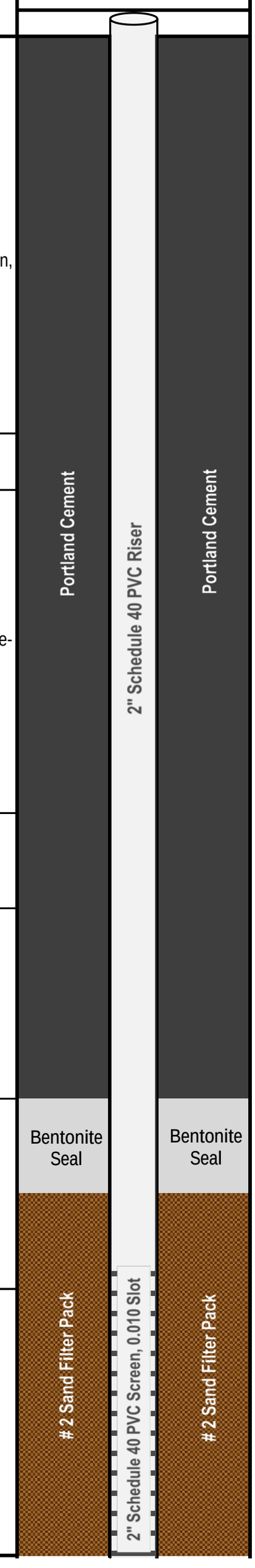
B-730 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/26/2012
Project No.:	6447-93318	End Date:	7/27/2012
Logged/Checked By	Daniel Forbes/Mathew Colone	Total Depth:	42.5'
Location Code:	B-730	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 32.5'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 32.5'-42.5', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description
1, 2, 3, 4			The first two feet of soil was disturbed while clearing access to this boring location.
5, 6	75	1-3-4-4	SAND, silty, brown, light and orangish brown, fine-grained, loose, black mineralization, micaceous, dry
7, 8, 9			
10, 11	88	3-3-4-5	
12, 13, 14			SAND, silty, weathered rock, white to light gray, and light orangish brown, fine-to coarse-grained, loose, micaceous, dry
15, 16	71	4-5-7-8	SAND, silty, light to dark brown, light to dark gray and orangish brown, and white, fine-grained, medium dense to dense, black mineralization, micaceous, dry
17, 18, 19			
20, 21	96	7-14-20-28	
22, 23, 24			SAND, silty, weathered rock, white to light gray, and light orangish brown, fine-to coarse-grained, dense, micaceous, dry
25, 26	42	28-50/5	SAND, silty, weathered rock, light to orangish brown, and light to dark gray, fine-to coarse-grained, very dense, micaceous, dry (Partially Weathered Rock)
27, 28, 29			
30, 31	58	12-32-50/4	SAND, silty, trace weathered rock, light brown to brown, orangish brown and dark gray, fine-to medium-grained, very dense, micaceous, dry (Partially Weathered Rock)
32, 33, 34			
35, 36	71	26-42-45-50/3	SAND, silty, trace weathered rock, light brown to orangish brown, light to dark gray and white, fine-to coarse-grained, dense to very dense, micaceous, dry to wet (Partially Weathered Rock)
37, 38, 39			
40	83	8-17-23-24	

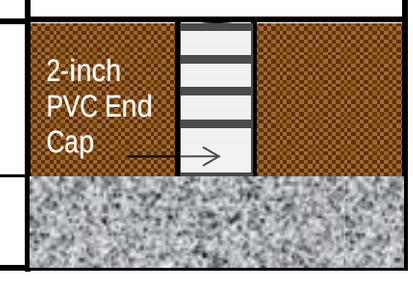
Well Construction
Above Grade Completion



B-730 Boring Log

Project:	Cell 7 Design Hydrogeologic Investigation	Start Date:	7/26/2012
Project No.:	6447-93318	End Date:	7/27/2012
Logged/Checked By	Daniel Forbes/Mathew Colone	Total Depth:	42.5'
Location Code:	B-730	Surface Casing Dia./Depth:	None
Location:	Buncombe County, North Carolina	Well Casing Dia./Depth:	2" PVC to 32.5'
Driller:	AE Drilling Services, LLC	Screen Dia./Depth/Slot:	2" PVC: 32.5'-42.5', 0.01"

Drilling Method: Hollow-Stem Auger (CME Model 750)

Depth (feet)	Recovery (percent)	Blows per 6-inches	Formation Description	Well Construction Above Grade Completion
41	83	8-17-23-24	SAND, silty, trace weathered rock, light brown to orangish brown, light to dark gray and white, fine-to coarse-grained, dense, micaceous, wet (Partially Weathered Rock)	
42				
43			Auger refusal at 42.5 feet.	
44				

Appendix B

Geotechnical Laboratory Data

September 18, 2012

Project No. 2012-733-01

Mr. Mat Colone
CDM, Inc.
5400 Glenwood Ave., Suite 300
Raleigh, NC 27612
colonemf@cdm.com

Transmittal
Laboratory Test Results
Cell 7 Subtitle D Landfill Expansion

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was transmitted to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens which were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectively submitted,
Geotechnics, Inc.

Michael P. Smith
Regional Manager

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

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INTEGRITY IN TESTING

MOISTURE CONTENT

ASTM D 2216-10

Client	CDM
Client Reference	CELL 7 SUB. D LF EXPANSION
Project No.	2012-733-01

Lab ID	.001	.002
Boring No.	B-726	B-729
Depth (ft)	0.5-26	0.5-26
Sample No.	B-1	B-2
Tare Number	814	803
Wt. of Tare & WS (gm)	434.2	340.49
Wt. of Tare & DS (gm)	409.87	312.07
Wt. of Tare (gm)	111.5	103.69
Wt. of Water (gm)	24.33	28.42
Wt. of DS (gm)	298.37	208.38
Water Content (%)	**8.2**	**13.6**

Notes : *NA*

Tested By *SFS* *Date* *9/10/2012* *Checked By* CEM *Date* 9-13-12

DCN: CT-S1 DATE 6-30-98 REVISION: 2

Z:\Data Sheets\[WATCONT W Header.XLS]Sheet1

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MOISTURE CONTENT

ASTM D 2216-10

Client	CDM
Client Reference	CELL 7 SUB D LF EXP
Project No.	2012-733-01

Lab ID	-03	-04	-05	-06	-07
Boring No.	B-722s	B-729	B-724	B-726	B-727d
Depth (ft)	14-16	3-5	24-26	9-11	5-7
Sample No.	S-1	S-2	S-3	S-4	S-5
Tare Number	820	SS-2	Y-11	8010	825
Wt. of Tare & WS (gm)	222.25	194.38	193.9	250.77	248.27
Wt. of Tare & DS (gm)	211.5	182.18	188.85	245.61	232.09
Wt. of Tare (gm)	136.26	100.43	96.39	135.82	136.98
Wt. of Water (gm)	10.75	12.2	5.05	5.16	16.18
Wt. of DS (gm)	75.24	81.75	92.46	109.79	95.11
Water Content (%)	**14.3**	**14.9**	**5.5**	**4.7**	**17.0**

Lab ID	-08	-09	-10	-11	-12
Boring No.	B-727d	B-730	B-719	B-721	B-725
Depth (ft)	40-42	14-16	28-30	19-21	3-5
Sample No.	S-6	S-7	S-8	S-9	S-10
Tare Number	822	821	817	818	826
Wt. of Tare & WS (gm)	232.52	215.09	208.29	243.03	227.67
Wt. of Tare & DS (gm)	220.32	207.43	198.88	234.81	220.56
Wt. of Tare (gm)	136.92	135.95	135.54	137.3	137.23
Wt. of Water (gm)	12.2	7.66	9.41	8.22	7.11
Wt. of DS (gm)	83.4	71.48	63.34	97.51	83.33
Water Content (%)	**14.6**	**10.7**	**14.9**	**8.4**	**8.5**

Notes : *NA*

Tested By *SFS* *Date* *9/7/2012* *Checked By* GEM *Date* 9-14-12

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INTEGRITY IN TESTING

MOISTURE CONTENT

ASTM D 2216-10

Client	CDM
Client Reference	CELL 7 SUB D LF EXP
Project No.	2012-733-01

Lab ID	-13	-14	-15	-16	-17
Boring No.	B-724	B-727d	B-728	B-729	B-728
Depth (ft)	4-6	30-32	35-37	18-20	10-12
Sample No.	S-11	S-12	S-13	S-14	S-15
Tare Number	828	819	823	816	827
Wt. of Tare & WS (gm)	222.16	245.86	241.09	233.59	227.58
Wt. of Tare & DS (gm)	217.25	229.85	230.18	221.73	216.02
Wt. of Tare (gm)	135.91	135.43	136.81	135.91	136.31
Wt. of Water (gm)	4.91	16.01	10.91	11.86	11.56
Wt. of DS (gm)	81.34	94.42	93.37	85.82	79.71
Water Content (%)	**6.0**	**17.0**	**11.7**	**13.8**	**14.5**

Lab ID	-18
Boring No.	B-727d
Depth (ft)	50-52
Sample No.	S-16
Tare Number	824
Wt. of Tare & WS (gm)	238.76
Wt. of Tare & DS (gm)	229.74
Wt. of Tare (gm)	135.49
Wt. of Water (gm)	9.02
Wt. of DS (gm)	94.25
Water Content (%)	**9.6**

Notes : *NA*

Tested By *SFS* *Date* *9/7/2012* *Checked By* GDM *Date* 9-14-12

DCN: CT-S1 DATE: 8/30/2012 REVISION: 2 *2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01 WATCONT W Header.XLS]Sheet1 (2)*

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SPECIFIC GRAVITY

ASTM D 854-10

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-1
Lab ID	2012-733-01-01	Visual Description	**TAN SAND**
			(MInus No.4 sieve material, airdried)

Replicate Number	**1**	**2**
Pycnometer ID	R 347	R 345
Weight of Pycnometer + Soil + Water (gm)	699.34	698.49
Temperature, T (°Celsius)	30.8	30.5
Weight of Pycnometer + Water (gm)	668.26	667.24
Tare Number	373	326
Weight of Tare + Dry Soil (gm)	155.11	154.2
Weight of Tare (gm)	105.11	104.2
Weight of Dry Soil (gm)	50.00	50.00
Specific Gravity of Soil @ T	2.642	2.667
Specific Gravity of Water @ T	0.9954	0.9955
Conversion Factor for Temperature T	0.9972	0.9973
Specific Gravity @ 20° Celsius	2.650	2.674

Average Specific Gravity @ 20° Celsius	2.66

Tested By SFS *Date* 9/12/2012 *Checked By* GEM *Date* 9-13-12

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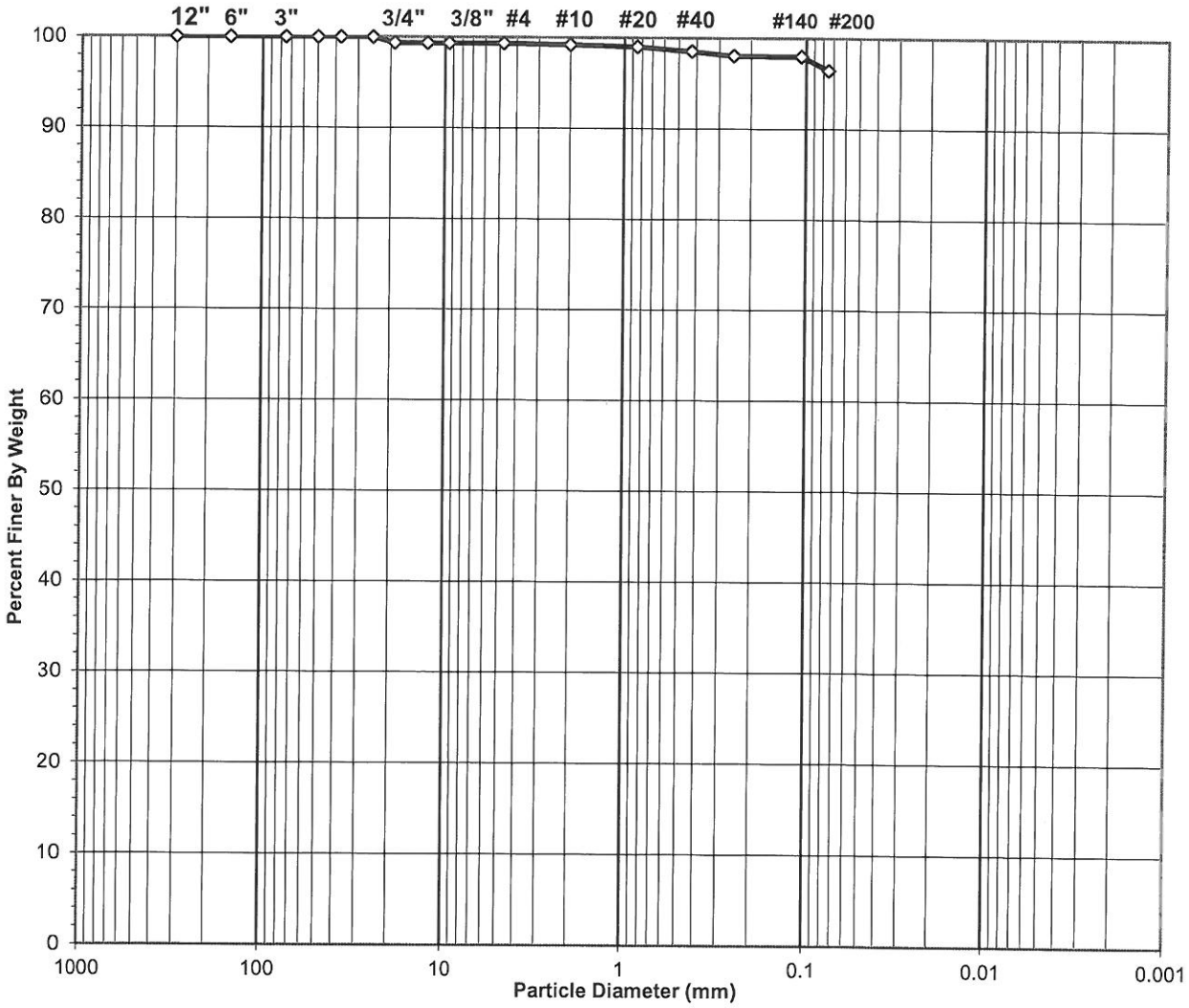
INTEGRITY IN TESTING

SIEVE ANALYSIS
ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-1
Lab ID	2012-733-01-01	Soil Color	**TAN SAND**

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol ***ML, TESTED***

USCS Classification SILT

Tested By SFS Date 9/6/2012 Checked By GEM Date 9-13-12

DCN: CT-S3A DATE 6-25-98 REVISION 2 *PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-01 J-SIEVEON WHeader.xls]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-1
Lab ID	2012-733-01-01	Soil Color	**TAN SAND**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	211	Tare No.	804.00
Wgt.Tare + Wet Specimen (gm)	788.58	Wgt.Tare + Wet Specimen (gm)	246.36
Wgt.Tare + Dry Specimen (gm)	739.06	Wgt.Tare + Dry Specimen (gm)	245.00
Weight of Tare (gm)	171.10	Weight of Tare (gm)	105.17
Weight of Water (gm)	49.52	Weight of Water (gm)	1.36
Weight of Dry Soil (gm)	567.96	Weight of Dry Soil (gm)	139.83
Moisture Content (%)	**8.7**	**Moisture Content (%)**	**1.0**

Wet Weight -3/4" Sample (gm)	22750	Weight of the Dry Specimen (gm)	567.96
Dry Weight - 3/4" Sample (gm)	20925.5	Weight of minus #200 material (gm)	551.45
Wet Weight +3/4" Sample (gm)	139.53	Weight of plus #200 material (gm)	16.51
Dry Weight + 3/4" Sample (gm)	138.19		
Total Dry Weight Sample (gm)	21063.7	**J - Factor (Percent Finer than 3/4")**	**0.9934**

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	0.00		0.0	0.0	100.0	**100.0**
3/4"	19	139.53		0.7	0.7	99.3	**99.3**
1/2"	12.5	0.00		0.0	0.0	100.0	**99.3**
3/8"	9.5	0.00		0.0	0.0	100.0	**99.3**
#4	4.75	0.00		0.0	0.0	100.0	**99.3**
#10	2	0.64		0.1	0.1	99.9	**99.2**
#20	0.85	1.23	(**)	0.2	0.3	99.7	**99.0**
#40	0.425	2.80		0.5	0.8	99.2	**98.5**
#60	0.25	2.66		0.5	1.3	98.7	**98.1**
#140	0.106	0.42		0.1	1.4	98.6	**98.0**
#200	0.075	8.76		1.5	2.9	97.1	**96.5**
Pan	-	551.45		97.1	100.0	-	**-**

Notes : *(*) The + 3/4" sieve analysis is based on the Total Dry Weight of the Sample*
*(**) The - 3/4" sieve analysis is based on the Weight of the Dry Specimen*

Tested By SFS Date 9/6/2012 Checked By GEM Date 9-13-12

DCN: CT-S3A DATE 5-17-00 REVISION 2 *\PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-01 J-SIEVEON WHeader.xls]Sheet1*

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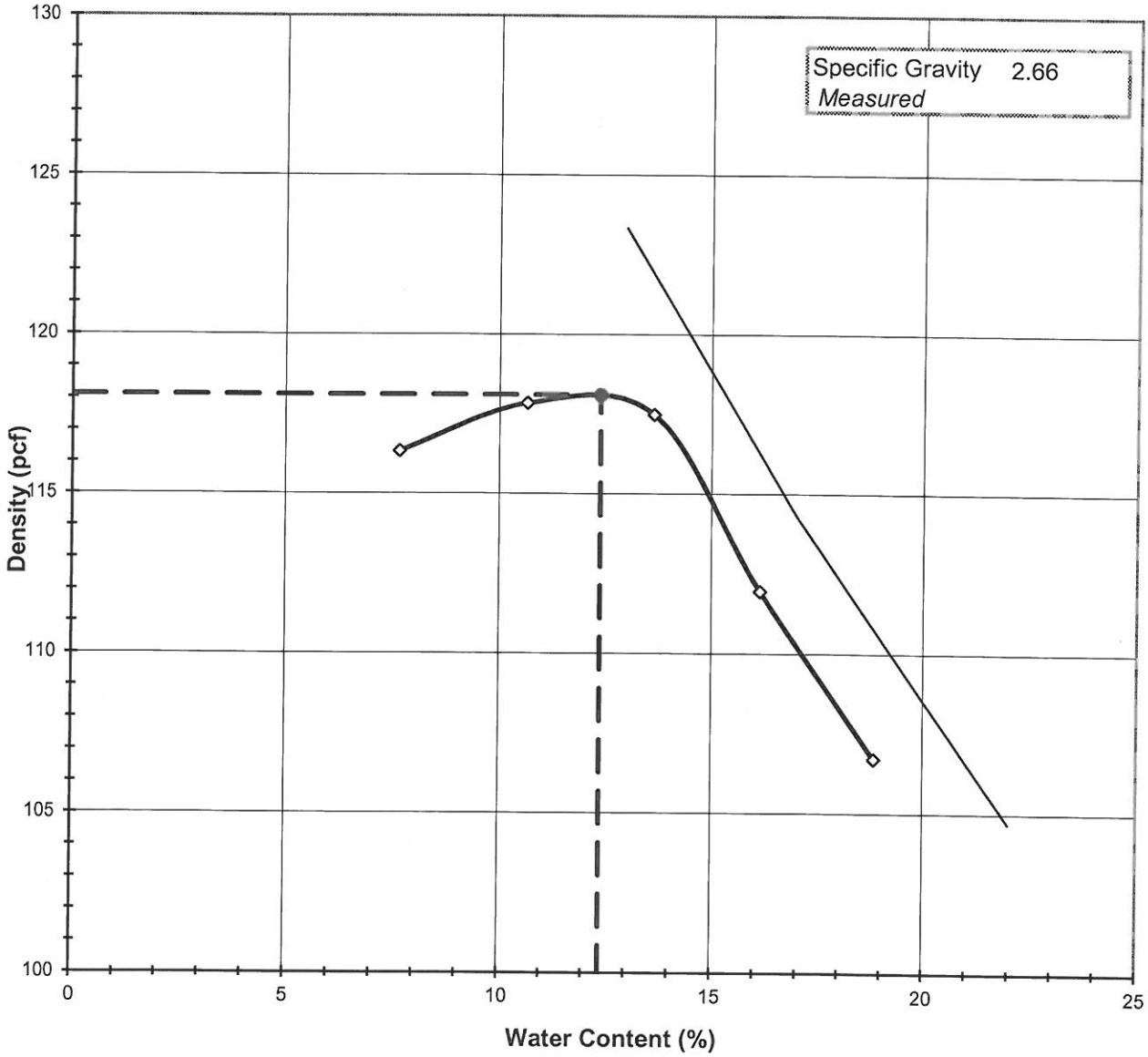
MOISTURE DENSITY RELATIONSHIP

ASTM D698-07e1

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-1
Lab ID	2012-733-01-01	Test Method	**STANDARD**

Visual Description TAN SAND

Optimum Water Content **12.4**
Maximum Dry Density **118.1**



Tested By SFS *Date* 9/10/2012 *Checked By* SFS *Date* 9-11-12

DCN:CT-S12 DATE:12/11/00 REVISION 5 Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-01 Proctor wHeaders.XLS]Sheet1

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MOISTURE - DENSITY RELATIONSHIP

ASTM D698-07e1

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-1
Lab ID	2012-733-01-01		

Visual Description TAN SAND

Total Weight of the Sample (gm)	22750
As Received Water Content(%)	8
Measured Specific Gravity	2.66
Percent Retained on 3/4"	NA
Percent Retained on 3/8"	NA
Percent Retained on #4	6
Oversize Material	Not included
Procedure Used	B

TestType		**STANDARD**
Rammer Weight (lbs)		5.5
Rammer Drop (in)		12
Rammer Type		MECHANICAL
Machine ID	R	174
Mold ID	R	172
Mold diameter		4"
Weight of the Mold		4284
Volume of the Mold(cc)		941

Mold / Specimen

Point No.	**1**	**2**	**3**	**4**	**5**
Wt. of Mold & WS (gm)	6173	6251	6298	6245	6197
Wt.of Mold (gm)	4284	4284	4284	4284	4284
Wt. of WS	1889	1967	2014	1961	1913
Mold Volume (cc)	941	941	941	941	941

Moisture Content / Density

Tare Number	300	305	303	304	398
Wt. of Tare & WS (gm)	704.90	842.95	703.95	972.84	760.36
Wt. of Tare & DS (gm)	662.66	769.89	632.80	853.08	653.24
Wt. of Tare (gm)	110.86	84.98	111.61	110.97	84.84
Wt. of Water (gm)	42.24	73.06	71.15	119.76	107.12
Wt. of DS (gm)	551.80	684.91	521.19	742.11	568.40

Wet Density (gm/cc)	2.01	2.09	2.14	2.08	2.03
Wet Density (pcf)	125.2	130.4	133.5	130.0	126.8
Moisture Content (%)	**7.7**	**10.7**	**13.7**	**16.1**	**18.8**
Dry Density (pcf)	**116.3**	**117.8**	**117.5**	**111.9**	**106.7**

Zero Air Voids

Moisture Content (%)	13.0	17.0	22.0
Dry Unit Weight (pcf)	123.3	114.3	104.7

Tested By SFS *Date* 9/10/2012 *Checked By* SFS *Date* 9-11-12

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SPECIFIC GRAVITY

ASTM D 854-10

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-2
Lab ID	2012-733-01-02	Visual Description	**BROWN SAND**
			(MInus No.4 sieve material, airdried)

Replicate Number		**1**		**2**
Pycnometer ID	R	347	R	345
Weight of Pycnometer + Soil + Water (gm)		699.56		698.74
Temperature, T (°Celsius)		29.8		29.0
Weight of Pycnometer + Water (gm)		668.42		667.46
Tare Number		379		327
Weight of Tare + Dry Soil (gm)		159.07		151.74
Weight of Tare (gm)		109.07		101.74
Weight of Dry Soil (gm)		50.00		50.00
Specific Gravity of Soil @ T		2.651		2.671
Specific Gravity of Water @ T		0.9957		0.9960
Conversion Factor for Temperature T		0.9975		0.9978
Specific Gravity @ 20° Celsius		2.658		2.677

Average Specific Gravity @ 20° Celsius	2.67

Tested By SFS *Date* 9/12/2012 *Checked By* GZM *Date* 9-13-12

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SIEVE ANALYSIS
ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-2
Lab ID	2012-733-01-02	Soil Color	**BROWN**

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay

USCS Symbol ***sm, ASSUMED***

USCS Classification SILTY SAND

Tested By SFS Date 9/7/2012 Checked By GBM Date 9-13-12

DCN: CT-S3C DATE 6-25-98 REVISION 2 *ECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-02 GM SIEVON REV 4 wHeader.xls]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-2
Lab ID	2012-733-01-02	Soil Color	**BROWN**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	200	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	928.94	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	833.48	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	172.13	Weight of Tare (gm)	NA
Weight of Water (gm)	95.46	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	661.35	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**14.4**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	661.35
Dry Weight - 3/4" Sample (gm)	336.5	Weight of minus #200 material (gm)	324.82
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	336.53
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	4.52	0.7	0.7	99.3	**99.3**
#10	2.00	22.76	3.4	4.1	95.9	**95.9**
#20	0.850	57.76	8.7	12.9	87.1	**87.1**
#40	0.425	74.54	11.3	24.1	75.9	**75.9**
#60	0.250	59.90	9.1	33.2	66.8	**66.8**
#140	0.106	78.90	11.9	45.1	54.9	**54.9**
#200	0.075	38.15	5.8	50.9	49.1	**49.1**
Pan	-	324.82	49.1	100.0	-	**-**

Tested By SFS Date 9/7/2012 Checked By GCM Date 9-13-12

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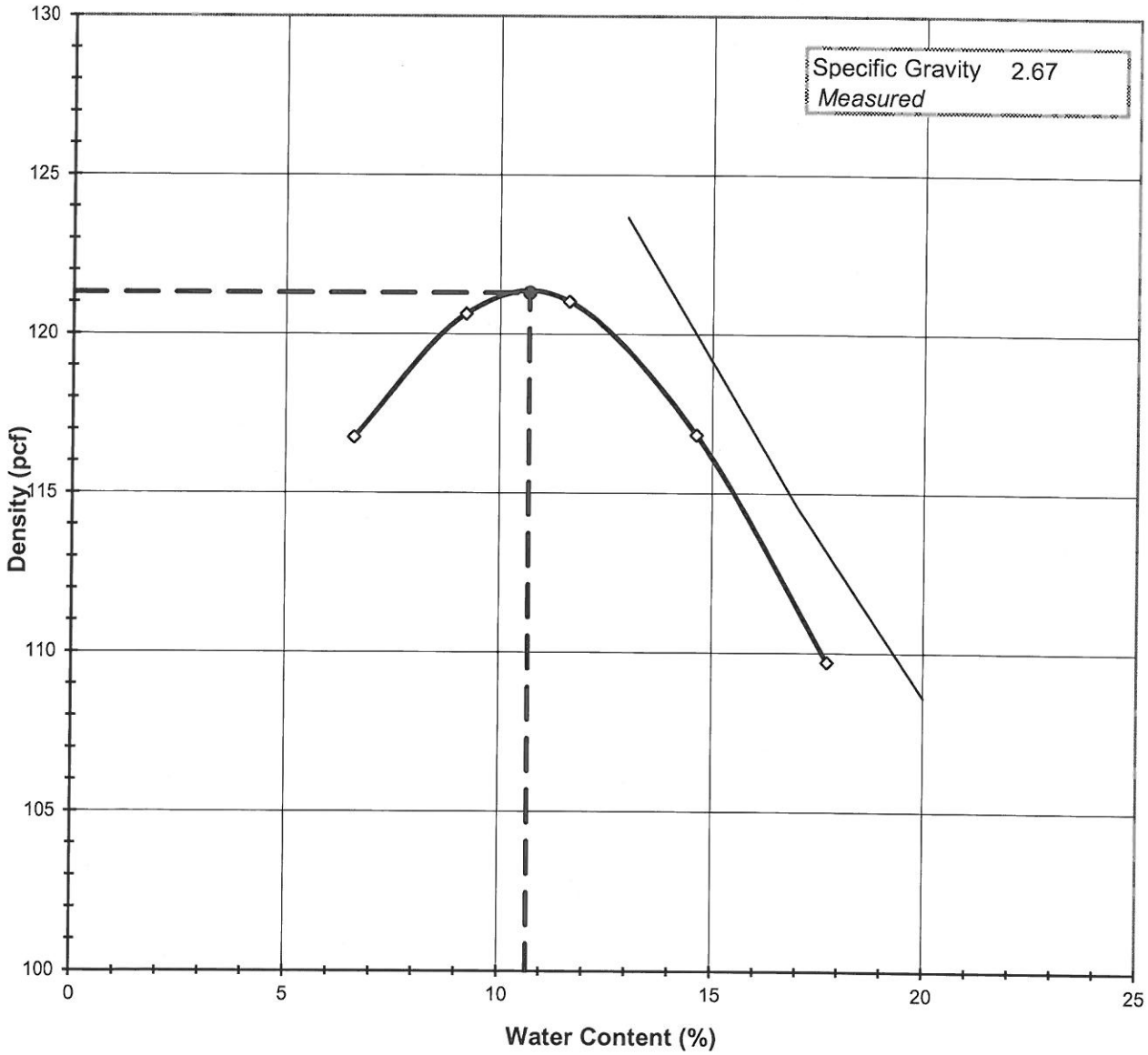
MOISTURE DENSITY RELATIONSHIP

ASTM D698-07e1

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-2
Lab ID	2012-733-01-02	Test Method	**STANDARD**

Visual Description BROWN SAND

Optimum Water Content	**10.7**
Maximum Dry Density	**121.3**



Tested By SFS *Date* 9/10/2012 *Checked By* GZM *Date* 9-13-12

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MOISTURE - DENSITY RELATIONSHIP

ASTM D698-07e1

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	0.5-26
Project No.	2012-733-01	Sample No.	B-2
Lab ID	2012-733-01-02		

Visual Description BROWN SAND

Total Weight of the Sample (gm)	22800
As Received Water Content(%)	14
Measured Specific Gravity	2.67
Percent Retained on 3/4"	NA
Percent Retained on 3/8"	NA
Percent Retained on #4	5
Oversize Material	Not included
Procedure Used	B

TestType		**STANDARD**
Rammer Weight (lbs)		5.5
Rammer Drop (in)		12
Rammer Type		MECHANICAL
Machine ID	R	174
Mold ID	R	172
Mold diameter		4"
Weight of the Mold		4284
Volume of the Mold(cc)		941

Mold / Specimen

Point No.	**1**	**2**	**3**	**4**	**5**
Wt. of Mold & WS (gm)	6161	6271	6322	6304	6232
Wt.of Mold (gm)	4284	4284	4284	4284	4284
Wt. of WS	1877	1987	2038	2020	1948
Mold Volume (cc)	941	941	941	941	941

Moisture Content / Density

Tare Number	310	308	311	318	317
Wt. of Tare & WS (gm)	819.77	1056.32	968.80	858.05	763.95
Wt. of Tare & DS (gm)	775.95	974.79	876.62	759.72	661.66
Wt. of Tare (gm)	110.44	88.69	84.88	87.30	84.54
Wt. of Water (gm)	43.82	81.53	92.18	98.33	102.29
Wt. of DS (gm)	665.51	886.10	791.74	672.42	577.12

Wet Density (gm/cc)	1.99	2.11	2.17	2.15	2.07
Wet Density (pcf)	124.4	131.7	135.1	133.9	129.1
Moisture Content (%)	**6.6**	**9.2**	**11.6**	**14.6**	**17.7**
Dry Density (pcf)	**116.8**	**120.6**	**121.0**	**116.8**	**109.7**

Zero Air Voids

Moisture Content (%)	13.0	17.0	20.0
Dry Unit Weight (pcf)	123.7	114.6	108.6

Tested By SFS *Date* 9/10/2012 *Checked By* GEM *Date* 9-13-12

DCN:CT-S12 DATE:12/11/00 REVISION 5 Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-02 Proctor wHeaders.XLS]Sheet1

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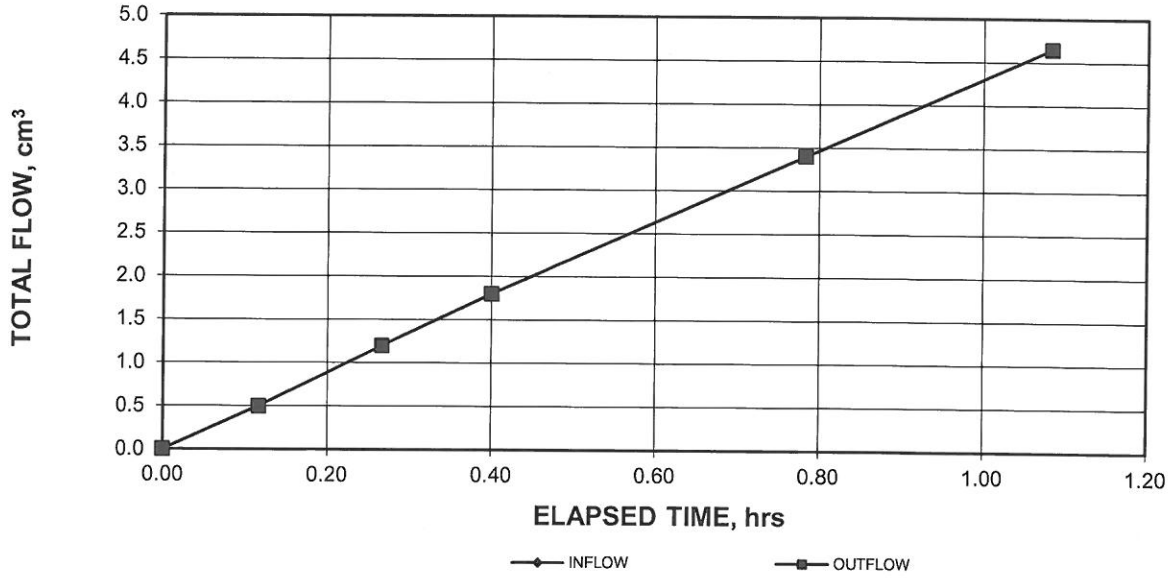
PERMEABILITY TEST

ASTM D 5084-03

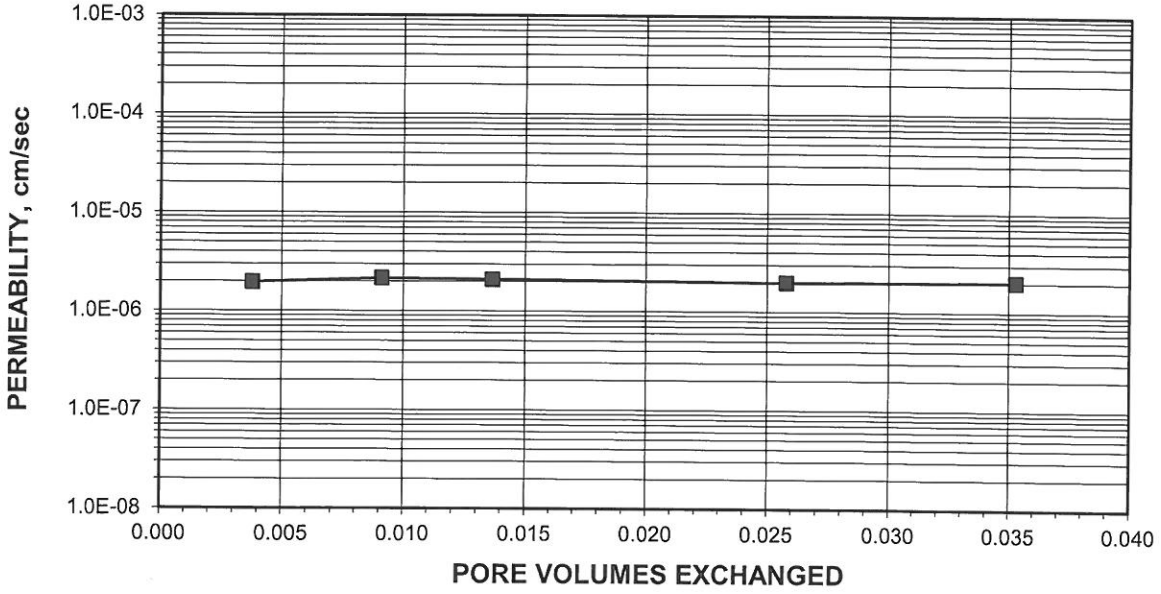
Client	CDM	Boring No.	B-726
Client Project	CELL 7 SUB D LF EXPANSION	Depth (ft.)	0.5-26
Project No.	2012-733-01	Sample No.	B-1
Lab ID No.	2012-733-01-01		

AVERAGE PERMEABILITY = 2.1E-06 cm/sec @ 20°C
AVERAGE PERMEABILITY = 2.1E-08 m/sec @ 20°C

TOTAL FLOW vs. ELAPSED TIME



PORE VOLUMES EXCHANGED vs. PERMEABILITY



Tested By: BW Date: 9/12/2012 Checked By: GEM Date: 9-14-12

DCN: CT-22 DATE: 02/27/03 REVISION: 0 L:\CELL 7 SUB D LF EXP\[2012-733-01-01 PERMflow w header (version 1).xls]Sheet1

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PERMEABILITY TEST

ASTM D 5084-10

Client	CDM	Boring No.	B-726
Client Project	CELL 7 SUB D LF EXPANSION	Depth (ft.)	0.5-26
Project No.	2012-733-01	Sample No.	B-1
Lab ID No.	2012-733-01-01		

Specific Gravity 2.66 Measured

Sample Condition Remolded

Visual Description: TAN SANDY CLAY

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	270	B-1
Wt. of Tare & WS (gm.)	92.42	388.86
Wt. of Tare & DS (gm.)	85.74	348.57
Wt. of Tare (gm.)	37.33	98.94
Wt. of Water (gm.)	6.68	40.29
Wt. of DS (gm.)	48.41	249.63
Moisture Content (%)	**13.8**	**16.1**

SPECIMEN:	BEFORE TEST	AFTER TEST
Wt. of Tube & WS (gm.)	2511.71	NA
Wt. of Tube (gm.)	1635.21	NA
Wt. of WS (calc.)(gm.)	876.50	894.53
Length 1 (in.)	4.003	3.988
Length 2 (in.)	4.003	3.985
Length 3 (in.)	4.003	3.965
Top Diameter (in.)	2.869	2.871
Middle Diameter (in.)	2.869	2.870
Bottom Diameter (in.)	2.869	2.864
Average Length (in.)	4.00	3.98
Average Area (in.^{2})	6.46	6.46
Sample Volume (cm^3)	424.07	421.37
Unit Wet Wt. (gm./ cm^3)	2.07	2.12
Unit Wet Wt. (pcf)	129.0	132.5
Unit Dry Wt. (pcf)	113.4	114.1
Unit Dry Wt. (gm./ cm^3)	1.82	1.83
Void Ratio, e	0.46	0.46
Porosity, n	0.32	0.31
Pore Volume (cm^3)	134.5	131.8
Total Wgt. Of Sample After Test		900.52

Tested By: BW Date: 9/12/2012 Checked By: GJM Date: 9-14-12

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PERMEABILITY TEST

ASTM D 5084-03

Client	CDM	Boring No.	B-726
Client Project	CELL 7 SUB D LF EXPANSION	Depth (ft.)	0.5-26
Project No.	2012-733-01	Sample No.	B-1
Lab ID No.	2012-733-01-01		

Pressure Heads (Constant)		Final Sample Dimensions	
Top Cap (psi)	38.5	Sample Length (cm), L	10.11
Bottom Cap (psi)	40.0	Sample Diameter (cm)	7.29
Cell (psi)	45.0	Sample Area (cm^2), A	41.69
Total Pressure Head (cm)	105.5	Inflow Burette Area (cm^2), a-in	0.852
Hydraulic Gradient	10.43	Outflow Burette Area (cm^2), a-out	0.972
		B Parameter (%)	96

AVERAGE PERMEABILITY = 2.1E-06 cm/sec @ 20°C

AVERAGE PERMEABILITY = 2.1E-08 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	TIME (min)	ELAPSED TIME t (hr)	TOTAL INFLOW (cm^3)	TOTAL OUTFLOW (cm^3)	TOTAL HEAD h (cm)	FLOW (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
9/13/2012	15	11	0.00	0.0	0.0	129.7	0	25.4	NA
9/13/2012	15	18	0.12	0.5	0.5	128.6	0	25.4	2.0E-06
9/13/2012	15	27	0.27	1.2	1.2	127.1	0	25.4	2.2E-06
9/13/2012	15	35	0.40	1.8	1.8	125.8	0	25.4	2.1E-06
9/13/2012	15	58	0.78	3.4	3.4	122.3	0	25.4	2.0E-06
9/13/2012	16	16	1.08	4.7	4.7	119.5	1	25.4	2.0E-06

Tested By: BW Date: 9/12/2012 Checked By: GJM Date: 9-14-12

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INTEGRITY IN TESTING

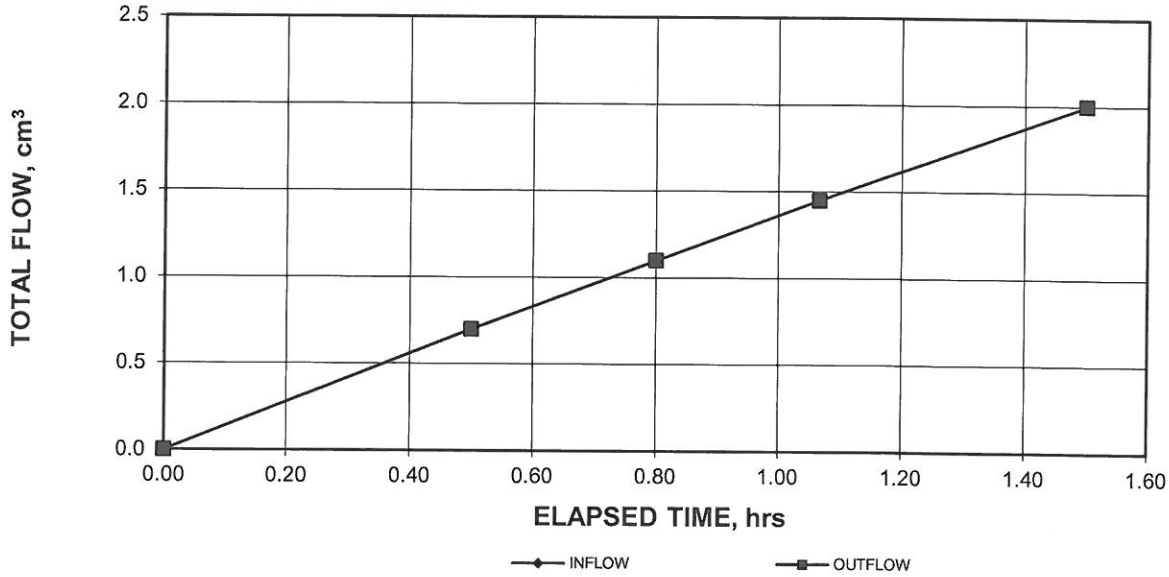
PERMEABILITY TEST

ASTM D 5084-03

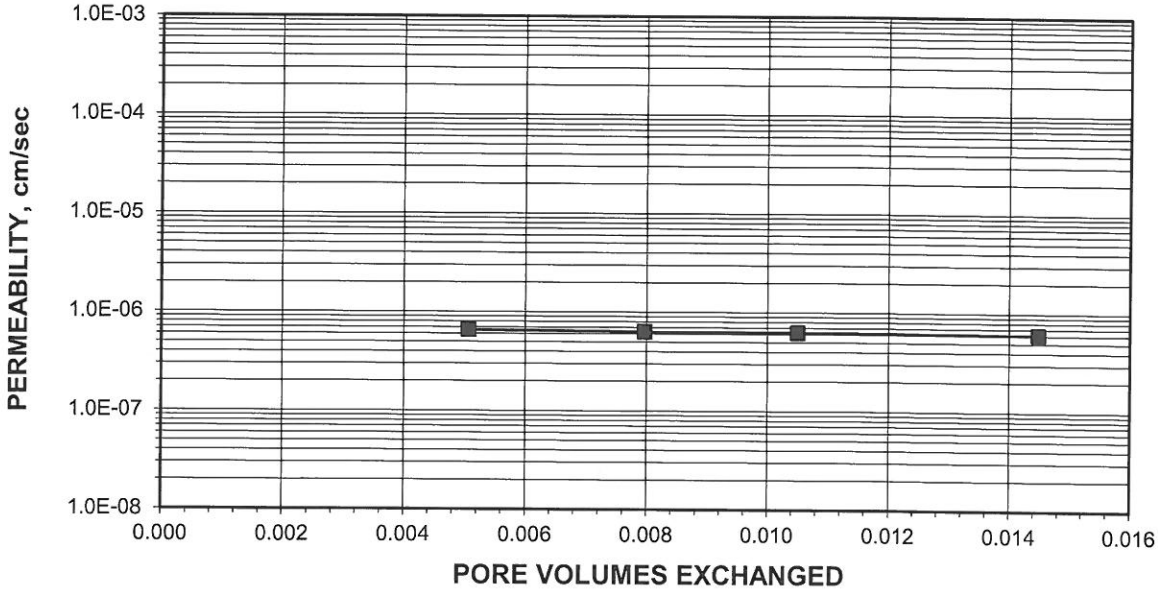
Client	CDM	Boring No.	B-729
Client Project	CELL 7 SUB D LF EXPANSION	Depth (ft.)	0.5-26
Project No.	2012-733-01	Sample No.	B-2
Lab ID No.	2012-733-01-02		

AVERAGE PERMEABILITY = 6.3E-07 cm/sec @ 20°C
AVERAGE PERMEABILITY = 6.3E-09 m/sec @ 20°C

TOTAL FLOW vs. ELAPSED TIME



PORE VOLUMES EXCHANGED vs. PERMEABILITY



Tested By: BW Date: 9/12/2012 Checked By: GBM Date: 9-14-12

DCN: CT-22 DATE: 02/27/13 REVISION: 1 7 SUB D LF EXP\[2012-733-01-02 PERMflow w header (version 1).xls]Sheet1

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PERMEABILITY TEST

ASTM D 5084-10

Client	CDM	Boring No.	B-729
Client Project	CELL 7 SUB D LF EXPANSION	Depth (ft.)	0.5-26
Project No.	2012-733-01	Sample No.	B-2
Lab ID No.	2012-733-01-02		

Specific Gravity 2.67 Measured

Sample Condition Remolded

Visual Description: BROWN SANDY CLAY

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	1010	SS-1
Wt. of Tare & WS (gm.)	83.50	336.81
Wt. of Tare & DS (gm.)	78.18	301.44
Wt. of Tare (gm.)	36.34	94.65
Wt. of Water (gm.)	5.32	35.37
Wt. of DS (gm.)	41.84	206.79
Moisture Content (%)	**12.7**	**17.1**

SPECIMEN:	BEFORE TEST	AFTER TEST
Wt. of Tube & WS (gm.)	2519.00	NA
Wt. of Tube (gm.)	1635.21	NA
Wt. of WS (calc.)(gm.)	883.79	918.21
Length 1 (in.)	4.003	4.058
Length 2 (in.)	4.003	4.029
Length 3 (in.)	4.003	4.050
Top Diameter (in.)	2.869	2.879
Middle Diameter (in.)	2.869	2.886
Bottom Diameter (in.)	2.869	2.874
Average Length (in.)	4.00	4.05
Average Area (in.^{2})	6.46	6.51
Sample Volume (cm^3)	424.07	431.78
Unit Wet Wt. (gm./ cm^3)	2.08	2.13
Unit Wet Wt. (pcf)	130.1	132.7
Unit Dry Wt. (pcf)	115.4	113.4
Unit Dry Wt. (gm./ cm^3)	1.85	1.82
Void Ratio, e	0.44	0.47
Porosity, n	0.31	0.32
Pore Volume (cm^3)	130.4	138.1
Total Wgt. Of Sample After Test		915.14

Tested By: BW Date: 9/12/2012 Checked By: GEM Date: 9-14-12

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PERMEABILITY TEST

ASTM D 5084-03

Client	CDM	Boring No.	B-729
Client Project	CELL 7 SUB D LF EXPANSION	Depth (ft.)	0.5-26
Project No.	2012-733-01	Sample No.	B-2
Lab ID No.	2012-733-01-02		

Pressure Heads (Constant)		Final Sample Dimensions	
Top Cap (psi)	38.5	Sample Length (cm), L	10.28
Bottom Cap (psi)	40.0	Sample Diameter (cm)	7.31
Cell (psi)	45.0	Sample Area (cm^2), A	42.02
Total Pressure Head (cm)	105.5	Inflow Burette Area (cm^2), a-in	0.977
Hydraulic Gradient	10.26	Outflow Burette Area (cm^2), a-out	0.868
		B Parameter (%)	98

AVERAGE PERMEABILITY = 6.3E-07 cm/sec @ 20°C

AVERAGE PERMEABILITY = 6.3E-09 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	TIME (min)	ELAPSED TIME t (hr)	TOTAL INFLOW (cm^3)	TOTAL OUTFLOW (cm^3)	TOTAL HEAD h (cm)	FLOW (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
9/13/2012	15	28	0.00	0.0	0.0	127.6	0	25.4	NA
9/13/2012	15	58	0.50	0.7	0.7	126.1	0	25.4	6.6E-07
9/13/2012	16	16	0.80	1.1	1.1	125.2	0	25.4	6.3E-07
9/13/2012	16	32	1.07	1.5	1.5	124.5	0	25.4	6.3E-07
9/13/2012	16	58	1.50	2.0	2.0	123.3	1	25.4	6.1E-07

Tested By: BW Date: 9/12/2012 Checked By: GEM Date: 9-14-12

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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-722s
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-1
Lab ID	2012-733-01-03	Soil Description	**DARK BROWN SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

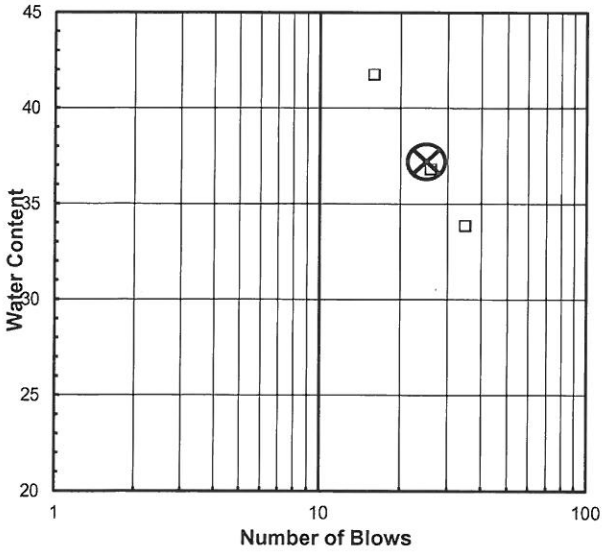
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	R	M	P	MULTIPOINT
Wt. of Tare & WS (gm)	25.79	22.29	21.82	
Wt. of Tare & DS (gm)	23.10	20.37	19.88	
Wt. of Tare (gm)	15.15	15.15	15.23	
Wt. of Water (gm)	2.7	1.9	1.9	
Wt. of DS (gm)	8.0	5.2	4.7	
Moisture Content (%)	**33.8**	**36.8**	**41.7**	
Number of Blows	**35**	**26**	**16**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	A-L	4M	
Wt. of Tare & WS (gm)	22.66	23.83	
Wt. of Tare & DS (gm)	20.83	21.80	
Wt. of Tare (gm)	15.56	15.60	
Wt. of Water (gm)	1.8	2.0	
Wt. of DS (gm)	5.3	6.2	
Moisture Content (%)	**34.7**	**32.7**	**2.0**

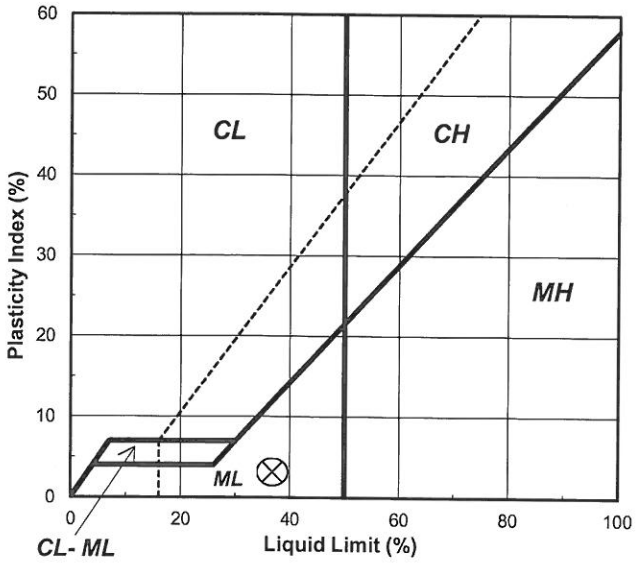
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**37**
Plastic Limit (%)	**34**
Plasticity Index (%)	**3**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



Tested By *BW* *Date* *9/12/2012* *Checked By* GJM *Date* 9-14-12

page 1 of 1 **DCN:** CT-S4B **DATE:** 6/24/2010 **REVISION:** 4

Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-03 3ptlimit with header.xls]Sheet1

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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-2
Lab ID	2012-733-01-04	Soil Description	**REDDISH BROWN SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

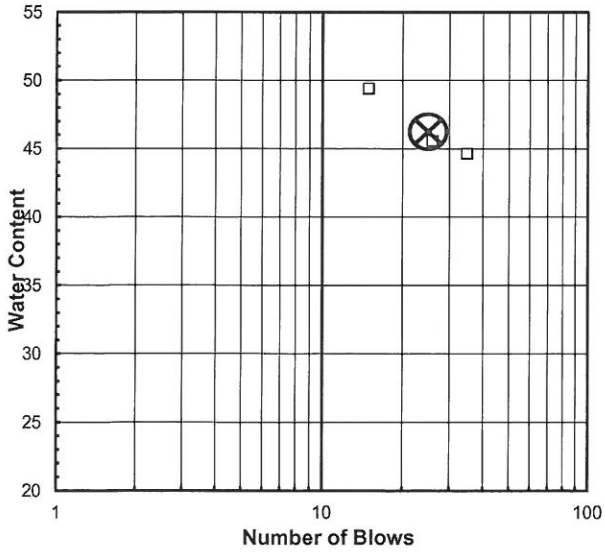
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	Q	B1	AP	MULTIPOINT
Wt. of Tare & WS (gm)	21.56	23.65	26.41	
Wt. of Tare & DS (gm)	19.58	21.20	22.91	
Wt. of Tare (gm)	15.14	15.82	15.82	
Wt. of Water (gm)	2.0	2.5	3.5	
Wt. of DS (gm)	4.4	5.4	7.1	
Moisture Content (%)	**44.6**	**45.5**	**49.4**	
Number of Blows	**35**	**26**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	O	A-T	
Wt. of Tare & WS (gm)	21.86	23.58	
Wt. of Tare & DS (gm)	20.12	21.45	
Wt. of Tare (gm)	15.21	15.80	
Wt. of Water (gm)	1.7	2.1	
Wt. of DS (gm)	4.9	5.7	
Moisture Content (%)	**35.4**	**37.7**	**-2.3**

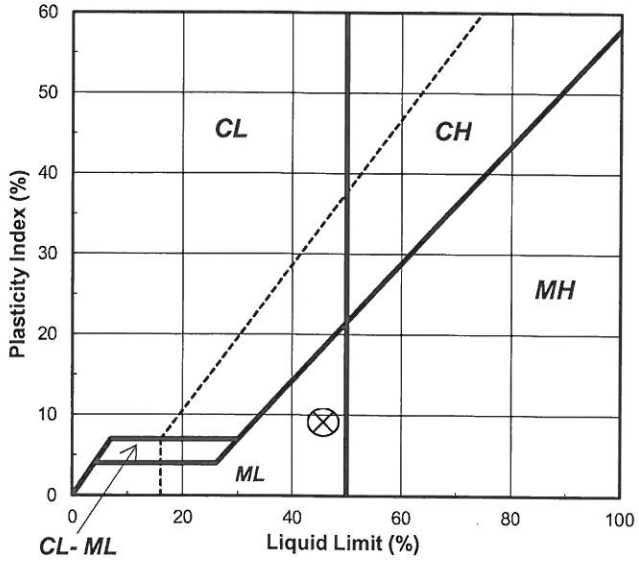
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**46**
Plastic Limit (%)	**37**
Plasticity Index (%)	**9**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



Tested By *BW* *Date* *9/12/2012* *Checked By* GM *Date* 9-14-12

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ATTERBERG LIMIT

ASTM D 4318-10

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	24-26
Project No.	2012-733-01	Sample No.	S-3
Lab ID	2012-733-01-05	Visual Description	**GRAY**

(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By *JBD* *Date* *9/12/2012* *Checked By* GZM *Date* 9-14-12

DCN: CT-S4C DATE: 7-11-97 REVISION : *Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-05 Limit-(NP) WHeader.xls]Sheet1*

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ATTERBERG LIMIT

ASTM D 4318-10

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	9-11
Project No.	2012-733-01	Sample No.	S-4
Lab ID	2012-733-01-06	Visual Description	**GRAY**

(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By JBD *Date* 9/12/2012 *Checked By* GEM *Date* 9-14-12

DCN: CT-S4C DATE: 7-11-97 REVISION : Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-05 Limit-(NP) WHeader.xls]Sheet1

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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	5-7
Project No.	2012-733-01	Sample No.	S-5
Lab ID	2012-733-01-07	Soil Description	**BROWN LEAN CLAY**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

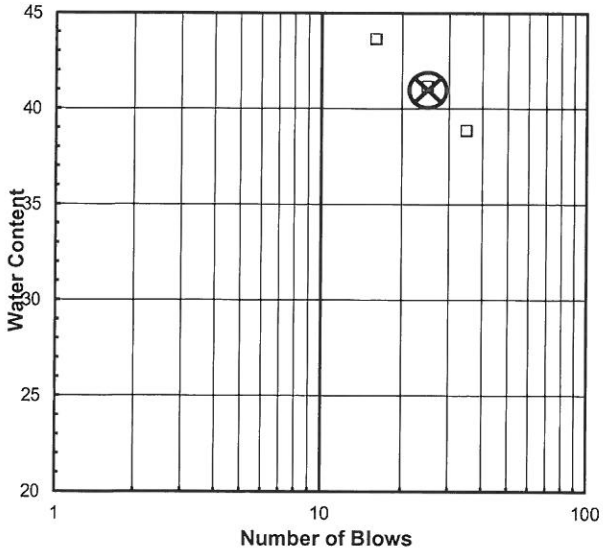
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	A-Q	2M	A-H	MULTIPOINT
Wt. of Tare & WS (gm)	30.39	32.71	36.44	
Wt. of Tare & DS (gm)	26.22	27.72	30.09	
Wt. of Tare (gm)	15.48	15.59	15.53	
Wt. of Water (gm)	4.2	5.0	6.4	
Wt. of DS (gm)	10.7	12.1	14.6	
Moisture Content (%)	**38.8**	**41.1**	**43.6**	
Number of Blows	**35**	**25**	**16**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	X-9	W-5	
Wt. of Tare & WS (gm)	23.16	23.21	
Wt. of Tare & DS (gm)	21.70	21.74	
Wt. of Tare (gm)	15.71	15.64	
Wt. of Water (gm)	1.5	1.5	
Wt. of DS (gm)	6.0	6.1	
Moisture Content (%)	**24.4**	**24.1**	**0.3**

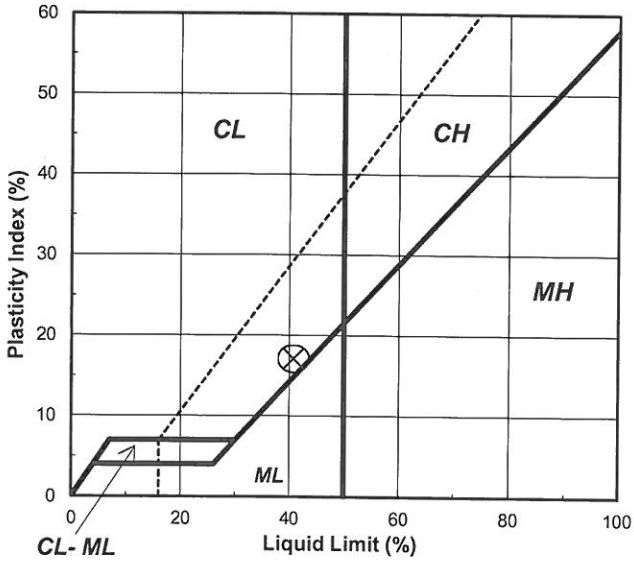
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**41**
Plastic Limit (%)	**24**
Plasticity Index (%)	**17**
USCS Symbol	**CL**

Flow Curve



Plasticity Chart



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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	40-42
Project No.	2012-733-01	Sample No.	S-6
Lab ID	2012-733-01-08	Soil Description	**BROWN SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

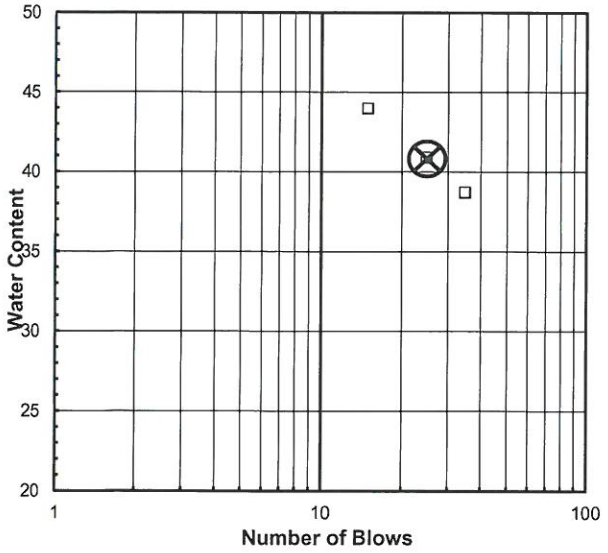
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	A-T	B1	A-P	MULTIPOINT
Wt. of Tare & WS (gm)	28.76	30.96	32.54	
Wt. of Tare & DS (gm)	25.12	26.63	27.37	
Wt. of Tare (gm)	15.71	16.04	15.61	
Wt. of Water (gm)	3.6	4.3	5.2	
Wt. of DS (gm)	9.4	10.6	11.8	
Moisture Content (%)	**38.7**	**40.9**	**44.0**	
Number of Blows	**35**	**25**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	Q	O	
Wt. of Tare & WS (gm)	24.50	23.53	
Wt. of Tare & DS (gm)	22.16	21.53	
Wt. of Tare (gm)	15.13	15.20	
Wt. of Water (gm)	2.3	2.0	
Wt. of DS (gm)	7.0	6.3	
Moisture Content (%)	**33.3**	**31.6**	**1.7**

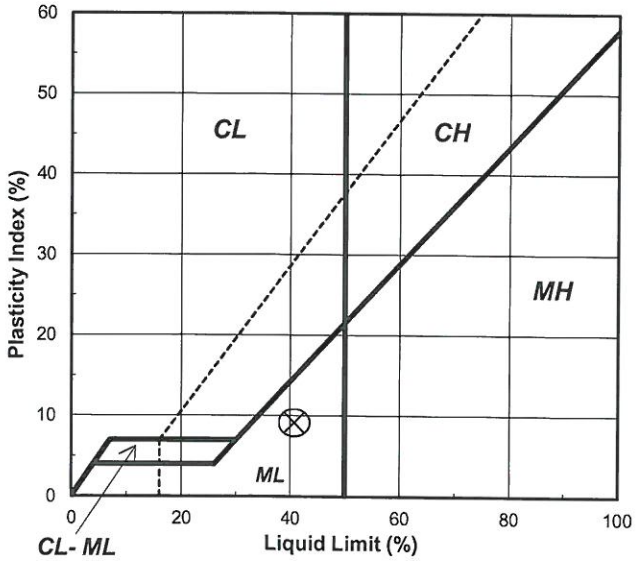
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**41**
Plastic Limit (%)	**32**
Plasticity Index (%)	**9**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



Tested By JBD *Date* 9/16/2012 *Checked By* GJM *Date* 9-17-12

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ATTERBERG LIMIT

ASTM D 4318-10

Client	CDM	Boring No.	B-730
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-7
Lab ID	2012-733-01-09	Visual Description	**BROWN**

(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By JBD *Date* 9/13/2012 *Checked By* GEM *Date* 9-14-12

DCN: CT-S4C DATE: 7-11-97 REVISION : *Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-13 Limit-(NP) WHeader.xls]Sheet1*

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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-719
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	28-30
Project No.	2012-733-01	Sample No.	S-8
Lab ID	2012-733-01-10	Soil Description	**LIGHT BROWN SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

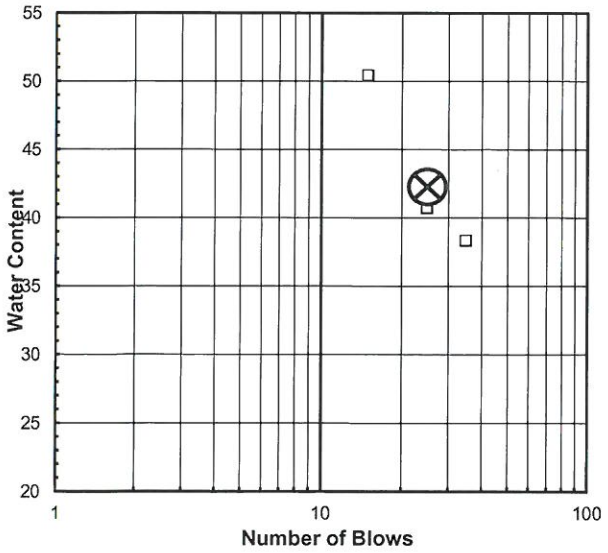
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	Z-4	17	A-O	MULTIPOINT
Wt. of Tare & WS (gm)	26.30	25.80	24.73	
Wt. of Tare & DS (gm)	23.33	22.81	21.61	
Wt. of Tare (gm)	15.58	15.46	15.42	
Wt. of Water (gm)	3.0	3.0	3.1	
Wt. of DS (gm)	7.8	7.4	6.2	
Moisture Content (%)	**38.3**	**40.7**	**50.4**	
Number of Blows	**35**	**25**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	3M	V-2	
Wt. of Tare & WS (gm)	22.95	22.17	
Wt. of Tare & DS (gm)	21.00	20.38	
Wt. of Tare (gm)	15.59	15.62	
Wt. of Water (gm)	2.0	1.8	
Wt. of DS (gm)	5.4	4.8	
Moisture Content (%)	**36.0**	**37.6**	**-1.6**

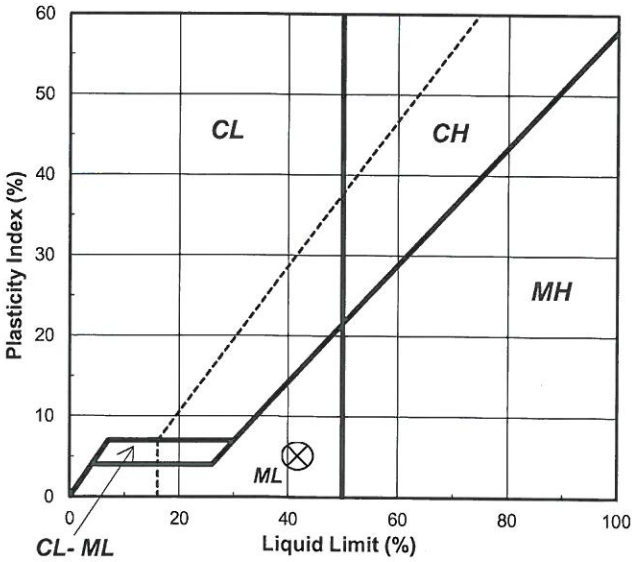
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**42**
Plastic Limit (%)	**37**
Plasticity Index (%)	**5**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



Tested By *BW* *Date* *9/12/2012* *Checked By* GEM *Date* 9-14-12

page 1 of 1 **DCN:** CT-S4B **DATE:** 6/24/2010 **REVISION:** 4

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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-721
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	19-21
Project No.	2012-733-01	Sample No.	S-9
Lab ID	2012-733-01-11	Soil Description	**GRAY SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

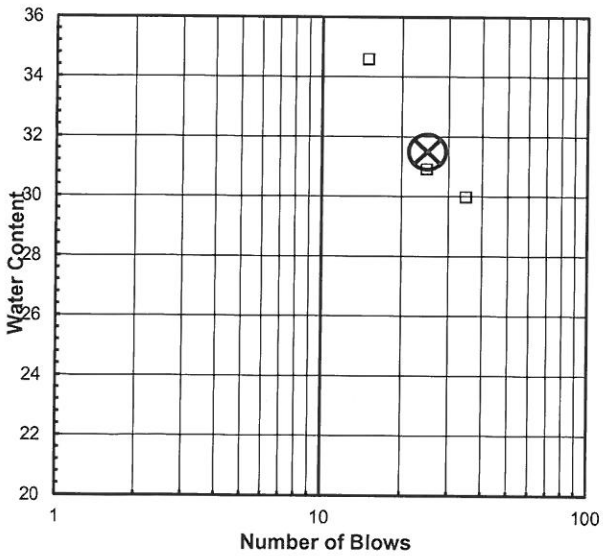
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	A-I	A-K	A-D	MULTIPOINT
Wt. of Tare & WS (gm)	27.55	27.68	28.75	
Wt. of Tare & DS (gm)	24.76	24.81	25.31	
Wt. of Tare (gm)	15.45	15.52	15.36	
Wt. of Water (gm)	2.8	2.9	3.4	
Wt. of DS (gm)	9.3	9.3	10.0	
Moisture Content (%)	**30.0**	**30.9**	**34.6**	
Number of Blows	**35**	**25**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	V	C	
Wt. of Tare & WS (gm)	22.70	22.41	
Wt. of Tare & DS (gm)	21.08	20.87	
Wt. of Tare (gm)	15.27	15.20	
Wt. of Water (gm)	1.6	1.5	
Wt. of DS (gm)	5.8	5.7	
Moisture Content (%)	**27.9**	**27.2**	**0.7**

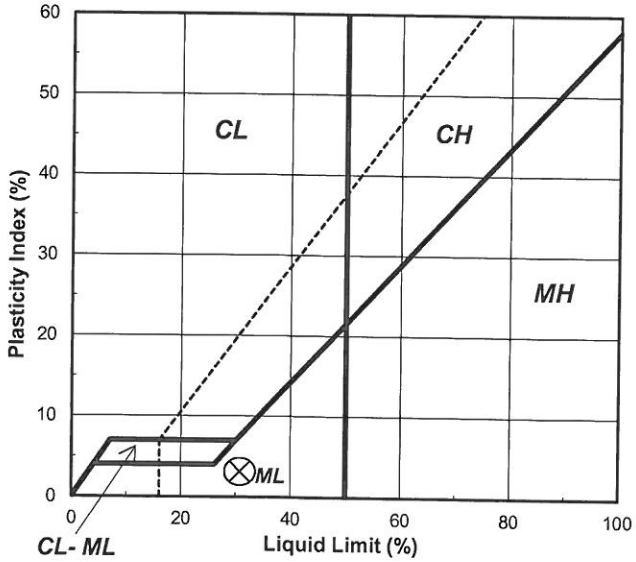
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**31**
Plastic Limit (%)	**28**
Plasticity Index (%)	**3**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-725
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-10
Lab ID	2012-733-01-12	Soil Description	**LIGHT BROWN SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

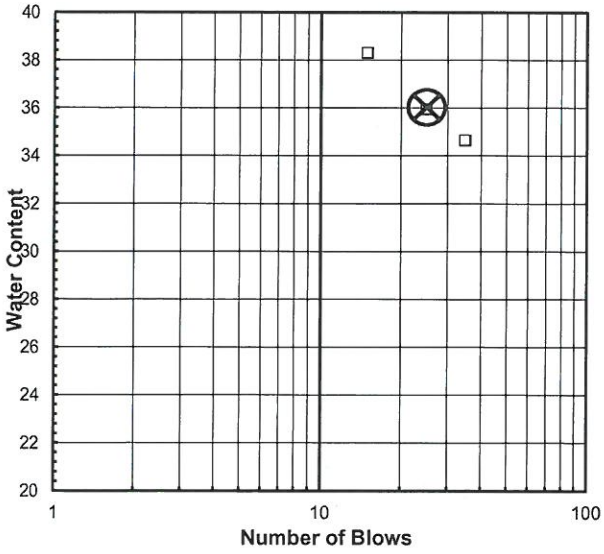
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	J	I	S	MULTIPOINT
Wt. of Tare & WS (gm)	28.17	30.03	28.85	
Wt. of Tare & DS (gm)	24.81	26.11	25.06	
Wt. of Tare (gm)	15.11	15.20	15.16	
Wt. of Water (gm)	3.4	3.9	3.8	
Wt. of DS (gm)	9.7	10.9	9.9	
Moisture Content (%)	**34.6**	**35.9**	**38.3**	
Number of Blows	**35**	**25**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	A-F	A-N	
Wt. of Tare & WS (gm)	23.39	25.38	
Wt. of Tare & DS (gm)	21.37	22.87	
Wt. of Tare (gm)	15.42	15.41	
Wt. of Water (gm)	2.0	2.5	
Wt. of DS (gm)	6.0	7.5	
Moisture Content (%)	**33.9**	**33.6**	**0.3**

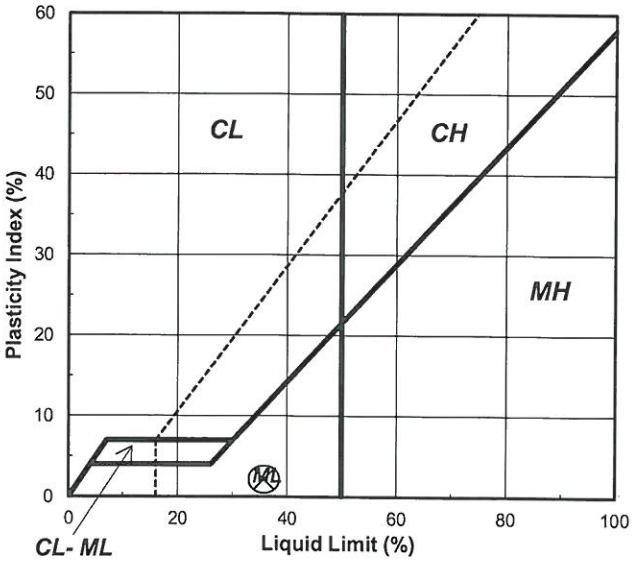
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**36**
Plastic Limit (%)	**34**
Plasticity Index (%)	**2**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



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ATTERBERG LIMIT

ASTM D 4318-10

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	4-6
Project No.	2012-733-01	Sample No.	S-11
Lab ID	2012-733-01-13	Visual Description	**TAN**

(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By JBD *Date* 9/13/2012 *Checked By* GEM *Date* 9-14-12

DCN: CT-S4C DATE: 7-11-97 REVISION : Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-05 Limit-(NP) WHeader.xls]Sheet1

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ATTERBERG LIMIT

ASTM D 4318-10

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	30-32
Project No.	2012-733-01	Sample No.	S-12
Lab ID	2012-733-01-14	Visual Description	**GRAY**

(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By *JBD* *Date* *9/14/2012* *Checked By* GEM *Date* 9-17-12

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

Z:\Data Sheets\[Limit-(NP) WHeader.xls]Sheet1

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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	35-37
Project No.	2012-733-01	Sample No.	S-13
Lab ID	2012-733-01-15	Soil Description	**GRAY SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

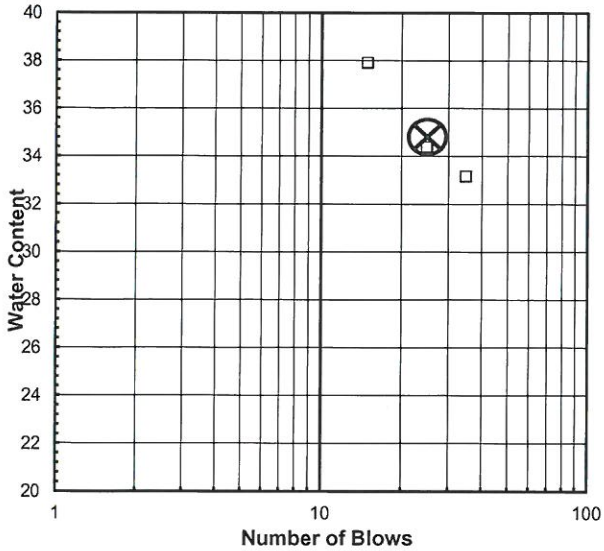
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	T	E	F	MULTIPOINT
Wt. of Tare & WS (gm)	29.17	30.85	29.15	
Wt. of Tare & DS (gm)	25.70	26.87	25.30	
Wt. of Tare (gm)	15.23	15.29	15.14	
Wt. of Water (gm)	3.5	4.0	3.9	
Wt. of DS (gm)	10.5	11.6	10.2	
Moisture Content (%)	**33.1**	**34.4**	**37.9**	
Number of Blows	**35**	**25**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	A-N	A-F	
Wt. of Tare & WS (gm)	23.53	22.75	
Wt. of Tare & DS (gm)	21.60	21.00	
Wt. of Tare (gm)	15.42	15.41	
Wt. of Water (gm)	1.9	1.8	
Wt. of DS (gm)	6.2	5.6	
Moisture Content (%)	**31.2**	**31.3**	**-0.1**

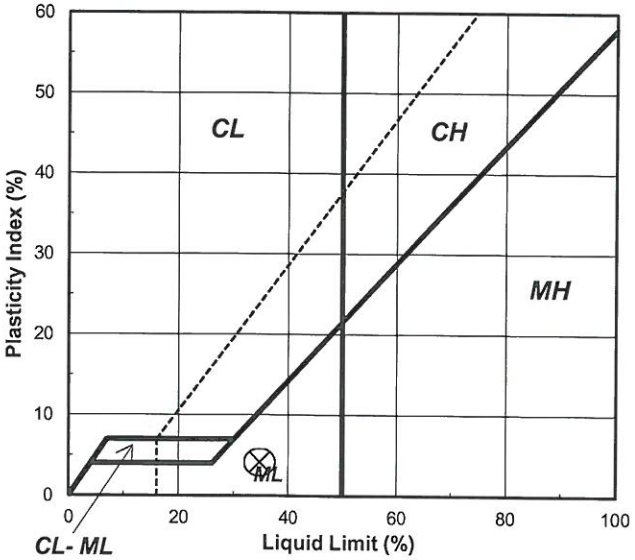
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**35**
Plastic Limit (%)	**31**
Plasticity Index (%)	**4**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	18-20
Project No.	2012-733-01	Sample No.	S-14
Lab ID	2012-733-01-16	Soil Description	**GRAY SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

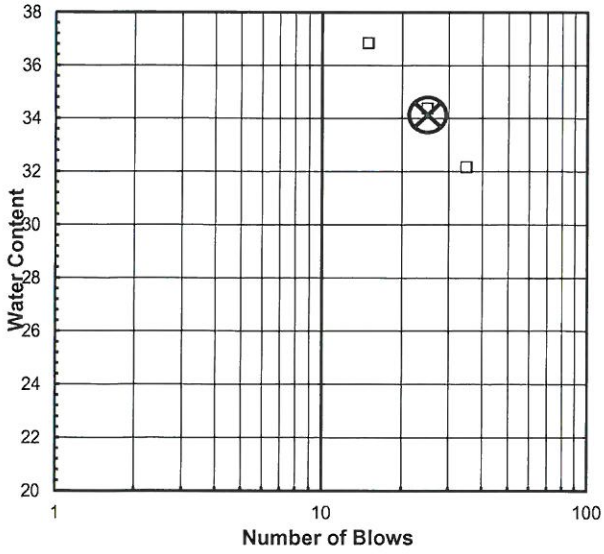
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	B-3	W-2	B2	MULTIPOINT
Wt. of Tare & WS (gm)	29.01	30.52	30.17	
Wt. of Tare & DS (gm)	25.81	26.75	26.20	
Wt. of Tare (gm)	15.86	15.78	15.42	
Wt. of Water (gm)	3.2	3.8	4.0	
Wt. of DS (gm)	10.0	11.0	10.8	
Moisture Content (%)	**32.2**	**34.4**	**36.8**	
Number of Blows	**35**	**25**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	W	Y	
Wt. of Tare & WS (gm)	24.25	24.67	
Wt. of Tare & DS (gm)	22.10	22.53	
Wt. of Tare (gm)	15.10	15.56	
Wt. of Water (gm)	2.2	2.1	
Wt. of DS (gm)	7.0	7.0	
Moisture Content (%)	**30.7**	**30.7**	**0.0**

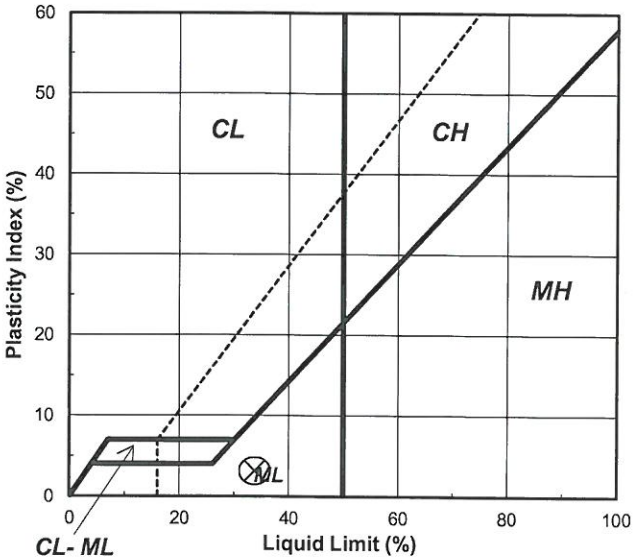
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**34**
Plastic Limit (%)	**31**
Plasticity Index (%)	**3**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	10-12
Project No.	2012-733-01	Sample No.	S-15
Lab ID	2012-733-01-17	Soil Description	**LIGHT BROWN SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

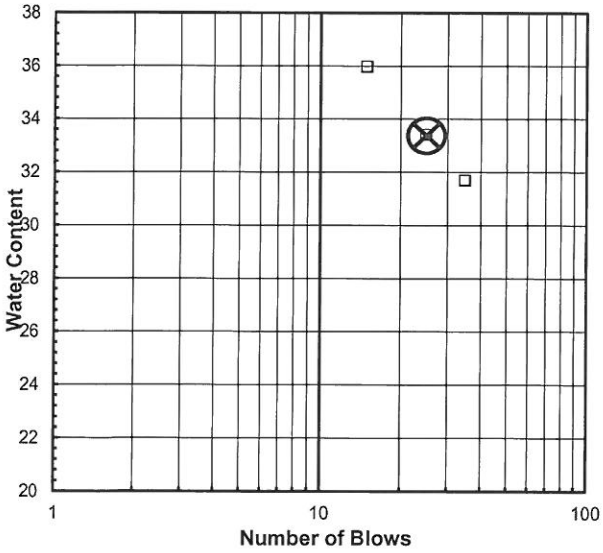
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	1	3	A	MULTIPOINT
Wt. of Tare & WS (gm)	31.82	29.41	29.72	
Wt. of Tare & DS (gm)	27.95	25.91	25.88	
Wt. of Tare (gm)	15.73	15.43	15.20	
Wt. of Water (gm)	3.9	3.5	3.8	
Wt. of DS (gm)	12.2	10.5	10.7	
Moisture Content (%)	**31.7**	**33.4**	**36.0**	
Number of Blows	**35**	**25**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	Y-3	5M	
Wt. of Tare & WS (gm)	24.07	23.51	
Wt. of Tare & DS (gm)	22.18	21.74	
Wt. of Tare (gm)	15.68	15.62	
Wt. of Water (gm)	1.9	1.8	
Wt. of DS (gm)	6.5	6.1	
Moisture Content (%)	**29.1**	**28.9**	**0.2**

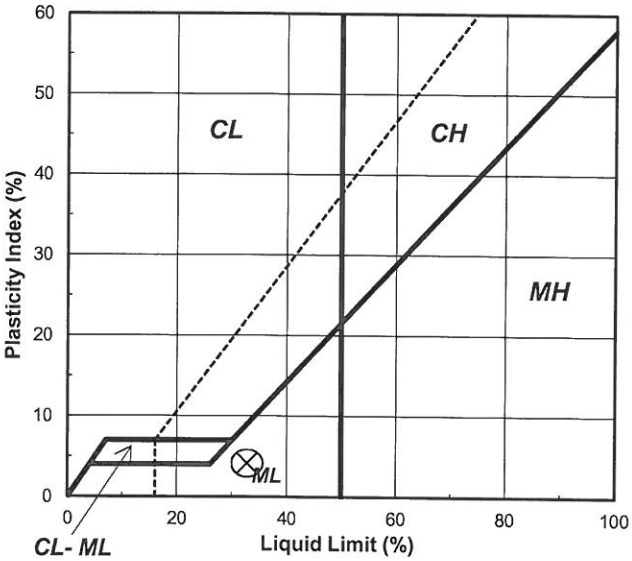
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**33**
Plastic Limit (%)	**29**
Plasticity Index (%)	**4**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



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ATTERBERG LIMITS

ASTM D 4318-10

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	50-52
Project No.	2012-733-01	Sample No.	S-16
Lab ID	2012-733-01-18	Soil Description	**GRAY SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

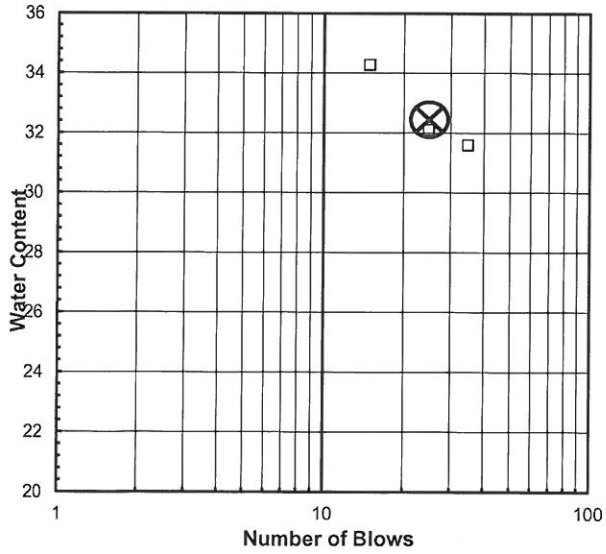
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	A-C	A-B	B-B	MULTIPOINT
Wt. of Tare & WS (gm)	29.34	31.74	29.00	
Wt. of Tare & DS (gm)	26.04	27.82	25.56	
Wt. of Tare (gm)	15.59	15.60	15.52	
Wt. of Water (gm)	3.3	3.9	3.4	
Wt. of DS (gm)	10.5	12.2	10.0	
Moisture Content (%)	**31.6**	**32.1**	**34.3**	
Number of Blows	**35**	**25**	**15**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	L	H	
Wt. of Tare & WS (gm)	23.47	24.10	
Wt. of Tare & DS (gm)	21.71	22.22	
Wt. of Tare (gm)	15.19	15.08	
Wt. of Water (gm)	1.8	1.9	
Wt. of DS (gm)	6.5	7.1	
Moisture Content (%)	**27.0**	**26.3**	**0.7**

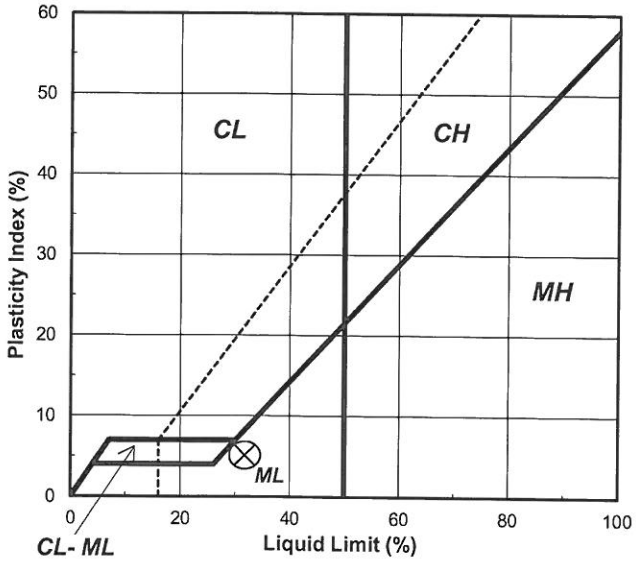
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**32**
Plastic Limit (%)	**27**
Plasticity Index (%)	**5**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



Tested By JBD *Date* 9/13/2012 *Checked By* GEM *Date* 9-14-12

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

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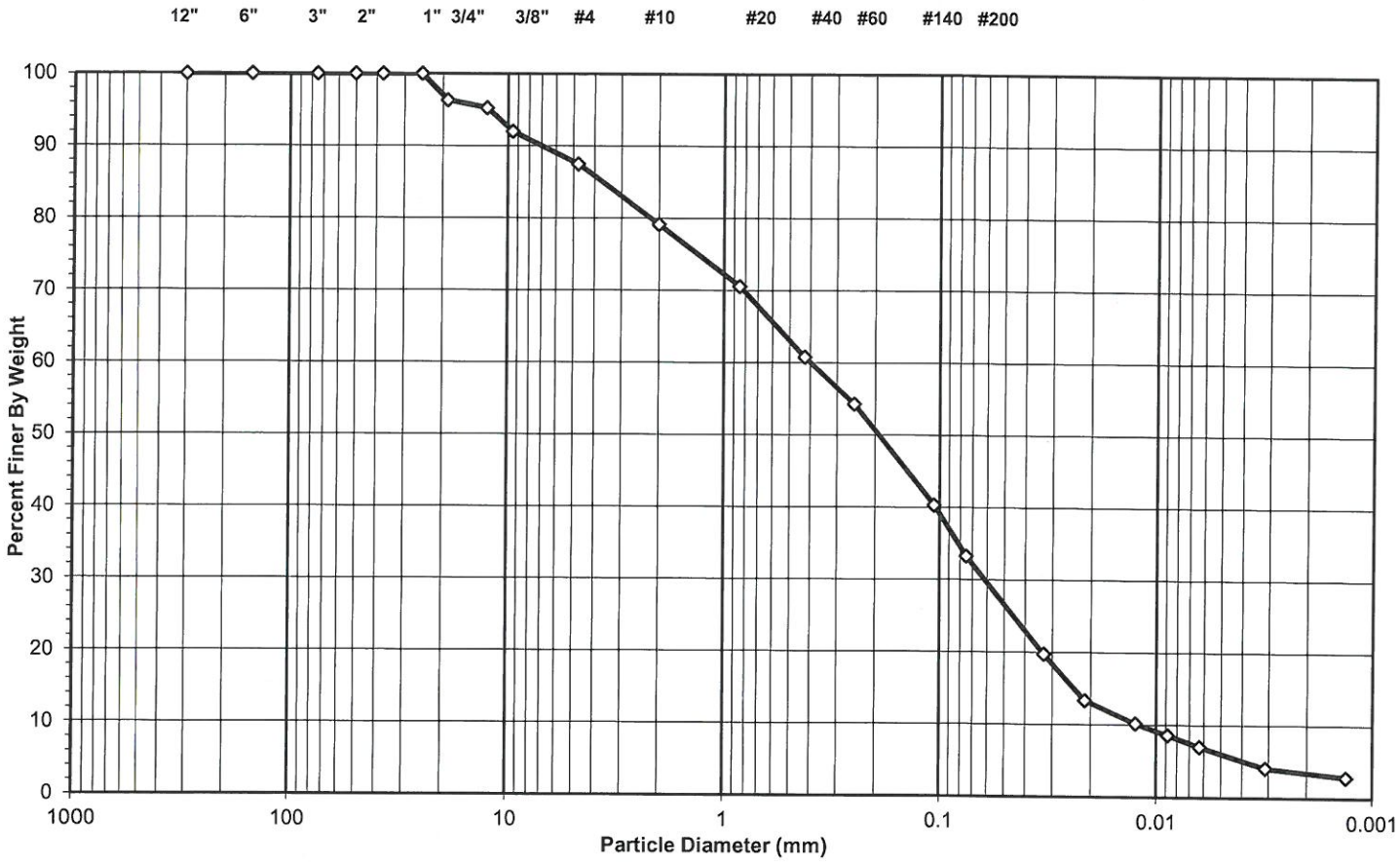
Client	CDM	Boring No.	B-722s
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-1
Lab ID	2012-733-01-03	Soil Color	**DARK BROWN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	12.49
#4 To #200	*Sand*	54.22
Finer Than #200	*Silt & Clay*	33.29

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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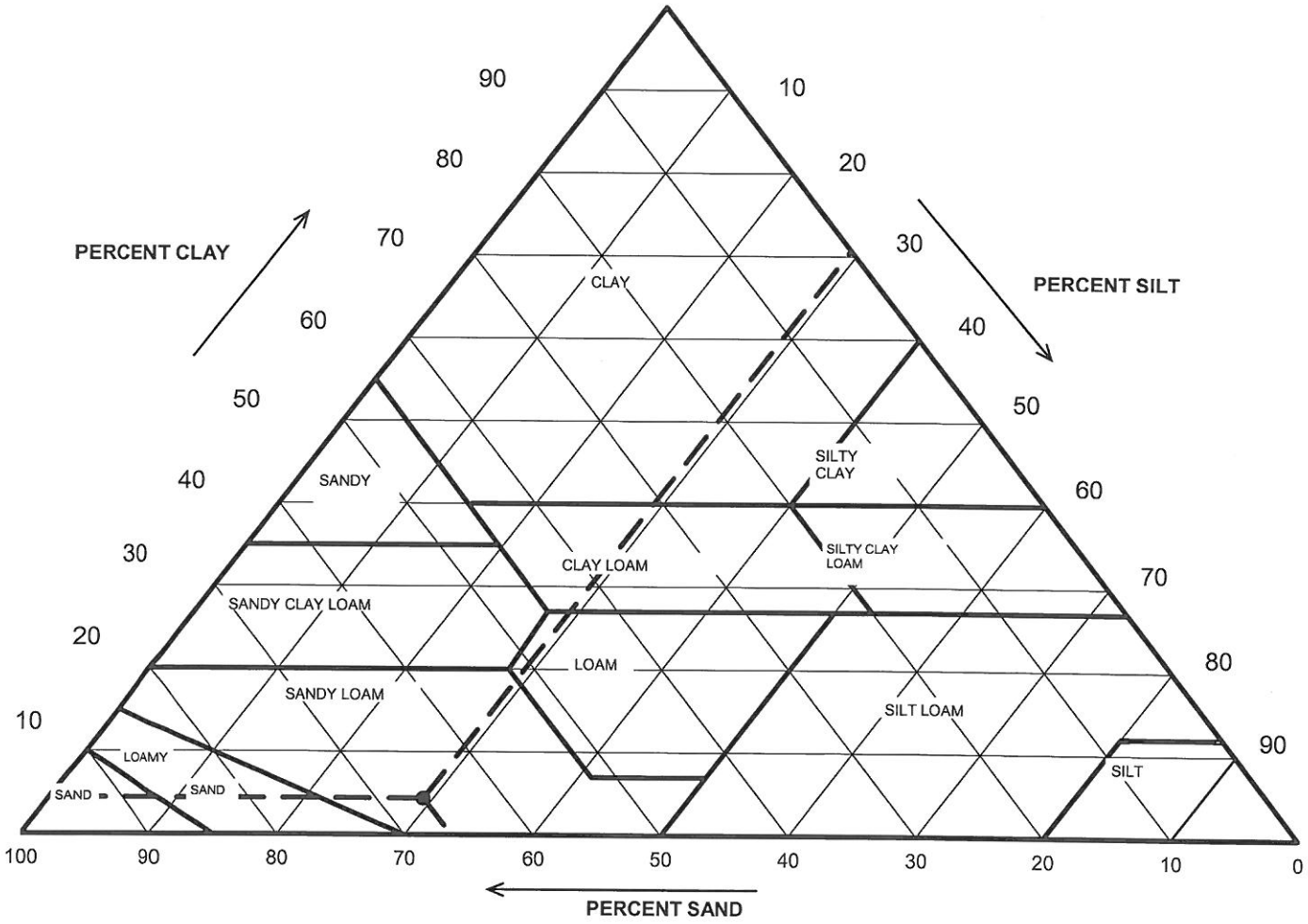
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-722s
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-1
Lab ID	2012-733-01-03	Soil Color	DARK BROWN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	20.86	**0.00**
2	79.14	*Sand*	52.52	**66.36**
0.05	26.62	*Silt*	23.15	**29.25**
0.002	3.47	*Clay*	3.47	**4.39**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-722s
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-1
Lab ID	2012-733-01-03	Soil Color	**DARK BROWN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	P-1	Air Dried - #10 Hydrometer Material (gm)	50.00
Wgt.Tare + Wet Soil (gm)	36.91	Corrected Dry Wt. of - #10 Material (gm)	49.16
Wgt.Tare + Dry Soil (gm)	36.66		
Weight of Tare (gm)	22.06	Weight of - #200 Material (gm)	20.68
Weight of Water (gm)	0.25	Weight of - #10 ; + #200 Material (gm)	28.48
Weight of Dry Soil (gm)	14.60		
Moisture Content (%)	**1.7**	**J-FACTOR (%FINER THAN #10)**	**0.7914**
	Soil Specimen Data		
Tare No.	214		
Wgt.Tare + Air Dry Soil (gm)	506.90		
Weight of Tare (gm)	171.16		
Air Dried Wgt. Total Sample (gm)	335.74	Dry Weight of Material Retained on #10 (gm)	69.10
Total Dry Sample Weight (gm)	331.25	Corrected Dry Sample Wt - #10 (gm)	262.15

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	12.16	3.7	3.7	96.3	**96.3**
1/2"	12.5	3.60	1.1	4.8	95.2	**95.2**
3/8"	9.50	10.81	3.3	8.0	92.0	**92.0**
#4	4.75	14.79	4.5	12.5	87.5	**87.5**
#10	2.00	27.74	8.4	20.9	79.1	**79.1**
#20	0.85	5.31	10.8	10.8	89.2	**70.6**
#40	0.425	6.09	12.4	23.2	76.8	**60.8**
#60	0.250	4.03	8.2	31.4	68.6	**54.3**
#140	0.106	8.67	17.6	49.0	51.0	**40.3**
#200	0.075	4.38	8.9	57.9	42.1	**33.3**
Pan	-	20.68	42.1	100.0	-	**-**

Notes :

Tested By SFS Date 9/14/2012 Checked By GEM Date 9-17-12

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-722s
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-1
Lab ID	2012-733-01-03	Soil Color	**DARK BROWN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	17.0	25.0	4.60	12.4	25.0	0.01268	0.0329	**19.8**
5	13.0	25.0	4.60	8.4	16.9	0.01268	0.0213	**13.4**
15	11.0	25.0	4.60	6.4	12.9	0.01268	0.0125	**10.2**
30	10.0	25.0	4.60	5.4	10.9	0.01268	0.0089	**8.6**
60	9.0	25.0	4.60	4.4	8.9	0.01268	0.0063	**7.0**
250	7.0	25.4	4.42	2.6	5.2	0.01262	0.0031	**4.1**
1440	7.0	23.7	5.20	1.8	3.6	0.01287	0.0013	**2.9**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	49.16	Hygroscopic Moisture Factor	0.983
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	79.14
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/14/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

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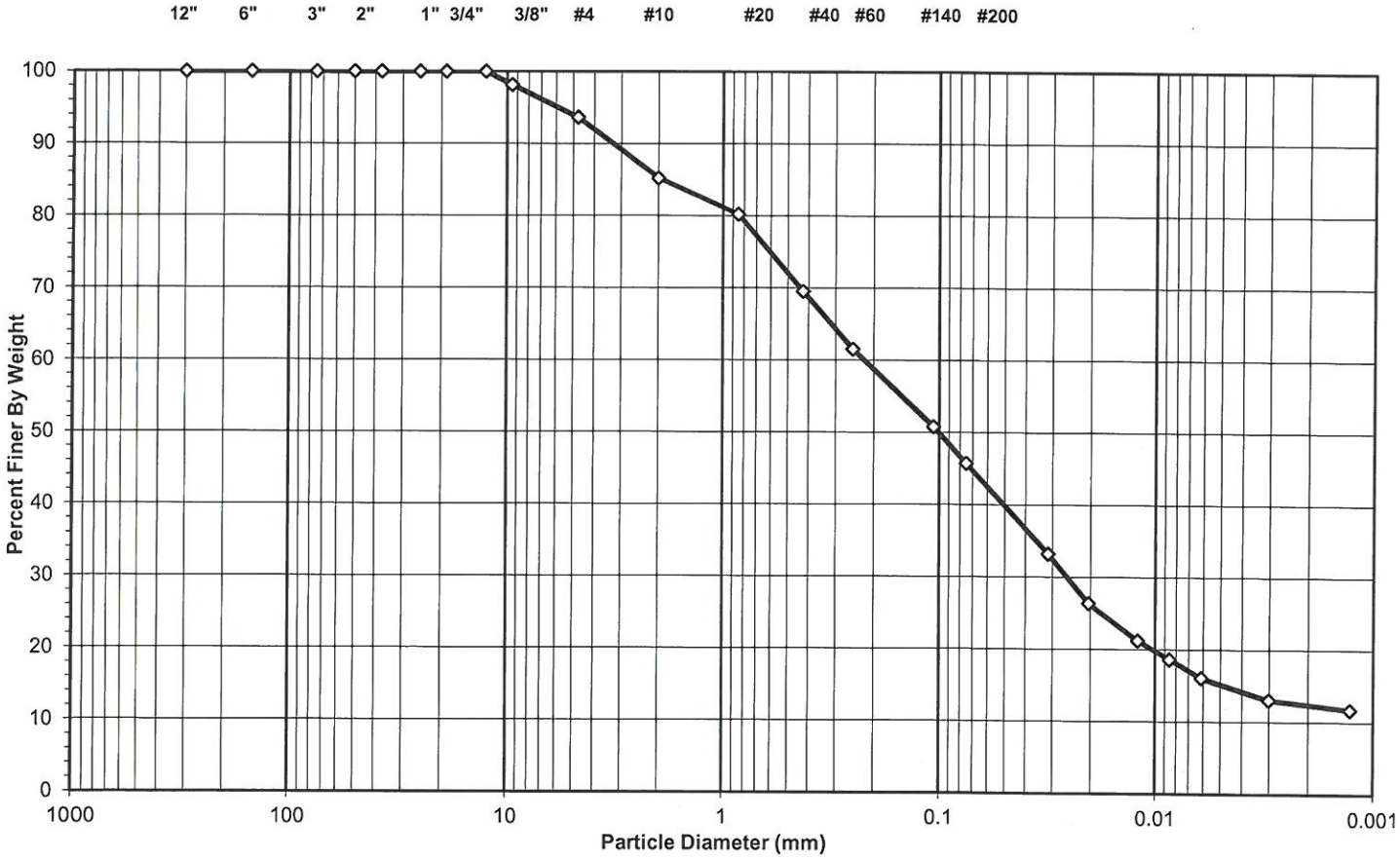
Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-2
Lab ID	2012-733-01-04	Soil Color	**REDDISH BROWN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	6.36
#4 To #200	*Sand*	47.91
Finer Than #200	*Silt & Clay*	45.73

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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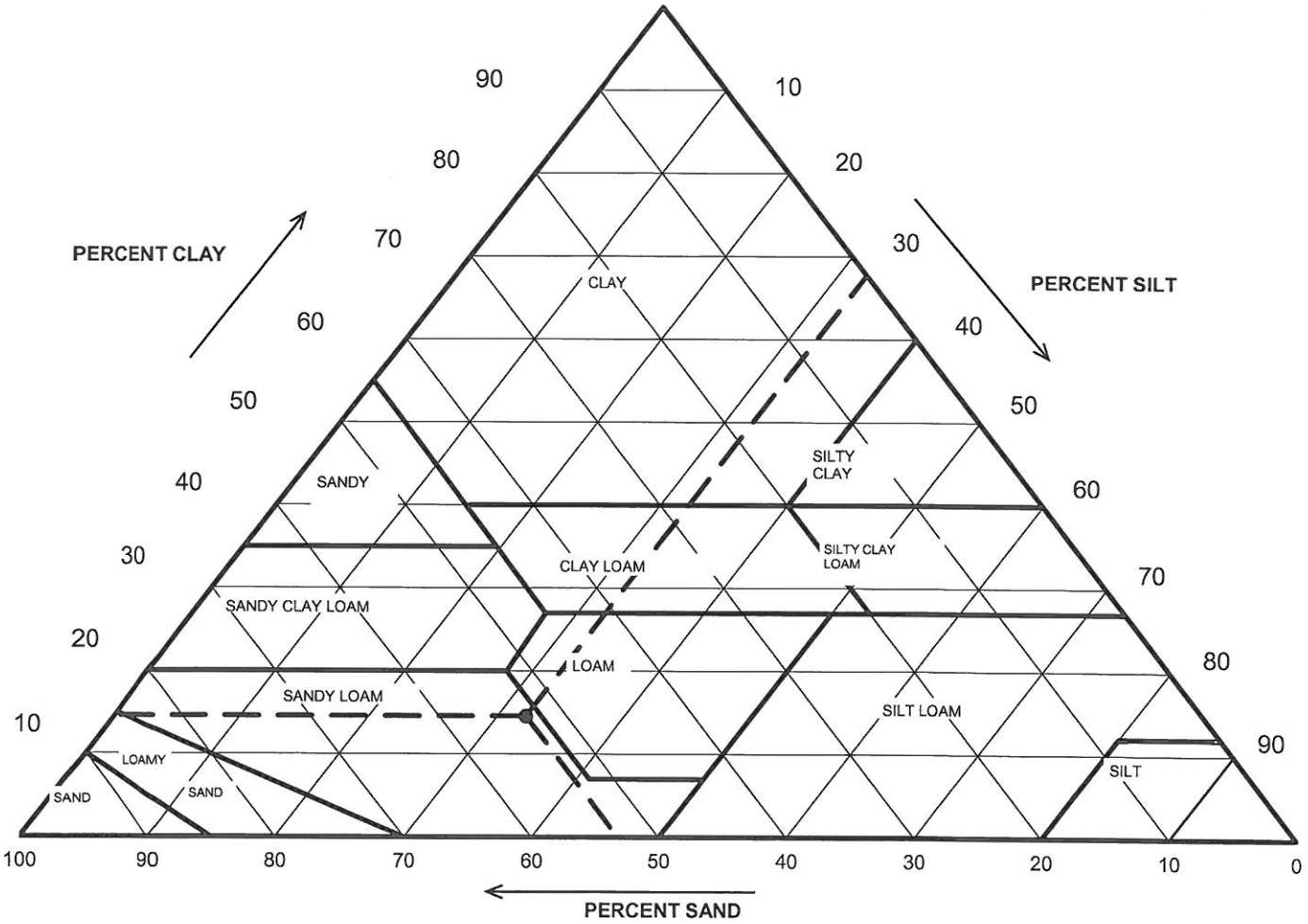
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-2
Lab ID	2012-733-01-04	Soil Color	REDDISH BROWN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	14.79	**0.00**
2	85.21	*Sand*	45.32	**53.19**
0.05	39.89	*Silt*	27.46	**32.23**
0.002	12.42	*Clay*	12.42	**14.58**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-2
Lab ID	2012-733-01-04	Soil Color	**REDDISH BROWN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	E-2	Air Dried - #10 Hydrometer Material (gm)	50.02
Wgt.Tare + Wet Soil (gm)	34.56	Corrected Dry Wt. of - #10 Material (gm)	49.23
Wgt.Tare + Dry Soil (gm)	34.36		
Weight of Tare (gm)	21.87	Weight of - #200 Material (gm)	26.42
Weight of Water (gm)	0.20	Weight of - #10 ; + #200 Material (gm)	22.81
Weight of Dry Soil (gm)	12.49		
Moisture Content (%)	**1.6**	**J-FACTOR (%FINER THAN #10)**	**0.8521**
Soil Specimen Data			
Tare No.	216		
Wgt.Tare + Air Dry Soil (gm)	570.84		
Weight of Tare (gm)	170.61		
Air Dried Wgt. Total Sample (gm)	400.23	Dry Weight of Material Retained on #10 (gm)	58.41
Total Dry Sample Weight (gm)	394.84	Corrected Dry Sample Wt - #10 (gm)	336.43

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"	12.5	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	7.39	1.9	1.9	98.1	**98.1**
#4	4.75	17.74	4.5	6.4	93.6	**93.6**
#10	2.00	33.28	8.4	14.8	85.2	**85.2**
#20	0.85	2.88	5.8	5.8	94.2	**80.2**
#40	0.425	6.17	12.5	18.4	81.6	**69.5**
#60	0.250	4.64	9.4	27.8	72.2	**61.5**
#140	0.106	6.19	12.6	40.4	59.6	**50.8**
#200	0.075	2.93	6.0	46.3	53.7	**45.7**
Pan	-	26.42	53.7	100.0	-	**-**

Notes :

Tested By SFS Date 9/15/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-2
Lab ID	2012-733-01-04	Soil Color	**REDDISH BROWN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	24.0	25.0	4.60	19.4	39.0	0.01268	0.0315	**33.2**
5	20.0	25.0	4.60	15.4	31.0	0.01268	0.0205	**26.4**
15	17.0	25.0	4.60	12.4	24.9	0.01268	0.0120	**21.2**
30	15.5	25.0	4.60	10.9	21.9	0.01268	0.0086	**18.7**
60	14.0	25.0	4.60	9.4	18.9	0.01268	0.0061	**16.1**
250	12.0	25.5	4.38	7.6	15.3	0.01260	0.0030	**13.1**
1440	12.0	23.8	5.15	6.8	13.8	0.01285	0.0013	**11.7**

Soil Specimen Data		**Other Corrections**	
Wgt. of Dry Material (gm)	49.23	Hygroscopic Moisture Factor	0.984
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	85.21
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/14/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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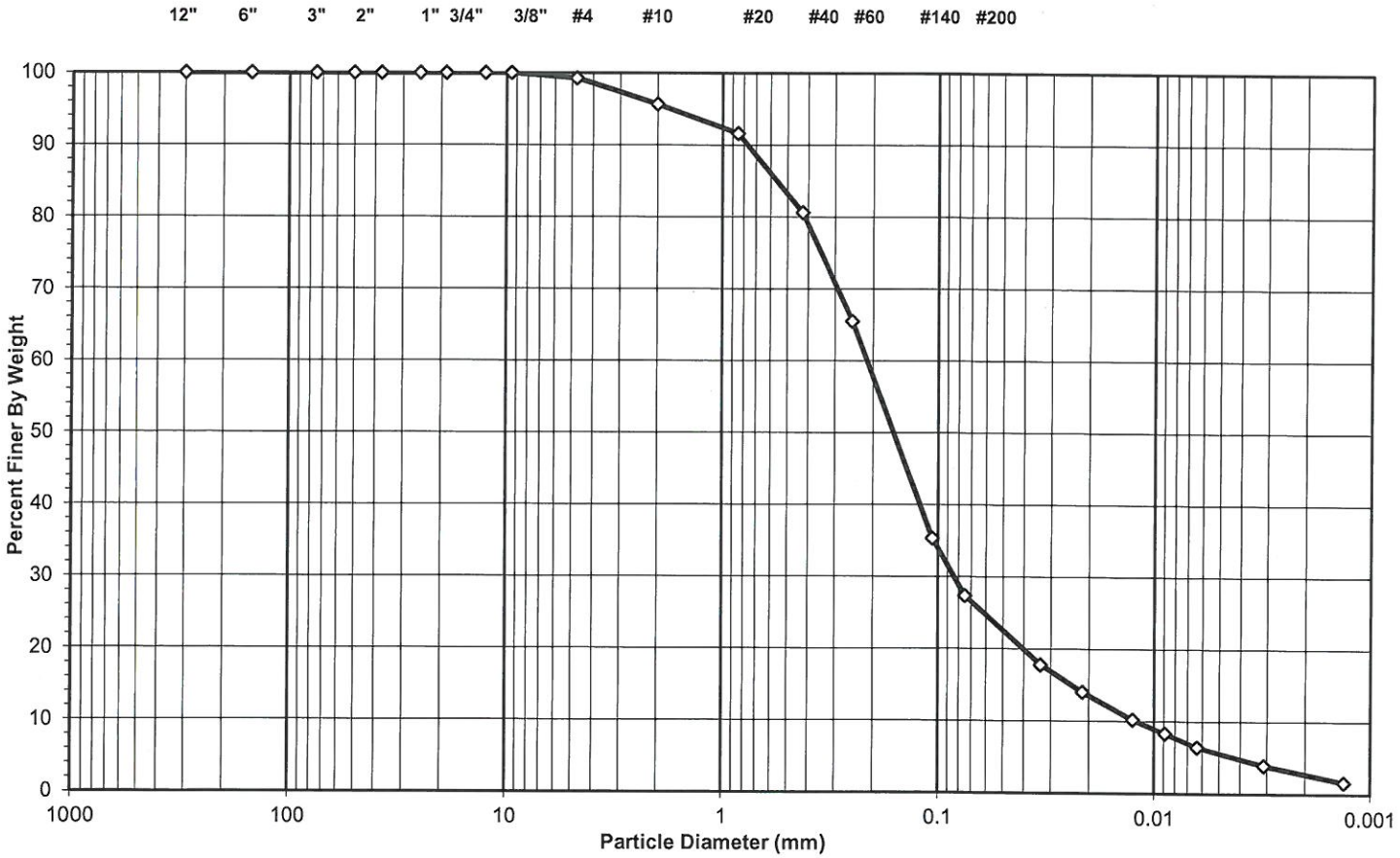
SIEVE AND HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	24-26
Project No.	2012-733-01	Sample No.	S-3
Lab ID	2012-733-01-05	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.73
#4 To #200	*Sand*	71.86
Finer Than #200	*Silt & Clay*	27.40

USCS Symbol ***SM, TESTED (NON PLASTIC FINES)***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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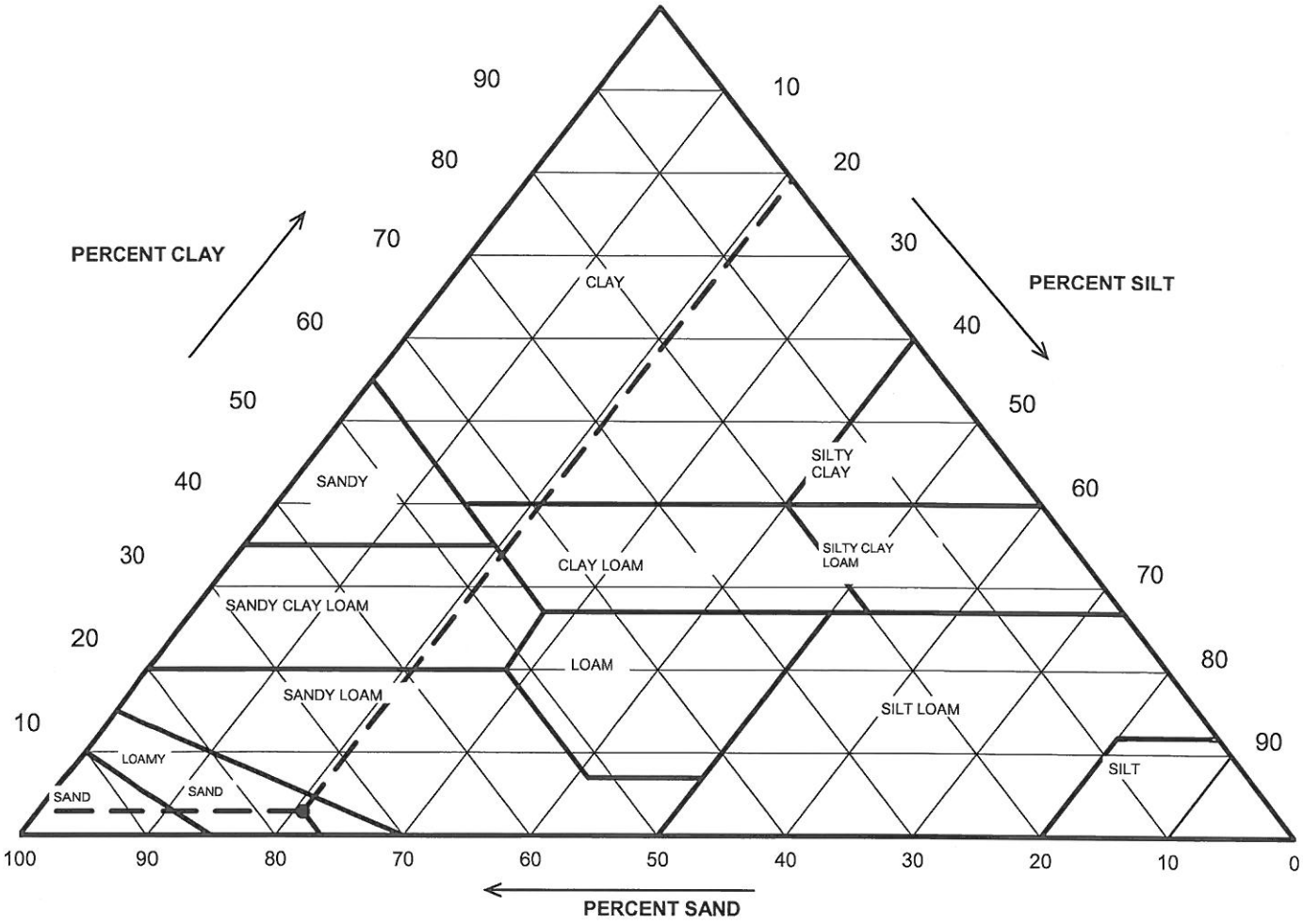
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	24-26
Project No.	2012-733-01	Sample No.	S-3
Lab ID	2012-733-01-05	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	4.34	**0.00**
2	95.66	*Sand*	73.07	**76.39**
0.05	22.59	*Silt*	19.85	**20.75**
0.002	2.73	*Clay*	2.73	**2.86**

USDA Classification: ***LOAMY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	24-26
Project No.	2012-733-01	Sample No.	S-3
Lab ID	2012-733-01-05	Soil Color	**GRAY**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	A-5	Air Dried - #10 Hydrometer Material (gm)	50.00
Wgt.Tare + Wet Soil (gm)	47.16	Corrected Dry Wt. of - #10 Material (gm)	49.86
Wgt.Tare + Dry Soil (gm)	47.09		
Weight of Tare (gm)	21.64	Weight of - #200 Material (gm)	14.28
Weight of Water (gm)	0.07	Weight of - #10 ; + #200 Material (gm)	35.58
Weight of Dry Soil (gm)	25.45		
Moisture Content (%)	**0.3**	**J-FACTOR (%FINER THAN #10)**	**0.9566**
Soil Specimen Data			
Tare No.	208		
Wgt.Tare + Air Dry Soil (gm)	685.67		
Weight of Tare (gm)	169.61		
Air Dried Wgt. Total Sample (gm)	516.06	Dry Weight of Material Retained on #10 (gm)	22.33
Total Dry Sample Weight (gm)	514.71	Corrected Dry Sample Wt - #10 (gm)	492.38

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"	12.5	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	3.78	0.7	0.7	99.3	**99.3**
#10	2.00	18.55	3.6	4.3	95.7	**95.7**
#20	0.85	2.12	4.3	4.3	95.7	**91.6**
#40	0.425	5.73	11.5	15.7	84.3	**80.6**
#60	0.250	7.86	15.8	31.5	68.5	**65.5**
#140	0.106	15.73	31.5	63.1	36.9	**35.3**
#200	0.075	4.14	8.3	71.4	28.6	**27.4**
Pan	-	14.28	28.6	100.0	-	**-**

Notes :

Tested By SFS Date 9/14/2012 Checked By GBM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	24-26
Project No.	2012-733-01	Sample No.	S-3
Lab ID	2012-733-01-05	Soil Color	**GRAY**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	14.0	25.0	4.60	9.4	18.7	0.01268	0.0335	**17.8**
5	12.0	25.0	4.60	7.4	14.7	0.01268	0.0215	**14.0**
15	10.0	25.0	4.60	5.4	10.7	0.01268	0.0125	**10.2**
30	9.0	25.0	4.60	4.4	8.7	0.01268	0.0089	**8.3**
60	8.0	25.0	4.60	3.4	6.7	0.01268	0.0063	**6.4**
250	6.5	25.4	4.42	2.1	4.1	0.01262	0.0031	**3.9**
1440	6.0	23.8	5.15	0.8	1.7	0.01285	0.0013	**1.6**

Soil Specimen Data		**Other Corrections**	
Wgt. of Dry Material (gm)	49.86	Hygroscopic Moisture Factor	0.997
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	95.66
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/13/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

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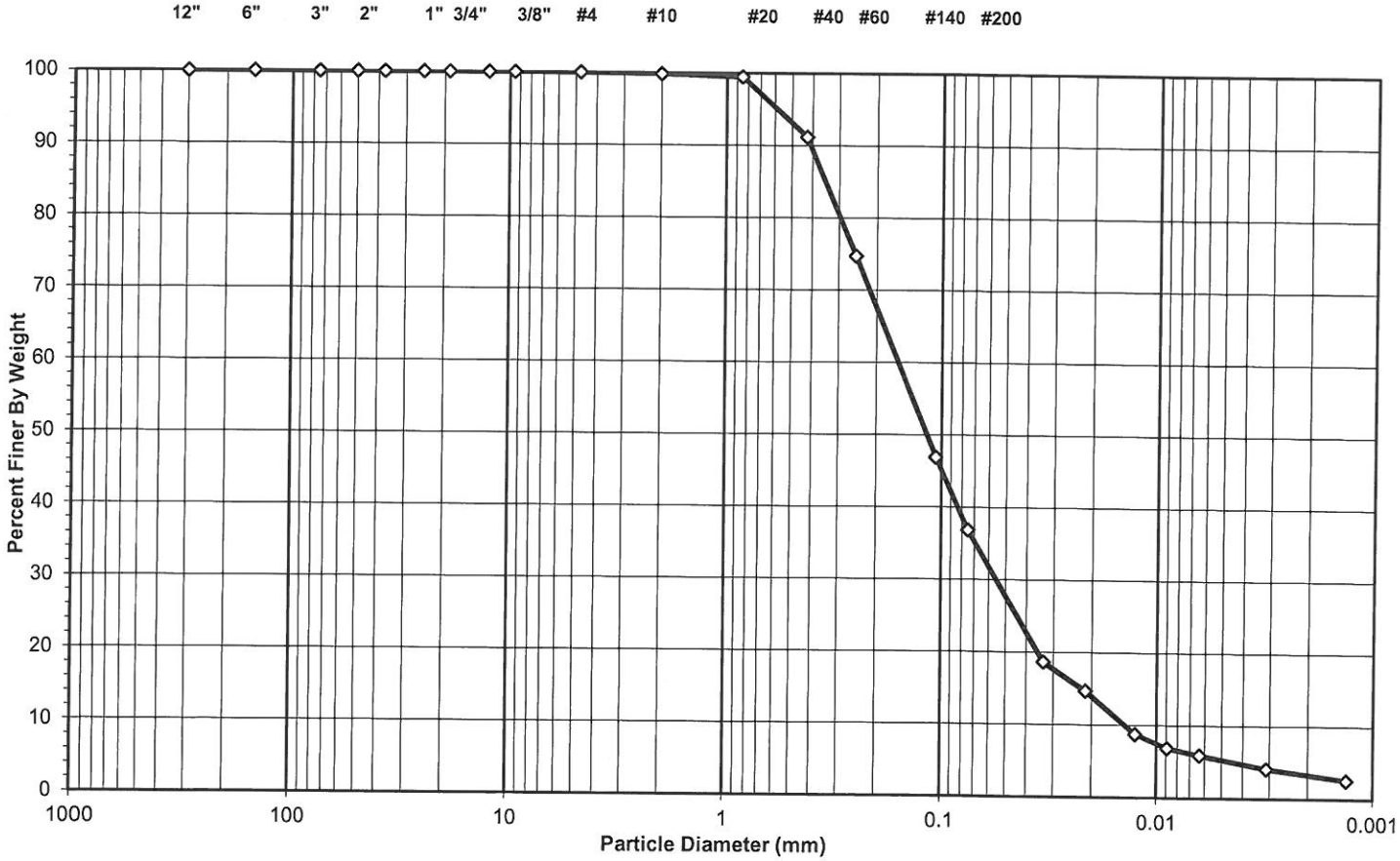
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	9-11
Project No.	2012-733-01	Sample No.	S-4
Lab ID	2012-733-01-06	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	63.14
Finer Than #200	*Silt & Clay*	36.86

USCS Symbol ***SM, TESTED (NON PLASTIC FINES)***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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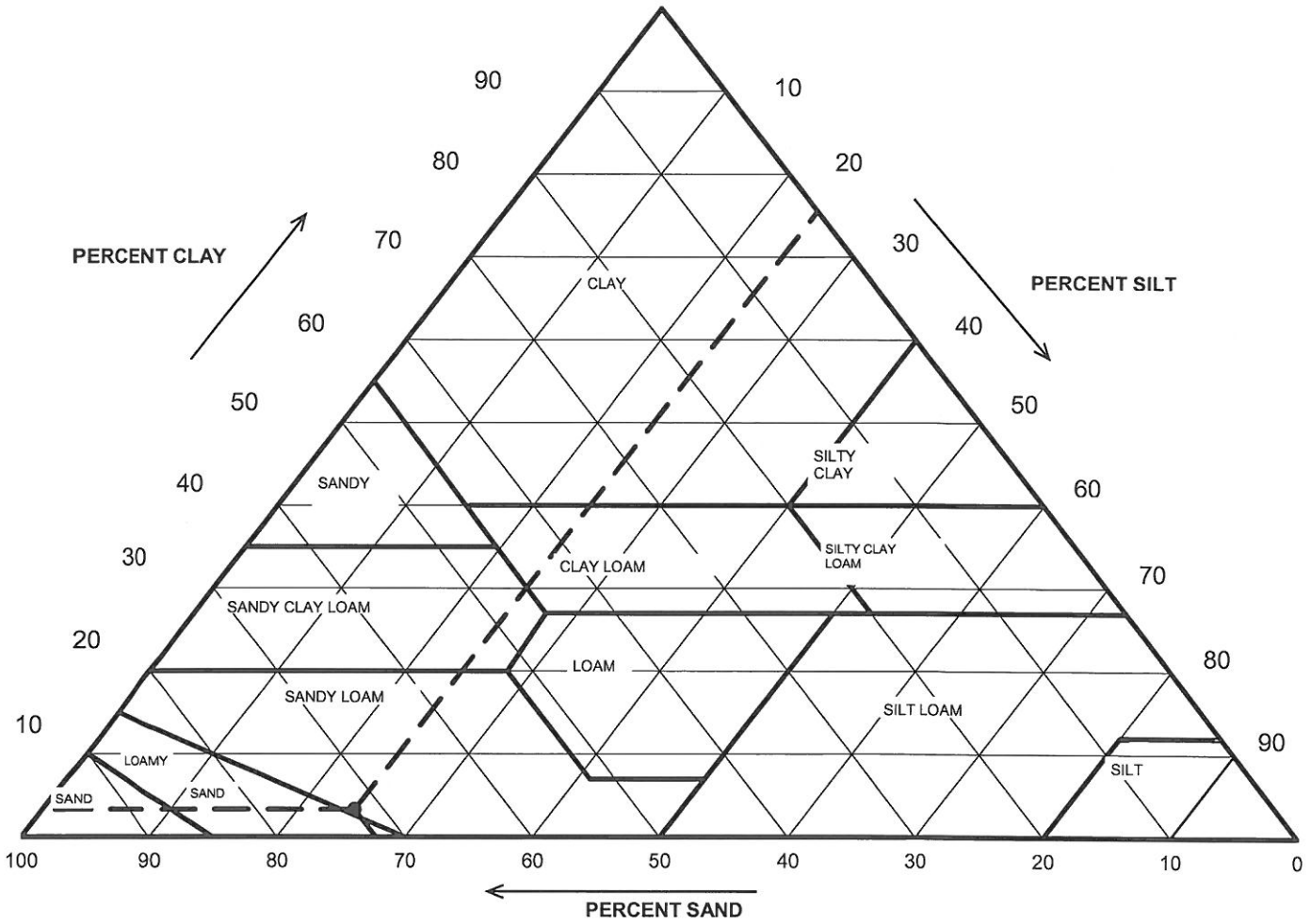
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	9-11
Project No.	2012-733-01	Sample No.	S-4
Lab ID	2012-733-01-06	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	0.16	**0.00**
2	99.84	*Sand*	72.13	**72.24**
0.05	27.72	*Silt*	24.40	**24.44**
0.002	3.32	*Clay*	3.32	**3.32**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	9-11
Project No.	2012-733-01	Sample No.	S-4
Lab ID	2012-733-01-06	Soil Color	**GRAY**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	R-1	Air Dried - #10 Hydrometer Material (gm)	50.00
Wgt.Tare + Wet Soil (gm)	45.28	Corrected Dry Wt. of - #10 Material (gm)	49.94
Wgt.Tare + Dry Soil (gm)	45.25		
Weight of Tare (gm)	21.98	Weight of - #200 Material (gm)	18.44
Weight of Water (gm)	0.03	Weight of - #10 ; + #200 Material (gm)	31.50
Weight of Dry Soil (gm)	23.27		
Moisture Content (%)	**0.1**	**J-FACTOR (%FINER THAN #10)**	**0.9984**
	Soil Specimen Data		
Tare No.	212		
Wgt.Tare + Air Dry Soil (gm)	578.29		
Weight of Tare (gm)	171.37		
Air Dried Wgt. Total Sample (gm)	406.92	Dry Weight of Material Retained on #10 (gm)	0.63
Total Dry Sample Weight (gm)	406.40	Corrected Dry Sample Wt - #10 (gm)	405.77

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"	12.5	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	0.63	0.2	0.2	99.8	**99.8**
#20	0.85	0.19	0.4	0.4	99.6	**99.5**
#40	0.425	4.14	8.3	8.7	91.3	**91.2**
#60	0.250	8.24	16.5	25.2	74.8	**74.7**
#140	0.106	13.91	27.9	53.0	47.0	**46.9**
#200	0.075	5.02	10.1	63.1	36.9	**36.9**
Pan	-	18.44	36.9	100.0	-	**-**

Notes :

Tested By SFS Date 9/14/2012 Checked By GZM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-726
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	9-11
Project No.	2012-733-01	Sample No.	S-4
Lab ID	2012-733-01-06	Soil Color	**GRAY**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	14.0	25.1	4.56	9.4	18.7	0.01266	0.0335	**18.7**
5	12.0	25.1	4.56	7.4	14.8	0.01266	0.0214	**14.7**
15	9.0	25.1	4.56	4.4	8.8	0.01266	0.0126	**8.8**
30	8.0	25.2	4.51	3.5	6.9	0.01265	0.0089	**6.9**
60	7.5	25.2	4.51	3.0	5.9	0.01265	0.0063	**5.9**
250	6.5	25.4	4.42	2.1	4.1	0.01262	0.0031	**4.1**
1440	6.5	23.7	5.20	1.3	2.6	0.01287	0.0013	**2.6**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	49.94	Hygroscopic Moisture Factor	0.999
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	99.84
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/13/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

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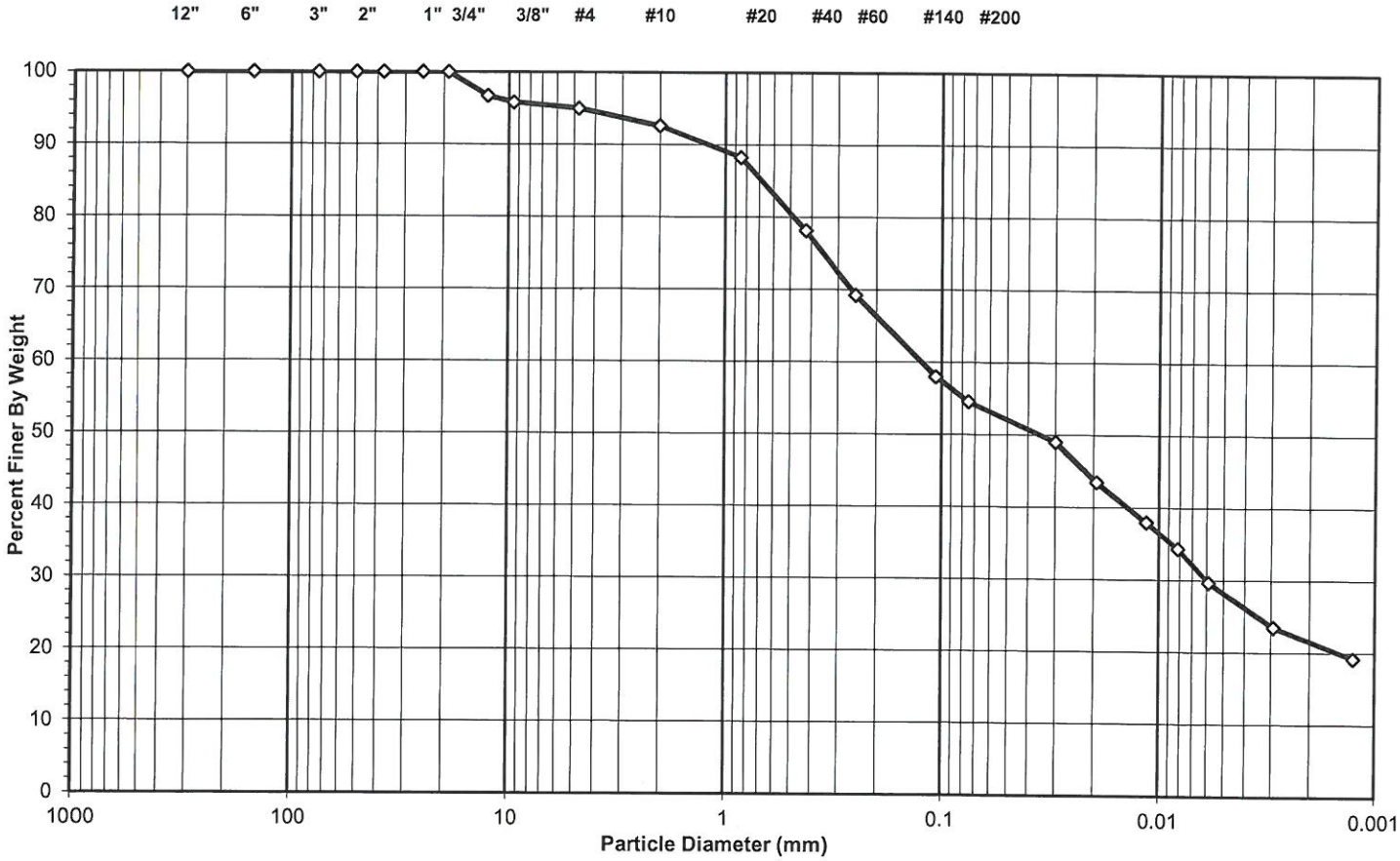
Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	5-7
Project No.	2012-733-01	Sample No.	S-5
Lab ID	2012-733-01-07	Soil Color	**BROWN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	5.01
#4 To #200	*Sand*	40.44
Finer Than #200	*Silt & Clay*	54.55

USCS Symbol ***CL, TESTED***

USCS Classification ***SANDY LEAN CLAY***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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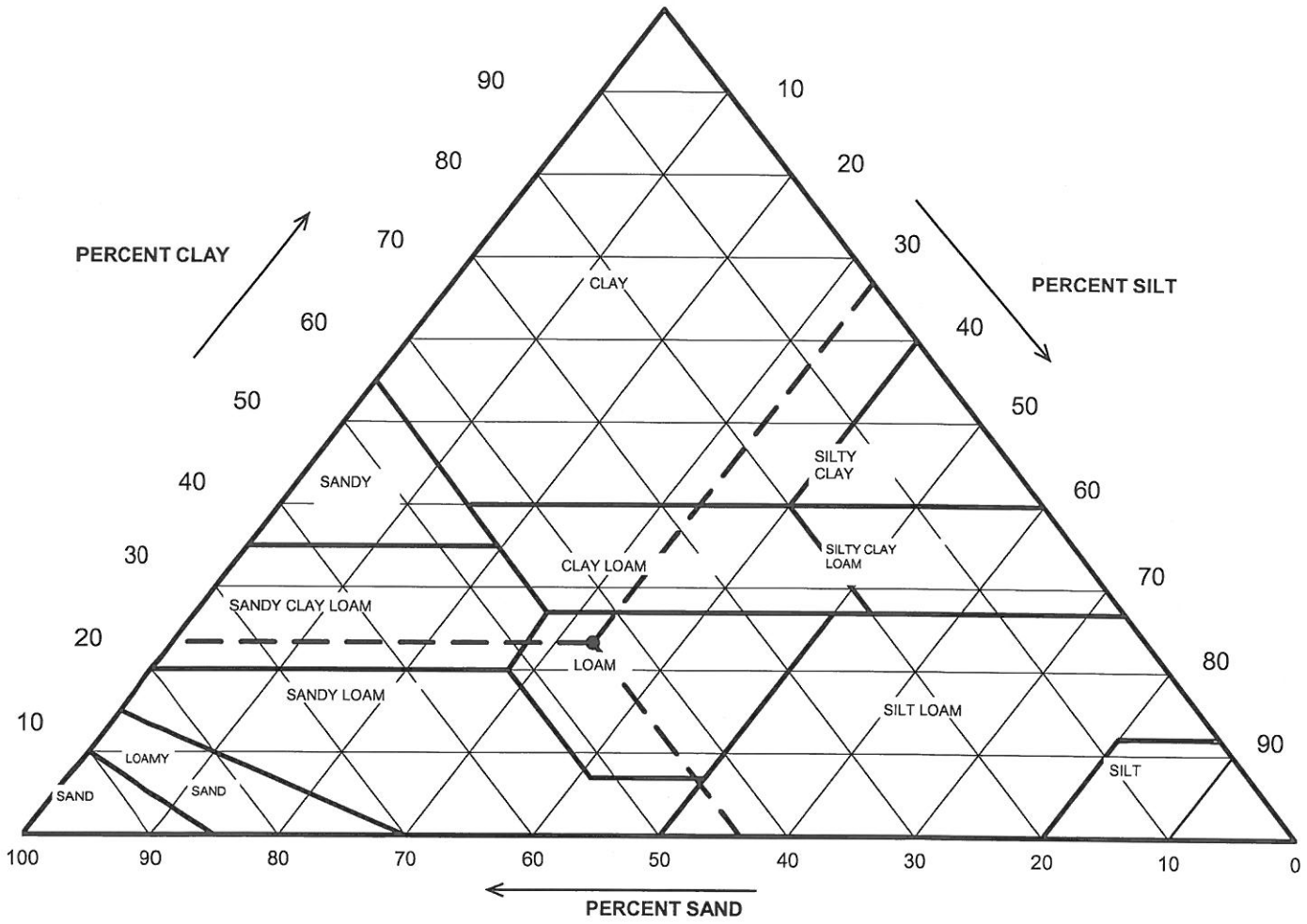
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	5-7
Project No.	2012-733-01	Sample No.	S-5
Lab ID	2012-733-01-07	Soil Color	BROWN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	7.41	**0.00**
2	92.59	*Sand*	40.48	**43.72**
0.05	52.11	*Silt*	30.51	**32.96**
0.002	21.60	*Clay*	21.60	**23.33**

USDA Classification: ***LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	5-7
Project No.	2012-733-01	Sample No.	S-5
Lab ID	2012-733-01-07	Soil Color	**BROWN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	V-1	Air Dried - #10 Hydrometer Material (gm)	50.00
Wgt.Tare + Wet Soil (gm)	35.18	Corrected Dry Wt. of - #10 Material (gm)	49.34
Wgt.Tare + Dry Soil (gm)	34.92		
Weight of Tare (gm)	15.61	Weight of - #200 Material (gm)	29.07
Weight of Water (gm)	0.26	Weight of - #10 ; + #200 Material (gm)	20.27
Weight of Dry Soil (gm)	19.31		
Moisture Content (%)	**1.3**	**J-FACTOR (%FINER THAN #10)**	**0.9259**
	Soil Specimen Data		
Tare No.	213		
Wgt.Tare + Air Dry Soil (gm)	491.66		
Weight of Tare (gm)	173.04		
Air Dried Wgt. Total Sample (gm)	318.62	Dry Weight of Material Retained on #10 (gm)	23.32
Total Dry Sample Weight (gm)	314.70	Corrected Dry Sample Wt - #10 (gm)	291.38

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"	12.5	10.38	3.3	3.3	96.7	**96.7**
3/8"	9.50	2.80	0.9	4.2	95.8	**95.8**
#4	4.75	2.58	0.8	5.0	95.0	**95.0**
#10	2.00	7.56	2.4	7.4	92.6	**92.6**
#20	0.85	2.32	4.7	4.7	95.3	**88.2**
#40	0.425	5.38	10.9	15.6	84.4	**78.1**
#60	0.250	4.75	9.6	25.2	74.8	**69.2**
#140	0.106	5.98	12.1	37.4	62.6	**58.0**
#200	0.075	1.84	3.7	41.1	58.9	**54.5**
Pan	-	29.07	58.9	100.0	-	**-**

Notes :

Tested By SFS Date 9/14/2012 Checked By GEM Date 9-17-12

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	5-7
Project No.	2012-733-01	Sample No.	S-5
Lab ID	2012-733-01-07	Soil Color	**BROWN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	31.0	25.0	4.60	26.4	53.0	0.01268	0.0300	**49.0**
5	28.0	25.0	4.60	23.4	46.9	0.01268	0.0194	**43.5**
15	25.0	25.1	4.56	20.4	41.0	0.01266	0.0114	**38.0**
30	23.0	25.2	4.51	18.5	37.1	0.01265	0.0082	**34.3**
60	20.5	25.2	4.51	16.0	32.1	0.01265	0.0059	**29.7**
250	17.0	25.6	4.33	12.7	25.4	0.01259	0.0029	**23.5**
1440	15.5	23.8	5.15	10.3	20.8	0.01285	0.0013	**19.2**

Soil Specimen Data		**Other Corrections**	
Wgt. of Dry Material (gm)	49.34	Hygroscopic Moisture Factor	0.987
Weight of Deflocculant (gm)	5.0		
		a - Factor	0.99
		Percent Finer than # 10	92.59
		Specific Gravity	2.70 Assumed

Notes:

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SIEVE AND HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

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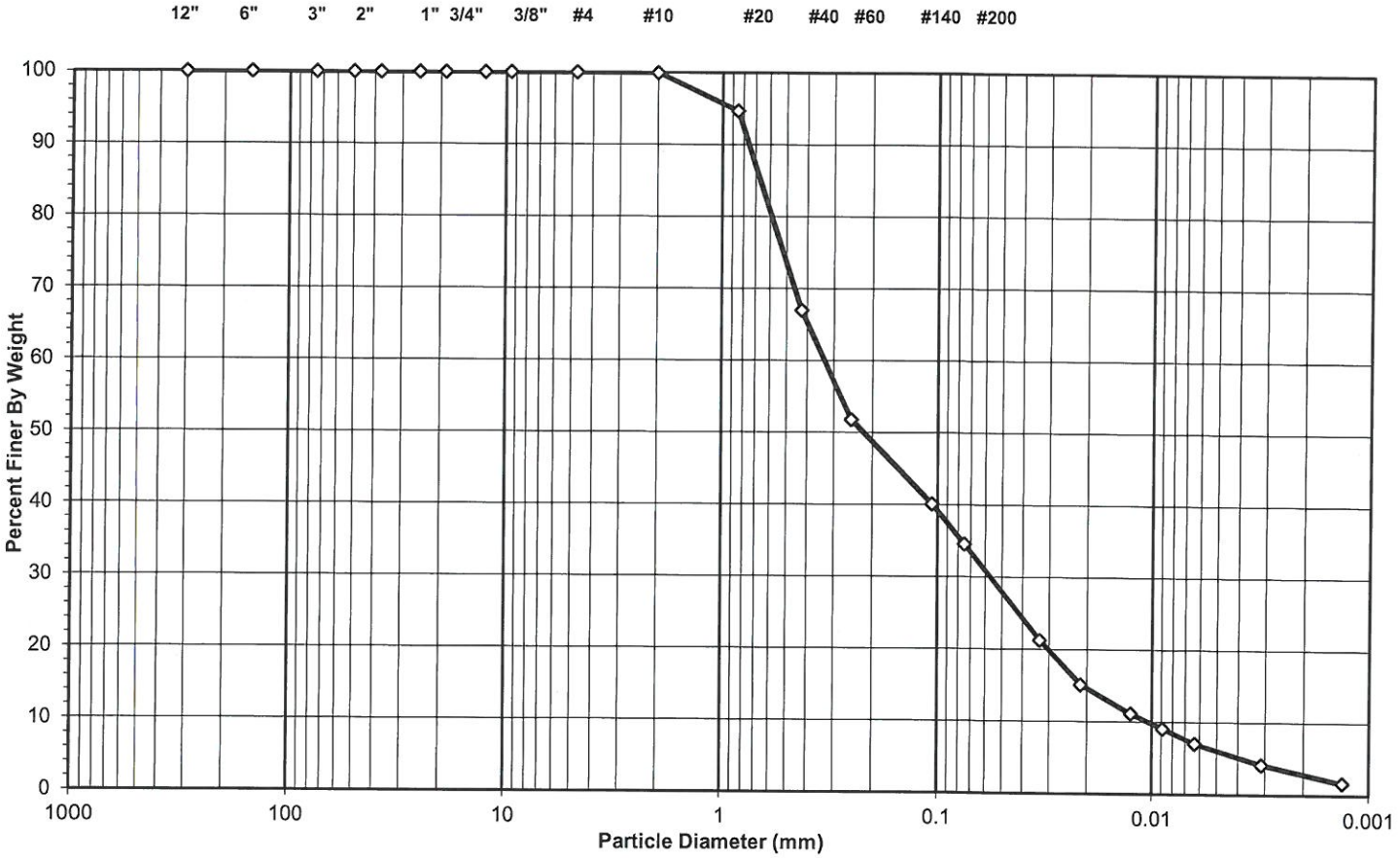
Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	40-42
Project No.	2012-733-01	Sample No.	S-6
Lab ID	2012-733-01-08	Soil Color	**BROWN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary		
Sieve Sizes (mm)		**Percentage**
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	65.42
Finer Than #200	*Silt & Clay*	34.58

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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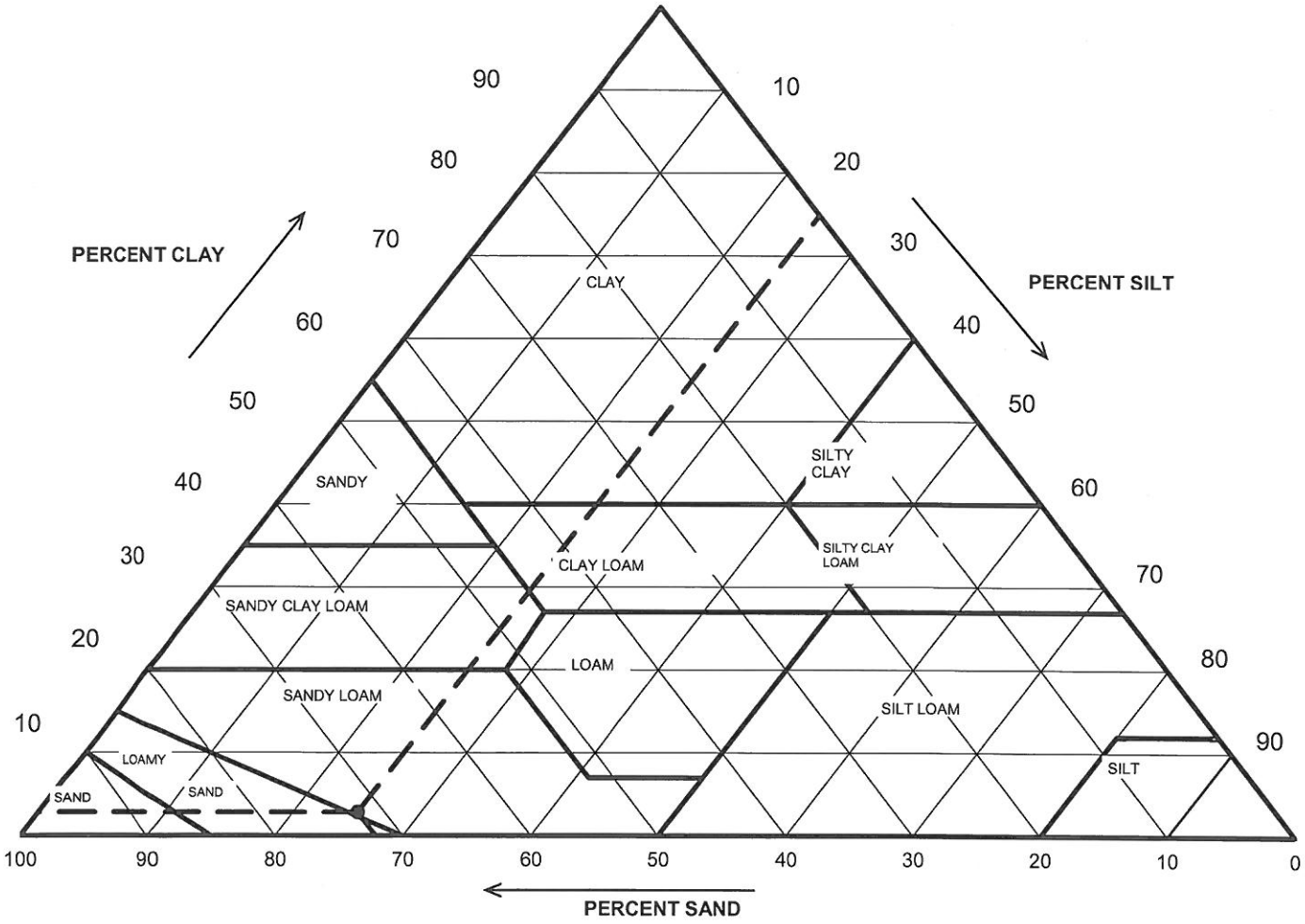
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	40-42
Project No.	2012-733-01	Sample No.	S-6
Lab ID	2012-733-01-08	Soil Color	BROWN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	0.03	**0.00**
2	99.97	*Sand*	72.04	**72.06**
0.05	27.93	*Silt*	25.08	**25.09**
0.002	2.85	*Clay*	2.85	**2.85**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	40-42
Project No.	2012-733-01	Sample No.	S-6
Lab ID	2012-733-01-08	Soil Color	**BROWN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	C-2	Air Dried - #10 Hydrometer Material (gm)	50.00
Wgt.Tare + Wet Soil (gm)	37.98	Corrected Dry Wt. of - #10 Material (gm)	48.32
Wgt.Tare + Dry Soil (gm)	37.44		
Weight of Tare (gm)	21.89	Weight of - #200 Material (gm)	16.71
Weight of Water (gm)	0.54	Weight of - #10 ; + #200 Material (gm)	31.61
Weight of Dry Soil (gm)	15.55		
Moisture Content (%)	**3.5**	**J-FACTOR (%FINER THAN #10)**	**0.9997**
Soil Specimen Data			
Tare No.	215		
Wgt.Tare + Air Dry Soil (gm)	653.60		
Weight of Tare (gm)	172.16		
Air Dried Wgt. Total Sample (gm)	481.44	Dry Weight of Material Retained on #10 (gm)	0.12
Total Dry Sample Weight (gm)	465.29	Corrected Dry Sample Wt - #10 (gm)	465.17

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"	12.5	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	0.12	0.0	0.0	100.0	**100.0**
#20	0.85	2.57	5.3	5.3	94.7	**94.7**
#40	0.425	13.38	27.7	33.0	67.0	**67.0**
#60	0.250	7.34	15.2	48.2	51.8	**51.8**
#140	0.106	5.65	11.7	59.9	40.1	**40.1**
#200	0.075	2.67	5.5	65.4	34.6	**34.6**
Pan	-	16.71	34.6	100.0	-	**-**

Notes :

Tested By SFS Date 9/14/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	40-42
Project No.	2012-733-01	Sample No.	S-6
Lab ID	2012-733-01-08	Soil Color	**BROWN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	15.0	25.0	4.60	10.4	21.3	0.01268	0.0333	**21.3**
5	12.0	25.0	4.60	7.4	15.2	0.01268	0.0215	**15.1**
15	10.0	25.1	4.56	5.4	11.1	0.01266	0.0125	**11.1**
30	9.0	25.1	4.56	4.4	9.1	0.01266	0.0089	**9.1**
60	8.0	25.1	4.56	3.4	7.1	0.01266	0.0063	**7.0**
250	6.5	25.3	4.47	2.0	4.2	0.01263	0.0031	**4.2**
1440	6.0	23.7	5.20	0.8	1.6	0.01287	0.0013	**1.6**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	48.32	Hygroscopic Moisture Factor	0.966
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	99.97
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/13/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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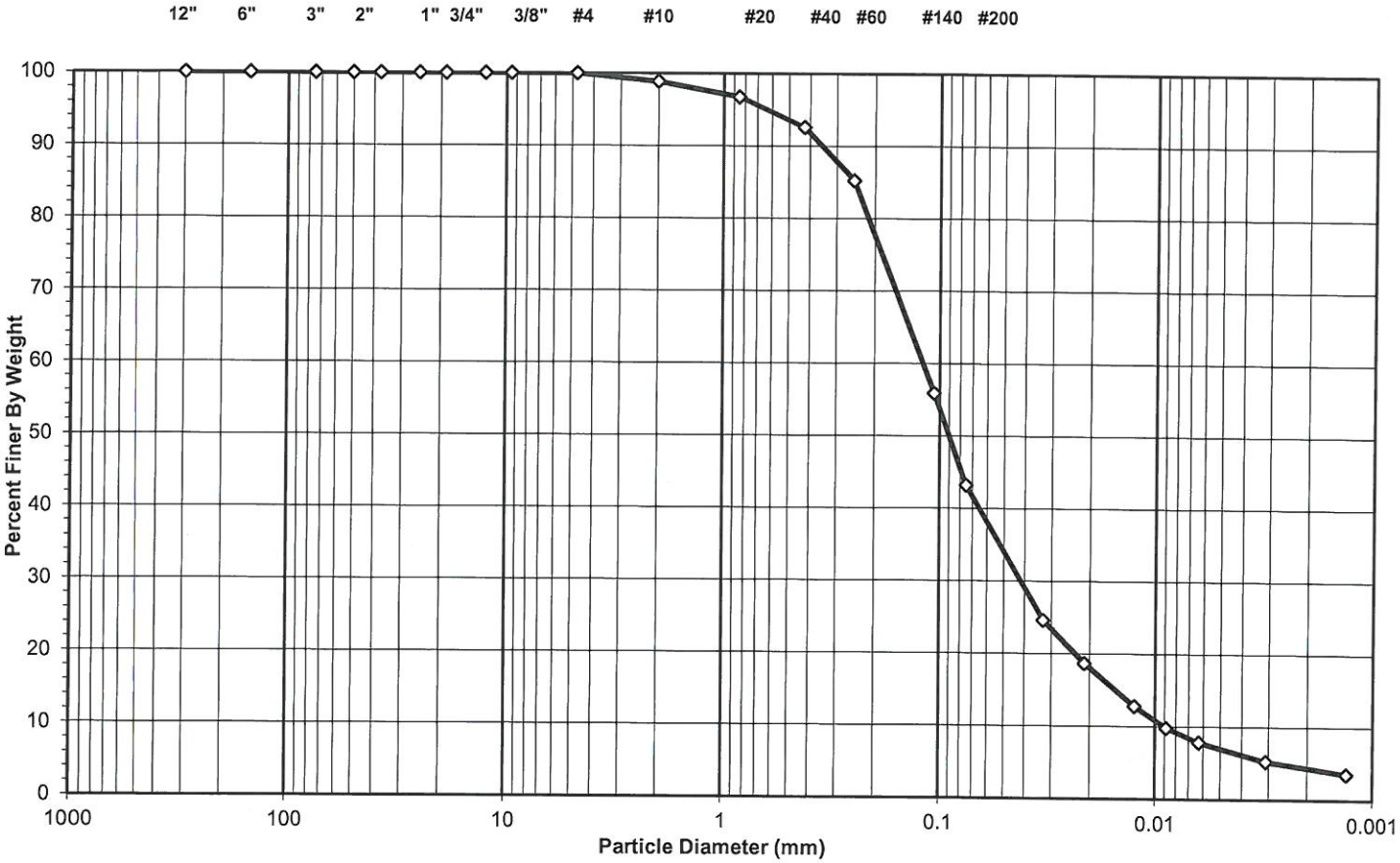
SIEVE AND HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-730
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-7
Lab ID	2012-733-01-09	Soil Color	**BROWN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	56.79
Finer Than #200	*Silt & Clay*	43.21

USCS Symbol ***SM, TESTED (NON PLASTIC FINES)***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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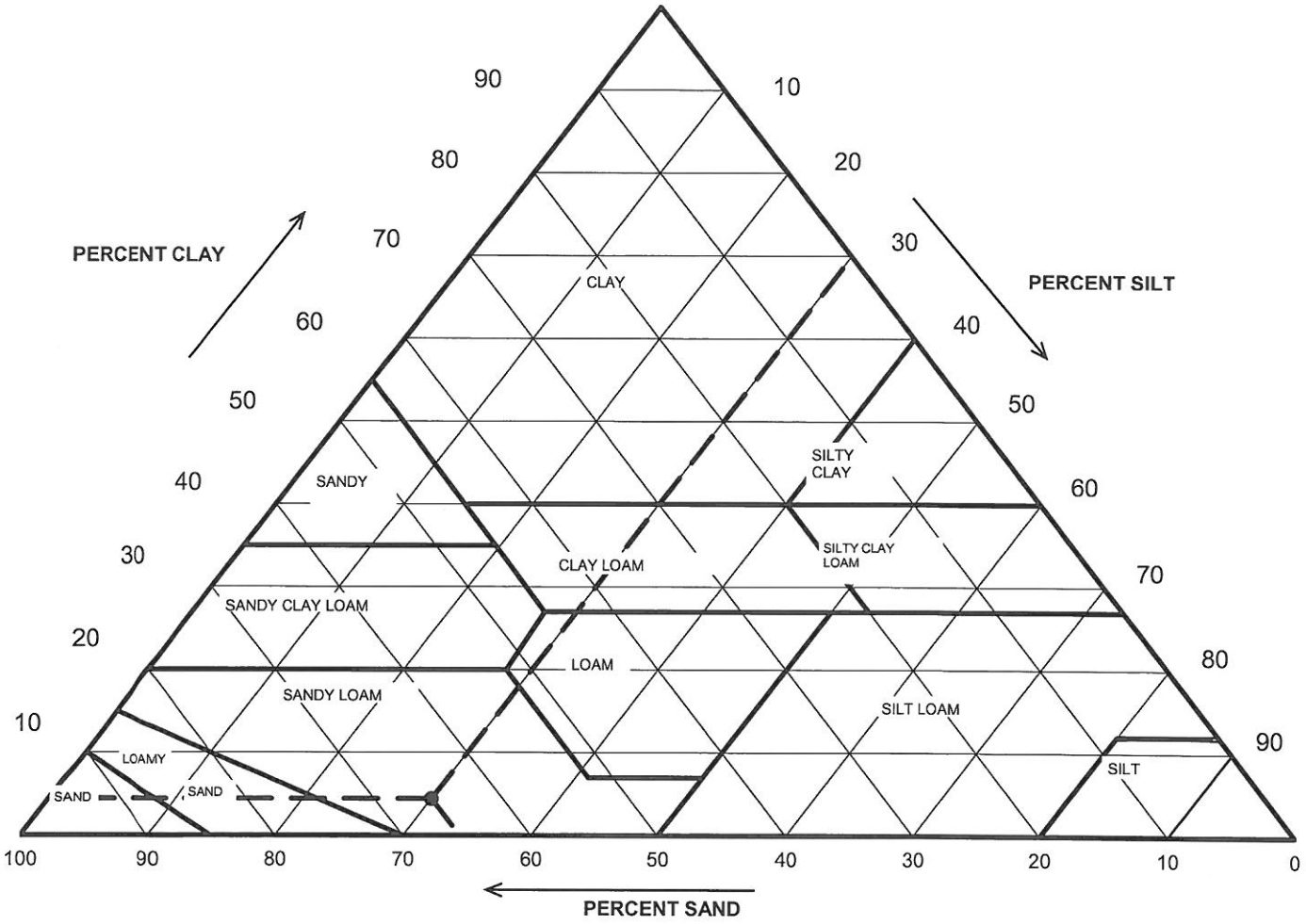
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-730
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-7
Lab ID	2012-733-01-09	Soil Color	BROWN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	1.13	**0.00**
2	98.87	*Sand*	64.80	**65.53**
0.05	34.08	*Silt*	29.69	**30.03**
0.002	4.39	*Clay*	4.39	**4.44**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-730
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-7
Lab ID	2012-733-01-09	Soil Color	**BROWN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	U-1	Air Dried - #10 Hydrometer Material (gm)	50.02
Wgt.Tare + Wet Soil (gm)	41.15	Corrected Dry Wt. of - #10 Material (gm)	49.63
Wgt.Tare + Dry Soil (gm)	41.00		
Weight of Tare (gm)	21.93	Weight of - #200 Material (gm)	21.69
Weight of Water (gm)	0.15	Weight of - #10 ; + #200 Material (gm)	27.94
Weight of Dry Soil (gm)	19.07		
Moisture Content (%)	**0.8**	**J-FACTOR (%FINER THAN #10)**	**0.9887**
Soil Specimen Data			
Tare No.	201		
Wgt.Tare + Air Dry Soil (gm)	455.38		
Weight of Tare (gm)	170.58		
Air Dried Wgt. Total Sample (gm)	284.80	Dry Weight of Material Retained on #10 (gm)	3.18
Total Dry Sample Weight (gm)	282.60	Corrected Dry Sample Wt - #10 (gm)	279.42

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"	12.5	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	3.18	1.1	1.1	98.9	**98.9**
#20	0.85	1.06	2.1	2.1	97.9	**96.8**
#40	0.425	2.09	4.2	6.3	93.7	**92.6**
#60	0.250	3.69	7.4	13.8	86.2	**85.2**
#140	0.106	14.72	29.7	43.4	56.6	**55.9**
#200	0.075	6.38	12.9	56.3	43.7	**43.2**
Pan	-	21.69	43.7	100.0	-	**-**

Notes :

Tested By SFS Date 9/15/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-730
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	14-16
Project No.	2012-733-01	Sample No.	S-7
Lab ID	2012-733-01-09	Soil Color	**BROWN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	17.0	25.2	4.51	12.5	24.9	0.01265	0.0329	**24.6**
5	14.0	25.2	4.51	9.5	18.9	0.01265	0.0212	**18.7**
15	11.0	25.2	4.51	6.5	12.9	0.01265	0.0124	**12.8**
30	9.5	25.2	4.51	5.0	9.9	0.01265	0.0089	**9.8**
60	8.5	25.2	4.51	4.0	8.0	0.01265	0.0063	**7.9**
250	7.0	25.6	4.33	2.7	5.3	0.01259	0.0031	**5.3**
1440	7.0	23.7	5.20	1.8	3.6	0.01287	0.0013	**3.6**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	49.63	Hygroscopic Moisture Factor	0.992
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	98.87
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/14/2012 Checked By GAM Date 9-17-12

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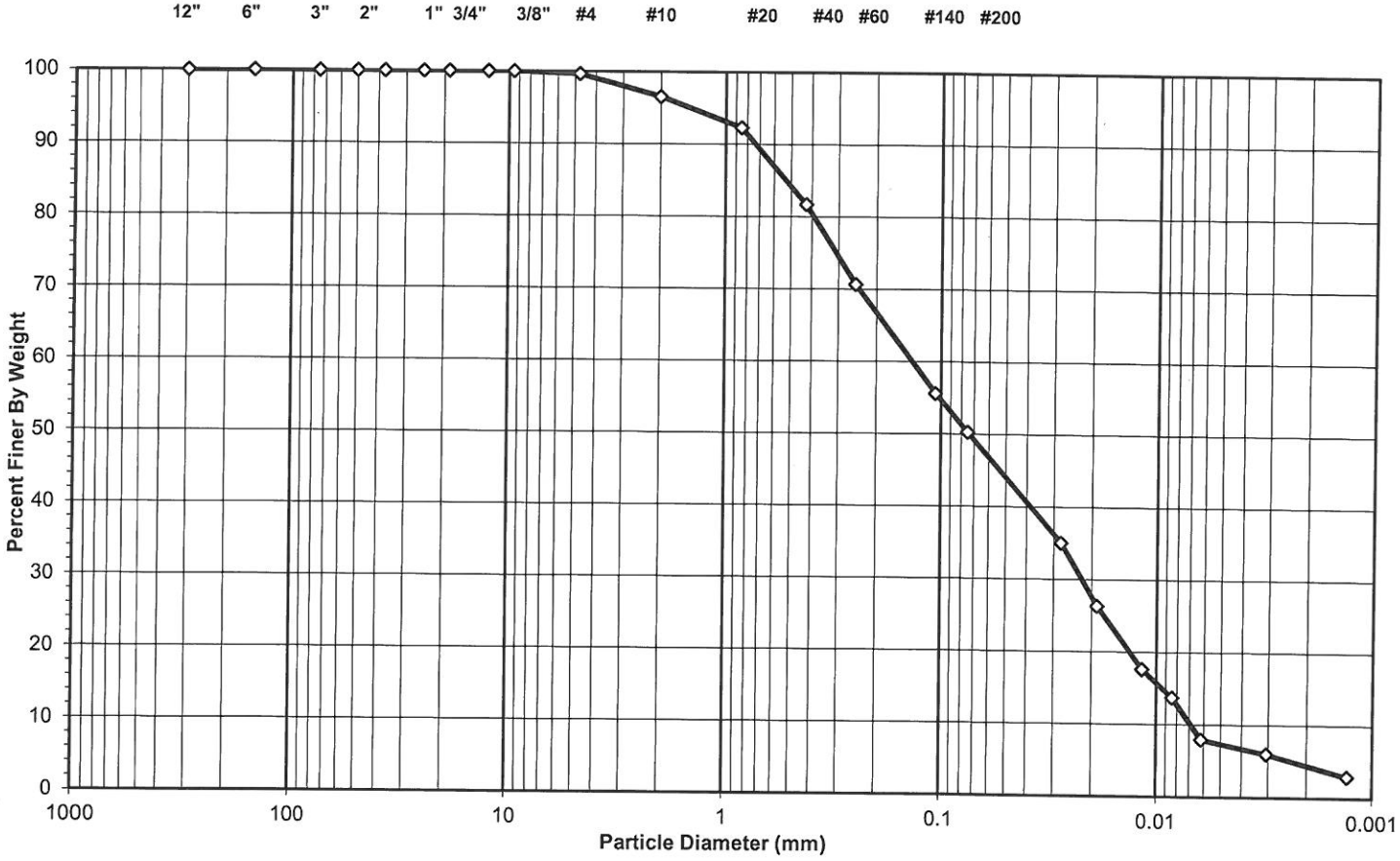
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-719
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	28-30
Project No.	2012-733-01	Sample No.	S-8
Lab ID	2012-733-01-10	Soil Color	**LIGHT BROWN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.36
#4 To #200	*Sand*	49.34
Finer Than #200	*Silt & Clay*	50.30

USCS Symbol ***ML, TESTED***

USCS Classification ***SANDY SILT***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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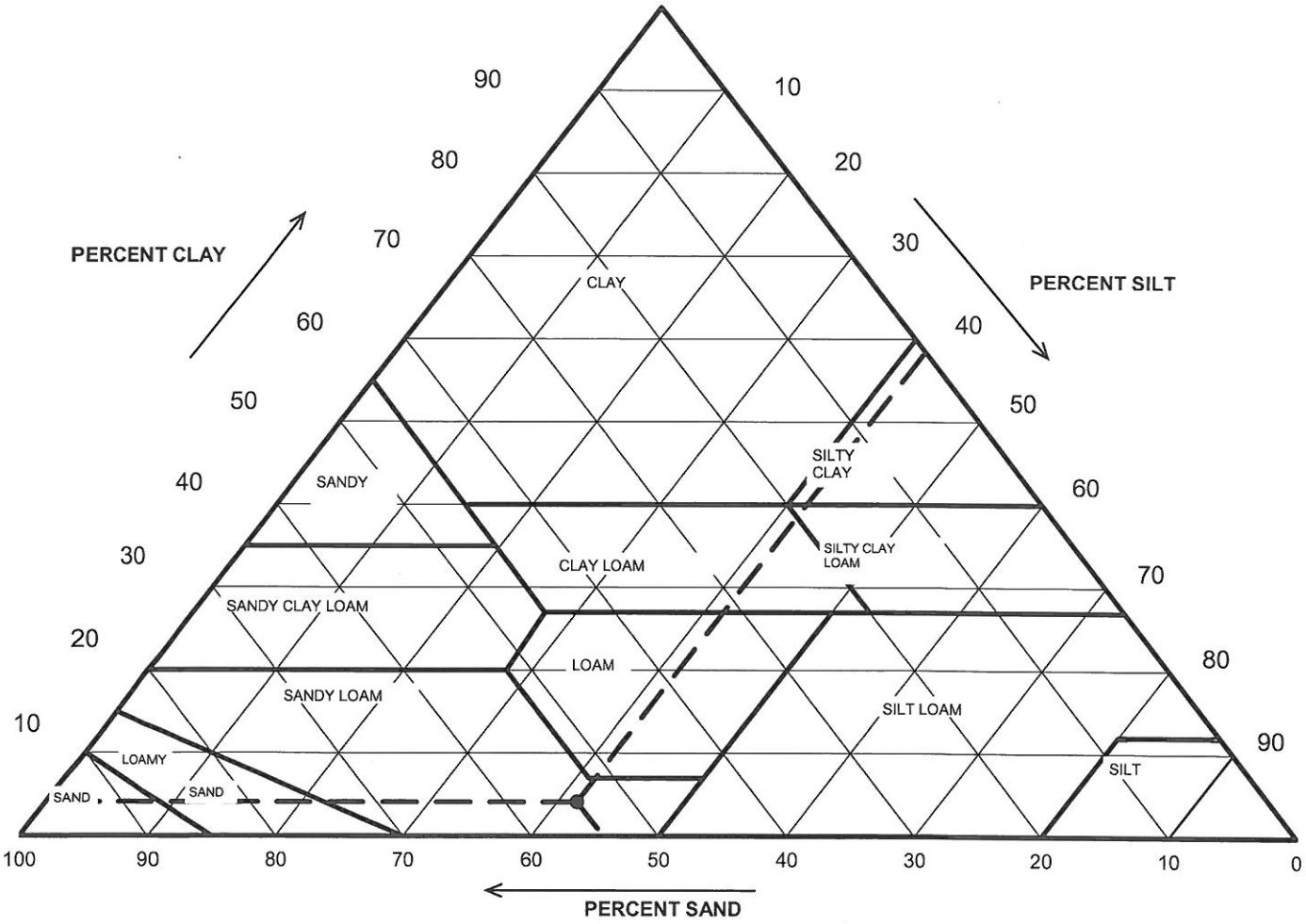
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-719
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	28-30
Project No.	2012-733-01	Sample No.	S-8
Lab ID	2012-733-01-10	Soil Color	LIGHT BROWN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	3.45	**0.00**
2	96.55	*Sand*	52.49	**54.37**
0.05	44.06	*Silt*	40.08	**41.51**
0.002	3.98	*Clay*	3.98	**4.13**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-719
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	28-30
Project No.	2012-733-01	Sample No.	S-8
Lab ID	2012-733-01-10	Soil Color	**LIGHT BROWN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	E-2	Air Dried - #10 Hydrometer Material (gm)	100.03
Wgt.Tare + Wet Soil (gm)	36.33	Corrected Dry Wt. of - #10 Material (gm)	98.72
Wgt.Tare + Dry Soil (gm)	36.14		
Weight of Tare (gm)	21.86	Weight of - #200 Material (gm)	51.43
Weight of Water (gm)	0.19	Weight of - #10 ; + #200 Material (gm)	47.29
Weight of Dry Soil (gm)	14.28		
Moisture Content (%)	**1.3**	**J-FACTOR (%FINER THAN #10)**	**0.9655**
	Soil Specimen Data		
Tare No.	209		
Wgt.Tare + Air Dry Soil (gm)	544.53		
Weight of Tare (gm)	171.56		
Air Dried Wgt. Total Sample (gm)	372.97	Dry Weight of Material Retained on #10 (gm)	12.70
Total Dry Sample Weight (gm)	368.24	Corrected Dry Sample Wt - #10 (gm)	355.54

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"	12.5	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	1.33	0.4	0.4	99.6	**99.6**
#10	2.00	11.37	3.1	3.4	96.6	**96.6**
#20	0.85	4.37	4.4	4.4	95.6	**92.3**
#40	0.425	10.83	11.0	15.4	84.6	**81.7**
#60	0.250	11.27	11.4	26.8	73.2	**70.7**
#140	0.106	15.39	15.6	42.4	57.6	**55.6**
#200	0.075	5.43	5.5	47.9	52.1	**50.3**
Pan	-	51.43	52.1	100.0	-	**-**

Notes :

Tested By SFS Date 9/11/2012 Checked By GEM Date 9-17-12

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-719
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	28-30
Project No.	2012-733-01	Sample No.	S-8
Lab ID	2012-733-01-10	Soil Color	**LIGHT BROWN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	41.0	24.6	4.79	36.2	36.3	0.01273	0.0279	**35.1**
5	32.0	24.6	4.79	27.2	27.3	0.01273	0.0189	**26.3**
15	23.0	24.6	4.79	18.2	18.3	0.01273	0.0116	**17.6**
30	19.0	24.6	4.79	14.2	14.3	0.01273	0.0084	**13.8**
60	13.0	24.6	4.79	8.2	8.2	0.01273	0.0062	**8.0**
250	11.0	24.6	4.79	6.2	6.2	0.01273	0.0031	**6.0**
1440	8.0	24.2	4.97	3.0	3.0	0.01279	0.0013	**2.9**

Soil Specimen Data		**Other Corrections**	
Wgt. of Dry Material (gm)	98.72	Hygroscopic Moisture Factor	0.987
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	96.55
		Specific Gravity	2.70 Assumed

Notes:

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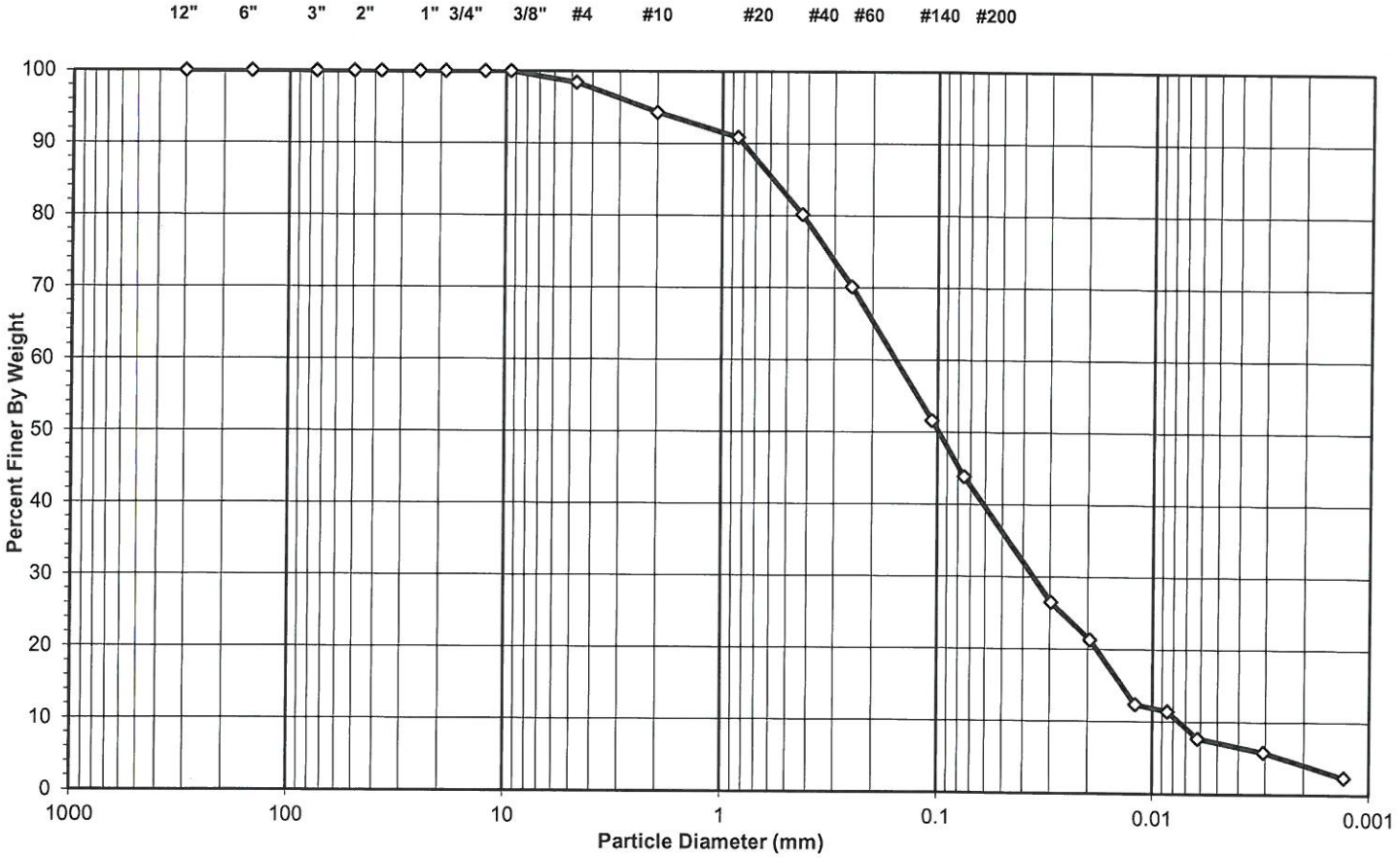
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-721
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	19-21
Project No.	2012-733-01	Sample No.	S-9
Lab ID	2012-733-01-11	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	1.58
#4 To #200	*Sand*	54.55
Finer Than #200	*Silt & Clay*	43.87

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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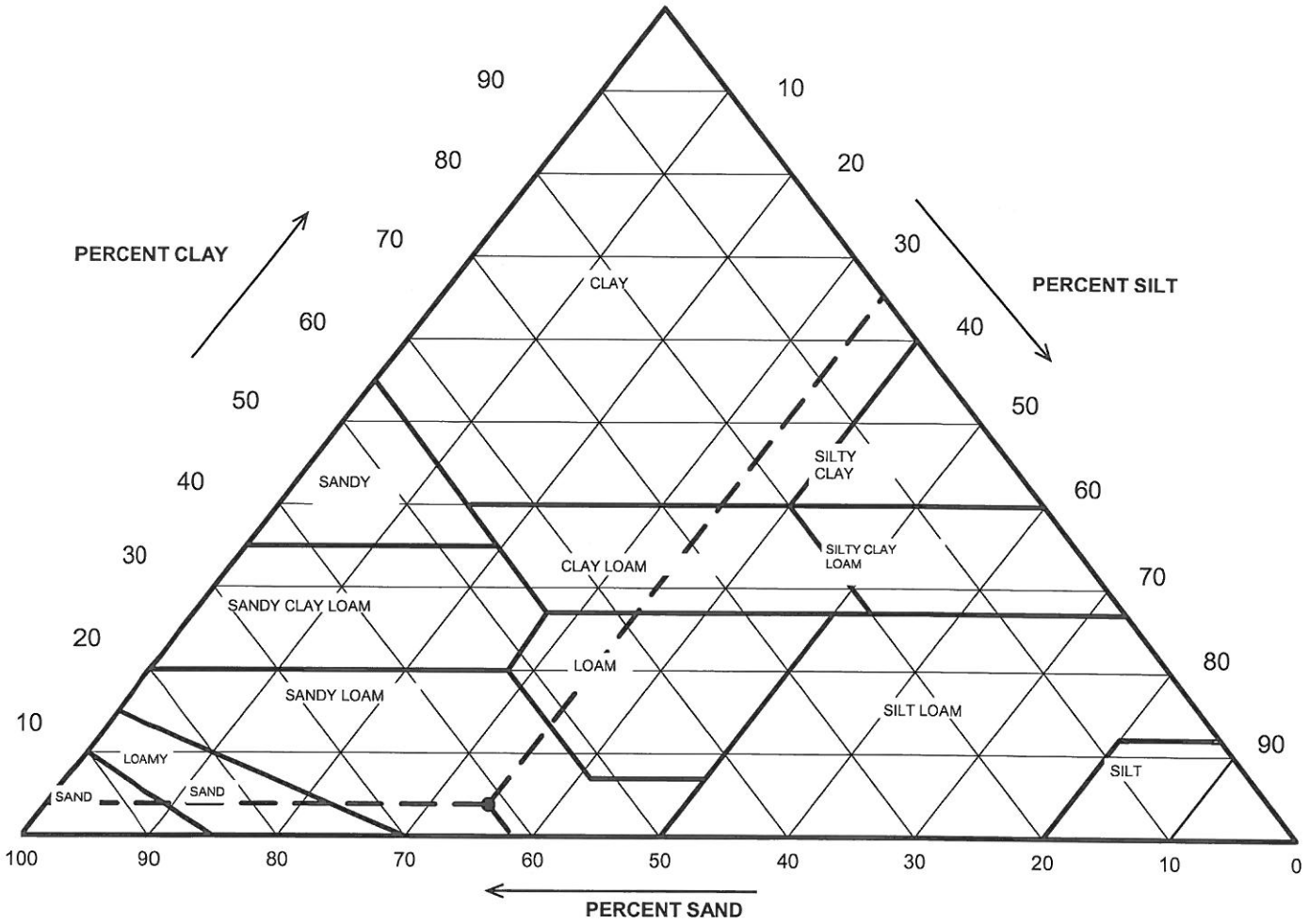
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-721
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	19-21
Project No.	2012-733-01	Sample No.	S-9
Lab ID	2012-733-01-11	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	5.71	**0.00**
2	94.29	*Sand*	58.02	**61.53**
0.05	36.27	*Silt*	32.65	**34.62**
0.002	3.62	*Clay*	3.62	**3.84**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-721
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	19-21
Project No.	2012-733-01	Sample No.	S-9
Lab ID	2012-733-01-11	Soil Color	**GRAY**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	P-1	Air Dried - #10 Hydrometer Material (gm)	100.00
Wgt.Tare + Wet Soil (gm)	47.99	Corrected Dry Wt. of - #10 Material (gm)	99.34
Wgt.Tare + Dry Soil (gm)	47.82		
Weight of Tare (gm)	22.05	Weight of - #200 Material (gm)	46.22
Weight of Water (gm)	0.17	Weight of - #10 ; + #200 Material (gm)	53.12
Weight of Dry Soil (gm)	25.77		
Moisture Content (%)	**0.7**	**J-FACTOR (%FINER THAN #10)**	**0.9429**
Soil Specimen Data			
Tare No.	250		
Wgt.Tare + Air Dry Soil (gm)	810.25		
Weight of Tare (gm)	169.29		
Air Dried Wgt. Total Sample (gm)	640.96	Dry Weight of Material Retained on #10 (gm)	36.37
Total Dry Sample Weight (gm)	637.00	Corrected Dry Sample Wt - #10 (gm)	600.63

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"	12.5	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	10.04	1.6	1.6	98.4	**98.4**
#10	2.00	26.33	4.1	5.7	94.3	**94.3**
#20	0.85	3.62	3.6	3.6	96.4	**90.9**
#40	0.425	11.23	11.3	14.9	85.1	**80.2**
#60	0.250	10.59	10.7	25.6	74.4	**70.1**
#140	0.106	19.50	19.6	45.2	54.8	**51.6**
#200	0.075	8.18	8.2	53.5	46.5	**43.9**
Pan	-	46.22	46.5	100.0	-	**-**

Notes :

Tested By SFS Date 9/11/2012 Checked By GAM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-721
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	19-21
Project No.	2012-733-01	Sample No.	S-9
Lab ID	2012-733-01-11	Soil Color	**GRAY**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	33.0	24.6	4.79	28.2	28.1	0.01273	0.0297	**26.5**
5	27.5	24.6	4.79	22.7	22.6	0.01273	0.0196	**21.3**
15	18.0	24.6	4.79	13.2	13.2	0.01273	0.0120	**12.4**
30	17.0	24.6	4.79	12.2	12.2	0.01273	0.0085	**11.5**
60	13.0	24.6	4.79	8.2	8.2	0.01273	0.0062	**7.7**
250	11.0	24.6	4.79	6.2	6.2	0.01273	0.0031	**5.8**
1440	7.5	24.2	4.97	2.5	2.5	0.01279	0.0013	**2.4**

Soil Specimen Data		**Other Corrections**	
Wgt. of Dry Material (gm)	99.34	Hygroscopic Moisture Factor	0.993
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	94.29
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/12/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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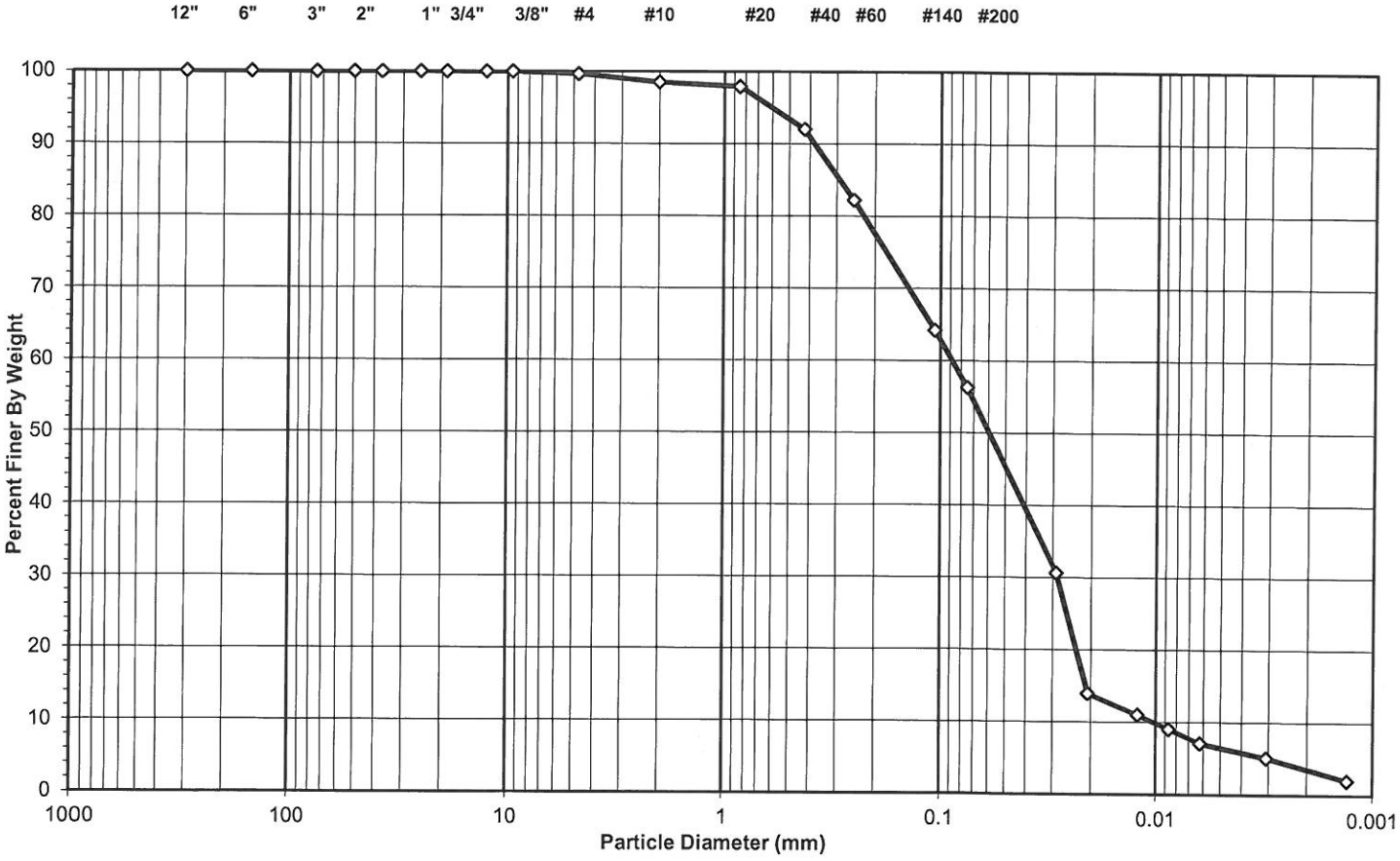
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-725
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-10
Lab ID	2012-733-01-12	Soil Color	**LIGHT BROWN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary		
Sieve Sizes (mm)		**Percentage**
Greater Than #4	*Gravel*	0.33
#4 To #200	*Sand*	43.38
Finer Than #200	*Silt & Clay*	56.28

USCS Symbol ***ML, TESTED***

USCS Classification ***SANDY SILT***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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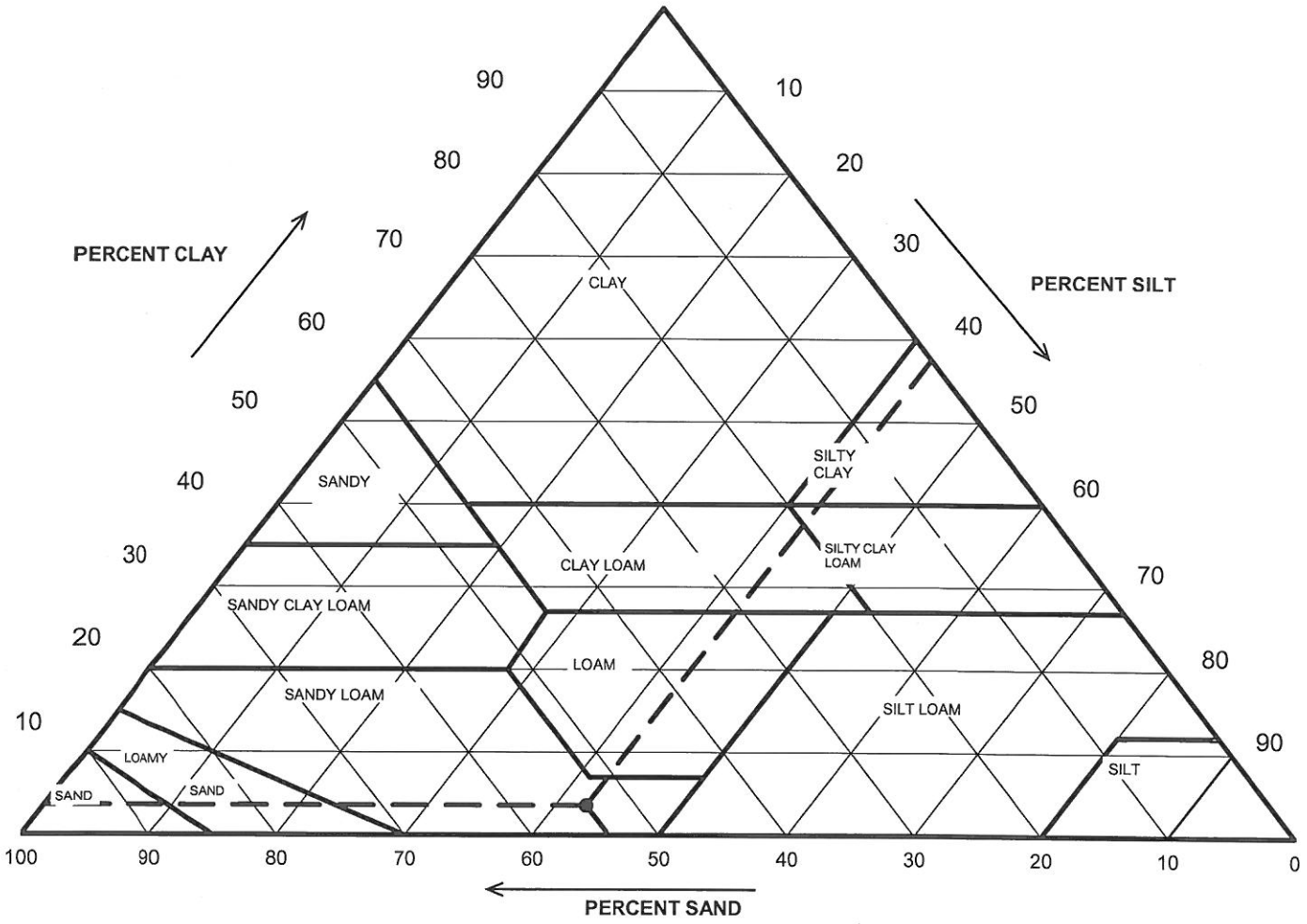
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-725
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-10
Lab ID	2012-733-01-12	Soil Color	LIGHT BROWN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	1.47	**0.00**
2	98.53	*Sand*	53.18	**53.97**
0.05	45.35	*Silt*	41.81	**42.43**
0.002	3.54	*Clay*	3.54	**3.59**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-725
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-10
Lab ID	2012-733-01-12	Soil Color	**LIGHT BROWN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	U-1	Air Dried - #10 Hydrometer Material (gm)	100.02
Wgt.Tare + Wet Soil (gm)	46.88	Corrected Dry Wt. of - #10 Material (gm)	99.22
Wgt.Tare + Dry Soil (gm)	46.68		
Weight of Tare (gm)	21.91	Weight of - #200 Material (gm)	56.68
Weight of Water (gm)	0.20	Weight of - #10 ; + #200 Material (gm)	42.54
Weight of Dry Soil (gm)	24.77		
Moisture Content (%)	**0.8**	**J-FACTOR (%FINER THAN #10)**	**0.9853**
	Soil Specimen Data		
Tare No.	210		
Wgt.Tare + Air Dry Soil (gm)	641.30		
Weight of Tare (gm)	172.69		
Air Dried Wgt. Total Sample (gm)	468.61	Dry Weight of Material Retained on #10 (gm)	6.85
Total Dry Sample Weight (gm)	464.91	Corrected Dry Sample Wt - #10 (gm)	458.06

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"	12.5	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	1.55	0.3	0.3	99.7	**99.7**
#10	2.00	5.30	1.1	1.5	98.5	**98.5**
#20	0.85	0.60	0.6	0.6	99.4	**97.9**
#40	0.425	5.94	6.0	6.6	93.4	**92.0**
#60	0.250	9.89	10.0	16.6	83.4	**82.2**
#140	0.106	18.14	18.3	34.8	65.2	**64.2**
#200	0.075	7.97	8.0	42.9	57.1	**56.3**
Pan	-	56.68	57.1	100.0	-	**-**

Notes :

Tested By SFS Date 9/11/2012 Checked By GEM Date 9-18-12

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-725
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	3-5
Project No.	2012-733-01	Sample No.	S-10
Lab ID	2012-733-01-12	Soil Color	**LIGHT BROWN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	36.0	24.6	4.79	31.2	31.1	0.01273	0.0290	**30.7**
5	19.0	24.6	4.79	14.2	14.2	0.01273	0.0207	**14.0**
15	16.0	24.6	4.79	11.2	11.2	0.01273	0.0122	**11.0**
30	14.0	24.6	4.79	9.2	9.2	0.01273	0.0087	**9.1**
60	12.0	24.6	4.79	7.2	7.2	0.01273	0.0062	**7.1**
250	10.0	24.6	4.79	5.2	5.2	0.01273	0.0031	**5.1**
1440	7.0	24.2	4.97	2.0	2.0	0.01279	0.0013	**2.0**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	99.22	Hygroscopic Moisture Factor	0.992
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	98.53
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/12/2012 Checked By GDM Date 9-18-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

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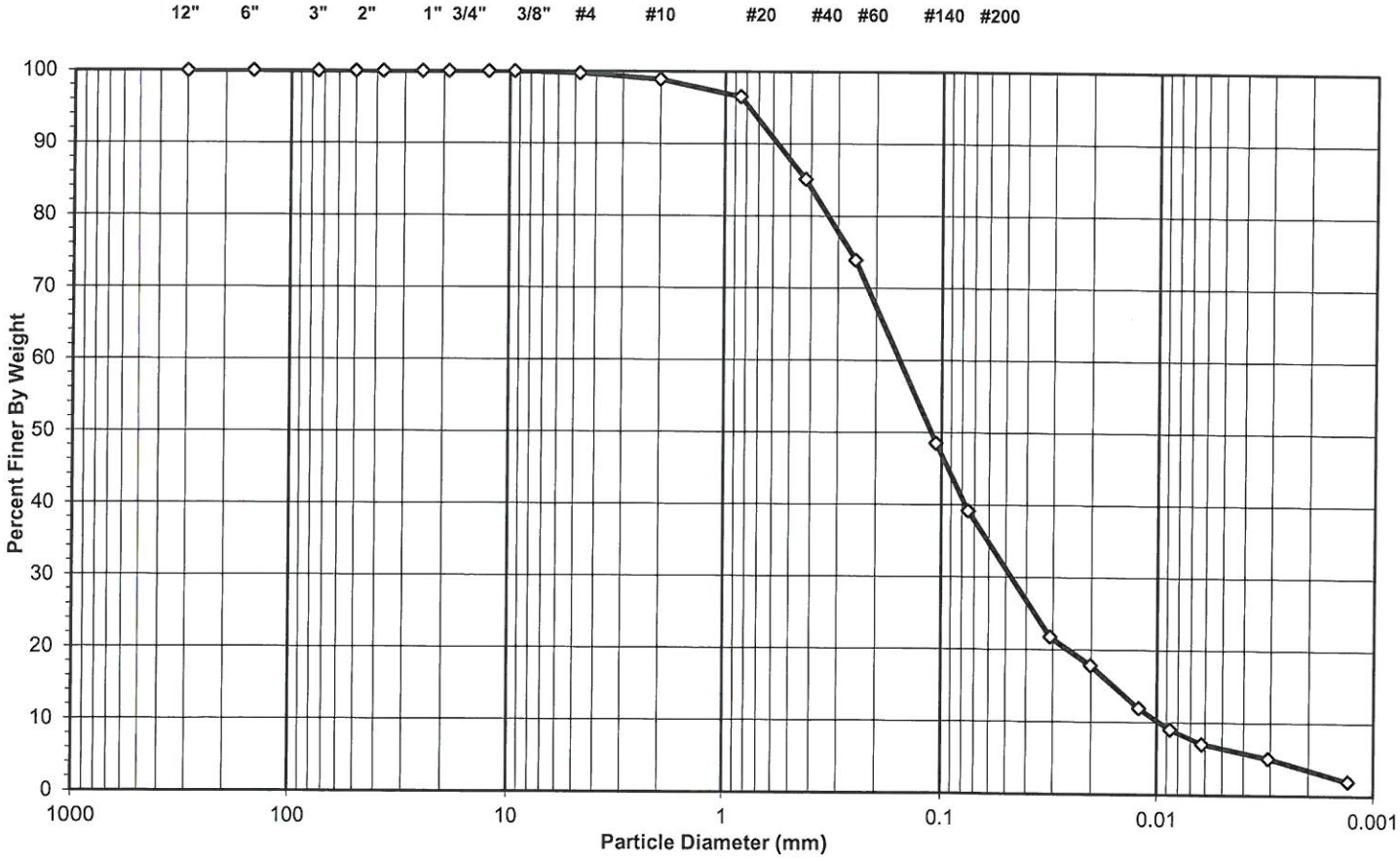
Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	4-6
Project No.	2012-733-01	Sample No.	S-11
Lab ID	2012-733-01-13	Soil Color	**TAN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	0.25
#4 To #200	*Sand*	60.56
Finer Than #200	*Silt & Clay*	39.18

USCS Symbol ***SM, TESTED (NON PLASTIC FINES)***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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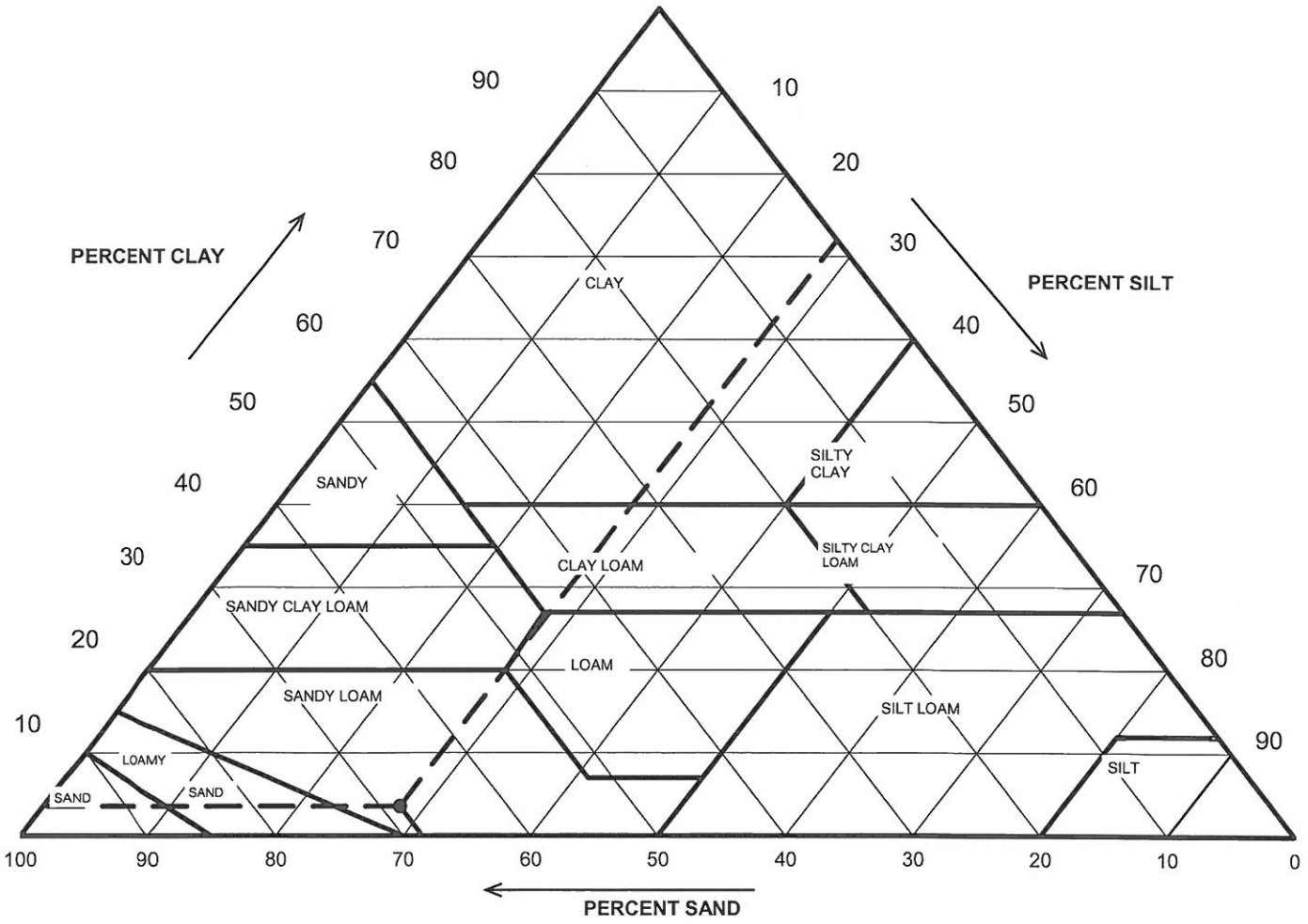
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	4-6
Project No.	2012-733-01	Sample No.	S-11
Lab ID	2012-733-01-13	Soil Color	TAN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	1.10	**0.00**
2	98.90	*Sand*	67.71	**68.46**
0.05	31.20	*Silt*	27.67	**27.97**
0.002	3.53	*Clay*	3.53	**3.57**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	4-6
Project No.	2012-733-01	Sample No.	S-11
Lab ID	2012-733-01-13	Soil Color	**TAN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	N-1	Air Dried - #10 Hydrometer Material (gm)	100.02
Wgt.Tare + Wet Soil (gm)	49.19	Corrected Dry Wt. of - #10 Material (gm)	99.80
Wgt.Tare + Dry Soil (gm)	49.13		
Weight of Tare (gm)	22.01	Weight of - #200 Material (gm)	39.54
Weight of Water (gm)	0.06	Weight of - #10 ; + #200 Material (gm)	60.26
Weight of Dry Soil (gm)	27.12		
Moisture Content (%)	**0.2**	**J-FACTOR (%FINER THAN #10)**	**0.9890**
	Soil Specimen Data		
Tare No.	211		
Wgt.Tare + Air Dry Soil (gm)	522.44		
Weight of Tare (gm)	171.06		
Air Dried Wgt. Total Sample (gm)	351.38	Dry Weight of Material Retained on #10 (gm)	3.84
Total Dry Sample Weight (gm)	350.61	Corrected Dry Sample Wt - #10 (gm)	346.77

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"	12.5	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	0.89	0.3	0.3	99.7	**99.7**
#10	2.00	2.95	0.8	1.1	98.9	**98.9**
#20	0.85	2.39	2.4	2.4	97.6	**96.5**
#40	0.425	11.54	11.6	14.0	86.0	**85.1**
#60	0.250	11.31	11.3	25.3	74.7	**73.9**
#140	0.106	25.57	25.6	50.9	49.1	**48.6**
#200	0.075	9.45	9.5	60.4	39.6	**39.2**
Pan	-	39.54	39.6	100.0	-	**-**

Notes :

Tested By SFS Date 9/11/2012 Checked By GEM Date 9-17-12

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-724
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	4-6
Project No.	2012-733-01	Sample No.	S-11
Lab ID	2012-733-01-13	Soil Color	**TAN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	27.0	24.6	4.79	22.2	22.0	0.01273	0.0310	**21.8**
5	23.0	24.6	4.79	18.2	18.1	0.01273	0.0202	**17.9**
15	17.0	24.6	4.79	12.2	12.1	0.01273	0.0121	**12.0**
30	14.0	24.6	4.79	9.2	9.1	0.01273	0.0087	**9.0**
60	12.0	24.6	4.79	7.2	7.2	0.01273	0.0062	**7.1**
250	10.0	24.6	4.79	5.2	5.2	0.01273	0.0031	**5.1**
1440	7.0	24.2	4.97	2.0	2.0	0.01279	0.0013	**2.0**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	99.80	Hygroscopic Moisture Factor	0.998
Weight of Deflocculant (gm)	5.0		
		a - Factor	0.99
		Percent Finer than # 10	98.90
		Specific Gravity	2.70 Assumed

Notes:

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

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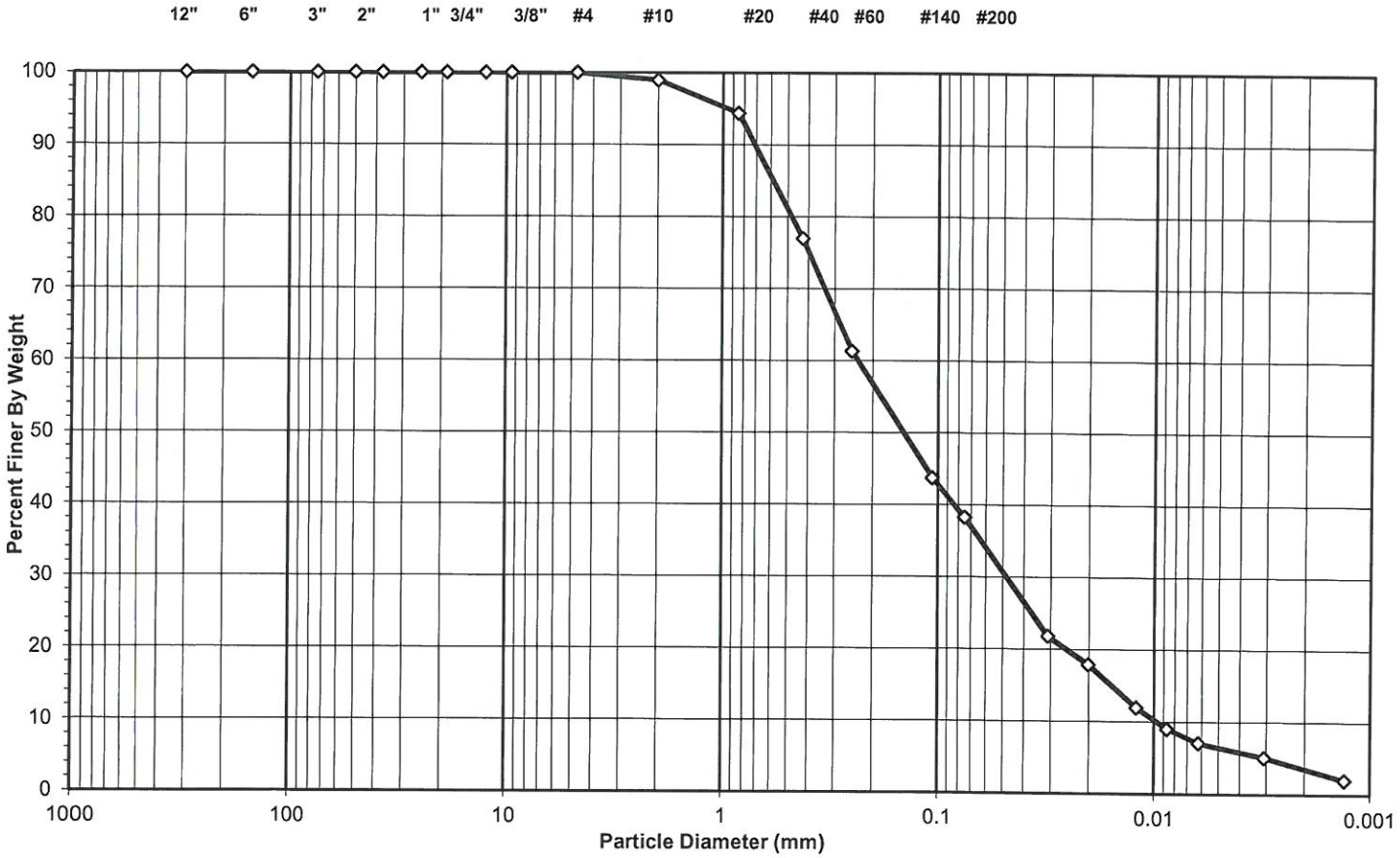
Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	30-32
Project No.	2012-733-01	Sample No.	S-12
Lab ID	2012-733-01-14	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	61.72
Finer Than #200	*Silt & Clay*	38.28

USCS Symbol ***SM, TESTED (NON PLASTIC FINES)***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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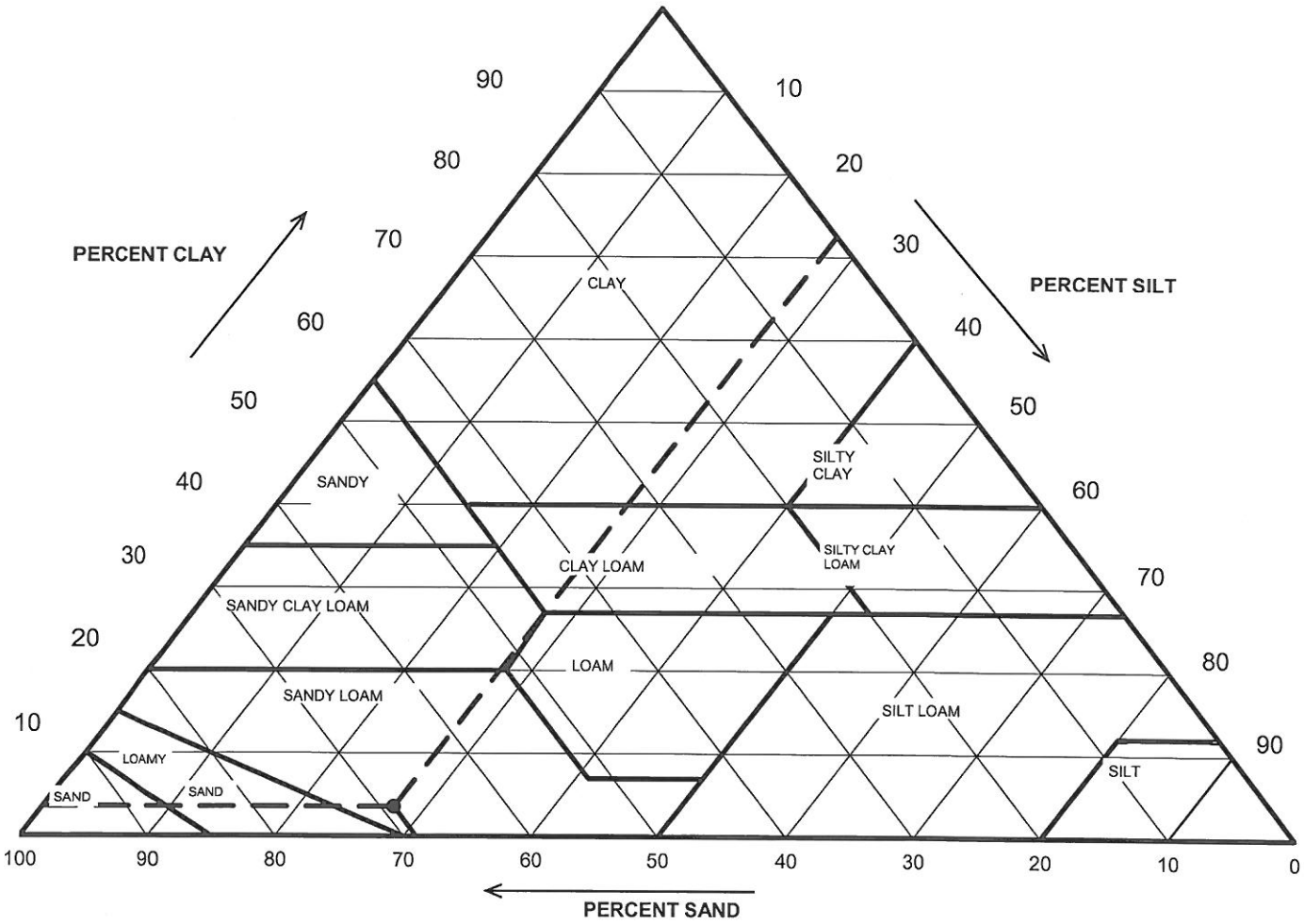
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	30-32
Project No.	2012-733-01	Sample No.	S-12
Lab ID	2012-733-01-14	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	1.02	**0.00**
2	98.98	*Sand*	68.26	**68.96**
0.05	30.72	*Silt*	27.19	**27.47**
0.002	3.54	*Clay*	3.54	**3.57**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	30-32
Project No.	2012-733-01	Sample No.	S-12
Lab ID	2012-733-01-14	Soil Color	**GRAY**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	C-2	Air Dried - #10 Hydrometer Material (gm)	100.05
Wgt.Tare + Wet Soil (gm)	41.27	Corrected Dry Wt. of - #10 Material (gm)	99.69
Wgt.Tare + Dry Soil (gm)	41.20		
Weight of Tare (gm)	21.89	Weight of - #200 Material (gm)	38.55
Weight of Water (gm)	0.07	Weight of - #10 ; + #200 Material (gm)	61.14
Weight of Dry Soil (gm)	19.31		
Moisture Content (%)	**0.4**	**J-FACTOR (%FINER THAN #10)**	**0.9898**
Soil Specimen Data			
Tare No.	203		
Wgt.Tare + Air Dry Soil (gm)	444.05		
Weight of Tare (gm)	170.90		
Air Dried Wgt. Total Sample (gm)	273.15	Dry Weight of Material Retained on #10 (gm)	2.77
Total Dry Sample Weight (gm)	272.17	Corrected Dry Sample Wt - #10 (gm)	269.40

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"	12.5	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	2.77	1.0	1.0	99.0	**99.0**
#20	0.85	4.62	4.6	4.6	95.4	**94.4**
#40	0.425	17.52	17.6	22.2	77.8	**77.0**
#60	0.250	15.78	15.8	38.0	62.0	**61.3**
#140	0.106	17.70	17.8	55.8	44.2	**43.8**
#200	0.075	5.52	5.5	61.3	38.7	**38.3**
Pan	-	38.55	38.7	100.0	-	**-**

Notes :

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	30-32
Project No.	2012-733-01	Sample No.	S-12
Lab ID	2012-733-01-14	Soil Color	**GRAY**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	27.0	24.6	4.79	22.2	22.1	0.01273	0.0310	**21.8**
5	23.0	24.6	4.79	18.2	18.1	0.01273	0.0202	**17.9**
15	17.0	24.6	4.79	12.2	12.1	0.01273	0.0121	**12.0**
30	14.0	24.6	4.79	9.2	9.1	0.01273	0.0087	**9.1**
60	12.0	24.6	4.79	7.2	7.2	0.01273	0.0062	**7.1**
250	10.0	24.6	4.79	5.2	5.2	0.01273	0.0031	**5.1**
1440	7.0	24.2	4.97	2.0	2.0	0.01279	0.0013	**2.0**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	99.69	Hygroscopic Moisture Factor	0.996
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	98.98
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/12/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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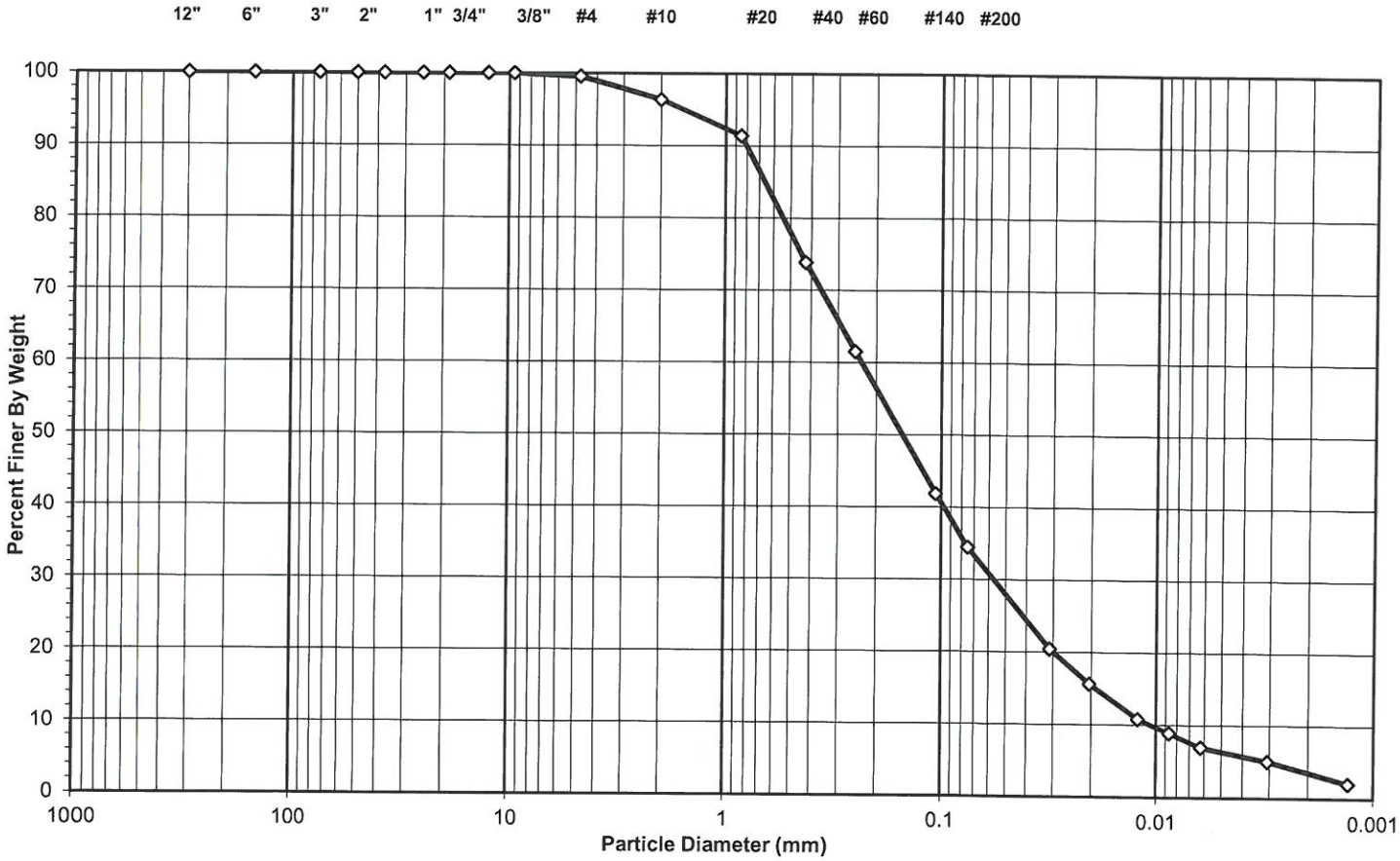
SIEVE AND HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	35-37
Project No.	2012-733-01	Sample No.	S-13
Lab ID	2012-733-01-15	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	0.44
#4 To #200	*Sand*	65.09
Finer Than #200	*Silt & Clay*	34.47

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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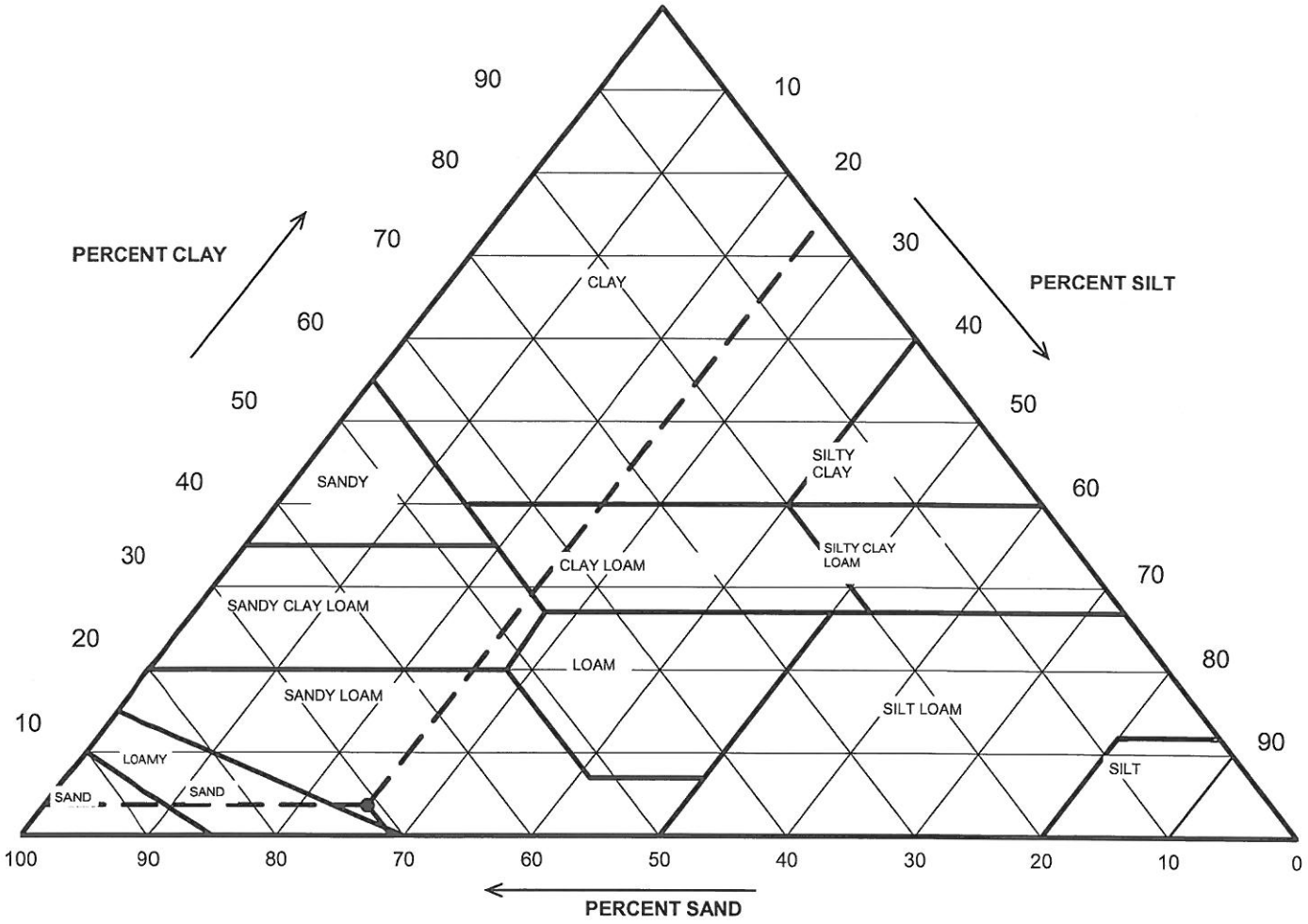
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	35-37
Project No.	2012-733-01	Sample No.	S-13
Lab ID	2012-733-01-15	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	3.63	**0.00**
2	96.37	*Sand*	68.37	**70.94**
0.05	28.00	*Silt*	24.47	**25.40**
0.002	3.53	*Clay*	3.53	**3.66**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	35-37
Project No.	2012-733-01	Sample No.	S-13
Lab ID	2012-733-01-15	Soil Color	**GRAY**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	R-1	Air Dried - #10 Hydrometer Material (gm)	100.00
Wgt.Tare + Wet Soil (gm)	43.22	Corrected Dry Wt. of - #10 Material (gm)	98.77
Wgt.Tare + Dry Soil (gm)	42.96		
Weight of Tare (gm)	22.02	Weight of - #200 Material (gm)	35.33
Weight of Water (gm)	0.26	Weight of - #10 ; + #200 Material (gm)	63.44
Weight of Dry Soil (gm)	20.94		
Moisture Content (%)	**1.2**	**J-FACTOR (%FINER THAN #10)**	**0.9637**
Soil Specimen Data			
Tare No.	832		
Wgt.Tare + Air Dry Soil (gm)	739.91		
Weight of Tare (gm)	259.01		
Air Dried Wgt. Total Sample (gm)	480.90	Dry Weight of Material Retained on #10 (gm)	17.27
Total Dry Sample Weight (gm)	475.21	Corrected Dry Sample Wt - #10 (gm)	457.94

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"	12.5	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	2.09	0.4	0.4	99.6	**99.6**
#10	2.00	15.18	3.2	3.6	96.4	**96.4**
#20	0.85	5.08	5.1	5.1	94.9	**91.4**
#40	0.425	17.97	18.2	23.3	76.7	**73.9**
#60	0.250	12.66	12.8	36.2	63.8	**61.5**
#140	0.106	20.11	20.4	56.5	43.5	**41.9**
#200	0.075	7.62	7.7	64.2	35.8	**34.5**
Pan	-	35.33	35.8	100.0	-	**-**

Notes :

Tested By SFS Date 9/11/2012 Checked By CEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	35-37
Project No.	2012-733-01	Sample No.	S-13
Lab ID	2012-733-01-15	Soil Color	**GRAY**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	26.0	24.6	4.79	21.2	21.3	0.01273	0.0312	**20.5**
5	21.0	24.6	4.79	16.2	16.2	0.01273	0.0204	**15.7**
15	16.0	24.6	4.79	11.2	11.2	0.01273	0.0122	**10.8**
30	14.0	24.6	4.79	9.2	9.2	0.01273	0.0087	**8.9**
60	12.0	24.6	4.79	7.2	7.2	0.01273	0.0062	**7.0**
250	10.0	24.7	4.74	5.3	5.3	0.01272	0.0031	**5.1**
1440	7.0	24.4	4.88	2.1	2.1	0.01276	0.0013	**2.0**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	98.77	Hygroscopic Moisture Factor	0.988
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	96.37
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/12/2012 Checked By GZM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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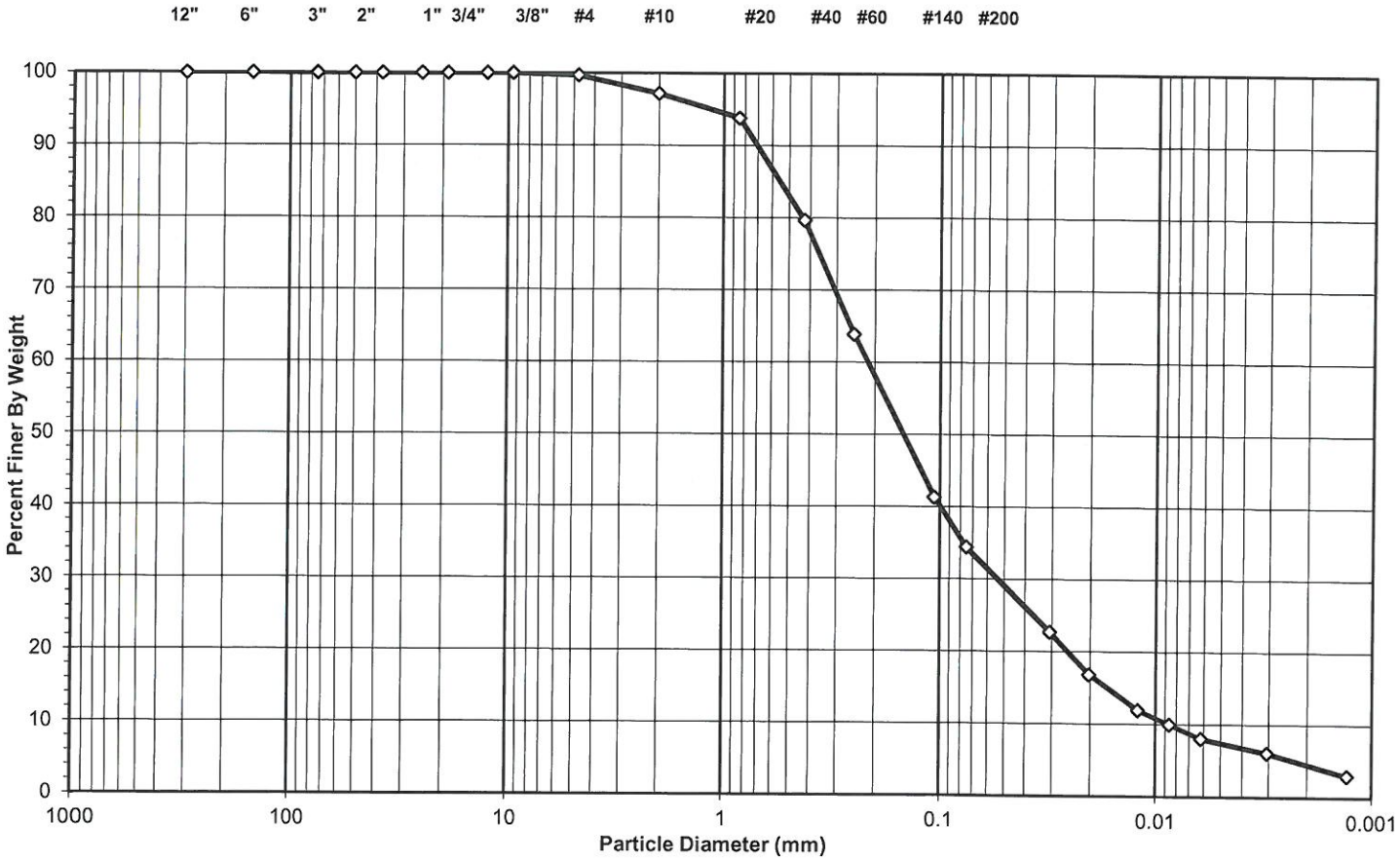
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	18-20
Project No.	2012-733-01	Sample No.	S-14
Lab ID	2012-733-01-16	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	0.32
#4 To #200	*Sand*	65.24
Finer Than #200	*Silt & Clay*	34.44

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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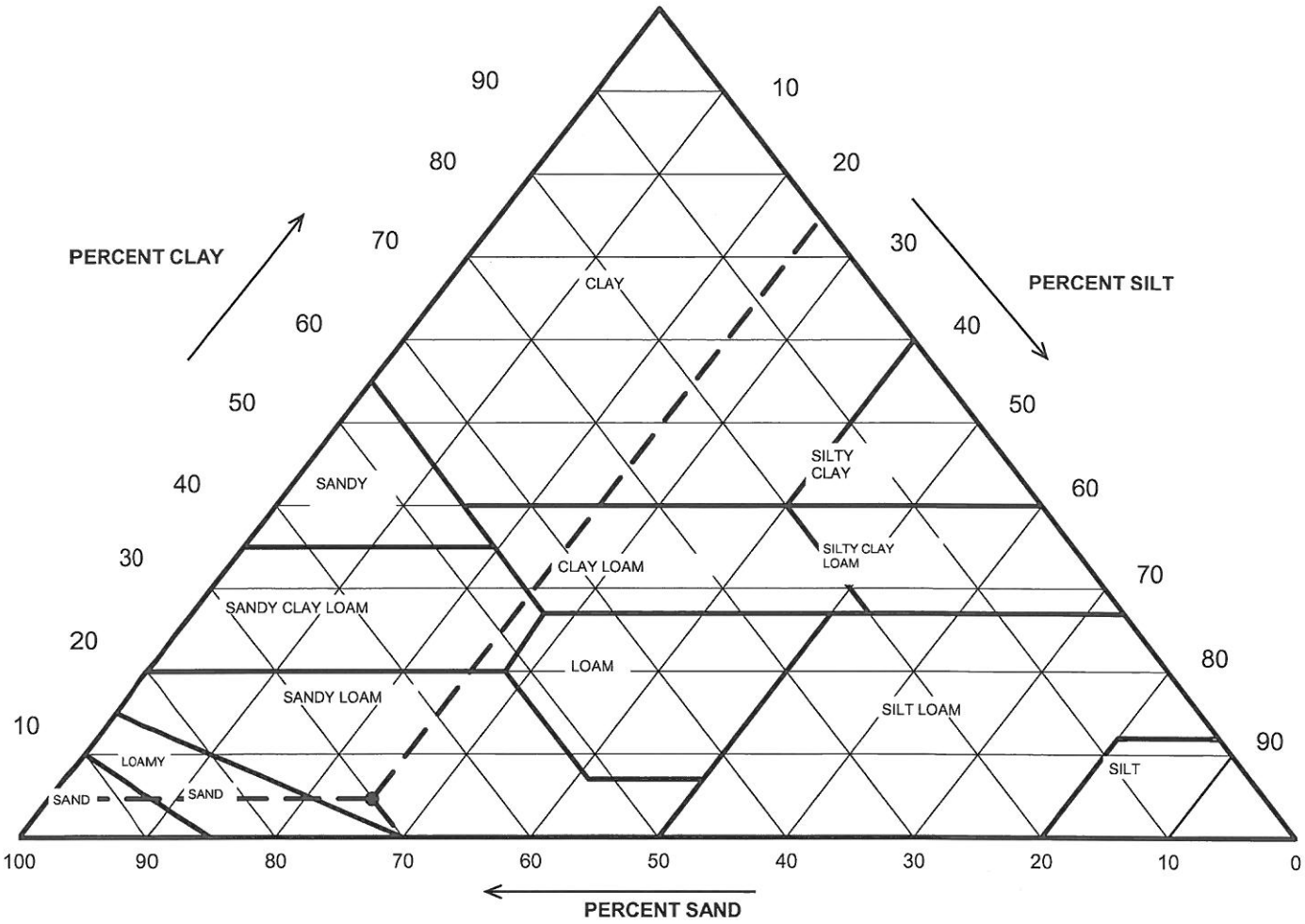
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	18-20
Project No.	2012-733-01	Sample No.	S-14
Lab ID	2012-733-01-16	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	2.81	**0.00**
2	97.19	*Sand*	68.09	**70.06**
0.05	29.10	*Silt*	24.58	**25.29**
0.002	4.52	*Clay*	4.52	**4.65**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	18-20
Project No.	2012-733-01	Sample No.	S-14
Lab ID	2012-733-01-16	Soil Color	**GRAY**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	B-1	Air Dried - #10 Hydrometer Material (gm)	99.99
Wgt.Tare + Wet Soil (gm)	44.75	Corrected Dry Wt. of - #10 Material (gm)	98.27
Wgt.Tare + Dry Soil (gm)	44.36		
Weight of Tare (gm)	22.05	Weight of - #200 Material (gm)	34.82
Weight of Water (gm)	0.39	Weight of - #10 ; + #200 Material (gm)	63.45
Weight of Dry Soil (gm)	22.31		
Moisture Content (%)	**1.7**	**J-FACTOR (%FINER THAN #10)**	**0.9719**
	Soil Specimen Data		
Tare No.	840		
Wgt.Tare + Air Dry Soil (gm)	711.82		
Weight of Tare (gm)	262.53		
Air Dried Wgt. Total Sample (gm)	449.29	Dry Weight of Material Retained on #10 (gm)	12.43
Total Dry Sample Weight (gm)	441.78	Corrected Dry Sample Wt - #10 (gm)	429.35

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"	12.5	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	1.43	0.3	0.3	99.7	**99.7**
#10	2.00	11.00	2.5	2.8	97.2	**97.2**
#20	0.85	3.39	3.4	3.4	96.6	**93.8**
#40	0.425	14.33	14.6	18.0	82.0	**79.7**
#60	0.250	15.96	16.2	34.3	65.7	**63.9**
#140	0.106	22.79	23.2	57.5	42.5	**41.3**
#200	0.075	6.98	7.1	64.6	35.4	**34.4**
Pan	-	34.82	35.4	100.0	-	**-**

Notes :

Tested By SFS Date 9/11/2012 Checked By GEM Date 9-17-12

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-729
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	18-20
Project No.	2012-733-01	Sample No.	S-14
Lab ID	2012-733-01-16	Soil Color	**GRAY**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	28.0	24.6	4.79	23.2	23.4	0.01273	0.0308	**22.7**
5	22.0	24.6	4.79	17.2	17.3	0.01273	0.0203	**16.9**
15	17.0	24.6	4.79	12.2	12.3	0.01273	0.0121	**12.0**
30	15.0	24.6	4.79	10.2	10.3	0.01273	0.0086	**10.0**
60	13.0	24.6	4.79	8.2	8.3	0.01273	0.0062	**8.0**
250	11.0	24.6	4.79	6.2	6.3	0.01273	0.0031	**6.1**
1440	8.0	24.2	4.97	3.0	3.1	0.01279	0.0013	**3.0**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	98.27	Hygroscopic Moisture Factor	0.983
Weight of Deflocculant (gm)	5.0		
		a - Factor	0.99
		Percent Finer than # 10	97.19
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/12/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

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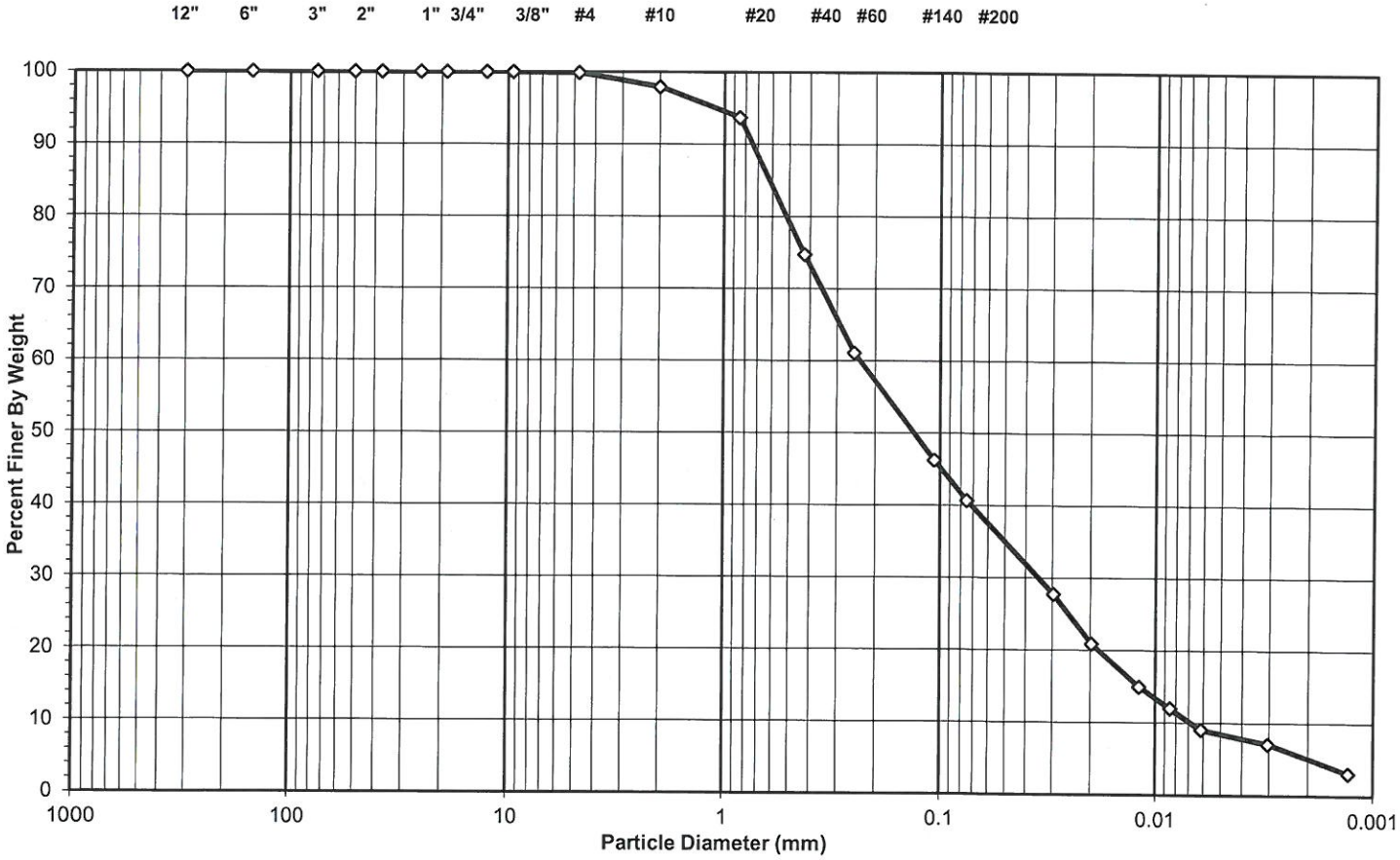
Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	10-12
Project No.	2012-733-01	Sample No.	S-15
Lab ID	2012-733-01-17	Soil Color	**LIGHT BROWN**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	0.12
#4 To #200	*Sand*	59.18
Finer Than #200	*Silt & Clay*	40.69

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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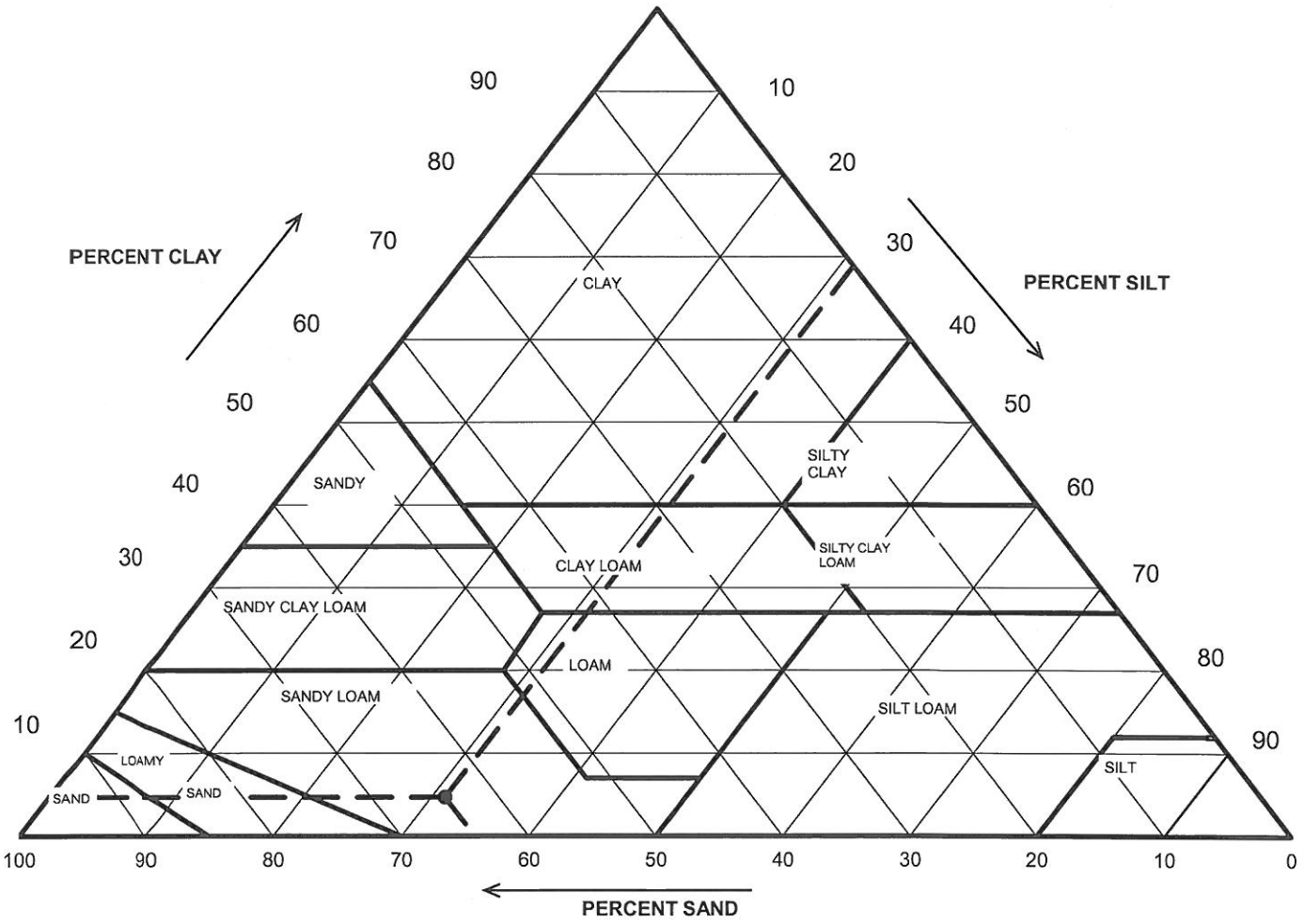
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	10-12
Project No.	2012-733-01	Sample No.	S-15
Lab ID	2012-733-01-17	Soil Color	LIGHT BROWN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	2.06	**0.00**
2	97.94	*Sand*	62.90	**64.22**
0.05	35.04	*Silt*	30.44	**31.08**
0.002	4.60	*Clay*	4.60	**4.70**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	10-12
Project No.	2012-733-01	Sample No.	S-15
Lab ID	2012-733-01-17	Soil Color	**LIGHT BROWN**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	A-5	Air Dried - #10 Hydrometer Material (gm)	100.02
Wgt.Tare + Wet Soil (gm)	41.09	Corrected Dry Wt. of - #10 Material (gm)	98.48
Wgt.Tare + Dry Soil (gm)	40.79		
Weight of Tare (gm)	21.65	Weight of - #200 Material (gm)	40.92
Weight of Water (gm)	0.30	Weight of - #10 ; + #200 Material (gm)	57.56
Weight of Dry Soil (gm)	19.14		
Moisture Content (%)	**1.6**	**J-FACTOR (%FINER THAN #10)**	**0.9794**
	Soil Specimen Data		
Tare No.	831		
Wgt.Tare + Air Dry Soil (gm)	697.81		
Weight of Tare (gm)	262.36		
Air Dried Wgt. Total Sample (gm)	435.45	Dry Weight of Material Retained on #10 (gm)	8.82
Total Dry Sample Weight (gm)	428.87	Corrected Dry Sample Wt - #10 (gm)	420.05

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"	12.5	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	0.53	0.1	0.1	99.9	**99.9**
#10	2.00	8.29	1.9	2.1	97.9	**97.9**
#20	0.85	4.28	4.3	4.3	95.7	**93.7**
#40	0.425	19.05	19.3	23.7	76.3	**74.7**
#60	0.250	13.73	13.9	37.6	62.4	**61.1**
#140	0.106	14.92	15.2	52.8	47.2	**46.2**
#200	0.075	5.58	5.7	58.5	41.5	**40.7**
Pan	-	40.92	41.5	100.0	-	**-**

Notes :

Tested By SFS Date 9/11/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-728
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	10-12
Project No.	2012-733-01	Sample No.	S-15
Lab ID	2012-733-01-17	Soil Color	**LIGHT BROWN**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	33.0	24.6	4.79	28.2	28.4	0.01273	0.0297	**27.8**
5	26.0	24.6	4.79	21.2	21.3	0.01273	0.0198	**20.9**
15	20.0	24.6	4.79	15.2	15.3	0.01273	0.0119	**15.0**
30	17.0	24.6	4.79	12.2	12.3	0.01273	0.0085	**12.0**
60	14.0	24.6	4.79	9.2	9.3	0.01273	0.0062	**9.1**
250	12.0	24.6	4.79	7.2	7.3	0.01273	0.0030	**7.1**
1440	8.0	24.4	4.88	3.1	3.1	0.01276	0.0013	**3.1**

Soil Specimen Data		**Other Corrections**	
Wgt. of Dry Material (gm)	98.48	Hygroscopic Moisture Factor	0.985
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	97.94
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/12/2012 Checked By GEM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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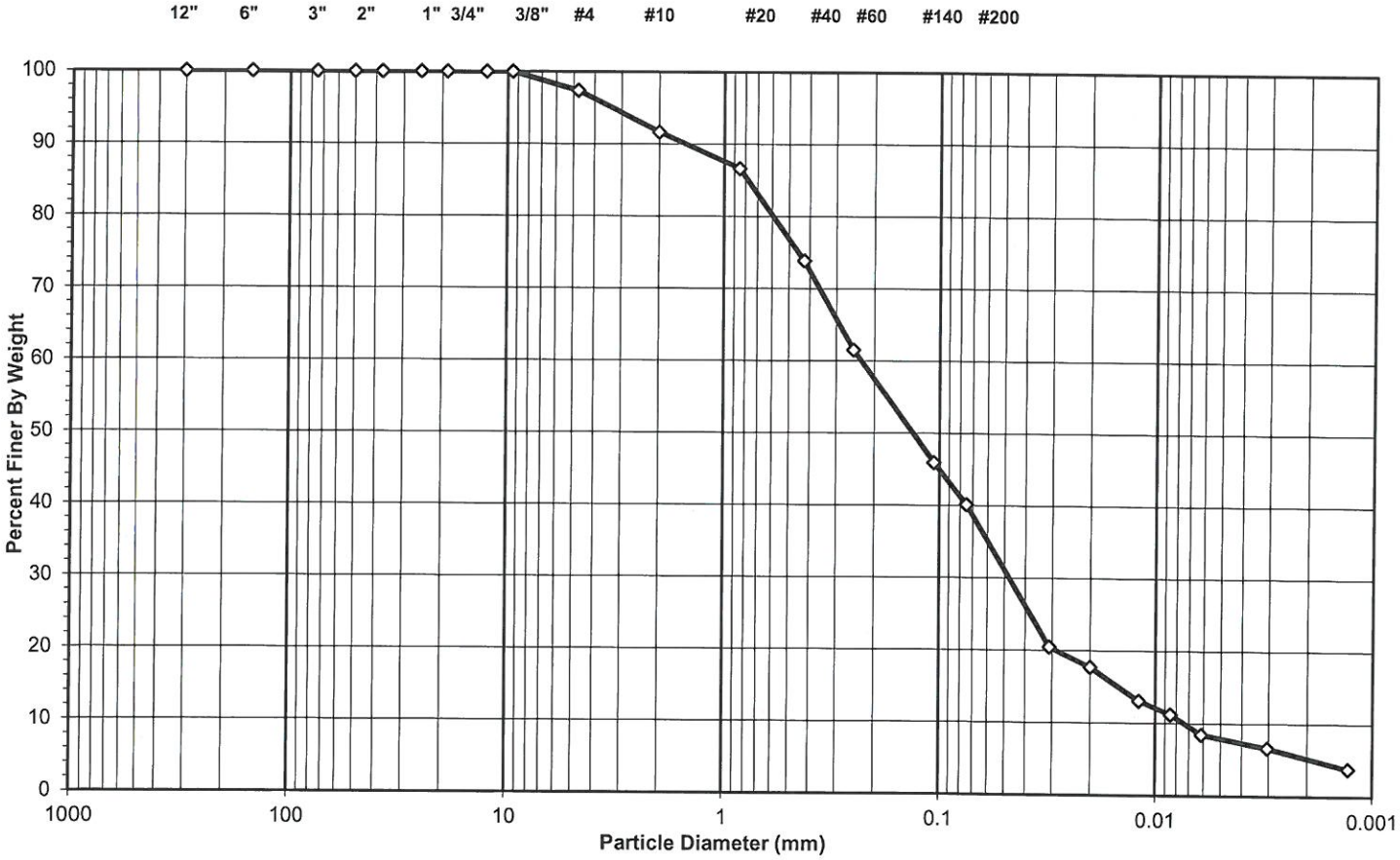
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	50-52
Project No.	2012-733-01	Sample No.	S-16
Lab ID	2012-733-01-18	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	2.60
#4 To #200	*Sand*	57.24
Finer Than #200	*Silt & Clay*	40.16

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

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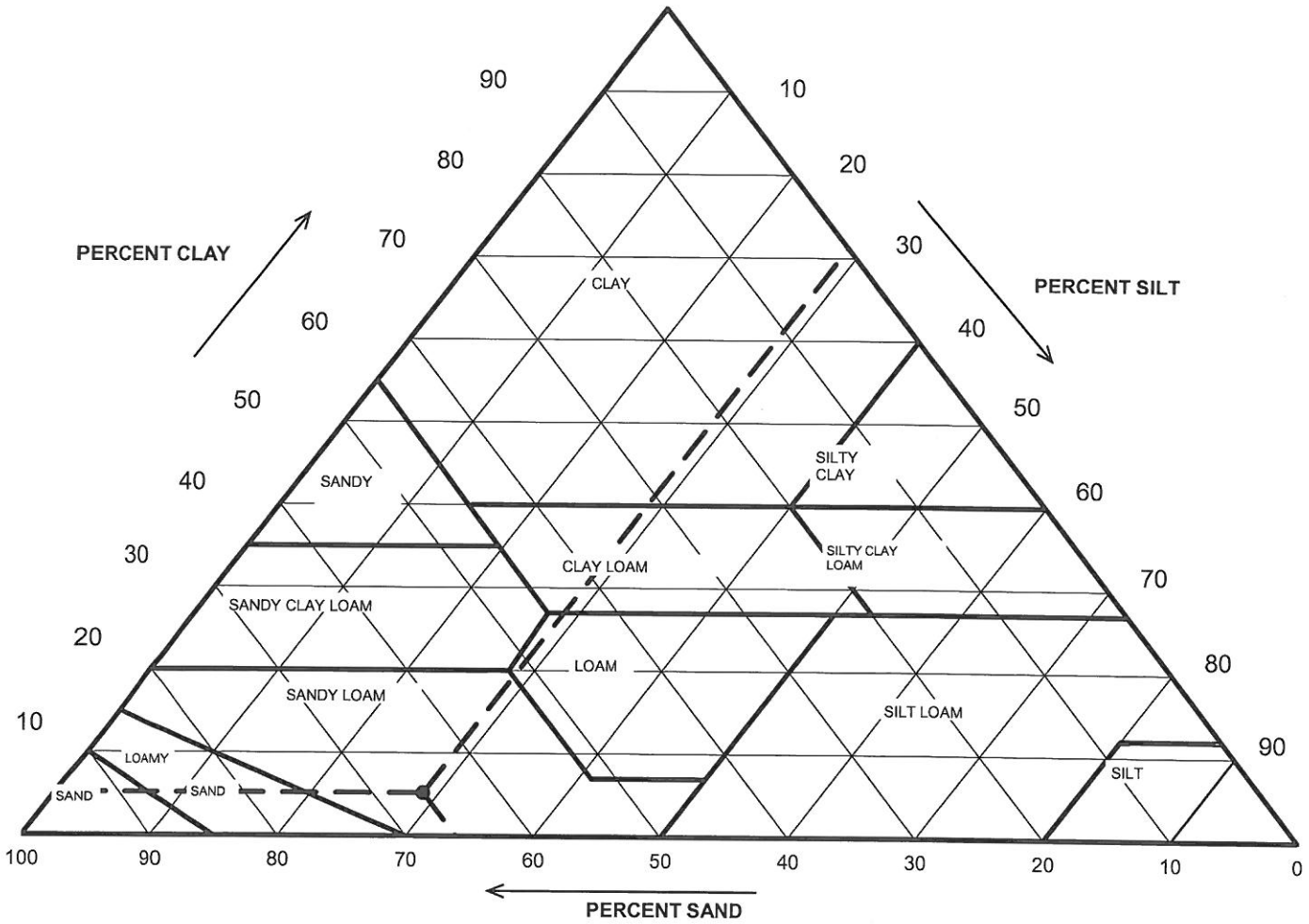
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	50-52
Project No.	2012-733-01	Sample No.	S-16
Lab ID	2012-733-01-18	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	8.35	**0.00**
2	91.65	*Sand*	60.52	**66.04**
0.05	31.13	*Silt*	26.35	**28.75**
0.002	4.78	*Clay*	4.78	**5.21**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-18 SIEVEHYD10 wHeader.xls]Sheet1

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	50-52
Project No.	2012-733-01	Sample No.	S-16
Lab ID	2012-733-01-18	Soil Color	**GRAY**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	V-1	Air Dried - #10 Hydrometer Material (gm)	100.01
Wgt.Tare + Wet Soil (gm)	39.32	Corrected Dry Wt. of - #10 Material (gm)	98.32
Wgt.Tare + Dry Soil (gm)	38.92		
Weight of Tare (gm)	15.59	Weight of - #200 Material (gm)	43.08
Weight of Water (gm)	0.40	Weight of - #10 ; + #200 Material (gm)	55.24
Weight of Dry Soil (gm)	23.33		
Moisture Content (%)	**1.7**	**J-FACTOR (%FINER THAN #10)**	**0.9165**
Soil Specimen Data			
Tare No.	838		
Wgt.Tare + Air Dry Soil (gm)	611.64		
Weight of Tare (gm)	261.56		
Air Dried Wgt. Total Sample (gm)	350.08	Dry Weight of Material Retained on #10 (gm)	28.77
Total Dry Sample Weight (gm)	344.66	Corrected Dry Sample Wt - #10 (gm)	315.89

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"	12.5	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	8.96	2.6	2.6	97.4	**97.4**
#10	2.00	19.81	5.7	8.3	91.7	**91.7**
#20	0.85	5.37	5.5	5.5	94.5	**86.6**
#40	0.425	13.70	13.9	19.4	80.6	**73.9**
#60	0.250	13.25	13.5	32.9	67.1	**61.5**
#140	0.106	16.70	17.0	49.9	50.1	**46.0**
#200	0.075	6.22	6.3	56.2	43.8	**40.2**
Pan	-	43.08	43.8	100.0	-	**-**

Notes :

Tested By SFS Date 9/11/2012 Checked By GM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-18 SIEVEHYD10 wHeader.xls]Sheet1

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	CDM	Boring No.	B-727d
Client Reference	CELL 7 SUB. D LF EXPANSION	Depth (ft)	50-52
Project No.	2012-733-01	Sample No.	S-16
Lab ID	2012-733-01-18	Soil Color	**GRAY**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	27.0	24.6	4.79	22.2	22.4	0.01273	0.0310	**20.5**
5	24.0	24.6	4.79	19.2	19.3	0.01273	0.0200	**17.7**
15	19.0	24.6	4.79	14.2	14.3	0.01273	0.0119	**13.1**
30	17.0	24.6	4.79	12.2	12.3	0.01273	0.0085	**11.3**
60	14.0	24.6	4.79	9.2	9.3	0.01273	0.0062	**8.5**
250	12.0	24.6	4.79	7.2	7.3	0.01273	0.0030	**6.7**
1440	9.0	24.4	4.88	4.1	4.1	0.01276	0.0013	**3.8**

Soil Specimen Data		Other Corrections	
Wgt. of Dry Material (gm)	98.32	Hygroscopic Moisture Factor	0.983
Weight of Deflocculant (gm)	5.0	a - Factor	0.99
		Percent Finer than # 10	91.65
		Specific Gravity	2.70 Assumed

Notes:

Tested By SFS Date 9/12/2012 Checked By GDM Date 9-17-12

DCN: CT-S3OR DATE: 2/20/08 REVISION: 5

Z:\2012 PROJECTS\2012-733 CDM - CELL 7 SUB D LF EXP\[2012-733-01-18 SIEVEHYD10 wHeader.xls]Sheet1

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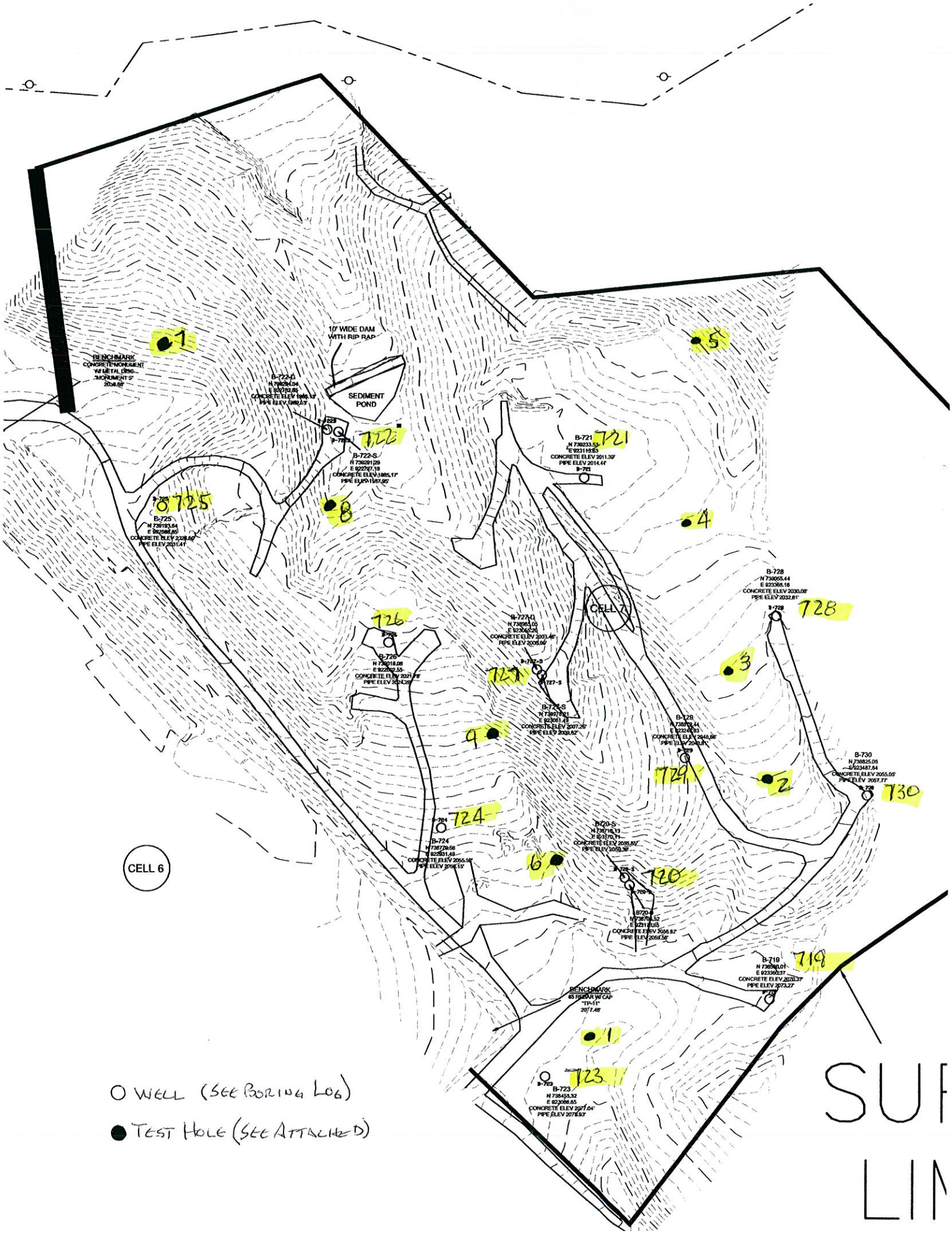
Appendix C

Field Notes



O WELL (SEE BORING LOG)

● TEST HOLE (SEE ATTACHED)

SUF

LIN

TEST HOLES DUG 9-6-12 CELL 7, BUNCOMBE CO. LANDFILL

HOLE NO.	DESCRIPTION
1	16' Deep, all good material. Sand with traces of clay, no rock found.
2	Removed topsoil 6", found rippable rock. 15' on either side of the test hole we found no rock. Dug approximatel 10' deep.
3	16' deep, some loose rock, not layered. Balance of material is sandy. No clay found.
4	16' deep, sand with trace of rock at bottom. Rock was rippable. No clay.
5	All sandy material. Some loose rock. No rock layer. 20' deep.
6	Red sandy clay, no rock. 20' deep.
7	Red sand, some clay. Boulders < 1/2 cy. 20' Deep.
8	5' red sand to rippable rock, then 15' of rippable rock.
9	20' deep, no rock all red sandy material with traces of clay.

No water was found at any excavated hole. All holes had approximately 6" of overburden material.

Appendix D

NCDENR DWR/USGS Hydrographs

North Carolina Department of Environment and Natural Resources

Division of Water Resources

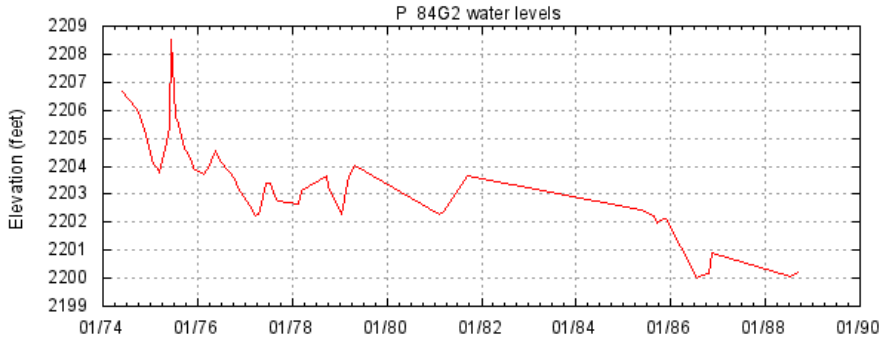
DWR Monitoring Database Detail for P 84G2

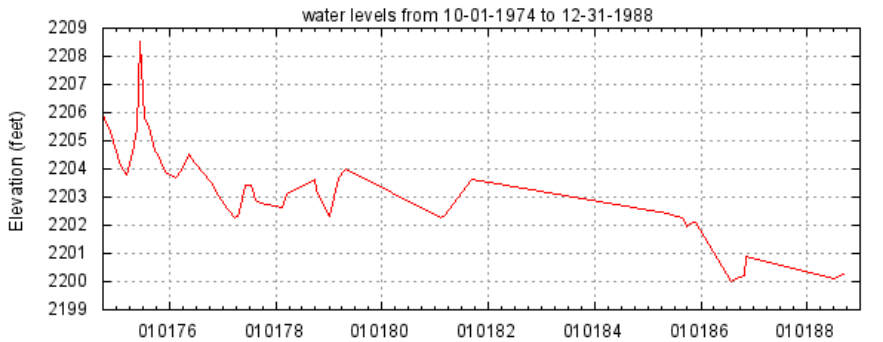
Show Map -- Monthly Statistics Plot -- Station Levels (may include USGS data)

Field	Data
County	Henderson
Quad	P 84G2
Name	Hendersonville
Latitude	35.397778
Longitude	-82.390000
Location Accuracy	
Netname (link to USGS data)	
USGS ID	
Aquifer	Saprolite
Land Surface NED elevation = 2,200.39 feet	2,239.50
Date Constructed	05/29/1974
Measuring Point (feet above land surface)	0.50
Depth	44.00
Diameter	24.00
Yield	0.00
Exists?	y
Recorder Box?	n
Top of Screen	0.00
Bottom of Screen	0.00
Number of Water Levels {date * feet below land surface * elevation} 05/29/1974 to 09/06/1988	52 ** 999.99 feet below land surface value indicates dry well

output file is tab-delimited text
National Elevation Dataset, 1/9 arc second value, ~3 X 3 meter grid

return to well table





slope: -0.31 feet/year over this date range

Start Date: 10 - 01 - 1974 End Date: 12 - 31 - 1988 Replot

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Last Modified: 10.09.2012
Comments, questions, or problems? Please contact the DWR Webmaster.

North Carolina Department of Environment and Natural Resources

Division of Water Resources

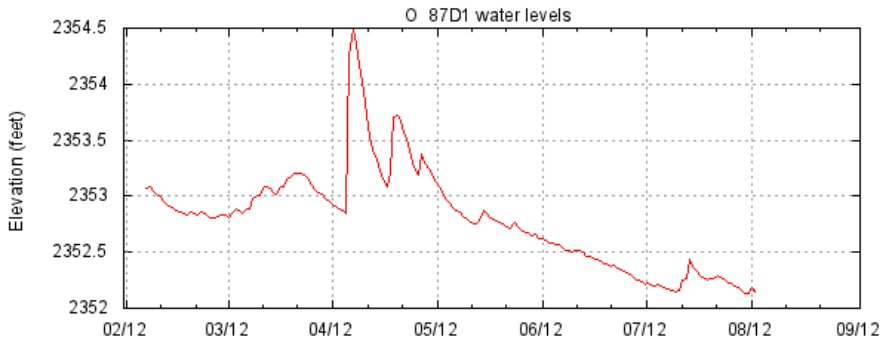
DWR Monitoring Database Detail for O 87D1

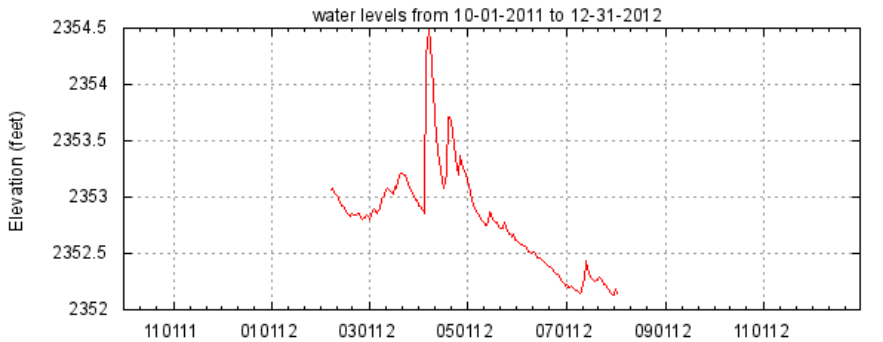
Show Map -- Station Levels (may include USGS data)

Field	Data
County	Buncombe
Quad	O 87D1
Name	Bent Creek (DWQ Research Station)
Latitude	35.490833
Longitude	-82.644167
Location Accuracy	GPS
Netname (link to USGS data)	BU-083
USGS ID	352827082383901
Aquifer	Surficial
Land Surface NED elevation = 2,364.07 feet	2,364.00
Date Constructed	07/17/2002
Measuring Point (feet above land surface)	2.97
Depth	25.00
Diameter	4.00
Yield	0.50
Exists?	y
Recorder Box?	y
Top of Screen	10.00
Bottom of Screen	25.00
Number of Water Levels {date * feet below land surface * elevation} 02/07/2012 to 08/02/2012	180 ** 999.99 feet below land surface value indicates dry well

output file is tab-delimited text
National Elevation Dataset, 1/9 arc second value, ~3 X 3 meter grid

return to well table





slope: -2.17 feet/year over this date range

Start Date: 10 - 01 - 2011 End Date: 12 - 31 - 2012 Replot

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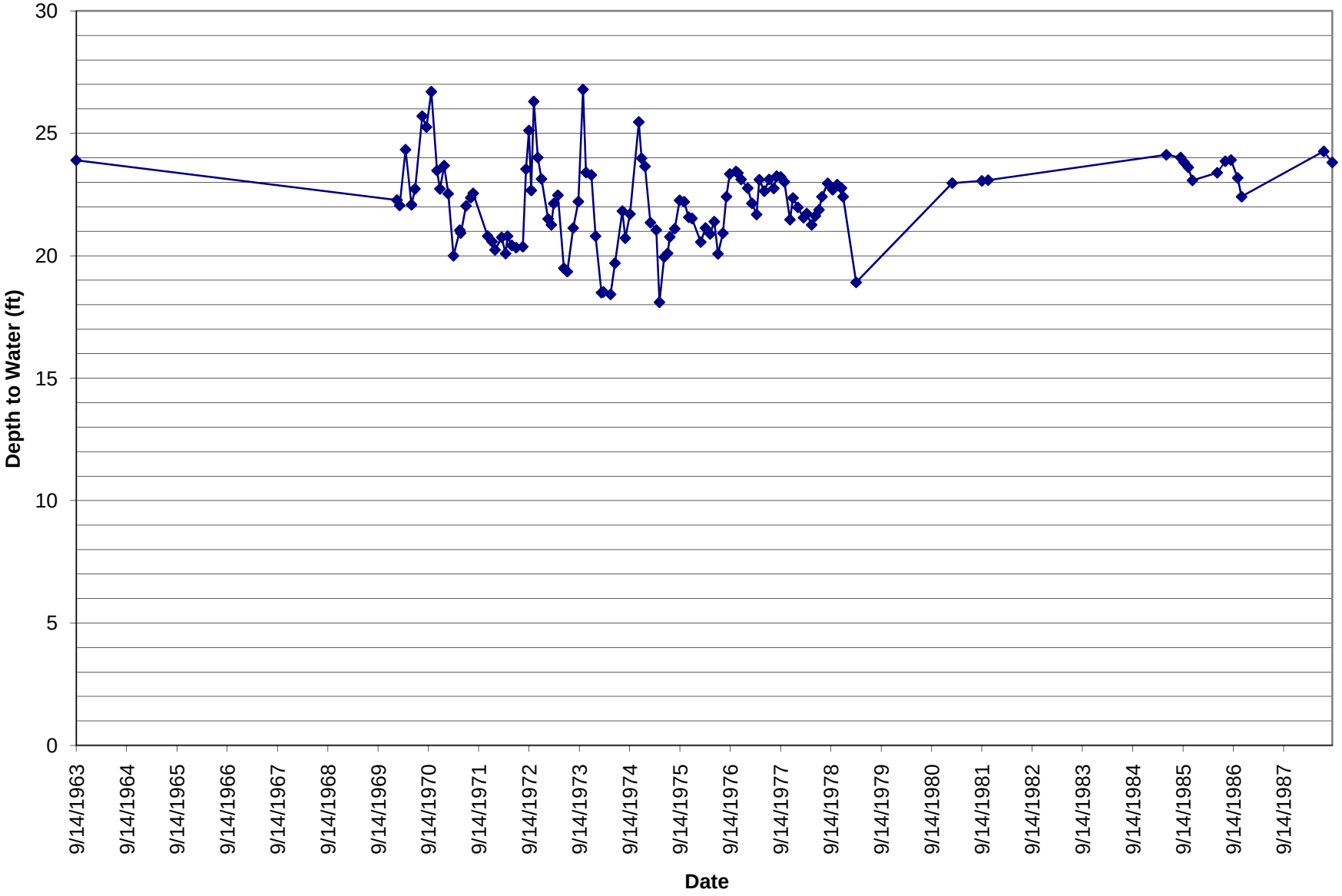
Last Modified: 10.09.2012

Depth to Water
Well #M8301
Black Mountain, Buncombe County, North Carolina



Saprolite Well
TD = 26'

North Carolina Department of Environment and Natural Resources

Division of Water Resources

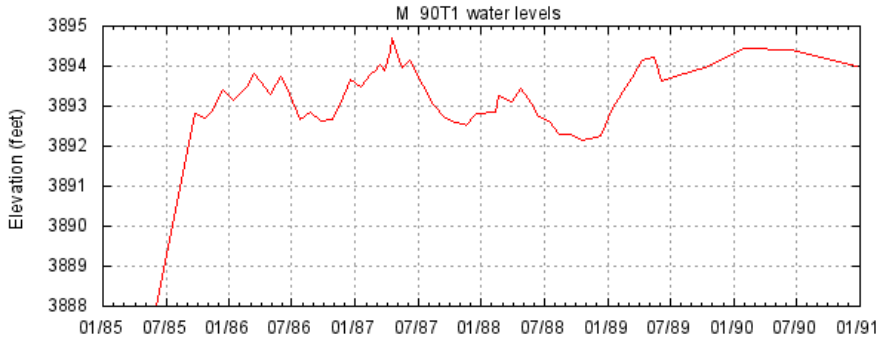
DWR Monitoring Database Detail for M 90T1

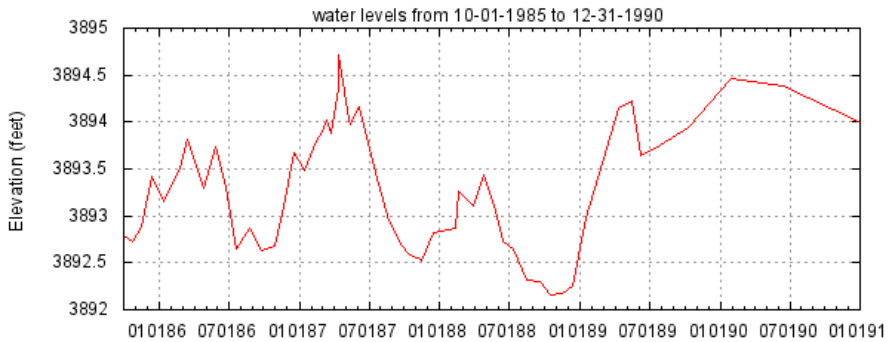
Show Map -- Monthly Statistics Plot -- Station Levels (may include USGS data)

Field	Data
County	Haywood
Quad	M 90T1
Name	Canton Watershed RS 1
Latitude	35.603611
Longitude	-82.843611
Location Accuracy	
Netname (link to USGS data)	
USGS ID	
Aquifer	Saprolite
Land Surface NED elevation = 3,906.22 feet	3,897.00
Date Constructed	06/04/1985
Measuring Point (feet above land surface)	3.00
Depth	35.00
Diameter	4.00
Yield	0.00
Exists?	y
Recorder Box?	n
Top of Screen	13.00
Bottom of Screen	35.00
Number of Water Levels {date * feet below land surface * elevation} 06/04/1985 to 12/26/1990	59 ** 999.99 feet below land surface value indicates dry well

output file is tab-delimited text
National Elevation Dataset, 1/9 arc second value, ~3 X 3 meter grid

return to well table



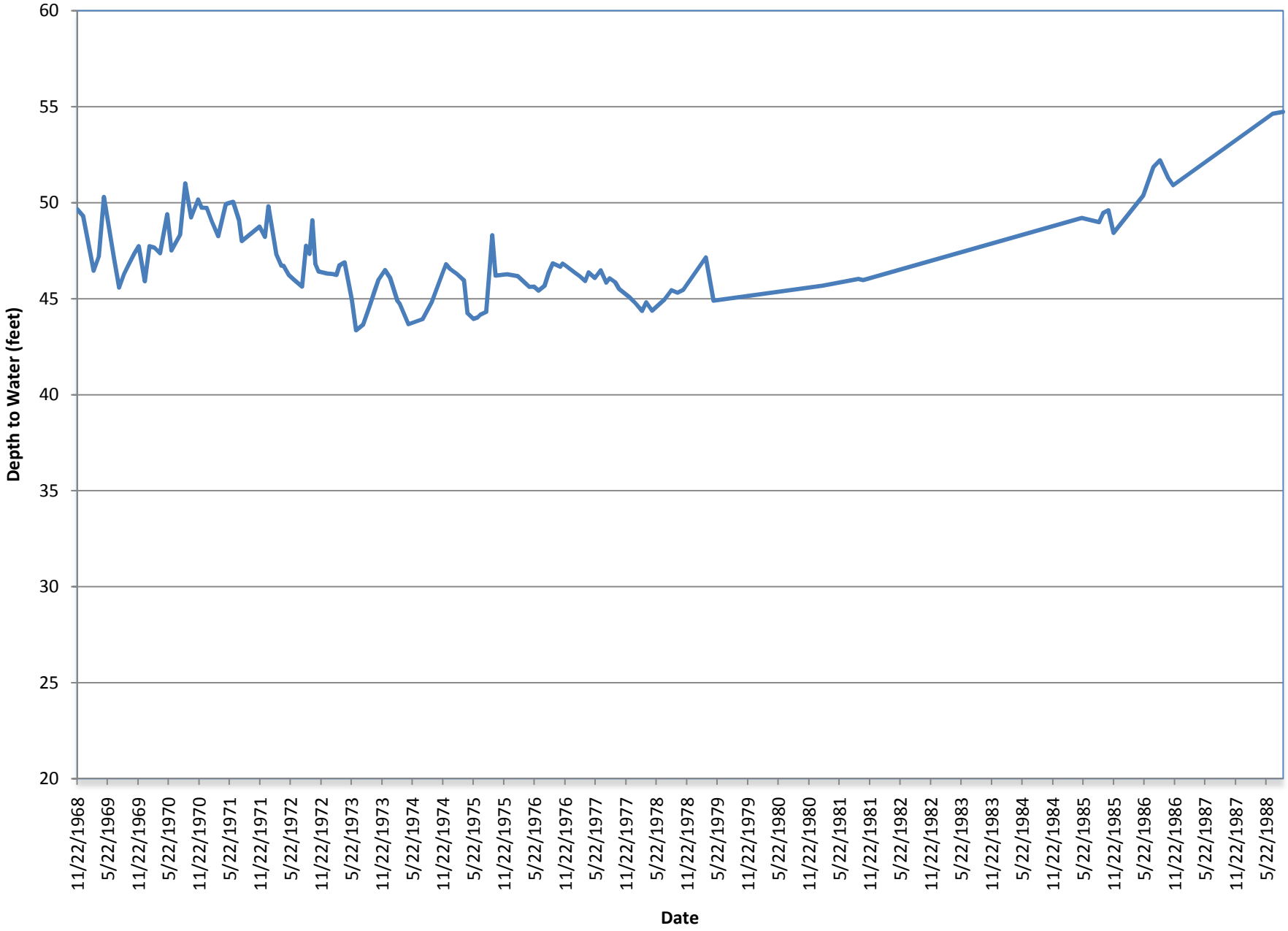


slope: +0.07 feet/year over this date range

Start Date: 10 - 01 - 1985 End Date: 12 - 31 - 1990 Replot

NC Division of Water Resources, DENR - 1611 Mail Service Center - Raleigh, NC 27699-1611
Phone: (919) 707-9000 - Fax: (919) 733-3558
Last Modified: 10.09.2012
Comments, questions, or problems? Please contact the DWR Webmaster.

Depth to Water
Well #M84P1
Swannanoa, Buncombe County, North Carolina



Bedrock Well
TD = 99'

North Carolina Department of Environment and Natural Resources

Division of Water Resources

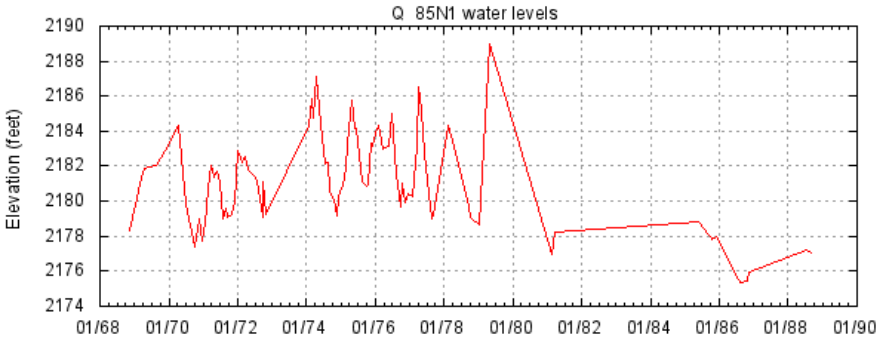
DWR Monitoring Database Detail for Q 85N1

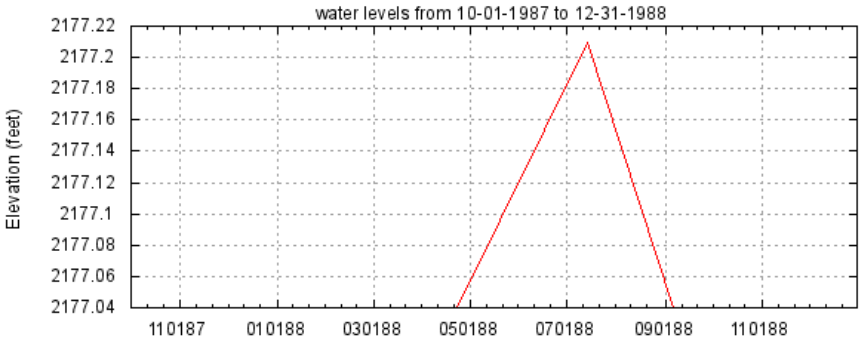
Show Map -- Monthly Statistics Plot -- Station Levels (may include USGS data)

Field	Data
County	Henderson
Quad	Q 85N1
Name	Hendersonville
Latitude	35.284167
Longitude	-82.481389
Location Accuracy	
Netname (link to USGS data)	
USGS ID	
Aquifer	Bedrock
Land Surface NED elevation = 2,193.85 feet	2,199.00
Date Constructed	
Measuring Point (feet above land surface)	
Depth	48.00
Diameter	6.00
Yield	15.00
Exists?	?
Recorder Box?	n
Top of Screen	0.00
Bottom of Screen	0.00
Number of Water Levels {date * feet below land surface * elevation} 11/14/1968 to 09/06/1988	90 ** 999.99 feet below land surface value indicates dry well

output file is tab-delimited text
National Elevation Dataset, 1/9 arc second value, ~3 X 3 meter grid

return to well table





slope: -1.15 feet/year over this date range

Start Date: 10 - 01 - 1988 End Date: 12 - 31 - 1988 Replot

NC Division of Water Resources, DENR - 1611 Mail Service Center - Raleigh, NC 27699-1611
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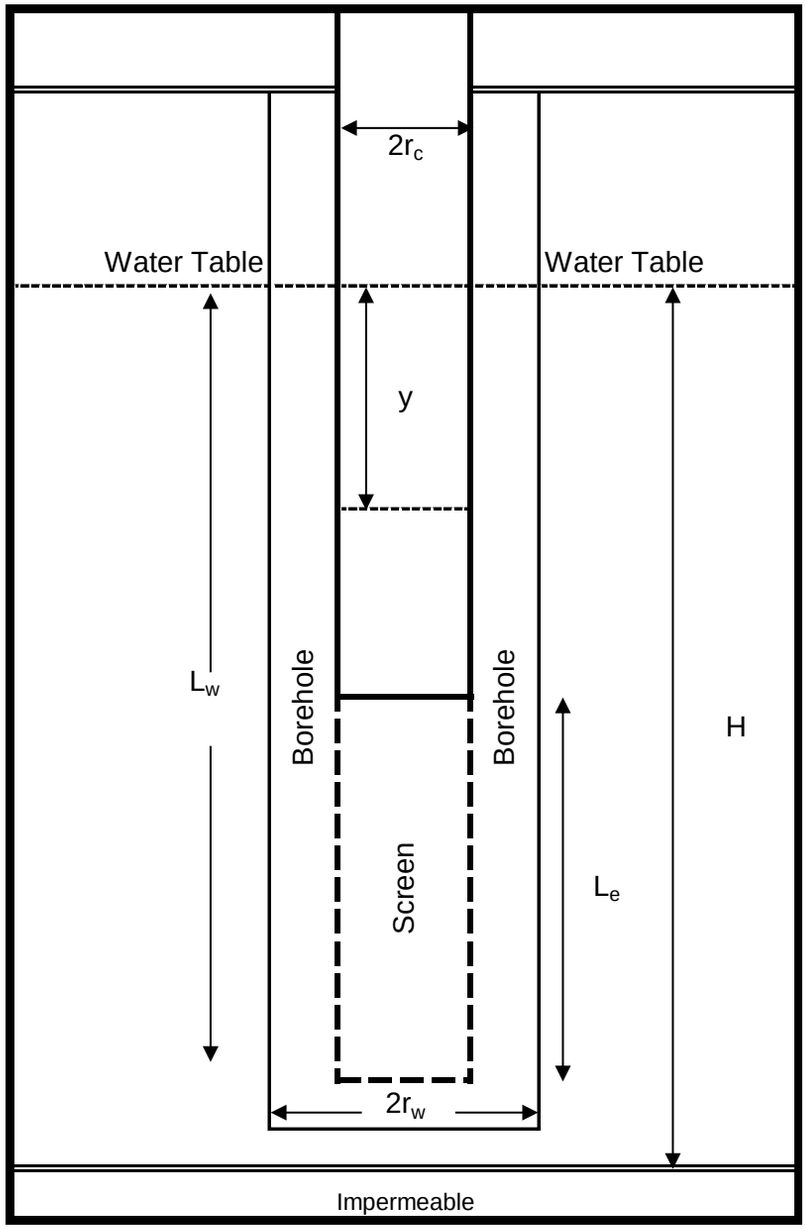
Last Modified: 10.09.2012

Appendix E

Slug Test Raw Data and Calculations



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	6
L_w	Feet	18.1
L_e	Feet	10
H	Feet	18.1
y_0	Feet	3
t_0	Seconds	0
y_t	Feet	0.0001
t	Seconds	1,000

Solutions

Hydraulic Conductivity in Feet/Second
1.21E-05
Hydraulic Conductivity in Feet/Minute
7.28E-04
Hydraulic Conductivity in Feet/Day
1.05E+00

Calculations

Term	Units		
L_e/r_W	Feet/Foot	40.00	3.172
A	None	2.780	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
B	None	0.430	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	2.336	3.172

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

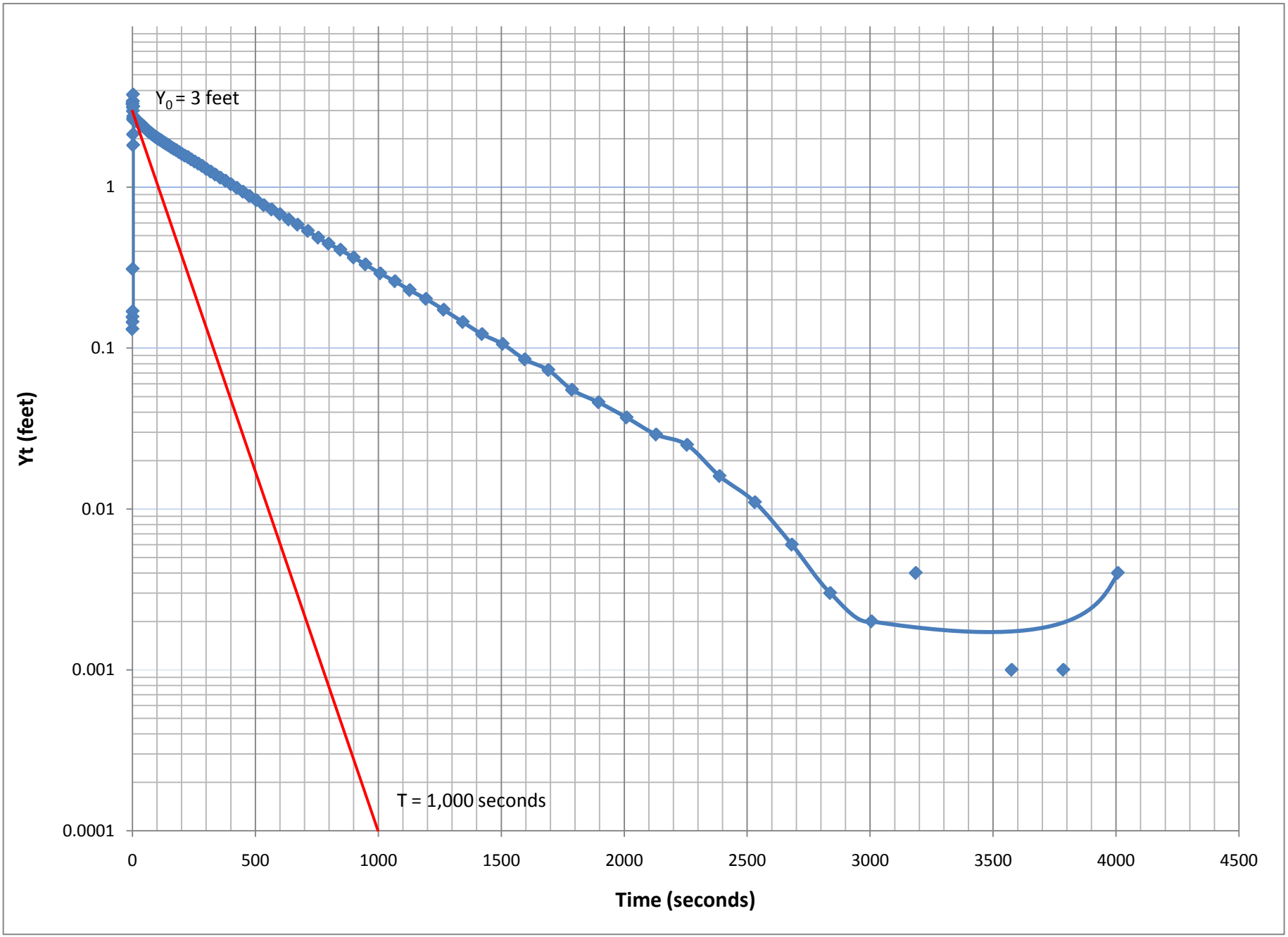
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-720s Fall - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-720s Fall


Y_0 = 3 feet
T = 1,000 seconds
Yt (feet)
1
0.1
0.01
0.001
0.0001
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Time (seconds)

B-720s Fall

Report Date:	8/7/2012 10:04
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-720s Fall
Create Date	8/2/2012 10:04
Device	Level TROLL 700
Site	Buncombe County
Serial Number	124344
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-720s Fall	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/2/2012 15:06	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	15.0843 (ft)
Head Pressure:	6.53291 (PSI)
Temperature:	13.664 (C)

Log Data:

Record Count 138

Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/2/2012	15:10:20 PM	0	39.698	14.931	3.298
8/2/2012	15:10:20 PM	0.251	39.734	14.947	0.131
8/2/2012	15:10:20 PM	0.501	39.709	14.962	0.156
8/2/2012	15:10:20 PM	0.751	39.72	14.968	0.145
8/2/2012	15:10:21 PM	1.001	39.696	14.974	0.169
8/2/2012	15:10:21 PM	1.251	39.555	14.981	0.31
8/2/2012	15:10:21 PM	1.501	36.445	14.983	3.42
8/2/2012	15:10:21 PM	1.751	36.469	14.987	3.396
8/2/2012	15:10:22 PM	2.001	36.731	14.99	3.134
8/2/2012	15:10:22 PM	2.251	36.892	14.99	2.973
8/2/2012	15:10:22 PM	2.501	36.105	14.993	3.76
8/2/2012	15:10:22 PM	2.751	37.206	14.992	2.659
8/2/2012	15:10:23 PM	3.001	37.735	14.991	2.13

B-720s Fall

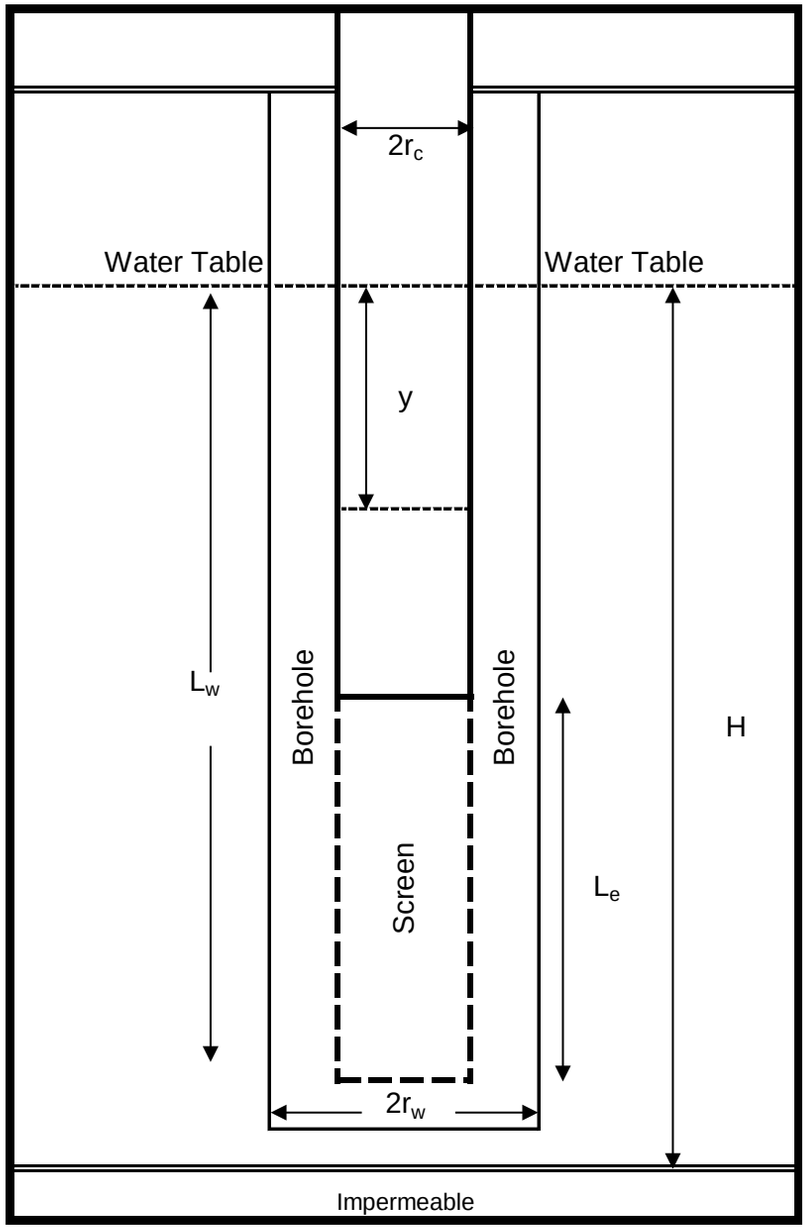
8/2/2012	15:10:23 PM	3.251	38.044	14.994	1.821
8/2/2012	15:10:23 PM	3.501	36.697	14.996	3.168
8/2/2012	15:10:23 PM	3.751	37.106	14.995	2.759
8/2/2012	15:10:24 PM	4.001	37.196	14.996	2.669
8/2/2012	15:10:24 PM	4.251	37.242	14.994	2.623
8/2/2012	15:10:24 PM	4.501	37.23	14.994	2.635
8/2/2012	15:10:24 PM	4.751	37.171	14.997	2.694
8/2/2012	15:10:25 PM	5.001	37.171	14.994	2.694
8/2/2012	15:10:25 PM	5.251	37.209	14.997	2.656
8/2/2012	15:10:25 PM	5.501	37.215	14.993	2.65
8/2/2012	15:10:25 PM	5.751	37.208	14.993	2.657
8/2/2012	15:10:26 PM	6.001	37.201	14.99	2.664
8/2/2012	15:10:26 PM	6.36	37.207	14.982	2.658
8/2/2012	15:10:26 PM	6.72	37.212	14.973	2.653
8/2/2012	15:10:27 PM	7.14	37.218	14.968	2.647
8/2/2012	15:10:27 PM	7.56	37.219	14.962	2.646
8/2/2012	15:10:28 PM	7.981	37.221	14.959	2.644
8/2/2012	15:10:28 PM	8.46	37.227	14.951	2.638
8/2/2012	15:10:29 PM	9	37.227	14.943	2.638
8/2/2012	15:10:29 PM	9.48	37.228	14.94	2.637
8/2/2012	15:10:30 PM	10.08	37.235	14.931	2.63
8/2/2012	15:10:30 PM	10.68	37.237	14.926	2.628
8/2/2012	15:10:31 PM	11.281	37.244	14.923	2.621
8/2/2012	15:10:31 PM	11.94	37.248	14.911	2.617
8/2/2012	15:10:32 PM	12.66	37.246	14.911	2.619
8/2/2012	15:10:33 PM	13.44	37.262	14.897	2.603
8/2/2012	15:10:34 PM	14.22	37.276	14.9	2.589
8/2/2012	15:10:35 PM	15.061	37.263	14.891	2.602
8/2/2012	15:10:35 PM	15.96	37.267	14.881	2.598
8/2/2012	15:10:36 PM	16.92	37.281	14.876	2.584
8/2/2012	15:10:37 PM	17.88	37.283	14.868	2.582
8/2/2012	15:10:38 PM	18.96	37.29	14.857	2.575
8/2/2012	15:10:40 PM	20.1	37.298	14.854	2.567
8/2/2012	15:10:41 PM	21.3	37.305	14.849	2.56
8/2/2012	15:10:42 PM	22.561	37.313	14.84	2.552
8/2/2012	15:10:43 PM	23.88	37.321	14.831	2.544
8/2/2012	15:10:45 PM	25.321	37.341	14.821	2.524
8/2/2012	15:10:46 PM	26.82	37.343	14.814	2.522
8/2/2012	15:10:48 PM	28.38	37.355	14.806	2.51
8/2/2012	15:10:50 PM	30.061	37.369	14.794	2.496
8/2/2012	15:10:51 PM	31.86	37.385	14.788	2.48
8/2/2012	15:10:53 PM	33.72	37.403	14.776	2.462
8/2/2012	15:10:55 PM	35.761	37.413	14.765	2.452
8/2/2012	15:10:57 PM	37.86	37.43	14.754	2.435
8/2/2012	15:11:00 PM	40.08	37.445	14.743	2.42
8/2/2012	15:11:02 PM	42.48	37.467	14.73	2.398
8/2/2012	15:11:05 PM	45	37.482	14.713	2.383
8/2/2012	15:11:07 PM	47.64	37.504	14.702	2.361
8/2/2012	15:11:10 PM	50.46	37.525	14.688	2.34
8/2/2012	15:11:13 PM	53.46	37.55	14.671	2.315
8/2/2012	15:11:16 PM	56.64	37.574	14.66	2.291
8/2/2012	15:11:20 PM	60.199	37.605	14.66	2.26
8/2/2012	15:11:23 PM	63.6	37.632	14.632	2.233
8/2/2012	15:11:27 PM	67.2	37.655	14.615	2.21
8/2/2012	15:11:31 PM	71.4	37.679	14.593	2.186
8/2/2012	15:11:35 PM	75.6	37.705	14.575	2.16

B-720s Fall

8/2/2012	15:11:39 PM	79.8	37.732	14.56	2.133
8/2/2012	15:11:44 PM	84.6	37.759	14.541	2.106
8/2/2012	15:11:50 PM	90	37.788	14.519	2.077
8/2/2012	15:11:54 PM	94.8	37.817	14.502	2.048
8/2/2012	15:12:00 PM	100.8	37.845	14.481	2.02
8/2/2012	15:12:06 PM	106.8	37.872	14.458	1.993
8/2/2012	15:12:12 PM	112.8	37.898	14.437	1.967
8/2/2012	15:12:19 PM	119.4	37.927	14.414	1.938
8/2/2012	15:12:26 PM	126.6	37.962	14.387	1.903
8/2/2012	15:12:34 PM	134.4	37.995	14.361	1.87
8/2/2012	15:12:42 PM	142.2	38.028	14.333	1.837
8/2/2012	15:12:50 PM	150.6	38.06	14.305	1.805
8/2/2012	15:12:59 PM	159.6	38.102	14.271	1.763
8/2/2012	15:13:09 PM	169.2	38.138	14.238	1.727
8/2/2012	15:13:18 PM	178.8	38.169	14.205	1.696
8/2/2012	15:13:29 PM	189.6	38.213	14.177	1.652
8/2/2012	15:13:41 PM	201	38.257	14.149	1.608
8/2/2012	15:13:53 PM	213	38.296	14.118	1.569
8/2/2012	15:14:05 PM	225.6	38.328	14.088	1.537
8/2/2012	15:14:18 PM	238.8	38.377	14.056	1.488
8/2/2012	15:14:33 PM	253.2	38.422	14.018	1.443
8/2/2012	15:14:48 PM	268.2	38.465	13.978	1.4
8/2/2012	15:15:03 PM	283.8	38.51	13.95	1.355
8/2/2012	15:15:20 PM	300.6	38.568	13.915	1.297
8/2/2012	15:15:38 PM	318.6	38.616	13.888	1.249
8/2/2012	15:15:57 PM	337.2	38.668	13.865	1.197
8/2/2012	15:16:17 PM	357.6	38.72	13.826	1.145
8/2/2012	15:16:38 PM	378.6	38.769	13.787	1.096
8/2/2012	15:17:00 PM	400.8	38.823	13.749	1.042
8/2/2012	15:17:24 PM	424.8	38.875	13.714	0.99
8/2/2012	15:17:50 PM	450	38.929	13.681	0.936
8/2/2012	15:18:16 PM	476.4	38.985	13.644	0.88
8/2/2012	15:18:44 PM	504.6	39.037	13.614	0.828
8/2/2012	15:19:14 PM	534.6	39.093	13.585	0.772
8/2/2012	15:19:46 PM	566.4	39.139	13.555	0.726
8/2/2012	15:20:20 PM	600	39.186	13.532	0.679
8/2/2012	15:20:56 PM	636	39.236	13.507	0.629
8/2/2012	15:21:32 PM	672	39.281	13.538	0.584
8/2/2012	15:22:14 PM	714	39.331	13.483	0.534
8/2/2012	15:22:56 PM	756	39.38	13.473	0.485
8/2/2012	15:23:38 PM	798	39.42	13.441	0.445
8/2/2012	15:24:26 PM	846.063	39.457	13.449	0.408
8/2/2012	15:25:20 PM	900	39.5	13.408	0.365
8/2/2012	15:26:08 PM	948	39.534	13.401	0.331
8/2/2012	15:27:08 PM	1008	39.574	13.394	0.291
8/2/2012	15:28:08 PM	1068	39.605	13.383	0.26
8/2/2012	15:29:08 PM	1128	39.636	13.378	0.229
8/2/2012	15:30:14 PM	1194	39.663	13.369	0.202
8/2/2012	15:31:26 PM	1266.119	39.692	13.389	0.173
8/2/2012	15:32:44 PM	1344	39.72	13.358	0.145
8/2/2012	15:34:02 PM	1422	39.743	13.359	0.122
8/2/2012	15:35:26 PM	1506	39.759	13.346	0.106
8/2/2012	15:36:56 PM	1596	39.78	13.343	0.085
8/2/2012	15:38:32 PM	1692	39.792	13.346	0.073
8/2/2012	15:40:08 PM	1788	39.81	13.341	0.055
8/2/2012	15:41:56 PM	1896	39.819	13.335	0.046

B-720s Fall

8/2/2012	15:43:50 PM	2010	39.828	13.332	0.037
8/2/2012	15:45:50 PM	2130	39.836	13.329	0.029
8/2/2012	15:47:56 PM	2256	39.84	13.326	0.025
8/2/2012	15:50:08 PM	2388	39.849	13.329	0.016
8/2/2012	15:52:32 PM	2532	39.854	13.306	0.011
8/2/2012	15:55:02 PM	2682	39.859	13.294	0.006
8/2/2012	15:57:38 PM	2838	39.862	13.29	0.003
8/2/2012	16:00:26 PM	3006	39.863	13.287	0.002
8/2/2012	16:03:26 PM	3186	39.861	13.283	0.004
8/2/2012	16:06:32 PM	3372	39.865	13.282	0
8/2/2012	16:09:56 PM	3576	39.864	13.28	0.001
8/2/2012	16:13:26 PM	3786	39.864	13.278	0.001
8/2/2012	16:17:08 PM	4008	39.861	13.275	0.004



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	6
L_w	Feet	18.1
L_e	Feet	10
H	Feet	18.1
y_0	Feet	2
t_0	Seconds	0
y_t	Feet	0.1
t	Seconds	2,190

Solutions

Hydraulic Conductivity in Feet/Second
1.61E-06
Hydraulic Conductivity in Feet/Minute
9.65E-05
Hydraulic Conductivity in Feet/Day
1.39E-01

Calculations

Term	Units		
L_e/r_W	Feet/Foot	40.00	3.172
A	None	2.780	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
B	None	0.430	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	2.336	3.172

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

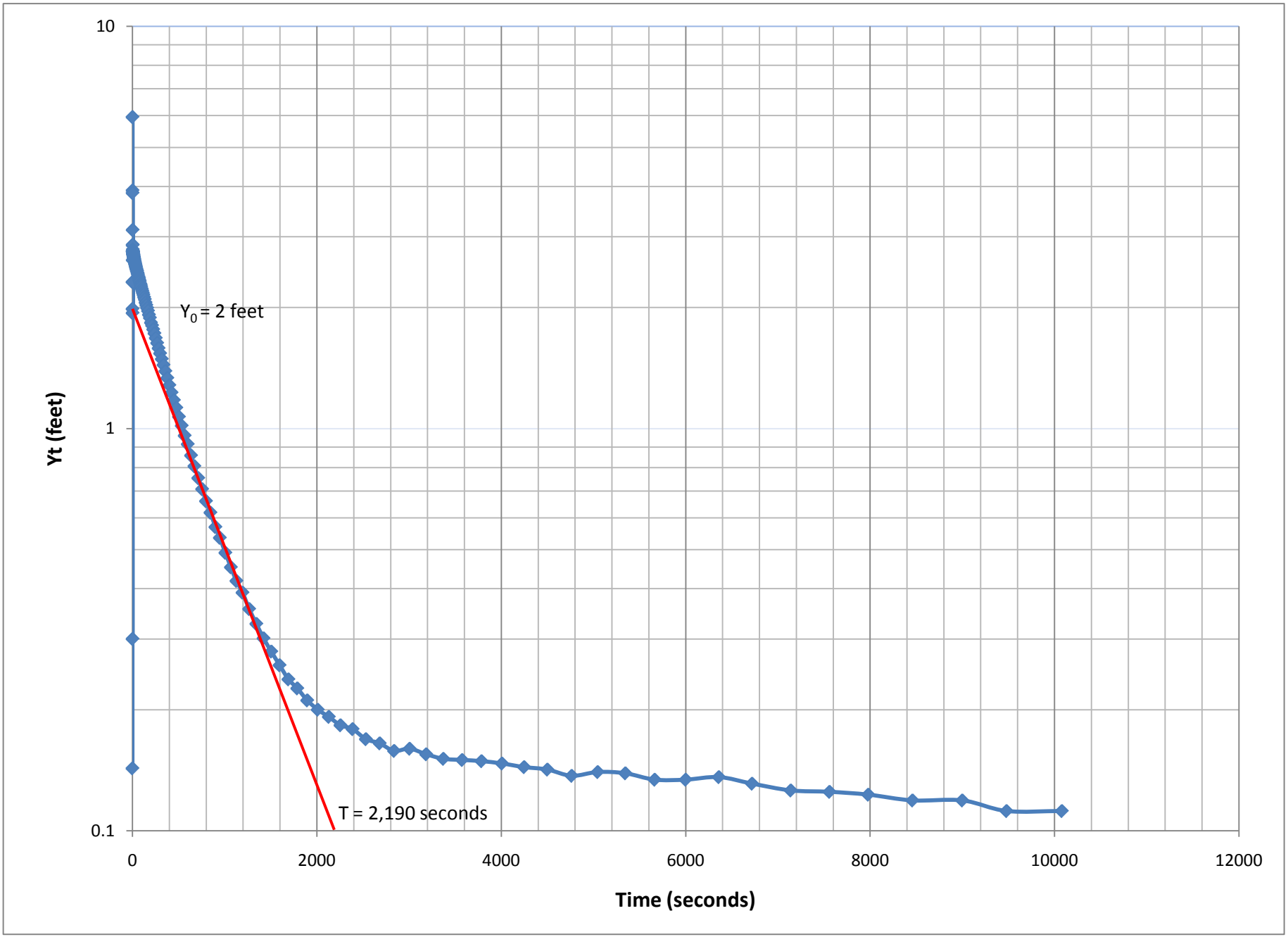
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-720s Recovery - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-720s Recovery



B-720s Recovery

Report Date:	8/7/2012 10:03
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-720s Recovery
Create Date	8/2/2012 14:20
Device	Level TROLL 700
Site	Buncombe County
Serial Number	124344
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-720s Recovery	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/2/2012 16:20	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	15.0843 (ft)
Head Pressure:	6.53291 (PSI)
Temperature:	13.664 (C)

Log Data:

Record Count 154

Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/2/2012	4:21:11 PM	0	39.843	13.287	0.143
8/2/2012	4:21:12 PM	0.25	42.013	13.302	2.313
8/2/2012	4:21:12 PM	0.6	45.645	13.315	5.945
8/2/2012	4:21:12 PM	0.827	41.683	13.334	1.983
8/2/2012	4:21:12 PM	1.049	40	13.339	0.3
8/2/2012	4:21:13 PM	1.269	43.607	13.35	3.907
8/2/2012	4:21:13 PM	1.5	43.55	13.352	3.85
8/2/2012	4:21:13 PM	1.75	41.637	13.355	1.937
8/2/2012	4:21:13 PM	2	42.555	13.358	2.855
8/2/2012	4:21:14 PM	2.25	42.816	13.362	3.116
8/2/2012	4:21:14 PM	2.5	42.322	13.364	2.622
8/2/2012	4:21:14 PM	2.75	42.464	13.364	2.764
8/2/2012	4:21:14 PM	3	42.563	13.366	2.863

B-720s Recovery

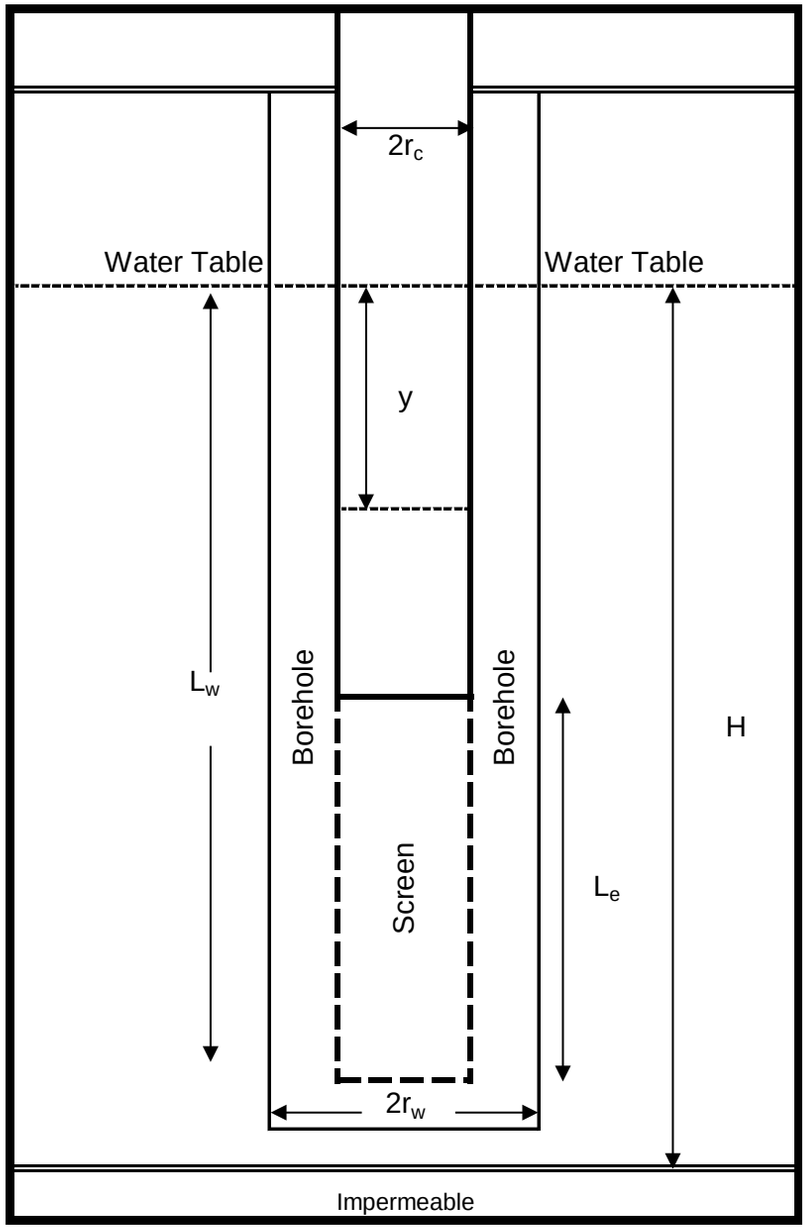
8/2/2012	4:21:15 PM	3.25	42.451	13.368	2.751
8/2/2012	4:21:15 PM	3.5	42.458	13.369	2.758
8/2/2012	4:21:15 PM	3.75	42.486	13.371	2.786
8/2/2012	4:21:15 PM	4	42.459	13.375	2.759
8/2/2012	4:21:16 PM	4.25	42.456	13.375	2.756
8/2/2012	4:21:16 PM	4.5	42.459	13.378	2.759
8/2/2012	4:21:16 PM	4.75	42.457	13.379	2.757
8/2/2012	4:21:16 PM	5	42.447	13.382	2.747
8/2/2012	4:21:17 PM	5.25	42.448	13.38	2.748
8/2/2012	4:21:17 PM	5.5	42.44	13.381	2.74
8/2/2012	4:21:17 PM	5.75	42.427	13.381	2.727
8/2/2012	4:21:17 PM	6	42.442	13.384	2.742
8/2/2012	4:21:18 PM	6.36	42.436	13.375	2.736
8/2/2012	4:21:18 PM	6.72	42.42	13.369	2.72
8/2/2012	4:21:18 PM	7.14	42.418	13.365	2.718
8/2/2012	4:21:19 PM	7.56	42.417	13.366	2.717
8/2/2012	4:21:19 PM	7.98	42.414	13.361	2.714
8/2/2012	4:21:20 PM	8.46	42.414	13.356	2.714
8/2/2012	4:21:20 PM	9	42.407	13.348	2.707
8/2/2012	4:21:21 PM	9.48	42.403	13.35	2.703
8/2/2012	4:21:21 PM	10.08	42.401	13.347	2.701
8/2/2012	4:21:22 PM	10.68	42.395	13.342	2.695
8/2/2012	4:21:23 PM	11.28	42.384	13.341	2.684
8/2/2012	4:21:23 PM	11.94	42.383	13.341	2.683
8/2/2012	4:21:24 PM	12.66	42.377	13.339	2.677
8/2/2012	4:21:25 PM	13.44	42.37	13.337	2.67
8/2/2012	4:21:26 PM	14.22	42.366	13.331	2.666
8/2/2012	4:21:26 PM	15.06	42.365	13.331	2.665
8/2/2012	4:21:27 PM	15.96	42.352	13.331	2.652
8/2/2012	4:21:28 PM	16.92	42.352	13.328	2.652
8/2/2012	4:21:29 PM	17.88	42.339	13.33	2.639
8/2/2012	4:21:30 PM	18.96	42.34	13.326	2.64
8/2/2012	4:21:31 PM	20.1	42.327	13.326	2.627
8/2/2012	4:21:33 PM	21.3	42.316	13.32	2.616
8/2/2012	4:21:34 PM	22.56	42.309	13.322	2.609
8/2/2012	4:21:35 PM	23.88	42.299	13.322	2.599
8/2/2012	4:21:37 PM	25.32	42.293	13.321	2.593
8/2/2012	4:21:38 PM	26.82	42.283	13.32	2.583
8/2/2012	4:21:40 PM	28.38	42.272	13.319	2.572
8/2/2012	4:21:41 PM	30.06	42.264	13.313	2.564
8/2/2012	4:21:43 PM	31.86	42.253	13.318	2.553
8/2/2012	4:21:45 PM	33.72	42.241	13.318	2.541
8/2/2012	4:21:47 PM	35.76	42.23	13.315	2.53
8/2/2012	4:21:49 PM	37.86	42.221	13.314	2.521
8/2/2012	4:21:51 PM	40.08	42.204	13.313	2.504
8/2/2012	4:21:54 PM	42.48	42.196	13.312	2.496
8/2/2012	4:21:56 PM	45	42.183	13.309	2.483
8/2/2012	4:21:59 PM	47.64	42.167	13.308	2.467
8/2/2012	4:22:02 PM	50.46	42.162	13.311	2.462
8/2/2012	4:22:05 PM	53.46	42.142	13.307	2.442
8/2/2012	4:22:08 PM	56.64	42.128	13.308	2.428
8/2/2012	4:22:11 PM	60	42.113	13.307	2.413
8/2/2012	4:22:15 PM	63.6	42.09	13.304	2.39
8/2/2012	4:22:19 PM	67.2	42.079	13.303	2.379
8/2/2012	4:22:23 PM	71.4	42.062	13.301	2.362
8/2/2012	4:22:27 PM	75.6	42.039	13.304	2.339

B-720s Recovery

8/2/2012	4:22:31 PM	79.8	42.021	13.302	2.321
8/2/2012	4:22:36 PM	84.6	41.993	13.299	2.293
8/2/2012	4:22:41 PM	90	41.976	13.299	2.276
8/2/2012	4:22:46 PM	94.8	41.954	13.305	2.254
8/2/2012	4:22:52 PM	100.807	41.926	13.298	2.226
8/2/2012	4:22:58 PM	106.8	41.901	13.303	2.201
8/2/2012	4:23:04 PM	112.8	41.876	13.301	2.176
8/2/2012	4:23:11 PM	119.4	41.852	13.308	2.152
8/2/2012	4:23:18 PM	126.6	41.821	13.301	2.121
8/2/2012	4:23:26 PM	134.4	41.794	13.311	2.094
8/2/2012	4:23:34 PM	142.2	41.757	13.3	2.057
8/2/2012	4:23:42 PM	150.6	41.727	13.303	2.027
8/2/2012	4:23:51 PM	159.6	41.694	13.305	1.994
8/2/2012	4:24:01 PM	169.2	41.661	13.308	1.961
8/2/2012	4:24:10 PM	178.874	41.618	13.315	1.918
8/2/2012	4:24:21 PM	189.6	41.584	13.311	1.884
8/2/2012	4:24:32 PM	201	41.533	13.304	1.833
8/2/2012	4:24:44 PM	213	41.504	13.305	1.804
8/2/2012	4:24:57 PM	225.6	41.464	13.304	1.764
8/2/2012	4:25:10 PM	238.8	41.424	13.302	1.724
8/2/2012	4:25:25 PM	253.2	41.378	13.295	1.678
8/2/2012	4:25:40 PM	268.2	41.331	13.295	1.631
8/2/2012	4:25:55 PM	283.8	41.283	13.291	1.583
8/2/2012	4:26:12 PM	300.6	41.237	13.287	1.537
8/2/2012	4:26:30 PM	318.6	41.188	13.285	1.488
8/2/2012	4:26:49 PM	337.2	41.139	13.282	1.439
8/2/2012	4:27:09 PM	357.6	41.088	13.28	1.388
8/2/2012	4:27:30 PM	378.6	41.035	13.28	1.335
8/2/2012	4:27:52 PM	400.8	40.981	13.278	1.281
8/2/2012	4:28:16 PM	424.8	40.928	13.275	1.228
8/2/2012	4:28:41 PM	450	40.876	13.276	1.176
8/2/2012	4:29:08 PM	476.4	40.826	13.276	1.126
8/2/2012	4:29:36 PM	504.6	40.769	13.274	1.069
8/2/2012	4:30:06 PM	534.6	40.716	13.272	1.016
8/2/2012	4:30:38 PM	566.4	40.66	13.271	0.96
8/2/2012	4:31:11 PM	600	40.614	13.268	0.914
8/2/2012	4:31:47 PM	636	40.557	13.268	0.857
8/2/2012	4:32:23 PM	672	40.506	13.267	0.806
8/2/2012	4:33:05 PM	714	40.453	13.269	0.753
8/2/2012	4:33:47 PM	756	40.407	13.267	0.707
8/2/2012	4:34:29 PM	798	40.36	13.267	0.66
8/2/2012	4:35:17 PM	846	40.318	13.265	0.618
8/2/2012	4:36:11 PM	900	40.269	13.263	0.569
8/2/2012	4:36:59 PM	948	40.235	13.26	0.535
8/2/2012	4:37:59 PM	1008	40.191	13.263	0.491
8/2/2012	4:38:59 PM	1068	40.152	13.26	0.452
8/2/2012	4:39:59 PM	1128	40.118	13.26	0.418
8/2/2012	4:41:05 PM	1194	40.091	13.261	0.391
8/2/2012	4:42:17 PM	1266	40.056	13.26	0.356
8/2/2012	4:43:35 PM	1344	40.027	13.258	0.327
8/2/2012	4:44:53 PM	1422	40.001	13.26	0.301
8/2/2012	4:46:17 PM	1506	39.979	13.259	0.279
8/2/2012	4:47:47 PM	1596	39.958	13.256	0.258
8/2/2012	4:49:23 PM	1692	39.938	13.255	0.238
8/2/2012	4:50:59 PM	1788	39.926	13.255	0.226
8/2/2012	4:52:47 PM	1896	39.911	13.257	0.211

B-720s Recovery

8/2/2012	4:54:41 PM	2010	39.9	13.255	0.2
8/2/2012	4:56:41 PM	2130	39.892	13.256	0.192
8/2/2012	4:58:47 PM	2256	39.883	13.256	0.183
8/2/2012	5:00:59 PM	2388	39.879	13.257	0.179
8/2/2012	5:03:23 PM	2532	39.869	13.254	0.169
8/2/2012	5:05:53 PM	2682	39.865	13.257	0.165
8/2/2012	5:08:29 PM	2838	39.858	13.255	0.158
8/2/2012	5:11:17 PM	3006	39.86	13.254	0.16
8/2/2012	5:14:17 PM	3186	39.855	13.254	0.155
8/2/2012	5:17:23 PM	3372	39.851	13.255	0.151
8/2/2012	5:20:47 PM	3576	39.85	13.253	0.15
8/2/2012	5:24:17 PM	3786	39.849	13.256	0.149
8/2/2012	5:27:59 PM	4008	39.847	13.258	0.147
8/2/2012	5:31:59 PM	4248	39.844	13.253	0.144
8/2/2012	5:36:11 PM	4500	39.842	13.252	0.142
8/2/2012	5:40:35 PM	4764	39.837	13.256	0.137
8/2/2012	5:45:17 PM	5046	39.84	13.254	0.14
8/2/2012	5:50:17 PM	5346	39.839	13.25	0.139
8/2/2012	5:55:35 PM	5664	39.834	13.253	0.134
8/2/2012	6:01:11 PM	6000	39.834	13.255	0.134
8/2/2012	6:07:11 PM	6360	39.836	13.248	0.136
8/2/2012	6:13:11 PM	6720	39.831	13.252	0.131
8/2/2012	6:20:11 PM	7140	39.826	13.254	0.126
8/2/2012	6:27:11 PM	7560	39.825	13.253	0.125
8/2/2012	6:34:11 PM	7980	39.823	13.249	0.123
8/2/2012	6:42:11 PM	8460	39.819	13.251	0.119
8/2/2012	6:51:11 PM	9000	39.819	13.252	0.119
8/2/2012	6:59:11 PM	9480	39.812	13.25	0.112
8/2/2012	7:09:11 PM	10080	39.812	13.254	0.112



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	6
L_w	Feet	31.72
L_e	Feet	10
H*	Feet	51.72
y_0	Feet	0.68
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	130

Solutions

Hydraulic Conductivity in Feet/Second
3.50E-05
Hydraulic Conductivity in Feet/Minute
2.10E-03
Hydraulic Conductivity in Feet/Day
3.03E+00

** Competent bedrock estimated at 100 feet*

Calculations

Term	Units		
L_e/r_W	Feet/Foot	40.00	2.910
A	None	2.780	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
B	None	0.430	2.910
C	None	2.336	$\ln(R_e/r_W)_{\text{full penetration}}$ =
			3.502

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

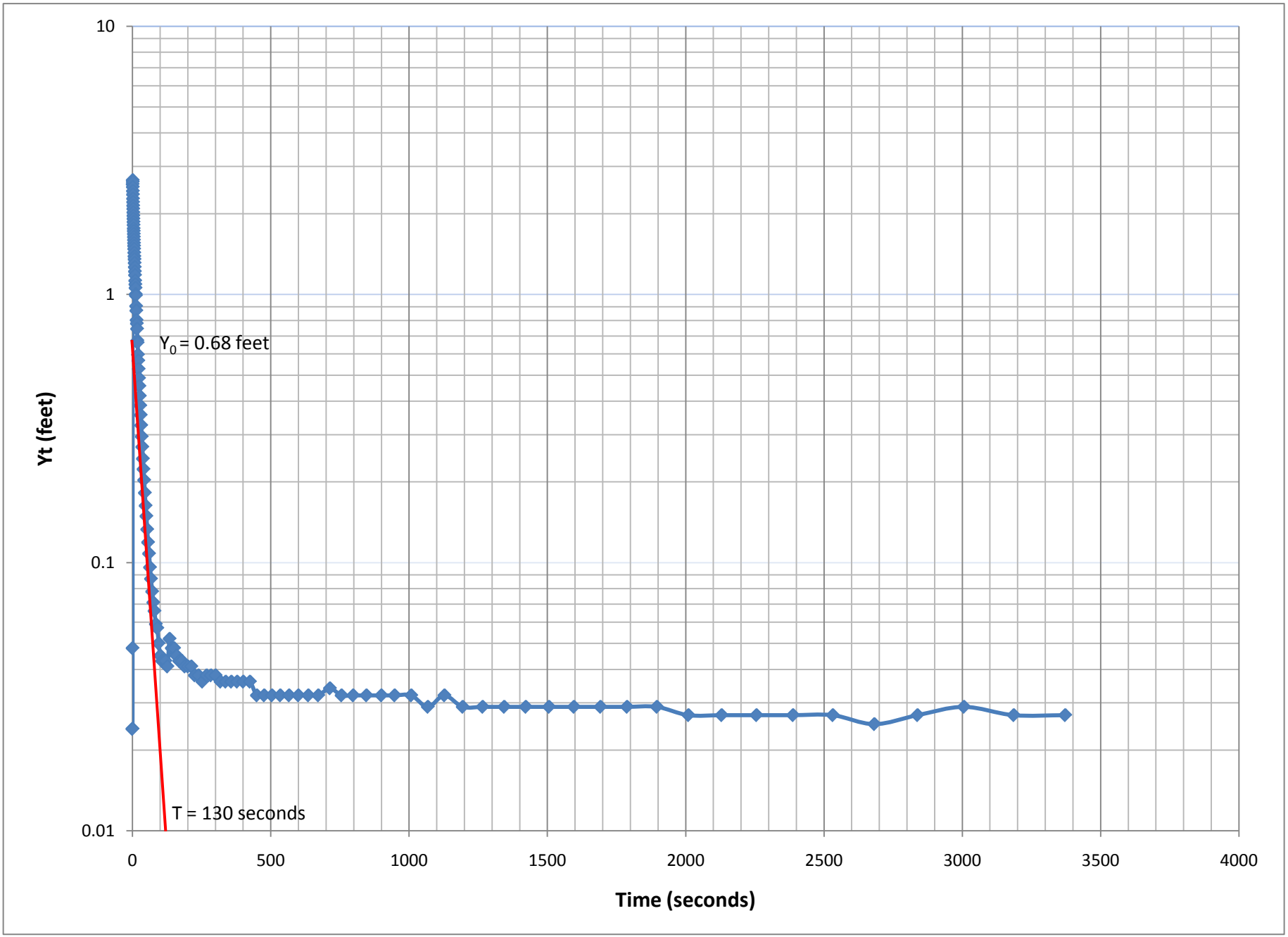
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-720d Fall - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-720d Fall


10
1
0.1
0.01
Yt (feet)
Y_0 = 0.68 feet
T = 130 seconds
0
500
1000
1500
2000
2500
3000
3500
4000
Time (seconds)

B-720d Fall

Report Date:	8/7/2012 10:06
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-720d Fall
Create Date	8/2/2012 12:04
Device	Level TROLL 700
Site	Buncombe County
Serial Number	124344
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	
Log Name	B-720d Fall
Created By	ForbesD
Computer Name	CDMLBKVLZL1
Application	WinSitu.exe
Application Version	5.6.17.7
Create Date	8/2/2012 13:06:44 PM Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time
Notes Size(bytes)	4096
Overwrite when full	Disabled
Scheduled Start Time	Manual Start Eastern Daylight Time
Scheduled Stop Time	No Stop Time Eastern Daylight Time
Type	True Logarithmic
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00
Level Reference Settings At Log Creation	
Level Measurement	
Mode	Level Depth To Water
Specific Gravity	0.999
Other Log Settings	
Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	15.0843 (ft)
Head Pressure:	6.53291 (PSI)
Temperature:	13.664 (C)
Log Data:	
Record Count	135

Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/2/2012	13:10:20 PM	0	48.276	13.831	0.024
8/2/2012	13:10:20 PM	0.251	48.252	13.847	0.024
8/2/2012	13:10:20 PM	0.501	45.724	13.862	0.048
8/2/2012	13:10:20 PM	0.751	45.633	13.868	2.576
8/2/2012	13:10:21 PM	1.001	45.673	13.874	2.667
8/2/2012	13:10:21 PM	1.251	45.785	13.881	2.627
8/2/2012	13:10:21 PM	1.501	45.871	13.883	2.515
8/2/2012	13:10:21 PM	1.751	45.943	13.887	2.429
8/2/2012	13:10:22 PM	2.001	46.025	13.88	2.357
8/2/2012	13:10:22 PM	2.251	46.092	13.88	2.275
8/2/2012	13:10:22 PM	2.501	46.157	13.883	2.208
8/2/2012	13:10:22 PM	2.751	46.215	13.882	2.143
8/2/2012	13:10:23 PM	3.001	46.278	13.881	2.085

B-720d Fall

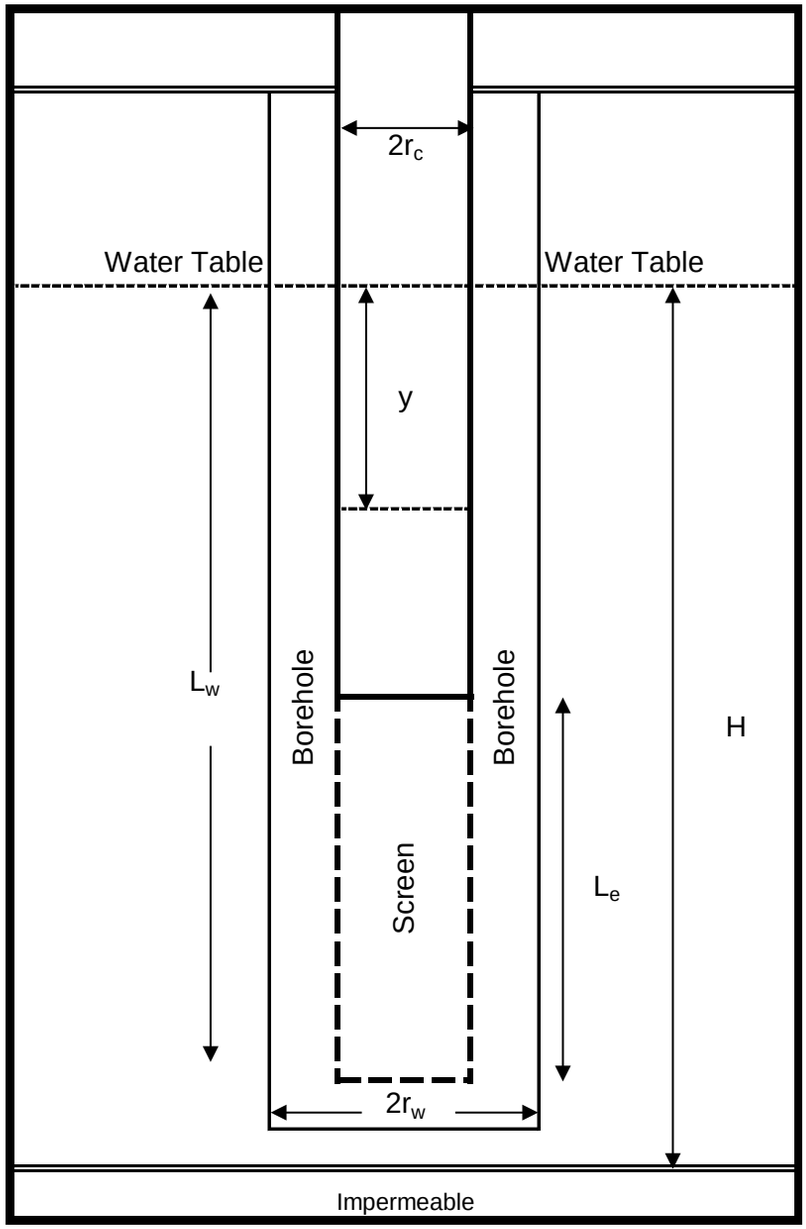
8/2/2012	13:10:23 PM	3.251	46.334	13.884	2.022
8/2/2012	13:10:23 PM	3.501	46.385	13.886	1.966
8/2/2012	13:10:23 PM	3.751	46.437	13.885	1.915
8/2/2012	13:10:24 PM	4.001	46.485	13.886	1.863
8/2/2012	13:10:24 PM	4.251	46.539	13.884	1.815
8/2/2012	13:10:24 PM	4.501	46.578	13.884	1.761
8/2/2012	13:10:24 PM	4.751	46.62	13.887	1.722
8/2/2012	13:10:25 PM	5.001	46.662	13.884	1.68
8/2/2012	13:10:25 PM	5.251	46.704	13.887	1.638
8/2/2012	13:10:25 PM	5.501	46.746	13.883	1.596
8/2/2012	13:10:25 PM	5.751	46.783	13.883	1.554
8/2/2012	13:10:26 PM	6.001	46.822	13.88	1.517
8/2/2012	13:10:26 PM	6.36	46.869	13.882	1.478
8/2/2012	13:10:26 PM	6.72	46.913	13.873	1.431
8/2/2012	13:10:27 PM	7.14	46.948	13.868	1.387
8/2/2012	13:10:27 PM	7.56	46.99	13.862	1.352
8/2/2012	13:10:28 PM	7.981	47.036	13.858	1.31
8/2/2012	13:10:28 PM	8.46	47.082	13.851	1.264
8/2/2012	13:10:29 PM	9	47.12	13.843	1.218
8/2/2012	13:10:29 PM	9.48	47.175	13.84	1.18
8/2/2012	13:10:30 PM	10.08	47.21	13.831	1.125
8/2/2012	13:10:30 PM	10.68	47.243	13.826	1.09
8/2/2012	13:10:31 PM	11.281	47.298	13.823	1.057
8/2/2012	13:10:31 PM	11.94	47.31	13.811	1.002
8/2/2012	13:10:32 PM	12.66	47.396	13.811	0.99
8/2/2012	13:10:33 PM	13.44	47.43	13.897	0.904
8/2/2012	13:10:34 PM	14.22	47.498	13.9	0.87
8/2/2012	13:10:35 PM	15.061	47.521	13.891	0.802
8/2/2012	13:10:35 PM	15.96	47.556	13.881	0.779
8/2/2012	13:10:36 PM	16.92	47.627	13.876	0.744
8/2/2012	13:10:37 PM	17.88	47.639	13.868	0.673
8/2/2012	13:10:38 PM	18.96	47.704	13.857	0.661
8/2/2012	13:10:40 PM	20.1	47.734	13.854	0.596
8/2/2012	13:10:41 PM	21.3	47.773	13.849	0.566
8/2/2012	13:10:42 PM	22.561	47.813	13.84	0.527
8/2/2012	13:10:43 PM	23.88	47.845	13.831	0.487
8/2/2012	13:10:45 PM	25.321	47.882	13.821	0.455
8/2/2012	13:10:46 PM	26.82	47.915	13.813	0.418
8/2/2012	13:10:48 PM	28.38	47.945	13.806	0.385
8/2/2012	13:10:50 PM	30.061	47.975	13.794	0.355
8/2/2012	13:10:51 PM	31.86	48.005	13.788	0.325
8/2/2012	13:10:53 PM	33.72	48.03	13.776	0.295
8/2/2012	13:10:55 PM	35.761	48.056	13.765	0.27
8/2/2012	13:10:57 PM	37.86	48.077	13.754	0.244
8/2/2012	13:11:00 PM	40.08	48.097	13.743	0.223
8/2/2012	13:11:02 PM	42.48	48.118	13.73	0.203
8/2/2012	13:11:05 PM	45	48.137	13.713	0.182
8/2/2012	13:11:07 PM	47.64	48.151	13.702	0.163
8/2/2012	13:11:10 PM	50.46	48.167	13.688	0.149
8/2/2012	13:11:13 PM	53.46	48.181	13.671	0.133
8/2/2012	13:11:16 PM	56.64	48.192	13.66	0.119
8/2/2012	13:11:20 PM	60.199	48.204	13.66	0.108
8/2/2012	13:11:23 PM	63.6	48.213	13.632	0.096
8/2/2012	13:11:27 PM	67.2	48.222	13.615	0.087
8/2/2012	13:11:31 PM	71.4	48.229	13.593	0.078
8/2/2012	13:11:35 PM	75.6	48.234	13.575	0.071
8/2/2012	13:11:39 PM	79.8	48.241	13.56	0.066
8/2/2012	13:11:44 PM	84.6	48.243	13.541	0.059
8/2/2012	13:11:50 PM	90	48.25	13.519	0.057

B-720d Fall

8/2/2012	13:11:54 PM	94.8	48.255	13.502	0.05
8/2/2012	13:12:00 PM	100.8	48.257	13.481	0.045
8/2/2012	13:12:06 PM	106.8	48.257	13.458	0.043
8/2/2012	13:12:12 PM	112.8	48.257	13.437	0.043
8/2/2012	13:12:19 PM	119.4	48.259	13.413	0.043
8/2/2012	13:12:26 PM	126.6	48.248	13.387	0.041
8/2/2012	13:12:34 PM	134.4	48.252	13.361	0.052
8/2/2012	13:12:42 PM	142.2	48.252	13.333	0.048
8/2/2012	13:12:50 PM	150.6	48.255	13.305	0.048
8/2/2012	13:12:59 PM	159.6	48.257	13.271	0.045
8/2/2012	13:13:09 PM	169.2	48.257	13.238	0.043
8/2/2012	13:13:18 PM	178.8	48.259	13.205	0.043
8/2/2012	13:13:29 PM	189.6	48.259	13.177	0.041
8/2/2012	13:13:41 PM	201	48.259	13.139	0.041
8/2/2012	13:13:53 PM	213	48.262	13.118	0.041
8/2/2012	13:14:05 PM	225.6	48.262	13.088	0.038
8/2/2012	13:14:18 PM	238.8	48.264	13.056	0.038
8/2/2012	13:14:33 PM	253.2	48.262	13.018	0.036
8/2/2012	13:14:48 PM	268.2	48.262	12.978	0.038
8/2/2012	13:13:03 PM	283.8	48.262	12.95	0.038
8/2/2012	13:13:20 PM	300.6	48.264	12.915	0.038
8/2/2012	13:13:38 PM	318.6	48.264	12.888	0.036
8/2/2012	13:13:57 PM	337.2	48.264	12.865	0.036
8/2/2012	13:16:17 PM	357.6	48.264	12.826	0.036
8/2/2012	13:16:38 PM	378.6	48.264	12.787	0.036
8/2/2012	13:17:00 PM	400.8	48.264	12.749	0.036
8/2/2012	13:17:24 PM	424.8	48.268	12.714	0.036
8/2/2012	13:17:50 PM	450	48.268	12.681	0.032
8/2/2012	13:18:16 PM	476.4	48.268	12.644	0.032
8/2/2012	13:18:44 PM	504.6	48.268	12.614	0.032
8/2/2012	13:19:14 PM	534.6	48.268	12.585	0.032
8/2/2012	13:19:46 PM	566.4	48.268	12.555	0.032
8/2/2012	13:20:20 PM	600	48.268	12.532	0.032
8/2/2012	13:20:56 PM	636	48.268	12.507	0.032
8/2/2012	13:21:32 PM	672	48.266	12.538	0.032
8/2/2012	13:22:14 PM	714	48.268	12.483	0.034
8/2/2012	13:22:56 PM	756	48.268	12.473	0.032
8/2/2012	13:23:38 PM	798	48.268	12.441	0.032
8/2/2012	13:24:26 PM	846.063	48.268	12.449	0.032
8/2/2012	13:25:20 PM	900	48.268	12.408	0.032
8/2/2012	13:26:08 PM	948	48.268	12.401	0.032
8/2/2012	13:27:08 PM	1008	48.271	12.394	0.032
8/2/2012	13:28:08 PM	1068	48.268	12.383	0.029
8/2/2012	13:29:08 PM	1128	48.271	12.378	0.032
8/2/2012	13:30:14 PM	1194	48.271	12.369	0.029
8/2/2012	13:31:26 PM	1266.119	48.271	12.389	0.029
8/2/2012	13:32:44 PM	1344	48.271	12.358	0.029
8/2/2012	13:34:02 PM	1422	48.271	12.359	0.029
8/2/2012	13:35:26 PM	1506	48.271	12.346	0.029
8/2/2012	13:36:56 PM	1596	48.271	12.343	0.029
8/2/2012	13:38:32 PM	1692	48.271	12.346	0.029
8/2/2012	13:40:08 PM	1788	48.271	12.341	0.029
8/2/2012	13:41:56 PM	1896	48.273	12.335	0.029
8/2/2012	13:43:50 PM	2010	48.273	12.332	0.027
8/2/2012	13:45:50 PM	2130	48.273	12.329	0.027
8/2/2012	13:47:56 PM	2256	48.273	12.326	0.027
8/2/2012	13:50:08 PM	2388	48.273	12.329	0.027
8/2/2012	13:52:32 PM	2532	48.275	12.306	0.027
8/2/2012	13:55:02 PM	2682	48.273	12.294	0.025

B-720d Fall

8/2/2012	13:57:38 PM	2838	48.271	12.29	0.027
8/2/2012	14:00:26 PM	3006	48.273	12.287	0.029
8/2/2012	14:03:26 PM	3186	48.273	12.283	0.027
8/2/2012	14:06:32 PM	3372	48.271	12.282	0.027



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	6
L_w	Feet	31.72
L_e	Feet	10
H*	Feet	51.72
y_0	Feet	0.5
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	160

Solutions

Hydraulic Conductivity in Feet/Second
2.64E-05
Hydraulic Conductivity in Feet/Minute
1.58E-03
Hydraulic Conductivity in Feet/Day
2.28E+00

** Competent bedrock estimated at 100 feet*

Calculations

Term	Units		
L_e/r_W	Feet/Foot	40.00	2.910
A	None	2.780	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
B	None	0.430	2.910
C	None	2.336	$\ln(R_e/r_W)_{\text{full penetration}}$ =
			3.502

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

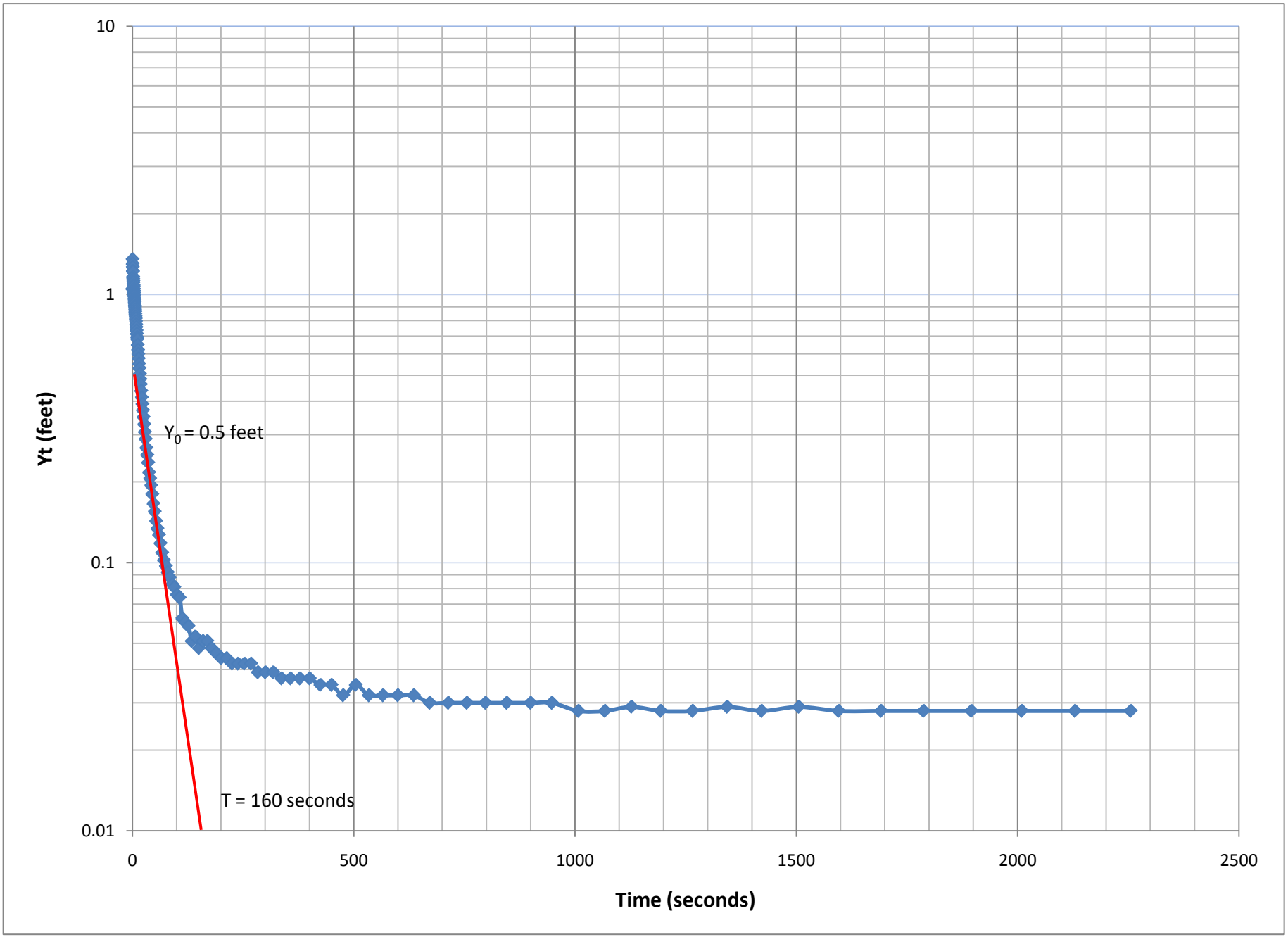
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-720d Recovery - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-720d Recovery



B-720d Recovery

Report Date:	8/7/2012 10:08
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-720d Recovery
Create Date	8/2/2012 12:04
Device	Level TROLL 700
Site	Buncombe County
Serial Number	124344
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-720d Fall	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/2/2012 13:07:44 PM	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement	
Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	15.0843 (ft)
Head Pressure:	6.53291 (PSI)
Temperature:	13.664 (C)

Log Data:

Record Count 128

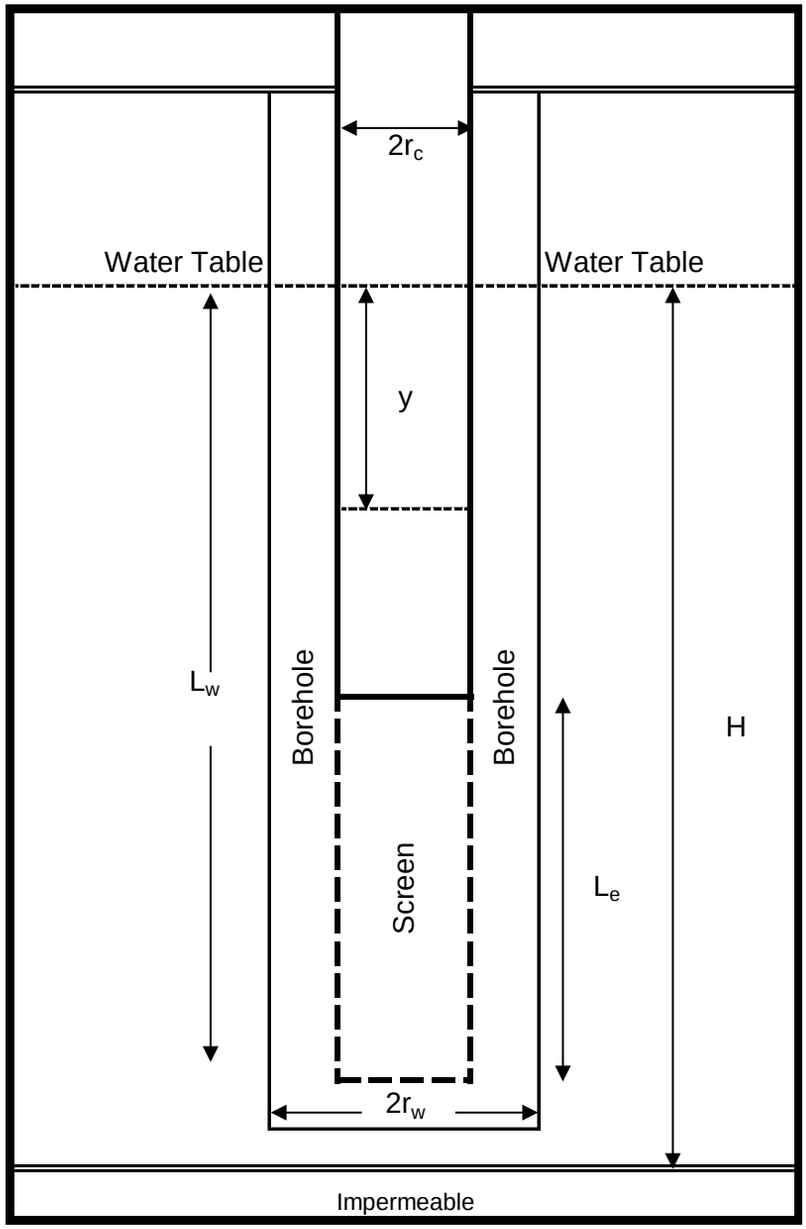
Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/2/2012	14:10:20 PM	0	49.25	14.931	1.05
8/2/2012	14:10:20 PM	0.251	49.554	14.947	1.354
8/2/2012	14:10:20 PM	0.501	49.503	14.962	1.303
8/2/2012	14:10:20 PM	0.751	49.466	14.968	1.266
8/2/2012	14:10:21 PM	1.001	49.423	14.974	1.223
8/2/2012	14:10:21 PM	1.251	49.418	14.981	1.218
8/2/2012	14:10:21 PM	1.501	49.358	14.983	1.158
8/2/2012	14:10:21 PM	1.751	49.365	14.987	1.165
8/2/2012	14:10:22 PM	2.001	49.342	14.99	1.142
8/2/2012	14:10:22 PM	2.251	49.324	14.99	1.124
8/2/2012	14:10:22 PM	2.501	49.308	14.993	1.108
8/2/2012	14:10:22 PM	2.751	49.285	14.992	1.085
8/2/2012	14:10:23 PM	3.001	49.273	14.991	1.073

B-720d Recovery

8/2/2012	14:10:23 PM	3.251	49.25	14.994	1.05
8/2/2012	14:10:23 PM	3.501	49.232	14.996	1.032
8/2/2012	14:10:23 PM	3.751	49.215	14.995	1.015
8/2/2012	14:10:24 PM	4.001	49.199	14.996	0.999
8/2/2012	14:10:24 PM	4.251	49.185	14.994	0.985
8/2/2012	14:10:24 PM	4.501	49.167	14.994	0.967
8/2/2012	14:10:24 PM	4.751	49.153	14.997	0.953
8/2/2012	14:10:25 PM	5.001	49.139	14.994	0.939
8/2/2012	14:10:25 PM	5.251	49.126	14.997	0.926
8/2/2012	14:10:25 PM	5.501	49.109	14.993	0.909
8/2/2012	14:10:25 PM	5.751	49.096	14.993	0.896
8/2/2012	14:10:26 PM	6.001	49.079	14.99	0.879
8/2/2012	14:10:26 PM	6.36	49.063	14.982	0.863
8/2/2012	14:10:26 PM	6.72	49.047	14.973	0.847
8/2/2012	14:10:27 PM	7.14	49.029	14.968	0.829
8/2/2012	14:10:27 PM	7.56	49.013	14.962	0.813
8/2/2012	14:10:28 PM	7.981	48.994	14.959	0.794
8/2/2012	14:10:28 PM	8.46	48.973	14.951	0.773
8/2/2012	14:10:29 PM	9	48.955	14.943	0.755
8/2/2012	14:10:29 PM	9.48	48.934	14.94	0.734
8/2/2012	14:10:30 PM	10.08	48.913	14.931	0.713
8/2/2012	14:10:30 PM	10.68	48.893	14.926	0.693
8/2/2012	14:10:31 PM	11.281	48.881	14.923	0.681
8/2/2012	14:10:31 PM	11.94	48.849	14.911	0.649
8/2/2012	14:10:32 PM	12.66	48.821	14.911	0.621
8/2/2012	14:10:33 PM	13.44	48.8	14.897	0.6
8/2/2012	14:10:34 PM	14.22	48.777	14.9	0.577
8/2/2012	14:10:35 PM	15.061	48.752	14.891	0.552
8/2/2012	14:10:35 PM	15.96	48.731	14.881	0.531
8/2/2012	14:10:36 PM	16.92	48.706	14.876	0.506
8/2/2012	14:10:37 PM	17.88	48.683	14.868	0.483
8/2/2012	14:10:38 PM	18.96	48.662	14.857	0.462
8/2/2012	14:10:40 PM	20.1	48.637	14.854	0.437
8/2/2012	14:10:41 PM	21.3	48.613	14.849	0.413
8/2/2012	14:10:42 PM	22.561	48.59	14.84	0.39
8/2/2012	14:10:43 PM	23.88	48.57	14.831	0.37
8/2/2012	14:10:45 PM	25.321	48.549	14.821	0.349
8/2/2012	14:10:46 PM	26.82	48.528	14.814	0.328
8/2/2012	14:10:48 PM	28.38	48.507	14.806	0.307
8/2/2012	14:10:50 PM	30.061	48.489	14.794	0.289
8/2/2012	14:10:51 PM	31.86	48.468	14.788	0.268
8/2/2012	14:10:53 PM	33.72	48.452	14.776	0.252
8/2/2012	14:10:55 PM	35.761	48.436	14.765	0.236
8/2/2012	14:10:57 PM	37.86	48.417	14.754	0.217
8/2/2012	14:11:00 PM	40.08	48.406	14.743	0.206
8/2/2012	14:11:02 PM	42.48	48.394	14.73	0.194
8/2/2012	14:11:05 PM	45	48.38	14.713	0.18
8/2/2012	14:11:07 PM	47.64	48.366	14.702	0.166
8/2/2012	14:11:10 PM	50.46	48.355	14.688	0.155
8/2/2012	14:11:13 PM	53.46	48.343	14.671	0.143
8/2/2012	14:11:16 PM	56.64	48.334	14.66	0.134
8/2/2012	14:11:20 PM	60.199	48.327	14.66	0.127
8/2/2012	14:11:23 PM	63.6	48.318	14.632	0.118
8/2/2012	14:11:27 PM	67.2	48.309	14.615	0.109
8/2/2012	14:11:31 PM	71.4	48.302	14.593	0.102
8/2/2012	14:11:35 PM	75.6	48.297	14.575	0.097
8/2/2012	14:11:39 PM	79.8	48.292	14.56	0.092
8/2/2012	14:11:44 PM	84.6	48.288	14.541	0.088
8/2/2012	14:11:50 PM	90	48.283	14.519	0.083

B-720d Recovery

8/2/2012	14:11:54 PM	94.8	48.281	14.502	0.081
8/2/2012	14:12:00 PM	100.8	48.276	14.481	0.076
8/2/2012	14:12:06 PM	106.8	48.274	14.458	0.074
8/2/2012	14:12:12 PM	112.8	48.262	14.437	0.062
8/2/2012	14:12:19 PM	119.4	48.26	14.414	0.06
8/2/2012	14:12:26 PM	126.6	48.258	14.387	0.058
8/2/2012	14:12:34 PM	134.4	48.251	14.361	0.051
8/2/2012	14:12:42 PM	142.2	48.253	14.333	0.053
8/2/2012	14:12:50 PM	150.6	48.248	14.305	0.048
8/2/2012	14:12:59 PM	159.6	48.251	14.271	0.051
8/2/2012	14:13:09 PM	169.2	48.251	14.238	0.051
8/2/2012	14:13:18 PM	178.8	48.248	14.205	0.048
8/2/2012	14:13:29 PM	189.6	48.246	14.177	0.046
8/2/2012	14:13:41 PM	201	48.244	14.149	0.044
8/2/2012	14:13:53 PM	213	48.244	14.118	0.044
8/2/2012	14:14:05 PM	225.6	48.242	14.088	0.042
8/2/2012	14:14:18 PM	238.8	48.242	14.056	0.042
8/2/2012	14:14:33 PM	253.2	48.242	14.018	0.042
8/2/2012	14:14:48 PM	268.2	48.242	13.978	0.042
8/2/2012	14:14:03 PM	283.8	48.239	13.95	0.039
8/2/2012	14:14:20 PM	300.6	48.239	13.915	0.039
8/2/2012	14:14:38 PM	318.6	48.239	13.888	0.039
8/2/2012	14:14:57 PM	337.2	48.237	13.865	0.037
8/2/2012	14:16:17 PM	357.6	48.237	13.826	0.037
8/2/2012	14:16:38 PM	378.6	48.237	13.787	0.037
8/2/2012	14:17:00 PM	400.8	48.237	13.749	0.037
8/2/2012	14:17:24 PM	424.8	48.235	13.714	0.035
8/2/2012	14:17:50 PM	450	48.235	13.681	0.035
8/2/2012	14:18:16 PM	476.4	48.232	13.644	0.032
8/2/2012	14:18:44 PM	504.6	48.235	13.614	0.035
8/2/2012	14:19:14 PM	534.6	48.232	13.585	0.032
8/2/2012	14:19:46 PM	566.4	48.232	13.555	0.032
8/2/2012	14:20:20 PM	600	48.232	13.532	0.032
8/2/2012	14:20:56 PM	636	48.232	13.507	0.032
8/2/2012	14:21:32 PM	672	48.23	13.538	0.03
8/2/2012	14:22:14 PM	714	48.23	13.483	0.03
8/2/2012	14:22:56 PM	756	48.23	13.473	0.03
8/2/2012	14:23:38 PM	798	48.23	13.441	0.03
8/2/2012	14:24:26 PM	846.063	48.23	13.449	0.03
8/2/2012	14:25:20 PM	900	48.23	13.408	0.03
8/2/2012	14:26:08 PM	948	48.23	13.401	0.03
8/2/2012	14:27:08 PM	1008	48.228	13.394	0.028
8/2/2012	14:28:08 PM	1068	48.228	13.383	0.028
8/2/2012	14:29:08 PM	1128	48.229	13.378	0.029
8/2/2012	14:30:14 PM	1194	48.228	13.369	0.028
8/2/2012	14:31:26 PM	1266.119	48.228	13.389	0.028
8/2/2012	14:32:44 PM	1344	48.229	13.358	0.029
8/2/2012	14:34:02 PM	1422	48.228	13.359	0.028
8/2/2012	14:35:26 PM	1506	48.229	13.346	0.029
8/2/2012	14:36:56 PM	1596	48.228	13.343	0.028
8/2/2012	14:38:32 PM	1692	48.228	13.346	0.028
8/2/2012	14:40:08 PM	1788	48.228	13.341	0.028
8/2/2012	14:41:56 PM	1896	48.228	13.335	0.028
8/2/2012	14:43:50 PM	2010	48.228	13.332	0.028
8/2/2012	14:45:50 PM	2130	48.228	13.329	0.028
8/2/2012	14:47:56 PM	2256	48.228	13.326	0.028



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	8
L_w	Feet	11.8
L_e	Feet	10
H	Feet	18.8
y_0	Feet	3.75
t_0	Seconds	0
y_t	Feet	1
t	Seconds	585

Solutions

Hydraulic Conductivity in Feet/Second
1.95E-06
Hydraulic Conductivity in Feet/Minute
1.17E-04
Hydraulic Conductivity in Feet/Day
1.69E-01

Calculations

Term	Units		
L_e/r_W	Feet/Foot	30.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 2.332
A	None	2.475	$\ln(R_e/r_W)_{\text{full penetration}}$ = 2.332
B	None	0.374	
C	None	2.001	

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

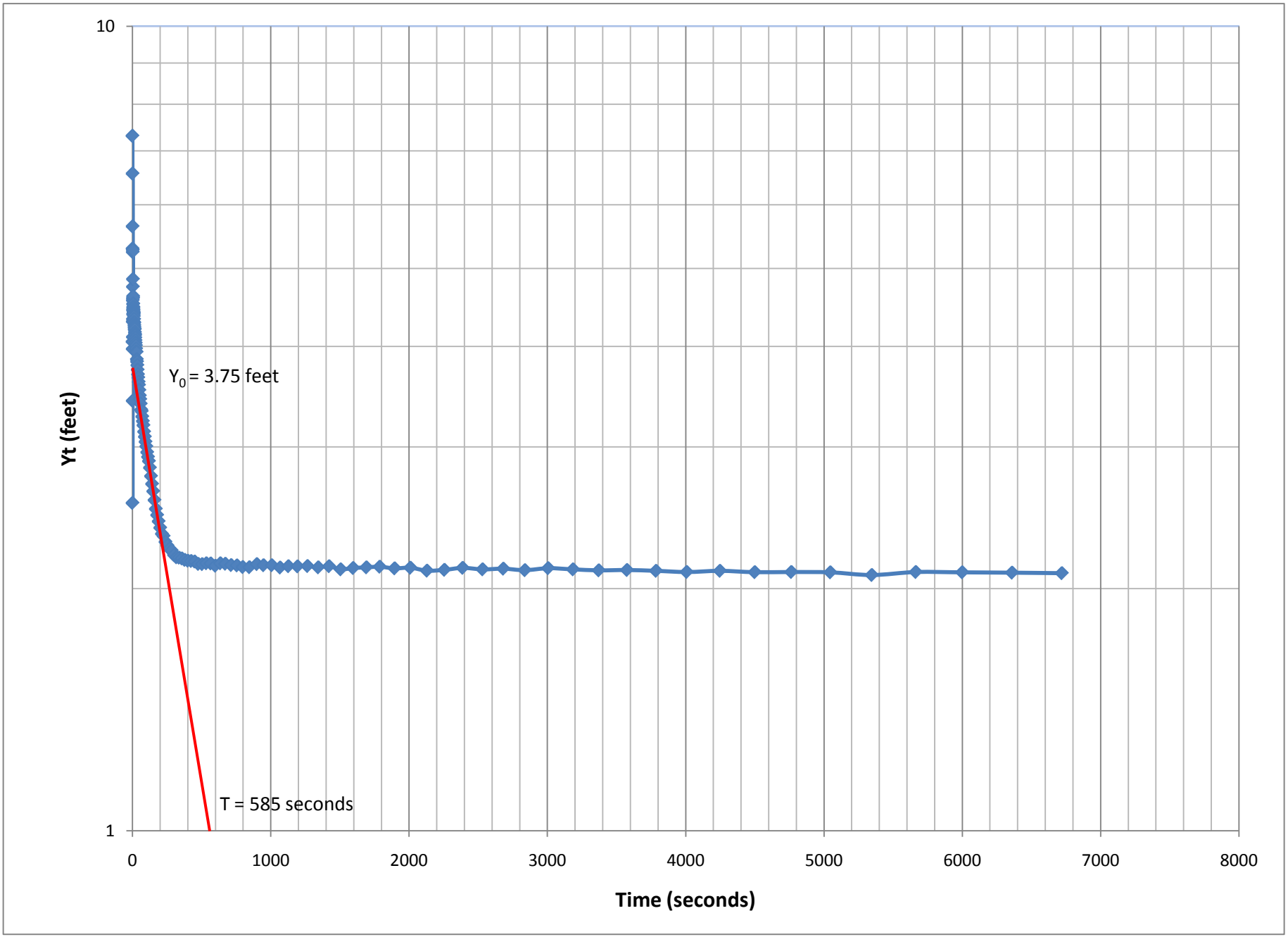
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-722s Fall - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-722s Fall


10
1
Yt (feet)
Y_0 = 3.75 feet
T = 585 seconds
0
1000
2000
3000
4000
5000
6000
7000
8000
Time (seconds)

B-722s Fall

Report Date:	8/20/2012 9:30
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-722s Fall
Create Date	8/16/2012 16:51
Device	Level TROLL 700
Site	Buncombe County
Serial Number	174297
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-722s Fall	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/16/2012 14:57	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	15.0843 (ft)
Head Pressure:	6.53291 (PSI)
Temperature:	13.664 (C)

Log Data:

Record Count 147

Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/16/2012	2:58:26 PM	0	7.093	13.478	7.307
8/16/2012	2:58:26 PM	0.251	10.346	13.503	4.054
8/16/2012	2:58:27 PM	0.501	11.845	13.513	2.555
8/16/2012	2:58:27 PM	0.751	9.108	13.525	5.292
8/16/2012	2:58:27 PM	1.001	7.841	13.531	6.559
8/16/2012	2:58:27 PM	1.251	8.761	13.534	5.639
8/16/2012	2:58:28 PM	1.501	10.429	13.541	3.971
8/16/2012	2:58:28 PM	1.751	10.977	13.545	3.423
8/16/2012	2:58:28 PM	2.001	10.106	13.545	4.294
8/16/2012	2:58:28 PM	2.251	9.16	13.549	5.24
8/16/2012	2:58:29 PM	2.501	9.129	13.551	5.271
8/16/2012	2:58:29 PM	2.751	9.837	13.556	4.563
8/16/2012	2:58:29 PM	3.001	10.291	13.557	4.109
8/16/2012	2:58:29 PM	3.251	10.075	13.558	4.325

B-722s Fall

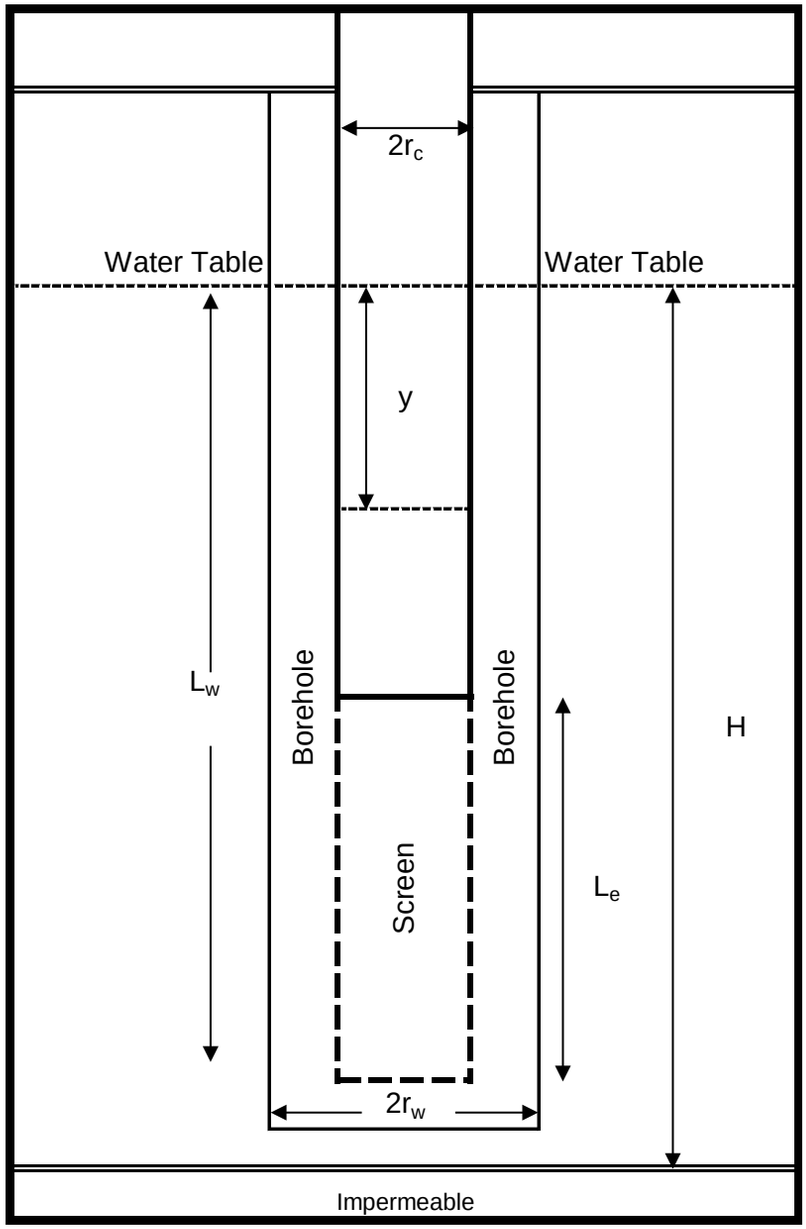
8/16/2012	2:58:30 PM	3.501	9.656	13.558	4.744
8/16/2012	2:58:30 PM	3.751	9.551	13.56	4.849
8/16/2012	2:58:30 PM	4.001	9.812	13.56	4.588
8/16/2012	2:58:30 PM	4.251	10.014	13.563	4.386
8/16/2012	2:58:31 PM	4.501	9.963	13.562	4.437
8/16/2012	2:58:31 PM	4.751	9.8	13.565	4.6
8/16/2012	2:58:31 PM	5.001	9.782	13.564	4.618
8/16/2012	2:58:31 PM	5.251	9.885	13.564	4.515
8/16/2012	2:58:32 PM	5.501	9.953	13.566	4.447
8/16/2012	2:58:32 PM	5.751	9.928	13.568	4.472
8/16/2012	2:58:32 PM	6.001	9.881	13.568	4.519
8/16/2012	2:58:32 PM	6.361	9.921	13.554	4.479
8/16/2012	2:58:33 PM	6.721	9.953	13.554	4.447
8/16/2012	2:58:33 PM	7.141	9.932	13.545	4.468
8/16/2012	2:58:34 PM	7.561	9.96	13.541	4.44
8/16/2012	2:58:34 PM	7.981	9.974	13.541	4.426
8/16/2012	2:58:35 PM	8.461	9.988	13.534	4.412
8/16/2012	2:58:35 PM	9.001	9.997	13.531	4.403
8/16/2012	2:58:36 PM	9.481	10.002	13.528	4.398
8/16/2012	2:58:36 PM	10.081	10.018	13.521	4.382
8/16/2012	2:58:37 PM	10.681	10.041	13.519	4.359
8/16/2012	2:58:37 PM	11.281	10.079	13.517	4.321
8/16/2012	2:58:38 PM	11.941	10.076	13.516	4.324
8/16/2012	2:58:39 PM	12.661	10.114	13.515	4.286
8/16/2012	2:58:40 PM	13.441	10.125	13.508	4.275
8/16/2012	2:58:40 PM	14.221	10.152	13.509	4.248
8/16/2012	2:58:41 PM	15.061	10.175	13.508	4.225
8/16/2012	2:58:42 PM	15.961	10.204	13.501	4.196
8/16/2012	2:58:43 PM	16.921	10.195	13.499	4.205
8/16/2012	2:58:44 PM	17.881	10.234	13.499	4.166
8/16/2012	2:58:45 PM	18.961	10.256	13.494	4.144
8/16/2012	2:58:46 PM	20.101	10.271	13.492	4.129
8/16/2012	2:58:47 PM	21.301	10.3	13.488	4.1
8/16/2012	2:58:49 PM	22.561	10.332	13.486	4.068
8/16/2012	2:58:50 PM	23.881	10.361	13.481	4.039
8/16/2012	2:58:51 PM	25.321	10.39	13.481	4.01
8/16/2012	2:58:53 PM	26.821	10.426	13.478	3.974
8/16/2012	2:58:54 PM	28.381	10.462	13.477	3.938
8/16/2012	2:58:56 PM	30.061	10.465	13.471	3.935
8/16/2012	2:58:58 PM	31.861	10.545	13.468	3.855
8/16/2012	2:59:00 PM	33.721	10.571	13.465	3.829
8/16/2012	2:59:02 PM	35.761	10.61	13.473	3.79
8/16/2012	2:59:04 PM	37.863	10.66	13.491	3.74
8/16/2012	2:59:06 PM	40.081	10.709	13.463	3.691
8/16/2012	2:59:09 PM	42.481	10.742	13.455	3.658
8/16/2012	2:59:11 PM	45	10.787	13.458	3.613
8/16/2012	2:59:14 PM	47.641	10.819	13.45	3.581
8/16/2012	2:59:17 PM	50.461	10.872	13.448	3.528
8/16/2012	2:59:20 PM	53.461	10.926	13.444	3.474
8/16/2012	2:59:23 PM	56.641	10.962	13.439	3.438
8/16/2012	2:59:26 PM	60.001	11.007	13.435	3.393
8/16/2012	2:59:30 PM	63.601	11.063	13.428	3.337
8/16/2012	2:59:33 PM	67.201	11.078	13.422	3.322
8/16/2012	2:59:37 PM	71.401	11.128	13.42	3.272
8/16/2012	2:59:42 PM	75.601	11.171	13.413	3.229
8/16/2012	2:59:46 PM	79.801	11.209	13.408	3.191

B-722s Fall

8/16/2012	2:59:51 PM	84.601	11.267	13.405	3.133
8/16/2012	2:59:56 PM	90.001	11.312	13.401	3.088
8/16/2012	3:00:01 PM	94.801	11.356	13.393	3.044
8/16/2012	3:00:07 PM	100.801	11.396	13.391	3.004
8/16/2012	3:00:13 PM	106.801	11.446	13.383	2.954
8/16/2012	3:00:19 PM	112.801	11.485	13.378	2.915
8/16/2012	3:00:25 PM	119.401	11.52	13.373	2.88
8/16/2012	3:00:33 PM	126.601	11.574	13.365	2.826
8/16/2012	3:00:40 PM	134.401	11.641	13.358	2.759
8/16/2012	3:00:48 PM	142.201	11.702	13.355	2.698
8/16/2012	3:00:57 PM	150.601	11.758	13.347	2.642
8/16/2012	3:01:06 PM	159.601	11.824	13.344	2.576
8/16/2012	3:01:15 PM	169.201	11.888	13.336	2.512
8/16/2012	3:01:25 PM	178.801	11.932	13.331	2.468
8/16/2012	3:01:36 PM	189.601	11.976	13.329	2.424
8/16/2012	3:01:47 PM	201.001	12.02	13.321	2.38
8/16/2012	3:01:59 PM	213.001	12.061	13.314	2.339
8/16/2012	3:02:12 PM	225.601	12.076	13.313	2.324
8/16/2012	3:02:25 PM	238.801	12.114	13.306	2.286
8/16/2012	3:02:39 PM	253.201	12.138	13.3	2.262
8/16/2012	3:02:54 PM	268.201	12.159	13.299	2.241
8/16/2012	3:03:10 PM	283.8	12.17	13.296	2.23
8/16/2012	3:03:27 PM	300.601	12.198	13.288	2.202
8/16/2012	3:03:45 PM	318.601	12.213	13.285	2.187
8/16/2012	3:04:03 PM	337.201	12.215	13.282	2.185
8/16/2012	3:04:24 PM	357.601	12.22	13.275	2.18
8/16/2012	3:04:45 PM	378.601	12.229	13.274	2.171
8/16/2012	3:05:07 PM	400.8	12.234	13.269	2.166
8/16/2012	3:05:31 PM	424.8	12.236	13.265	2.164
8/16/2012	3:05:56 PM	450.001	12.239	13.267	2.161
8/16/2012	3:06:22 PM	476.401	12.254	13.261	2.146
8/16/2012	3:06:51 PM	504.601	12.255	13.256	2.145
8/16/2012	3:07:21 PM	534.601	12.25	13.256	2.15
8/16/2012	3:07:52 PM	566.401	12.251	13.253	2.149
8/16/2012	3:08:26 PM	600	12.265	13.249	2.135
8/16/2012	3:09:02 PM	636	12.25	13.248	2.15
8/16/2012	3:09:38 PM	672	12.253	13.245	2.147
8/16/2012	3:10:20 PM	714	12.261	13.244	2.139
8/16/2012	3:11:02 PM	756	12.263	13.244	2.137
8/16/2012	3:11:44 PM	798	12.273	13.243	2.127
8/16/2012	3:12:32 PM	846	12.274	13.243	2.126
8/16/2012	3:13:26 PM	900	12.255	13.24	2.145
8/16/2012	3:14:14 PM	948	12.262	13.238	2.138
8/16/2012	3:15:14 PM	1008	12.262	13.237	2.138
8/16/2012	3:16:14 PM	1068	12.276	13.236	2.124
8/16/2012	3:17:14 PM	1128	12.268	13.236	2.132
8/16/2012	3:18:20 PM	1194	12.269	13.233	2.131
8/16/2012	3:19:32 PM	1266	12.267	13.23	2.133
8/16/2012	3:20:50 PM	1344	12.275	13.229	2.125
8/16/2012	3:22:08 PM	1422	12.268	13.226	2.132
8/16/2012	3:23:32 PM	1506	12.287	13.224	2.113
8/16/2012	3:25:02 PM	1596	12.279	13.224	2.121
8/16/2012	3:26:38 PM	1692	12.275	13.222	2.125
8/16/2012	3:28:14 PM	1788	12.271	13.218	2.129
8/16/2012	3:30:02 PM	1896	12.281	13.217	2.119
8/16/2012	3:31:56 PM	2010	12.277	13.213	2.123

B-722s Fall

8/16/2012	3:33:56 PM	2130	12.295	13.212	2.105
8/16/2012	3:36:02 PM	2256	12.29	13.212	2.11
8/16/2012	3:38:14 PM	2388	12.278	13.207	2.122
8/16/2012	3:40:38 PM	2532	12.287	13.201	2.113
8/16/2012	3:43:08 PM	2682	12.283	13.204	2.117
8/16/2012	3:45:44 PM	2838	12.292	13.208	2.108
8/16/2012	3:48:32 PM	3006	12.28	13.211	2.12
8/16/2012	3:51:32 PM	3186	12.287	13.222	2.113
8/16/2012	3:54:38 PM	3372	12.293	13.236	2.107
8/16/2012	3:58:02 PM	3576	12.291	13.244	2.109
8/16/2012	4:01:32 PM	3786	12.296	13.255	2.104
8/16/2012	4:05:14 PM	4008	12.303	13.264	2.097
8/16/2012	4:09:14 PM	4248	12.296	13.264	2.104
8/16/2012	4:13:26 PM	4500	12.304	13.264	2.096
8/16/2012	4:17:50 PM	4764	12.303	13.265	2.097
8/16/2012	4:22:32 PM	5046	12.305	13.262	2.095
8/16/2012	4:27:32 PM	5346	12.321	13.261	2.079
8/16/2012	4:32:50 PM	5664	12.303	13.255	2.097
8/16/2012	4:38:26 PM	6000	12.305	13.252	2.095
8/16/2012	4:44:26 PM	6360	12.307	13.249	2.093
8/16/2012	4:50:26 PM	6720	12.31	13.242	2.09



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	8
L_w	Feet	11.8
L_e	Feet	10
H	Feet	18.8
y_0	Feet	0.2
t_0	Seconds	0
y_t	Feet	0.0001
t	Seconds	600

Solutions

Hydraulic Conductivity in Feet/Second
1.10E-05
Hydraulic Conductivity in Feet/Minute
6.57E-04
Hydraulic Conductivity in Feet/Day
9.47E-01

Calculations

Term	Units		
L_e/r_W	Feet/Foot	30.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 2.332
A	None	2.475	$\ln(R_e/r_W)_{\text{full penetration}}$ = 2.332
B	None	0.374	
C	None	2.001	

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

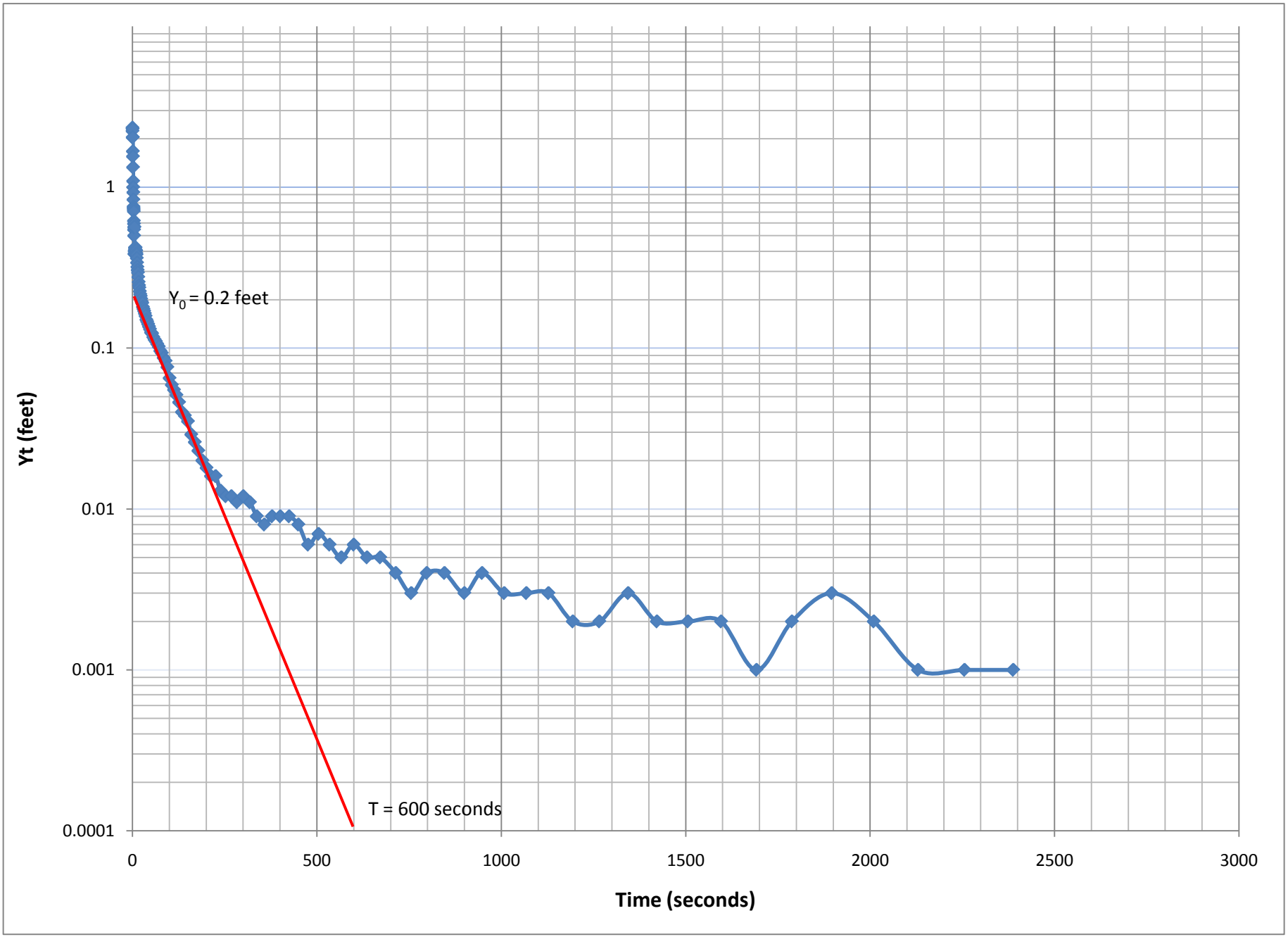
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-722s Recovery - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-722s Recovery



B-722s Recovery

Report Date:	8/20/2012 9:34
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-722s Recovery
Create Date	8/16/2012 11:51
Device	Level TROLL 700
Site	Buncombe County
Serial Number	174297
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	
Log Name	B-722s Recovery
Created By	ForbesD
Computer Name	CDMLBKVLZL1
Application	WinSitu.exe
Application Version	5.6.17.7
Create Date	8/16/2012 16:51 Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time
Notes Size(bytes)	4096
Overwrite when full	Disabled
Scheduled Start Time	Manual Start Eastern Daylight Time
Scheduled Stop Time	No Stop Time Eastern Daylight Time
Type	True Logarithmic
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00
Level Reference Settings At Log Creation	
Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999
Other Log Settings	
Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	15.0843 (ft)
Head Pressure:	6.53291 (PSI)
Temperature:	13.664 (C)
Log Data:	
Record Count	129

Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/16/2012	4:52:26 PM	0	14.566	13.478	2.341
8/16/2012	4:52:26 PM	0.251	14.455	13.303	2.23
8/16/2012	4:52:27 PM	0.501	14.526	13.313	2.301
8/16/2012	4:52:27 PM	0.751	14.259	13.323	2.034
8/16/2012	4:52:27 PM	1.001	14.266	13.331	2.041
8/16/2012	4:52:27 PM	1.251	13.894	13.334	1.669
8/16/2012	4:52:28 PM	1.501	13.775	13.341	1.55
8/16/2012	4:52:28 PM	1.751	13.553	13.343	1.328
8/16/2012	4:52:28 PM	2.001	13.315	13.343	1.09
8/16/2012	4:52:28 PM	2.251	13.223	13.349	0.998
8/16/2012	4:52:29 PM	2.501	13.152	13.331	0.927
8/16/2012	4:52:29 PM	2.751	13.061	13.336	0.836
8/16/2012	4:52:29 PM	3.001	12.981	13.337	0.756
8/16/2012	4:52:29 PM	3.251	12.965	13.338	0.74

B-722s Recovery

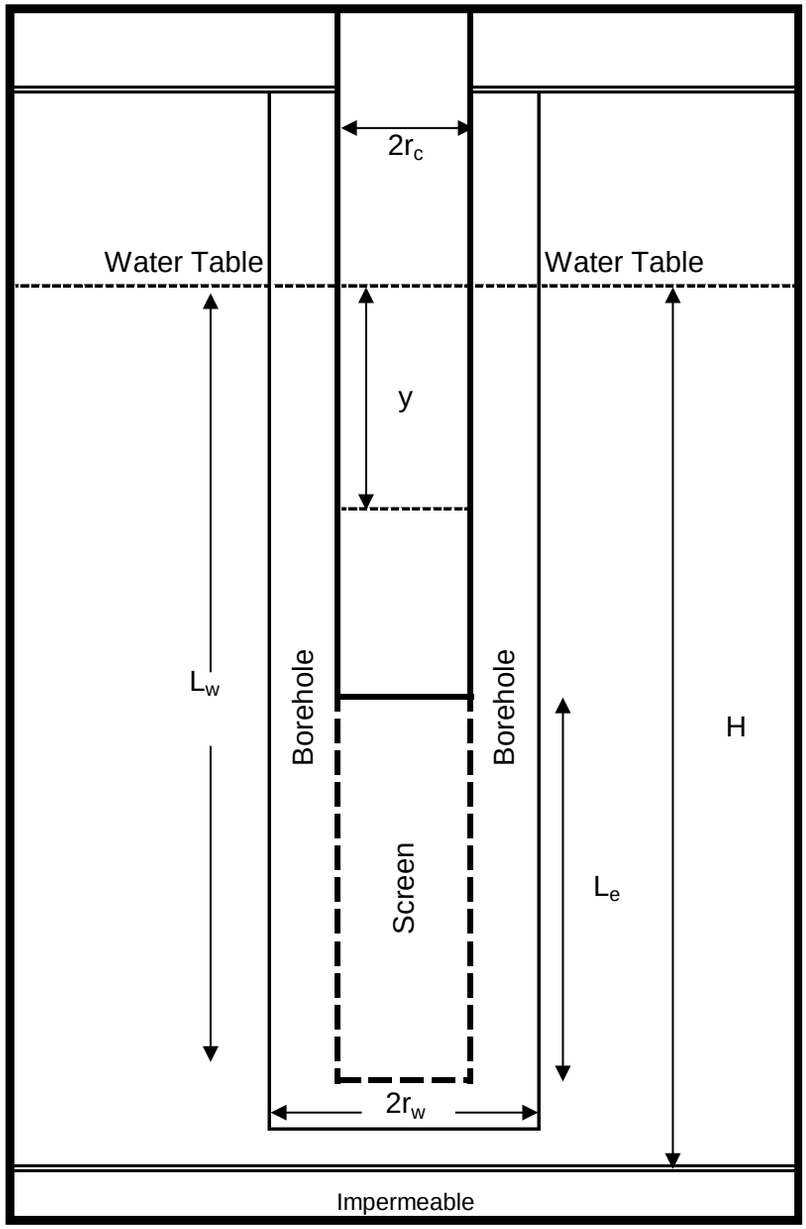
8/16/2012	4:52:30 PM	3.501	12.950	13.338	0.725
8/16/2012	4:52:30 PM	3.751	12.932	13.36	0.707
8/16/2012	4:52:30 PM	4.001	12.842	13.36	0.617
8/16/2012	4:52:30 PM	4.251	12.817	13.363	0.592
8/16/2012	4:52:31 PM	4.501	12.768	13.362	0.543
8/16/2012	4:52:31 PM	4.751	12.724	13.363	0.499
8/16/2012	4:52:31 PM	5.001	12.787	13.364	0.562
8/16/2012	4:52:31 PM	5.251	12.791	13.364	0.566
8/16/2012	4:52:32 PM	5.501	12.61	13.366	0.385
8/16/2012	4:52:32 PM	5.751	12.61	13.368	0.385
8/16/2012	4:52:32 PM	6.001	12.625	13.368	0.4
8/16/2012	4:52:32 PM	6.361	12.627	13.334	0.402
8/16/2012	4:52:33 PM	6.721	12.633	13.334	0.408
8/16/2012	4:52:33 PM	7.141	12.646	13.343	0.421
8/16/2012	4:52:34 PM	7.561	12.644	13.341	0.419
8/16/2012	4:52:34 PM	7.981	12.646	13.341	0.421
8/16/2012	4:52:35 PM	8.461	12.646	13.334	0.421
8/16/2012	4:52:35 PM	9.001	12.632	13.331	0.407
8/16/2012	4:52:36 PM	9.481	12.625	13.328	0.4
8/16/2012	4:52:36 PM	10.081	12.627	13.321	0.402
8/16/2012	4:52:37 PM	10.681	12.613	13.319	0.388
8/16/2012	4:52:37 PM	11.281	12.605	13.317	0.38
8/16/2012	4:52:38 PM	11.941	12.587	13.316	0.362
8/16/2012	4:52:39 PM	12.661	12.564	13.313	0.339
8/16/2012	4:52:40 PM	13.441	12.544	13.308	0.319
8/16/2012	4:52:40 PM	14.221	12.530	13.309	0.305
8/16/2012	4:52:41 PM	15.061	12.519	13.308	0.294
8/16/2012	4:52:42 PM	15.961	12.501	13.301	0.276
8/16/2012	4:52:43 PM	16.921	12.482	13.299	0.257
8/16/2012	4:52:44 PM	17.881	12.47	13.299	0.245
8/16/2012	4:52:45 PM	18.961	12.462	13.292	0.237
8/16/2012	4:52:46 PM	20.101	12.45	13.292	0.225
8/16/2012	4:52:47 PM	21.301	12.441	13.288	0.216
8/16/2012	4:52:49 PM	22.561	12.435	13.286	0.21
8/16/2012	4:52:50 PM	23.881	12.427	13.281	0.202
8/16/2012	4:52:51 PM	25.321	12.419	13.281	0.194
8/16/2012	4:52:53 PM	26.821	12.415	13.278	0.19
8/16/2012	4:52:54 PM	28.381	12.405	13.277	0.18
8/16/2012	4:52:56 PM	30.061	12.400	13.271	0.175
8/16/2012	4:52:58 PM	31.861	12.395	13.268	0.17
8/16/2012	4:53:00 PM	33.721	12.389	13.265	0.164
8/16/2012	4:53:02 PM	35.761	12.383	13.273	0.158
8/16/2012	4:53:04 PM	37.863	12.375	13.291	0.15
8/16/2012	4:53:06 PM	40.081	12.371	13.263	0.146
8/16/2012	4:53:09 PM	42.481	12.366	13.255	0.141
8/16/2012	4:53:11 PM	45	12.361	13.258	0.136
8/16/2012	4:53:14 PM	47.641	12.356	13.25	0.131
8/16/2012	4:53:17 PM	50.461	12.35	13.228	0.125
8/16/2012	4:53:20 PM	53.461	12.348	13.222	0.123
8/16/2012	4:53:23 PM	56.641	12.342	13.239	0.117
8/16/2012	4:53:26 PM	60.001	12.338	13.235	0.113
8/16/2012	4:53:30 PM	63.601	12.335	13.228	0.11
8/16/2012	4:53:33 PM	67.201	12.331	13.222	0.106
8/16/2012	4:53:37 PM	71.401	12.327	13.22	0.102
8/16/2012	4:53:42 PM	75.601	12.321	13.213	0.096
8/16/2012	4:53:46 PM	79.801	12.318	13.208	0.093

B-722s Recovery

8/16/2012	4:53:51 PM	84.601	12.312	13.205	0.087
8/16/2012	4:53:56 PM	90.001	12.308	13.201	0.083
8/16/2012	4:54:01 PM	94.801	12.301	13.191	0.076
8/16/2012	4:54:07 PM	100.801	12.290	13.191	0.065
8/16/2012	4:54:13 PM	106.801	12.284	13.181	0.059
8/16/2012	4:54:19 PM	112.801	12.280	13.178	0.055
8/16/2012	4:54:25 PM	119.401	12.276	13.171	0.051
8/16/2012	4:54:33 PM	126.601	12.271	13.165	0.046
8/16/2012	4:54:40 PM	134.401	12.265	13.158	0.04
8/16/2012	4:54:48 PM	142.201	12.263	13.155	0.038
8/16/2012	4:54:57 PM	150.601	12.26	13.147	0.035
8/16/2012	4:55:06 PM	159.601	12.254	13.144	0.029
8/16/2012	4:55:15 PM	169.201	12.251	13.116	0.026
8/16/2012	4:55:25 PM	178.801	12.248	13.111	0.023
8/16/2012	4:55:36 PM	189.601	12.245	13.129	0.02
8/16/2012	4:55:47 PM	201.001	12.243	13.121	0.018
8/16/2012	4:55:59 PM	213.001	12.241	13.114	0.016
8/16/2012	4:56:12 PM	225.601	12.241	13.111	0.016
8/16/2012	4:56:25 PM	238.801	12.238	13.106	0.013
8/16/2012	4:56:39 PM	253.201	12.237	13.100	0.012
8/16/2012	4:56:54 PM	268.201	12.237	13.099	0.012
8/16/2012	4:57:10 PM	283.8	12.236	13.096	0.011
8/16/2012	4:57:27 PM	300.601	12.237	13.088	0.012
8/16/2012	4:57:45 PM	318.601	12.236	13.085	0.011
8/16/2012	4:58:03 PM	337.201	12.234	13.08	0.009
8/16/2012	4:59:24 PM	357.601	12.233	13.075	0.008
8/16/2012	4:59:45 PM	378.601	12.234	13.074	0.009
8/16/2012	5:00:07 PM	400.8	12.234	13.069	0.009
8/16/2012	5:00:31 PM	424.8	12.234	13.065	0.009
8/16/2012	5:00:56 PM	450.001	12.233	13.067	0.008
8/16/2012	5:01:22 PM	476.401	12.231	13.061	0.006
8/16/2012	5:01:51 PM	504.601	12.232	13.056	0.007
8/16/2012	5:02:21 PM	534.601	12.231	13.056	0.006
8/16/2012	5:02:52 PM	566.401	12.23	13.053	0.005
8/16/2012	5:03:26 PM	600	12.231	13.049	0.006
8/16/2012	5:04:02 PM	636	12.23	13.048	0.005
8/16/2012	5:04:38 PM	672	12.23	13.045	0.005
8/16/2012	5:05:20 PM	714	12.229	13.044	0.004
8/16/2012	5:06:02 PM	756	12.228	13.044	0.003
8/16/2012	5:06:44 PM	798	12.229	13.043	0.004
8/16/2012	5:07:32 PM	846	12.229	13.043	0.004
8/16/2012	5:08:26 PM	900	12.228	13.04	0.003
8/16/2012	5:09:14 PM	948	12.229	13.038	0.004
8/16/2012	5:10:14 PM	1008	12.228	13.037	0.003
8/16/2012	5:11:14 PM	1068	12.228	13.036	0.003
8/16/2012	5:12:14 PM	1128	12.228	13.036	0.003
8/16/2012	5:13:20 PM	1194	12.227	13.033	0.002
8/16/2012	5:14:32 PM	1266	12.227	13.030	0.002
8/16/2012	5:16:50 PM	1344	12.228	13.009	0.003
8/16/2012	5:18:08 PM	1422	12.227	13.006	0.002
8/16/2012	5:20:32 PM	1506	12.227	13.004	0.002
8/16/2012	5:22:02 PM	1596	12.227	13.004	0.002
8/16/2012	5:23:38 PM	1692	12.226	13.000	0.001
8/16/2012	5:25:14 PM	1788	12.227	13.018	0.002
8/16/2012	5:27:02 PM	1896	12.228	13.017	0.003
8/16/2012	5:30:56 PM	2010	12.227	13.013	0.002

B-722s Recovery

8/16/2012	5:33:56 PM	2130	12.226	13.010	0.001
8/16/2012	5:36:02 PM	2256	12.226	13.010	0.001
8/16/2012	5:39:14 PM	2388	12.226	13.007	0.001



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	6
L_w	Feet	26.7
L_e	Feet	5
H*	Feet	60.7
y_0	Feet	0.18
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	285

Solutions

Hydraulic Conductivity in Feet/Second
1.79E-05
Hydraulic Conductivity in Feet/Minute
1.07E-03
Hydraulic Conductivity in Feet/Day
1.55E+00

**Competent bedrock estimated at 75 feet*

Calculations

Term	Units		
L_e/r_W	Feet/Foot	20.00	2.378
A	None	2.155	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 2.378
B	None	0.314	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	1.605	3.167

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

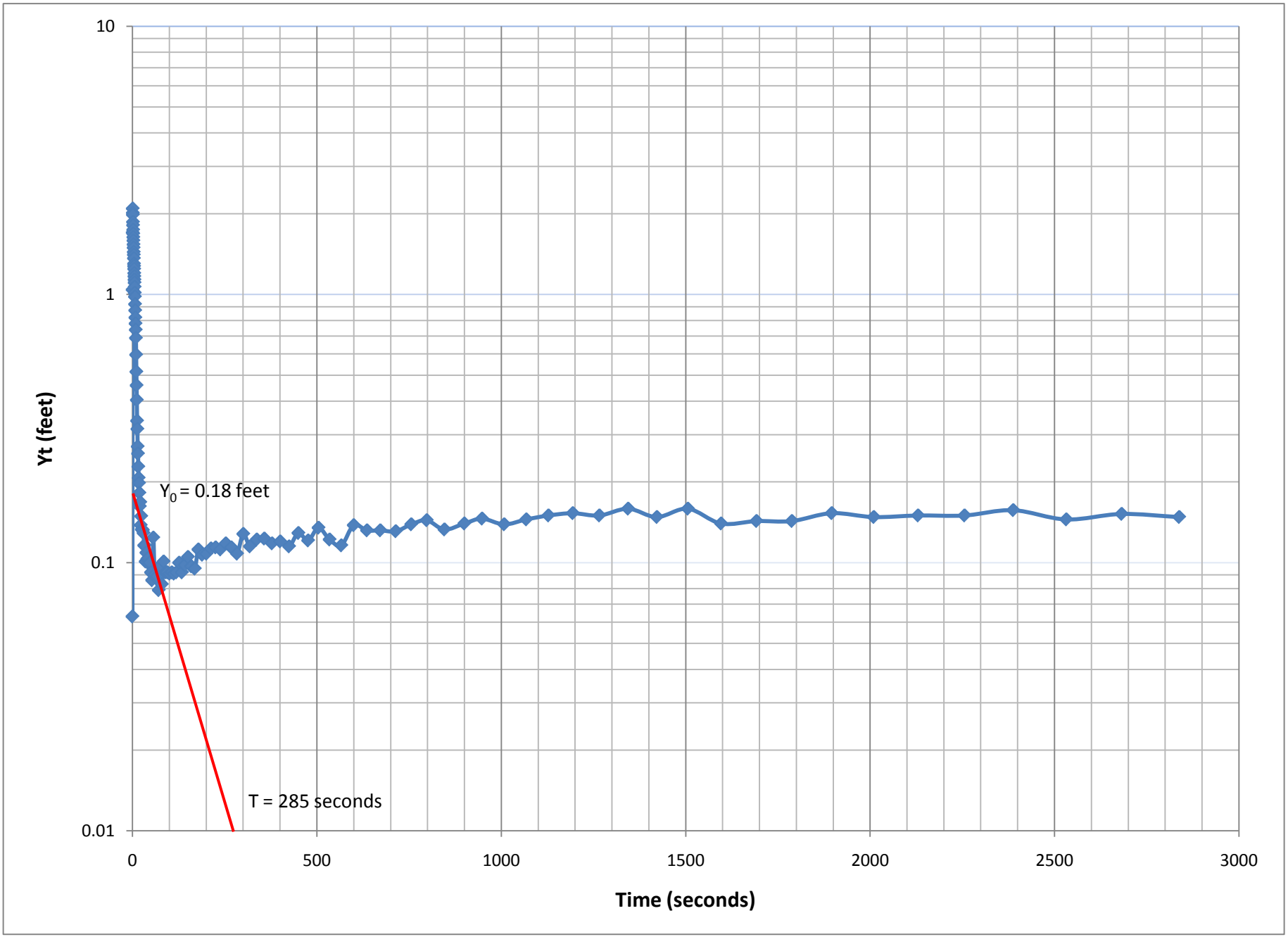
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-722d Fall - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-722d Fall


10
1
0.1
0.01
Yt (feet)
Y_0 = 0.18 feet
T = 285 seconds
0
500
1000
1500
2000
2500
3000
Time (seconds)

B-722d Fall

Report Date:	8/20/2012 9:25
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-722d Fall
Create Date	8/16/2012 9:24
Device	Level TROLL 700
Site	Buncombe County
Serial Number	174297
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-722D Fall	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/16/2012 12:09	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	19.6031 (ft)
Head Pressure:	8.48997 (PSI)
Temperature:	18.8073 (C)

Log Data:

Record Count 132

Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/16/2012	12:10:18 PM	0	14.037	17.706	0.063
8/16/2012	12:10:18 PM	0.25	13.058	17.723	1.042
8/16/2012	12:10:18 PM	0.5	12.398	17.731	1.702
8/16/2012	12:10:19 PM	0.75	12.009	17.736	2.091
8/16/2012	12:10:19 PM	1	12.085	17.738	2.015
8/16/2012	12:10:19 PM	1.25	12.118	17.738	1.982
8/16/2012	12:10:19 PM	1.5	12.237	17.738	1.863
8/16/2012	12:10:20 PM	1.75	12.288	17.739	1.812
8/16/2012	12:10:20 PM	2	12.358	17.735	1.742
8/16/2012	12:10:20 PM	2.25	12.415	17.732	1.685
8/16/2012	12:10:20 PM	2.5	12.465	17.733	1.635
8/16/2012	12:10:21 PM	2.75	12.512	17.731	1.588
8/16/2012	12:10:21 PM	3	12.564	17.728	1.536
8/16/2012	12:10:21 PM	3.25	12.606	17.724	1.494

B-722d Fall

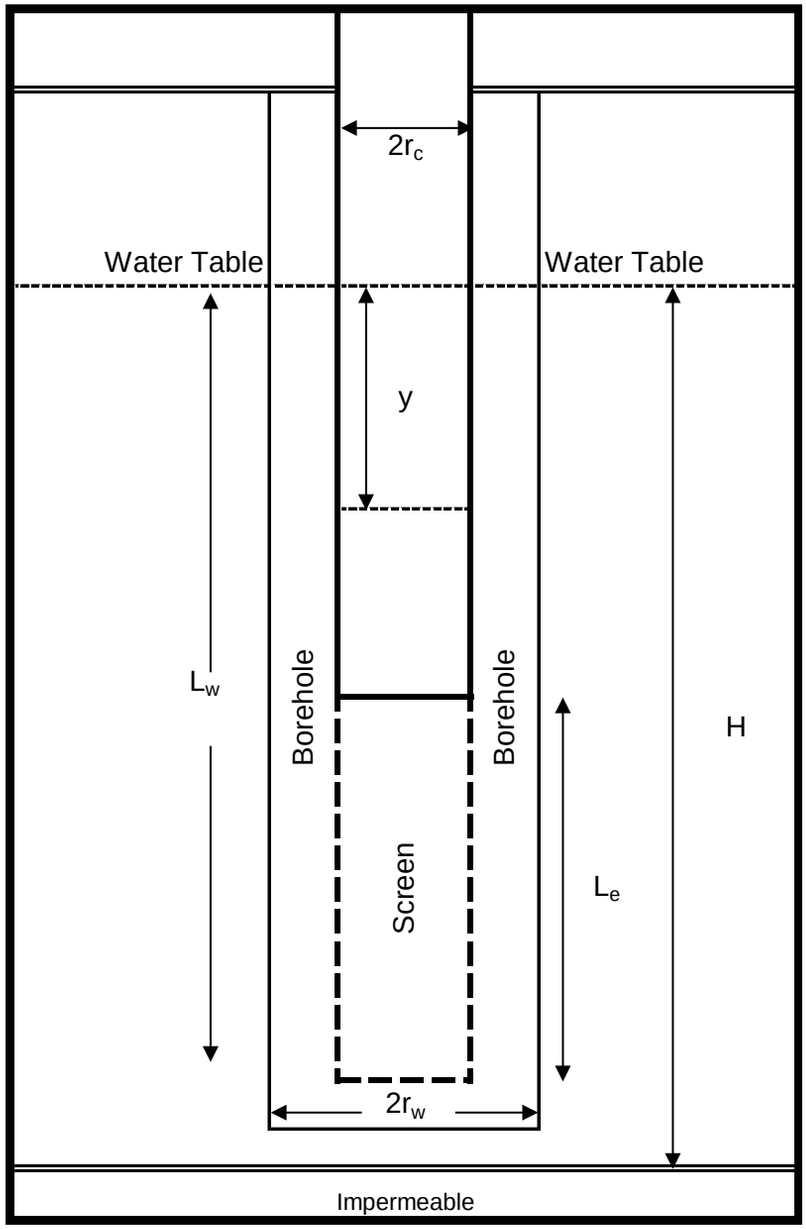
8/16/2012	12:10:21 PM	3.5	12.66	17.721	1.44
8/16/2012	12:10:22 PM	3.75	12.694	17.714	1.406
8/16/2012	12:10:22 PM	4	12.736	17.713	1.364
8/16/2012	12:10:22 PM	4.25	12.798	17.71	1.302
8/16/2012	12:10:22 PM	4.5	12.825	17.705	1.275
8/16/2012	12:10:23 PM	4.75	12.855	17.7	1.245
8/16/2012	12:10:23 PM	5	12.9	17.699	1.2
8/16/2012	12:10:23 PM	5.25	12.932	17.691	1.168
8/16/2012	12:10:23 PM	5.5	12.965	17.691	1.135
8/16/2012	12:10:24 PM	5.75	12.993	17.685	1.107
8/16/2012	12:10:24 PM	6	13.033	17.68	1.067
8/16/2012	12:10:24 PM	6.36	13.086	17.662	1.014
8/16/2012	12:10:25 PM	6.72	13.119	17.655	0.981
8/16/2012	12:10:25 PM	7.14	13.18	17.639	0.92
8/16/2012	12:10:25 PM	7.56	13.228	17.627	0.872
8/16/2012	12:10:26 PM	7.98	13.28	17.62	0.82
8/16/2012	12:10:26 PM	8.46	13.321	17.603	0.779
8/16/2012	12:10:27 PM	9	13.362	17.59	0.738
8/16/2012	12:10:27 PM	9.48	13.412	17.578	0.688
8/16/2012	12:10:28 PM	10.08	13.504	17.563	0.596
8/16/2012	12:10:28 PM	10.68	13.585	17.549	0.515
8/16/2012	12:10:29 PM	11.28	13.642	17.534	0.458
8/16/2012	12:10:30 PM	11.94	13.696	17.52	0.404
8/16/2012	12:10:30 PM	12.66	13.762	17.502	0.338
8/16/2012	12:10:31 PM	13.44	13.785	17.487	0.315
8/16/2012	12:10:32 PM	14.22	13.829	17.47	0.271
8/16/2012	12:10:33 PM	15.06	13.845	17.453	0.255
8/16/2012	12:10:34 PM	15.96	13.872	17.433	0.228
8/16/2012	12:10:35 PM	16.92	13.893	17.414	0.207
8/16/2012	12:10:36 PM	17.88	13.902	17.395	0.198
8/16/2012	12:10:37 PM	18.96	13.918	17.375	0.182
8/16/2012	12:10:38 PM	20.1	13.938	17.354	0.162
8/16/2012	12:10:39 PM	21.3	13.932	17.33	0.168
8/16/2012	12:10:40 PM	22.56	13.962	17.308	0.138
8/16/2012	12:10:42 PM	23.88	13.951	17.282	0.149
8/16/2012	12:10:43 PM	25.32	13.967	17.252	0.133
8/16/2012	12:10:45 PM	26.82	13.967	17.225	0.133
8/16/2012	12:10:46 PM	28.38	13.968	17.2	0.132
8/16/2012	12:10:48 PM	30.06	13.971	17.176	0.129
8/16/2012	12:10:50 PM	31.881	13.984	17.172	0.116
8/16/2012	12:10:52 PM	33.72	13.984	17.113	0.116
8/16/2012	12:10:54 PM	35.76	13.999	17.075	0.101
8/16/2012	12:10:56 PM	37.86	13.991	17.048	0.109
8/16/2012	12:10:58 PM	40.08	13.997	17.003	0.103
8/16/2012	12:11:00 PM	42.48	13.996	16.98	0.104
8/16/2012	12:11:03 PM	45	14.001	16.925	0.099
8/16/2012	12:11:05 PM	47.64	14	16.896	0.1
8/16/2012	12:11:08 PM	50.46	14.008	16.844	0.092
8/16/2012	12:11:11 PM	53.46	14.014	16.8	0.086
8/16/2012	12:11:14 PM	56.64	13.976	16.75	0.124
8/16/2012	12:11:18 PM	60	14.01	16.704	0.09
8/16/2012	12:11:21 PM	63.6	14.012	16.657	0.088
8/16/2012	12:11:25 PM	67.386	14.011	16.615	0.089
8/16/2012	12:11:29 PM	71.4	14.021	16.546	0.079
8/16/2012	12:11:33 PM	75.6	14.003	16.495	0.097
8/16/2012	12:11:38 PM	79.8	14.017	16.443	0.083

B-722d Fall

8/16/2012	12:11:42 PM	84.6	13.999	16.385	0.101
8/16/2012	12:11:48 PM	90	14.008	16.324	0.092
8/16/2012	12:11:53 PM	94.8	14.008	16.268	0.092
8/16/2012	12:11:59 PM	100.8	14.009	16.198	0.091
8/16/2012	12:12:05 PM	106.8	14.008	16.133	0.092
8/16/2012	12:12:11 PM	112.8	14.009	16.071	0.091
8/16/2012	12:12:17 PM	119.4	14.008	16.004	0.092
8/16/2012	12:12:24 PM	126.6	14	15.936	0.1
8/16/2012	12:12:32 PM	134.4	14.008	15.862	0.092
8/16/2012	12:12:40 PM	142.2	14.002	15.793	0.098
8/16/2012	12:12:48 PM	150.6	13.995	15.723	0.105
8/16/2012	12:12:57 PM	159.6	14.003	15.651	0.097
8/16/2012	12:13:07 PM	169.2	14.005	15.577	0.095
8/16/2012	12:13:17 PM	178.8	13.988	15.509	0.112
8/16/2012	12:13:27 PM	189.6	13.993	15.434	0.107
8/16/2012	12:13:39 PM	201	13.992	15.361	0.108
8/16/2012	12:13:51 PM	213	13.987	15.288	0.113
8/16/2012	12:14:03 PM	225.6	13.986	15.215	0.114
8/16/2012	12:14:17 PM	238.8	13.988	15.142	0.112
8/16/2012	12:14:31 PM	253.2	13.982	15.072	0.118
8/16/2012	12:14:46 PM	268.2	13.986	15.004	0.114
8/16/2012	12:15:02 PM	283.8	13.992	14.934	0.108
8/16/2012	12:15:18 PM	300.6	13.972	14.866	0.128
8/16/2012	12:15:36 PM	318.6	13.985	14.801	0.115
8/16/2012	12:15:55 PM	337.2	13.978	14.736	0.122
8/16/2012	12:16:15 PM	357.6	13.977	14.678	0.123
8/16/2012	12:16:36 PM	378.6	13.982	14.621	0.118
8/16/2012	12:16:59 PM	400.8	13.98	14.565	0.12
8/16/2012	12:17:23 PM	424.8	13.985	14.511	0.115
8/16/2012	12:17:48 PM	450	13.971	14.458	0.129
8/16/2012	12:18:14 PM	476.4	13.979	14.411	0.121
8/16/2012	12:18:42 PM	504.6	13.965	14.364	0.135
8/16/2012	12:19:12 PM	534.6	13.978	14.324	0.122
8/16/2012	12:19:44 PM	566.4	13.984	14.286	0.116
8/16/2012	12:20:18 PM	600	13.962	14.249	0.138
8/16/2012	12:20:54 PM	636	13.968	14.217	0.132
8/16/2012	12:21:30 PM	672	13.968	14.188	0.132
8/16/2012	12:22:12 PM	714	13.969	14.159	0.131
8/16/2012	12:22:54 PM	756	13.961	14.137	0.139
8/16/2012	12:23:36 PM	798	13.956	14.116	0.144
8/16/2012	12:24:24 PM	846	13.967	14.096	0.133
8/16/2012	12:25:18 PM	900	13.96	14.077	0.14
8/16/2012	12:26:06 PM	948	13.954	14.059	0.146
8/16/2012	12:27:06 PM	1008	13.961	14.049	0.139
8/16/2012	12:28:06 PM	1068	13.955	14.036	0.145
8/16/2012	12:29:06 PM	1128	13.95	14.025	0.15
8/16/2012	12:30:12 PM	1194	13.947	14.017	0.153
8/16/2012	12:31:24 PM	1266	13.95	14.006	0.15
8/16/2012	12:32:42 PM	1344	13.941	13.997	0.159
8/16/2012	12:34:00 PM	1422	13.952	13.991	0.148
8/16/2012	12:35:24 PM	1506	13.941	13.986	0.159
8/16/2012	12:36:54 PM	1596	13.96	13.978	0.14
8/16/2012	12:38:30 PM	1692	13.957	13.972	0.143
8/16/2012	12:40:06 PM	1788	13.957	13.971	0.143
8/16/2012	12:41:54 PM	1896	13.947	13.966	0.153
8/16/2012	12:43:48 PM	2010	13.952	13.961	0.148

B-722d Fall

8/16/2012	12:45:48 PM	2130	13.95	13.957	0.15
8/16/2012	12:47:54 PM	2256	13.95	13.952	0.15
8/16/2012	12:50:06 PM	2388	13.943	13.946	0.157
8/16/2012	12:52:30 PM	2532	13.955	13.946	0.145
8/16/2012	12:55:00 PM	2682	13.948	13.943	0.152
8/16/2012	12:57:36 PM	2837.999	13.952	13.958	0.148



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	6
L_w	Feet	26.7
L_e	Feet	5
H*	Feet	60.7
y_0	Feet	0.2
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	400

Solutions

Hydraulic Conductivity in Feet/Second
1.32E-05
Hydraulic Conductivity in Feet/Minute
7.93E-04
Hydraulic Conductivity in Feet/Day
1.14E+00

**Competent bedrock estimated at 75 feet*

Calculations

Term	Units		
L_e/r_W	Feet/Foot	20.00	2.378
A	None	2.155	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 2.378
B	None	0.314	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	1.605	3.167

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

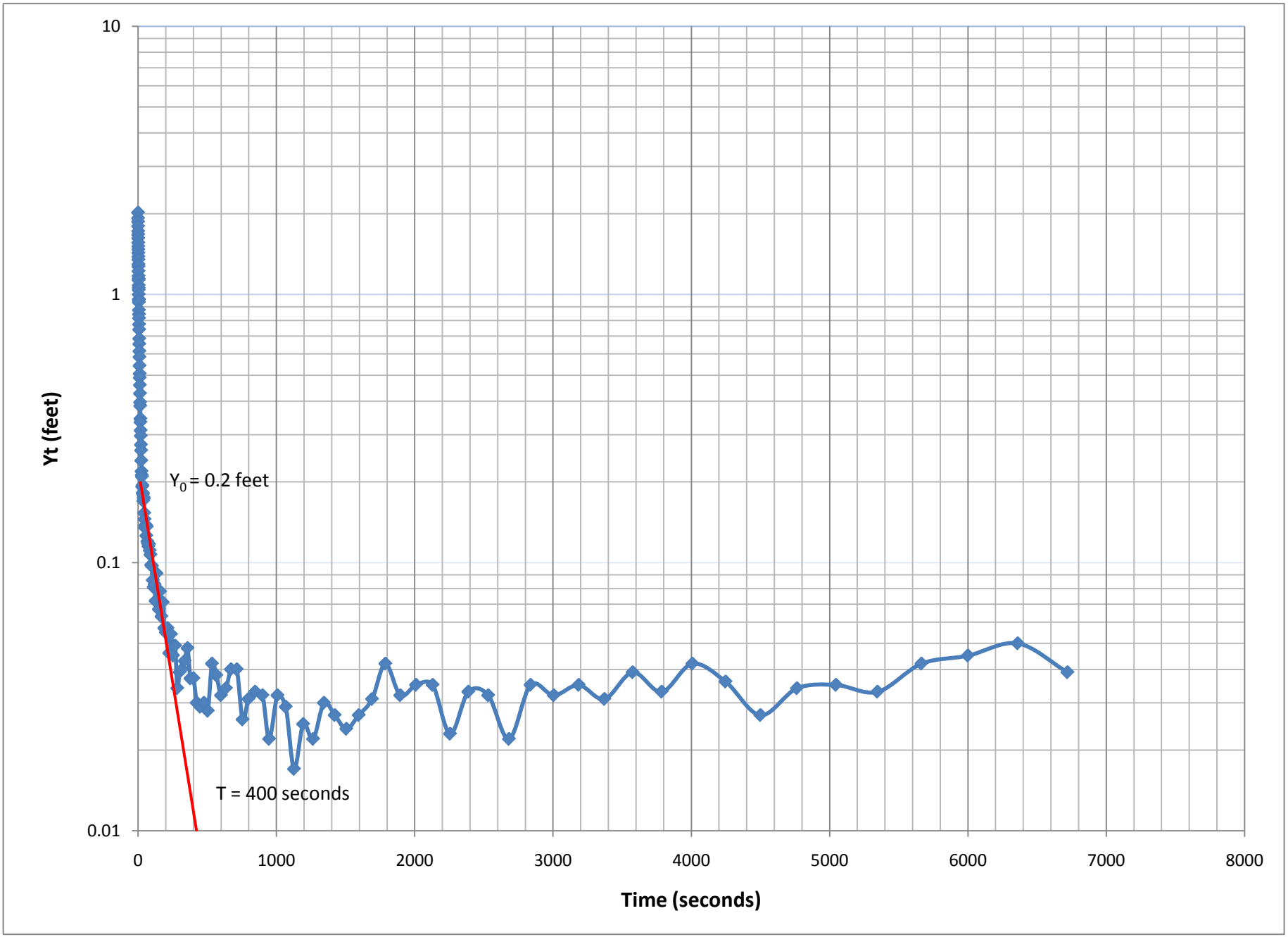
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-722d Recovery - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-722d Recovery



B-722d Recovery

Report Date:	8/20/2012 9:27
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-722d Recovery
Create Date	8/20/2012 9:26
Device	Level TROLL 700
Site	Buncombe County
Serial Number	174297
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	
Log Name	B-722D Recovery
Created By	ForbesD
Computer Name	CDMLBKVLZL1
Application	WinSitu.exe
Application Version	5.6.17.7
Create Date	8/16/2012 12:59 Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time
Notes Size(bytes)	4096
Overwrite when full	Disabled
Scheduled Start Time	Manual Start Eastern Daylight Time
Scheduled Stop Time	No Stop Time Eastern Daylight Time
Type	True Logarithmic
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00
Level Reference Settings At Log Creation	
Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999
Other Log Settings	
Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	19.9187 (ft)
Head Pressure:	8.62664 (PSI)
Temperature:	14.0647 (C)

Log Notes:

Date	Time	Note
8/16/2012	12:59:35 PM	Sensor: 174297 Factory calibration has expired.: 9/28/2011 2:06:56 PM
8/16/2012	12:59:36 PM	Used Battery: 14% Used Memory: 3% User Name: ForbesD
8/16/2012	12:59:56 PM	Manual Start Command
8/16/2012	2:52:37 PM	Log Download - Used Battery: 14% Used Memory: 3% User Name: ForbesD
8/16/2012	2:53:12 PM	Used Battery: 14% Used Memory: 3% User Name: ForbesD
8/16/2012	2:53:13 PM	Manual Stop Command

Log Data:

Record Count 147

B-722d Recovery

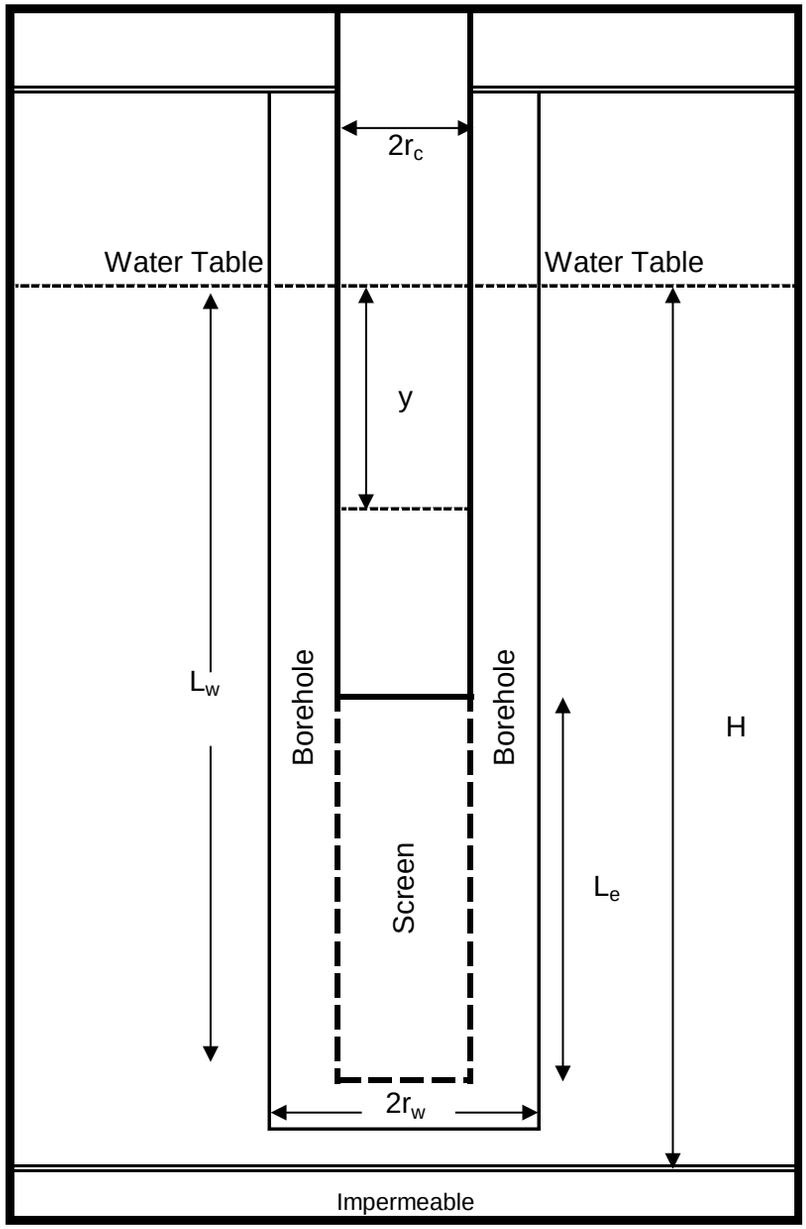
Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/16/2012	12:59:56 PM	0	15.949	13.954	2.019
8/16/2012	12:59:56 PM	0.25	15.854	13.977	1.924
8/16/2012	12:59:56 PM	0.5	15.796	13.987	1.866
8/16/2012	12:59:56 PM	0.75	15.725	13.996	1.795
8/16/2012	12:59:57 PM	1	15.65	14.005	1.72
8/16/2012	12:59:57 PM	1.25	15.602	14.01	1.672
8/16/2012	12:59:57 PM	1.5	15.551	14.015	1.621
8/16/2012	12:59:57 PM	1.75	15.489	14.017	1.559
8/16/2012	12:59:58 PM	2	15.44	14.024	1.51
8/16/2012	12:59:58 PM	2.25	15.4	14.027	1.47
8/16/2012	12:59:58 PM	2.5	15.357	14.028	1.427
8/16/2012	12:59:58 PM	2.75	15.313	14.031	1.383
8/16/2012	12:59:59 PM	3	15.277	14.031	1.347
8/16/2012	12:59:59 PM	3.25	15.225	14.033	1.295
8/16/2012	12:59:59 PM	3.5	15.2	14.035	1.27
8/16/2012	12:59:59 PM	3.75	15.151	14.035	1.221
8/16/2012	1:00:00 PM	4	15.102	14.037	1.172
8/16/2012	1:00:00 PM	4.25	15.074	14.04	1.144
8/16/2012	1:00:00 PM	4.5	15.06	14.037	1.13
8/16/2012	1:00:00 PM	4.75	15.011	14.041	1.081
8/16/2012	1:00:01 PM	5	14.986	14.041	1.056
8/16/2012	1:00:01 PM	5.25	14.969	14.041	1.039
8/16/2012	1:00:01 PM	5.5	14.93	14.044	1
8/16/2012	1:00:01 PM	5.75	14.89	14.048	0.96
8/16/2012	1:00:02 PM	6	14.882	14.046	0.952
8/16/2012	1:00:02 PM	6.36	14.864	14.036	0.934
8/16/2012	1:00:02 PM	6.72	14.804	14.034	0.874
8/16/2012	1:00:03 PM	7.14	14.773	14.028	0.843
8/16/2012	1:00:03 PM	7.56	14.745	14.023	0.815
8/16/2012	1:00:04 PM	7.98	14.703	14.022	0.773
8/16/2012	1:00:04 PM	8.46	14.669	14.02	0.739
8/16/2012	1:00:05 PM	9	14.614	14.01	0.684
8/16/2012	1:00:05 PM	9.48	14.583	14.014	0.653
8/16/2012	1:00:06 PM	10.08	14.544	14.007	0.614
8/16/2012	1:00:06 PM	10.68	14.514	14.004	0.584
8/16/2012	1:00:07 PM	11.28	14.472	14.001	0.542
8/16/2012	1:00:08 PM	11.94	14.436	14.001	0.506
8/16/2012	1:00:08 PM	12.66	14.419	13.997	0.489
8/16/2012	1:00:09 PM	13.44	14.389	13.992	0.459
8/16/2012	1:00:10 PM	14.22	14.357	13.992	0.427
8/16/2012	1:00:11 PM	15.06	14.326	13.989	0.396
8/16/2012	1:00:12 PM	15.96	14.314	13.986	0.384
8/16/2012	1:00:13 PM	16.92	14.274	13.981	0.344
8/16/2012	1:00:14 PM	17.88	14.264	13.984	0.334
8/16/2012	1:00:15 PM	18.96	14.241	13.978	0.311
8/16/2012	1:00:16 PM	20.1	14.227	13.976	0.297
8/16/2012	1:00:17 PM	21.3	14.205	13.974	0.275
8/16/2012	1:00:18 PM	22.654	14.192	13.984	0.262
8/16/2012	1:00:20 PM	23.88	14.17	13.971	0.24
8/16/2012	1:00:21 PM	25.32	14.149	13.965	0.219
8/16/2012	1:00:23 PM	26.82	14.142	13.961	0.212
8/16/2012	1:00:24 PM	28.38	14.139	13.96	0.209
8/16/2012	1:00:26 PM	30.06	14.122	13.957	0.192
8/16/2012	1:00:28 PM	31.86	14.124	13.96	0.194
8/16/2012	1:00:29 PM	33.72	14.112	13.953	0.182

B-722d Recovery

8/16/2012	1:00:31 PM	35.76	14.11	13.946	0.18
8/16/2012	1:00:34 PM	37.86	14.1	13.942	0.17
8/16/2012	1:00:36 PM	40.08	14.105	13.937	0.175
8/16/2012	1:00:38 PM	42.48	14.103	13.932	0.173
8/16/2012	1:00:41 PM	45	14.083	13.93	0.153
8/16/2012	1:00:43 PM	47.64	14.075	13.926	0.145
8/16/2012	1:00:46 PM	50.46	14.065	13.92	0.135
8/16/2012	1:00:49 PM	53.46	14.068	13.915	0.138
8/16/2012	1:00:52 PM	56.64	14.068	13.911	0.138
8/16/2012	1:00:56 PM	60	14.056	13.903	0.126
8/16/2012	1:00:59 PM	63.6	14.066	13.899	0.136
8/16/2012	1:01:03 PM	67.2	14.05	13.893	0.12
8/16/2012	1:01:07 PM	71.4	14.048	13.884	0.118
8/16/2012	1:01:11 PM	75.6	14.045	13.877	0.115
8/16/2012	1:01:16 PM	79.8	14.047	13.872	0.117
8/16/2012	1:01:20 PM	84.6	14.041	13.865	0.111
8/16/2012	1:01:26 PM	90	14.037	13.856	0.107
8/16/2012	1:01:31 PM	94.8	14.028	13.848	0.098
8/16/2012	1:01:37 PM	100.8	14.027	13.839	0.097
8/16/2012	1:01:43 PM	106.8	14.016	13.832	0.086
8/16/2012	1:01:49 PM	112.8	14.011	13.825	0.081
8/16/2012	1:01:55 PM	119.4	14.013	13.818	0.083
8/16/2012	1:02:02 PM	126.6	14.002	13.808	0.072
8/16/2012	1:02:10 PM	134.4	14.021	13.801	0.091
8/16/2012	1:02:18 PM	142.2	14.009	13.793	0.079
8/16/2012	1:02:26 PM	150.6	13.997	13.787	0.067
8/16/2012	1:02:35 PM	159.6	14.008	13.777	0.078
8/16/2012	1:02:45 PM	169.2	13.993	13.771	0.063
8/16/2012	1:02:55 PM	178.8	14.001	13.763	0.071
8/16/2012	1:03:05 PM	189.6	13.987	13.755	0.057
8/16/2012	1:03:17 PM	201	13.985	13.749	0.055
8/16/2012	1:03:29 PM	213	13.987	13.74	0.057
8/16/2012	1:03:41 PM	225.6	13.976	13.736	0.046
8/16/2012	1:03:55 PM	238.8	13.984	13.73	0.054
8/16/2012	1:04:09 PM	253.2	13.975	13.725	0.045
8/16/2012	1:04:24 PM	268.2	13.979	13.72	0.049
8/16/2012	1:04:40 PM	283.8	13.964	13.715	0.034
8/16/2012	1:04:56 PM	300.6	13.969	13.712	0.039
8/16/2012	1:05:14 PM	318.6	13.97	13.708	0.04
8/16/2012	1:05:33 PM	337.2	13.973	13.706	0.043
8/16/2012	1:05:53 PM	357.6	13.978	13.699	0.048
8/16/2012	1:06:14 PM	378.6	13.967	13.7	0.037
8/16/2012	1:06:37 PM	400.8	13.967	13.698	0.037
8/16/2012	1:07:01 PM	424.8	13.96	13.697	0.03
8/16/2012	1:07:26 PM	450	13.959	13.698	0.029
8/16/2012	1:07:52 PM	476.4	13.96	13.696	0.03
8/16/2012	1:08:20 PM	504.6	13.958	13.698	0.028
8/16/2012	1:08:50 PM	534.6	13.972	13.697	0.042
8/16/2012	1:09:22 PM	566.4	13.968	13.698	0.038
8/16/2012	1:09:56 PM	600	13.962	13.699	0.032
8/16/2012	1:10:32 PM	636	13.964	13.699	0.034
8/16/2012	1:11:08 PM	672	13.97	13.7	0.04
8/16/2012	1:11:50 PM	714	13.97	13.704	0.04
8/16/2012	1:12:32 PM	756	13.956	13.707	0.026
8/16/2012	1:13:14 PM	798	13.961	13.709	0.031
8/16/2012	1:14:02 PM	846	13.963	13.712	0.033

B-722d Recovery

8/16/2012	1:14:56 PM	900	13.962	13.716	0.032
8/16/2012	1:15:44 PM	948	13.952	13.722	0.022
8/16/2012	1:16:44 PM	1008	13.962	13.726	0.032
8/16/2012	1:17:44 PM	1068	13.959	13.728	0.029
8/16/2012	1:18:44 PM	1128	13.947	13.733	0.017
8/16/2012	1:19:50 PM	1194	13.955	13.738	0.025
8/16/2012	1:21:02 PM	1266	13.952	13.742	0.022
8/16/2012	1:22:20 PM	1344	13.96	13.747	0.03
8/16/2012	1:23:38 PM	1422	13.957	13.75	0.027
8/16/2012	1:25:02 PM	1506	13.954	13.754	0.024
8/16/2012	1:26:32 PM	1596	13.957	13.759	0.027
8/16/2012	1:28:08 PM	1692	13.961	13.765	0.031
8/16/2012	1:29:44 PM	1788	13.972	13.768	0.042
8/16/2012	1:31:32 PM	1896	13.962	13.771	0.032
8/16/2012	1:33:26 PM	2010	13.965	13.778	0.035
8/16/2012	1:35:26 PM	2130	13.965	13.781	0.035
8/16/2012	1:37:32 PM	2256	13.953	13.786	0.023
8/16/2012	1:39:44 PM	2388	13.963	13.788	0.033
8/16/2012	1:42:08 PM	2532	13.962	13.793	0.032
8/16/2012	1:44:38 PM	2682	13.952	13.799	0.022
8/16/2012	1:47:14 PM	2838	13.965	13.804	0.035
8/16/2012	1:50:02 PM	3006	13.962	13.806	0.032
8/16/2012	1:53:02 PM	3186	13.965	13.81	0.035
8/16/2012	1:56:08 PM	3372	13.961	13.813	0.031
8/16/2012	1:59:32 PM	3576	13.969	13.818	0.039
8/16/2012	2:03:02 PM	3786	13.963	13.824	0.033
8/16/2012	2:06:44 PM	4008	13.972	13.828	0.042
8/16/2012	2:10:44 PM	4248	13.966	13.829	0.036
8/16/2012	2:14:56 PM	4500	13.957	13.832	0.027
8/16/2012	2:19:20 PM	4764	13.964	13.834	0.034
8/16/2012	2:24:02 PM	5046	13.965	13.836	0.035
8/16/2012	2:29:02 PM	5346	13.963	13.84	0.033
8/16/2012	2:34:20 PM	5664	13.972	13.838	0.042
8/16/2012	2:39:56 PM	6000	13.975	13.844	0.045
8/16/2012	2:45:56 PM	6360	13.98	13.849	0.05
8/16/2012	2:51:56 PM	6720	13.969	13.849	0.039



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	8
L_w	Feet	11.8
L_e	Feet	10
H	Feet	18.8
y_0	Feet	0.6
t_0	Seconds	0
y_t	Feet	0.001
t	Seconds	160

Solutions

Hydraulic Conductivity in Feet/Second
3.46E-05
Hydraulic Conductivity in Feet/Minute
2.07E-03
Hydraulic Conductivity in Feet/Day
2.99E+00

Calculations

Term	Units		
L_e/r_W	Feet/Foot	30.00	2.332
A	None	2.475	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 2.332
B	None	0.374	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	2.001	2.666

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

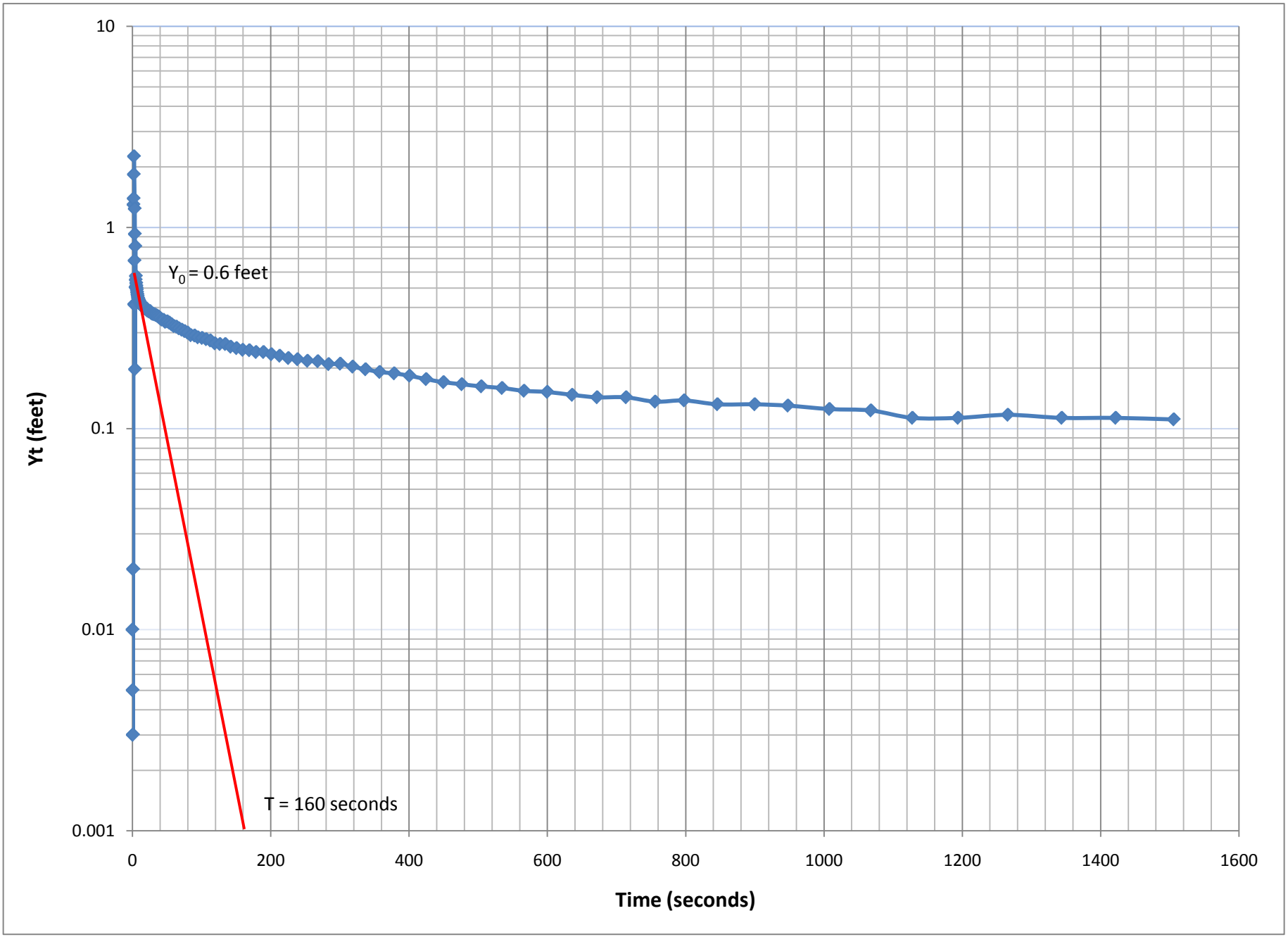
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-727s Fall - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-727s Fall


10
1
0.1
0.01
0.001
Yt (feet)
Y_0 = 0.6 feet
T = 160 seconds
0
200
400
600
800
1000
1200
1400
1600
Time (seconds)

B-727s Fall

Report Date:	8/20/2012 9:30
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-727s Fall
Create Date	8/3/2012 7:12
Device	Level TROLL 700
Site	Buncombe County
Serial Number	174297
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-727s Fall	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/3/2012 7:30	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.0574265 (PSI)
Depth of Probe:	15.0843 (ft)
Head Pressure:	6.53291 (PSI)
Temperature:	13.664 (C)

Log Data:

Record Count 121

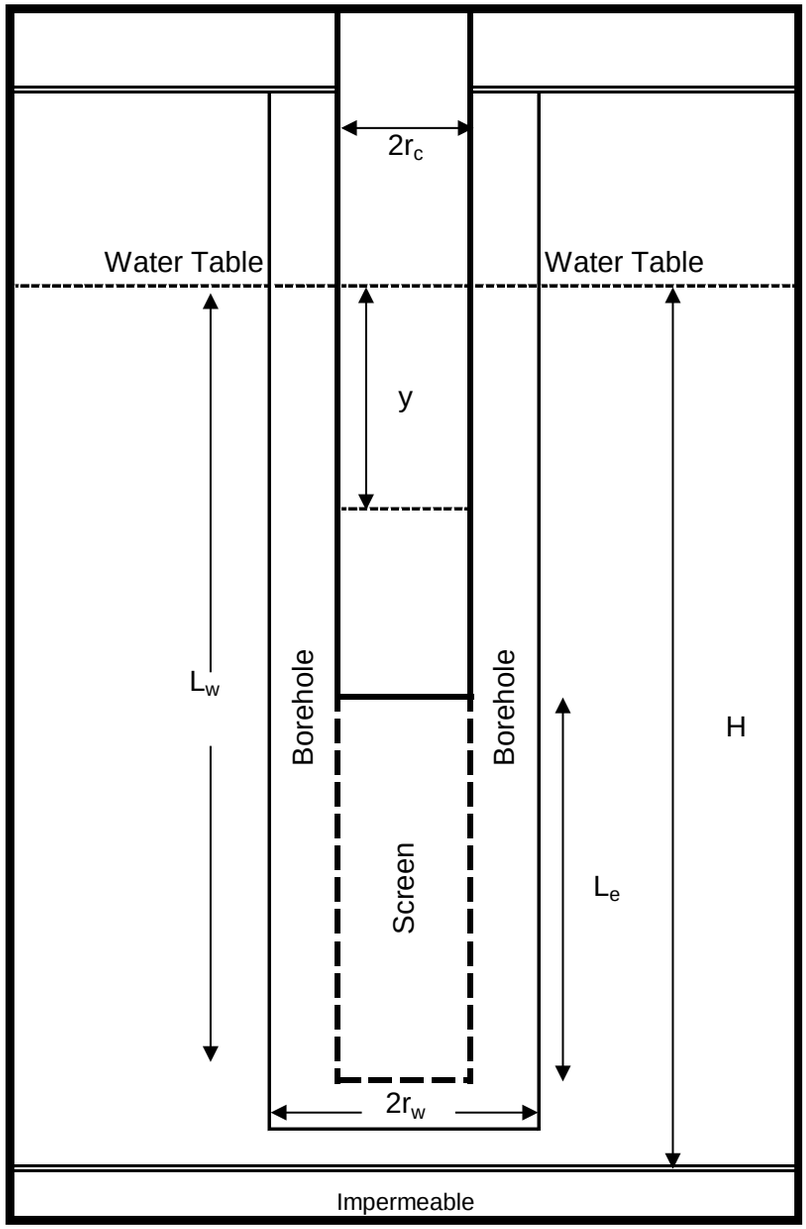
Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/3/2012	7:36:33 AM	0	17.17	13.972	0.01
8/3/2012	7:36:33 AM	0.251	17.175	13.99	0.005
8/3/2012	7:36:33 AM	0.501	17.177	14.004	0.003
8/3/2012	7:36:34 AM	0.751	17.177	14.01	0.003
8/3/2012	7:36:34 AM	1.001	17.16	14.016	0.02
8/3/2012	7:36:34 AM	1.251	17.16	14.023	0.02
8/3/2012	7:36:34 AM	1.501	15.881	14.025	1.299
8/3/2012	7:36:35 AM	1.751	15.787	14.029	1.393
8/3/2012	7:36:35 AM	2.001	15.345	14.034	1.835
8/3/2012	7:36:35 AM	2.251	14.924	14.034	2.256
8/3/2012	7:36:35 AM	2.501	16.765	14.02	0.415
8/3/2012	7:36:36 AM	2.751	17.446	14.031	-0.266
8/3/2012	7:36:36 AM	3.001	16.496	14.036	0.684
8/3/2012	7:36:36 AM	3.251	15.941	14.041	1.239
8/3/2012	7:36:36 AM	3.501	16.253	14.043	0.927

B-727s Fall

8/3/2012	7:36:37 AM	3.751	16.983	14.045	0.197
8/3/2012	7:36:37 AM	4.001	16.769	14.047	0.411
8/3/2012	7:36:37 AM	4.251	16.375	14.047	0.805
8/3/2012	7:36:37 AM	4.501	16.676	14.044	0.504
8/3/2012	7:36:38 AM	4.751	16.631	14.047	0.549
8/3/2012	7:36:38 AM	5.001	16.607	14.043	0.573
8/3/2012	7:36:38 AM	5.251	16.674	14.045	0.506
8/3/2012	7:36:38 AM	5.501	16.651	14.043	0.529
8/3/2012	7:36:39 AM	5.751	16.667	14.041	0.513
8/3/2012	7:36:39 AM	6.001	16.68	14.043	0.5
8/3/2012	7:36:39 AM	6.361	16.69	14.035	0.49
8/3/2012	7:36:40 AM	6.721	16.703	14.026	0.477
8/3/2012	7:36:40 AM	7.141	16.714	14.017	0.466
8/3/2012	7:36:40 AM	7.561	16.723	14.013	0.457
8/3/2012	7:36:41 AM	7.981	16.733	14.009	0.447
8/3/2012	7:36:41 AM	8.461	16.737	14.003	0.443
8/3/2012	7:36:42 AM	9.001	16.743	13.993	0.437
8/3/2012	7:36:42 AM	9.481	16.747	13.992	0.433
8/3/2012	7:36:43 AM	10.081	16.75	13.988	0.43
8/3/2012	7:36:44 AM	10.681	16.756	13.982	0.424
8/3/2012	7:36:44 AM	11.281	16.759	13.978	0.421
8/3/2012	7:36:45 AM	11.941	16.764	13.975	0.416
8/3/2012	7:36:46 AM	12.661	16.768	13.967	0.412
8/3/2012	7:36:46 AM	13.441	16.771	13.961	0.409
8/3/2012	7:36:47 AM	14.221	16.773	13.959	0.407
8/3/2012	7:36:48 AM	15.061	16.774	13.953	0.406
8/3/2012	7:36:49 AM	15.961	16.777	13.947	0.403
8/3/2012	7:36:50 AM	16.921	16.782	13.941	0.398
8/3/2012	7:36:51 AM	17.881	16.784	13.936	0.396
8/3/2012	7:36:52 AM	18.961	16.784	13.929	0.396
8/3/2012	7:36:53 AM	20.101	16.784	13.927	0.396
8/3/2012	7:36:54 AM	21.301	16.793	13.916	0.387
8/3/2012	7:36:55 AM	22.561	16.794	13.914	0.386
8/3/2012	7:36:57 AM	23.881	16.798	13.905	0.382
8/3/2012	7:36:58 AM	25.321	16.796	13.898	0.384
8/3/2012	7:37:00 AM	26.821	16.803	13.888	0.377
8/3/2012	7:37:01 AM	28.381	16.807	13.884	0.373
8/3/2012	7:37:03 AM	30.061	16.809	13.878	0.371
8/3/2012	7:37:05 AM	31.861	16.81	13.868	0.37
8/3/2012	7:37:07 AM	33.721	16.813	13.865	0.367
8/3/2012	7:37:09 AM	35.761	16.816	13.853	0.364
8/3/2012	7:37:11 AM	37.863	16.82	13.844	0.36
8/3/2012	7:37:13 AM	40.081	16.826	13.835	0.354
8/3/2012	7:37:15 AM	42.481	16.832	13.823	0.348
8/3/2012	7:37:18 AM	45	16.833	13.823	0.347
8/3/2012	7:37:21 AM	47.641	16.841	13.815	0.339
8/3/2012	7:37:23 AM	50.461	16.839	13.796	0.341
8/3/2012	7:37:26 AM	53.461	16.844	13.79	0.336
8/3/2012	7:37:30 AM	56.641	16.85	13.775	0.33
8/3/2012	7:37:33 AM	60.001	16.857	13.766	0.323
8/3/2012	7:37:36 AM	63.601	16.859	13.756	0.321
8/3/2012	7:37:40 AM	67.201	16.865	13.751	0.315
8/3/2012	7:37:44 AM	71.401	16.87	13.726	0.31
8/3/2012	7:37:48 AM	75.601	16.875	13.711	0.305
8/3/2012	7:37:53 AM	79.801	16.88	13.695	0.3
8/3/2012	7:37:57 AM	84.601	16.889	13.68	0.291
8/3/2012	7:38:03 AM	90.001	16.89	13.663	0.29
8/3/2012	7:38:08 AM	94.801	16.896	13.65	0.284

B-727s Fall

8/3/2012	7:38:14 AM	100.801	16.898	13.629	0.282
8/3/2012	7:38:20 AM	106.801	16.902	13.613	0.278
8/3/2012	7:38:26 AM	112.801	16.906	13.594	0.274
8/3/2012	7:38:32 AM	119.401	16.915	13.58	0.265
8/3/2012	7:38:39 AM	126.601	16.917	13.561	0.263
8/3/2012	7:38:47 AM	134.401	16.917	13.535	0.263
8/3/2012	7:38:55 AM	142.201	16.925	13.521	0.255
8/3/2012	7:39:03 AM	150.601	16.929	13.503	0.251
8/3/2012	7:39:12 AM	159.601	16.934	13.484	0.246
8/3/2012	7:39:22 AM	169.201	16.935	13.466	0.245
8/3/2012	7:39:32 AM	178.801	16.94	13.45	0.24
8/3/2012	7:39:42 AM	189.601	16.94	13.429	0.24
8/3/2012	7:39:54 AM	201.001	16.946	13.419	0.234
8/3/2012	7:40:06 AM	213.001	16.95	13.409	0.23
8/3/2012	7:40:18 AM	225.601	16.956	13.4	0.224
8/3/2012	7:40:32 AM	238.801	16.959	13.392	0.221
8/3/2012	7:40:46 AM	253.201	16.963	13.386	0.217
8/3/2012	7:41:01 AM	268.201	16.964	13.377	0.216
8/3/2012	7:41:17 AM	283.8	16.971	13.372	0.209
8/3/2012	7:41:33 AM	300.601	16.97	13.369	0.21
8/3/2012	7:41:51 AM	318.601	16.977	13.371	0.203
8/3/2012	7:42:10 AM	337.201	16.983	13.371	0.197
8/3/2012	7:42:30 AM	357.601	16.989	13.369	0.191
8/3/2012	7:42:51 AM	378.601	16.992	13.373	0.188
8/3/2012	7:43:14 AM	400.8	16.997	13.377	0.183
8/3/2012	7:43:38 AM	424.8	17.004	13.391	0.176
8/3/2012	7:44:03 AM	450.001	17.01	13.41	0.17
8/3/2012	7:44:29 AM	476.401	17.014	13.418	0.166
8/3/2012	7:44:57 AM	504.601	17.018	13.415	0.162
8/3/2012	7:45:27 AM	534.601	17.021	13.401	0.159
8/3/2012	7:45:59 AM	566.401	17.026	13.386	0.154
8/3/2012	7:46:33 AM	600	17.028	13.367	0.152
8/3/2012	7:47:09 AM	636	17.033	13.342	0.147
8/3/2012	7:47:45 AM	672	17.037	13.313	0.143
8/3/2012	7:48:27 AM	714	17.037	13.291	0.143
8/3/2012	7:49:09 AM	756	17.044	13.272	0.136
8/3/2012	7:49:51 AM	798	17.042	13.266	0.138
8/3/2012	7:50:39 AM	846	17.048	13.259	0.132
8/3/2012	7:51:33 AM	900	17.048	13.256	0.132
8/3/2012	7:52:21 AM	948	17.05	13.238	0.13
8/3/2012	7:53:21 AM	1008	17.055	13.237	0.125
8/3/2012	7:54:21 AM	1068	17.057	13.239	0.123
8/3/2012	7:55:21 AM	1128	17.067	13.247	0.113
8/3/2012	7:56:27 AM	1194	17.067	13.254	0.113
8/3/2012	7:57:39 AM	1266	17.063	13.252	0.117
8/3/2012	7:58:57 AM	1344	17.067	13.251	0.113
8/3/2012	8:00:15 AM	1422	17.067	13.257	0.113
8/3/2012	8:01:39 AM	1506	17.069	13.239	0.111



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	8
L_w	Feet	11.8
L_e	Feet	10
H	Feet	18.8
y_0	Feet	2.4
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	140

Solutions

Hydraulic Conductivity in Feet/Second
3.39E-05
Hydraulic Conductivity in Feet/Minute
2.03E-03
Hydraulic Conductivity in Feet/Day
2.92E+00

Calculations

Term	Units		
L_e/r_W	Feet/Foot	30.00	2.332
A	None	2.475	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
B	None	0.374	2.332
C	None	2.001	$\ln(R_e/r_W)_{\text{full penetration}}$ =
			2.666

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

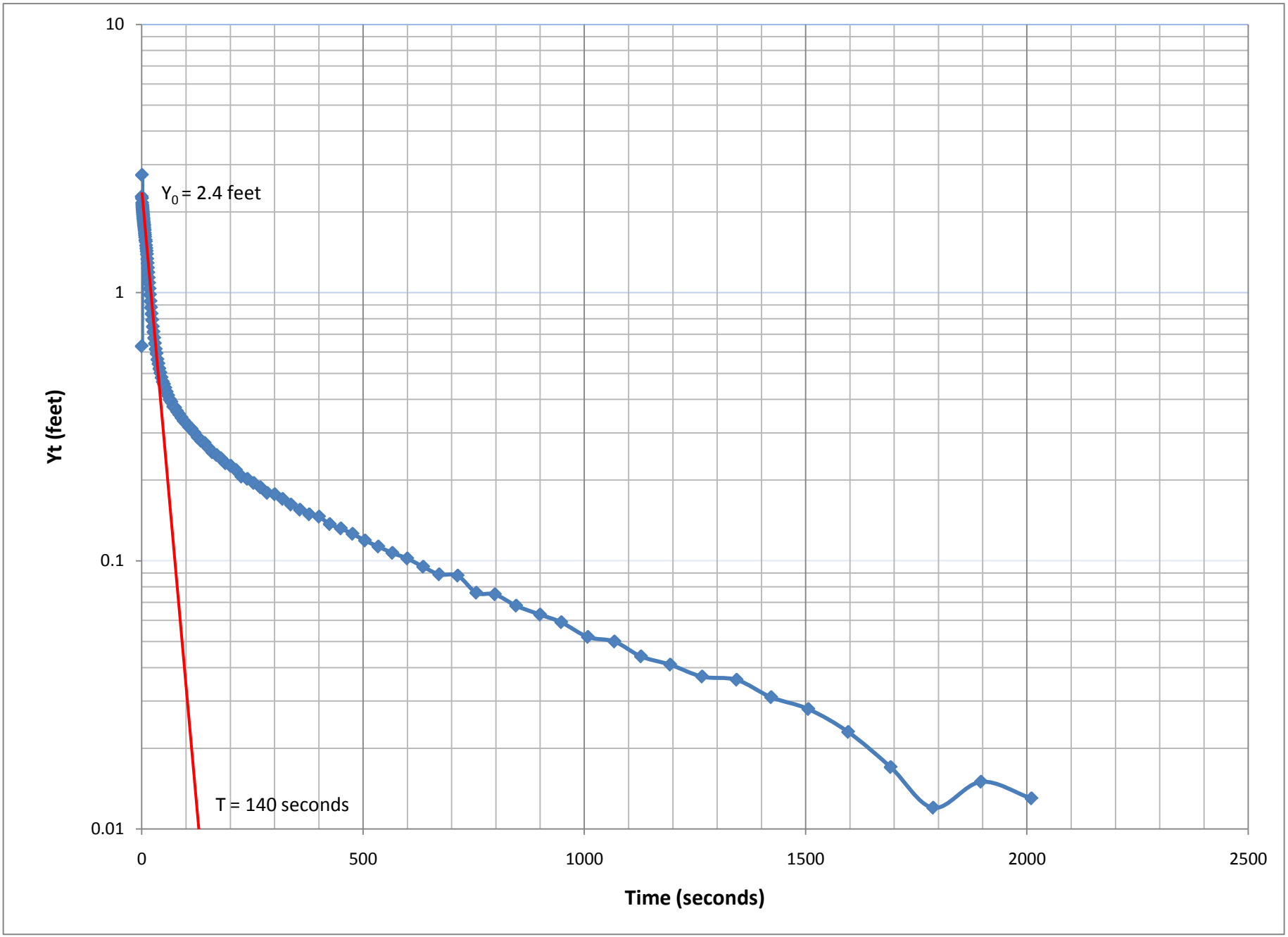
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-727s Recovery - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-727s Recovery



B-727s Recovery

Report Date:	8/20/2012 9:34
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-727s Recovery
Create Date	8/3/2012 7:12
Device	Level TROLL 700
Site	Buncombe County
Serial Number	124344
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-727s Recovery	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/3/2012 8:02	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.639212 (PSI)
Depth of Probe:	7.22466 (ft)
Head Pressure:	3.12895 (PSI)
Temperature:	13.2771 (C)

Log Data:

Record Count 126

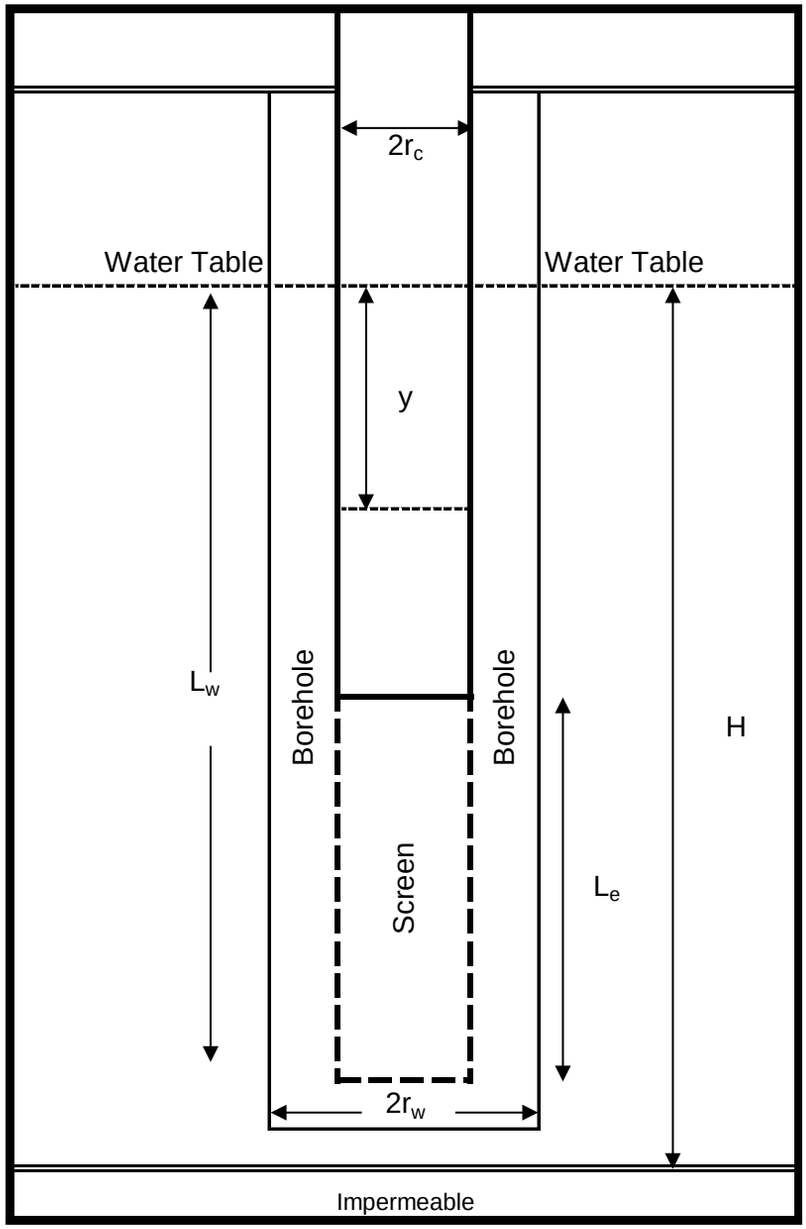
Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/3/2012	8:03:24 AM	0	17.621	13.219	2.279
8/3/2012	8:03:25 AM	0.25	17.771	13.232	0.631
8/3/2012	8:03:25 AM	0.704	19.884	13.255	2.744
8/3/2012	8:03:25 AM	0.925	19.384	13.267	2.244
8/3/2012	8:03:26 AM	1.152	19.299	13.272	2.159
8/3/2012	8:03:26 AM	1.393	19.261	13.285	2.121
8/3/2012	8:03:26 AM	1.615	19.234	13.29	2.094
8/3/2012	8:03:26 AM	1.835	19.214	13.294	2.074
8/3/2012	8:03:26 AM	2.056	19.192	13.296	2.052
8/3/2012	8:03:27 AM	2.276	19.171	13.302	2.031
8/3/2012	8:03:27 AM	2.496	19.148	13.306	2.008
8/3/2012	8:03:27 AM	2.75	19.128	13.306	1.988
8/3/2012	8:03:27 AM	3	19.105	13.308	1.965
8/3/2012	8:03:28 AM	3.25	19.086	13.305	1.946

B-727s Recovery

8/3/2012	8:03:28 AM	3.5	19.064	13.306	1.924
8/3/2012	8:03:28 AM	3.75	19.036	13.312	1.896
8/3/2012	8:03:28 AM	4	19.029	13.309	1.889
8/3/2012	8:03:29 AM	4.25	19.014	13.31	1.874
8/3/2012	8:03:29 AM	4.5	18.99	13.311	1.85
8/3/2012	8:03:29 AM	4.75	18.969	13.314	1.829
8/3/2012	8:03:29 AM	5	18.951	13.314	1.811
8/3/2012	8:03:30 AM	5.25	18.93	13.316	1.79
8/3/2012	8:03:30 AM	5.5	18.92	13.317	1.78
8/3/2012	8:03:30 AM	5.75	18.917	13.319	1.777
8/3/2012	8:03:30 AM	6	18.887	13.319	1.747
8/3/2012	8:03:31 AM	6.36	18.86	13.309	1.72
8/3/2012	8:03:31 AM	6.72	18.843	13.306	1.703
8/3/2012	8:03:32 AM	7.14	18.807	13.298	1.667
8/3/2012	8:03:32 AM	7.56	18.778	13.293	1.638
8/3/2012	8:03:32 AM	7.98	18.751	13.291	1.611
8/3/2012	8:03:33 AM	8.46	18.707	13.29	1.567
8/3/2012	8:03:33 AM	9	18.708	13.283	1.568
8/3/2012	8:03:34 AM	9.48	18.686	13.284	1.546
8/3/2012	8:03:34 AM	10.08	18.638	13.279	1.498
8/3/2012	8:03:35 AM	10.68	18.601	13.278	1.461
8/3/2012	8:03:36 AM	11.28	18.567	13.273	1.427
8/3/2012	8:03:36 AM	11.94	18.529	13.273	1.389
8/3/2012	8:03:37 AM	12.66	18.474	13.268	1.334
8/3/2012	8:03:38 AM	13.44	18.426	13.266	1.286
8/3/2012	8:03:39 AM	14.22	18.374	13.264	1.234
8/3/2012	8:03:39 AM	15.06	18.326	13.266	1.186
8/3/2012	8:03:40 AM	15.96	18.274	13.262	1.134
8/3/2012	8:03:41 AM	16.92	18.225	13.259	1.085
8/3/2012	8:03:42 AM	17.88	18.173	13.259	1.033
8/3/2012	8:03:43 AM	18.96	18.121	13.259	0.981
8/3/2012	8:03:44 AM	20.1	18.068	13.255	0.928
8/3/2012	8:03:46 AM	21.3	18.019	13.252	0.879
8/3/2012	8:03:47 AM	22.56	17.973	13.253	0.833
8/3/2012	8:03:48 AM	23.88	17.93	13.251	0.79
8/3/2012	8:03:50 AM	25.32	17.886	13.246	0.746
8/3/2012	8:03:51 AM	26.82	17.853	13.244	0.713
8/3/2012	8:03:53 AM	28.38	17.817	13.248	0.677
8/3/2012	8:03:54 AM	30.06	17.786	13.244	0.646
8/3/2012	8:03:56 AM	31.86	17.755	13.243	0.615
8/3/2012	8:03:58 AM	33.72	17.732	13.24	0.592
8/3/2012	8:04:00 AM	35.76	17.703	13.239	0.563
8/3/2012	8:04:02 AM	37.86	17.683	13.238	0.543
8/3/2012	8:04:04 AM	40.08	17.66	13.235	0.52
8/3/2012	8:04:07 AM	42.48	17.642	13.232	0.502
8/3/2012	8:04:09 AM	45	17.622	13.231	0.482
8/3/2012	8:04:12 AM	47.64	17.605	13.227	0.465
8/3/2012	8:04:15 AM	50.46	17.595	13.225	0.455
8/3/2012	8:04:18 AM	53.46	17.581	13.224	0.441
8/3/2012	8:04:21 AM	56.64	17.566	13.22	0.426
8/3/2012	8:04:24 AM	60	17.553	13.218	0.413
8/3/2012	8:04:28 AM	63.6	17.539	13.214	0.399
8/3/2012	8:04:32 AM	67.2	17.531	13.215	0.391
8/3/2012	8:04:36 AM	71.4	17.516	13.21	0.376
8/3/2012	8:04:40 AM	75.6	17.512	13.208	0.372
8/3/2012	8:04:44 AM	79.8	17.501	13.205	0.361

B-727s Recovery

8/3/2012	8:04:49 AM	84.6	17.492	13.202	0.352
8/3/2012	8:04:54 AM	90	17.482	13.198	0.342
8/3/2012	8:04:59 AM	94.8	17.473	13.193	0.333
8/3/2012	8:05:05 AM	100.8	17.465	13.19	0.325
8/3/2012	8:05:11 AM	106.8	17.456	13.184	0.316
8/3/2012	8:05:17 AM	112.8	17.45	13.18	0.31
8/3/2012	8:05:24 AM	119.4	17.44	13.178	0.3
8/3/2012	8:05:31 AM	126.6	17.429	13.171	0.289
8/3/2012	8:05:39 AM	134.4	17.42	13.169	0.28
8/3/2012	8:05:47 AM	142.2	17.415	13.163	0.275
8/3/2012	8:05:55 AM	150.6	17.404	13.16	0.264
8/3/2012	8:06:04 AM	159.6	17.394	13.155	0.254
8/3/2012	8:06:14 AM	169.2	17.388	13.15	0.248
8/3/2012	8:06:23 AM	178.8	17.381	13.149	0.241
8/3/2012	8:06:34 AM	189.6	17.371	13.143	0.231
8/3/2012	8:06:45 AM	201	17.366	13.14	0.226
8/3/2012	8:06:57 AM	213	17.358	13.14	0.218
8/3/2012	8:07:10 AM	225.6	17.346	13.138	0.206
8/3/2012	8:07:23 AM	238.8	17.342	13.133	0.202
8/3/2012	8:07:38 AM	253.2	17.335	13.133	0.195
8/3/2012	8:07:53 AM	268.2	17.328	13.128	0.188
8/3/2012	8:08:08 AM	283.8	17.319	13.129	0.179
8/3/2012	8:08:25 AM	300.6	17.317	13.131	0.177
8/3/2012	8:08:43 AM	318.6	17.31	13.131	0.17
8/3/2012	8:08:02 AM	337.2	17.302	13.138	0.162
8/3/2012	8:08:22 AM	357.6	17.295	13.144	0.155
8/3/2012	8:08:43 AM	378.6	17.289	13.155	0.149
8/3/2012	8:10:05 AM	400.8	17.286	13.165	0.146
8/3/2012	8:10:29 AM	424.8	17.277	13.173	0.137
8/3/2012	8:10:54 AM	450	17.272	13.178	0.132
8/3/2012	8:11:21 AM	476.4	17.266	13.19	0.126
8/3/2012	8:11:49 AM	504.6	17.259	13.188	0.119
8/3/2012	8:12:19 AM	534.6	17.253	13.193	0.113
8/3/2012	8:12:51 AM	566.4	17.247	13.194	0.107
8/3/2012	8:13:24 AM	600	17.242	13.192	0.102
8/3/2012	8:14:00 AM	636	17.235	13.195	0.095
8/3/2012	8:14:36 AM	672	17.229	13.196	0.089
8/3/2012	8:15:18 AM	714	17.228	13.199	0.088
8/3/2012	8:16:00 AM	756	17.216	13.203	0.076
8/3/2012	8:16:42 AM	798	17.215	13.2	0.075
8/3/2012	8:17:30 AM	846	17.208	13.203	0.068
8/3/2012	8:18:24 AM	900	17.203	13.207	0.063
8/3/2012	8:18:12 AM	948	17.199	13.206	0.059
8/3/2012	8:20:12 AM	1008	17.192	13.208	0.052
8/3/2012	8:21:12 AM	1068	17.19	13.209	0.05
8/3/2012	8:22:12 AM	1128	17.184	13.211	0.044
8/3/2012	8:23:18 AM	1194	17.181	13.21	0.041
8/3/2012	8:24:30 AM	1266	17.177	13.214	0.037
8/3/2012	8:25:48 AM	1344	17.176	13.215	0.036
8/3/2012	8:27:06 AM	1422	17.171	13.216	0.031
8/3/2012	8:28:30 AM	1506	17.168	13.213	0.028
8/3/2012	8:30:00 AM	1596	17.163	13.213	0.023
8/3/2012	8:31:36 AM	1692	17.157	13.214	0.017
8/3/2012	8:33:12 AM	1788	17.152	13.216	0.012
8/3/2012	8:35:00 AM	1896	17.155	13.211	0.015
8/3/2012	8:36:54 AM	2009.999	17.153	13.219	0.013



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	8
L_w	Feet	35.22
L_e	Feet	10
H	Feet	35.22
y_0	Feet	3.8
t_0	Seconds	0
y_t	Feet	0.001
t	Seconds	1,140

Solutions

Hydraulic Conductivity in Feet/Second
8.86E-06
Hydraulic Conductivity in Feet/Minute
5.31E-04
Hydraulic Conductivity in Feet/Day
7.65E-01

Calculations

Term	Units		
L_e/r_W	Feet/Foot	30.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 3.303
A	None	2.475	
B	None	0.374	$\ln(R_e/r_W)_{\text{full penetration}}$ = 3.562
C	None	2.001	

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

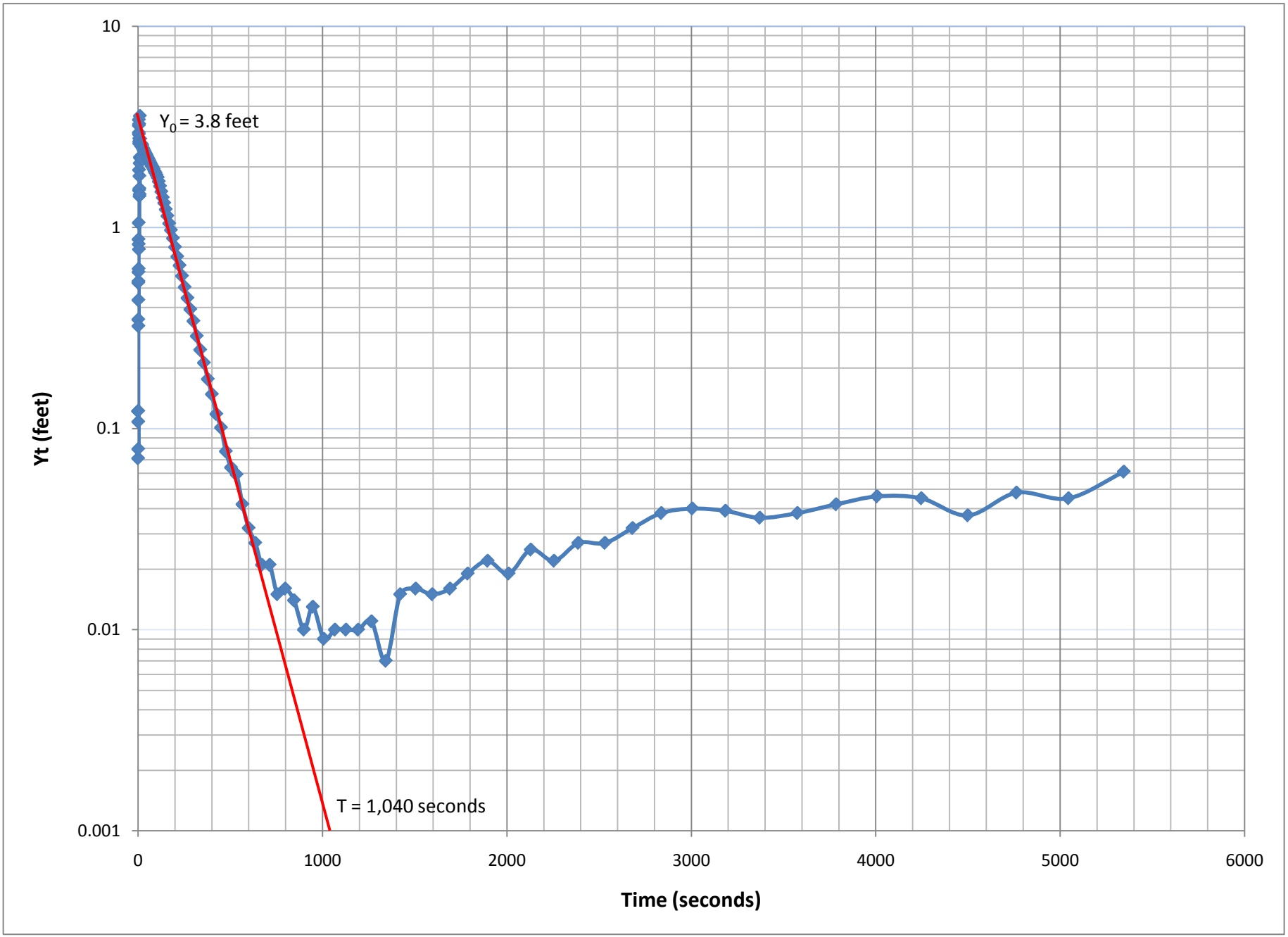
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-727d Fall - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-727d Fall


10
1
0.1
0.01
0.001
Yt (feet)
Y_0 = 3.8 feet
T = 1,040 seconds
0
1000
2000
3000
4000
5000
6000
Time (seconds)

B-727d Fall

Report Date:	8/20/2012 9:35
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-727d Fall
Create Date	8/3/2012 9:47
Device	Level TROLL 700
Site	Buncombe County
Serial Number	124344
Firmware Version	2.08
Hardware Version	2
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-727D Fall	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/3/2012 9:44	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.639212 (PSI)
Depth of Probe:	21.4392 (ft)
Head Pressure:	9.28519 (PSI)
Temperature:	13.3714 (C)

Log Data:

Record Count 143

Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/3/2012	8:45:41 AM	0	17.554	13.289	0.096
8/3/2012	8:45:41 AM	0.251	17.528	13.299	0.122
8/3/2012	8:45:42 AM	0.721	17.579	13.32	0.071
8/3/2012	8:45:42 AM	0.942	17.528	13.333	0.122
8/3/2012	8:45:42 AM	1.166	17.571	13.345	0.079
8/3/2012	8:45:42 AM	1.389	17.542	13.347	0.108
8/3/2012	8:45:42 AM	1.613	17.302	13.356	0.348
8/3/2012	8:45:43 AM	1.836	17.120	13.359	0.53
8/3/2012	8:45:43 AM	2.059	17.215	13.364	0.435
8/3/2012	8:45:43 AM	2.282	17.327	13.37	0.323
8/3/2012	8:45:43 AM	2.505	17.111	13.373	0.539
8/3/2012	8:45:44 AM	2.764	17.051	13.371	0.599
8/3/2012	8:45:44 AM	3.001	16.779	13.373	0.871
8/3/2012	8:45:44 AM	3.251	17.875	13.377	-0.225
8/3/2012	8:45:44 AM	3.501	17.028	13.376	0.622
8/3/2012	8:45:45 AM	3.751	16.826	13.375	0.824

B-727d Fall

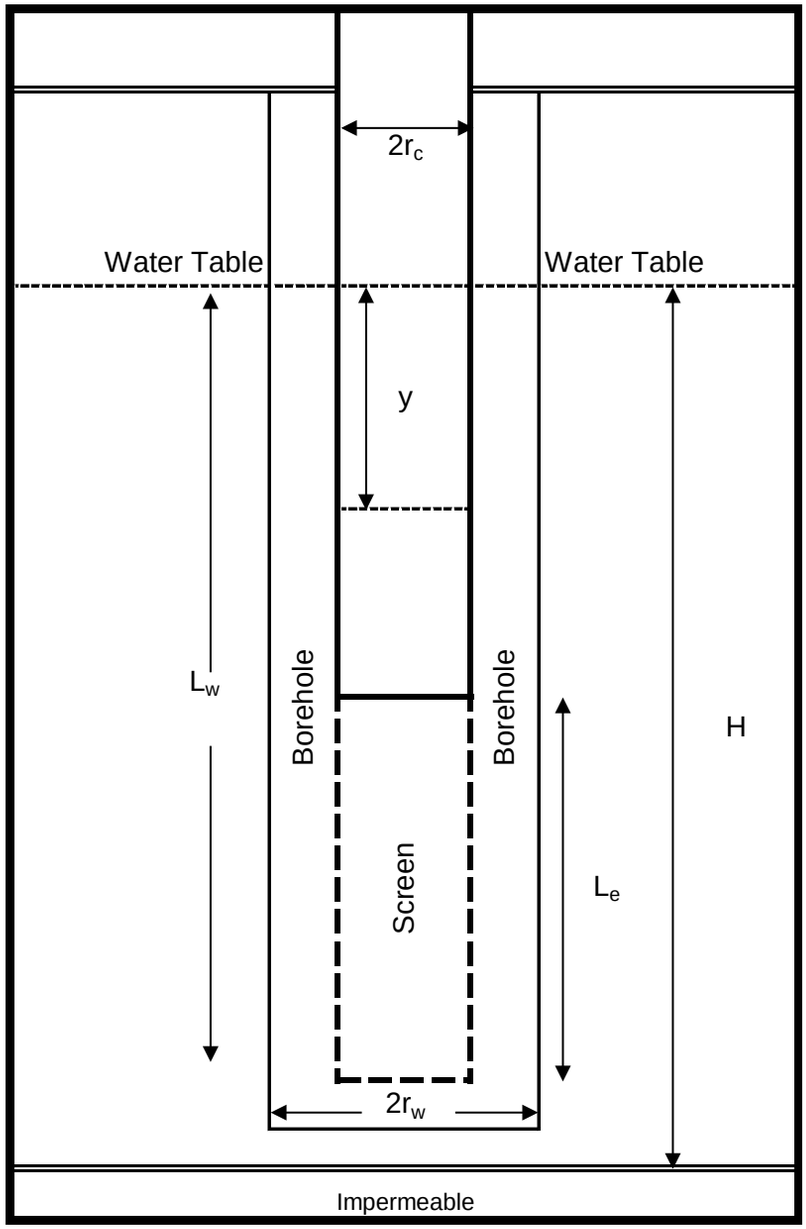
8/3/2012	8:45:45 AM	4.001	16.597	13.377	1.053
8/3/2012	8:45:45 AM	4.251	14.694	13.379	2.956
8/3/2012	8:45:45 AM	4.501	14.444	13.382	3.206
8/3/2012	8:45:46 AM	4.751	14.227	13.381	3.423
8/3/2012	8:45:46 AM	5.001	14.749	13.384	2.901
8/3/2012	8:45:46 AM	5.251	16.873	13.384	0.777
8/3/2012	8:45:46 AM	5.501	16.123	13.384	1.527
8/3/2012	8:45:47 AM	5.751	15.722	13.386	1.928
8/3/2012	8:45:47 AM	6.001	14.389	13.386	3.261
8/3/2012	8:45:47 AM	6.36	15.037	13.379	2.613
8/3/2012	8:45:48 AM	6.72	14.976	13.371	2.674
8/3/2012	8:45:48 AM	7.14	14.881	13.369	2.769
8/3/2012	8:45:48 AM	7.56	16.093	13.365	1.557
8/3/2012	8:45:49 AM	7.98	15.852	13.36	1.798
8/3/2012	8:45:49 AM	8.46	16.224	13.355	1.426
8/3/2012	8:45:50 AM	9.001	16.193	13.353	1.457
8/3/2012	8:45:50 AM	9.48	15.566	13.352	2.084
8/3/2012	8:45:51 AM	10.081	14.073	13.346	3.577
8/3/2012	8:45:52 AM	10.681	15.415	13.344	2.235
8/3/2012	8:45:52 AM	11.281	15.434	13.344	2.216
8/3/2012	8:45:53 AM	11.94	14.900	13.34	2.75
8/3/2012	8:45:54 AM	12.66	15.024	13.338	2.626
8/3/2012	8:45:54 AM	13.44	15.045	13.339	2.605
8/3/2012	8:45:55 AM	14.22	15.048	13.333	2.602
8/3/2012	8:45:56 AM	15.06	15.057	13.334	2.593
8/3/2012	8:45:57 AM	15.96	15.072	13.328	2.578
8/3/2012	8:45:58 AM	16.92	15.115	13.33	2.535
8/3/2012	8:45:59 AM	17.88	15.439	13.329	2.211
8/3/2012	8:46:00 AM	18.96	15.071	13.327	2.579
8/3/2012	8:46:01 AM	20.101	15.057	13.322	2.593
8/3/2012	8:46:02 AM	21.301	15.077	13.322	2.573
8/3/2012	8:46:03 AM	22.561	15.098	13.322	2.552
8/3/2012	8:46:05 AM	23.88	15.150	13.323	2.5
8/3/2012	8:46:06 AM	25.32	15.168	13.319	2.482
8/3/2012	8:46:08 AM	26.82	15.180	13.319	2.47
8/3/2012	8:46:09 AM	28.38	15.198	13.315	2.452
8/3/2012	8:46:11 AM	30.061	15.217	13.314	2.433
8/3/2012	8:46:13 AM	31.86	15.237	13.314	2.413
8/3/2012	8:46:15 AM	33.72	15.255	13.312	2.395
8/3/2012	8:46:17 AM	35.76	15.274	13.311	2.376
8/3/2012	8:46:19 AM	37.86	15.297	13.309	2.353
8/3/2012	8:46:21 AM	40.08	15.315	13.308	2.335
8/3/2012	8:46:23 AM	42.48	15.338	13.305	2.312
8/3/2012	8:46:26 AM	45	15.353	13.302	2.297
8/3/2012	8:46:29 AM	47.64	15.388	13.303	2.262
8/3/2012	8:46:31 AM	50.46	15.413	13.303	2.237
8/3/2012	8:46:34 AM	53.46	15.442	13.305	2.208
8/3/2012	8:46:38 AM	56.64	15.469	13.304	2.181
8/3/2012	8:46:41 AM	60	15.498	13.31	2.152
8/3/2012	8:46:44 AM	63.6	15.529	13.298	2.121
8/3/2012	8:46:48 AM	67.2	15.562	13.3	2.088
8/3/2012	8:46:52 AM	71.4	15.598	13.301	2.052
8/3/2012	8:46:56 AM	75.6	15.632	13.301	2.018
8/3/2012	8:47:01 AM	79.826	15.659	13.308	1.991
8/3/2012	8:47:05 AM	84.6	15.703	13.291	1.947
8/3/2012	8:47:11 AM	90	15.751	13.306	1.899
8/3/2012	8:47:16 AM	94.826	15.783	13.307	1.867
8/3/2012	8:47:22 AM	100.8	15.832	13.295	1.818

B-727d Fall

8/3/2012	8:47:28 AM	106.8	15.881	13.29	1.769
8/3/2012	8:47:34 AM	112.8	15.960	13.287	1.69
8/3/2012	8:47:40 AM	119.59	16.049	13.303	1.601
8/3/2012	8:47:47 AM	126.6	16.146	13.288	1.504
8/3/2012	8:47:55 AM	134.4	16.244	13.281	1.406
8/3/2012	8:48:03 AM	142.2	16.329	13.276	1.321
8/3/2012	8:48:11 AM	150.6	16.423	13.276	1.227
8/3/2012	8:48:20 AM	159.6	16.511	13.268	1.139
8/3/2012	8:48:30 AM	169.2	16.605	13.261	1.045
8/3/2012	8:48:40 AM	178.8	16.682	13.261	0.968
8/3/2012	8:48:50 AM	189.6	16.768	13.258	0.882
8/3/2012	8:49:02 AM	201	16.853	13.256	0.797
8/3/2012	8:49:14 AM	213	16.935	13.251	0.715
8/3/2012	8:49:26 AM	225.6	17.004	13.249	0.646
8/3/2012	8:49:40 AM	238.8	17.077	13.244	0.573
8/3/2012	8:49:54 AM	253.2	17.146	13.242	0.504
8/3/2012	8:50:09 AM	268.2	17.205	13.24	0.445
8/3/2012	8:50:25 AM	283.8	17.259	13.236	0.391
8/3/2012	8:50:41 AM	300.6	17.308	13.232	0.342
8/3/2012	8:50:59 AM	318.6	17.362	13.231	0.288
8/3/2012	8:51:18 AM	337.2	17.404	13.227	0.246
8/3/2012	8:51:38 AM	357.6	17.438	13.227	0.212
8/3/2012	8:51:59 AM	378.6	17.474	13.225	0.176
8/3/2012	8:52:22 AM	400.8	17.502	13.221	0.148
8/3/2012	8:52:46 AM	424.8	17.532	13.223	0.118
8/3/2012	8:53:11 AM	450	17.549	13.218	0.101
8/3/2012	8:53:37 AM	476.4	17.573	13.218	0.077
8/3/2012	8:54:05 AM	504.6	17.586	13.215	0.064
8/3/2012	8:54:35 AM	534.6	17.591	13.214	0.059
8/3/2012	8:55:07 AM	566.4	17.608	13.21	0.042
8/3/2012	8:55:41 AM	600	17.618	13.209	0.032
8/3/2012	8:56:17 AM	636	17.623	13.208	0.027
8/3/2012	8:56:53 AM	672	17.629	13.209	0.021
8/3/2012	8:57:35 AM	714	17.629	13.208	0.021
8/3/2012	8:58:17 AM	756	17.635	13.21	0.015
8/3/2012	8:58:59 AM	798	17.634	13.21	0.016
8/3/2012	8:59:47 AM	846	17.636	13.207	0.014
8/3/2012	9:00:41 AM	900	17.640	13.207	0.01
8/3/2012	9:01:29 AM	948	17.637	13.206	0.013
8/3/2012	9:02:29 AM	1008	17.641	13.206	0.009
8/3/2012	9:03:29 AM	1068	17.640	13.206	0.01
8/3/2012	9:04:29 AM	1128	17.640	13.206	0.01
8/3/2012	9:05:35 AM	1194	17.640	13.204	0.01
8/3/2012	9:06:47 AM	1266	17.639	13.206	0.011
8/3/2012	9:08:05 AM	1344	17.643	13.207	0.007
8/3/2012	9:09:23 AM	1422	17.635	13.203	0.015
8/3/2012	9:10:47 AM	1506	17.634	13.202	0.016
8/3/2012	9:12:17 AM	1596	17.635	13.199	0.015
8/3/2012	9:13:53 AM	1692	17.634	13.203	0.016
8/3/2012	9:15:29 AM	1788	17.631	13.2	0.019
8/3/2012	9:17:17 AM	1896	17.628	13.202	0.022
8/3/2012	9:19:11 AM	2010	17.631	13.201	0.019
8/3/2012	9:21:11 AM	2130	17.625	13.206	0.025
8/3/2012	9:23:17 AM	2256	17.628	13.207	0.022
8/3/2012	9:25:29 AM	2388	17.623	13.206	0.027
8/3/2012	9:27:53 AM	2532	17.623	13.211	0.027
8/3/2012	9:30:23 AM	2682	17.618	13.211	0.032
8/3/2012	9:32:59 AM	2838	17.612	13.213	0.038

B-727d Fall

8/3/2012	9:35:47 AM	3006	17.610	13.212	0.04
8/3/2012	9:38:47 AM	3186	17.611	13.212	0.039
8/3/2012	9:41:53 AM	3372	17.614	13.218	0.036
8/3/2012	9:45:17 AM	3576	17.612	13.215	0.038
8/3/2012	9:48:47 AM	3786	17.608	13.218	0.042
8/3/2012	9:52:29 AM	4008	17.604	13.214	0.046
8/3/2012	9:56:29 AM	4248	17.605	13.216	0.045
8/3/2012	10:00:41 AM	4500	17.613	13.213	0.037
8/3/2012	10:05:05 AM	4764	17.602	13.215	0.048
8/3/2012	10:09:47 AM	5046	17.605	13.214	0.045
8/3/2012	10:14:47 AM	5346	17.589	13.216	0.061



Input Data

Term	Units	
$2r_c$	Inches	2.067
$2r_W$	Inches	8
L_w	Feet	35.22
L_e	Feet	10
H	Feet	35.22
y_0	Feet	1.7
t_0	Seconds	0
y_t	Feet	0.001
t	Seconds	1,240

Solutions

Hydraulic Conductivity in Feet/Second
7.35E-06
Hydraulic Conductivity in Feet/Minute
4.41E-04
Hydraulic Conductivity in Feet/Day
6.35E-01

Calculations

Term	Units		
L_e/r_W	Feet/Foot	30.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 3.303
A	None	2.475	
B	None	0.374	$\ln(R_e/r_W)_{\text{full penetration}}$ = 3.562
C	None	2.001	

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

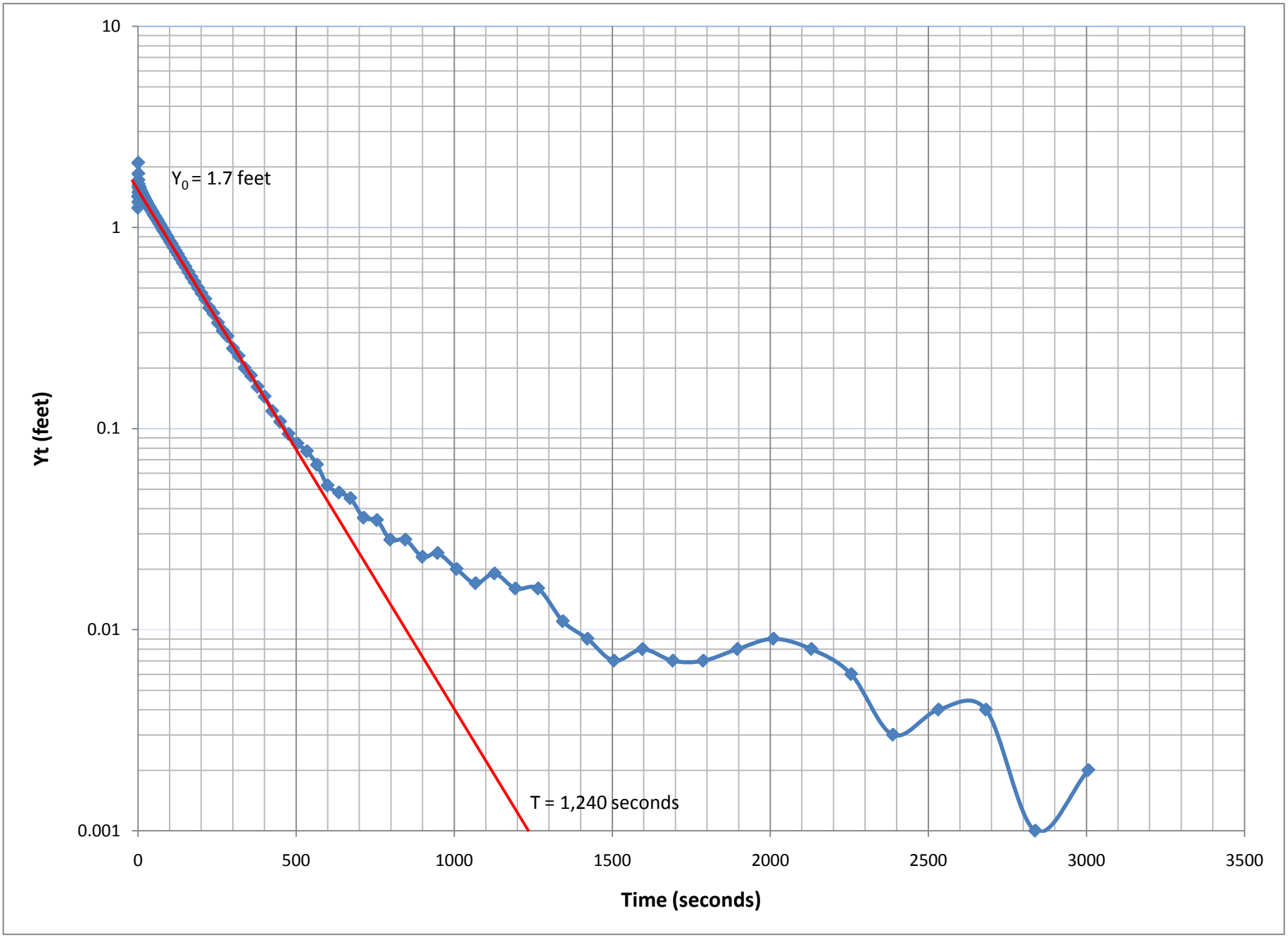
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM Smith

B-727d Recovery - Slug Test Calculations

Buncombe County Subtitle D Landfill Expansion - Cell 7
Design Hydrogeologic Investigation

B-727d Recovery



B-727d Recovery

Report Date:	8/20/2012 9:38
Report User Name:	ForbesD
Report Computer Name:	CDMLBKVLZL1
Application:	WinSitu.exe
Application Version:	5.6.17.7
Log File Properties	
File Name	B-727d Recovery
Create Date	8/3/2012 12:09
Device	Level TROLL 700
Site	Buncombe County
Serial Number	124344
Firmware Version	2.08
Hardware Version	3
Device Address	1
Device Comm Cfg	19200
Log Configuration	

Log Name	B-727D Recovery	
Created By	ForbesD	
Computer Name	CDMLBKVLZL1	
Application	WinSitu.exe	
Application Version	5.6.17.7	
Create Date	8/3/2012 11:15	Eastern Daylight Time
Log Setup Time Zone	Eastern Daylight Time	
Notes Size(bytes)	4096	
Overwrite when full	Disabled	
Scheduled Start Time	Manual Start	Eastern Daylight Time
Scheduled Stop Time	No Stop Time	Eastern Daylight Time
Type	True Logarithmic	
Max Interval	Days: 0 hrs: 00 mins: 30 secs: 00	

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999

Other Log Settings

Zero Pressure Offset:	0.639212 (PSI)
Depth of Probe:	21.42 (ft)
Head Pressure:	9.27685 (PSI)
Temperature:	13.268 (C)

Log Data:

Record Count 133

Date	Time	Seconds	Level Depth To Water (feet)	Temperature (C)	Recovery (feet)
8/3/2012	10:16:12 AM	0	17.615	13.220	-0.137
8/3/2012	10:16:12 AM	0.251	19.179	13.234	1.427
8/3/2012	10:16:13 AM	0.722	19.002	13.256	1.25
8/3/2012	10:16:13 AM	0.943	19.845	13.268	2.093
8/3/2012	10:16:13 AM	1.167	19.089	13.273	1.337
8/3/2012	10:16:13 AM	1.39	19.599	13.282	1.847
8/3/2012	10:16:14 AM	1.614	19.248	13.290	1.496
8/3/2012	10:16:14 AM	1.837	19.468	13.294	1.716
8/3/2012	10:16:14 AM	2.061	19.333	13.301	1.581
8/3/2012	10:16:14 AM	2.285	19.391	13.306	1.639
8/3/2012	10:16:14 AM	2.508	19.347	13.306	1.595
8/3/2012	10:16:15 AM	2.817	19.352	13.300	1.6
8/3/2012	10:16:15 AM	3.038	19.352	13.308	1.6

B-727d Recovery

8/3/2012	10:16:15 AM	3.258	19.323	13.313	1.571
8/3/2012	10:16:15 AM	3.501	19.346	13.310	1.594
8/3/2012	10:16:16 AM	3.751	19.342	13.315	1.59
8/3/2012	10:16:16 AM	4.001	19.342	13.316	1.59
8/3/2012	10:16:16 AM	4.251	19.337	13.315	1.585
8/3/2012	10:16:16 AM	4.501	19.315	13.316	1.563
8/3/2012	10:16:17 AM	4.751	19.319	13.317	1.567
8/3/2012	10:16:17 AM	5.001	19.322	13.319	1.57
8/3/2012	10:16:17 AM	5.251	19.309	13.319	1.557
8/3/2012	10:16:17 AM	5.501	19.311	13.319	1.559
8/3/2012	10:16:18 AM	5.751	19.302	13.322	1.55
8/3/2012	10:16:18 AM	6.001	19.3	13.322	1.548
8/3/2012	10:16:18 AM	6.361	19.301	13.315	1.549
8/3/2012	10:16:19 AM	6.721	19.292	13.311	1.54
8/3/2012	10:16:19 AM	7.141	19.287	13.302	1.535
8/3/2012	10:16:20 AM	7.561	19.281	13.301	1.529
8/3/2012	10:16:20 AM	7.98	19.269	13.297	1.517
8/3/2012	10:16:20 AM	8.461	19.27	13.293	1.518
8/3/2012	10:16:21 AM	9	19.262	13.289	1.51
8/3/2012	10:16:21 AM	9.48	19.255	13.292	1.503
8/3/2012	10:16:22 AM	10.081	19.252	13.282	1.5
8/3/2012	10:16:23 AM	10.681	19.245	13.286	1.493
8/3/2012	10:16:23 AM	11.281	19.236	13.281	1.484
8/3/2012	10:16:24 AM	11.94	19.23	13.280	1.478
8/3/2012	10:16:25 AM	12.66	19.221	13.277	1.469
8/3/2012	10:16:25 AM	13.441	19.217	13.273	1.465
8/3/2012	10:16:26 AM	14.221	19.205	13.273	1.453
8/3/2012	10:16:27 AM	15.061	19.202	13.272	1.45
8/3/2012	10:16:28 AM	15.961	19.192	13.269	1.44
8/3/2012	10:16:29 AM	16.921	19.186	13.269	1.434
8/3/2012	10:16:30 AM	17.881	19.172	13.269	1.42
8/3/2012	10:16:31 AM	18.96	19.163	13.266	1.411
8/3/2012	10:16:32 AM	20.101	19.154	13.259	1.402
8/3/2012	10:16:33 AM	21.301	19.139	13.263	1.387
8/3/2012	10:16:35 AM	22.561	19.126	13.260	1.374
8/3/2012	10:16:36 AM	23.881	19.114	13.261	1.362
8/3/2012	10:16:37 AM	25.321	19.102	13.258	1.35
8/3/2012	10:16:39 AM	26.821	19.094	13.259	1.342
8/3/2012	10:16:40 AM	28.381	19.078	13.257	1.326
8/3/2012	10:16:42 AM	30.061	19.062	13.257	1.31
8/3/2012	10:16:44 AM	31.86	19.045	13.256	1.293
8/3/2012	10:16:46 AM	33.72	19.032	13.254	1.28
8/3/2012	10:16:48 AM	35.761	19.014	13.252	1.262
8/3/2012	10:16:50 AM	37.861	19.005	13.254	1.253
8/3/2012	10:16:52 AM	40.08	18.981	13.249	1.229
8/3/2012	10:16:54 AM	42.48	18.968	13.251	1.216
8/3/2012	10:16:57 AM	45	18.95	13.248	1.198
8/3/2012	10:17:00 AM	47.641	18.931	13.246	1.179
8/3/2012	10:17:02 AM	50.46	18.903	13.247	1.151
8/3/2012	10:17:05 AM	53.46	18.889	13.246	1.137
8/3/2012	10:17:09 AM	56.641	18.867	13.247	1.115
8/3/2012	10:17:12 AM	60	18.847	13.247	1.095
8/3/2012	10:17:16 AM	63.601	18.822	13.247	1.07
8/3/2012	10:17:19 AM	67.2	18.799	13.244	1.047
8/3/2012	10:17:23 AM	71.401	18.776	13.247	1.024
8/3/2012	10:17:28 AM	75.601	18.747	13.244	0.995

B-727d Recovery

8/3/2012	10:17:32 AM	79.801	18.72	13.244	0.968
8/3/2012	10:17:37 AM	84.601	18.696	13.245	0.944
8/3/2012	10:17:42 AM	90	18.664	13.242	0.912
8/3/2012	10:17:47 AM	94.801	18.639	13.244	0.887
8/3/2012	10:17:53 AM	100.801	18.605	13.242	0.853
8/3/2012	10:17:59 AM	106.801	18.579	13.241	0.827
8/3/2012	10:18:05 AM	112.801	18.547	13.242	0.795
8/3/2012	10:18:10 AM	119.4	18.515	13.238	0.763
8/3/2012	10:18:19 AM	126.601	18.485	13.241	0.733
8/3/2012	10:18:26 AM	134.4	18.45	13.239	0.698
8/3/2012	10:18:34 AM	142.2	18.417	13.240	0.665
8/3/2012	10:18:43 AM	150.601	18.388	13.241	0.636
8/3/2012	10:18:52 AM	159.601	18.352	13.240	0.6
8/3/2012	10:19:01 AM	169.2	18.318	13.241	0.566
8/3/2012	10:19:10 AM	178.801	18.287	13.243	0.535
8/3/2012	10:19:22 AM	189.6	18.253	13.243	0.501
8/3/2012	10:19:33 AM	201	18.222	13.245	0.47
8/3/2012	10:19:45 AM	213	18.191	13.244	0.439
8/3/2012	10:19:58 AM	225.6	18.15	13.246	0.398
8/3/2012	10:20:10 AM	238.801	18.125	13.245	0.373
8/3/2012	10:20:25 AM	253.2	18.087	13.247	0.335
8/3/2012	10:20:40 AM	268.2	18.058	13.246	0.306
8/3/2012	10:20:56 AM	283.8	18.039	13.248	0.287
8/3/2012	10:21:13 AM	300.6	18.002	13.246	0.25
8/3/2012	10:21:31 AM	318.6	17.981	13.250	0.229
8/3/2012	10:21:49 AM	337.2	17.952	13.247	0.2
8/3/2012	10:22:10 AM	357.6	17.935	13.247	0.183
8/3/2012	10:22:31 AM	378.6	17.913	13.247	0.161
8/3/2012	10:22:53 AM	400.8	17.896	13.242	0.144
8/3/2012	10:23:17 AM	424.8	17.874	13.247	0.122
8/3/2012	10:23:42 AM	450	17.86	13.242	0.108
8/3/2012	10:24:08 AM	476.4	17.846	13.239	0.094
8/3/2012	10:24:37 AM	504.6	17.836	13.241	0.084
8/3/2012	10:25:07 AM	534.6	17.829	13.241	0.077
8/3/2012	10:25:38 AM	566.4	17.818	13.238	0.066
8/3/2012	10:26:12 AM	600	17.804	13.234	0.052
8/3/2012	10:26:48 AM	636	17.8	13.233	0.048
8/3/2012	10:27:24 AM	672	17.797	13.231	0.045
8/3/2012	10:28:06 AM	714	17.788	13.227	0.036
8/3/2012	10:28:48 AM	756	17.787	13.226	0.035
8/3/2012	10:29:30 AM	798	17.78	13.226	0.028
8/3/2012	10:30:18 AM	846	17.78	13.226	0.028
8/3/2012	10:31:12 AM	900	17.775	13.225	0.023
8/3/2012	10:32:00 AM	948	17.776	13.223	0.024
8/3/2012	10:33:00 AM	1008	17.772	13.224	0.02
8/3/2012	10:34:00 AM	1068	17.769	13.225	0.017
8/3/2012	10:35:00 AM	1128	17.771	13.223	0.019
8/3/2012	10:36:06 AM	1194	17.768	13.221	0.016
8/3/2012	10:37:18 AM	1266	17.768	13.220	0.016
8/3/2012	10:38:36 AM	1344	17.763	13.219	0.011
8/3/2012	10:39:54 AM	1422	17.761	13.222	0.009
8/3/2012	10:41:18 AM	1506	17.759	13.219	0.007
8/3/2012	10:42:48 AM	1596	17.76	13.216	0.008
8/3/2012	10:44:24 AM	1692	17.759	13.217	0.007
8/3/2012	10:46:00 AM	1788	17.759	13.215	0.007
8/3/2012	10:47:48 AM	1896	17.76	13.217	0.008

B-727d Recovery

8/3/2012	10:49:42 AM	2010	17.761	13.217	0.009
8/3/2012	10:51:42 AM	2130	17.76	13.214	0.008
8/3/2012	10:53:48 AM	2256	17.758	13.216	0.006
8/3/2012	10:56:00 AM	2388	17.755	13.218	0.003
8/3/2012	10:58:24 AM	2532	17.756	13.213	0.004
8/3/2012	11:00:54 PM	2682	17.756	13.214	0.004
8/3/2012	11:03:30 PM	2838	17.753	13.214	0.001
8/3/2012	11:06:18 PM	3006	17.754	13.211	0.002

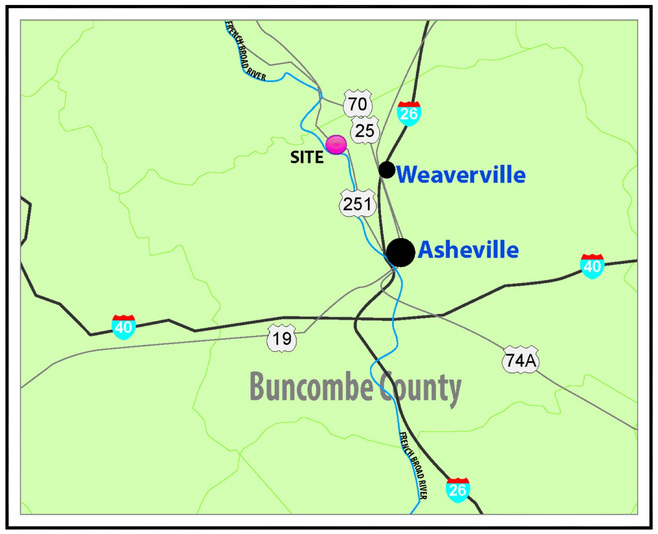
Engineering Plan

Appendix D – Engineering Drawings

CDM Smith

BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION
SUBTITLE D LANDFILL - PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS



LOCATION MAP

NOT TO SCALE

INDEX OF DRAWINGS

EP-1	EXISTING CONDITIONS
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EP-3	LINER SYSTEM PLAN
EP-4	PIPING PLAN
EP-4A	STORMWATER DIVERSION PLAN
EP-5	FINAL CLOSURE PLAN
EP-6	CROSS SECTIONS
EP-6A	BEDROCK ELEVATIONS
EP-6B	SEASONAL HIGH GROUNDWATER ELEVATIONS
EP-6C	BEDROCK/SHGW COMPOSITE ELEVATIONS
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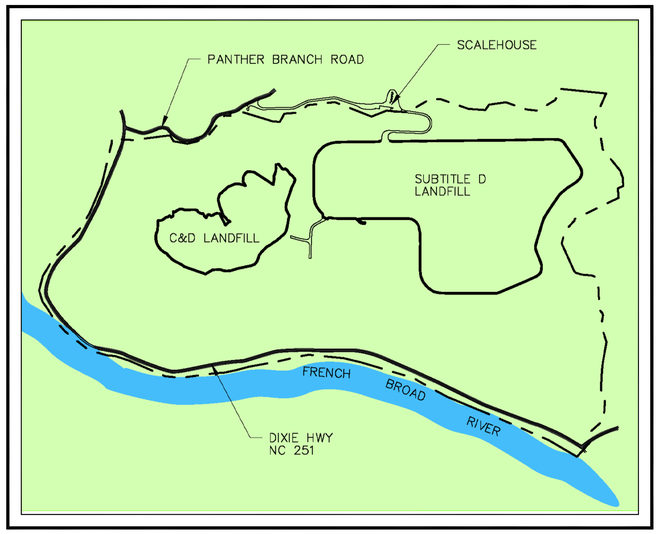
EP-16	HORIZONTAL INJECTION HEADER PLAN
EP-17	HORIZONTAL INJECTION SYSTEM DETAILS



VICINITY MAP

NOT TO SCALE

APRIL 2014

PREPARED BY

CDM Smith

Camp Dresser McKee & Smith
5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612 | Tel: (919) 787-5620
NC F-1255

6447-97693

PERMIT DRAWINGS

PIEZOMETER AND MONITORING WELL ABANDONMENT SCHEDULE			
Piezometer I.D.	Borehole Depth	Location	
		Northing	Easting
B-719	62	738560.01	923360.37
B-720s	58	738706.52	923176.65
B-720d	80	738716.13	923170.11
B-721	34	739233.53	923115.63
B-722s	24	739291.29	922797.19
B-722d	41	739294.04	922782.85
B-723	62	738458.32	923066.65
B-724	50	738779.56	922931.49
B-725	58	739193.64	922568.85
B-726	67	739019.08	922862.55
B-727s	22	738978.21	923061.49
B-727d	63	738985.05	923055.2
B-728	48.5	739055.44	923368.16
B-729	36	738872.44	923248.93
B-730	42.5	738825.08	923487.84

NOTE:

1. PIEZOMETERS TO BE ABANDONED ACCORDING TO TITLE 15A NCAC SUB-CHAPTER 2C WELL CONSTRUCTION STANDARDS.

1" = 100'
50 0 100

N

LEGEND

- 2010 — INDEX CONTOUR
- PROPERTY LINE
- LIMITS OF SEPT 2012 SURVEY
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- CHAINLINK FENCE
- STRUCTURE
- B-721 — BORING LOCATION

NOTES:

1. SURVEY OF MSW LANDFILL (CELL 6) BY ED HOLMES AND ASSOCIATES DATED OCTOBER 2013. SURVEY OF MSW LANDFILL (CELL 7) BY ED HOLMES AND ASSOCIATES DATED SEPTEMBER 2012.
2. TOPOGRAPHY OUTSIDE OF MSW BOUNDARY LIMITS DERIVED FROM AERIAL SURVEY PROVIDED BY AERODYNAMICS, CHARLOTTE, N.C. JULY 1993.
3. NORTH CAROLINA 1983 GRID DATUM.
4. THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS FOR 1"=100' SCALE, 10' CONTOUR INTERVAL.
5. CONTOURS WITHIN DENSE FOLIAGE AREAS INDICATE DOUBTFUL ACCURACY DUE TO OBSCURED VIEW FROM VEGETATION, SHADOWS, ETC.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

CDM Smith
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5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612 | Tel: (919) 787-5620
NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

EXISTING CONDITIONS

PROJECT NO. 6447-97693
FILE NAME: EP-1.DWG
SHEET NO.
EP-1

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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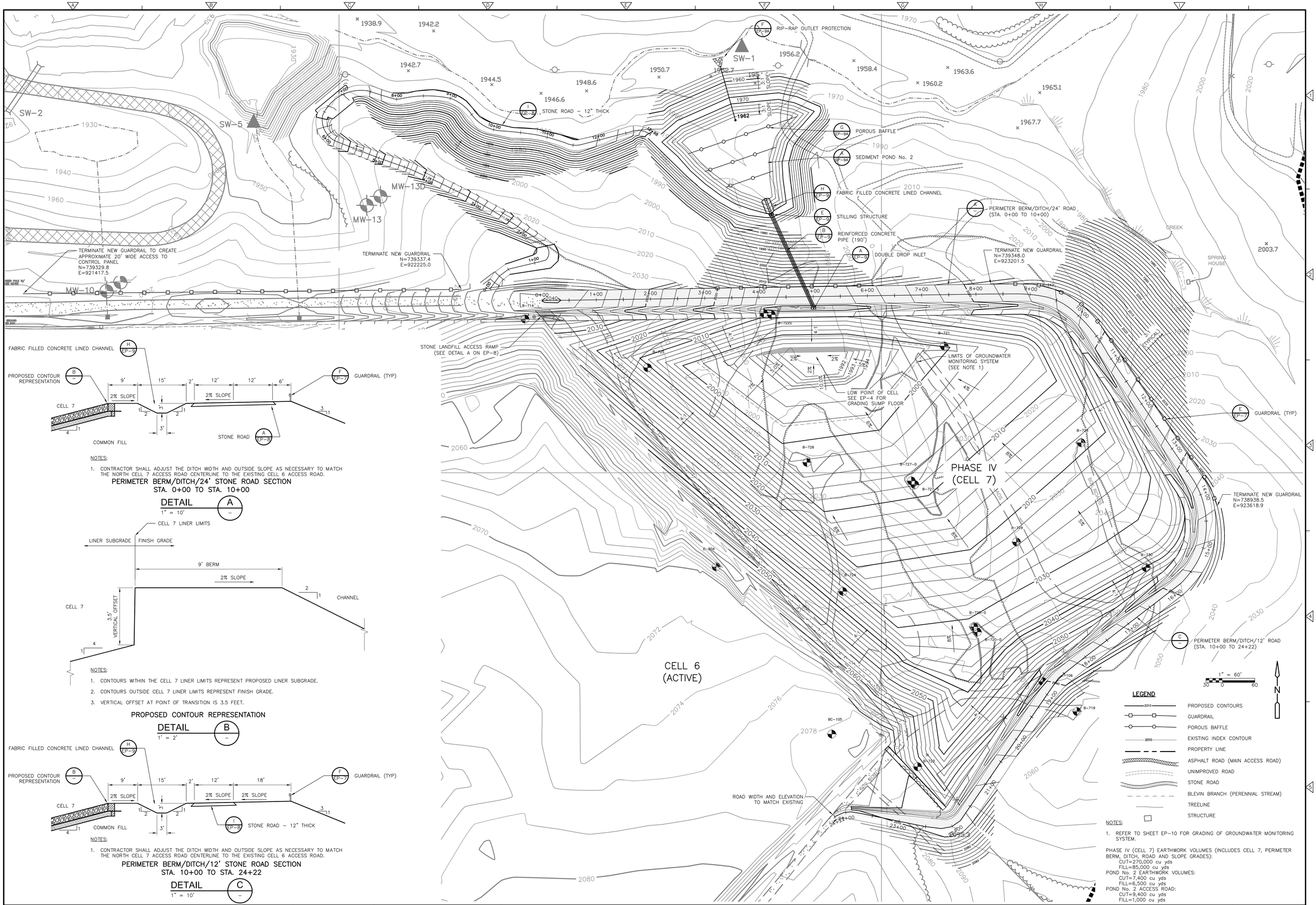

NOTES:

1. REFER TO SHEET EP-10 FOR GRADING OF GROUNDWATER MONITORING SYSTEM.

PHASE IV (CELL 7) EARTHWORK VOLUMES (INCLUDES CELL 7, PERIMETER BERM, DITCH, ROAD AND SLOPE GRADES):
CUT=270,000 cu yds
FILL=85,000 cu yds
POND No. 2 EARTHWORK VOLUMES:
CUT=7,400 cu yds
FILL=6,500 cu yds
POND No. 2 ACCESS ROAD:
CUT=9,400 cu yds
FILL=1,000 cu yds

NOTES:

1. CONTRACTOR SHALL ADJUST THE DITCH WIDTH AND OUTSIDE SLOPE AS NECESSARY TO MATCH THE NORTH CELL 7 ACCESS ROAD CENTERLINE TO THE EXISTING CELL 6 ACCESS ROAD.

PERIMETER BERM/DITCH/24' STONE ROAD SECTION
STA. 0+00 TO STA. 10+00

DETAIL A
1" = 10'

NOTES:

1. CONTOURS WITHIN THE CELL 7 LINER LIMITS REPRESENT PROPOSED LINER SUBGRADE.
2. CONTOURS OUTSIDE CELL 7 LINER LIMITS REPRESENT FINISH GRADE.
3. VERTICAL OFFSET AT POINT OF TRANSITION IS 3.5 FEET.

PROPOSED CONTOUR REPRESENTATION

DETAIL B
1" = 2'

NOTES:

1. CONTRACTOR SHALL ADJUST THE DITCH WIDTH AND OUTSIDE SLOPE AS NECESSARY TO MATCH THE NORTH CELL 7 ACCESS ROAD CENTERLINE TO THE EXISTING CELL 6 ACCESS ROAD.

PERIMETER BERM/DITCH/12' STONE ROAD SECTION
STA. 10+00 TO STA. 24+22

DETAIL C
1" = 10'

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

CDM Smith
Camp Dresser McKee & Smith
5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612 | Tel: (919) 787-5620
NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

GRADING PLAN

PROJECT NO. 6447-97693
FILE NAME: EP-2.DWG
SHEET NO.
EP-2

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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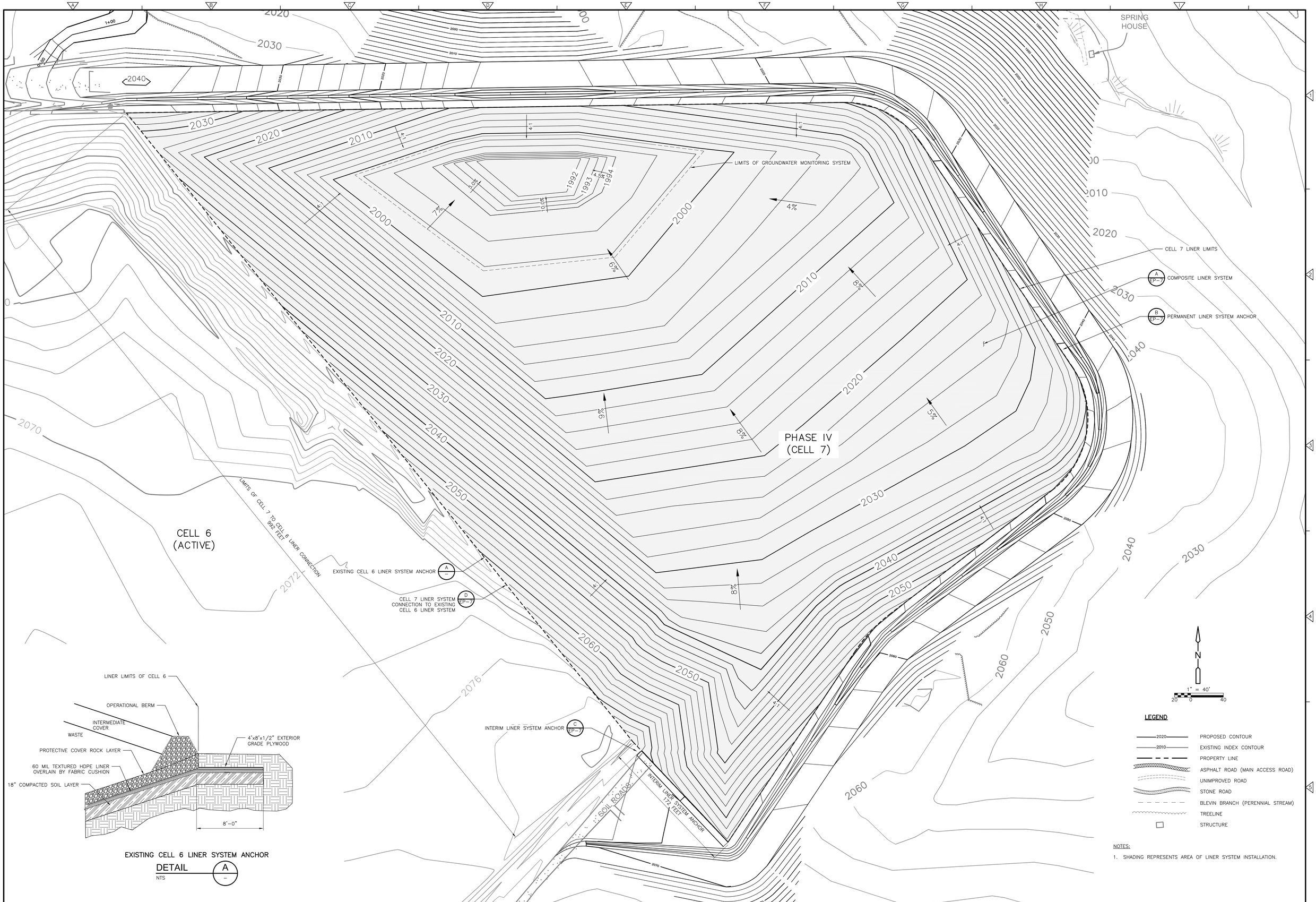

EXISTING CELL 6 LINER SYSTEM ANCHOR

DETAIL A –

NTS

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

LINER SYSTEM PLAN

PROJECT NO. 6447-97693
FILE NAME: EP-3.DWG
SHEET NO.
EP-3

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REMOVE BLIND FLANGES/CAP AND CONNECT NEW 24-INCH GAS, 6-INCH LEACHATE, AND 6-INCH LEACHATE RECIRC TO EXISTING PIPING

F EP-8 CONDENSATE RECOVERY SYSTEM (NOTE 1)

SPRING HOUSE

PERIMETER BERM PIPING 24-INCH GAS 6-INCH LEACHATE 6-INCH LEACHATE RECIRC

E EP-8

7-A

7-B

LEACHATE PUMP STATION A EP-11

7-C

H EP-8 STUB OUT (2-LEACHATE RECIRC, 7-GAS)

119' 10" HDPE SOLID PIPE

65' 10" HDPE SOLID PIPE

82' 10" HDPE SOLID PIPE

END 6-INCH LEACHATE RECIRC 3 FEET EAST OF THIS STUB OUT LOCATION WITH WELDED END CAP

252' 10" HDPE PERFORATED PIPE

121' 10" HDPE SOLID PIPE

7-D

144' 10" HDPE PERFORATED PIPE

124' 10" HDPE PERFORATED PIPE

SWEEPING BEND

SWEEPING BEND

B EP-8 LEACHATE COLLECTION PIPE (TYP)

SWEEPING BEND

SEE SUMP ENLARGED VIEW THIS SHEET

EXISTING PIPING: 24-INCH GAS 6-INCH LEACHATE 6-INCH LEACHATE RECIRC 1-INCH COMPRESSED AIR

LIMITS OF GROUNDWATER MONITORING SYSTEM

24-INCH GAS

B EP-8 LEACHATE COLLECTION PIPE (TYP)

D EP-8 LEACHATE CLEANOUT (TYP 7)

450' 10" HDPE PERFORATED PIPE

7-E

551' 10" HDPE PERFORATED PIPE

SWEEPING BEND

20' 10" HDPE SOLID PIPE

CELL 6 (ACTIVE)

PHASE IV (CELL 7)

765' 10" HDPE PERFORATED PIPE

206' 10" HDPE PERFORATED PIPE

82' 10" HDPE SOLID PIPE

7-F

89' 10" HDPE SOLID PIPE

7-G

END 24-INCH GAS WITH WELDED CAP

LEACHATE PUMP STATION A EP-11

END 6-INCH LEACHATE FORCEMAIN AT LEACHATE PUMP STATION

D EP-8 LEACHATE CLEANOUT

18-INCH SOLID LEACHATE SUMP PUMP RISER PIPE

10-INCH GROUNDWATER MONITORING SYSTEM PIPE

10" SOLID HDPE PIPE

224' 24" HDPE PERFORATED PIPE

2% SLOPE

2% SLOPE

LOW POINT OF CELL

24-INCH PERFORATED LEACHATE PIPE

LEACHATE SUMP A EP-10

2% SLOPE

10-INCH PERFORATED LEACHATE HEADER PIPE

24-INCH PERFORATED LEACHATE PIPE

10-INCH PERFORATED LEACHATE HEADER PIPE

SUMP ENLARGED VIEW

1" = 20'

10 0 20

N

1" = 40'

20 0 40

LEGEND

- 2010 EXISTING INDEX CONTOUR
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE
- 10" HDPE SOLID PIPE
- 10" HDPE PERFORATED PIPE
- 24" HDPE PERFORATED PIPE

NOTES:

1. LOCATE CONDENSATE RECOVERY SYSTEM CONNECTION TO GAS PIPE AT LOW POINT OF GAS PIPE.

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ENGINEERING PLAN DRAWINGS

PIPING PLAN

PROJECT NO. 6447-97693
FILE NAME: EP-4.DWG
SHEET NO.
EP-4

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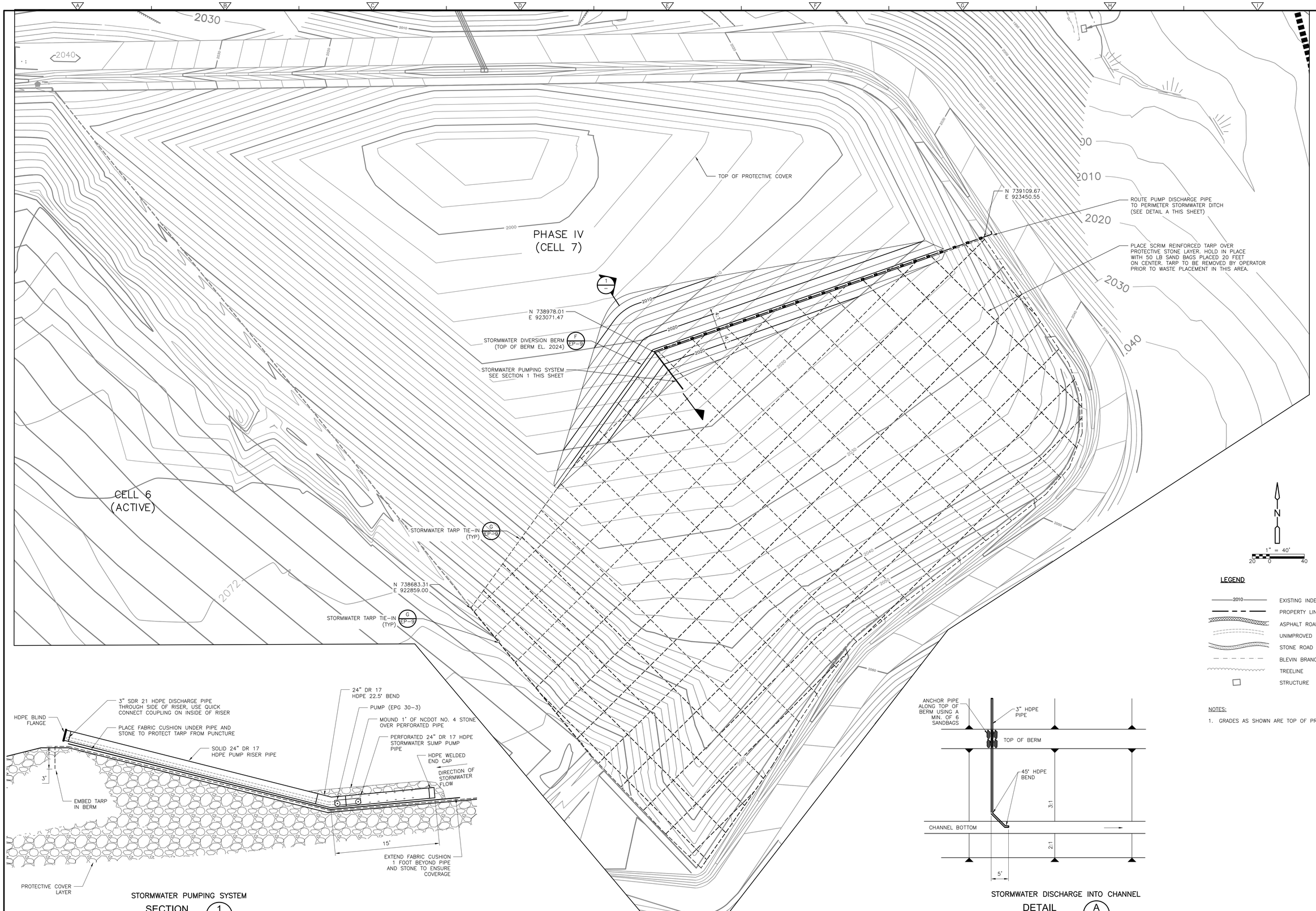

LEGEND

- 2010 — EXISTING INDEX CONTOUR
- PROPERTY LINE
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE

NOTES:

1. GRADES AS SHOWN ARE TOP OF PROTECTIVE COVER.

STORMWATER PUMPING SYSTEM
SECTION 1
1" = 5'

STORMWATER DISCHARGE INTO CHANNEL
DETAIL A
1"=10'

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ENGINEERING PLAN DRAWINGS

STORMWATER DIVERSION PLAN

PROJECT NO. 6447-97693
FILE NAME: EP-4A.DWG
SHEET NO.
EP-4A

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REV. NO.	DATE	DRWN	CHKD	REMARKS

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FINAL CLOSURE PLAN

PROJECT NO. 6447-97693
FILE NAME: EP-5.DWG
SHEET NO.
EP-5

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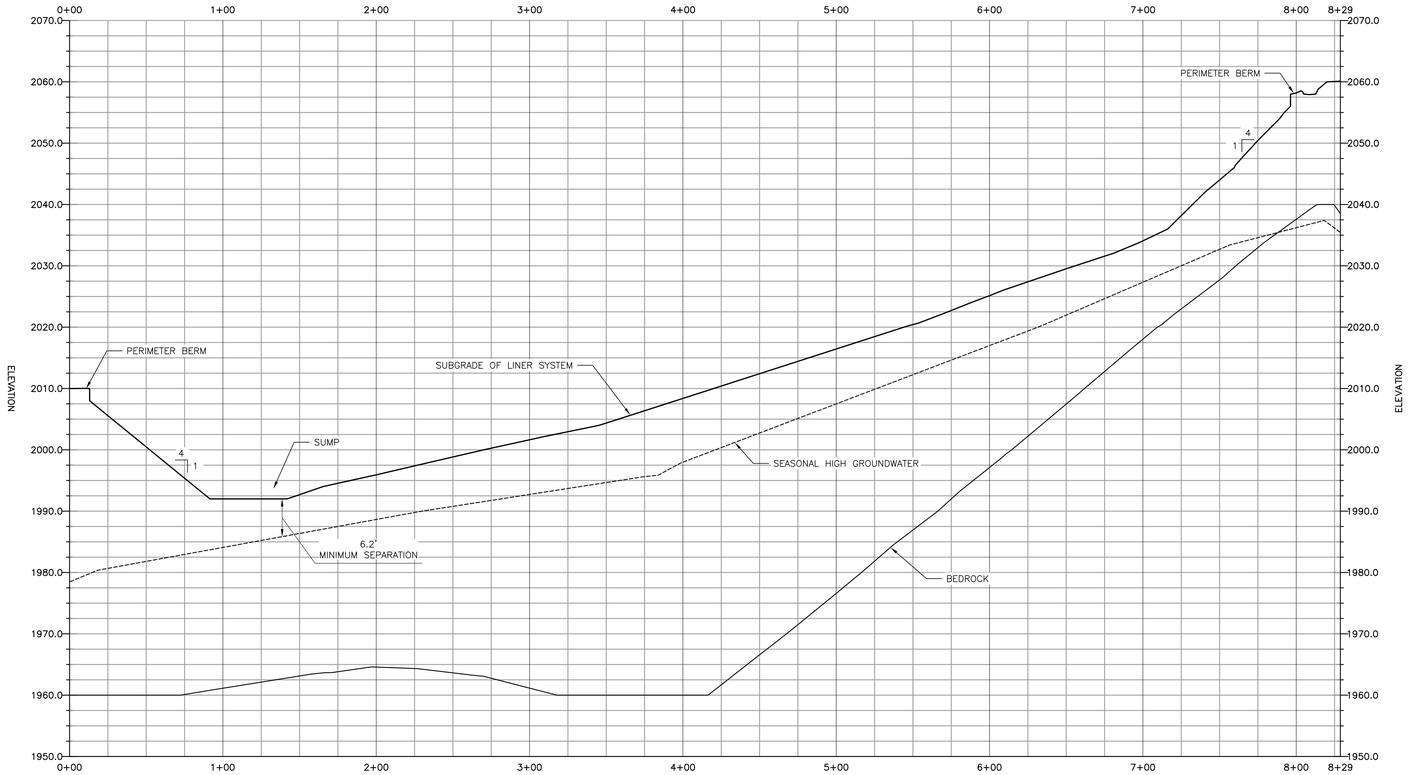
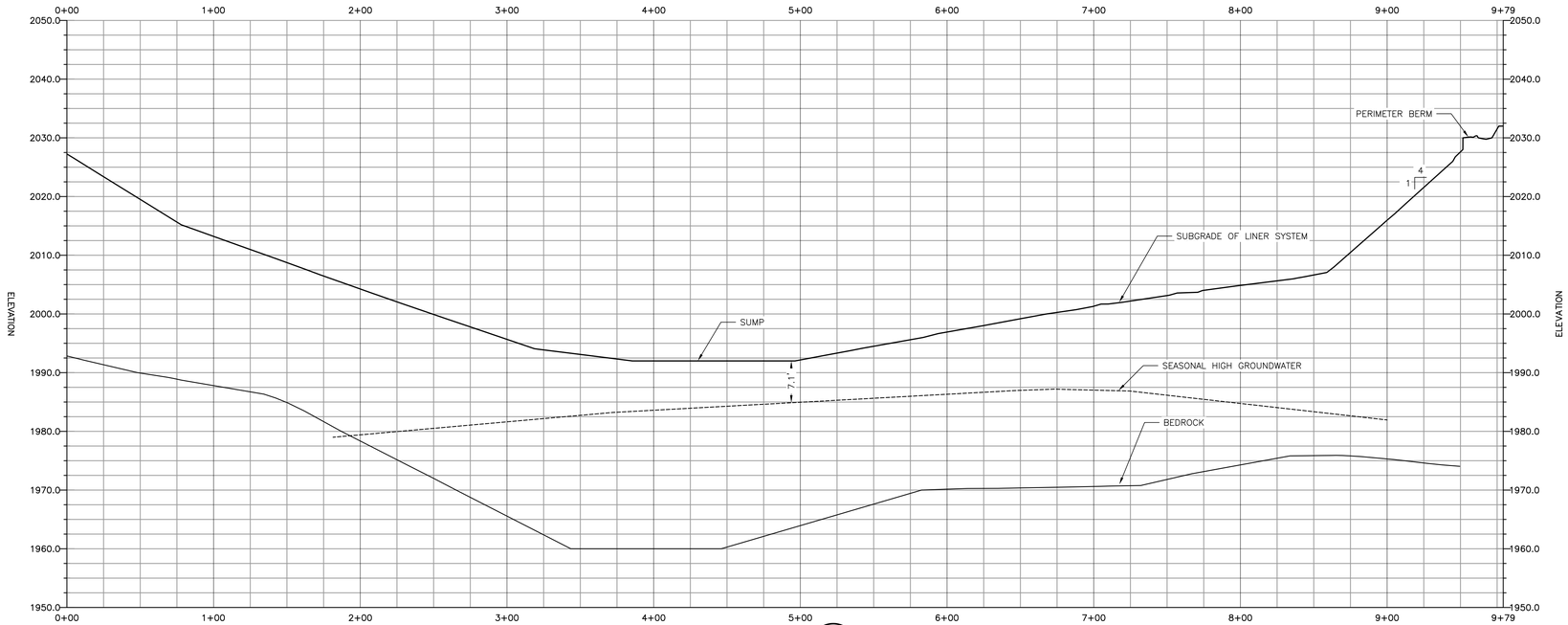


SECTION 1 EP-6A

HORZ 1" = 40'
VERT 1" = 10'



SECTION 2 EP-6A

HORZ 1" = 40'
VERT 1" = 10'

VERTICAL 1" = 10' 5 0 10

HORIZONTAL 1" = 40' 20 0 40

REV. NO.	DATE	DRWN	CHKD	REMARKS

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CROSS CHK'D BY: C. GABEL
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CROSS SECTIONS

PROJECT NO. 6447-97693
FILE NAME: EP-6.DWG

SHEET NO.
EP-6

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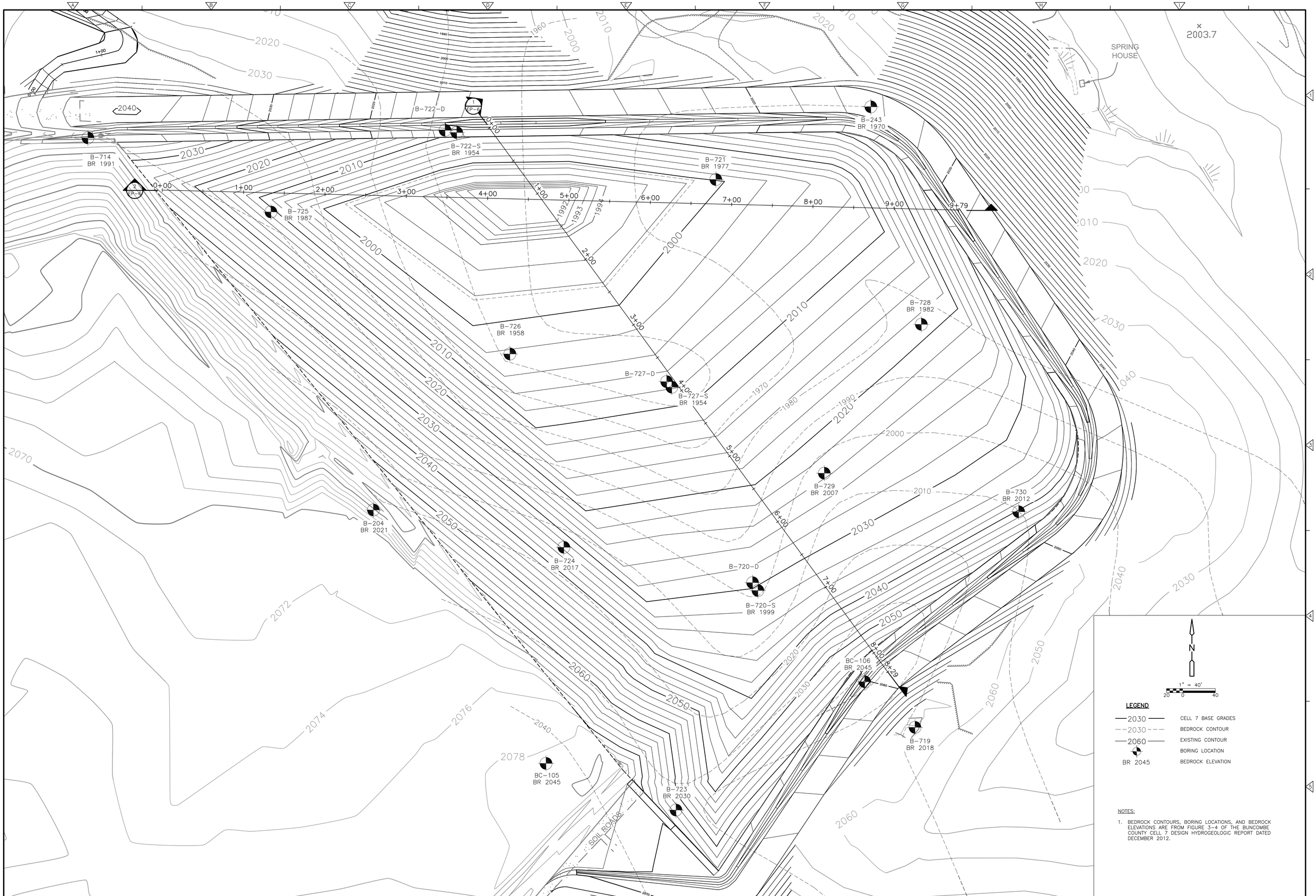

NOTES:

1. BEDROCK CONTOURS, BORING LOCATIONS, AND BEDROCK ELEVATIONS ARE FROM FIGURE 3-4 OF THE BUNCOMBE COUNTY CELL 7 DESIGN HYDROGEOLOGIC REPORT DATED DECEMBER 2012.

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BEDROCK ELEVATIONS

PROJECT NO. 6447-97693
FILE NAME: EP-6A.DWG
SHEET NO.
EP-6A

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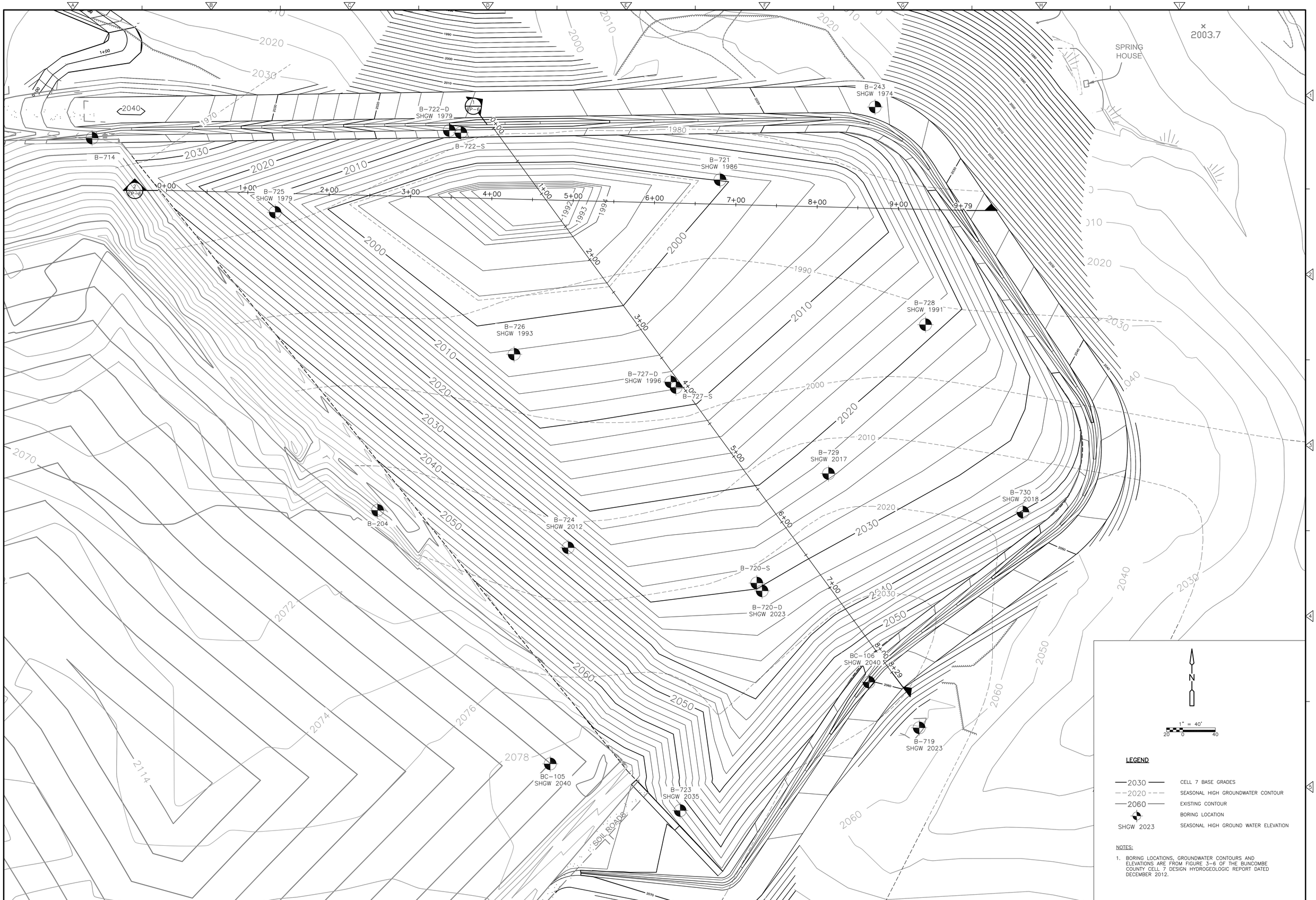

LEGEND

2030	CELL 7 BASE GRADES
2020	SEASONAL HIGH GROUNDWATER CONTOUR
2060	EXISTING CONTOUR
	BORING LOCATION
SHGW 2023	SEASONAL HIGH GROUND WATER ELEVATION

NOTES:

1. BORING LOCATIONS, GROUNDWATER CONTOURS AND ELEVATIONS ARE FROM FIGURE 3-6 OF THE BUNCOMBE COUNTY CELL 7 DESIGN HYDROGEOLOGIC REPORT DATED DECEMBER 2012.

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SEASONAL HIGH GROUNDWATER ELEVATIONS

PROJECT NO. 6447-97693
FILE NAME: EP-6B.DWG
SHEET NO.
EP-6B

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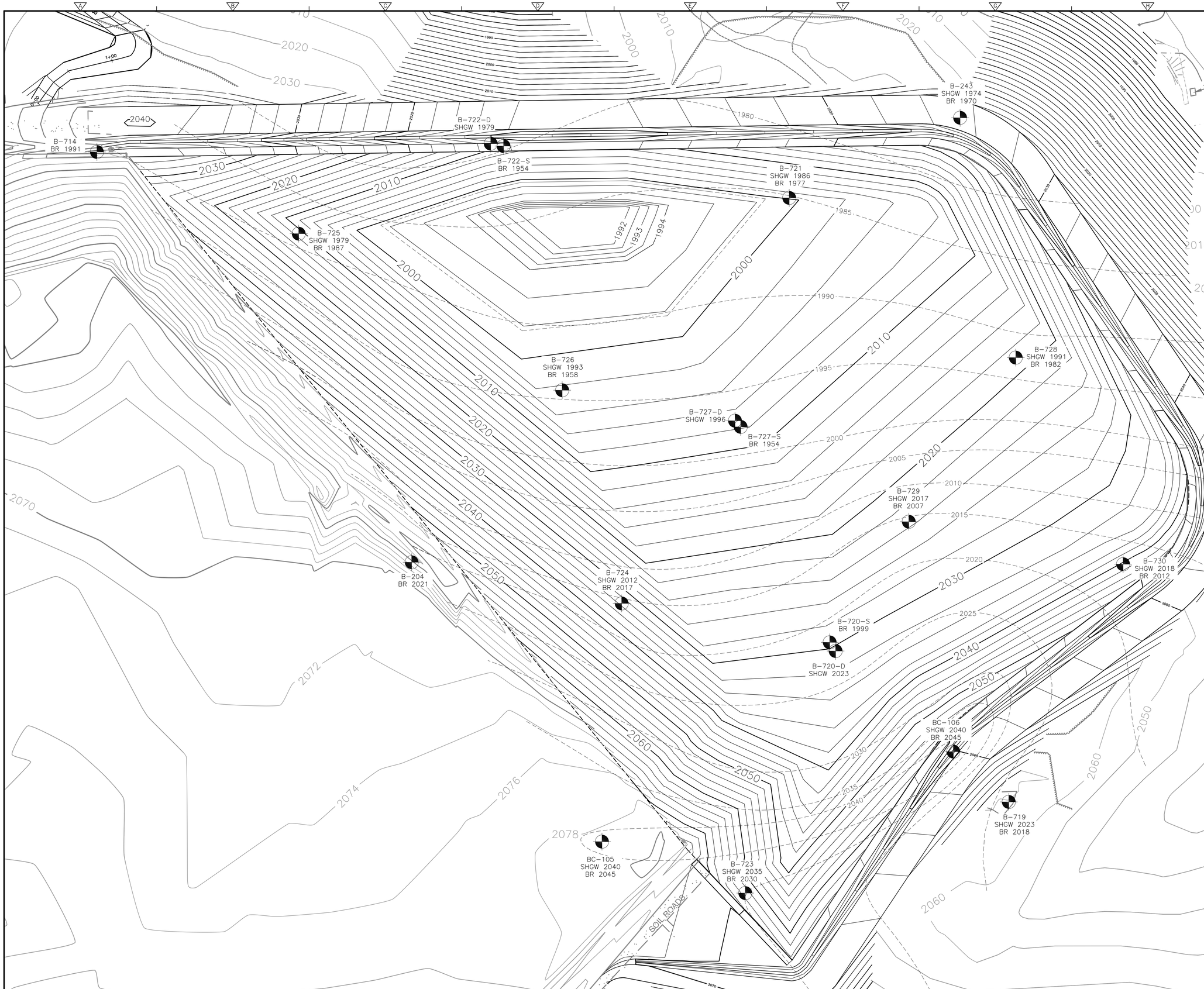

N

1" = 40'

20 0 40

LEGEND

—2030—	CELL 7 BASE GRADES
- -2030- - -	BEDROCK/SHGW COMPOSITE CONTOUR
—2060—	EXISTING CONTOUR
⊕	BORING LOCATION
SHGW 2023	SEASONAL HIGH GROUNDWATER ELEVATION
BR 2045	BEDROCK ELEVATION
BR (2012)	ELEVATION NOT USED FOR CONTOURING

NOTES:

1. BEDROCK/SHGW COMPOSITE CONTOURS WERE PREPARED BY COMPARING BEDROCK AND SHGW ELEVATIONS AT EACH BORING AND USING WHICHEVER ELEVATION WAS HIGHER. THE COMPOSITE ELEVATIONS ARE USED TO CONFIRM THAT ADEQUATE VERTICAL SEPARATION IS ACHIEVED BETWEEN BEDROCK/SHGW AND THE CELL 7 POST-SETTLEMENT BASE GRADES.

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BEDROCK\SHGW COMPOSITE ELEVATIONS

PROJECT NO. 6447-97693
FILE NAME: EP-6C.DWG
SHEET NO.
EP-6C

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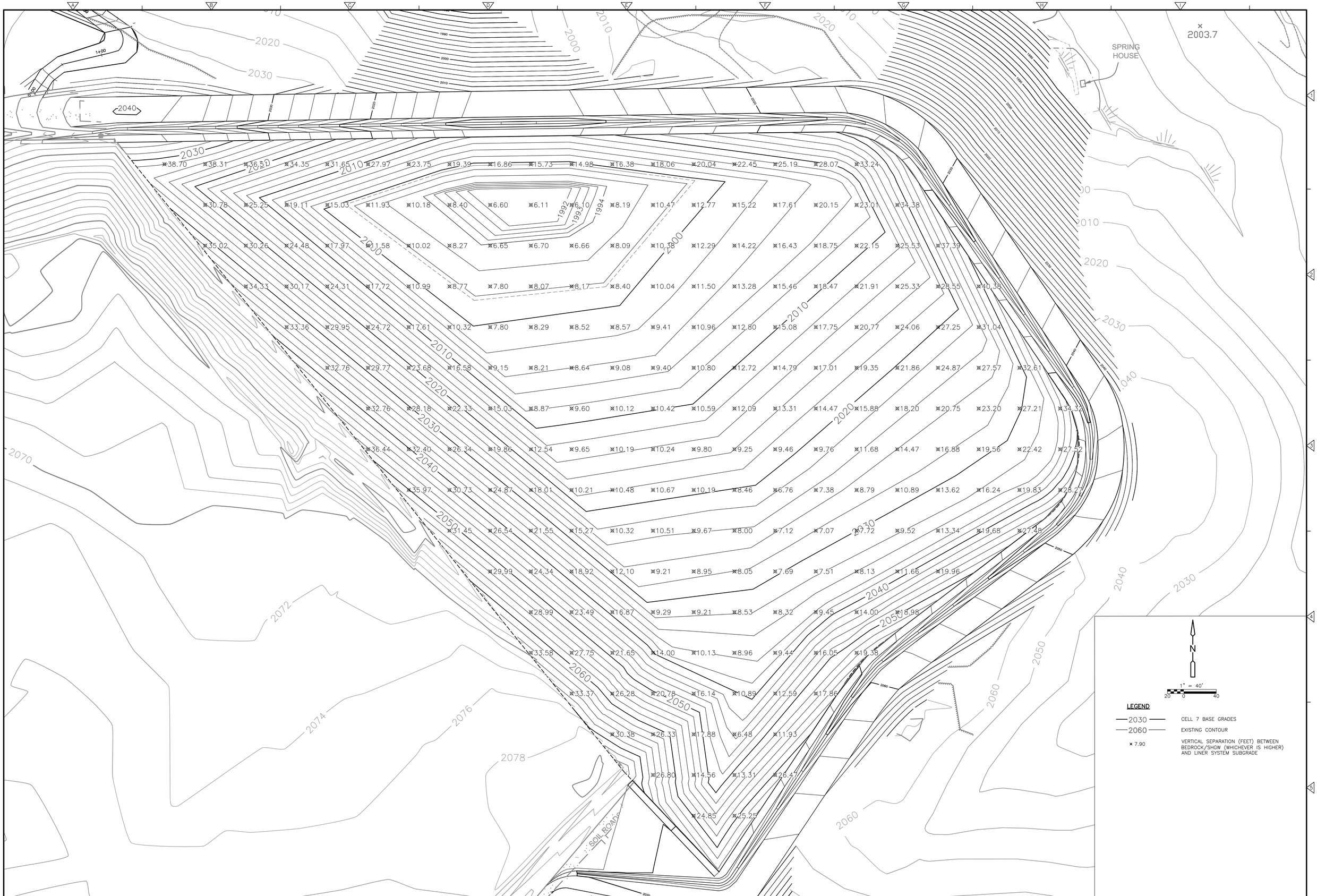

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VERTICAL SEPARATION BETWEEN BEDROCK/SHGW AND LINER SYSTEM SUBGRADE

PROJECT NO. 6447-97693
FILE NAME: EP-6D.DWG
SHEET NO.
EP-6D

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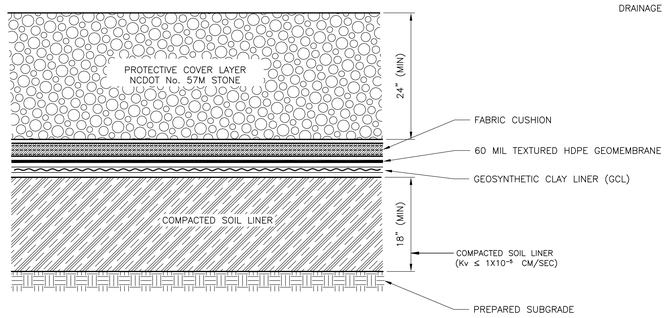
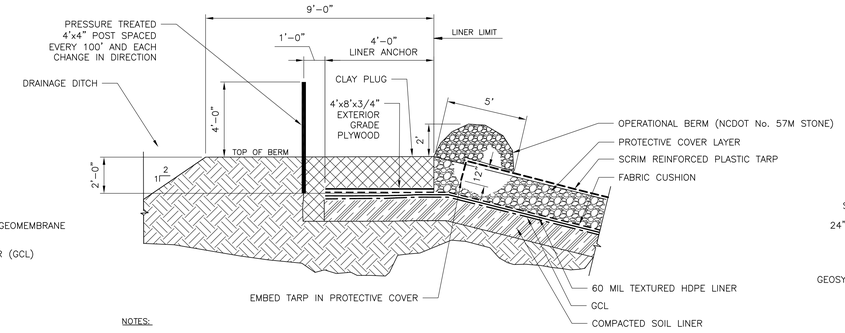


COMPOSITE LINER SYSTEM

DETAIL A
NTS EP-3

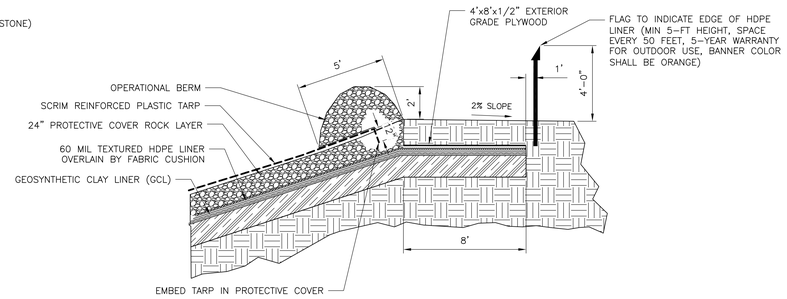


NOTES:

1. CLAY PLUG FOR BACKFILLING OVER THE LINER ANCHOR SHALL HAVE A HYDRAULIC CONDUCTIVITY LESS THAN OR EQUAL TO 1x10-7 cm/sec.

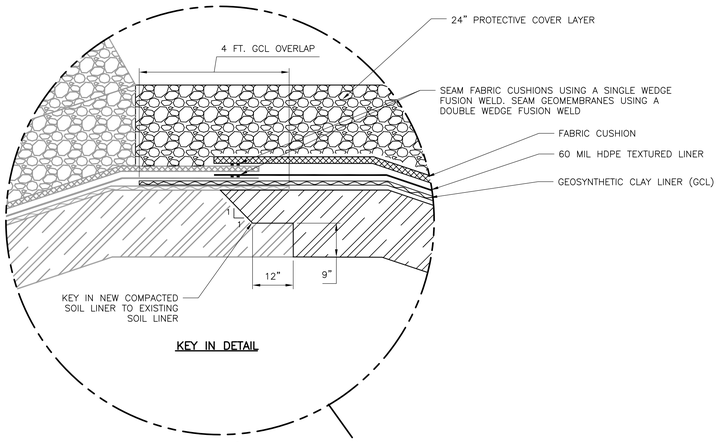
PERMANENT LINER SYSTEM ANCHOR

DETAIL B
NTS EP-3

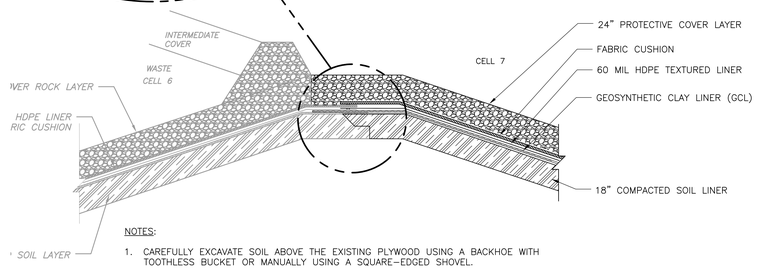


INTERIM LINER SYSTEM ANCHOR

DETAIL C
NTS EP-3



KEY IN DETAIL

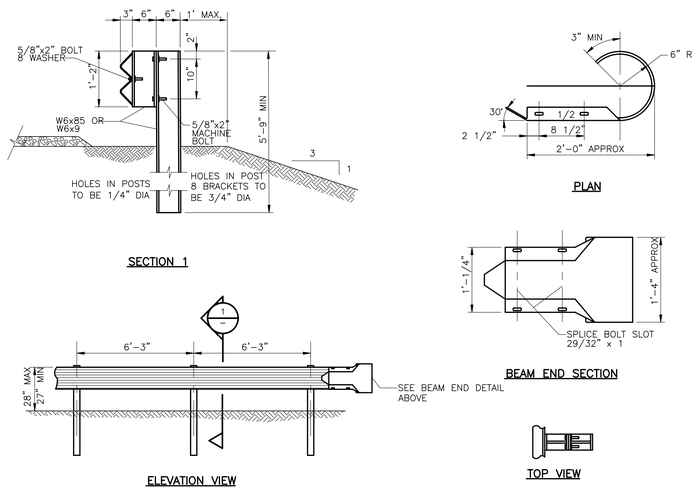


NOTES:

1. CAREFULLY EXCAVATE SOIL ABOVE THE EXISTING PLYWOOD USING A BACKHOE WITH TOOTHLESS BUCKET OR MANUALLY USING A SQUARE-EDGED SHOVEL.
2. REMOVE AND DISCARD EXISTING PLYWOOD AND ROLL BACK THE LINER SYSTEM COMPONENTS TO EXPOSE THE SOIL LINER.
3. KEY-IN THE NEW SOIL LINER TO THE EXISTING SOIL USING A STAGGERED OFFSET AS SHOWN.
4. PROVIDE A 4 FOOT MINIMUM OVERLAP OF NEW AND EXISTING GCL PANELS.
5. THOROUGHLY CLEAN EXISTING GEOMEMBRANE AND FUSION WELD NEW AND EXISTING GEOMEMBRANES USING A DOUBLE WEDGE WELDER.
6. JOIN NEW AND EXISTING FABRIC CUSHIONS USING FUSION WELDS OR SEWN SEAMS.
7. PLACE COVER ROCK OVER FABRIC CUSHION AND ABUT TO EXISTING COVER ROCK.

CELL 7 LINER SYSTEM CONNECTION TO EXISTING CELL 6 LINER SYSTEM

DETAIL D
NTS EP-3



METAL GUARDRAIL AND HARDWARE

DETAIL E
NTS EP-2

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
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ENGINEERING PLAN DRAWINGS

DETAILS I

PROJECT NO. 6447-97693
FILE NAME: EP-7.DWG
SHEET NO.
EP-7

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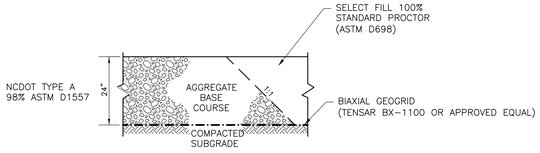


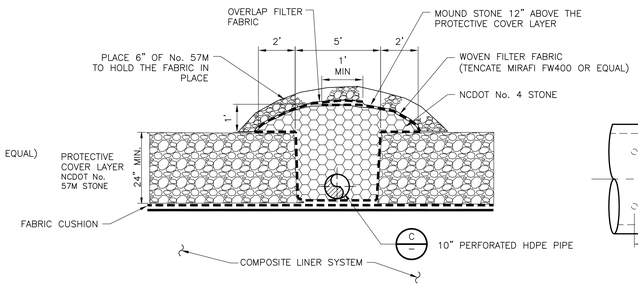
NOTES:

1. PROOFROLL SUBGRADE IN CUT AREAS PER SPECIFICATIONS.
2. 2' MINIMUM SELECT FILL COMPACTED TO 100% STD. PROCTOR (ASTM D698) IN FILL AREAS.

STONE ROAD – 24" THICK

DETAIL A / EP-2

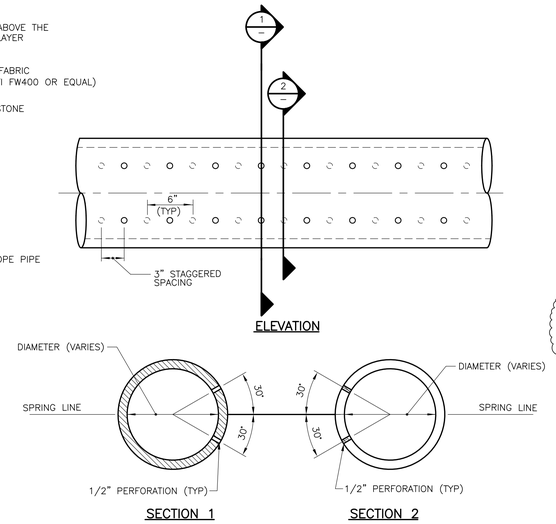
NTS



LEACHATE COLLECTION PIPE

DETAIL B / EP-4

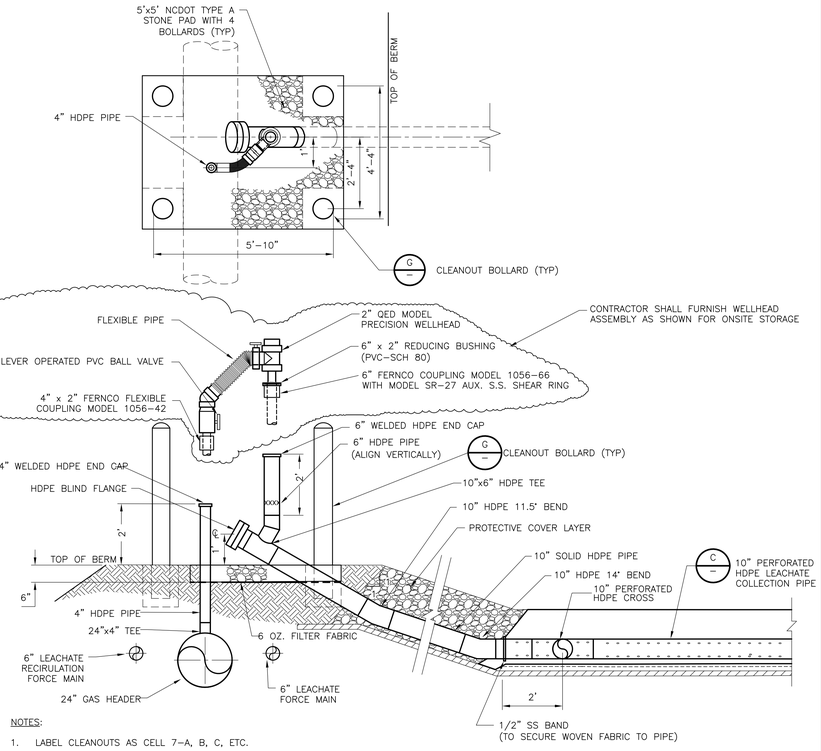
NTS



PERFORATED HDPE PIPE

DETAIL C / –

NTS



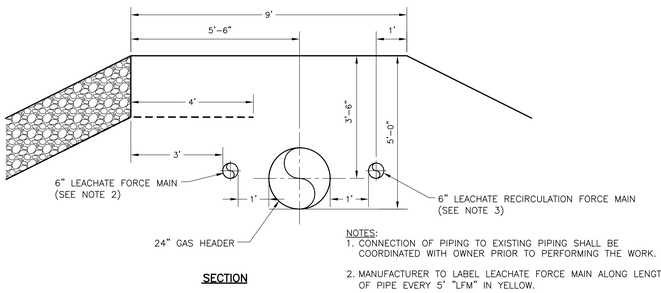
NOTES:

1. LABEL CLEANOUTS AS CELL 7-A, B, C, ETC.

LEACHATE CLEANOUT

DETAIL D / EP-4

NTS



SECTION

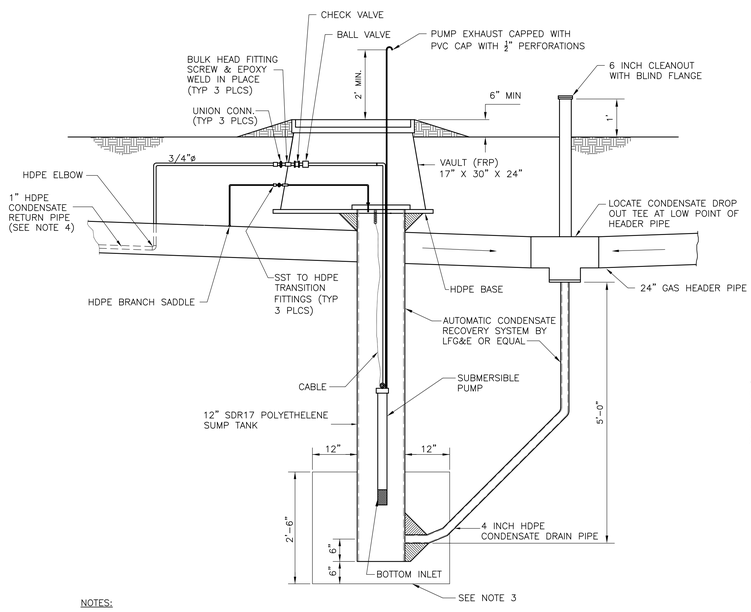
NOTES:

1. CONNECTION OF PIPING TO EXISTING PIPING SHALL BE COORDINATED WITH OWNER PRIOR TO PERFORMING THE WORK.
2. MANUFACTURER TO LABEL LEACHATE FORCE MAIN ALONG LENGTH OF PIPE EVERY 5' "LFM" IN YELLOW.
3. MANUFACTURER TO LABEL LEACHATE RECIRCULATION FORCE MAIN ALONG LENGTH OF PIPE EVERY 5' "RECIRC" IN GREEN.
4. PIPING LAYOUT WILL BE INSTALLED AS SHOWN REGARDLESS OF IF CERTAIN PIPES ARE NOT LOCATED THROUGHOUT THE BERM.
5. CONTRACTOR TO TRANSITION EXISTING PIPING CONFIGURATION FROM CELL 6 AS SHOWN.

PERIMETER BERM PIPING

DETAIL E / EP-4

1" = 2'



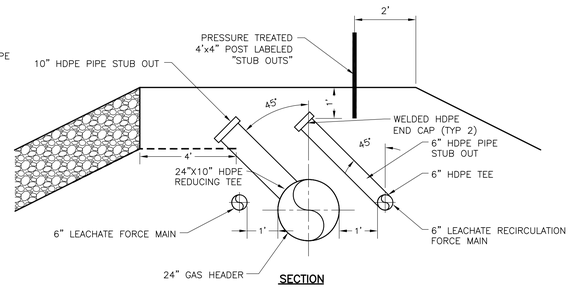
NOTES:

1. CONDENSATE RECOVERY SYSTEM SHALL BE COMPLETELY ASSEMBLED AND FACTORY TESTED PRIOR TO DELIVERY.
2. CONDENSATE DISCHARGE CONNECTIONS SHALL BE MADE WITH HDPE TO STAINLESS STEEL TRANSITION FITTINGS AND STAINLESS STEEL UNIONS.
3. AFTER INSTALLATION OF THE POLYETHYLENE SUMP TANK, BACKFILL WITH APPROXIMATELY 2 FEET OF NCDOT No. 57M STONE IN ORDER TO COVER THE 4 INCH INLET AND HOLD THE SUMP IN PLACE.
4. CONNECT HDPE CONDENSATE DISCHARGE PIPE TO THE CELL 7 LEACHATE RISER.

CONDENSATE RECOVERY SYSTEM

DETAIL F / EP-4

NTS

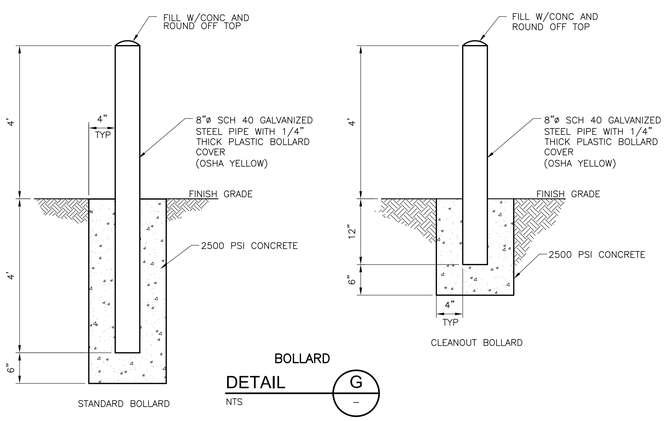


SECTION

STUB OUT

DETAIL H / EP-4

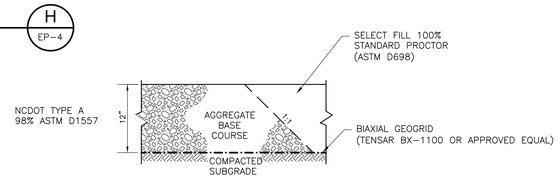
1" = 2'



BOLLARD

DETAIL G / –

NTS



NOTES:

1. PROOFROLL SUBGRADE IN CUT AREAS PER SPECIFICATIONS.
2. 2' MINIMUM SELECT FILL COMPACTED TO 100% STD. PROCTOR (ASTM D698) IN FILL AREAS.

STONE ROAD – 12" THICK

DETAIL I / EP-2

NTS

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

CDM Smith
Camp Dresser McKee & Smith
5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612 | Tel: (919) 787-5620
NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

DETAILS II

PROJECT NO. 6447-97693
FILE NAME: EP-8.DWG
SHEET NO.
EP-8

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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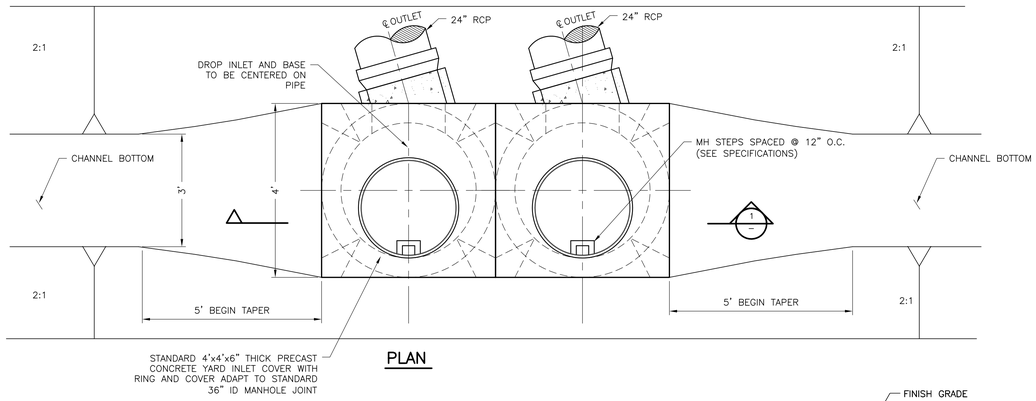
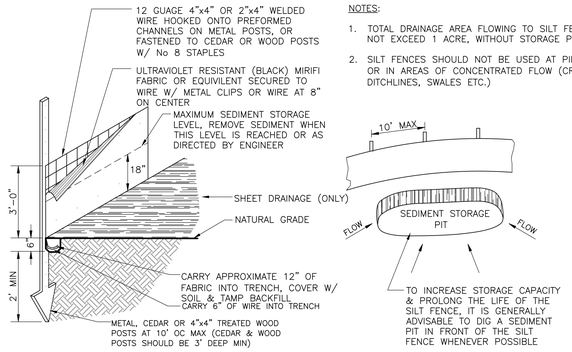


PLAN

NOTES:

1. STEPS SHALL BE STEEL REINFORCED COPOLYMER POLYPROPYLENE PLASTIC STEPS THAT CONFORM TO LATEST ASTM C478 SPECIFICATIONS IN BOTH MATERIAL AND DESIGN.
2. SECTION JOINTS SHALL BE SEALED WITH NON-SHRINK GROUT.
3. COAT OUTSIDE OF MANHOLE WITH COAL TAR EPOXY – 2 COATS OF 9 mil. EACH DRY FILM THICKNESS.

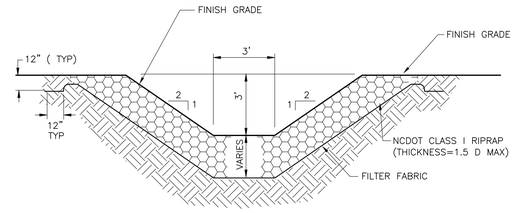
DOUBLE DROP INLET
DETAIL A
NTS EP-2



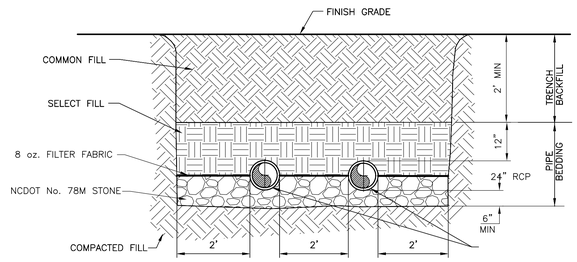
NOTES:

1. TOTAL DRAINAGE AREA FLOWING TO SILT FENCE MAY NOT EXCEED 1 ACRE, WITHOUT STORAGE PIT.
2. SILT FENCES SHOULD NOT BE USED AT PIPE OUTLETS OR IN AREAS OF CONCENTRATED FLOW (CREEKS, DITCHLINES, SWALES ETC.)

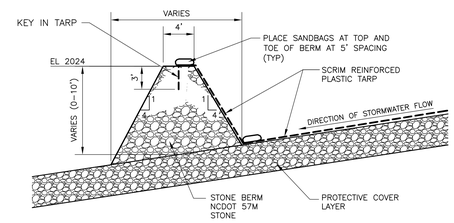
SILT FENCE
DETAIL C
NTS –



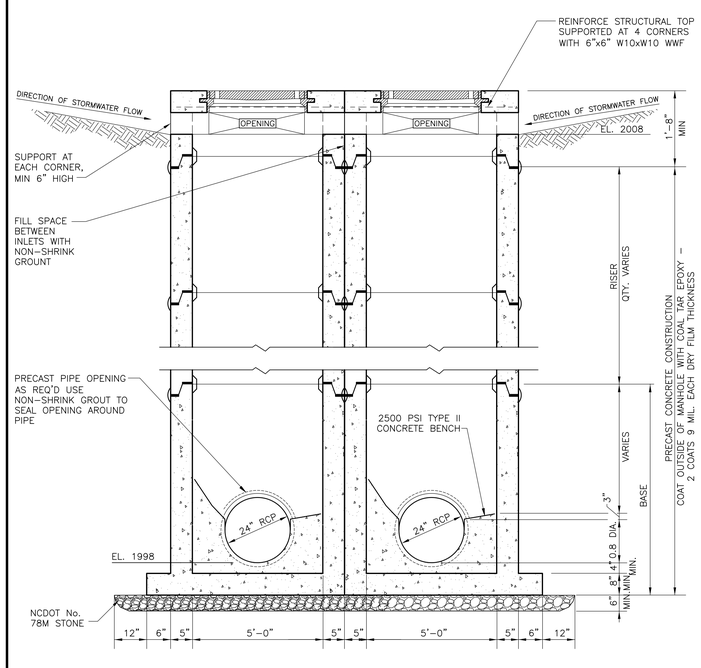
RIP RAP LINED CHANNEL
DETAIL D
NTS EP-2



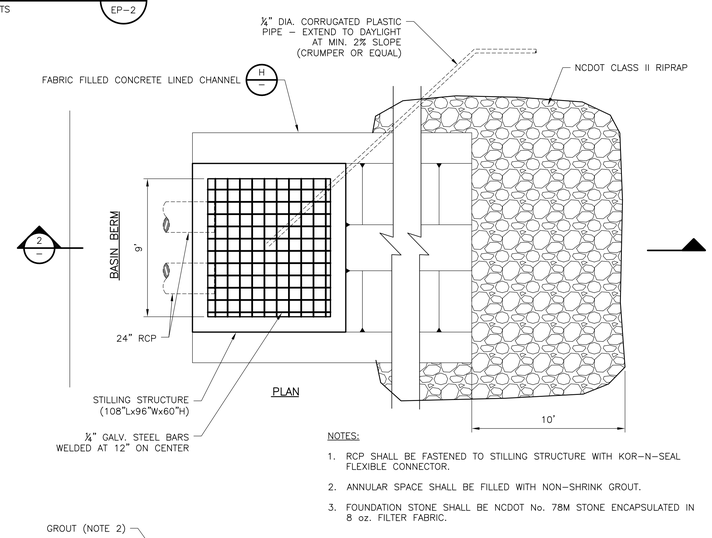
REINFORCED CONCRETE PIPE (RCP) BEDDING
DETAIL B
NTS EP-2



STORMWATER DIVERSION BERM
DETAIL F
NTS EP-4A

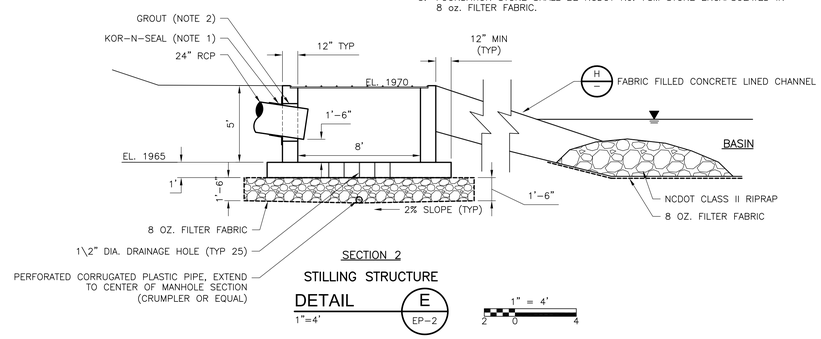


DOUBLE DROP INLET
SECTION 1
NTS –



NOTES:

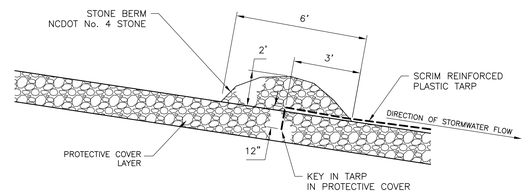
1. RCP SHALL BE FASTENED TO STILLING STRUCTURE WITH KOR-N-SEAL FLEXIBLE CONNECTOR.
2. ANNULAR SPACE SHALL BE FILLED WITH NON-SHRINK GROUT.
3. FOUNDATION STONE SHALL BE NCDOT No. 78M STONE ENCAPSULATED IN 8 oz. FILTER FABRIC.



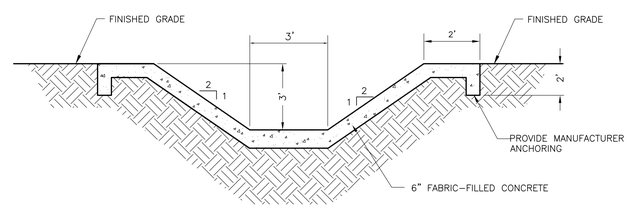
SECTION 2

STILLING STRUCTURE
DETAIL E
1"=4' EP-2

1" = 4'
2 0 4



STORMWATER TARP TIE-IN
DETAIL G
NTS EP-4A



SECTION

FABRIC FILLED CONCRETE LINED CHANNEL
DETAIL H
NTS EP-2

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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5400 Glenwood Avenue, Suite 300
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NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

DETAILS III

PROJECT NO. 6447-97693
FILE NAME: EP-9.DWG
SHEET NO.
EP-9

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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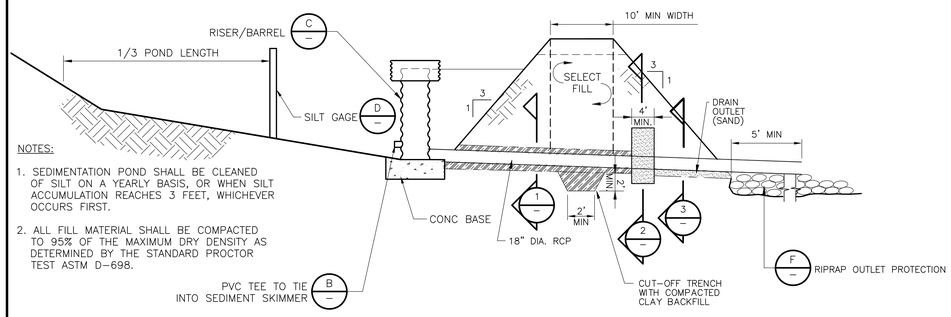
SEDIMENTATION POND 2 DATA												
POND		PIPE RISER			PIPE BARREL							SKIMMER
SEDIMENTATION POND NO.	BOTTOM ELEV.	DIAMETER (IN)	CREST ELEV.	TRASH GUARD DIA. (IN)	DIAMETER (IN.)	LENGTH (FT)	SLOPE (%)	INVERT IN ELEV.	INVERT OUT ELEV.	CONCRETE BASE (CY)	TOP OF DAM ELEV.	COUPLING /TEE SIZE (IN)
POND 2	1962.0	36	1965.5	48	18	110	9	1962	1952	3.7	1970.0	8

NOTES:

1. EMERGENCY SPILLWAY NOT REQUIRED. POND IS SIZED TO PASS THE 100-YR 24-HR EVENT THROUGH THE RISER STRUCTURE.



NOTES:

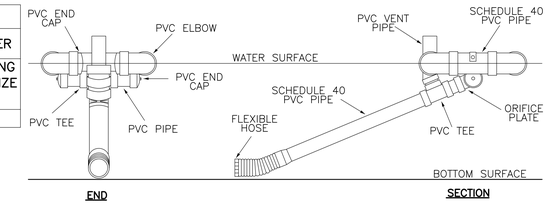
1. SEDIMENTATION POND SHALL BE CLEANED OF SILT ON A YEARLY BASIS, OR WHEN SILT ACCUMULATION REACHES 3 FEET, WHICHEVER OCCURS FIRST.
2. ALL FILL MATERIAL SHALL BE COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE STANDARD PROCTOR TEST ASTM D-698.

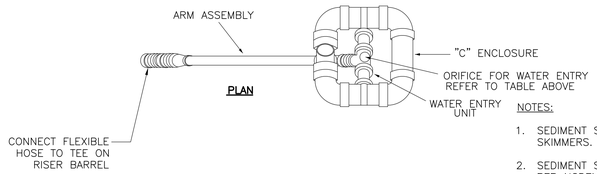
SECTION

SEDIMENTATION NO. POND 2

DETAIL A

NTS EP-2





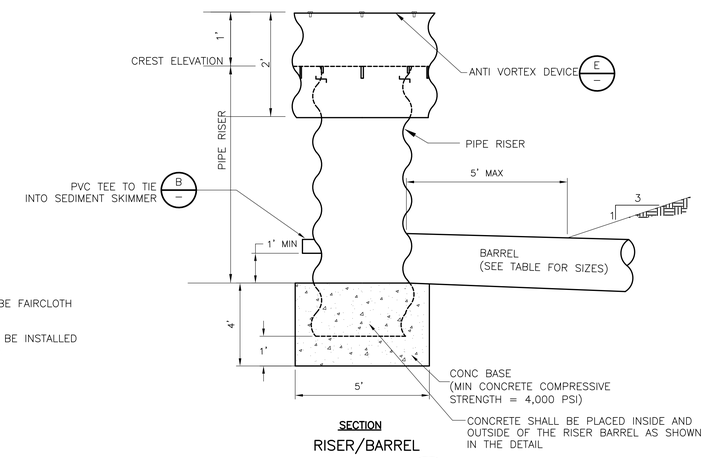
NOTES:

1. SEDIMENT SKIMMER SHALL BE FAIRCLOTH SKIMMERS.
2. SEDIMENT SKIMMERS SHALL BE INSTALLED PER NCDENR STD PRACTICE

SEDIMENT SKIMMER

DETAIL B

NTS

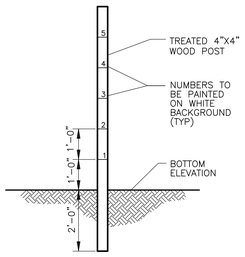


SECTION

RISER/BARREL

DETAIL C

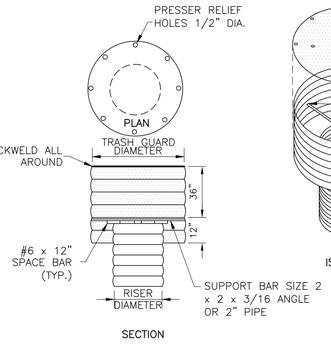
NTS

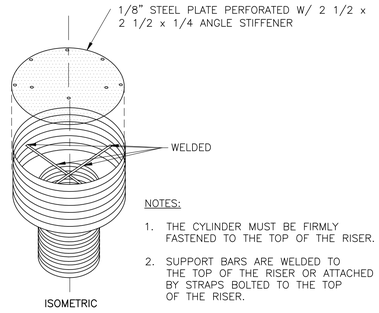


SILT GAUGE

DETAIL D

NOT TO SCALE





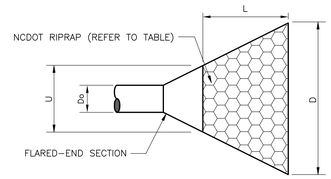
NOTES:

1. THE CYLINDER MUST BE FIRMLY FASTENED TO THE TOP OF THE RISER.
2. SUPPORT BARS ARE WELDED TO THE TOP OF THE RISER OR ATTACHED BY STRAPS BOLTED TO THE TOP OF THE RISER.
3. HOT DIP GALVANIZE THE ENTIRE DEVICE AFTER ASSEMBLY.
4. CYLINDER IS 10 GAGE CORRUGATED METAL PIPE

ANTI-VORTEX DEVICE

DETAIL E

NTS



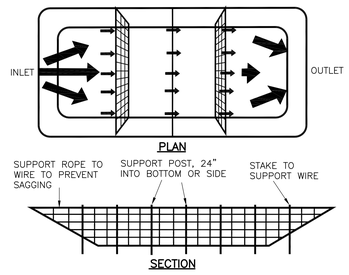
NOTE: PLACE 8-OZ/SY NONWOVEN GEOTEXTILE (FILTER FABRIC) BENEATH RIPRAP

LOCATION	NO. OF PIPES	PIPE DIA-IN. Do	LENGTH L-(FT)	DEPTH (FT)	UPSTREAM WIDTH - U (FT)	DOWNSTREAM WIDTH - D (FT)	NCDOT RIPRAP CLASS
SB-2 OUTLET	1	18	18	2.0	4.5	19.5	I

RIPRAP OUTLET PROTECTION

DETAIL F

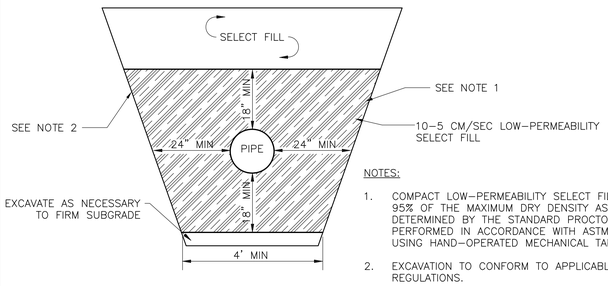
NTS EP-2



POROUS BAFFLE IN SEDIMENT POND

DETAIL G

NTS EP-2



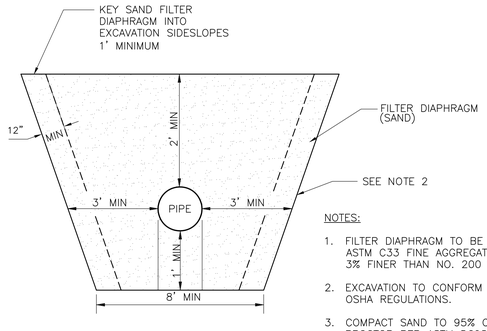
NOTES:

1. COMPACT LOW-PERMEABILITY SELECT FILL TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE STANDARD PROCTOR TEST PERFORMED IN ACCORDANCE WITH ASTM D698 USING HAND-OPERATED MECHANICAL TAMPS.
2. EXCAVATION TO CONFORM TO APPLICABLE OSHA REGULATIONS.
3. EXCAVATE TRENCH TO MINIMUM LIMITS SHOWN. EXCAVATE TRENCH LARGER OR DEEPER IF NECESSARY TO REMOVE ALL UNSUITABLE SOIL, OVER STEEP SLOPES, AND IRREGULAR SURFACES CAUSED BY THE PREVIOUS EROSION.

UPSTREAM OF FILTER DIAPHRAGM

SECTION 1

NOT TO SCALE



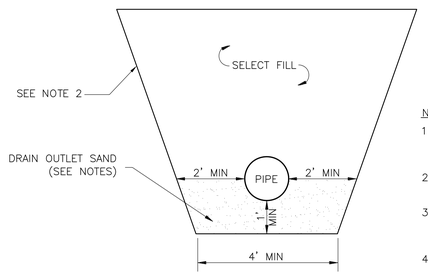
NOTES:

1. FILTER DIAPHRAGM TO BE SAND MEETING ASTM C33 FINE AGGREGATE WITH LESS THAN 3% FINER THAN NO. 200 SIEVE.
2. EXCAVATION TO CONFORM TO APPLICABLE OSHA REGULATIONS.
3. COMPACT SAND TO 95% OF STANDARD PROCTOR PER ASTM D698.
4. EXCAVATE TRENCH TO MINIMUM LIMITS SHOWN. EXCAVATE TRENCH LARGER OR DEEPER IF NECESSARY TO REMOVE ALL LOOSE SOIL, OVER STEEP SLOPES, AND IRREGULAR SURFACES CAUSED BY THE PREVIOUS EROSION.

FILTER DIAPHRAGM

SECTION 2

NOT TO SCALE



NOTES:

1. DRAIN OUTLET TO BE SAND MEETING ASTM C33 FINE AGGREGATE WITH LESS THAN 3% FINER THAN NO. 200 SIEVE.
2. EXCAVATION TO CONFORM TO APPLICABLE OSHA REGULATIONS.
3. DRAIN OUTLET SAND TO BE COMPACTED TO 95% OF STANDARD PROCTOR PER ASTM D698.
4. EXCAVATE TRENCH TO MINIMUM LIMITS SHOWN. EXCAVATE TRENCH LARGER OR DEEPER IF NECESSARY TO REMOVE ALL UNSUITABLE SOIL, OVER STEEP SLOPES, AND IRREGULAR SURFACES CAUSED BY THE PREVIOUS EROSION.

DOWNSTREAM OF FILTER DIAPHRAGM

SECTION 3

NOT TO SCALE

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

DETAILS IV

PROJECT NO. 6447-97693
FILE NAME: EP-9A.DWG
SHEET NO.
EP-9A

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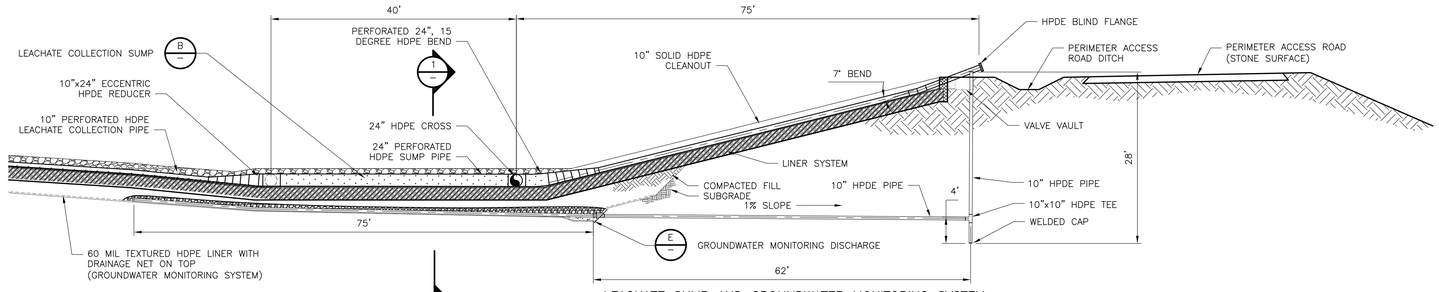
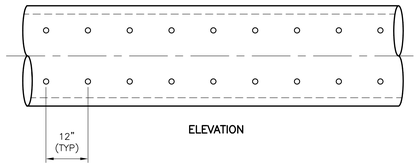


LEACHATE SUMP AND GROUNDWATER MONITORING SYSTEM

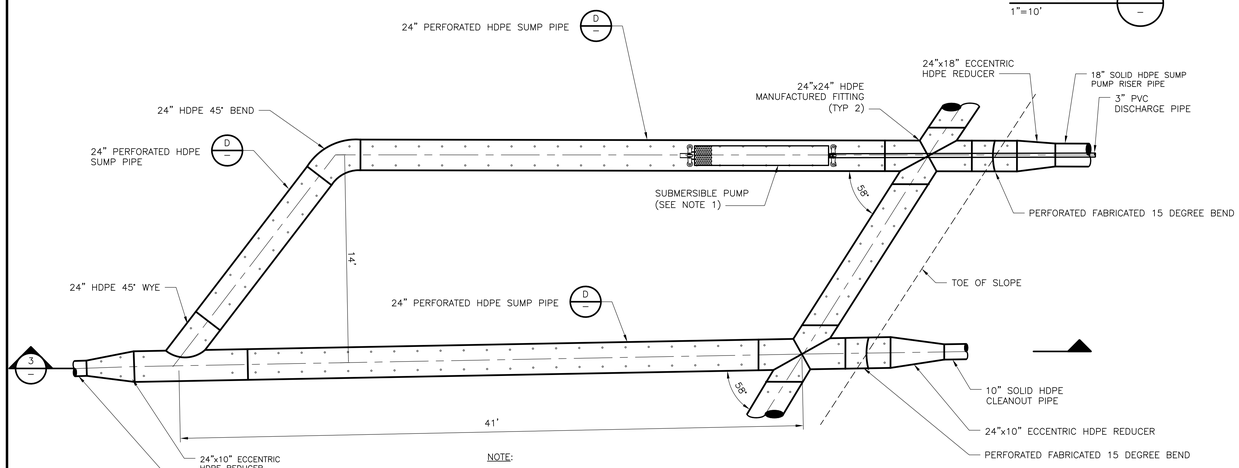
SECTION 3
1"=10'

1" = 10'
5 0 10



PERFORATED HDPE SUMP PIPE

DETAIL D
NTS



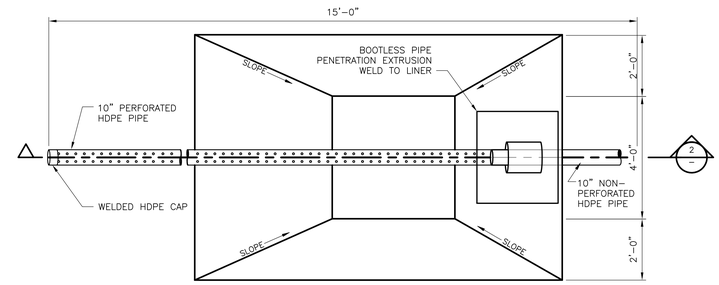
NOTE:

1. REAM INNER WELD BEADS OF 18" RISER, REDUCER, AND 24" SUMP TO ALLOW PUMP TO ROLL FREELY INTO THE SUMP.

1" = 4'
2 0 4

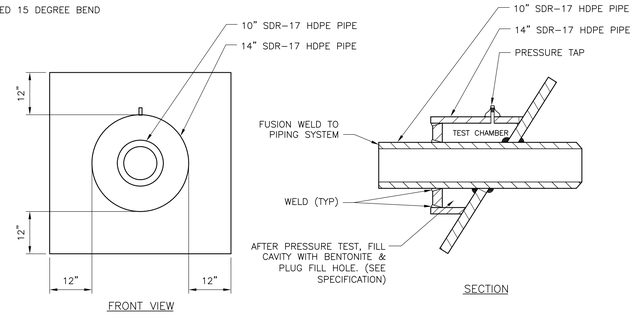
LEACHATE COLLECTION SUMP PLAN VIEW

DETAIL A
1" = 4'



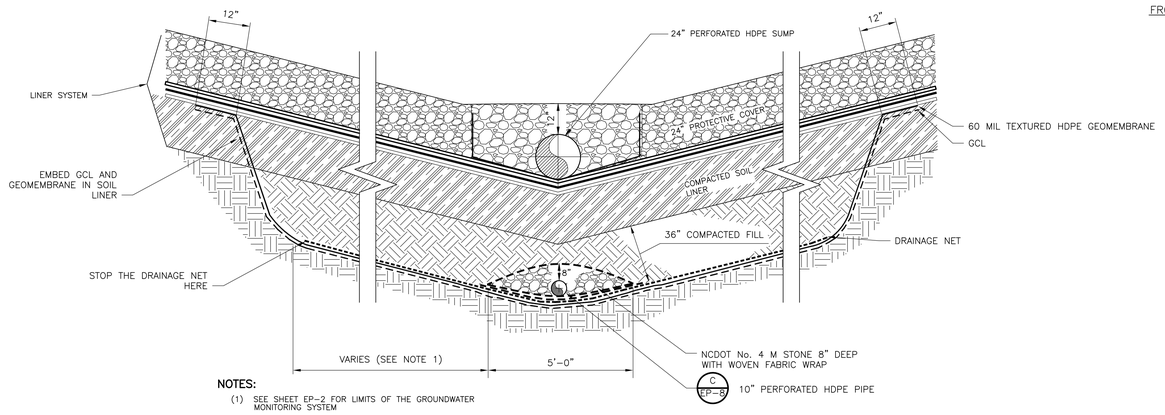
GROUNDWATER MONITORING DISCHARGE PLAN VIEW

DETAIL E
NTS



BOOTLESS PIPE PENETRATION

DETAIL C
NTS



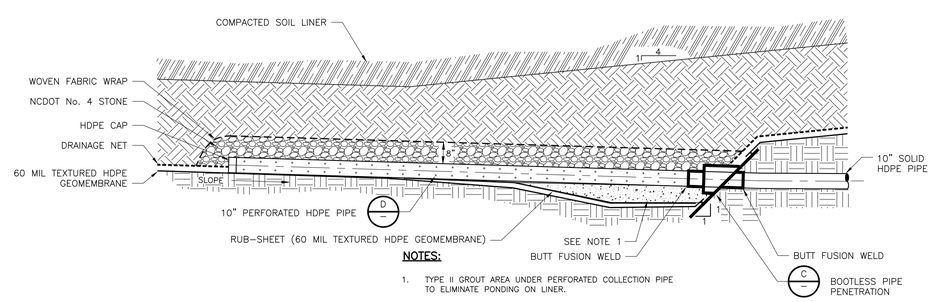
NOTES:

(1) SEE SHEET EP-2 FOR LIMITS OF THE GROUNDWATER MONITORING SYSTEM

(2) TYPE II GROUT AREA UNDER PERFORATED COLLECTION PIPE TO ELIMINATE PONDING ON LINER.

GROUNDWATER MONITORING SYSTEM

SECTION 1
NTS



NOTES:

1. TYPE II GROUT AREA UNDER PERFORATED COLLECTION PIPE TO ELIMINATE PONDING ON LINER.

GROUNDWATER MONITORING SYSTEM DISCHARGE

SECTION 2
NTS

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

CDM Smith
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5400 Glenwood Avenue, Suite 300
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NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

DETAILS V

PROJECT NO. 6447-97693
FILE NAME: EP-10.DWG
SHEET NO.
EP-10

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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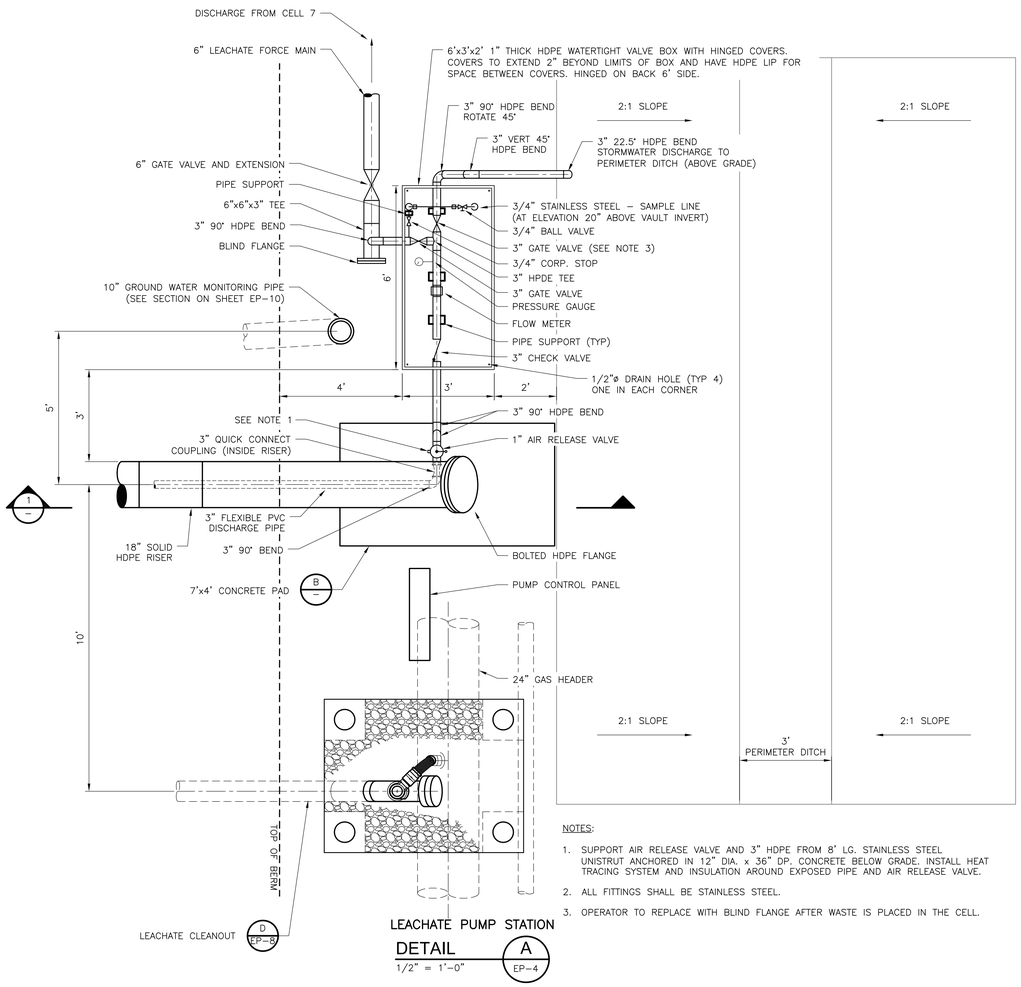


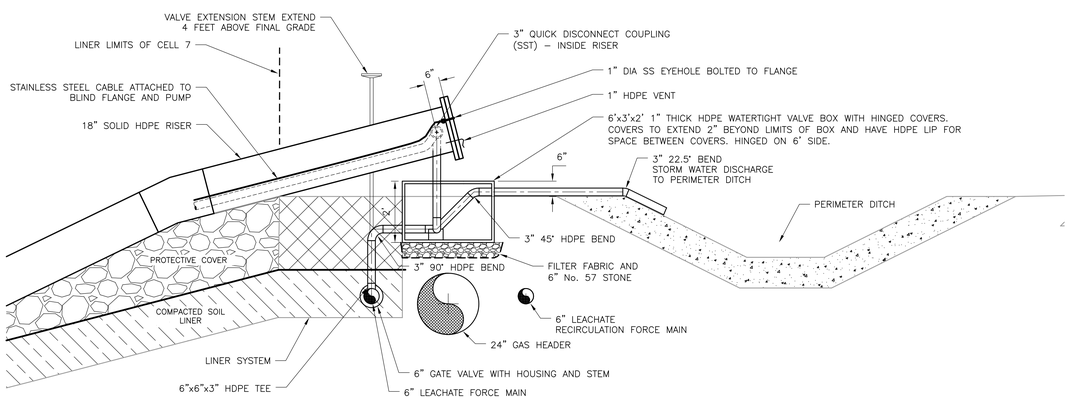
NOTES:

1. SUPPORT AIR RELEASE VALVE AND 3" HDPE FROM 8' LG. STAINLESS STEEL UNISTRUT ANCHORED IN 12" DIA. x 36" DP. CONCRETE BELOW GRADE. INSTALL HEAT TRACING SYSTEM AND INSULATION AROUND EXPOSED PIPE AND AIR RELEASE VALVE.
2. ALL FITTINGS SHALL BE STAINLESS STEEL.
3. OPERATOR TO REPLACE WITH BLIND FLANGE AFTER WASTE IS PLACED IN THE CELL.

LEACHATE PUMP STATION

DETAIL A

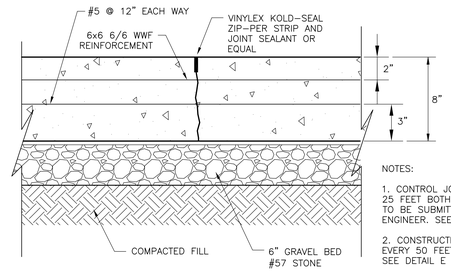
1/2" = 1'-0" EP-4



PUMP DISCHARGE

SECTION 1

1/2" = 1'-0" –



CONCRETE PAD

DETAIL B

NOT TO SCALE –

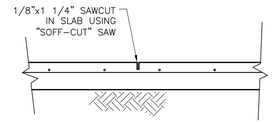
NOTES:

1. CONTROL JOINTS SHALL BE PROVIDED EVERY 25 FEET BOTH WAYS; CONTROL JOINT LOCATIONS TO BE SUBMITTED FOR APPROVAL BY THE ENGINEER. SEE DETAIL C THIS SHEET.

2. CONSTRUCTION JOINTS SHALL BE PROVIDED EVERY 50 FEET ON CENTER IN EACH DIRECTION. SEE DETAIL E THIS SHEET.

3. PRIOR TO CONSTRUCTION OF CONCRETE SLAB AND GRAVEL ROAD, PROOFROLL ENTIRE AREA AS SPECIFIED IN SECTION 02200 OF THE SPECIFICATION.

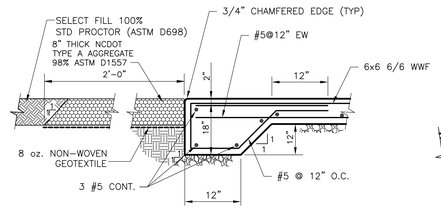
4. REINFORCING STEEL SHALL HAVE THE FOLLOWING MINIMUM CLEAR CONCRETE COVER UNLESS OTHERWISE NOTED:
–CONCRETE CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH – 3 IN.
–CONCRETE SURFACES IN CONTACT WITH –SOIL OR EXPOSED TO WEATHER – 2 IN.



CONTROL JOINT

DETAIL C

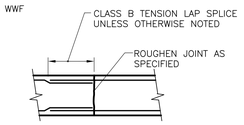
NTS –



THICKENED SLAB EDGE/GRAVEL ROAD

DETAIL D

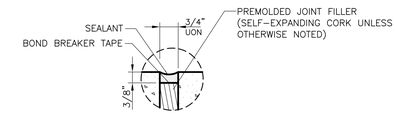
NTS –



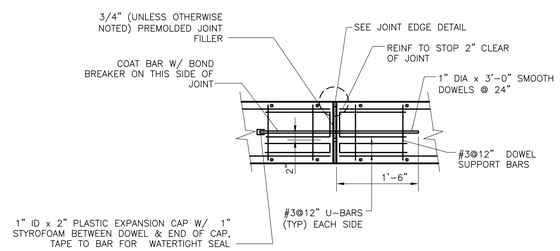
CONSTRUCTION JOINT

DETAIL E

NTS –



JOINT EDGE DETAIL



FOR LOCATIONS REQUIRING SEALANT AND WATERSTOPS, SEE CONCRETE JOINT NOTES AND DRAWINGS – ELSEWHERE PROVIDE EDGE CHAMFER, EXCEPT ON UNDERSIDE OF SLAB

EXPANSION JOINT AND SEALANT

DETAIL F

NTS –

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
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PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

DETAILS VI

PROJECT NO. 6447-97693
FILE NAME: EP-11.DWG
SHEET NO.
EP-11

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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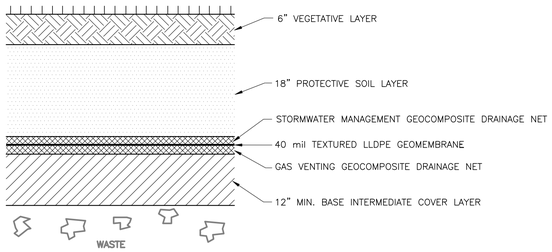
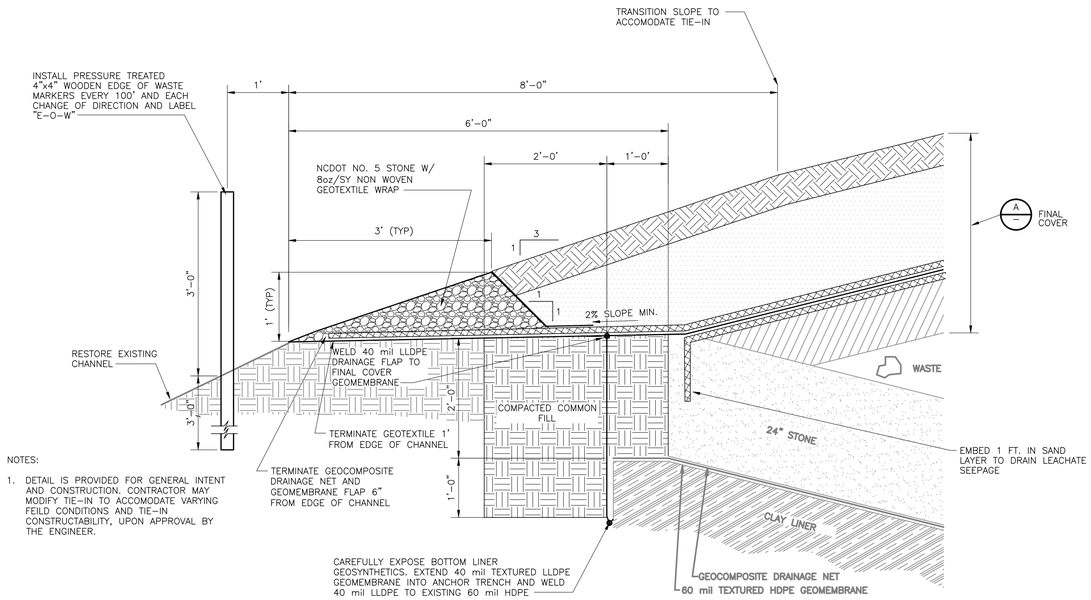


NOTES:

1. STRIP VEGETATION AND DETERMINE EXISTING INTERMEDIATE COVER MATERIAL THICKNESS.
2. REMOVE EXISTING INTERMEDIATE COVER MATERIAL IN AREAS GREATER THAN 12 INCHES.
3. REPAIR EROSION DAMAGE USING REMOVED INTERMEDIATE COVER MATERIAL AND VERIFY MINIMUM 12" INTERMEDIATE COVER MATERIAL LAYER THICKNESS. IMPORT OFF-SITE INTERMEDIATE COVER MATERIAL IF NECESSARY.
4. FOLLOWING THICKNESS VERIFICATION, PLACE FINAL COVER GEOSYNTHETICS.

FINAL COVER

DETAIL A
NOT TO SCALE EP-5

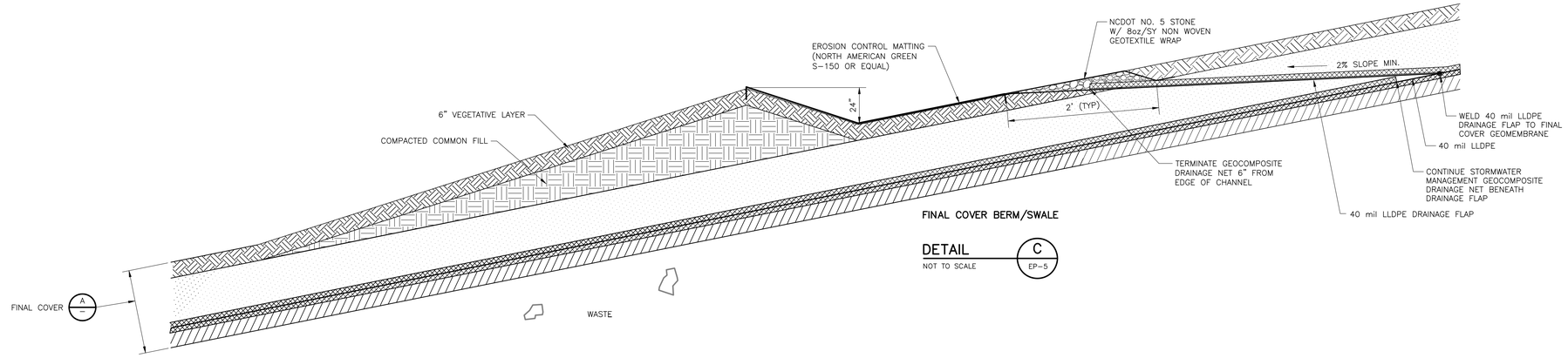


NOTES:

1. DETAIL IS PROVIDED FOR GENERAL INTENT AND CONSTRUCTION. CONTRACTOR MAY MODIFY TIE-IN TO ACCOMODATE VARYING FEILD CONDITIONS AND TIE-IN CONSTRUCTABILITY, UPON APPROVAL BY THE ENGINEER.

FINAL COVER TIE-IN TO BASE LINER

DETAIL B
1" = 1'-0" EP-5



FINAL COVER BERM/SWALE

DETAIL C
NOT TO SCALE EP-5

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REV. NO.	DATE	DRWN	CHKD	REMARKS

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DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
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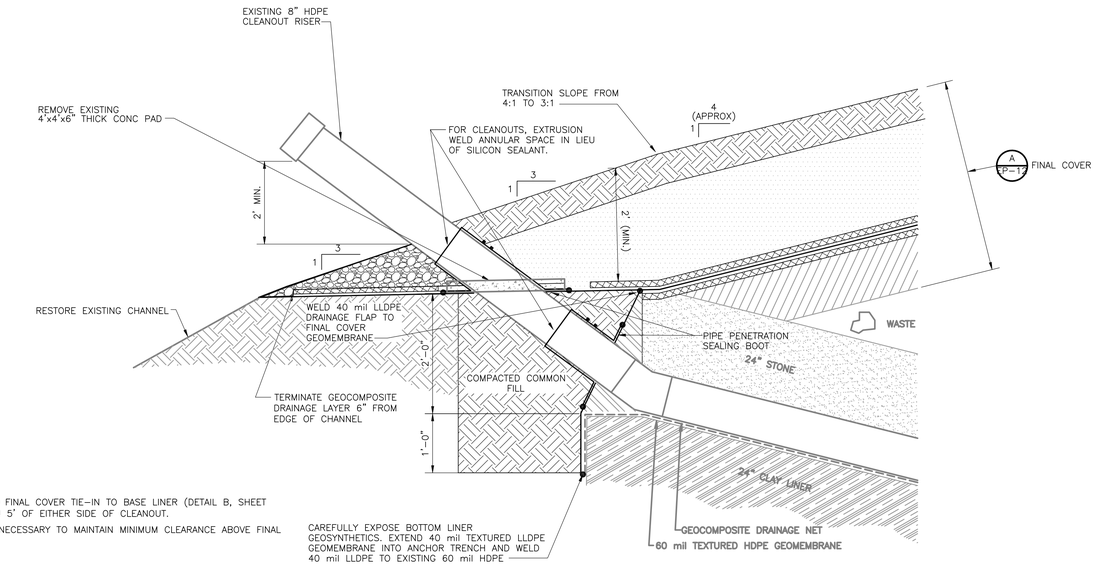
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

CLOSURE DETAILS I

PROJECT NO. 6447-97693
FILE NAME: EP-12.DWG
SHEET NO.
EP-12

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

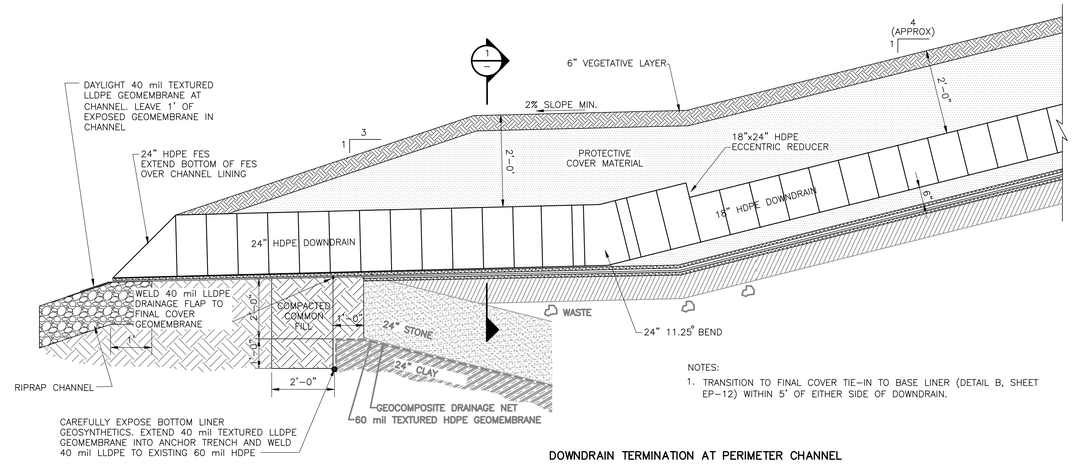


NOTES:

1. TRANSITION TO FINAL COVER TIE-IN TO BASE LINER (DETAIL B, SHEET EP-12) WITHIN 5' OF EITHER SIDE OF CLEANOUT.
2. ADD PIPE AS NECESSARY TO MAINTAIN MINIMUM CLEARANCE ABOVE FINAL COVER.

FINAL COVER AT EXISTING CLEANOUTS

DETAIL A
1" = 1'-0" EP-5

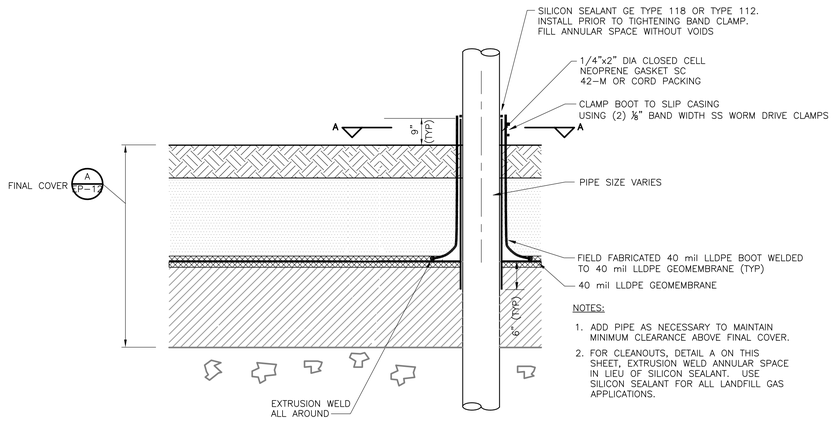


NOTES:

1. TRANSITION TO FINAL COVER TIE-IN TO BASE LINER (DETAIL B, SHEET EP-12) WITHIN 5' OF EITHER SIDE OF DOWNDRAIN.

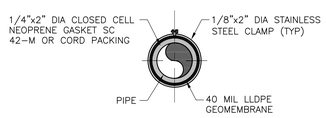
DOWNDRAIN TERMINATION AT PERIMETER CHANNEL

DETAIL B
NOT TO SCALE EP-5



NOTES:

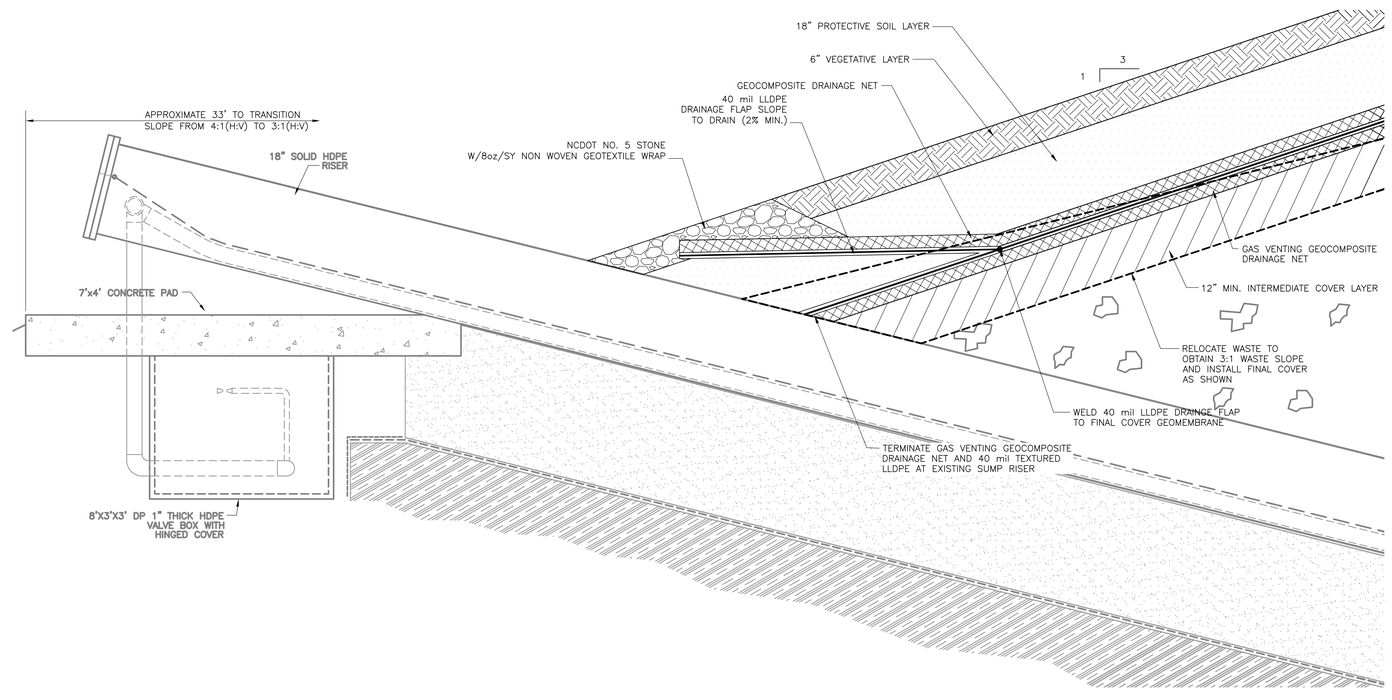
1. ADD PIPE AS NECESSARY TO MAINTAIN MINIMUM CLEARANCE ABOVE FINAL COVER.
2. FOR CLEANOUTS, DETAIL A ON THIS SHEET, EXTRUSION WELD ANNULAR SPACE IN LIEU OF SILICON SEALANT. USE SILICON SEALANT FOR ALL LANDFILL GAS APPLICATIONS.



SECTION A-A

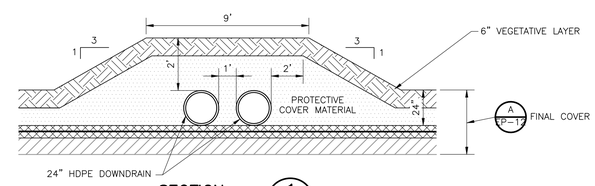
PIPE PENETRATION SEALING BOOT

DETAIL C
NTS –



FINAL COVER AT EXISTING SUMP

DETAIL D
1" = 2' EP-5



SECTION 1
NOT TO SCALE –

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REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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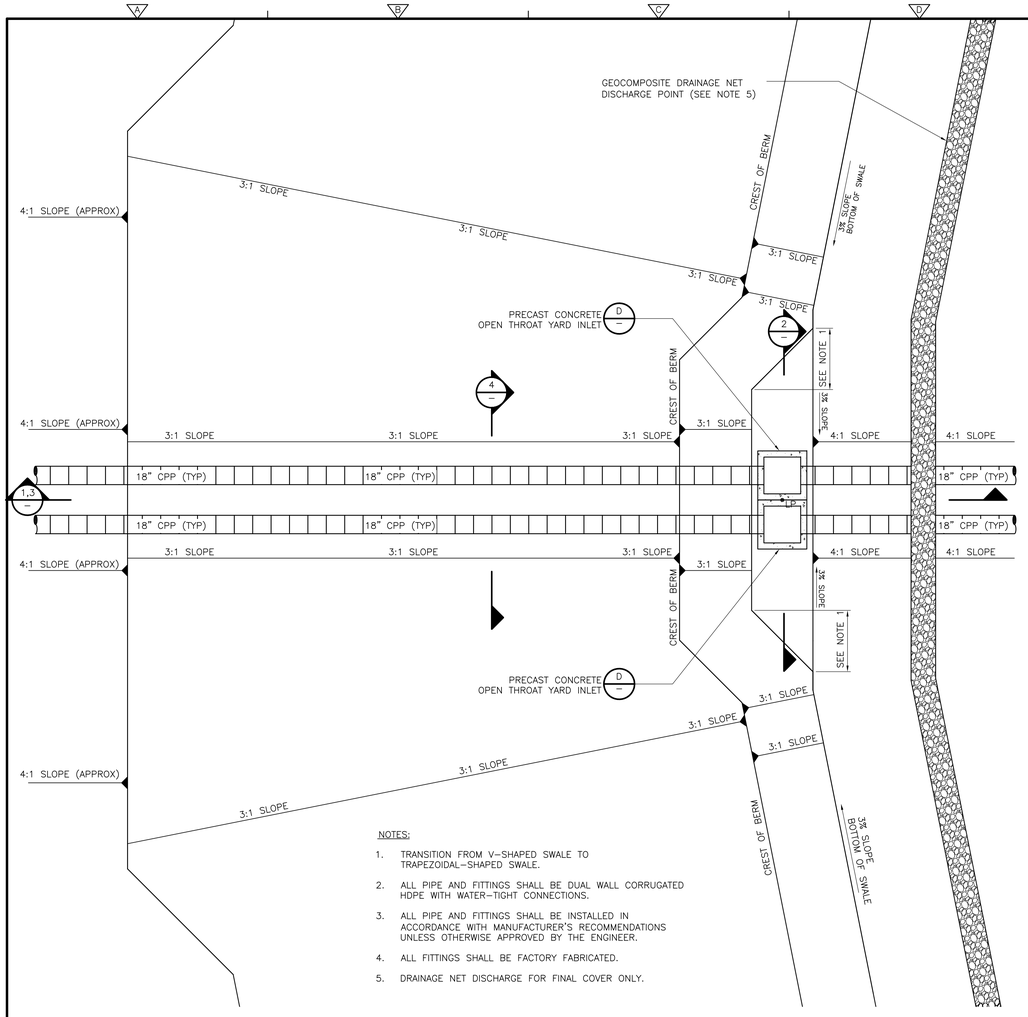
BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

CLOSURE DETAILS II

PROJECT NO. 6447-97693
FILE NAME: EP-13.DWG
SHEET NO.
EP-13

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

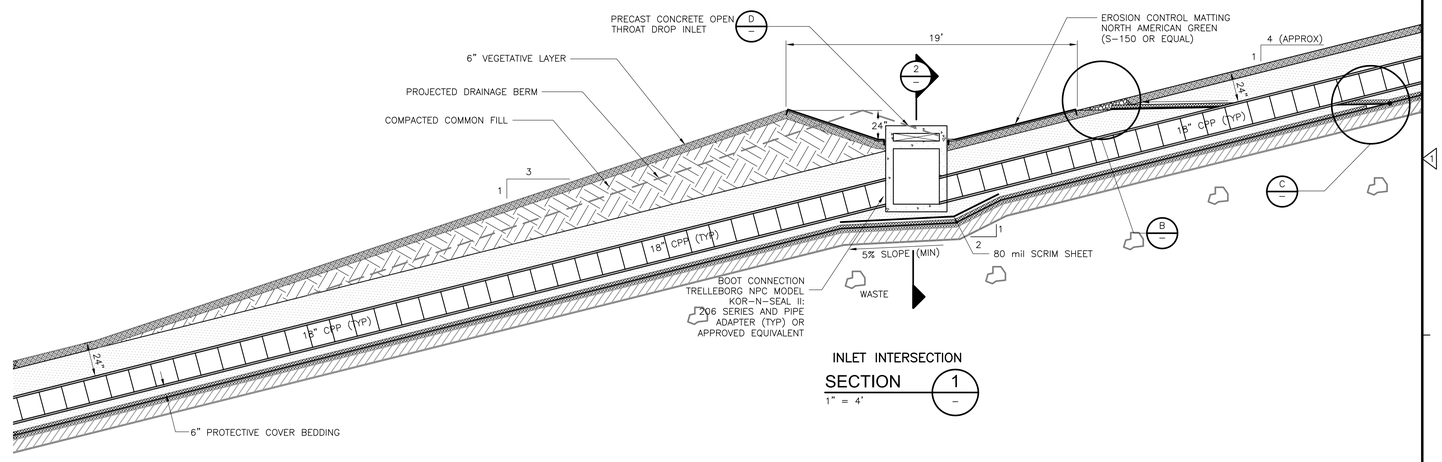


NOTES:

1. TRANSITION FROM V-SHAPED SWALE TO TRAPEZOIDAL-SHAPED SWALE.
2. ALL PIPE AND FITTINGS SHALL BE DUAL WALL CORRUGATED HDPE WITH WATER-TIGHT CONNECTIONS.
3. ALL PIPE AND FITTINGS SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS UNLESS OTHERWISE APPROVED BY THE ENGINEER.
4. ALL FITTINGS SHALL BE FACTORY FABRICATED.
5. DRAINAGE NET DISCHARGE FOR FINAL COVER ONLY.

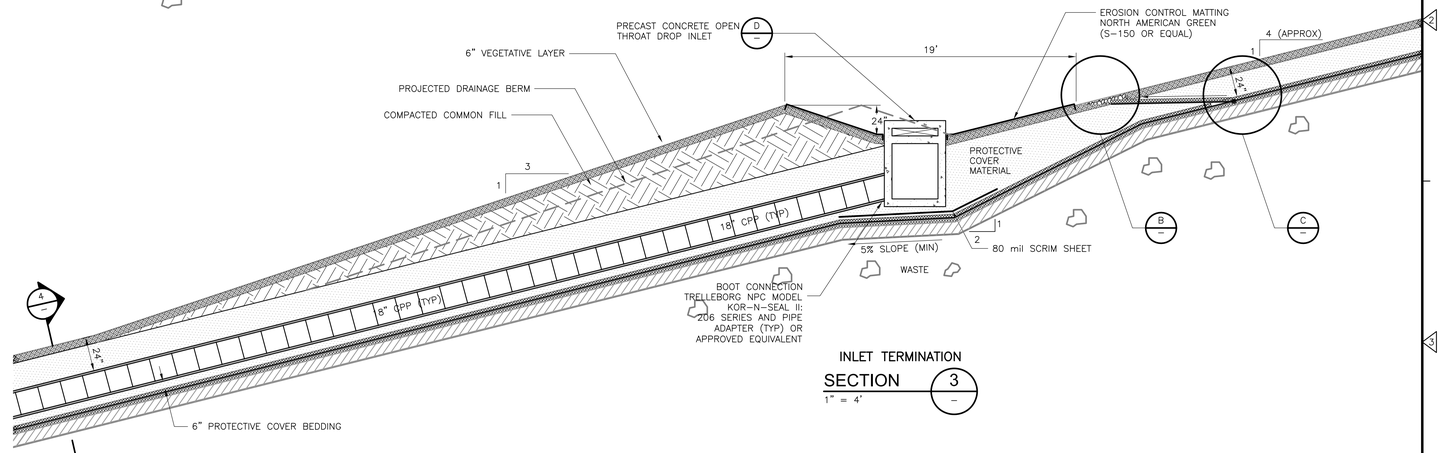
DOUBLE HDPE DOWNDRAIN PIPE/COVER SWALE INTERSECTION

DETAIL A
1" = 5' EP-5



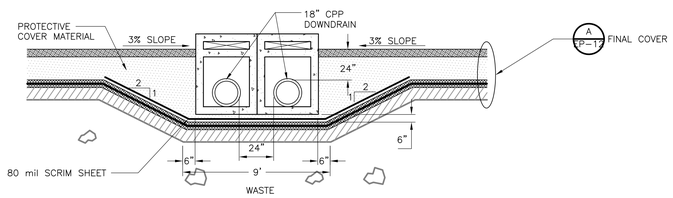
INLET INTERSECTION

SECTION 1
1" = 4'



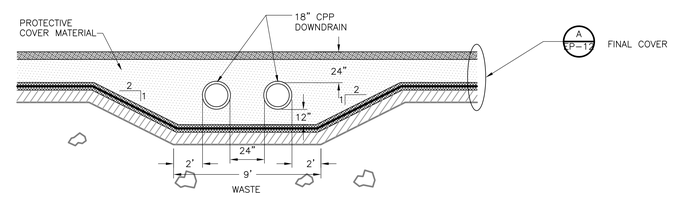
INLET TERMINATION

SECTION 3
1" = 4'



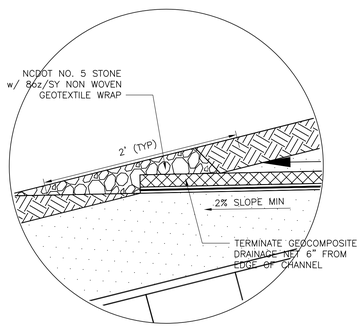
INLETS

SECTION 2
1" = 4'

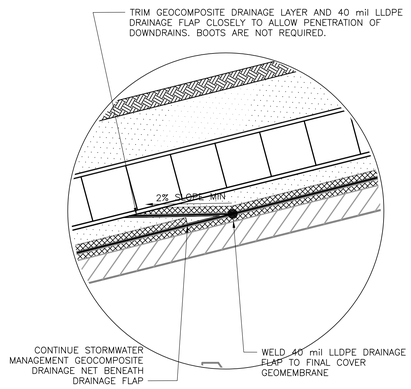


DOWNDRAIN

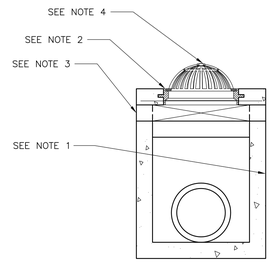
SECTION 4
1" = 4'



DETAIL B
1" = 1'



DETAIL C
1" = 2'



PRECAST CONCRETE OPEN THROAT YARD INLET

DETAIL D
NOT TO SCALE

NOTES:

1. 3'W X 3'L PRECAST CONCRETE BOX CONSTRUCTED PER NCDOT 840.45.
2. 6" MIN SLAB DESIGNED TO SUPPORT 100 PSF MIN LIVE LOAD.
3. SUPPORTED AT EACH CORNER, MINIMUM 6" HIGH.
4. GRATE WITH FRAME (NEENAH MODEL NO. R-4353 OR APPROVED EQUIVALENT).

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
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ENGINEERING PLAN DRAWINGS

CLOSURE DETAILS III

PROJECT NO. 6447-97693
FILE NAME: EP-14.DWG
SHEET NO.
EP-14

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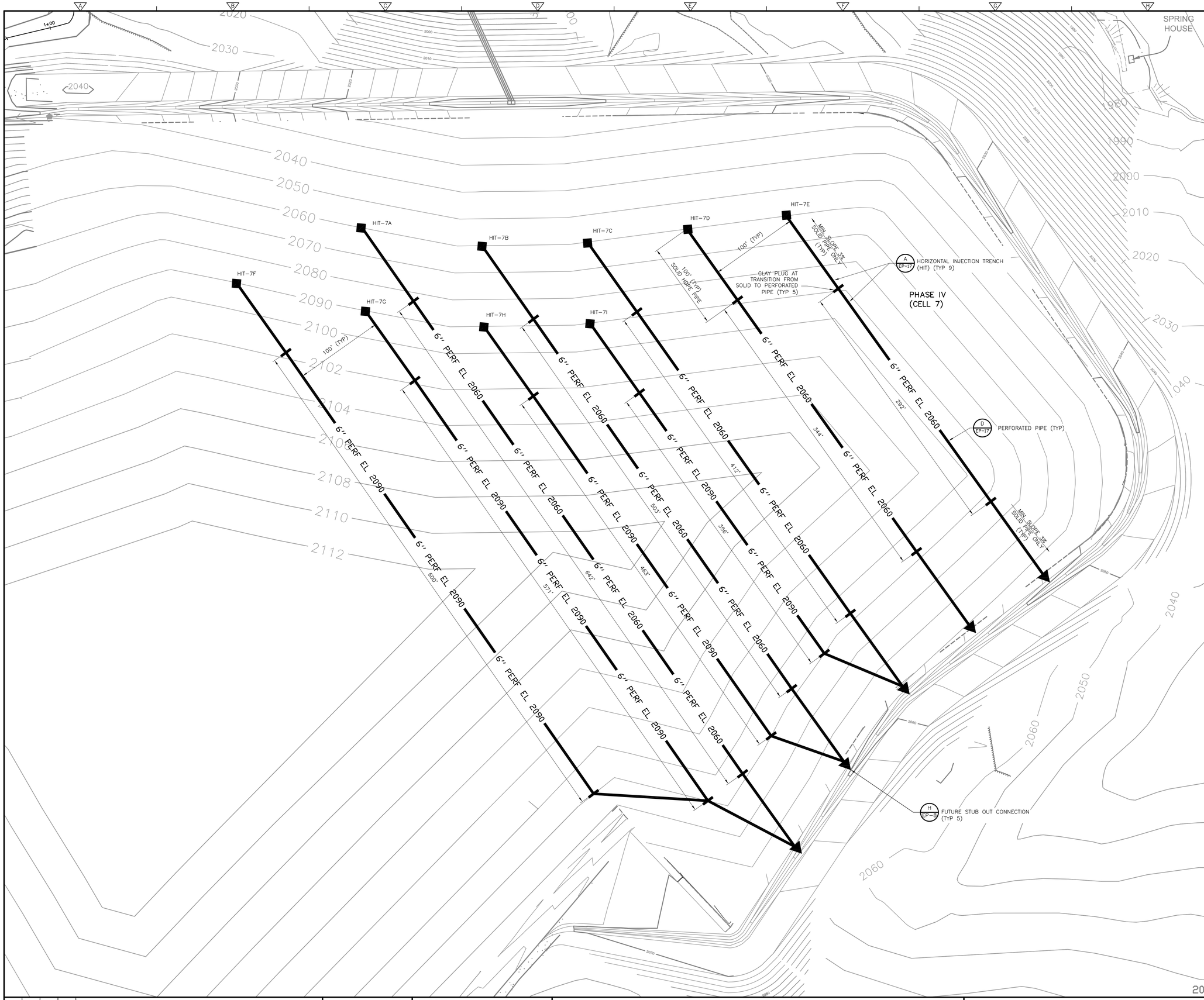

NOTES:

1. VARY DEPTH OF TRENCH FOR SOLID PIPE TO ACHIEVE MINIMUM 3% SLOPE.
2. ALL PIPE IS DR17 HDPE.
3. ALL EXCAVATED WASTE SHALL BE HAULED AND PLACED BY THE CONTRACTOR IN THE CELL 7 ACTIVE DISPOSAL AREA AS IDENTIFIED AND DIRECTED BY THE COUNTY.

6" PERF EL 2060	6" PERFORATED HDPE PIPE AT EL 2060
6" PERF EL 2090	6" PERFORATED HDPE PIPE AT EL 2090
	6" SOLID HDPE PIPE
■	WELLHEAD/VALVING
2010	INDEX CONTOUR

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
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PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

HORIZONTAL INJECTION TRENCHES

PROJECT NO. 6447-97693
FILE NAME: EP-15.DWG
SHEET NO.
EP-15

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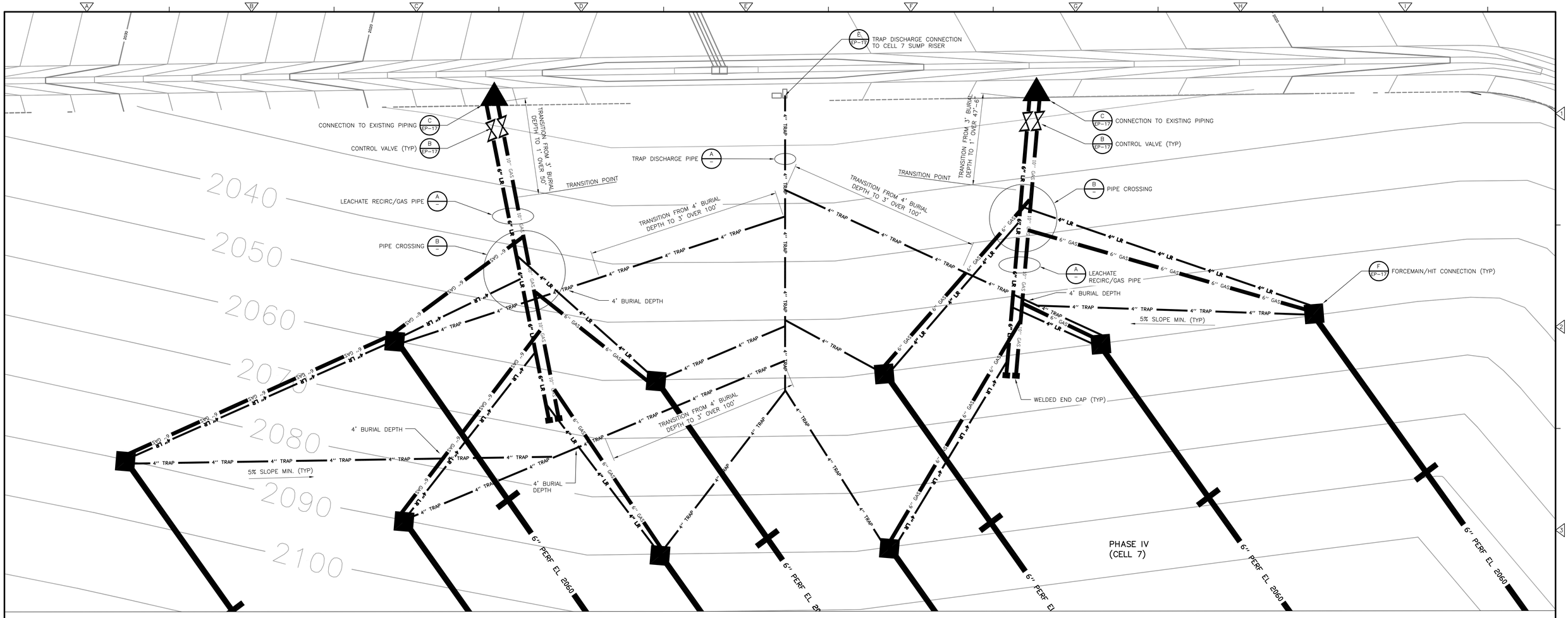
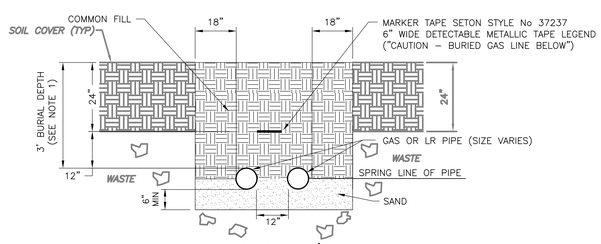


HIT HEADER PLAN

PLAN

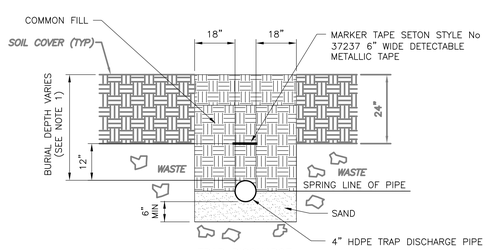
1" = 20'



LEACHATE RECIRCULATION/GAS PIPE

NOTES:

1. TRANSITION TO 1' BURIAL DEPTH AT TOE OF SLOPE TO STAY ABOVE THE LINER SYSTEM ANCHOR TRENCH.



TRAP DISCHARGE

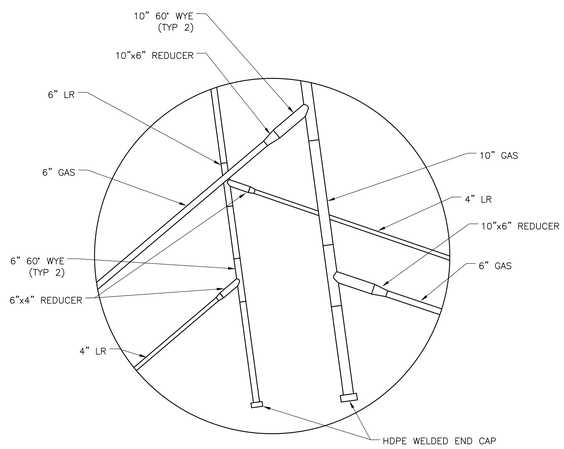
NOTES:

1. FOR TRAP PIPES CROSSING GAS AND LR PIPE THE BURIAL DEPTH IS 48" FROM WELLHEAD TO TRANSITION POINT.

PIPE BEDDING

DETAIL A

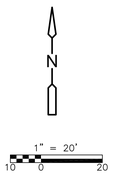
NTS



PIPE CROSSINGS

DETAIL B

NTS



⋈	CONTROL VALVE
4" TRAP	4" TRAP DISCHARGE PIPE
10" GAS	10" GAS PIPE
6" GAS	6" GAS PIPE
6" LR	6" LEACHATE RECIRCULATION (LR) PIPE
4" LR	4" LEACHATE RECIRCULATION (LR) PIPE
6" PERF EL 2060	6" PERFORATED HDPE PIPE AT EL 2060
6" PERF EL 2090	6" PERFORATED HDPE PIPE AT EL 2090
	6" SOLID HDPE PIPE
■	WELLHEAD/VALVING
2010	INDEX CONTOUR

NOTE: ALL PIPE IS DR17 HDPE.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

HORIZONTAL INJECTION HEADER PLAN

PROJECT NO. 6447-97693
FILE NAME: EP-16.DWG
SHEET NO.
EP-16

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

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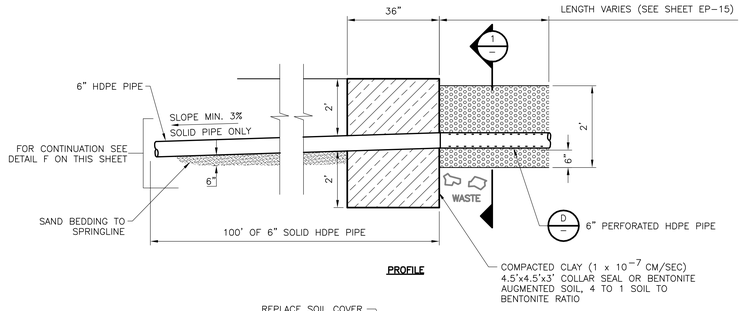
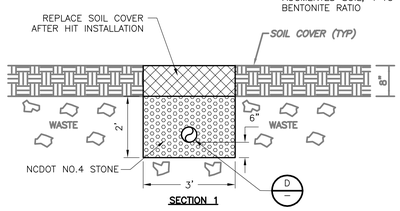
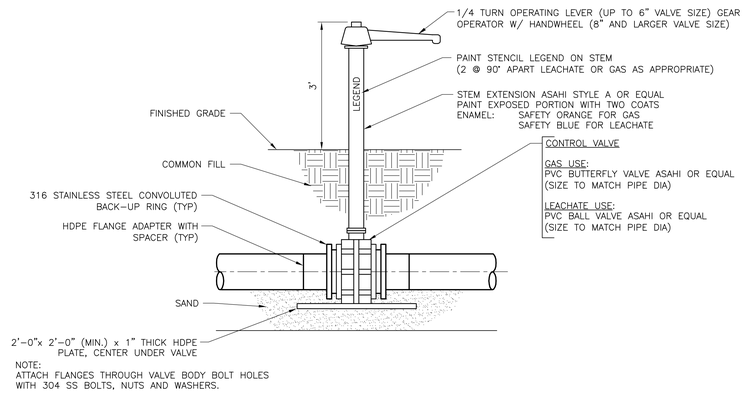




NOTES:

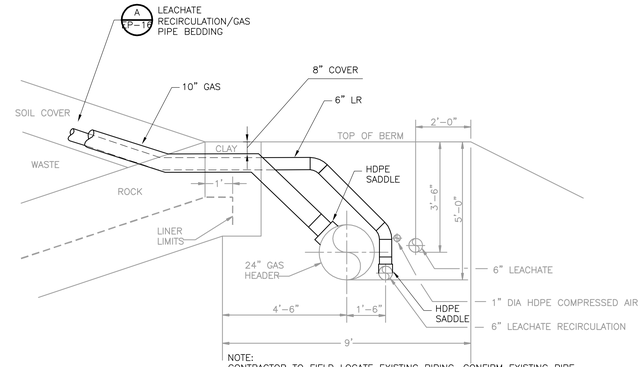
1. ALL EXCAVATED WASTE SHALL BE HAULED AND PLACED BY THE CONTRACTOR IN THE CELL 7 ACTIVE DISPOSAL AREA AS IDENTIFIED AND DIRECTED BY THE OWNER.

HORIZONTAL INJECTION TRENCH
DETAIL A EP-15
NTS



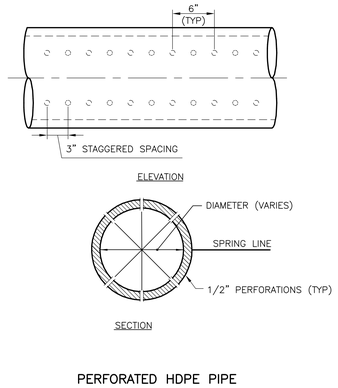
NOTE:
ATTACH FLANGES THROUGH VALVE BODY BOLT HOLES WITH 304 SS BOLTS, NUTS AND WASHERS.

CONTROL VALVE – GAS OR LEACHATE
DETAIL B EP-16
NTS

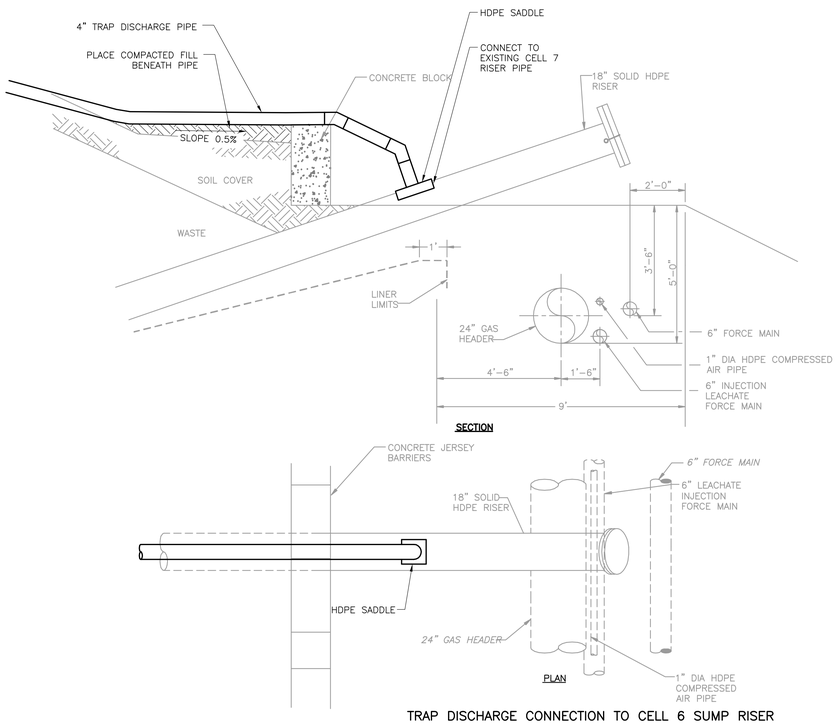


NOTE:
CONTRACTOR TO FIELD LOCATE EXISTING PIPING. CONFIRM EXISTING PIPE IDENTIFICATION WITH ENGINEER PRIOR TO CONNECTING.

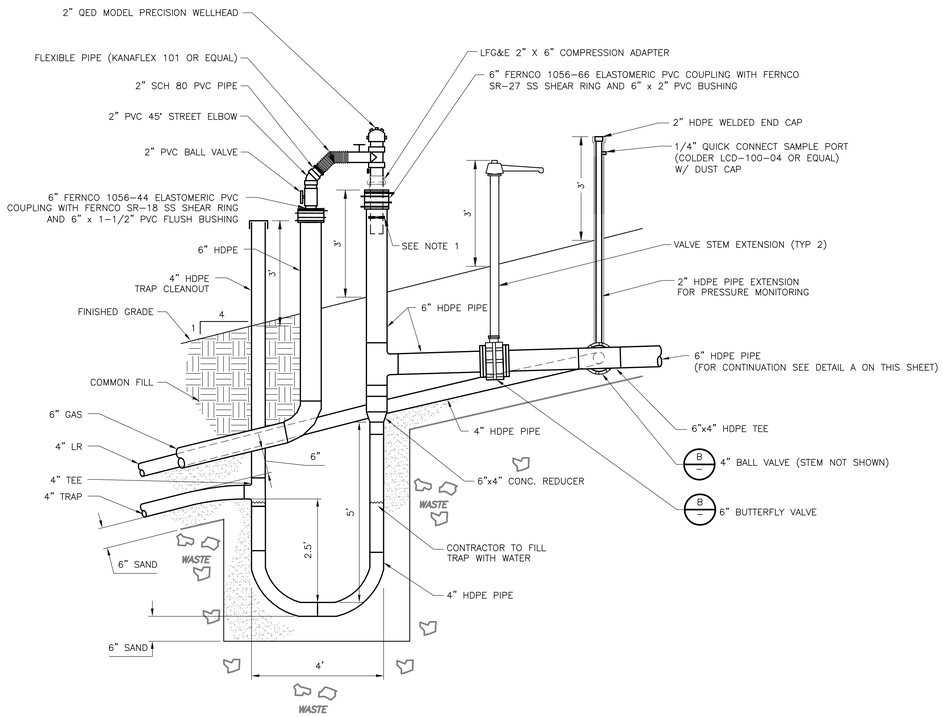
CONNECTIONS TO EXISTING PIPING
DETAIL C EP-16
NTS



PERFORATED HDPE PIPE
DETAIL D EP-15
NTS



TRAP DISCHARGE CONNECTION TO CELL 6 SUMP RISER
DETAIL E EP-16
NTS



NOTES:

1. PROVIDE IDENTIFICATION LABELS OF WELL NUMBER SETON STYLE NO. M3859 –3" OUTDOOR LETTERS AND NUMBERS.
2. CONTRACTOR TO PROVIDE ONE HANDHELD DIGITAL MANOMETER (DWYER 490-1 WITH CARRYING POUCH.

FORCEMAIN/HIT CONNECTION
DETAIL F EP-15
NTS

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: A. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
ENGINEERING PLAN DRAWINGS

HORIZONTAL INJECTION SYSTEM DETAILS

PROJECT NO. 6447-97693
FILE NAME: EP-17
SHEET NO.
EP-17

PERMIT DRAWINGS - NOT FOR CONSTRUCTION

Xref's: [CDM_3042] Images: []
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Buncombe County, North Carolina

Buncombe County Solid Waste Management Facility Subtitle D Landfill Phase IV (Cell 7) Permit to Construct Application

Part 4 – Construction Quality Assurance Plan

April 2014

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Section 1 - Introduction

Construction Quality Assurance Plan

1.1 Purpose

This Construction Quality Assurance (CQA) Plan is intended to fulfill Rule .1621 that requires that a CQA Plan be developed and used as part of the construction for a Subtitle D lined landfill. This plan describes the observations and tests that will be used before, during, and upon completion of construction to ensure that the construction materials and workmanship meet the design specifications and the requirements set forth in Rule .1624 of the Solid Waste Rules.

1.2 Quality Assurance and Quality Control

In the context of this CQA Plan, quality assurance and quality control are defined as follows:

Quality Assurance: A program of tests and observations, executed by a party independent of the contractor, performed in order to confirm that completed work meets contractual and regulatory requirements and will perform satisfactorily in service.

Quality Control: Those actions performed by the contractor or an agent of the contractor which provide a means to monitor the quality of the work being performed.

1.3 Units

In this CQA Manual, all properties and dimensions are expressed in U.S. units, with "equivalent" SI units in parentheses. It should be noted that the conversion is typically only accurate within ten percent. In cases of conflict or clarification, the U.S. units shall be deemed to govern.

1.4 References

The CQA Manual includes references to test procedures of the American Society for Testing Materials (ASTM) and the Geosynthetic Research Institute (GRI).

1.5 Overview of Plan

Per Rule .1621(b)(1), (2), (3) and (4) this CQA plan addresses:

1. Responsibilities and authorities. The manual establishes responsibilities and authorities for the construction management organization. This includes a pre-construction meeting conducted prior to beginning construction of the base liner system for a new cell. The meeting shall include a discussion of the construction management organization, respective duties during construction, and periodic reporting requirements for test results and construction activities. This information is presented in Sections 2 and 3.

2. Inspection activities: A description of all field observations, tests, and equipment that will be used to ensure that the construction meets or exceeds all design criteria established in accordance with Rules .1620 and .1624 of this Section is presented in Sections 4 and 5.

3. Sampling strategies. A description of all sampling protocols, sample size, methods for determining sample locations and frequency of sampling is presented in Sections 4 and 5.

4. Documentation. Reporting requirements for CQA activities are described in detail in Sections 3 and 5.

Section 2 – Definitions, Responsibilities, and Qualifications of Parties

Construction Quality Assurance Plan

The parties discussed in this section are associated with the ownership, design, manufacture, transportation, installation, and quality assurance of the liner and leachate collection systems. The definitions, responsibilities, and qualifications of these parties are summarized in **Table 2-1** and outlined in the following subsections.

2.1 Contractor

2.1.1 Definition

The Contractor is the company with which the Owner has entered into agreement to construct the project.

2.1.2 Responsibilities

The Contractor is ultimately responsible for meeting the requirements of the contract documents and the successful completion of the landfill construction. Some of the Contractor's specific responsibilities include: providing qualified personnel to perform quality control, providing submittals for the various materials as required by the specifications, scheduling and coordinating the work with suppliers and subcontractors, providing a representative at all times during construction activity, provide surveying services, furnish progress and record drawings, attending progress meetings, and notifying the Engineer of design discrepancies.

2.1.3 Qualifications

The Contractor shall be experienced in all aspects of the work required to successfully construct the project. The Contractor shall be registered in the state where the project is located and shall provide references from previous projects.

2.2 Contractor's Representative

2.2.1 Definition

The Contractor's Representative is a qualified individual assigned by the Contractor to represent him/her onsite during construction activities.

2.2.2 Responsibilities

The Contractor's Representative is responsible for: communication with the Engineer and Owner, coordinating and supervising his crew, subcontractors, and quality control personnel, ensuring that construction activities are conducted in accordance with the plans and specifications, immediately notifying the Engineer's Field Representative of any discrepancies between the plans and specifications and the field conditions, attending all meetings held on the project, and keeping a daily log of all construction activities onsite.

Table 2-1. Project Personnel Responsibilities

Party	Definition	Responsibilities	Qualifications	Report To
Contractor	Company contracted by Owner to construct project in accordance with plans and specifications	Page 2-1	Licensed in North Carolina similar project experience	Owner, Engineer, and EFR
Contractor's Representative	Person assigned by the Contractor to act as the Contractor Representative onsite	Pages 2-1 and 2-3	Similar project experience	Contractor and EFR
Engineer	Company Contracted by Owner for design of the project and to provide services during construction	Page 2-3	Registered professional engineer in North Carolina	Owner
Engineer's Field Representative (EFR)	Person assigned by the Engineer to perform QA inspection and document construction activities	Pages 2-3 to 2-5	Similar project experience	Engineer and Owner
Installation Supervisor	Person assigned by an Installer to provide supervision and guidance to the installation crews	Page 2-5	See Technical Specifications	Contractor's Representative and EFR
Installer	Company Contracted to install one of the liner or Leachate collection system products	Pages 2-5 to 2-6	See Technical Specifications	Contractor's Representative and EFR
Manufacturer	A producer of one or more Liner or LCS products	Page 2-6	See Technical Specifications	Contractor's Representative and EFR
Quality Assurance Laboratory (QAL)	Lab assigned by Owner to conduct materials testing	Pages 2-6 to 2-7	GRI accredited and experience in testing in accordance with ASTM and GRI	EFR and Owner

2.2.3 Qualifications

The Contractor's Representative shall be an individual who demonstrates the capability to direct all tasks required for landfill construction. The Contractor's Representative shall demonstrate experience similar to the nature of the project and be knowledgeable of all aspects of the work.

2.3 Engineer

2.3.1 Definition

The Engineer is the party responsible for the preparation of the contract documents, including plans and specifications, and for providing administrative and quality assurance services during construction.

2.3.2 Responsibilities

The Engineer is responsible for performing the engineering design and preparing the associated drawings and specifications. The Engineer is responsible for approving all design and specification changes, clarifying the design, reviewing and approving shop drawings, and other tasks as required during construction. The Engineer conducts the pre-construction meeting and progress meetings outlined in this plan. The Engineer will certify that the construction was completed in accordance with this CQA plan, the conditions of the permit to construct, the requirements of Rules, and with acceptable engineering practices.

2.3.3 Qualifications

The Engineer shall be a professional engineer registered by the State of North Carolina. The Engineer shall be familiar with geosynthetics (including detailed geosynthetic design methods and procedures), and all applicable regulatory requirements.

2.4 Engineer's Field Representative

2.4.1 Definition

The Engineer's Field Representative (EFR) is a qualified individual assigned by the Engineer to observe and document activities requiring quality assurance.

2.4.2 Responsibilities

The EFR is responsible for observing and documenting activities related to the quality assurance of the production, handling, storage, and installation of the liner and leachate collection systems. The EFR is responsible for implementation of this CQA plan and coordination of the Quality Assurance Laboratory (QAL).

The specific duties of the EFR personnel are as follows:

a. Review all design drawings and specifications.

b. Review other site-specific documentation, including proposed layouts, and Manufacturer's and Installer's literature.

c. Develop a site-specific addendum for quality assurance of geosynthetics, if necessary.

d. Administer the geosynthetic portions of the CQA Plan, e.g., assigns and manages all geosynthetic quality assurance personnel, reviews all field reports, and provides engineering review of all quality assurance related issues.

e. Review all changes to design drawings and specifications as issued by the Engineer.

f. Act as the onsite (resident) representative of the owner.

g. Attend all quality assurance related meetings, e.g., resolution, pre-construction, daily, weekly.

h. Review all Manufacturer and Installer certifications and documentation and makes appropriate recommendations.

i. Review the Installer's personnel qualifications for conformance with those qualifications pre-approved for work onsite.

j. Review the calibration certification of the onsite tensiometer, if applicable.

k. Review all daily reports, logs, and photographs.

l. Note any onsite activities that could result in damage to the liner system.

m. Report to the Engineer, and logs in the daily report, and any relevant observations.

n. Prepare daily reportin addition to Contractor's daily report.

o. Prepare a daily summary of the quantities of geosynthetics installed that day.

p. Prepare the daily reports of the liner system quality assurance activities.

q. Oversee the marking, packaging, and shipping of all laboratory test samples.

r. Review the results of laboratory testing.

s. Report any unapproved deviations from the CQA Manual.

t. Prepare the final certification report.

u. Monitor, logs, photographs, and/or documents all geosynthetic installation operations and installation of leachate collection system. Photographs shall be taken routinely of critical areas during installation sequence.

v. Monitor the following operations for all lining and leachate collection system materials:

   (1) Material delivery

   (2) Unloading and onsite transport and storage

   (3) Sampling for conformance testing

   (4) Deployment operations

   (5) Joining and/or seaming operations

   (6) Condition of panels as placed

   (7) Visual inspection by walkover

   (8) Repair operations

w. Monitor and document the geomembrane seaming and leachate pipe fusing operations, including:

   (1) Pre-weld seams

(2) Seam preparation

(3) Seaming and/or fusing

(4) Nondestructive seam testing

(5) Sampling for destructive seam testing

(6) Destructive seam testing

(7) Appropriate log for seaming and patching destructive testing

(8) Field tensiometer testing

(9) Laboratory sample marking

(10) Repair operations

x. Monitor by visual inspection and document leachate pipe installation operations and testing.

y. Document any onsite activities that could result in damage to the lining system. Any problems noted shall be reported as soon as possible to the Engineer.

2.4.3 Qualifications

The EFR shall be experienced with the implementation and preparation of quality assurance documentation including: quality assurance forms, reports, certifications, and manuals; and shall have prior experience with soil and geosynthetics installation.

2.5 Installation Supervisor

2.5.1 Definition

The Installation Supervisor is the individual provided and assigned by the Installer to be the field representative to provide supervision and guidance to the installation crew.

2.5.2 Responsibilities

The Installation Supervisor is responsible for coordinating the installation of the clay liner; fusing the pipes; and the seaming and installation of the geosynthetic products. The Installation Supervisor is responsible for providing supervision and guidance to the installation crew. The Installation Supervisor is responsible for obtaining samples for field testing and for coordinating testing activities with the Contractor's Representative and Engineer's Field Representative. The Installation Supervisor is responsible for keeping a daily log of all activities related to geosynthetic products installation and testing and for attending all related project meetings.

2.5.3 Qualifications

The Installation Supervisor must be qualified based on previously demonstrated experience, management ability, and authority. Qualification requirements are provided in the technical specifications.

2.6 Installer

2.6.1 Definition

The Installer is the company employed by the Contractor to install a particular component of the landfill such as the synthetic liner or leachate collection pipe. This is not limited to synthetic products.

The Installer is a Manufacturer or an approved installer trained and certified to install a Manufacturer's product.

2.6.2 Responsibilities

The Installer shall be responsible for field handling, storing, deploying, seaming, curing, temporary restraining, and all other aspects of the product installation. The Installer shall be responsible for submittal of the documentation listed in the technical specification.

2.6.3 Qualifications

The Installer shall be certified to install the material used, shall be pre-qualified by the Engineer, shall be able to provide qualified personnel to meet the demands of the project. Qualification requirements are provided in the technical specifications.

2.7 Manufacturer

2.7.1 Definition

The Manufacturer is the firm or corporation responsible for production of material to be used in the project. The Manufacturer is responsible for the condition of the material until the material is accepted by the Engineer's Field Representative upon delivery. The Manufacturer shall produce a consistent product meeting the project specifications, and shall provide quality control documentation for the delivered material.

2.7.2 Responsibilities

Each Manufacturer is responsible for the production of its material and for the condition of the material until the material is accepted by the Engineer's Field Representative upon delivery. Each Manufacturer shall produce a consistent product meeting the project specifications and shall provide quality control documentation for its product as specified in this CQA Plan.

2.7.3 Qualifications

Prior to shipment of any material, each Manufacturer shall be pre-qualified by the Engineer. Qualification requirements are provided in the technical specifications.

2.8 Quality Assurance Laboratory

2.8.1 Definition

The Quality Assurance Laboratory is a firm, independent from the Contractor, Manufacturer, and Installer, responsible for conducting tests on samples of geosynthetics obtained from the site.

2.8.2 Responsibilities

The Quality Assurance Laboratory shall be responsible for conducting the appropriate laboratory tests as directed by the Engineer and in accordance with the project plans and specifications. The test procedures shall be done in accordance with the test methods outlined in the technical specifications. The Quality Assurance Laboratory shall be responsible for providing tests results as outlined in the technical specifications.

2.8.3 Qualifications

The Quality Assurance Laboratory shall have experience in testing geosynthetics and be familiar with ASTM, GRI, and other applicable test standards. The Quality Assurance Laboratory shall be capable of providing verbal results of destructive seam tests within 24 hours of receipt of test samples and shall maintain that standard throughout the installation.

2.8.4 Submittals

The Quality Assurance Laboratory shall deliver all destructive seam test results to the Engineer in written form within 24 hours of receipt of test samples. Written test results shall be in an easily readable format and include references to the standard test methods used.

Section 3 – Communications Between Involved Parties

Construction Quality Assurance Plan

Open channels are essential to achieve a high level of quality during construction and to assure a final product that meets all project requirements. This section discusses the necessary lines of communication.

3.1 Lines of Communication

All communication between parties shall go through the Engineer's Field Representative (EFR), who, in turn, will direct the communication through the proper channels.

3.2 Pre-Construction Meeting

A pre-construction meeting shall be held before construction activity begins. The meeting shall be conducted by the Engineer and attended by the Owner, EFR, Contractor's Representative, Installer, and a Solid Waste Section representative.

As per Rule .1621(b)(1), the meeting will include a review of the project documents, any modifications to these documents, the responsibilities and duties of each party; the construction strategy, the proposed schedule and critical path, and a discussion of the procedures for periodic reporting for testing and construction activities.

3.3 Progress Meetings

Progress meetings shall be conducted by the Engineer and attended by the Owner, EFR, Contractor's Representative, Installation Supervisor, and any other concerned parties shall be held as deemed necessary. These meetings shall discuss current progress, planned activities for the next week, issues requiring resolution, and any new business or revisions to the work. The EFR shall log any problems, decisions, or questions arising at this meeting in his weekly report. If any matter remains unresolved at the end of this meeting, the EFR will be responsible for obtaining a resolution of the matter and for forwarding communication of the decision to the appropriate parties.

Section 4 – Construction Materials Construction Quality Assurance Plan

This section provides information on construction materials that compiles with Rules .1621 and .1624. The section is presented from bottom to top for the base liner (including landfill subgrade) and also includes leachate collection system materials. Material construction specifications are provided in **Appendix** A.

4.1 Landfill Subgrade

Table 4-1 presents Rule .1624 requirements for the landfill subgrade and information located in the material Specification Section 02200 provided in Appendix A.

Table 4-1: Landfill Subgrade

Requirement	Rule Reference	Specification Reference
Material	.1624(b)(7)(A)	2.01 Materials
Construction	.1624(b)(7)(B)	Part 3: Execution
Certification	.1624(b)(7)(C)	2.02 Conformance Testing

4.2 Compacted Clay Liner

Following subgrade preparation, a compacted clay liner will be installed. **Table 4-2** presents Rule .1624 requirements and information located in the material Specification Section 02278 provided in Appendix A.

Table 4-2: Compacted Clay Liner

Requirement	Rule Reference	Specification Reference
Material	.1624(b)(8)(A)	2.01 Materials
Construction	.1624(b)(8)(B)	Part 3: Execution
Certification	.1624(b)(8)(C)	2.02 Conformance Testing 3.04 Quality Assurance

4.3 Geosynthetic Clay Liner

Following installation of the compacted clay liner, a geosynthetic clay liner (GCL) will be installed. **Table 4-3** presents Rule .1624 requirements and information located in the material Specification Section 02277 provided in Appendix A.

Table 4-3: Geosynthetic Clay Liner

Requirement	Rule Reference	Specification Reference
Material	.1624(b)(9)(A)	2.01 Materials
Construction	.1624(b)(9)(B)	Part 3: Execution
Certification	.1624(b)(9)(C)	2.02 Quality Control Documentation 2.03 Conformance Testing

4.4 Geomembrane

Following the GCL, a textured high density polyethylene (HDPE) geomembrane will be installed. **Table 4-4** presents Rule .1624 requirements and information located in the material Specification Section 02776 provided in **Appendix A**.

Table 4-4: Geomembrane

Requirement	Rule Reference	Specification Reference
Material	.1624(b)(10)(A)	2.01 Materials
Construction	.1624(b)(10)(B)	Part 3: Execution
Certification	.1624(b)(10)(C)	2.02 Quality Control Documentation 2.03 Conformance Testing Part 3: Execution

4.5 Leachate Collection Pipes

Table 4-5 presents Rule .1624 requirements and information located in the material Specification Section 02623 provided in **Appendix A**.

Table 4-5: Leachate Collection Pipes

Requirement	Rule Reference	Specification Reference
Material	.1624(b)(11)(A)	Part 2: Products and Engineering Drawings for pipe diameter
Construction	.1624(b)(11)(B)	Part 3: Execution Bedding – see 02700
Certification	.1624(b)(11)(C)	3.02 Testing 3.03 Cleaning and Video Inspection

4.6 Drainage Layer Materials

A stone 24-inch protective cover material layer, per Rule .1624(b)(2)(B) will be installed. **Table 4-6** presents Rule .1624 requirements and information located in the material Specification Section 02700 provided in **Appendix A**.

Table 4-6: Drainage Layer Material

Requirement	Rule Reference	Specification Reference
Material	.1624(b)(12)(A)	2.02 Materials
Construction	.1624(b)(12)(B)	Part 3: Execution
Certification	.1624(b)(12)(C)	2.02 Conformance Testing

4.7 Geotextile

A geotextile will be installed around the stone that surrounds the leachate collection pipes. **Table 4-7** presents Rule .1624 requirements and information located in the material Specification Section 02273 provided in **Appendix A**.

Table 4-7: Geotextile

Requirement	Rule Reference	Specification Reference
Material	.1624(b)(13)(A)	2.02 Materials
Construction	.1624(b)(13)(B)	Part 3: Execution

Certification	.1624(b)(13)(C)	2.03 Quality Control Documentation 2.04 Conformance Testing

.

Section 5 – Documentation

Construction Quality Assurance Plan

This Section is intended to comply with Rule .1624(b)(15)(A)(i), (B), and (C).

Upon completion of construction activities, a Construction Quality Assurance Certification Report will be submitted to the Solid Waste Section in accordance with 15A NCAC 13B .1621 and .1624. The report will summarize all quality assurance services performed during construction of the sanitary landfill. The report will contain field observation inspection reports, the results of all construction quality assurance and construction quality control testing required in this Rule including documentation of any failed test results, descriptions of procedures used to correct the improperly installed material and results of all retesting performed. The CQA report shall contain record drawings noting any deviation from the approved engineering plans and shall also contain a comprehensive narrative including but not limited to daily reports from the project engineer and a series of color photographs of major project features.

The report will also include a discussion of all areas which failed initial testing requirements, and efforts required to repair the area to within specifications. Areas of failure and destructive testing will be identified on the record drawings. The following construction elements will be discussed in the certification report:

- Landfill Subgrade
- Compacted Clay Liner
- Geosynthetic Clay Liner
- Geomembrane
- Protective Layer
- Leachate Collection System

The CQA Certification report shall bear the seal of the project engineer and a certification that construction was completed in accordance with:

1. This CQA Manual;
2. The conditions of the permit to construct;
3. The requirements of Rules .1621 and .1624; and
4. Good engineering practices.

CQA Plan

Appendix A – Material Construction Specifications

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SECTION 02200

EXCAVATION, BACKFILL, AND COMPACTION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals necessary to perform all excavation, backfill, compaction, and grading required to complete the work shown on the Drawings and specified herein. The work shall include, but not necessarily be limited to excavation, obtaining and hauling fill/backfill materials, filling/backfilling, grading, compaction, placing clay, disposal of waste and surplus materials, placing crushed stone, constructing of berms, and all related work such as stable slope construction, sheeting, shoring, bracing, and dewatering.

B. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA excavation safety standards 29 CFR Part 1926.650 Subpart P and State requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.

C. Topsoil, if any, and excess cut material will be stockpiles in locations approved by the Engineer.

1.02 RELATED WORK

A. Section 01410: Testing and Laboratory Services.

B. Section 02100: Site Preparation.

C. Section 02276: Erosion and Sedimentation Control.

D. Section 02278: Compacted Soil Liner.

E. Section 02505: Crushed Stone Paving.

F. Section 02623: High Density Polyethylene (HDPE) Pipe.

G. Section 02700: Protective Cover Material.

H. Section 02776: High Density Polyethylene (HDPE) Liner.

I. Section 02985: Seeding and Mulching.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 – Standard Specification for Concrete Aggregates.

2. ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils.

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3. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).

4. ASTM D854 – Standard Test Method for Specific Gravity of Soil Solids by Water Pycnometer.

5. ASTM D1140 – Standard Test Method for Amount of Material in Soils Finer Than the Number 200 (75 micrometer) Sieve.

6. ASTM D1556 – Standard Test Method for Density and Limit Weight of Soil in Place by the Sand-Cone Method.

7. ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

8. ASTM D2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

9. ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

10. ASTM D2922 – Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

11. ASTM D2937 – Standard Test Method for Density of Soil in Place by Drive-Cylinder Method.

12. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

13. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

B. North Carolina Department of Environment and Natural Resources (NCDENR) Solid Waste Section current guidelines titled *Rock Blasting at Lined Landfill Unit.*

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SUBMITTALS

A. Furnish the Engineer a representative sample weighing approximately 50 pounds of each fill material, including low-permeability select fill, sand and crushed stone, contained in sealed 5-gallon containers, at least 30 calendar days prior to the date of anticipated use of such material for approval, in accordance with Section 01410.

B. Submit quality control material conformance test results on soil materials as specified in Paragraph 2.02.

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C. If required by OSHA guidelines, Excavation and excavation support designs shall be prepared by a licensed Professional Engineer, registered in the State of North Carolina, having a minimum of five years of professional experience in the design and construction of excavations and excavation support systems. Submit an original and three copies of the licensed Professional Engineer's certification, on the PE certification form attached to Section 01300, stating that the excavation support systems designs have been prepared by the Professional Engineer, are consistent with the proposed dewatering and drainage systems, and that the Professional Engineer will be responsible for their execution.

D. Dewatering and drainage system designs shall be prepared by a licensed Professional Engineer, registered in the State of North Carolina, having a minimum of five years of professional experience in the design and construction of dewatering and drainage systems. Submit an original and three copies of the licensed Professional Engineer's certification, on the PE certification form attached to Section 01300, stating that the dewatering and drainage system designs have been prepared by the Professional Engineer and that the Professional Engineer will be responsible for their execution. Do not submit dewatering and drainage system designs unless requested in writing by the Engineer.

1.05 PROTECTION

A. Sheeting and Bracing (if required)

1. Furnish, install, and maintain such sheeting and bracing as may be required by Federal, State, and local safety requirements to support the sides of excavations; to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction; and to protect adjacent improvements (structures, utilities, embankment, landfill, etc.) from undermining or other damage. If the Engineer is of the opinion that at any location sufficient or proper supports have not been provided, he/she may order additional supports put in, and compliance with such order shall not relieve or release the Contractor from his/her responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed. Where soil cannot be properly compacted to fill a void, lean concrete shall be used as backfill. All voids shall be filled to the satisfaction of the Engineer.

2. Construct the sheeting outside the neat lines of the foundation, unless indicated otherwise, to the extent deemed desirable for the method of operation. Sheeting shall be plumb and securely braced and tied in position. Sheeting and bracing shall be adequate to withstand all pressures to which the structure or trench will be subjected. Any movement or bulging which may occur shall be corrected to provide the necessary clearances and dimensions.

3. All sheeting and bracing shall be carefully removed in such manner as not to endanger the construction or other structures, utilities, or property. The Contractor’s excavation support system designer shall provide direction for the abandonment of excavation support systems in such a manner that existing/proposed improvements are not damaged due to abandonment/removal activities. Such direction shall include cut-off elevations, elements to remain-in-place, removal procedures, etc. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand, which must be approved by the Engineer, by ramming with tools especially adapted to that purpose, or otherwise as may be directed.

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4. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating any obligation on his/her part to issue such orders and his/her failure to exercise his/her right to do so shall not relieve the Contractor from liability for damages to persons or property occurring from or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place sufficient sheeting and bracing to prevent any caving or moving of the ground.

5. No sheeting is to be withdrawn if driven below mid-diameter of any pipe and under no circumstances shall any sheeting be cut off at a level lower than 1foot above the top of any pipe.

B. Drainage and Dewatering

1. Dewatering shall be performed as specified during the excavation of organic materials and unstable soils from the site. Dewatering is expected to be required during the excavation and filling of ponds, ditches and where the topsoil layer extends below the water table.

2. At all times during construction provide and maintain proper equipment and facilities to remove all water entering excavations and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade condition until the fills, structures, or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water into the excavated areas. Groundwater shall be lowered to at least 2 feet below the bottom of excavations.

3. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation. Well or sump installations shall be constructed with proper sand filters to prevent drawing of finer grained soil from the surrounding ground.

4. Surface runoff shall be collected, drained to sumps and pumped from the disposal unit to maintain an excavation bottom free from standing water.

5. Dewatering of wetlands or ditches filled with water shall be performed in such a manner as to control discharge water by use of sediment basins and/or check dams or other erosion control structures approved by the Land Quality Section of NCDENR.

6. Take all additional precautions to prevent uplift of any structure during construction.

7. Drainage shall be disposed of so that flow or seepage back into the excavated area will be prevented. Drainage shall be disposed of in an approved area in accordance with regulatory requirements.

8. Flotation shall be prevented by maintaining a positive and continuous operation of the dewatering system. The Contractor shall be fully responsible and liable for all damages, which may result from failure of this system.

9. Remove the dewatering equipment after the system is no longer required.

10. Take all necessary precautions to preclude the accidental discharge of fuel, oil, etc in order to prevent adverse effects on groundwater or surface water quality.

11. Discharge from dewatering and drainage operations shall be controlled to prevent adverse effects on the Owner's and neighboring property.

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1.06 SOIL TESTING

A. Prior to the placement of fill, the Engineer may select areas within the limits of the fill for testing by the Quality Assurance Laboratory (QAL). The Contractor shall cooperate fully in obtaining the information desired.

B. Payment for testing by the QAL will be made by the Owner. If test results are unsatisfactory, all costs involved in correcting deficiencies in compacted materials to the satisfaction of the Engineer, will be borne by the Contractor.

C. The Contractor is solely responsible for Quality Control.

D. Conformance testing requirements are specified in Paragraph 2.02.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for use as fill shall be as described below. The Contractor shall notify the Engineer of the source of each material. Materials shall be furnished from on-site grading and/or as required from approved off-site sources and hauled to the site.

B. Common fill shall consist of soil free of organic materials, loam, wood, trash, topsoil, highly micaceous silt, debris, or other deleterious materials which will deteriorate in time or which cannot be properly compacted. Common fill shall not contain stones larger than six inches in diameter and shall have a maximum of 75 percent passing the No. 200 sieve, a maximum liquid limit of 50, and a maximum plasticity index of 30. Common Fill shall not contain granite blocks, broken concrete, masonry rubble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling. Snow, ice, and frozen soil will not be permitted.

   Common Fill shall be placed in maximum 8-inch-thick lifts and compacted to 95% of the Standard Proctor (ASTM D698) maximum dry density, or as otherwise shown in the Drawings. Since these soils are moisture sensitive with respect to achieving proper compaction, particular care should be taken to control the moisture content during placement and compaction. The soils shall be wetted or dried as necessary so that the moisture content during compaction is near the optimum moisture content to consistently achieve compaction to 95%. Moisture conditioning and compaction will likely be difficult during rainy or freezing weather due to the high fines content of the material.

C. Select Fill shall consist of mineral soil free from organic materials, loam, wood, trash or other objectionable materials which may be compressible or which cannot be properly compacted. It shall contain no stones larger than three inches and shall have a maximum of 50 percent passing the number 200 sieve, a maximum liquid limit of 50 percent and a maximum plasticity index of 15 percent. Select Fill shall be placed in maximum 8-inch-thick lifts and compacted to 95% of the Standard Proctor ASTM D698 maximum dry density, or as otherwise shown in the Drawings. In areas beneath roadways, the top 24-inches of Select Fill shall be compacted to 98% of the maximum dry density of ASTM D698. The soils shall be wetted or dried as necessary so that the moisture content during compaction is less than two percent above the optimum moisture content.

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D. Highly micaceous and elastic silts shall not be used for common or select fill.

E. Rip Rap

1. Provide Class 1 Plain Rip Rap meeting the requirements of Section 1042 of NCDOT Standard Specifications for Roads and Structures where indicated on the drawings.

2. Unless indicated otherwise on the drawings, Rip Rap shall be a minimum of 24-inches thick.

F. Backfill Stone

All backfill stone shall meet NCDOT requirements for No. 5 washed stone.

G. Crushed Stone

1. All crushed stone shall meet the requirements of Section 1005 of NCDOT Standard Specifications for Roads and Structures.

2. Refer to Section 02505 for Crushed Stone Paving

H. Protective Cover Material

1. Refer to Section 02700 for the requirements of protective cover material.

2.02 CONFORMANCE TESTING

A. Periodic conformance testing shall be conducted by the Contractor's Quality Control Laboratory (QCL) on common, select, and structural fill materials prior to their use on the project. The following tests shall be conducted at the indicated frequencies:

Test	Method	Frequency
Grain Size	ASTM D422	Every 5,000 cy or change in material
Atterberg Limits	ASTM D4318	Every 5,000 cy or change in material
Moisture/Density	ASTM D698	Every 10,000 cy or change in material
Natural Moisture	ASTM D2216	Every 5,000 cy or change in material

The grain size conformance tests and frequencies listed above also apply to crushed stone.

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Results of the tests shall be submitted to the Engineer within 24 hours of test completion and prior to material use on the project. The Engineer reserves the right to reject material based on the results of these conformance tests and/or independent quality assurance testing conducted by the Engineer. Rejected materials shall be removed from the site at no cost to the Owner.

PART 3 EXECUTION

3.01 GENERAL EXCAVATION

A. Excavation shall be made to the grades shown on the Drawings. The bottom of the excavations shall be rendered firm and dry and in all respects acceptable to the Engineer.

B. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. Soils which become soft, loose, "quick", or otherwise unsatisfactory for support of structures, earthen or man-made, as a result of inadequate excavation, dewatering, proofrolling, or other construction methods shall be removed and replaced as required by the Engineer at the Contractor's expense.

C. Dewatering shall lower the groundwater to at least 2 feet below excavation subgrade and prevent "boiling" condition or detrimental underseepage at the base of the excavation as specified herein.

D. Excavation equipment shall be satisfactory for carrying out the work in accordance with the Specifications. In no case shall the earth by ploughed, scraped, or dug with machinery so near to the finished subgrade as to result in excavation of, or disturbance of material below grade.

E. When excavation for subgrade has reached prescribed elevations, the Engineer shall be notified for inspection of the subgrade conditions. If conditions are unsatisfactory to the Engineer, the Engineer will issue directions for correcting the unsatisfactory conditions.

F. In excavating to subgrade the Contractor will use care to prevent disturbance and remolding of the subgrade. Material which has become softened and mixed with water shall be removed. The Engineer will be the sole judge as to whether the work has been accomplished satisfactorily.

G. All proofrolling shall be conducted in the presence of the Engineer. The Engineer may require excavation and replacement or other remediation as necessary to provide a firm, stable subgrade for paved roads in areas that appear to be rutting, weaving or otherwise appear unstable while proofrolling.

3.02 TRENCH EXCAVATION

A. Excavation for all trenches required for the installation of pipes shall be made to the depths indicated on the Drawings and in such a manner and to such widths as will give suitable room for laying the pipe within the trenches, for bracing and supporting the trench sides, and for pumping and drainage facilities. Contractor shall render the bottom of the excavations firm and stable and in all respects acceptable to the Engineer.

B. Rock shall be removed to a minimum 8-in clearance around the bottom and sides of all the pipe being laid. Select Fill shall be used as backfill upon removal of any rock subject to the approval of the Engineer.

C. The trench may be excavated by machinery to, or just below the designated subgrade provided that the material remaining in the bottom of the trench is no more than slightly disturbed.

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D. Where pipe is to be installed in fill, fill shall be placed and compacted to the total depth required (rough grade elevation) and then re-excavated for pipe installation.

3.03 EXCAVATION BELOW DESIGN GRADE

A. Excavation below the design grade limits shown on the Drawings performed without the approval of the Engineer shall be refilled at the Contractor's expense with 8-in layers of compacted Select Fill or other material satisfactory to the Engineer.

B. If, in the opinion of the Engineer, the subgrade material, in its undisturbed natural condition after excavation, at or below the design grade of the excavation as indicated on the Drawings is unsuitable for foundations (i.e., waste materials, organic soils, highly micaceous silt and other unsuitable materials or rock within 4 feet of the subgrade) it shall be removed to such dimensions as directed by the Engineer and be replaced with suitable material for which compensation will be made to the Contractor at the unit price established in Section 00300.

C. If the Contractor does not care for the subgrade properly through: failure to postpone final excavation immediately above the subgrade until shortly before placing of the new work thereon, failure to provide adequate dewatering or surface drainage, or other failure or neglect to conduct the excavation work properly so that the surface of the subgrade is in proper condition for further construction; the Contractor shall remove the unsuitable material and replace it with concrete, compacted select fill, or other approved material at the Contractor's expense so that the condition of the subgrade meets the approval of the Engineer before any work is placed thereon.

3.04 ROCK AND BOULDER EXCAVATION (if applicable)

A. The following material classifications, based on the type of excavation equipment required, shall be used to identify materials for payment:

1. Soil or Partially Weathered Rock - Soil or partially weathered rock (PWR) shall be defined as any material that can be removed by a hydraulic excavator having a maximum draw bar force of not less than 59,000 pounds (Komatsu PC300LC or equivalent) based on the manufacturer’s specifications for standard configuration.

2. Rippable rock - Rippable rock shall be defined as any material that cannot be removed by a hydraulic excavator having a maximum draw bar force of not less than 59,000 pounds (Komatsu PC300LC or equivalent) but can be removed by a Caterpillar D-8N or equivalent equipped with a single tooth ripper.

3. Rock - Rock shall be defined as any material that cannot be removed by a Caterpillar D-8N or equivalent equipped with a single shank ripper. Rock materials that are located within the lines of required excavation shall be excavated using hydraulic breakers, jack hammers or other similar approved method. Blasting is not allowed unless approved by the Engineer provided the procedure follows NCDENR Solid Waste Section current guidelines titled *Rock Blasting at Lined Landfill Units* and conforms to the following criteria:

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- If overburden is left in place during blasting operations, the definition of rock is when a Tamrock or equivalent drill with a downward pressure of 50 bars will not rotate and the hammer has to be applied to penetrate the material. Rock excavation quantities shall be determined per Specification Section 01025 – Measurement and Payment.

- A written site specific blasting plan for the use of explosives shall be submitted to the Engineer for approval before any blasting is to commence. The Contractor shall obtain all other necessary permits from authorities having jurisdiction. No explosives shall be used until these written authorizations have been approved.

B. Where rock is encountered, it shall be uncovered but not excavated until measurements have been made in accordance with Specification Section 01025 – Measurement and Payment. The means of excavation shall be subject to approval by the Engineer. There will not be additional payment for excavation of partially weathered rock.

C. Excavation below the Compacted Soil Liner will be based on the grades shown on the Drawings and the Engineer. The minimum depth of rock excavation below the bottom of the Compacted Soil Liner shall be four feet.

D. Trench excavation for pipes will be based on the rectangular cross sections as follows:

1. Width: Minimum 8 inches from the sides of the pipe and larger as necessary for proper placement and compaction of pipe bedding and backfill.

2. Depth: 8 inches below the bottom of the pipe or deeper where directed by the Engineer.

3. Height: Based on the actual elevation of top of rock surface, as determined by the Engineer.

4. Boulders of more than 1 cubic yard in volume will be measured for payment as rock excavation.

3.05 MISCELLANEOUS EXCAVATION

A. The Contractor shall perform all excavations necessary for the placing of seeding and plants, for constructing roadways, ponds, and any other miscellaneous earth excavation required under this Contract.

3.06 GENERAL BACKFILL

A. Materials placed in fill areas shall be placed to the lines and grades shown on the Drawings. Unless otherwise specified, common fill shall be used for backfill.

B. Fill shall be placed in accordance with the Contract Documents.

C. Material conforming to the requirements of Common Fill and Select Fill shall be placed in layers having a maximum thickness of 8-inches measured before compaction and shall be compacted as specified in paragraph 2.01. The minimum frequency of testing shall be 1 test per lift per 10,000 square feet or as directed by the Engineer in irregular-shaped fill areas.

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D. The surfaces of filled areas shall be graded to smooth true lines, conforming to grades indicated on the grading plan and no soft spots or uncompacted areas will be allowed in the work.

E. No compaction shall be done when the material is covered with frost or is frozen or is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have thawed and/or dried sufficiently to permit proper compaction.

F. All backfill shall be placed at a moisture content within 3% of standard Proctor (ASTM D698) optimum moisture content, unless otherwise stated.

3.07 TRENCH BACKFILL

A. Backfilling over pipes shall begin as soon as practicable after the pipe has been laid, jointed, and inspected. All backfilling shall be performed expeditiously.

1. Screened gravel shall be placed around the lower half of the pipe and compacted by machine tamping to obtain uniform subgrade for pipe installation as shown on the drawings.

2. Select Fill shall be thoroughly compacted by machine tamping in 12-inch layers as required to provide 95% of the maximum dry density as determined by ASTM D698.

3. The remainder of the trench shall be backfilled with common fill placed in loose layers not to exceed 8-inches and thoroughly compacted with mechanical tampers as required to obtain 95% of the maximum dry density as determined by ASTM D698.

4. Backfilling under haunches shall be performed manually by tamping rods or similar hand equipment to eliminate voids underneath sides of the pipe or haunch.

5. Quality assurance field density testing shall be conducted at a minimum testing frequency of one test per lift per 50 linear feet of trench for all material types.

3.08 ROAD SUBGRADE

A. The road subgrade for crushed stone pavement areas in fill sections shall consist of a two-foot-thick layer of select fill. The select fill shall be placed and compacted in accordance with Paragraph 3.06.

B. The road subgrade for crushed stone pavement areas in cut sections shall consist of firm natural soils as approved by the Engineer.

C. Road subgrades shall be proofrolled as described in Paragraph 3.01 G.

3.09 HANDLING OF SURPLUS MATERIAL

A. Excavated materials shall not be removed from the site except as specified by the Engineer. Materials shall be neatly stockpiled on-site at locations directed by the Owner.

B. Surplus fill shall become the property of the Owner and be stockpiled at locations directed by the Owner.

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3.10 DISPOSAL AND REPLACING OF ROCK

A. The Contractor shall remove and dispose of all pieces of ledge and boulders which are not suitable for use in other parts of the work. Rock disposed by hauling away to spoil areas is to be replaced by approved surplus soil excavation obtained elsewhere on the work, insofar as it is available. Any deficiency in the backfill material shall be made up with acceptable onsite material approved by the Engineer. The cost of replacement of rock with soil shall be included within the rock excavation pay item.

B. Rock and boulders larger than 6-inches in diameter may not be used in Common Fill.

3.11 GRADING

A. Grading in preparation for placing of Compacted Soil Liner shall be performed to the elevations shown and otherwise as directed by the Engineer and shall be performed in such a manner that the requirements for formation of embankments can be followed. During the process of grading, the subgrade shall be maintained in such condition that it will be well drained at all times. When required, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the performance or condition of work.

B. If at the time of grading it is not possible to place material in its final location, it shall be stockpiled in approved areas. Stockpiled material shall be placed, compacted and smooth rolled at the end of each day to deter water infiltration. No extra payment will be made for the stockpiling or double handling of excavated material.

C. Engineer reserves the right to make minor adjustments in lines or grades if deemed necessary as the work progresses, in order to obtain satisfactory construction.

D. Stone or rock fragments larger than four (4) inches in their greatest diameter will not be permitted in the top six (6) inches of the finished subgrade of all fills or embankments.

E. In cuts, all loose or protruding rocks on the back slopes shall be barred loose or otherwise removed to finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings or as directed by the Engineer.

F. In cuts where highly, micaceous, elastic silts or cohesionless silts are encountered at subgrade, the material shall be undercut to a depth of at least 18 inches below the subgrade and replaced with Select Fill as directed by the Engineer. Payment for this item will be as bid in Section 00300.

G. Final grading of earthwork shall be uniform in slope and shall result in a finished surface with a tolerance of 0.3 feet above or 0.1 feet below the elevations indicated on the Drawings except for the subgrade of the Subtitle D Landfill cell which shall be uniform in slope and shall result in a finished subgrade surface with a tolerance of 0.1 feet above or below the elevations indicated on the Drawings.

END OF SECTION

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SECTION 02273

WOVEN MONOFILAMENT FABRIC

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install woven monofilament geotextile complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Section 02271: Fabric Cushion.

B. Section 02623: High Density Polyethylene (HDPE) Pipe.

C. Section 02776: High Density Polyethylene (HDPE) Liner.

1.03 SUBMITTALS

A. Within 15 calendar days following the Effective Date of the Agreement, submit the following information in accordance with Section 01300:

1. Manufacturer's background information.

2. Information on factory size, equipment, personnel, number of shifts per day and production capacity per shift.

3. List of material properties and samples of geotextile with attached certified test results.

4. Manufacturer’s quality control program and manual including description of laboratory facilities.

5. A list of ten completed facilities where the geotextile is used including:

   a. Name and purpose of facility, its location and date of installation.

   b. Name of Owner, project manager, design engineer and installer.

   c. Geotextile thickness and percent open area.

   d. Information on performance of the facility.

6. Shop Drawing, including:

   a. Details of overlap and seaming of the geotextile, anchoring, connections and other construction details as well as any variance or additional details which deviate from the drawings.

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7. Installation schedule.

8. A manual that specifically defines the quality control and quality assurance program during installation including manufacturer's installation instructions.

9. Copy of quality control certificates in conformance with Paragraph 2.03.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D5199 – Standard Method for Measuring Nominal Thickness Geosynthetics.

2. ASTM D3776 – Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.

3. ASTM D3786 - Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method.

4. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

5. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

6. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

7. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile.

8. ASTM D4833 – Standard Test Method for Index Puncture Resistant of Geotextiles, Geomembranes and Related Products.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The quality control and quality assurance consist of conformance testing of material delivered to the site and field quality control during installation.

B. Conformance testing requirements are specified in Paragraph 2.04. The purpose of conformance testing is to assure that the supplied material conforms to the Specifications and to the manufacturer's quality control certificates.

C. Field quality control requirements are specified in Paragraph 3.03. The purpose of field quality control procedures is to assure that the geotextile material has been installed in accordance with the Specifications and manufacturer's recommendations.

1.06 SYSTEM DESCRIPTION

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A. The geotextile is intended to act as a filter between the protective rock layer and the rock surrounding the leachate collection pipe.

1.07 DELIVERY, STORAGE AND HANDLING

A. The geotextile shall be shipped, stored and handled in accordance with manufacturer's recommendations and as specified herein.

B. No mechanical equipment shall be driven directly on top of the geotextile.

C. The geotextile shall be stored in such a way that is protected from prolonged exposure to ultraviolet radiation and shall be elevated from the ground (a minimum of 3-in) to protect the geotextile from standing water.

1.08 MATERIAL WARRANTY

A. The manufacturer shall warrant that the fabric shall be of merchantable quantity (as defined by the Uniform Commercial Code). The manufacturer shall guarantee that the fabric furnished is suitable for the purpose intended and free from defects of material and workmanship. In the event the fabric fails to perform as specified, the fabric manufacturer shall promptly replace defective fabric without any cost to the Owner.

1.09 GUARANTEE

A. The CONTRACTOR shall guarantee the woven monofilament geotextile against defects in installation and workmanship for the period of two (2) years commencing with the date of Final Acceptance. The guarantee shall include the services of qualified service technicians and all materials required for the repairs at no expense to the Owner.

PART 2: PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration.

2.02 MATERIALS

A. Woven Geotextile

1. The geotextile shall be a monofilament woven material consisting of propylene formed into a stable network such that the filaments retain their relative position to each other. Material shall be nonbiodegradable, nonreactive within a pH range of three to eleven, resistant to ultraviolet light exposure and shall meet the following minimum average roll values:

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MINIMUM AVERAGE ROLL VALUES

Properties	Test Method	Unit	Min. Avg. Roll Values
Fabric Weight	ASTM D3776	oz/sq yd	5.8
Thickness	ASTM D5199	mils	26.0
Grab Strength	ASTM D4632	lbs	260.0
Grab Elongation	ASTM D4632	percent	15.0
Puncture Resistance	ASTM D4833	lbs	130.0
Mullen Burst Strength	ASTM D3786	psi	515.0
Water Flow Rate	ASTM D4491	gpm/sq ft	110.0
Permittivity	ASTM D4491	SEC^{-1}	1.1
Coef. of Permeability	ASTM D4491	cm/sec	0.05
Apparent Opening Size	ASTM D4751	mm sieve	0.60 30.0

2. The values listed above are for the weaker principal direction.

2.03 QUALITY CONTROL DOCUMENTATION

A. Prior to installation commencement of any woven monofilament geotextile material, the Contractor shall provide to the Owner the following information certified by the manufacturer for the delivered woven monofilament geotextile material.

1. Each roll delivered to the Project site shall have the following identification information:

a. Manufacturer's name

b. Product identification

c. Thickness

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d. Roll number

e. Roll dimensions

2. Quality control certificates, signed by the manufacturer's quality assurance manager. Each certificate shall have roll identification number, sampling procedures, frequency and test results. At a minimum the following test results shall be provided every 200,000 square feet of manufactured geotextile in accordance with test requirements specified in Paragraph 2.02.

a. Thickness

b. Mass per unit area

c. Puncture Resistance

d. Mullen Burst Strength

e. Grab Tensile

f. Percent Open Area

g. Permeability

h. Apparent Opening Size

2.04 CONFORMANCE TESTING

A. Conformance testing shall be performed by an independent Quality Assurance Laboratory (QAL) procured by the Contractor. Engineer shall obtain samples from the delivered material, mark the machine direction and identification number. One sample shall be taken per 100,000 square feet, or one sample per lot, whichever results in the greater number of conformance tests. A Lot number will be defined as a continuous production process without changes to raw material or manufacturing methods. This sampling frequency may be increased as deemed necessary by the Engineer. For every change in Lot number, the Contractor shall perform conformance testing on the initial roll. The samples shall be taken across the entire roll width and shall not include the first 3-ft. The following conformance tests shall be conducted at the laboratory:

1. Mass per unit area (ASTM D3776)

2. Mullen burst strength (ASTM D3786)

3. Puncture resistance (ASTM D4833)

4. Grab tensile (ASTM D4632)

5. Permittivity (ASTM D4491)

6. Apparent opening size (ASTM D4751)

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7. Percent Open Area

B. These conformance tests shall be performed in accordance with test requirements specified in Paragraph 2.02 and conducted in accordance with ASTM D4759.

C. All conformance test results shall be reviewed by the Engineer and accepted or rejected, prior to the deployment of the geotextile. All test results shall meet, or exceed, the property values listed in Paragraph 2.02 above. The course of action to be implemented for failing tests shall be approved by the Engineer.

D. The manufacturer may obtain additional samples from rolls immediately before and after the failing roll or as directed by the Engineer and have them tested by the QAL. If these rolls pass, then only the failing roll will be rejected. If they fail, then the entire lot will be rejected.

PART 3: EXECUTION

3.01 PREPARATION

A. All work shall be done in a manner so as not to damage or degrade any existing landfill liner system, leachate collection or gas collection system.

B. General

1. Following excavation, backfill, and compaction and prior to placement of the geotextile, preparation of the subgrade shall be in accordance with Sections 02200 and 02271.

2. The liner and nonwoven geotextile cushion shall be inspected by the CQA Staff prior to installation of the woven geotextile.

3.02 INSTALLATION

A. Panel Placement

1. The geotextile shall be installed as shown on the Drawings and in accordance with the manufacturer's recommendations and approved shop drawings. The number of rolls and installed surface area should be documented.

2. No mechanical equipment shall be driven directly on top of the geotextile.

3. The geomembrane liner shall be protected during installation of the geotextile.

4. HDPE Pipe shall be installed in accordance with Section 02623.

5. No mechanical equipment shall be allowed directly on top of the geotextile material. Equipment shall be driven on pre-deposited material.

6. Damage to the geotextile occurring during the placement of soil cover shall be repaired immediately at no additional expense to the Owner.

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7. All geotextile installation shall be completely covered at the end of each work day unless otherwise approved by the Engineer.

8. The geotextile shall be properly weighted to avoid uplift due to wind.

B. Field Seaming

1. The geotextile panels shall be sewn together. The thread used to sew the panels shall be suitable for intended use in leachate systems and as approved by the manufacturer. Sewn geotextile panels shall be overlapped by a minimum of 6-in.

3.03 FIELD QUALITY CONTROL

A. Prior to completion of the leachate collection system, the geotextile installation and related work shall be inspected by the Engineer. All work in the system therein being inspected shall be complete, clean and ready for use. All work shall meet the requirements as to line, grade, cleanliness and workmanship, as determined by the Engineer.

B. All discrepancies shall be noted and repaired at no additional expense. Final acceptance of the system shall be contingent upon the approval of the Engineer.

3.04 DISPOSAL OF WASTE MATERIAL

A. Upon completion of installation, dispose of all trash, waste material and equipment used in connection with the performed work and shall leave the premises in a neat and acceptable condition.

END OF SECTION

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SECTION 02277

GEOSYNTHETIC CLAY LINER (GCL)

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to install Geosynthetic Clay Liner (GCL) as shown on the Drawings and as specified herein. The work shall include unloading, storing placement, seaming, and anchoring of the GCL, field quality control, and all other work as shown on the Drawings and as specified herein.

B. Sufficient material and accessory bentonite shall be furnished to cover all areas as shown on the Drawings, including overlaps at field seams.

1.02 RELATED WORK

A. Section 02200: Excavation, Backfill, and Compaction.

B. Section 02278: Compacted Soil Liner.

C. Section 02776: High Density Polyethylene (HDPE) Geomembrane.

1.03 SUBMITTALS

A. Within 30 calendar days following the Effective Date of the Agreement, submit the following information:

1. Submittals relating to GCL Manufacturer and GCL:

a. Corporate Background

b. Manufacturing capabilities:

1) Information on factory size, equipment, personnel, number of shifts per day and production capacity per shift.

2) List of material properties and samples of GCL with attached certified test results.

3) Manufacturer's quality control program and manual including description of laboratory facilities.

4) A list of ten similarly completed facilities totaling a minimum of ten million square feet, for which the Manufacturer has manufactured a GCL. The following information shall be provided for each facility.

a) Name and purpose of facility, its location and date of installation.

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b) Name of owner, project manager, design engineer and installer.
c) GCL surface area.
d) Information on performance of the facility.

c. The origin of the bentonite and geotextiles to be used in the manufacturing of the GCL including the suppliers name and production plant, as well as brand name and number.

d. Manufacturer's literature including:

- Material samples;
- Technical data including Minimum Average Roll Values (MARVs) for the items listed in GRI-GCL3;
- Material Warranty covering materials and workmanship of the GCL, including batch identifications and associated roll numbers; and
- Certificate of permeability and bentonite content per square foot of mat.

e. Copy of quality control certificates in conformance with Paragraphs 2.01 and 2.02.

2. Submittals relating to installing Contractor

a. Background Information, including a list of completed facilities totaling one million square feet for which the Installer has installed GCL. The following information shall be provided for each facility:

1) Name and purpose of facility, its location and date of installation.
2) Name of owner, design engineer, manufacturer and name and telephone number of contact at the facility who can discuss the project.

b. Installation capabilities:

1) Information on equipment and personnel.
2) Anticipated average daily production.

c. Shop drawings, including:

1) A proposed plan detailing GCL storage location and methods;
2) A proposed plan for placement and a proposed panel layout showing the installation layout identifying field seams as well as any variance or additional details which deviate from the Drawings.
3) Details of seaming the GCL, anchoring, connections, penetrations, and other construction details.
4) The Contractor shall perform and submit the analytical testing results for the GCL at the frequencies specified in GRI-GCL3 of this Section.

d. Installation schedule.

e. A quality control manual that specifically defines the quality control program during installation. The manual shall include daily procedures, installation techniques, field testing procedures, lab testing procedures, specific steps that are to be taken in the

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event of a failure or defect, personnel requirements, levels of authority and all other information necessary to ensure a high quality GCL installation.

f. Resume of the Supervisor to be assigned to the project, demonstrating the supervision of one million square feet of GCL installation.

g. A list of personnel performing field seaming operations along with pertinent experience information.

3. Material Testing Requirements

Contractor shall submit for approval results of direct shear testing on the actual GCL, geomembrane, geocomposite and compacted soil liner that will be used in accordance with ASTM D6243 and ASTM D5321 that verify acceptable interface shear strength. The tests shall consist of at least 3 separate shear tests run at normal stresses of 1, 20, 40, and 60 psi. The tests shall be performed on the GCL samples hydrated a minimum of 24 hours under the normal stress at which the sample is to be sheared. The compacted soil liner shall be prepared for testing at a moisture content and dry density within the acceptance zone determined in accordance with Section 02278. The minimum acceptable effective friction angle for HDPE geomembrane is 19 degrees. Results shall include:

- Internal shear strength of the GCL
- Interface strength between the compacted soil liner material and the GCL
- Interface strength between the GCL and the HDPE geomembrane
- Interface strength between the HDPE geomembrane and geocomposite
- Interface strength between the geocomposite and protective cover material

Manufacturer shall submit for approval results of hydraulic conductivity test ASTM D5887 conducted using distilled water for hydration and permeant.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D6243 – Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method.

2. ASTM D3786 – Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-Woven Fabrics - Diaphragm Bursting Strength Tester Method.

3. ASTM D4632 – Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).

4. ASTM D5261 – Test Method for Measuring the mass per unit area of Geotextiles.

5. ASTM D2216 – Determination of Moisture Content of soil.

6. ASTM D5321 – Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear Method.

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7. ASTM D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

8. ASTM D413 – Test Method for Rubber Property - Adhesion to Flexible Substrate.

9. ASTM D3776 – Test Method for Mass Per Unit Area.

10. ASTM D5887 – Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.

11. ASTM D5888 – GCL Storage and Handling Guidelines.

12. ASTM D6102 – GCL Installation Guidelines.

13. ASTM D5890 – "Swell Index Test"

14. ASTM D5891 - "Specification for Fluid Lost Test"

B. Geosynthetic Research Institute (GRI)

1. GRI GCL3 – Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. In addition to the Manufacturer and installer requirements for qualifications and certification specified in Paragraph 1.03, the quality assurance consists of conformance testing of the material delivered to the site and field quality control during installation.

B. Conformance testing requirements are specified in Paragraph 2.03. The purpose of conformance testing is to assure that the supplied material conforms to the Specifications and to the Manufacturer's quality control certificates.

C. Field quality control requirements are specified in Paragraph 3.06. The purpose of field quality control procedures is to assure that the GCL has been installed in accordance with the Specifications and Manufacturer's recommendations.

D. Quality Control Plan

1. The forms for GCL quality control documentation, included in Appendix A, shall be used for field installation documentation. Alternative forms may be used for documentation as approved by the CQA Manager.

E. GCL Quality Control Documentation

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1. Prior to commencing work, a pre-installation conference shall be held and the following Project personnel shall be identified by name and recorded in the Project files:

   - Engineer
   - Contractor's Representative
   - Resident Project Representative
   - CQA Manager
   - Installation Supervisor
   - Quality Assurance Laboratory
   - Quality Assurance Technician

2. Two duplicate project files shall be maintained. One shall be maintained by the CQA Manager and the other shall be maintained by the Installation Supervisor. At the end of each work day (no later than noon the following day) the files shall be updated and checked to assure that copies of all pertinent project information is included in each file.

3. Blank copies of the following four project forms shall be available onsite throughout the duration of the project:

Form No.	Title
CQC - 100	GCL Project QC Log
CQC - 101	Receiving QC Log
CQC - 102	Personnel QC Log
CQC - 103	Subgrade Surface Acceptance
CQC - 104	GCL Installation Tracking Log
CQC - 105	GCL Damage Report

F. Record Drawings

1. Furnish record drawings and a copy of complete documentation for final installation of the GCL. Record drawings should detail the GCL panel Roll Number, Lot Number, and orientation in the liner system. All repairs should also be identified and located in the record drawings.

1.06 QUALIFICATIONS

A. Manufacturer

1. The Manufacturer of the GCL described hereunder shall have previously demonstrated his/her ability to produce this GCL by having at least two years continuous experience in the manufacturing of GCLs and successfully manufactured a minimum of 10 million square feet of GCL material.

B. Installer

1. The installer shall be the Manufacturer or an installer certified by the Manufacturer to install the GCL. Installation shall be performed under the constant direction of a single Installation Supervisor who shall remain on site and be in responsible charge, throughout the GCL

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installation, for GCL layout, seaming, patching, testing, repairs and all other activities required by the installer.

GCL Installer must either have installed at least one million square feet of GCL, or must provide to the Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The bentonite mat rolls shall be packaged and shipped by appropriate means to prevent damage of the bentonite mat rolls. The Manufacturer shall ensure that proper methods of securing and fastening the rolls of GCL during shipping will be implemented. The CQA staff will inspect the liner material as it arrives on site for any damage to the liner. Straps securing the liner during shipping shall not cut into the liner material. Any rolls that appear damaged as a result of tight fastening, or otherwise, may be rejected at the discretion of the Engineer. Off-loading, in accordance with Manufacturer's recommendations, inspection and storage of the bentonite mat is the responsibility of the Contractor. The Contractor shall be responsible for replacing any damaged or unacceptable material at no cost to the Owner.

   Handling and storage of materials shall be in accordance with Manufacturer's recommendations and ASTM D5888 and is the responsibility of the Contractor.

   Materials shall be protected from rain during storage and shall be dry before or during periods of rain.

B. GCL material that appears hydrated prior to or during installation will not be accepted by the Engineer. GCL material which has been hydrated prior to placement of confining stress greater than 0.75 psi shall be removed and replaced at the Contractor's expense. Hydrated GCL is defined as material which has become soft as determined by squeezing the material with finger pressure, material which has exhibited visible swelling. Exceptions to this requirement will be made at the discretion of the Engineer.

C. No off-loading shall be performed unless the CQA Manager is present. Damage during off-loading shall be documented by the CQA Manager and CQA Technician (QAT). All damaged rolls must be separated from the undamaged rolls until the proper disposition of that material has been determined by the CQA Manager.

D. The GCL rolls shall be stored so as to be protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions and excessive heat that may damage the GCL material. The rolls shall be stored on a prepared surface and shall not be stacked more than two rolls high.

E. The GCL shall be wound around a cardboard core 4 inches in diameter to facilitate handling. The core is not intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

1.08 WARRANTY

A. The GCL Manufacturer shall warrant the GCL against manufacturing defects and material degradation in its design condition for a period of five years from the date of installation. The

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Manufacturer shall replace at no expense any material that fails from the above causes within the warranty period. The Manufacturer shall furnish a written warranty to the Engineer covering the requirements of this Paragraph.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair and/or relocation and replacement of the GCL.

1.09 GUARANTEE

A. The Contractor shall guarantee the GCL installation and workmanship for the period of two years commencing with the date of Final Acceptance. The guarantee shall include the services of qualified service technicians and all materials required for the repairs at no expense to the Owner.

1.10 DEFINITIONS AND RESPONSIBILITIES

A. Manufacturer

1. The Manufacturer is the firm or corporation responsible for production of the GCL material to be used in the Project. The Manufacturer is responsible for any damage to the GCL until the material is accepted by the Engineer or his/her field representative upon delivery. The Manufacturer shall produce a consistent product meeting the Specifications and shall provide quality control documentation for the product specified herein.

B. Installer

1. The installer is the firm responsible for installation of the GCL. The installer shall be the Manufacturer or an approved installer by the Manufacturer to install the Manufacturer's GCL. The installer shall provide an Installation Supervisor responsible for the installation field crew. The installer shall be responsible for field handling, storing, placing, seaming and all other aspects of the GCL installation. The Contractor is ultimately responsible for installation of the GCL and final acceptance of the project by the Owner.

PART 2: PRODUCTS

2.01 MATERIALS

A. General

1. The GCL shall be formulated and manufactured from polypropylene geotextiles and high swelling sodium bentonite.

2. The reinforced GCL shall be BENTOMAT® ST, as manufactured by Colloid Environmental Technologies Company (CETCO®) of Arlington Heights, IL, BENTOFIX NSL by GSE, Houston, TX or approved equal.

3. The materials shall be manufactured by the mechanical bonding of the needle punch process to enhance the friction characteristics of the liner and to maintain the integrity of the liner under hydration. No glues or adhesives shall be used in lieu of the needlepunch process so as to retain these characteristics. Needle punched bentonite geocomposites are those which, by the process of a needling board (similar to that used in the manufacture of

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standard non-woven geotextiles) have fibers of a non-woven geotextile pushed through the bentonite clay core and integrated into a woven or non-woven geotextile without the use of any chemical binders or adhesives.

4. No disassociation of geotextile components from the bentonite core shall occur under any conditions.

5. The GCL shall be manufactured in accordance with GRI-GCL3. The bentonite shall meet the base mineralogical composition as listed in GRI-GCL3.

6. Rolls shall be manufactured a minimum of 12 feet wide and 100 feet long. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

7. The encapsulating geotextile shall be polypropylene and shall meet the mass per unit area as listed in GRI-GCL3. The non-woven component of the geocomposite shall be a needle punched geotextile. The non-woven fabric shall be inspected by the Manufacturer for broken needles by permanently installed on-line metal detectors at the production facility. The Manufacturer must have an aggressive, thorough and effective means for ensuring that needles are detected and removed from all non-woven fabric produced. If the Engineer determines that the Manufacturer's quality assurance program is inadequate, the material may be rejected.

B. Properties

1. The GCL shall meet the minimum average properties listed in GRI-GCL3.

C. Other Materials

1. Accessory granular Bentonite shall conform with the requirements listed in GRI-GCL3.

2.02 QUALITY CONTROL DOCUMENTATION

A. Prior to installation commencement of any GCL material, the Contractor shall provide to the Owner the following information certified by the Manufacturer for the delivered GCL.

1. Origin, identification, and production of the Bentonite (supplier's name, brand name and production plant).
2. Copies of quality control certificates issued by the Bentonite supplier.
3. Each roll delivered to the Project site shall have the following identification information;

   - Manufacturer's name
   - Product identification
   - GCL roll weight
   - Roll number
   - Lot number
   - Roll dimensions

4. Quality control certificates, signed by the Manufacturer's quality assurance manager. Each certificate shall have roll identification number, sampling procedures, frequency, and test

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results. At a minimum, the test results shall be in accordance with certified requirements specified in GRI-GCL3.

2.03 CONFORMANCE TESTING

A. Conformance testing shall be performed by an independent Quality Assurance Laboratory retained by the Contractor which is approved by the Owner and Engineer. A Quality Assurance Technician (QAT) from the QAL shall obtain the samples from the roll, and mark the sample with an appropriate identification number.

B. These conformance tests shall be performed in accordance with GRI-GCL3 and include:

- Bentonite Mass per Area
- Bentonite Free Swell
- Bentonite Fluid Loss
- Woven Geotextile Mass per Unit Area
- Non-Woven Geotextile Mass per Unit Area
- GCL Mass per Unit Area
- GCL Index Flux
- Peel Strength
- Tensile Strength

C. All conformance test results shall be reviewed by the CQA Manager and accepted or rejected, prior to the placement of the GCL. All test results shall meet, or exceed, the property values listed in GRI-GCL3. The course of action implemented for failing tests shall be approved by the CQA Manager. In case of failing test results, the Manufacturer may request that another sample be retested by the QAL with Manufacturer's technical representative present during the testing procedures. This retesting shall be paid for by the Manufacturer. The Manufacturer may also have the sample retested at two different laboratories approved by the Engineer. If both laboratories report passing results, the material shall be accepted. If both laboratories do not report passing results, all GCL material from the lot representing the failing sample will be considered out of specification and rejected. The Manufacturer reserves the right to obtain additional samples from rolls immediately before and after the failing roll or as directed by the QAT and test it by the QAL at his/her own expense. If these rolls pass, then only the failing roll will be rejected. If they fail, then the entire lot will be rejected.

PART 3: EXECUTION

3.01 SUBGRADE PREPARATION

A. Preparation of the GCL subgrade shall be as specified in Section 02278. The GCL will be placed directly over the prepared compacted soil liner subgrade.

B. The surface shall be smooth, uniform, free from sudden changes in grade (such as vehicular ruts), rocks, stones, debris, and deleterious materials. The GCL must be maintained within the project specifications until the geomembrane has been installed. During actual placing and seaming of the geomembrane, the GCL surface shall be kept free of all standing water. If the GCL below the liner becomes wet and unstable, it shall be removed and replaced.

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C. Before the GCL installation begins, the Contractor and installer shall verify in writing and submit to the Engineer:

1. Lines and grades are in conformance with the Drawings and Specifications.

2. The surface area to be lined has been rolled and compacted, free of irregularities and abrupt changes in grade.

D. If the Contractor proceeds with installation of materials that cover the GCL prior to providing the appropriate documentation and test results verifying installation of the GCL, the Contractor will do so at his/her own risk. If the GCL is covered and failing tests are identified, the Contractor will be required to remove overlying liner system layers, repair the deficient GCL area(s) and reinstall the liner system in accordance with project specification requirements. Any liner system materials damaged during the repair work shall be replaced with new material. All costs associated with such actions will be paid for entirely by the Contractor including, but not limited to, labor, additional liner system material, testing, labor and material costs incurred by the Engineer to perform additional inspection services.

3.02 ANCHOR TRENCH

A. The anchor trench shall be constructed as shown on the design drawings and as specified herein.

B. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the GCL.

C. The anchor trench shall be adequately drained to prevent water ponding and softening to adjacent soils. The anchor trench shall be backfilled with common fill and compacted to 95 percent of standard Proctor, ASTM D698.

D. The amount of trench open at any time shall be limited to one day of GCL installation capacity. The anchor trench shall be backfilled and compacted at the end of each day in accordance with the Specifications.

3.03 GCL PLACEMENT

A. Weather Conditions

1. GCL placement shall not proceed during precipitation, excessive moisture, in an area of ponded water, or excessive winds.

B. Method of Placement

1. Placement of the GCL shall be conducted in accordance with the Manufacturer's recommendations and in accordance with ASTM D6102 guidelines. Any deviations from these procedures must be pre-approved by the Engineer.

2. Each panel of the GCL shall be rolled out and installed in accordance with the approved shop drawings prepared by the Contractor. The layout shall be designed to keep field joining of the GCL to a minimum and consistent with proper methods of GCL installation.

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3. GCL rolls shall be placed using proper spreader and rolling bars with chain or cloth slings. If a sheet must be replaced a distance greater than its width, a slip or rub sheet shall be used.

4. The QAT and CQA monitors shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels shall be replaced or repaired, as approved by the Engineer.

5. The installer shall avoid dragging the GCL sheets on rough soil subgrades.

6. All GCL shall be anchored as shown on the Drawings and consistent with Manufacturer's recommendations. Seams shall be perpendicular to the toe of slope at all times.

7. The GCL shall be properly weighted, if needed, to avoid uplift due to wind.

8. Vehicular traffic across the GCL shall not be allowed. Use of a low ground pressure all-terrain vehicle (ATV) that exerts a maximum of 6 psi may be allowed as standard operating procedure for deployment of geomembrane if endorsed by the Manufacturer in writing and approved by the Engineer.

9. All damage shall be recorded and located in the record drawings.

10. The GCL shall be kept free of debris, unnecessary tools and materials. In general, the GCL area shall remain neat in appearance.

11. Equipment necessary to perform the installation (generators, compressors, etc) shall have a scrap GCL sheet placed underneath to protect the installed GCL from possible damage.

12. In the opinion of the CQA Manager, any seam, or edge of GCL material exposed for more than 24 hours or considered partially hydrated when seaming occurs shall receive a 3-foot overlap (rainlap) from the adjoining GCL panel.

13. The Contractor shall only work on an area that can be completed in one working day. Completion shall be defined as the full installation and anchoring of the GCL liner and placement of the specified liners or cover soils. Upon completing placement of bentonite panels in any area, the geomembrane shall be immediately installed over bentonite panels as detailed in Section 02776**.** Under no circumstances will the Engineer allow the GCL mat to be exposed to the elements overnight.

14. The minimum allowable size for a GCL "panel" shall be 120 feet in length.

15. The GCL shall not get wet before or during installation. The GCL mat shall not be installed during periods of any precipitation. If a precipitation event occurs after the installation of a bentonite mat panel, but prior to covering with geomembrane, a thin film plastic sheeting may be used to cover and to temporarily protect the bentonite mat from moisture if approved by the Engineer. The GCL shall not be installed in standing water.

16. GCL material that appears hydrated prior to or during installation will not be accepted by the CQA Manager. GCL material, which has been hydrated prior to placement of confining stress greater than 0.75 psi, shall be removed and replaced at the Contractor's

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expense. Hydrated GCL is defined as material which has become soft as determined by squeezing the material with finger pressure, material which has exhibited visible swelling, or material which has a moisture content greater than 50 percent as determined by ASTM D2216.

17. For protection and proper performance, no machinery or equipment shall be allowed on the GCL, unless previously approved by the Engineer and Manufacturer.

18. GCL panels shall be placed with the non-woven geotextile side facing down. On sloped areas equal to or exceeding a steepness of 4H:1V, the long dimension of all panels shall be oriented parallel to the slope. Panels should be placed from the highest elevation to the lowest within the area to be lined, to facilitate drainage in the event of precipitation. Panels shall be placed free of tension or stress yet without wrinkles or folds. It is not permissible to stretch the GCL in order to fit a designated area. Panels shall not be dragged across the subgrade into position except where necessary to obtain the correct overlap for adjacent panels.

19. When covering GCL installed on sloped areas equal to or steeper than 4H:1V, the cover material should be pushed upslope to minimize tension on the GCL.

20. Any leading edge of panels left uncovered shall be protected at the end of the working day with a waterproof sheet, which is adequately secured with sandbags and other ballast.

21. Reinforced GCL panels on sideslopes shall extend a minimum of 10 ft beyond the interface of the steep sideslope and the bottom.

C. Liner Penetrations

1. GCL aprons or shrouds shall be furnished and installed where indicated on the Drawings. The aprons shall be of the same material as the GCL.

2. Aprons and shrouds shall fit snugly around the pipe.

3. For any penetrations or structures the mat will contact, a small notch (approximately 3 inches wide and 8 inches deep) shall be cut against the edge of the subgrade area. The mat shall be brought up to the edge of the structure and trimmed to fit into the notch. The Contractor shall then hand-apply a pure bead of bentonite into half the notch. The mat shall then be inserted into the notch, with the remaining volume of the notch refilled with the pure bentonite and compacted.

3.04 FIELD SEAMS

A. Individual panels of GCL shall be laid out and overlapped by a minimum of 24-inches for end seams and or minimum of 6-inches for side seams prior to seaming. The area to be seamed shall be cleaned and prepared prior to placement of granular bentonite, if required by manufacturer's recommendations.

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B. All seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the record drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be seamed.

C. Seam areas or runs shall also be flat and clear of any large rocks, debris, or ruts. Contacting surfaces shall be clean and clear of dirt or native soil with all edges pulled tight to maximize contact and to smooth out any wrinkles or creases. Overlaps shall verified by CQA monitors.

D. Seams shall be augmented with granular bentonite to ensure seam integrity, if required by manufacturer's recommendations. Granular bentonite shall be dispersed evenly from the panel edge to the lap line at a minimum rate of 1/4 pound per lineal foot continuously along all seams or overlap areas. Accessory bentonite shall be of the same type as the material within the composite liner itself.

E. All seams constructed on sloped surfaces shall be vertical seams.

F. On gently sloping areas (gentler than 4H:1V) where seams may be placed across the slope, overlaps should be "shingled" so as to prevent flow into the seam.

3.05 DISPOSAL OF WASTE MATERIAL

A. Upon completion of installation, the Contractor shall dispose of all trash, waste material and equipment used in connection with the performed work and shall leave the premises in a neat and acceptable condition.

3.06 FIELD QUALITY CONTROL

A. Repair Procedures

1. Any portion of the GCL exhibiting signs of defect shall be repaired. The following procedure should be used to repair these areas. The final decision as to the appropriate repair procedure shall be made by the Engineer.

   Large rips or tears shall be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch over the damage, with a minimum overlap of 12 inches on all edges. Accessory bentonite shall be placed between the patch and the repaired material at a rate of 1/4 pound per lineal foot of edge, spread in a 6-inch width. The above procedures shall also be implemented if a rip or tear occurs on a sloped surface. In this instance, the edges of the patch shall be fastened to the repaired liner with construction adhesive, in addition to the bentonite-enhanced seam.

B. Repair Verification

1. Each repair shall be numbered and logged by the installer and located on the as-built drawings. The QAT and CQA Staff shall observe repairs. The installer shall record the number of each repair the date the repair was made.

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END OF SECTION

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APPENDIX A

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The following forms are included and shall be completed by the responsible party as shown on the forms.

Form No.	Title
CQC - 100	GCL Project QC Log
CQC - 101	Receiving QC Log
CQC - 102	Personnel QC Log
CQC - 103	Subgrade Surface Acceptance
CQC - 104	GCL Installation Tracking Log
CQC - 105	GCL Damage Report

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FORM CQC - 100
GCL PROJECT QC LOG
(one sheet per project)

PROJECT

NAME: _____

NUMBER: _____

LOCATION: _____

OWNER: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

ENGINEERING

ENGINEERING FIRM: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

CONTRACTOR

GENERAL CONTRACTOR: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

SUPPLIER OF GCL MATERIALS

NAME: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

QC INSPECTION

NAME: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

FORM CQC - 100
GCL PROJECT QC LOG
(one sheet per project)
(Continued)

TESTING LABORATORY

GCL TESTING LABORATORY: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

FABRICATOR OF MATERIAL

NAME: _____

ADDRESS: _____

CONTACT: _____

INSTALLER OF MATERIAL

NAME: _____

ADDRESS: _____

CONTACT: _____

GCL MATERIALS

SPECIFIED GCL MATERIALS: _____ TYPE: _____

MATERIAL CERTIFICATION

MATERIAL CERTIFICATION RECEIVED: _____

DATE: _____ ACCEPTED: _____

FORM CQC - 101
RECEIVING QC LOG
(one sheet per truck)

PROJECT NAME: _____

DATE: _____ TIME: _____ PROJECT NUMBER: _____

TRUCKERS ID: _____

NO. OF PIECES ON BOARD: _____ AGREE WITH PACKING LIST? _____

CONDITION OF PACKAGING: _____

VERIFY PROPER MATERIALS: _____ VERIFY PROPER THICKNESS: _____

IDENTIFY ROLL NUMBERS: _____

_____

IDENTIFY ACCESSORIES:_____

_____

IDENTIFY DAMAGED ITEMS: _____

_____

TYPE OF UNLOADING EQUIPMENT USED: _____

OPERATOR: _____

COMMENTS: _____

_____

STORAGE AREA

CONDITION *(surface)*: _____

LOCATION TO PLACEMENT AREA: _____

MATERIAL PROPERLY COVERED: _____

WEATHER

CONDITIONS: _____ TEMP: _____

SIGNATURES

QC INSPECTOR: _____

SITE SUPERVISOR: _____

Use back for other comments

FORM CQC - 102
PERSONNEL QC LOG
(installation personnel)
(complete for each mobilization or change of personnel)

PROJECT NAME: _____

DATE: _____ PROJECT NUMBER: _____

SAFETY MEETING CONDUCTED ON MATERIALS HANDLING: _____

GIVEN BY: _____ DATE: _____

SUPERINTENDENT OF INSTALLATION: _____

INSTALLATION CREW PERSONNEL

#1 CREW LEADER: _____ HELPER: _____

#2 CREW LEADER: _____ HELPER: _____

#3 CREW LEADER: _____ HELPER: _____

#4 CREW LEADER: _____ HELPER: _____

#5 CREW LEADER: _____ HELPER: _____

#6 CREW LEADER: _____ HELPER: _____

#7 CREW LEADER: _____ HELPER: _____

#8 CREW LEADER: _____ HELPER: _____

OTHER CREW MEMBERS

NAME: _____ NAME: _____

NAME: _____ NAME: _____

NAME: _____ NAME: _____

SIGNED: _____
QC Inspector

FORM CQC - 103
SUBGRADE SURFACE ACCEPTANCE
(one sheet per Day of GCL Deployment)

1. Surface for GCL placement accepted, covered by panel numbers: _____

_____

_____

Approximate size of area: _____

CERTIFICATE OF ACCEPTANCE
OF SUBGRADE SOIL LINER BY INSTALLER

I the undersigned, duly authorized representative of _____ do hereby accept the soil liner surface as being acceptable for the placement of GCL.

_____	_____	_____	_____
Name	Signature	Title	Date

Certificate Accepted by Inspector - Company: _____

_____	_____	_____	_____
Name	Signature	Title	Date

QC INSPECTOR: _____

SITE SUPERVISOR: _____

INSTALLING SUPERVISOR: _____

COMMENTS

_____

_____

_____

_____

FORM CQC - 104
GCL INSTALLATION TRACKING LOG

DATE	PANEL NO.	CELL NO.	ROLL NO.	LENGTH	WIDTH	SQUARE FT.

FORM CQC - 105
GCL DAMAGE REPORT

JOB NAME: _____ JOB NO.: _____
PAGE: _____

DATE	PANEL NO.	SEAM NO.	LOCATION OF DAMAGE	TYPE OF DAMAGE	TYPE OF REPAIR	PATCH NO.

COMMENTS: _____

_____

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SECTION 02278

COMPACTED SOIL LINER

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install compacted low-permeability soil liner of 18-inch minimum thickness below geosynthetic clay liner (GCL) as shown on the Drawings and as specified herein. Associated work includes quality control testing, borrow source excavation, hauling, screening, constructing test pads, placement, moisture conditioning, harrowing, compaction, and grading of compacted low-permeability soil liner.

1.02 RELATED WORK

A. Section 02200: Excavation, Backfill, and Compaction.

B. Section 02277: Geosynthetic Clay Liner (GCL).

1.03 SUBMITTALS

A. Within 15 calendar days following the Effective Date of the Agreement, the Contractor shall submit the following information as a complete package in accordance with Section 01300:

1. Identification of the compacted low-permeability soil liner source. Submit the following documentation:

   a. Name of the proposed low-permeability soil source and location relative to the site.

   b. Test results and other documentation as necessary to verify that the proposed low-permeability soil meets the requirements of Paragraph 2.01A of this Section and that a sufficient volume of the material is available to the project from the proposed borrow source. Include a map of the borrow source showing locations of test pits excavated to collect conformance test samples. Minimum testing frequencies for initial conformance testing are specified in Paragraph 2.02A.

2. A signed certification letter, with all necessary permits, that the material source is in full compliance with State, County, and local laws and regulations.

3. A description and schedule of the proposed installation procedures for low-permeability soil liner construction. Include a list of installation equipment and the procedures for providing survey control during low-permeability soil liner construction. If grade stakes are proposed for survey control, submit a map showing proposed metal grade stake locations and inventory numbering system (refer to Paragraph 3.04E).

4. A Construction Quality Control (CQC) Plan for the low-permeability soil liner installation including:

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a. Names and qualifications of the quality control laboratory (QCL) including the QCL manager to be retained by the Contractor.

b. Names and qualifications of proposed CQC site personnel.

c. CQC procedures for monitoring and testing at the borrow source and for test pad construction.

d. CQC procedures for compacted low-permeability soil liner installation including the removal of oversized stones and organic matter from the soil liner material, moisture control, placement, compaction and lift thickness control.

e. Procedure for grade stake recovery and inventory, if grade stakes are proposed for survey control during permeability soil liner installation.

f. Procedure for restoration of field density test locations, depth check locations, grade stake locations and permeability test sampling locations.

g. Procedure for protection of liner from adverse weather conditions (precipitation, frost, or intense heat).

h. All other relevant procedures.

5. Experience and performance questionnaire in conformance with Paragraph 1.06A.

B. At least 21 calendar days prior to test pad construction, submit at least 250 lbs of the proposed compacted soil liner material contained in sealed 5-gallon pails to the QAL address(es) provided by the Engineer.

C. Prior to compacted low-permeability soil liner construction submit a survey map of the final prepared subgrade elevations in a form acceptable to the Engineer.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.

2. ASTM D698 - Standard Test Method for Laboratory Compacted Characteristics of Soil using Standard Effort (12,400 ft-lbf/ft^3 (600 KN-m/m^3)).

3. ASTM D854 - Standard Test Method for Specific Gravity of Soils Solids by Water Pycnometer.

4. ASTM D1140 - Standard Test Method for Amount of Material in Soils Finer than the Number 200 (75 micrometer) Sieve.

5. ASTM D1556 - Standard Test Methods for Density and Unit Weight of Soil in Place by Sand-Cone Method.

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6. ASTM D1557 - Standard Test Methods for Laboratory Compacted Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 KN-m/m^3)).

7. ASTM D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

8. ASTM D2487 - Standard Classification of Soils for Engineering Purposes.

9. ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).

10. ASTM D2937 - Standard Test Method for Density of Soils in Place by the Drive-Cylinder Method.

11. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

12. ASTM D3017 - Standard Test Method for Water Content of Soil in Place by Nuclear Methods (Shallow Depth).

13. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

14. ASTM D4767 - Test method for Consolidated - Undrained Triaxial Compression Test on Cohesive Soils.

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

16. ASTM D5321 - Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic friction by the Direct Shear Method.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE AND QUALITY CONTROL

A. The Owner will retain a geotechnical Quality Assurance Laboratory (QAL) who is experienced in the construction of low-permeability liners and who has sufficient hydraulic conductivity testing equipment to provide test results in a timely manner in accordance with the Specifications. The QAL shall observe the Contractor's work and perform tests as specified to provide assurance that the liner meets the requirements of this specification.

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B. The Contractor shall retain an independent geotechnical Quality Control Laboratory (QCL) that is experienced in the construction of low-permeability liners and capable of performing the tests specified herein. The QCL shall provide direction and testing as necessary to control the quality of the borrow material (material property requirements specified in Paragraphs 2.01A) and proper construction of the test pad and the low-permeability liner.

C. Conformance testing requirements are specified in Paragraph 2.02. The purpose of conformance testing is to assure that the liner material delivered from the borrow source consistently meets the requirements of the specifications. In the event that the material from the initial borrow source varies significantly, fails to conform to the required criteria or fails to contain sufficient volume of suitable soil to complete the liner, the Contractor may locate another source, and upon submission and approval of results of initial conformance tests specified in Paragraphs 2.01 and 2.02, may submit samples from the new source for acceptance zone testing by the QAL, followed by construction of additional test pads, with all related costs born by the Contractor including engineering, laboratory testing and construction quality assurance.

D. The Contractor shall arrange for a joint site inspection of the low-permeability borrow source(s) by the QCL and the QAL after initial conformance test data have been submitted and approved and prior to stockpiling low-permeability on the site for the purpose of coordinating quality control and quality assurance procedures for borrow source excavation and stockpiling of material on-site.

E. A test pad shall be constructed on site using the same equipment and installation procedures that will be used during full scale soil liner construction. The purpose of the test pad is to assure that the construction procedures followed during liner system installation will produce an acceptable liner. Construction requirements and testing procedures for the test pad are specified in Paragraph 3.01.

1.06 QUALIFICATIONS

A. The work shall be performed by personnel that have experience in processing and installation of low-permeability soil liners. The Contractor shall demonstrate experience of personnel by completing the bid questionnaire (Section 00420).

B. The Contractor shall show evidence of an adequate, homogenous supply of material within a designated area which is properly permitted by the appropriate local, State and Federal agencies.

1.07 DELIVERY, STORAGE AND HANDLING

A. Soil materials for low-permeability soil liner construction shall be stockpiled onsite in designated areas approved by the Engineer. The low-permeability soil liner material shall be stockpiled separately from other materials. Soil material containing oversized rocks, roots, stumps, topsoil or other organic matter shall not be stockpiled on the site in the designated low-permeability soil liner stockpile areas. Removal and placement of stockpiled material shall be done in a manner to minimize mixing with soils adjacent to and beneath the stockpile.

B. The Contractor shall protect the low-permeability soil materials delivered to the site from inclement weather conditions and any traffic that may occur near the stockpile.

PART 2: PRODUCTS

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2.01 MATERIALS

A. Compacted low-permeability soil liner materials, shall consist of natural mineral soil that is uniform in character, free from fill materials, organic materials, loam, wood, trash, snow, ice and other objectionable materials and shall conform to the following properties:

	Property	Standard	Requirement
1.	Passing the 1-inch Sieve	ASTM D422	100%
2.	Passing the 200 Sieve	ASTM D1140	40% minimum
3.	Liquid Limit	ASTM D4318	30% minimum
4.	Plasticity Index	ASTM D4318	10% minimum
5.	USCS Soil Classification	ASTM D2488	SC, CH, CL, MH
6.	Hydraulic Conductivity	ASTM D5084	1.0×10^{-5} cm/s max
7.	Interface Friction Angle	Direct Shear ASTM D5321	23° minimum (interface with synthetic rotational shear liner) or as approved by ENGINEER
8.	Internal Friction Angle	ASTM D4767	23° minimum or as approved by ENGINEER
9.	Organic Content	ASTM D2974	5% maximum

B. The material proposed for the compacted soil liner construction shall be uniform in character and after compaction, shall have an in-place saturated hydraulic conductivity of 1.0×10^{-5} cm/s or less based on testing according to Paragraph 3.01 (F) of this Section.

C. The compacted soil liner material shall be tested for interface friction with the geosynthetic liner according to the requirements of ASTM D5321 and should have a friction angle of at least 23° for the range of normal stress indicated below. Testing should be conducted according to the following:

1. Test specimens shall be compacted to 95% of maximum dry density as determined by ASTM D698 unless otherwise specified by the Engineer.

2. Normal stresses representing field conditions expected prior to waste placement and after waste placement should not be used. The normal stresses shall be 1, 20, 40 and 60 psi.

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3. If normal stresses less than 5 psi are applied, dead weights should be used to apply normal stresses.

4. Test shall be conducted so that the normal stress is applied to the soil and the soil is moved against the stationary membrane.

Interpretation of the angle of the test data failure envelope (i.e. interface friction angle) shall be based on a best-fit line through the test failure condition data with a y-intercept of zero.

D. The internal friction angle shall be measured using consolidated-undrained triaxial tests with pore pressure measurements (ASTM D4767). Test specimens shall be compacted to 95% of maximum dry density as determined by ASTM D698 unless otherwise specified by the Engineer. Effective consolidation pressures representing field conditions expected prior to waste placement and after waste placement should be used. Consolidation pressures shall be 1, 15, 30 and 50 psi. The test results shall include stress-strain curves, pore pressure measurements, stress path photos and Mohr circle plots.

2.02 CONFORMANCE TESTING

A. Initial conformance testing shall be performed by the QCL on samples of the proposed low-permeability soil at the rate of at least one series of tests per 30,000 cubic yards of soil. A test series shall include the tests specified in Paragraphs 2.01A. Test samples shall be obtained from test pits excavated throughout the borrow source under the direction of the QCL to characterize the full extent of the borrow source.

B. The QAL will determine an acceptable zone of moisture contents and dry unit weights for which the strength and permeability requirements are met by performing the following testing and analysis procedures:

1. Using representative samples of the low-permeability soil provided by the QCL that were excavated from borrow source, perform a standard Proctor compaction test to develop a moisture-density curve for the material. Use up to five specimens prepared at different moisture contents to develop the moisture content vs. dry density curve.

2. Prepare up to five flexible wall permeability test samples, each at a dry density and moisture content combination determined by the Engineer based on the results of the standard Proctor test and index tests. Permeate each compacted specimen to determine its hydraulic conductivity in accordance with Paragraph 3.01F.

3. On the graph of dry density vs. moisture content, identify the samples which have hydraulic conductivities less than or equal to $1x10^{-5}$ cm/s.

4. Perform consolidated undrained triaxial compression tests (ASTM D4767) on specimens prepared at the high moisture/low dry density end of the acceptance zone and plot friction angles as a function of molding water content.

5. Based on the hydraulic conductivity test results, shear test results and other pertinent factors such as potential for desiccation cracks, constructability, shrink/swell potential and consolidation, the QAL will prepare an acceptance zone for the material.

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6. The QAL will define the acceptance zone as described above for one material source at the expense of the OWNER. If additional sources are used, the tests described above shall be performed by the QAL and the costs will be paid by the Contractor.

C. The Contractor's QCL personnel shall monitor each delivery of material from the borrow source, and note, on an approved form, the classification of the soil by visual-manual procedures (ASTM D2488), color of the material, date, time, and approximate quantity of material brought onsite and submit two (2) copies of completed forms to the Engineer at the end of each work day.

D. The low-permeability soil shall be tested by the QCL prior to use on the site at the frequencies listed below. The QCL shall ensure that the low-permeability soil is free of oversized rocks and organic matter such as roots, stumps, leaves and branches and other deleterious matter as it is being spread over the landfill prior to compaction. If changes occur in material, as identified by the Engineer, additional tests shall be performed at the expense of the Contractor.

Test	Method	Frequency
Grain Size (sieve only)	ASTM D422	Every 2000 cy or change in material
Atterberg Limits	ASTM D4318	Every 2000 cy change in material
Moisture/Density	ASTM D698	Every 4000 cy change in material
Natural Moisture	ASTM D2216	Every 1000 cy change in material

Results of the tests shall be submitted to the QAL within 24 hours of test completion and prior to use of the material on site. The QAL reserves the right to reject material based on the results of the QCL or QAL conformance tests.

PART 3: EXECUTION

3.01 TEST PAD

A. At least one test pad meeting all testing requirements with dimensions of not less than 40-ft by 60-ft and 18-in thickness and not more than 80-ft by 120-ft and 18-in thickness shall be constructed onsite using the same equipment, subgrade preparation procedures, and materials processing and installation procedures that will be used during full-scale liner construction. If approved by the Engineer, the test pad may be installed within the liner limits and incorporated in the work, provided all testing requirements are met.

B. The construction of the test pad shall be directed by the QCL. The QCL shall use the acceptance zone established by the QAL to set moisture contents and percent compaction. The QCL shall perform tests as needed to assist in the construction of the test pad. However, only the results of the QAL's tests will be recognized for accepting or rejecting the pad.

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C. The final compacted thickness of each lift shall be a maximum 6" lift thickness. For each lift, the QAL will perform testing of moisture content and density at a minimum of three test locations. Two thin-wall tube samples (ASTM D1587) shall be obtained per lift by the QAL. One tube will be used to perform a permeability test. The second tube will be kept as a backup in case of damage to the first sample.

D. If the initial test pad does not provide the specified results, additional test pad(s) shall be performed, at the Contractor's cost (including CQA costs), until the specified requirements are met.

E. The Contractor may construct test pads for more than one source of low-permeability liner material. However, only one test pad will be tested and evaluated at the OWNER's cost as a part of the specified construction quality assurance (CQA). All costs associated with subsequent test pads shall be paid for by the Contractor. If the Contractor changes the source of low-permeability soil, or if the characteristics of the low-permeability soil within the selected source changes significantly, the Engineer may order the construction of additional test pads as specified above to evaluate the performance of the compacted low-permeability liner. Construction of additional test pads and the related CQA work shall be paid by the Contractor.

F. One triaxial hydraulic conductivity test (ASTM D5084) will be performed on a sample obtained from each lift of the test pad. These tests will be performed on undisturbed thin-wall tube samples collected by the QAL in accordance with ASTM D1587. The samples shall be trimmed if needed, encapsulated within a flexible latex membrane, and mounted in permeameters conforming to the requirements of ASTM D5084. Each test specimen shall be consolidated under an effective stress of 1 to 3 psi and permeated under a back pressure as recommended in paragraph 8.3 of ASTM D5084 to achieve saturation. The maximum hydraulic gradient across the sample shall not exceed thirty (30) as per paragraph 8.5.1 of ASTM D5084 or as specified by Engineer. The hydraulic gradient shall be increased slowly in increments with careful observations of the test sample for consolidation, piping, etc. Test samples that are consolidated in volume by more than 5 percent during the test shall be voided. The inflow and outflow from the sample shall then be monitored and the hydraulic conductivity calculated for each recorded flow increment. The tests will continue until steady state flow is achieved as specified in paragraph 8.5 of ASTM D5084.

G. The low-permeability liner thickness shall be determined from three test locations per lift selected by the QAL per test pad using a method consisting of hand augering or push tube sampling (with a minimum of a 3/4" diameter sample) or as approved by the Engineer.

3.02 SUBGRADE PREPARATION

A. The subgrade shall be graded in accordance with the plans.

B. The low-permeability liner subgrade shall be compacted by the Contractor under direction of the QCL and observation by the QAL and Engineer until sufficiently stable for low-permeability soil liner construction. Any unsuitable areas encountered at subgrade elevation shall be removed and replaced or recompacted as necessary to create a stable subgrade for liner construction.

C. Select Fill may be placed to replace unstable subgrade material in the low-permeability liner area. Select fill shall be compacted to at least 95 percent of maximum density as determined by

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ASTM D698 or higher if necessary to create a stable subgrade for the low-permeability soil liner.

D. The Engineer shall observe and approve the subgrade and the survey plan of subgrade elevation submitted by the Contractor before installation of the low-permeability soil liner can proceed. It shall be the Contractor's responsibility to properly prepare and maintain the subgrade in a uniform and compacted condition during installation of the liner.

E. If the subgrade is damaged during liner installation, the Contractor shall restore and recompact the area and the QAL shall retest the subgrade in accordance with ASTM D1556 or D2937 prior to installing the liner. All costs related to the retest and restoration of the subgrade shall be paid for by the Contractor.

3.03 LOW-PERMEABILITY SOIL LINER PLACEMENT

A. The QCL shall supervise the liner installation. Work shall not be performed by the Contractor without the QCL at the liner installation work area. The QCL shall perform field tests (i.e. moisture content, densities, etc.) as required to ensure proper installation. The QAL shall perform tests as described in section 3.04 to determine acceptance of the in-place compacted low-permeability liner after the QCL indicates that an area is ready for testing based on the QCL observations and testing.

B. The placement moisture content shall be within the acceptance zone determined by the QAL. The acceptance zone may be modified by the Engineer based on results and observations of the test pad.

C. Water for Compaction

1. The Contractor shall provide water as required to maintain the moisture content of the in-place and stockpiled low-permeability soil liner material within the acceptance zone.

2. The water shall be of potable quality.

3. Prior to installing the liner, the Contractor shall inspect the subgrade to ensure that it has been sufficiently wetted to prevent excessive absorption of moisture from the installed low-permeability soil liner material.

4. Should the material be stockpiled for any length of time, the Contractor shall slope, seal and compact the stockpile to prevent erosion and oversaturation.

5. Should the material become oversaturated, the Contractor shall spread and dry the material as needed to adjust the moisture to the proper percentage.

D. The materials shall be uniformly compacted to no less than the minimum dry density of the acceptance zone. Density shall be uniformly obtained throughout the entire thickness of the liner. The liner shall be constructed in lifts with a maximum compacted thickness of 6 inches per lift to assure achievement of the specified compaction in the lower part of the liner. The surface of a lower lift shall be scarified prior to placement of an upper lift. However, the subgrade of the compacted low-permeability liner shall not be scarified. During placement of the initial lift, care should be taken to avoid mixing of the liner material and subgrade material.

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To achieve the specified compaction the Contractor shall use a self-propelled compactor such as the Caterpillar 815, or an equivalent, which provides steel kneading feet capable of fully penetrating the loose lift and into the previously compacted lift, in spreading and kneading the materials. Finally, a smooth wheel compactor such as a Caterpillar CS553 shall be used with sufficient number of passes to smooth the upper surface of the low-permeability liner. This type of compactor shall be used only for final smoothing of the surface. It shall not be used for achieving the specified compaction.

E. Liner material shall be disked, harrowed, and kneaded as necessary to break down all clods and produce a uniform material that is free of clods. A clod is defined for the purposes of construction as any sub-rounded ball of low-permeability soil exceeding 1-½" in diameter, typically with the core containing less than the specified moisture. If the Engineer observes that all clods have not been broken down, the Contractor shall rework the material to the satisfaction of the Engineer.

F. Liner material which has been contaminated with clusters of rock or gravel, sand lenses, organic debris or other deleterious material shall be removed and replaced with uncontaminated low-permeability materials.

G. For the final lift, the Contractor shall employ a crew of laborers to remove all rocks 1 inch in largest dimension prior to smooth rolling.

H. No liner material shall be placed, spread, or compacted while the ground or the liner material is frozen/thawing, saturated, desiccated, or during unfavorable weather conditions or periods of precipitation. The liner surface shall be made smooth and free from ruts or indentations at the end of any working day when significant precipitation is forecast and/or at the completion of the compaction operations in that area in order to prevent saturation of the liner material. Any regrading due to the above conditions or final preparation should be retested at those locations for liner thickness prior to placement of the next lift. Thickness measurements should be performed as indicated in Section 3.04 A. Areas previously meeting the conformance test requirements that are reworked in excess of the top 3-inch per lift shall be retested. Retesting will be at the cost of the Contractor.

I. Work shall be limited to an area where a lift can be completed in one working day. Completion of a lift shall be defined as the construction of a lift that is homogeneously installed with moisture content and density within the acceptance zone, free of organic materials and oversized rocks and possessing a smooth rolled surface.

J. If a lift is not to receive a subsequent lift within 16 hours of its completion, the lift shall be sealed with a smooth wheel compactor, such as the caterpillar CS553, at the end of each day's work to protect the liner from desiccation. Should desiccation cracks develop, the liner shall be scarified, disked, rewetted, rehomogenized and recompacted in accordance with the Specifications to the depth of any such cracks or as instructed by the ENGINEER. If desiccation extends below ½ the lift thickness, the entire lift shall be reworked and retested as described above. Retesting will be at the expense of the Contractor.

K. During construction, the Contractor shall make all necessary provisions to deal with inclement weather conditions. The Contractor shall be fully responsible for control of stormwater during installation of the liner system and for moisture control and protection of the low-permeability soil liner against erosion.

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L. After finish grading and smooth rolling is completed, the compacted low-permeability soil liner shall not be less than 18 inches in any location and the surface shall not contain roots, other organic matter or stones larger than one inch in diameter. Liner thickness will be tested by the QAL on a per lift basis at a frequency specified in 3.04A using a method of hand augering or push tube sampling (minimum 3/4" sample). Each test shall penetrate all underlying lifts to the subgrade elevation. The thickness shall be measured from top of subgrade to top of low-permeability liner. Areas not meeting the thickness requirements shall be augmented with additional low-permeability soil material at the expense of the Contractor. The final low-permeability soil liner thickness will be determined from the Contractor's survey. The Contractor's surveyor shall be available to assist in determining the areal extent of low-permeability soil liner and areas of less than 18 inches. Any additional testing or CQA services associated with corrective action for achieving the 18 inch liner thickness requirement will be at the cost of the Contractor. The added material shall be worked into the in-place liner to ensure homogeneity and proper bonding. This shall be done by scarification of the surface prior to addition of the new material. As a minimum, the top 3-inches of the liner shall be wetted, kneaded, compacted and reworked with a Caterpillar 815 or equivalent to bond the additional material with the previous lifts to obtain the required thickness. The upper surface of the low-permeability soil liner should then be rolled with a smooth wheel compactor such as a Caterpillar CS553 or equivalent prior to final low-permeability soil liner thickness determination by the Contractor's surveyor.

3.04 QUALITY ASSURANCE DURING PLACEMENT

A. The QAL shall conduct the following tests during installation of the compacted low-permeability soil liner at the specified minimum frequencies after indication from the QCL that the low-permeability soil liner meets the specification requirements based on QCL monitoring and testing. The QCL shall provide direction and testing as necessary to the Contractor to control quality of the low-permeability soil liner materials as specified herein, however, only the results of QAL testing will be considered in accepting or rejecting low-permeability liner soil materials.

Test	Method	Frequency
Density	ASTM D2937 or ASTM D2922	4/acre/lift
Natural Moisture	ASTM D2216 or ASTM D3017	4/acre/lift
Undisturbed Permeability	ASTM D5084	1/two acres/ lift
Natural Moisture of Undisturbed Permeability sample	ASTM D2216	1/two acres/ lift
Atterberg limits of Undisturbed Permeability Sample	ASTM D4318	1/two acres/ lift

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Atterberg Limits	ASTM D4318	2/acre/lift
Grain Size (sieve only)	ASTM D422	2/acre/lift
Liner thickness	Hand Auger or push tube	4/acre

B. All holes made as a result of depth measurements, permeability samples, density tests, grade stakes or other activities shall be completely filled by the Contractor with bentonite, soil-bentonite mix, or low-permeability liner soil, as instructed by the Engineer.

C. The Engineer shall have the authority to request additional permeability tests in areas that, in the Engineer's judgement, may be suspect or deficient. Hydraulic conductivity tests shall be conducted in accordance with ASTM D5084 except as modified in Paragraph 3.01F. For each sample tested, one back-up sample will be extracted in the proximity of the sample location. This sample will be held in a controlled environment at the QAL laboratory as a backup sample for future testing, if needed. If adequate demonstration is presented that a sample was not representative of the low-permeability soil liner or that an error in testing occurred, the backup sample will be tested and the original test will be disregarded.

D. Any sample or area tested shall be rejected, removed and replaced if it does not meet the requirements of the technical specifications. Reconstructed areas shall have feathered, overlapping edges that tie into adjacent liner areas.

E. The Contractor shall provide survey control in the field for the QCL and QAL to reference sample locations. If grade stakes are provided in the field for this purpose, the grade stakes shall be numbered by the Contractor and located on an inventory map. The inventory map shall be submitted to the Engineer. Upon completion of an area, the removed stakes shall be compared to the inventory map to ensure that none were left in-place. Only metal stakes are acceptable.

F. The Contractor shall submit a survey plan with final elevation of top of low-permeability soil liner for Engineer's approval in accordance with Section 01050 and Section 01300 prior to covering with Common Fill and erosion control matting.

3.05 Corrective Action

If soil has been desiccated to a depth less than or equal to the thickness of a single lift, the desiccated lift shall be disked, moistened, and recompacted. However, disking may produce large, hard clods of low-permeability soil that will need to be pulverized before moisture conditioning. Also, it should be recognized that if the soil is wetted, time must be allowed for water to be absorbed into the low-permeability soil and hydration to take place uniformly. For this reason it will be necessary to remove the desiccated soil from the construction area, to process the lift in a separate processing area, and to replace the soil accordingly.

END OF SECTION

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SECTION 02623

HIGH DENSITY POLYETHYLENE (HDPE) PIPE FOR LEACHATE COLLECTION SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install high density polyethylene (HDPE) leachate pipe, fittings and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK

Related work includes, but is not limited to, the following:

A. Section 02200: Excavation, Backfill, and Compaction.

B. Section 02700: Protective Cover Material.

C. Section 02776: High Density Polyethylene (HDPE) Geomembrane.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, and within 30 days following the Effective Date of the Agreement, the following:

1. List of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

2. The origin of the resin to be used in the manufacturing of the pipe including the suppliers name and production plant, as well as brand name and number.

3. Documentation from the resin's manufacturer showing results of the following tests for resin identification:

   a. Melt Flow Index ASTM D1238

   b. Density ASTM D1505

4. Manufacturer quality control manual describing implementation of quality control procedures during pipe manufacturing process.

5. Pipe manufacturer's certification of compliance with this Section.

6. Complete, detailed shop drawings of all polyethylene pipe, including the location of all fittings, joints and connections to structures.

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7. Manufacturer's recommendations for handling, storing and installing pipe and fittings.

8. For each shipment of pipe a manufacturer's certification that the pipe was manufactured from the same resin identified above.

9. Certification demonstrating that the joining technician was trained by the pipe manufacturer and is qualified to perform heat fusion welding.

10. Cleaning and video inspection Contractor qualifications for the new and existing leachate piping that comply with Paragraphs 3.03 and 3.04.

1.04 REFERENCE STANDARDS

Referenced standards include, but are not limited to, the following:

A. American Society for Testing and Materials (ASTM)

1. ASTM D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.

2. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

3. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.

4. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

5. ASTM D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

6. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

B. Plastic Pipe Institute (PPI)

1. Handbook of Polyethylene Pipe

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Resin Evaluation

1. All incoming resin shall be sampled for conformance testing against test results supplied by the resin manufacturer. Samples shall be taken from the top and bottom of each

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compartment from every hopper car received. The following conformance tests shall be performed on the sample:

a. Melt Flow Index ASTM D1238

b. Density ASTM D1505

c. The results of these tests shall become part of the manufacturer's permanent quality control records.

B. Finished Product Evaluation

1. Each length of pipe produced shall be checked by production staff for the items listed below. The results of all measurements shall be recorded on production sheets which become part of the manufacturer's permanent records.

a. Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc).

b. Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM F714.

c. Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM F714.

d. Pipe length shall be measured.

e. Pipe marking shall be examined and checked for accuracy.

f. Pipe ends shall be checked to ensure they are cut square and clean.

g. Subject inside surface to a "reverse bend test" to ensure the pipe is free of oxidation (brittleness).

C. Stress Regression Testing

1. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined in accordance with ASTM D2837.

1.06 SYSTEM DESCRIPTION

A. The high density polyethylene pipe specified herein shall be suitable for landfill conditions.

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PART 2 PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. The pipes and fittings shall be Performance Pipe DriscoPlex 4100 series, Polypipe, or equal. The pipe shall be made from PE 3408/3608 resin.

B. HDPE pipe shall be Standard Dimension Ratio SDR-17 unless otherwise noted on the Drawings.

B. The pipes shall have the nominal dimensions shown on the Drawings.

C. All polyethylene pipe shall meet the requirements of ASTM F714.

D. The pipe shall be joined with butt, heat fusion joints. All joints shall be made in strict compliance with the manufacturer's recommendations.

E. Pipe shall be furnished in standard laying lengths not exceeding 50-ft.

F. All high density polyethylene pipe and fittings shall be made from the same resin.

2.02 PIPE IDENTIFICATION

A. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5-ft per ASTM F714:

1. Manufacturing standard reference, e.g., ASTM F714.

2. Name and/or trademark of the pipe manufacturer.

3. The letters PE followed by the polyethylene grade in accordance with ASTM D3350, e.g., PE 345464C. Where applicable, the standard thermoplastic pipe materials designation code may be used as an alternative marking, eg. PE 3608.

4. Nominal pipe size

5. Dimension ratio

6. A production code from which the date and place of manufacture can be determined.

7. The Leachate Forcemain shall have a yellow 1-inch thick stripe along the length of the pipe at 0, 90, 180, and 270 degrees on the cross-section of the pipe.

8. The Leachate Recirculation Forcemain shall have a green 1-inch thick stripe along the length of the pipe at 0, 90, 180, and 270 degrees on the cross-section of the pipe.

2.03 PERFORATIONS

A. The leachate collection pipes, as shown on the Drawings, shall be perforated. The perforations shall be drilled into the pipe at the factory after manufacturing, as shown on the Drawings.

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B. The perforations shall be covered with tape compatible to the pipe material upon delivery to prevent soil material from entering the pipe prior to installation.

PART 3 EXECUTION

3.01 INSTALLATION

A. All HDPE Pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein. All heat fusion joints shall be done by a factory qualified joining technician as designated by the pipe manufacturer.

B. Pipe shall be laid to lines and grade shown on the Drawings with bedding and backfill as shown on the Drawings. The tape covering the perforations shall be removed during installation. The pipe shall be installed such that perforations face the bottom of trench.

C. Following fusion of each joint, the internal fusion bead shall be removed from all 10-inch HDPE pipes or larger used as slope risers. The internal fusion bead shall be removed and extracted from the pipe using a bead trimmer tool as manufactured by R&L Manufacturing, Inc. of Camas, WA or equal. The removal of the internal fusion bead shall be in accordance with the bead trimmer tool manufacturer's operations manual. The internal bead shall be removed during the cooling stages of the fusion process.

Verification that the internal fusion bead was removed completely will be made by the Engineer through examination of the extracted bead and through CCTV video inspection. The extracted bead shall have a double roll back that is similar in appearance to the external bead and possess a smooth root cut. Wall mass removal shall not exceed $1/10^{th}$ of the pipe wall thickness.

D. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means. All plugs shall be OD fitting type plugs. No plugs will be allowed that require insertion of the plug into pipe.

E. Pipe shall be stored on clean level ground to prevent undue scratching or gouging. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 10 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches.

F. Sections of pipe with cuts, scratches or gouges deeper than allowed shall be removed completely and the ends of the pipeline rejoined.

G. The pipe shall be joined by the method of thermal butt fusion, as outlined in ASTM D2657 or as recommended by the manufacturer. In tight locations in which the butt fusion equipment cannot be set up, a thermal coupling such as Central Electrofusion Systems or equal shall be used.

H. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consist of the following:

1. A stainless steel back-up, polyethylene flange shall be thermally butt-fused to the stub end of the pipe.

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2. A Type 316 stainless steel back up ring on both sides of the connection shall be used as approved by the Engineer.

I. Flange connections shall be provided with a full face neoprene gasket.

J. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

K. Installation of pipe shall be observed and accepted by the Engineer prior to backfilling.

3.02 FORCE MAIN TESTING

A. All force mains shall be field tested. The Contractor shall supply all labor, equipment, material, gauges, pumps, meters and incidentals required for testing. Pressure test each force main upon completion of the pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.

B. All force mains shall be tested at 150 percent of the operating design pressure of the pipe unless otherwise approved by the Engineer. The test pressure shall be measured at the highest point along the test section by a recording type pressure gauge and a copy of the readout shall be submitted to the Engineer upon completion of the test. All testing shall be conducted in the presence of the Engineer or his/her designated representative.

C. Testing shall be conducted after backfilling has been completed and before placement of permanent surface.

D. Testing procedure shall be as follows:

1. Fill line slowly with water. Maintain flow velocity less than 2 fps.

2. Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation.

3. Apply initial test pressure and allow to stand without makeup pressure for 2 to 3 hours, to allow for diametric expansion or pipe stretching to stabilize.

4. After this equilibrium period, apply the specified test pressure and turn the pump off. The final test pressure shall be held for 1 to 3 hours.

5. Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the resident project representative at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the Engineer.

E. Allowable amount of makeup water for expansion during the pressure test shall conform to Table 3 Test Phase Make-up Amount, from Chapter 2 of the Handbook of Polyethylene Pipe, published by the Plastic Pipe Institute (PPI). If there are no visual leaks or significant pressure drops during the final test period, the installed pipe passes the test.

F. If any test of pipe laid disclosed leakage significant pressure drop greater than that allowed the Contractor shall, at his/her own expense, locate and repair the cause of leakage and retest the line.

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G. All visible leaks are to be repaired regardless of the amount of leakage.

3.03 CLEANING

A. At the conclusion of the work, thoroughly clean all of the new pipelines to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. Debris cleaned from the lines shall be removed from the job site. If, after this cleaning, any obstructions remain, they shall be removed. Cleaning of the leachate collection and header pipes shall be conducted by a qualified Contractor (such as Jetclean America) experienced in working within landfill environments. All proposed leachate pipes shall be completely cleaned as a requirement for Substantial Completion.

3.04 VIDEO INSPECTION

A. Prior to Substantial Completion, all proposed leachate collection and header pipes shall be subject to video camera inspection by the Contractor under the observation of the Owner and Engineer. It is the intent to video leachate pipes to locate pipe defects, deviations to gradient, and clogs. When this inspection is performed, the Contractor shall be responsible for preparing the pipes for inspection and furnishing labor as required at no expense to the Owner. Video inspections of the leachate collection and header pipes shall be conducted by a qualified contractor (such as Jetclean America) experienced in working within landfill environments. Color video tape (one copy each) or DVD recordings of the completed leachate pipes shall be provided to the Owner and Engineer as a permanent record. Each video tape shall have an audio and written log of that video tape's contents. Refer to specification Section 01390 for audio and log contents.

B. Video camera system shall be capable of accessing the leachate collection and header lines from the proposed cleanouts. Video camera equipment utilized to inspect the leachate pipes must comply with the requirements of Class 1, Division 1 Groups C&D of the National Electrical Code Section NFPA 70.

C. The recordings shall be properly exposed and the camera shall be in proper focus so that good, clear recordings showing detail are produced. Recordings shall be identified by audio recordings noting the leachate pipe, any leaks, cracks, or pipe defects. Video tapes or DVDs (original and one copy) of the completed leachate pipes shall be delivered to the Engineer. The Contractor shall provide any assistance required by the Engineer to assist the Engineer with visual inspections.

END OF SECTION

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SECTION 02700

PROTECTIVE COVER MATERIAL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install the protective cover layer associated with the leachate collection system and composite liner system as shown on the Drawings and as specified herein. Associated work includes testing, sample collection, excavation, loading, shipping, delivering, stockpiling, and installation of protective cover materials.

B. The protective cover layer consists of 24 inches of material placed over a heavy weigh fabric. The leachate collection and header pipes are surrounded by NCDOT No. 4 stone wrapped in woven fabric. The locations of leachate collection pipes and associated details are indicated on the Contract Drawings.

1.02 RELATED WORK

A. Section 02200: Excavation, Backfill, and Compaction.

B. Section 02271: Fabric Cushion.

C. Section 02272: Filter Fabric.

D. Section 02277: Geosynthetic Clay Liner.

E. Section 02623: High Density Polyethylene (HDPE) Pipe.

F. Section 02776: Textured High Density Polyethylene (HDPE) Geomembrane.

1.03 SUBMITTALS

A. Within 30 calendar days following the Effective Date of the Agreement and before furnishing and installing the protective cover layer, the Contractor shall submit the following information in accordance with Section 01300:

1. Identification of the suppliers.

2. Test results and other documentation as necessary to verify that proposed materials meet the requirements of Paragraph 2.02 of this Section.

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3. Signed certifications from the suppliers, with permit numbers and type, stating that the protective cover sources are in full compliance with applicable standards and regulations.

4. A schedule and description of the installation procedures and equipment for the protective cover layer and leachate collection system.

5. A Quality Control/Quality Assurance Plan for the protective cover layer and leachate collection system installation.

6. Documentation and related past experience in accordance with Paragraph 1.06.

7. A 5-gallon bucket sample for laboratory testing from each protective cover material to be used for the protective cover layer and leachate collection system.

B. Within three weeks after completion of the protective cover layer and leachate collection system installation, the Contractor shall submit to the Engineer a survey plan certified by a Land Surveyor Registered in the State of North Carolina showing the elevations of the top of the protective cover layer.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 – Standard Specification for Concrete Aggregates.

2. ASTM C40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

3. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

4. ASTM C289 – Standard Test Method for Alkali-Silica Reactivity of Aggregates (Chemical Method).

5. ASTM D75 – Standard Practice for Sampling Aggregates.

6. ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils.

7. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).

8. ASTM D854 – Standard Test Method for Specific Gravity of Soil Solids by Water Pycnometer.

9. ASTM D2434 – Standard Test Method for Permeability of Granular Soils (Constant Head).

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10. ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

11. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

12. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

13. ASTM D3042 – Standard Test Method for Insoluble Residue in Carbonate Aggregates.

14. ASTM D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

15. ASTM D4373 – Standard Test Method for Calcium Carbonate Content of Soils.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The Quality Control and Quality Assurance consists of laboratory conformance testing of samples supplied from each granular fill and coarse aggregate source and quality control testing during installation.

B. The Owner shall retain a Quality Assurance Laboratory (QAL) that has appropriate equipment and experience to conduct and provide hydraulic conductivity test results in a timely manner in accordance with the Specifications. The Contractor shall coordinate and schedule all tests as required.

C. The Contractor shall retain an independent geotechnical Quality Control Laboratory (QCL) that is experienced in the construction of protective covers and leachate collection system and capable of performing the tests specified herein. The QCL shall provide direction and testing as necessary to control the quality of the borrow material (material property requirements specified in Paragraphs 2.01A and B) and placement and compaction procedures.

D. Conformance testing requirements are specified in Paragraph 2.02. The purpose of conformance testing is to assure that the supplied samples from each source conform to the Specifications and specified hydraulic conductivity.

E. Field quality control requirements are specified in Paragraph 3.02. The purpose of field quality control procedures is to assure that the protective cover and leachate collection system have been installed in accordance with the specifications meeting the specified hydraulic conductivity.

1.06 QUALIFICATIONS

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A. The work shall be performed by a Contractor that has experience in installation of leachate collection systems and protective cover materials over synthetic liners. The Contractor shall demonstrate proven experience by providing a minimum of three similar completed projects with the following information:

1. Types and thicknesses of installed materials.

2. Name and purpose of facility, its location, and date of installation.

3. Name of owner and design engineer. Name and telephone number of contact at the facility who can discuss the project.

B. The suppliers shall show evidence of adequate supplies of each material to be provided within the schedule of construction and evidence that each source area can provide homogenous material and is properly permitted by the appropriate local, State, and Federal agencies.

1.07 DELIVERY, STORAGE AND HANDLING

A. If materials are delivered to the site prior to placement approval, materials shall be stockpiled on site in areas as directed by the Engineer. Provision shall be implemented to minimize surface water impact on the stockpile. Removal and placement of granular fill material shall be done in a manner to minimize intrusion of soils adjacent to and beneath the stockpile.

PART 2 PRODUCT

2.01 MATERIAL

A. NCDOT No. 4 Stone

1. Washed stone to be used for filtration around the leachate collection pipe, as shown on the Drawings, shall be sound, hard, durable, resistant to weathering and shall be free of overburden, spoil, shale, limestone, and organic material. The stone shall be rounded to sub-angular as defined in ASTM D2488 and meeting NCDOT No. 4. The Contractor shall provide a certification letter in addition to physical and chemical tests results indicating that the stone meets the NCDOT requirements for No. 4 stone and is granite gneiss and free of limestone. The chemical results shall at a minimum include the results from the “Insoluble Residue in Carbonate Aggregate” test in accordance with ASTM D3042. The weight loss of the aggregate shall be less than five percent.

B. NCDOT No. 57M STONE

1. Stone meeting the gradation of NCDOT No. 57M shall be used for the Protective Cover Rock Layer. NCDOT No. 57M stone shall be sound, hard, durable, resistant to weathering and shall be free of overburden, spoil, shale, limestone, and organic material. The stone shall be Department of Transportation (NCDOT) No. 57M or gradation approved by the Engineer. The Contractor shall provide a certification letter in addition to

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physical and chemical tests results indicating that the stone meets the NCDOT requirements for No. 57M stone and is granite gneiss and free of limestone. The chemical results shall at a minimum include the results from the "Insoluble Residue in Carbonate Aggregate" test in accordance with ASTM D3042. The weight loss of the aggregate shall be less than five percent.

2.02 CONFORMANCE TESTING

A. The Contractor shall submit samples of materials from approved sources for testing by the QAL. If samples do not meet the specified criteria the Contractor may submit additional samples from sources approved by the Engineer for conformance testing by the QAL at the Contractor's expense.

B. Conformance testing shall be performed by the QAL on samples from each source of stone to assure compliance with the Specifications. The following test shall be performed on the samples.

a. Sieve Analysis (ASTM D422)

b. Specific Gravity (ASTM D854)

c. Permeability (ASTM D5084)

C. Gradation analysis shall be performed by the QAL on samples from each source of stone to assure compliance with the Specifications.

PART 3 EXECUTION

3.01 PROTECTIVE LAYER

A. After installation completion and acceptance of the composite liner system, fabric cushion and related work activities, place the protective cover material to the thickness and areal extents as shown on the Drawings.

B. During the placement of the protective cover material, no construction equipment shall be allowed directly on the liner or fabric cushion. Any damage to these components shall be repaired immediately in accordance with the specifications. A 4-foot-thick traffic surface consisting of protective cover material shall be constructed to support haul trucks traveling over the liner.

C. Stockpiles of protective cover material during placement shall be deposited in the designated areas without vehicles traveling on the fabric cushion. Protective cover material shall be then pushed over the exposed areas of the fabric cushion with bulldozers. Advancement of protective cover material shall be achieved by pushing a minimum 2-foot-thick lift ahead of the dozer blade.

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D. Only low ground pressure dozers (10 psi or less track pressure) shall be used for spreading and grading of the protective cover material. Only large radius turns by the loader and other equipment shall be permitted as sharp turns may damage the liner.

E. The protective cover material shall be placed on slopes starting at the toe of the slope and spreading toward the top of the slope.

F. Protective cover material shall only be spread when the liner is laying evenly over the base of the landfill. Material shall not be spread over "standing waves" in the liner that form during periods of high temperature and direct sunlight. A standing wave is defined as a ripple in the liner in which the height of the ripple (as measured from the composite liner surface) exceeds the width of the ripple. If standing waves are occurring during peak temperature hours, the spreading operation shall be limited to mornings (before 10:00 am) and evenings (after 6:00 pm) or hours agreed upon by the Engineer and Contractor.

G. No material shall be placed, spread, or compacted while the ground or material is frozen or thawing or during unfavorable weather conditions.

H. The leachate piping shall be installed as specified in Section 02623, and shall be backfilled with NCDOT No. 4 Stone to the depth and width shown on the Drawings. Care shall be taken during backfilling of the pipe to assure the pipe will not be gouged or otherwise damaged. Excavation of the trench will be performed with a backhoe bucket equipped with a protective sleeve over the bucket teeth or by another method approved by the Engineer. The Contractor shall exercise extreme care not to disturb or damage the underlying fabric or liner.

I. The NCDOT No. 4 Stone shall be mounded over the trench as indicated on the drawings.

3.02 FIELD QUALITY CONTROL

A. Periodic conformance testing shall be conducted by the Contractor's QCL as specified in Paragraph 2.02.

B. The protective cover thickness shall be confirmed by a topographic survey performed on a 50-foot grid as specified in Section 01050. Areas of insufficient thickness shall be filled to the required depth at no additional cost to the Owner.

END OF SECTION

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SECTION 02776

TEXTURED HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install High Density Polyethylene (HDPE) geomembrane as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Section 02200: Excavation, Backfill and Compaction.

B. Section 02277: Geosynthetic Clay Liner (GCL).

C. Section 02278: Compacted Soil Liner.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, and within 30 calendar days from the Notice to Proceed, submit the following information:

1. Submittals relating to geomembrane manufacturer and geomembrane:

   a. Corporate Background

   b. Manufacturing capabilities:

      1) Information on factory size, equipment, personnel, number of shifts per day and production capacity per shift.

      2) List of material properties and samples of geomembrane with attached certified test results.

      3) Manufacturer's quality control program and manual including description of laboratory facilities.

      4) A list of ten completed facilities totaling a minimum of five million square feet, for which the manufacturer has manufactured HDPE geomembrane. The following information shall be provided for each facility.

         a) Name and purpose of facility, its location and date of installation.
         b) Name of owner, project manager, design engineer and installer.
         c) Geomembrane thickness and surface area.

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d) Information on performance of the facility.

c. The origin of the resin to be used in the manufacturing of geomembrane including the supplier's name and production plant, as well as brand name and number. In addition, the Contractor shall include the Certificate of Analysis from the resin supplier.

d. Copy of the Manufacturer's quality control certificates signed by the Quality Control Manager in conformance with Paragraphs 2.01 and 2.02.

e. Certification that the HDPE geomembrane and extrudate produced for this project has the same properties.

f. A "Sample Warranty" in accordance with Paragraph 1.08.

2. Submittals relating to the installer

a. Background Information including Approved Installation Contractor (AIC) status documentation as issued by the International Association of Geosynthetic Installers.

b. Installation capabilities:

1) Information on equipment and personnel.

2) Anticipated average daily production.

c. A list of five completed facilities totaling two million square feet for which the Installer has installed HDPE geomembrane. The following information shall be provided for each facility:

1) Name and purpose of facility, its location and date of installation.

2) Name of owner, design engineer, manufacturer and name and telephone number of contact at the facility who can discuss the project.

3) Thickness of geomembrane and surface area of the installed geomembrane.

4) Type of seaming, patching and tacking equipment.

5) A copy of the manufacturer's certification or approval letter.

3. Submittals relating to the Electrical Leak Location Survey Contractor

a. Company Background.

b. Electrical leak location capabilities.

c. Contractor shall submit a list of at least five similar completed projects

1) Name and purpose of facility, its location and date of installation.

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2) Name of owner, design engineer, manufacturer and name and telephone number of contact at the facility who can discuss the project.

3) Thickness of geomembrane and surface area of the electrical leak location survey.

4. Material Testing Requirements

a. See Specification Section 02277, Paragraph 1.03A.3. for interface material strength testing.

B. Within 45 days prior to geomembrane installation submit the following:

1. Shop Drawings

a. Proposed panel layout showing the installation layout identifying field seams as well as any variance or additional details which deviate from the Drawings.

b. Details of seaming the geomembrane, anchoring, connections, penetrations and other construction details.

c. Electrical Leak Location Survey Plan per paragraph 3.08 A.

2. Installation Schedule.

3. Quality Control Manual

a. A Quality Control manual that specifically defines the quality assurance program during installation. The manual shall include daily procedures, welding techniques, field testing procedures, lab testing procedures, specific steps that are to be taken in the event of a failure or defect, personnel requirements, levels of authority and all other information necessary to ensure a high quality geomembrane installation.

4. Field Personnel Information

a. Resume of the installation supervisor to be assigned to the project. The installation supervisor shall have installed or supervised the installation and seaming of a minimum of two million square feet of HDPE geomembrane.

b. Resume of the master seamer to be assigned to the project. Master seamer must have completed a minimum of one million square feet of geomembrane seaming using the type of seaming apparatus proposed for use on this project.

c. Resume of the quality control personnel to be assigned to the Project along with pertinent experience information.

d. A list of personnel performing field seaming operations along with pertinent experience information

1.04 REFERENCE STANDARDS

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A. American Society for Testing and Materials (ASTM)

1. ASTM D6693 - Test method for Tensile Properties of Plastics

2. ASTM D792 - Specific Gravity (Relative Density) and Density of Plastics by Displacement

3. ASTM D1004 - Test Method for Initial Tear Resistance of Plastics Film and Sheeting

4. ASTM D1238 - Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

5. ASTM D1505 - Test Method for Density of Plastics by the Density-Gradient Technique

6. ASTM D1603 - Test Method for Carbon Black in Olefin Plastics

7. ASTM D3895 - Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis

8. ASTM D4218 - Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

9. ASTM D4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products

10. ASTM D6392 - Standard Test Method for Determining the Integrity of Non-reinforced Geomembranes Seams Produced Using Thermo-Fusion Methods

11. ASTM D5397 - Procedure to Perform a Single Point Notched Constat Tensile Load - Appendix (SP-NCTL) Test

12. ASTM D5596 - Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

13. ASTM D5721 - Practice for Air-Oven Aging of Polyolefin Geomembranes

14. ASTM D5885 - Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry

15. ASTM D5994 - Test Method for Measuring the Core Thickness of Textured Geomembranes

B. Geosynthetic Research Institute (GRI) Standards

1. GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

2. GM11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Devise

3. GM12 Measurement of the Asperity height of Textured Geomembranes Using a Depth Gage

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4. GM13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

5. GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. In addition to manufacturer and installer requirements for qualifications and certification specified in Paragraph 1.03 the Quality Assurance consists of conformance testing of the material delivered to the site and field quality control during installation.

B. Conformance testing requirements are specified in Paragraph 2.03. The purpose of conformance testing is to assure that the supplied material conforms to this Section and to the manufacturer's quality control certificates.

C. Field quality control requirements are specified in Paragraph 3.06. The purpose of field quality control procedures is to assure that the geomembrane has been installed in accordance with the specifications and manufacturer's recommendations.

D. Quality Control Plan

1. The forms in Appendix A, forms for geomembrane quality control documentation, shall be used for field installation documentation. Alternative forms may be used for documentation as approved by the Engineer’s field representative (EFR).

E. Geomembrane Quality Control Documentation

1. Pre-installation Conference

a. Prior to commencing work, a pre-installation conference shall be held and the following project personnel shall be identified by name and recorded in the project files:

- Owner's Representative
- Contractor’s Representative
- Engineer’s Field Representative
- Installation Supervisor
- Master Seamer
- Quality Assurance Laboratory
- Quality Assurance Technician

b. Two duplicate project files shall be maintained. One shall be maintained by the EFR and the other shall be maintained by the Installer QC Technician. The installer shall provide the EFR with daily documentation by the end of the following work day. At the end of each work week the files shall be updated and checked to assure that copies of all pertinent project information is included in each file.

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c. Blank copies of the following project forms shall be available onsite throughout the duration of the project:

Form No.	Title
CQC - 100	Liner Project QC Log
CQC - 101	Receiving QC Log
CQC - 102	Personnel QC Log
CQC - 103	Daily QC Report Pre-weld Testing
CQC - 104	HDPE Liner Installation Tracking Log
CQC - 105	Seaming Log
CQC - 106	Patch Placement Log
CQC - 107	Destructive Test Log
CQC - 108	Damage and/or Failure Report
CQC - 109	Protective Cover Daily Report

1.06 QUALIFICATIONS

A. Manufacturer

1. The manufacturer of the lining material described hereunder shall have previously demonstrated his/her ability to produce this geomembrane by having at least 5 years continuous experience in the manufacturing of HDPE geomembrane and successfully manufactured a minimum of 10 million square feet of similar geomembrane material for hydraulic lining installations.

B. Installer

1. The installer shall be the manufacturer or an approved installer trained and certified to install the manufacturer's geomembrane. Installation shall be performed under the constant direction of a single field installation supervisor who shall remain on site and be in responsible charge, through the geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs and all other activities required by the installer. The field installation supervisor shall have installed or supervised the installation and seaming of a minimum of two million square feet of HDPE geomembrane.

1.07 DELIVERY, STORAGE AND HANDLING

A. The geomembrane rolls shall be packaged and shipped by appropriate means to prevent damage of the geomembrane rolls. Off-loading and storage of the geomembrane is the responsibility of the Contractor. The Contractor shall be responsible for replacing any damaged or unacceptable material at no additional cost to the Owner.

B. No off-loading shall be performed unless the EFR is present. Damage during off-loading shall be documented by the EFR. All damaged rolls must be separated from the undamaged rolls until the proper disposition of that material has been determined by the EFR.

C. The geomembrane rolls shall be stored so as to be protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions and excessive heat that may damage the geomembrane

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material. The rolls shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than two rolls high.

1.08 MATERIAL WARRANTY

A. The HDPE geomembrane manufacturer shall warrant the geomembrane against manufacturing defects and material degradation under outdoor exposure for a period of five (5) years from the date of final payment and acceptance in accordance with the General Conditions. The manufacturer shall repair or replace, at no additional cost to the Owner, any material which fails from the above causes within the warranty period. The manufacturer shall furnish a written warranty covering the requirements of this Paragraph.

1.09 GUARANTEE

A. The Contractor shall guarantee the HDPE geomembrane against defects in installation and workmanship for the period of two (2) years commencing with the date of final payment and acceptance in accordance with the General Conditions. The guarantee shall include the services of qualified service technicians and all materials required for the repairs at no additional cost to the Owner.

1.10 DEFINITIONS AND RESPONSIBILITIES

A. Contractor

1. The Contractor is the firm or corporation with whom the Owner has entered into agreement to construct the project. The Contractor is responsible for all submittals by the manufacturer and the installer as required by this Section. The Contractor is also responsible for scheduling and coordination of the required work with the manufacturer and the installer to complete the project. The Contractor is responsible for furnishing as-built drawings and a copy of the complete documentation of the liner system. The Contractor is also responsible for daily updating of the design drawings onsite and for any and all deviations from these Drawings. All deviations must be initialed and approved by the EFR.

B. Manufacturer

1. The manufacturer is the firm or corporation responsible for production of the geomembrane material to be used in the project. The manufacturer shall produce a consistent product meeting the project specifications and shall provide quality control documentation for the product specified herein.

C. Installer

1. The installer is the firm or corporation responsible for installation of the geomembrane. The installer shall be the manufacturer or an approved installer trained and certified to install the manufacturer's geomembrane. The Installer shall be responsible for field handling, storing, placing, seaming and all other aspects of the geomembrane installation.

PART 2 PRODUCTS

2.01 MATERIALS

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A. General

1. The geomembrane shall be manufactured of new, prime first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures and chemically resistant to leachate.

2. The geomembrane material shall be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.

3. The sheets shall be manufactured in a minimum 15-ft seamless width. Labels on the roll shall identify the thickness, length, width, roll number and Manufacturer's lot number.

4. The textured sheet must not delaminate during tensile testing (i.e., textured layers and "particles" of texture must not separate)

B. Properties

1. The geomembrane rolls shall be 60-mil textured HDPE and shall meet the specified physical, mechanical and chemical property requirements listed in GRI GM13.

C. Other Materials

1. Extrudate welding rods shall be of the same compound as the geomembrane and supplied by the manufacturer and shall be delivered in the original sealed containers. Each container shall have a label bearing the brand name, manufacturer's lot number and complete directions as to proper storage.

5. Boots and shrouds for pipe penetration shall fit snugly around the pipe. Prefabricated material shall be designed to fit site specific conditions for the intended slope and size of pipe.

2.02 QUALITY CONTROL DOCUMENTATION

A. Prior to installation commencement of any geomembrane material, the Contractor shall provide the following information certified by the manufacturer for the delivered geomembrane material.

1. Origin, identification and production of the resin (supplier's name, brand name and production plant).

2. Copies of quality control certificates issued by the resin supplier.

3. Manufacturer's certification verifying that the quality of the resin used to manufacture the geomembrane meets the requirements specified in Paragraph 2.01.

4. Each roll delivered to the project site shall have the following identification information:

- Manufacturer's name
- Product identification

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- Thickness
- Roll number
- Roll dimensions
- Lot number

5. Quality control certificates, signed by the manufacturer's quality assurance manager, shall be submitted for each roll delivered to the site. Each certificate shall have roll identification number, sampling procedures, frequency and test results. At a minimum, test results shall be provided for each roll delivered to the site in accordance with test requirements specified in GRI GM13.

2.03 CONFORMANCE TESTING

A. Conformance testing shall be performed by an independent, GRI certified, Quality Assurance Laboratory (QAL), employed by the Contractor. A qualified technician from the QAL shall obtain the samples from the roll, mark the machine direction and identification number at a frequency of one sample per 100,000 square feet or one per lot whichever is more. The following conformance tests shall be conducted at the laboratory:

- Thickness
- Asperity Height
- Density
- Tensile properties
- Tear resistance
- Puncture Resistance
- Carbon black content
- Carbon black dispersion

B. These conformance tests shall be performed in accordance with GRI GM13.

C. All conformance test results shall be reviewed by the Engineer and accepted or rejected, prior to the placement of the geomembrane. All test result shall meet, or exceed, the property values listed in GRI GM13. The course of action implemented for retesting failing tests shall be approved by the Engineer. In case of failing test results, the manufacturer may request that another sample be retested by the independent laboratory with manufacturer's and Engineer's technical representative present during the testing procedures. This retesting shall be paid for by the Contractor. The manufacturer may also have the sample retested at two different laboratories approved by the Engineer. If both laboratories report passing results, the material shall be accepted. If both laboratories do not report passing results, all geomembrane material from the lot representing the failing sample will be considered out of specification and rejected.

PART 3 EXECUTION

3.01 COMPACTED SOIL LINER AND GCL PREPARATION

A. Preparation of the compacted soil liner surface shall be as specified in Section 02278.

B. Preparation of the geosynthetic clay liner (GCL) surface shall be as specified in Section 02277.

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C. The surface of the compacted soil liner shall be smooth, uniform, free from sudden changes in grade (such as vehicular ruts), rocks, stones, debris and deleterious materials. The moisture content of the compacted soil liner must be maintained within the project specifications until the synthetic liner has been installed. If excessive drying occurs, the contractor shall rehydrate and compact the affected area to the Engineer's satisfaction. During actual placing and seaming of the liner, the compacted soil liner surface shall be kept free of all standing water. If the compacted soil liner surface below the liner becomes wet and unstable, it shall be dried and recompacted to the Engineer's satisfaction. If drying and recompacting the material is insufficient, the unstable material must be removed and replaced with approved material.

D. The GCL surface shall be smooth, uniform, free from sudden changes in grade (such as vehicular ruts), rocks, stones, debris and deleterious materials.

E. Upon competing placement of GCL panels in any area, the HDPE liner shall be immediately installed over the GCL panels to prevent the GCL from becoming wet as required in Section 02277.

F. Before the liner installation begins, the Contractor and installer shall verify in writing and submit to the Engineer:

1. Lines and grades are in conformance with the Drawings and Specifications.

2. The surface area to be lined has been rolled and compacted, free of irregularities and abrupt changes in grade.

G. The Contractor shall not proceed with synthetic liner installation until a complete report on the compacted soil liner thickness and hydraulic conductivity tests has been submitted and approved by the Engineer. If the Contractor proceeds with synthetic liner installation and associated layers (fabric cushion and protective cover material) prior to completion of the report, the Contractor will do so at his/her own risk. If any compacted soil liner tests fail, the Contractor will be required to remove overlying liner system layers, repair deficient compacted soil liner area(s) and reinstall the liner system in accordance with project specification requirements. Any liner system materials damaged during the repair work shall be replaced with new material. All costs associated with such actions will be paid for entirely by the Contractor including, but not limited to, labor, additional liner system material, testing, labor and material costs incurred by the Engineer to perform additional inspection services.

3.02 ANCHOR TRENCH

A. The anchor trench shall be constructed as shown on the Drawings and as specified herein.

B. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the geomembrane.

C. The anchor trench shall be adequately drained to prevent water ponding and softening to adjacent soils. The anchor trench shall be backfilled with fill materials as shown on the Drawings and compacted to 90 percent of the standard proctor maximum dry density, ASTM D698.

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D. The amount of trench open at any time shall be limited to one day of geomembrane installation capacity. Geosynthetic material in the anchor trench shall be temporary anchored with sandbags or other suitable materials.

E. Backfilling of the anchor trench shall be conducted when the geomembrane is in its most contracted (taut) state.

F. Care shall be taken when backfilling and compacting the trenches to prevent any damage to the lining materials.

G. If the anchor trench is located in a clay susceptible to desiccation, the amount of trench open at any time shall be limited to one day of liner installation capacity.

3.03 GEOMEMBRANE PLACEMENT

A. Weather Conditions

1. Geomembrane placement shall not proceed at an ambient temperature below 32 degrees F or above 104 degrees F unless otherwise authorized, in writing, by the Engineer or his/her field representative. Geomembrane placement shall not be performed during precipitation, excessive moisture, in an area of ponded water, or excessive winds that adversely affect the geomembrane placement.

B. GCL Care during Installation

1. The equipment used to deploy the geomembrane shall not cause rutting of the GCL surface. If rutting occurs, the Contractor shall suspend all geomembrane placement activities and repair the ruts and immediately employ an alternative method for geomembrane deployment. Geomembrane rolls shall be placed using spreader and rolling bars with cloth slings. If a sheet must be relocated a distance greater than its width, a slip sheet shall be used.

2. The installer shall not drag the geomembrane panels over the GCL.

C. Method of Placement

1. Each panel of the geomembrane shall be rolled out and installed in accordance with the approved shop drawings prepared by the Contractor. The layout shall be designed to keep field seams of the HDPE geomembrane to a minimum and consistent with proper methods of HDPE geomembrane installation. Panel layout and deployment shall be such that all seams run down slope on the perimeter berms (i.e., perpendicular to top of slope). Horizontal seams across the slope are not permitted. If white geomembrane is used, the white textured surface will be installed facing up. For liner placed on 4 to 1 or steeper slopes, the seams shall be oriented in the direction of the slope. Horizontal seams on 4 to 1 slopes or steeper shall not be allowed except for cases in which it is unavoidable. In these instances, a cap strip shall be placed over the seam.

2. Each liner panel shall be identified by panel number, roll number and date of deployment. The liner panel number shall be placed on the ends and in the middle of each panel.

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3. The EFR shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels shall be replaced or repaired, in accordance with Paragraph 3.07G.

4. All geomembrane shall be anchored as shown on the Drawings and consistent with manufacturer's recommendations.

5. Personnel working on the geomembrane shall not smoke, wear damaging shoes or involve themselves in any activity that may damage the geomembrane.

6. All edges of the geomembrane shall be properly weighted to avoid uplift due to wind. The geomembrane shall be properly weighted with sand bags to avoid uplift due to wind. Sand bag material shall be sufficiently close- knit to prevent soil fines from working through the bags and discharging on the geomembrane.

7. Vehicular traffic across the geomembrane shall not be allowed.

8. All damaged areas and destructive sample locations shall be recorded and located on the as-built drawings.

9. When tying into existing geomembrane, all excavation of previously installed geomembrane shall be performed by hand to prevent damage.

10. The geomembrane shall be kept free of debris, unnecessary tools and materials. In general, the geomembrane area shall remain neat in appearance.

11. Equipment necessary to perform the installation (generators, compressors, etc) shall have a scrap geomembrane sheet placed underneath to protect the installed geomembrane from possible damage.

12. No welder or testing equipment shall be allowed to remain on top of the installed geomembrane overnight. All equipment must be removed and stored away from the installed geomembrane.

13. No fueling of installer's equipment will be allowed on top of the installed geomembrane. No fuel containers shall be allowed on the geomembrane.

14. Any vehicle used prior to or after liner placement shall be first approved by the EFR. All vehicles are restricted from traveling on the liner material unless a temporary access is constructed.

15. To prevent a "trampoline effect" from forming, the CONTRACTOR shall place sufficient sand bags on the liner along the toe of slopes to ensure full contact of the geomembrane liner with the clay liner surface. In addition, the horizontal seams nearest the toe of slope shall remain unwelded until all other seams in the area are completed. The final seam shall be welded when the liner is cool and fully contracted. Care shall be taken to ensure that the liner contacts the subgrade in all locations before completing the seam.

D. Liner Boots (Pipe Penetrations)

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1. HDPE boots or shrouds shall be furnished and installed where indicated on the Drawings. The boots shall be of the same material as the geomembrane.

2. The geomembrane end of the boots shall terminate in a skirt section suitable for welding to the geomembrane liner. The overlap between the boot and the geomembrane shall be approximately 18-in. The boot shall be welded to the geomembrane as previously specified herein.

3. Boots and shrouds shall fit snugly around the pipe. Prefabricated material shall be designed to fit site specific condition, for the intended slope and size of pipe.

4. A Neoprene rubber gasket shall be used between the boot or shroud and the pipe with a stainless steel clamp. An HDPE sacrificial sheet shall be used between the boot or shroud and the clamp for protection.

5. For pipes larger than 4-in diameter, a second clamp shall be used. The fastener of the second clamp shall be located on the opposite side of the pipe from the first clamp, to compensate for uneven pressure and elongation.

3.04 FIELD SEAMS

A. Individual panels of geomembrane shall be laid out and overlapped by a minimum of 4-in prior to welding. The area to be welded shall be cleaned and prepared in accordance with the quality control welding procedures approved by the EFR.

B. Double track hot wedge fusion welds shall be used for straight welding.

C. Extrusion welds shall be used for patches, repairs and penetration boots.

D. The repairs and patches shall have the white surface of the geomembrane facing up so that the final product is a white geomembrane with black welds on white repairs, if white geomembrane is used.

E. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the geomembrane material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.

F. No "fish mouths" will be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped and a patch extrusion weld shall be applied. All welds upon completion of the work shall be tightly bonded. Any geomembrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of geomembrane. The number of patches per 100-ft length shall not exceed five. If more than five patches per 100-ft length are necessary, then the entire 100-ft length of seam shall be removed. Further welding will cease at this time and the Engineer shall be notified.

G. All seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the as-built drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be welded together.

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H. All fusion welded "T" seams (i.e., the result of the geomembrane panels placed perpendicular to each other) shall be double welded where possible. The extrusion process shall be used for the second weld.

I. All extrudate shall be free of dirt, dry and protected from damage.

J. If an extrusion welder is stopped for longer than one minute, it shall be purged to remove heat-degraded extrudate. All purged extrudate shall be placed on a sacrificial sheet and disposed of.

K. All seams constructed on sloped surfaces shall be perpendicular to the top and toe of the slope (vertical seams).

L. All panels placed on sloped surfaces shall extend 5-ft inward (on the flat) from the toe of slope or edge of trench.

M. All end seams shall be staggered a minimum of 5-ft in length between contiguous panels. No end seams are allowed on slopes 25 percent (4 horizontal and 1 vertical) or greater, unless otherwise approved by the Engineer.

N. To prevent moisture buildup during fusion welding, it may be necessary to place a movable protective layer of plastic (skid sheet) directly below each overlap of geomembrane that is to be seamed.

O. If required, a firm substrate shall be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.

P. All seam welds shall extend the full extent into the anchor trench.

Q. All factory seams, field seams and repair welds shall meet seam strength requirements specified in GRI GM19.

R. All seams shall be "shingled" or "rain-lapped”.

3.05 SEAMING WEATHER CONDITIONS

A. Normal Weather Conditions

1. The normal required weather conditions for seaming are:

a. Ambient temperature higher than 32 degrees F and lower than 104 degrees F.

b. No precipitation or other excessive moisture, such as fog or dew.

c. No excessive winds.

2. These weather conditions shall be fulfilled during seaming process.

B. Cold Weather Conditions

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1. If the ambient air temperature is below 32 degrees F, the following procedures shall be implemented:

    a. Preheating the surface of the geomembrane to achieve normal temperature range.

    b. Preheating may be waived by the EFR if the Installer demonstrates that satisfactory welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

    c. Preheating devices shall be approved by the manufacturer.

    d. Care shall be taken to assure that surface temperatures are not lowered below the minimum required surface temperature for welding due to winds.

    e. Additional destructive tests samples shall be taken at the discretion of the EFR

    f. Test seams, as described in Paragraph 3.06A, shall be performed under the same ambient temperature conditions as the actual seams.

C. Warm Weather Conditions

1. If the ambient air temperature is above 104 degrees F, no seaming of geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the EFR that geomembrane seam quality is not adversely impacted.

2. Test seams shall be performed under the same ambient air temperature conditions as the actual seams.

3. Additional destructive tests shall be taken at the discretion of the EFR.

3.06 FIELD QUALITY CONTROL

A. Start-up Testing

1. A test weld 3-ft long from each welding machine shall be run upon the beginning of each shift and every four hours thereafter, under the same conditions as exist for the geomembrane welding. The test weld shall be marked with date, time of day, Seamer's initials, temperature and speed settings (for fusion welds) or temperature and preheat settings (for extrusion welds), and machine number. A tensiometer shall be required to be on-site before and during geomembrane installation for the purpose of testing samples. Six 1-in wide specimens shall be cut from the test weld and tested on-site at the presence of the EFR (three for peel and three for shear strength) in accordance with GRI GM19. No welder may start work until the sample weld has been approved by the EFR.

2. Test seams shall be performed under the same conditions as the actual seams and shall be at least 3-ft long and 1-ft wide after seaming. Material for test seams shall be cut out of the approved geomembrane rolls.

B. Nondestructive Seam Testing

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1. The installer shall perform nondestructive test on all field seams over their full length. The purpose of this test is to assure continuity and integrity of the seams. Vacuum and air pressure tests shall be used for nondestructive testing. The vacuum test shall be used for extrusion welds. The air pressure test shall be used for double track hot wedge welds.

2. Vacuum Testing

   a. Equipment for testing single wedge fusion seams and extrusion seams shall be comprised of the following:

      1) 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.

      2) A vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

      3) A rubber pressure/vacuum hose with fittings and connections.

      4) A plastic bucket and wide paint brush.

      5) A soapy solution.

   b. The following procedures shall be followed by the installer:

      1) Excess sheet overlap shall be trimmed away.

      2) Clean the window, gasket surfaces and check for leaks.

      3) Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.

      4) Wet a strip of geomembrane approximately 12-in by 48-in (length of box) with the soapy solution.

      5) Place the box over the wetted area and compress.

      6) Close the bleed valve and open the vacuum valve.

      7) Ensure that a leak-tight seal is created.

      8) For a minimum period of 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

      9) If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum of 3-in overlap and repeat the process.

      10) All areas where soap bubbles appear shall be marked and repaired in accordance with Paragraph 3.07G and then retested.

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11) All test locations which have passed vacuum testing shall be marked with the test date and individual performing the test.

c. If the seam is not accessible to vacuum box equipment cannot be tested prior to final installation, the seaming operations shall be observed by the EFR for uniformity and completeness.

3. Air Pressure Testing (for double track fusion seams only).

a. The following procedures are applicable to those processes which produce a double seam with an enclosed space.

b. Equipment for testing double fusion seams shall be comprised of the following:

1) An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.

2) A manometer equipped with a sharp hollow needle, or other approved pressure feed device.

c. The following procedures shall be followed by the Installer:

1) Seal both ends of the seam to be tested. The length of seam shall not exceed 500-ft without approval by the EFR.

2) Insert needle or other approved pressure feed device into the tunnel created by the double wedge fusion weld.

3) Energize the air pump to a pressure between 25 and 30 psi. After allowing two minutes for relaxation, the pressure shall be monitored over a test period not less than five minutes.

4) If the loss of pressure exceeds 4-psi, or the pressure does not stabilize, the weld shall be considered faulty (unless the Installer can demonstrate that monitoring for an additional five minutes does not cause an additional loss in pressure in excess of 1 psi, and that the pressure stabilizes within the second monitoring period). Locate the faulty area, repair in accordance with Paragraph 3.07G and retest.

5) If the faulty area cannot be isolated and repaired, the length of seam which cannot be tested shall be capped with liner strip, extrusion welded and vacuum tested. The seam shall be documented as a failed seam indicating the corrective measure.

6) If the pressure loss is less than 4 psi after five minutes, cut the air channel on the opposite end the pressure device to confirm there is no blockage and verify the length of the seam tested. Remove needle of other approved pressured feed device and seal with an extrusion weld.

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7) Remove needle or other approved pressure feed device and seal.

8) All test locations which have passed air pressure testing shall be marked with the test date and individual performing the test.

d. Destructive seam testing shall be performed in accordance with Paragraph 3.07 below.

3.07 DESTRUCTIVE SEAM TESTING

A. The purpose of the destructive testing is to evaluate seam strength properties. A minimum of one test sample shall be obtained per 500-ft of performed seam length. The location of samples shall be determined by the EFR. Selection of such locations may be prompted by suspicion of overheating, contamination, or other potential cause that may adversely impact the welds. Location at samples shall not be revealed to Installer in advance. Sampling shall be performed by the installer. The Contractor shall forward the samples to the QAL for testing and shall pay for the testing.

B. Sampling Procedures

1. Samples shall be cut by the installer at locations chosen by the EFR as the seaming progresses.

2. The seams shall not be covered by another material before they have been tested and accepted by EFR.

3. Upon obtaining each sample, assign a number to the sample and mark it accordingly.

4. Record sample location on layout drawing.

5. Record purpose of the sample, statistical routine or suspicious weld area.

6. Holes in the geomembrane resulting from destructive seam testing shall be immediately repaired in accordance with Paragraph 3.07G.

C. Size and Disposition of Samples

1. Two samples, 12-in wide by 18-in shall be taken for field testing. Each of these samples shall be cut with a 1-in wide die, with the seam centered parallel to the width. The distance between these two samples shall be 36-in. If all samples pass the field test described in Paragraph 3.07D, a sample for laboratory testing shall be taken.

2. The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12-in wide by 36-in long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

a. One portion to the Installer for optional laboratory testing, 12-in by 12-in.

b. One portion for geosynthetic laboratory quality assurance testing, 12-in by 12-in.

c. One portion to the Engineer for archive storage, 12-in by 12-in.

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D. Field Testing

1. The following shall be performed by the Installer in the presence of the Engineer:

   a. The installer shall cut six 1-in wide replicate specimens from the field testing samples to be tested for shear and peel strength, in accordance with the criteria set in GRI GM19.

   b. The installer shall test three specimens for shear seam strength and three for peel strength. All replicate test specimens shall pass for the seam to be acceptable.

   c. Samples shall be tested with a tensiometer equipped with a drive/pull apparatus adjusted to a pull rate of 2-in per minute for both peel and sheer testing. Each sample shall be tested until film tearing bond (FTB) is achieved. At a minimum, the required pass criteria for peel and shear shall be as specified in GRI GM19.

   d. Any specimen that fails through the weld or through the fusion at the weld sheet interface is a non-FTB (Film Tearing Bond) break and shall be considered a failure even if it achieves the acceptable strengths.

E. Quality Assurance Laboratory Test

1. The Contractor shall package and ship destructive test samples to the GRI accredited independent QAL employed by the Contractor.

2. Laboratory test shall include shear and peel strength tests. The minimum acceptable values obtained in these tests shall be in accordance with GRI GM19.

3. The laboratory shall cut the sample to 1-inch wide coupons using die cast or other means. At least ten (10) coupons shall be cut for peel and shear test.

4. At least five specimen shall be tested each for shear and peel strength. A passing test shall meet the minimum required values in all five specimens tested for each method.

5. The QAL shall provide verbal test results to the EFR no more than 48 hours after they receive the samples. The EFR shall review the laboratory results as soon as they become available.

F. Procedures for Destructive Test Failure

1. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted in the field or by the QAL. The Installer has two options.

   a. The Installer can repair the seam between any two passing test locations in accordance with Paragraph 3.07G.

   b. The Installer can retrace the welding path to an intermediate location a minimum of 10-ft on each side of the failed sample. The sample shall be tested in the field.

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Subsequent failure of test samples shall cause the testing to move further down the seam until the extent of faulty seam has been determined.

2. All acceptable repaired seams shall be bound by two conservative passing locations on each side of the original sample. In cases where repaired seam exceeds 150-ft, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Paragraph 3.07G.

3. The EFR shall document all actions taken in conjunction with destructive test failures.

G. Repair Procedures

1. Any portion of the geomembrane exhibiting signs of any kind of defect, or failing a destructive or a nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the EFR.

2. The repair procedures available include:

a. Patching, used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

b. Spot welding or seaming used to repair small tears, pinholes, or other minor, localized defects.

c. Capping is used to repair large lengths of failed seams.

d. Removing bad seam and replacing with a strip of new material welded in place.

e. For small lengths of failed seam (less than 3 feet), extrusion welding can be used to repair provided there is sufficient overlap between the two liner panels.

3. For any repair method, the following provisions shall be satisfied:

a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.

b. All surfaces shall be clean and dry at the time of the repair.

c. All seaming equipment used in repairing procedures shall be qualified.

d. All patches and caps shall extend at least 4-in beyond the edge of the defect.

e. All patches shall have rounded corners.

H. Repair Verification

1. Each repair shall be numbered and logged by the installer. Each repair shall be nondestructively tested using the methods described in Paragraph 3.06 as appropriate. Repairs, which pass the nondestructive test, shall be taken as an indication of an adequate

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repair. Repairs more than 150-ft long may be of sufficient length to require destructive test sampling at the discretion of the EFR. Failed test of the repaired section indicates that the repair shall be redone and retested until a passing test results are achieved. The EFR shall observe all nondestructive testing of repairs. The installer shall record the number of each repair, date and test outcome.

I. Wrinkles

1. Large wrinkles that remain in the sheet as result of temperature expansion or uneven surface preparation may need removal as determined by the EFR in consideration of applied loads on the wrinkle. Should the wrinkle need removing, the lower down-slope edge of the wrinkle shall be cut, overlapped and repaired as described in Paragraph 3.07G. Both ends of the wrinkle repair shall be patched. Caution must be taken in removing any wrinkles. Wrinkles are needed to allow for future contraction of the geomembrane, especially in cold weather.

J. Construction Equipment

1. Construction equipment or vehicles with steel tracks shall not be permitted on the geomembrane. Other equipment such as portable generators and power centers shall be permitted if the support apparatus is protected from damaging the geomembrane, and if care is taken to prevent leaking lubricants from damaging the geomembrane.

3.08 ELECTRICAL LEAK LOCATION SURVEY

A. Follow installation of the 24-inch minimum protective cover layer, the Contractor shall provide and pay for electrical leak location survey performed by Leak Location Services, Inc. or equal to ensure that no puncturing of the liner occurred during installation. The Contractor will fully cooperate with the testing including providing survey service and laborers to establish testing points and vacating areas designated by the testers.

B. All leaks located by the survey shall be repaired at no additional cost to the Owner. Following completion of all repairs, at no additional cost to the Owner, the repairs shall be verified by additional electrical leak location survey. This process shall be performed until all repairs have been deemed acceptable.

C. The Contractor shall submit a plan prior to performing the work that describes the methods to be employed and demonstrates equivalency to the requirements specified herein. The results of the leak location survey shall be communicated to the Engineer before the leak location survey crew leaves the site. Contractor shall submit two (2) copies of the certified test results documenting the electrical leak location surveys within 14 days of the completion of each leak survey. The reports shall document the methodology used, the locations and descriptions of the leaks, and a diagram of the facility showing the approximate leak locations.

3.09 DISPOSAL OF WASTE MATERIAL

A. Upon completion of installation, the Contractor shall properly remove and dispose of all trash, waste material and equipment used in connection with the performed work and shall leave the premises in a neat and acceptable condition.

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3.10 AS-BUILT DRAWINGS

A. The Installer shall prepare and submit to the Engineer an as-built drawing reflecting the actual installation of geomembrane, including the location of all seams, the location of destructive samples, and the location of all repair work. The as-built drawing shall be submitted to the Engineer within 14 days of job completion. In addition, a copy of the complete documentation package will accompany the as-built drawing.

END OF SECTION

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APPENDIX A

The following forms are included and shall be completed by the responsible party as shown on the forms.

Form No.	Title
CQC - 100	Liner Project QC Log
CQC - 101	Receiving QC Log
CQC - 102	Personnel QC Log
CQC - 103	Daily QC Report Pre-weld Testing
CQC - 104	HDPE Liner Installation Tracking Log
CQC - 105	Seaming Log
CQC - 106	Patch Placement Log
CQC - 107	Destructive Test Log
CQC - 108	Damage and/or Failure Report
CQC - 109	Protective Cover Daily Report

FORM CQC - 100
LINER PROJECT QC LOG
(one sheet per project)

PROJECT

NAME: _____

NUMBER: _____

LOCATION: _____

OWNER: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

ENGINEER

NAME: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

CONTRACTOR

NAME: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

SUPPLIER OF LINER MATERIALS

NAME: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

QC INSPECTION

NAME: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

TESTING LABORATORY

LINER TESTING LABORATORY: _____

ADDRESS: _____

CONTACT: _____ PHONE: _____

FORM CQC - 100
LINER PROJECT QC LOG
(one sheet per project)
(Continued)

FABRICATOR OF MATERIAL

NAME: _____

ADDRESS: _____

CONTACT: _____

INSTALLER OF MATERIAL

NAME: _____

ADDRESS: _____

CONTACT: _____

LINER MATERIALS

SPECIFIED LINER MATERIALS: _____ THICKNESS & TYPE: _____

MATERIAL CERTIFICATION

MATERIAL CERTIFICATION RECEIVED: _____

DATE: _____ ACCEPTED: _____

FORM CQC - 101
RECEIVING QC LOG
(one sheet per truck)

PROJECT NAME: _____

DATE: _____ TIME: _____ PROJECT NUMBER: _____

TRUCKERS ID: _____

NO. OF PIECES ON BOARD: _____ AGREE WITH PACKING LIST? _____

CONDITION OF PACKAGING: _____

VERIFY PROPER MATERIALS: _____ VERIFY PROPER THICKNESS: _____

IDENTIFY ROLL NUMBERS: _____

_____

IDENTIFY ACCESSORIES (*adhesive, battens, boots, etc.)*: _____

_____

IDENTIFY DAMAGED ITEMS: _____

_____

TYPE OF UNLOADING EQUIPMENT USED: _____

OPERATOR: _____

COMMENTS: _____

_____

STORAGE AREA

CONDITION *(surface)*: _____

LOCATION TO PLACEMENT AREA: _____

MATERIAL PROPERLY COVERED: _____

WEATHER

CONDITIONS: _____ TEMP: _____

SIGNATURES

QC INSPECTOR: _____

SITE SUPERVISOR: _____

Use back for other comments

FORM CQC - 102
PERSONNEL QC LOG
(installation & field seaming personnel)
(complete for each mobilization or change of personnel)

PROJECT NAME: _____

DATE: _____ PROJECT NUMBER: _____

SAFETY MEETING CONDUCTED ON MATERIALS HANDLING: _____

GIVEN BY: _____ DATE: _____

SUPERINTENDENT OF INSTALLATION: _____

SEAMING CREW PERSONNEL

#1 CREW LEADER: _____ HELPER: _____

#2 CREW LEADER: _____ HELPER: _____

#3 CREW LEADER: _____ HELPER: _____

#4 CREW LEADER: _____ HELPER: _____

#5 CREW LEADER: _____ HELPER: _____

#6 CREW LEADER: _____ HELPER: _____

#7 CREW LEADER: _____ HELPER: _____

#8 CREW LEADER: _____ HELPER: _____

OTHER CREW MEMBERS

NAME: _____ NAME: _____

NAME: _____ NAME: _____

NAME: _____ NAME: _____

SIGNED: _____
QC Inspector

ORM CQC - 103
DAILY QC REPORT
PRE-WELD TESTING

DATE: _____ JOB NAME: _____ JOB NO.: _____ MATERIAL: ____

TIME	AMBIENT TEMP.	WEATHER	WIND	TECH.	MACHINE			DESTRUCTIVE TEST						PASS FAIL	EFR INITIALS
					ID NO.	TEMP.	SPEED	PEEL			SHEAR				

FORM CQC - 104
HDPE LINER INSTALLATION TRACKING LOG

DATE	PANEL NO.	CELL NO.	ROLL NO.	LENGTH	WIDTH	SQUARE FT.

FORM CQC - 105
SEAMING LOG
(one sheet per day)

DATE: _____ JOB NAME: _____ JOB NO.: _____ MATERIAL: ____

AMBIENT TEMP.: _____AM_____PM_____ WIND: AM_____PM_____ WEATHER: AM_____PM_____

	LOCATION		INSTALLATION				WEDGE WELD		EXTRUSION WELD		
TIME	SEAM NO.	LENGTH	TECH.	MACH ID. NO.	MACH. TEMP.	SPEED	START PSI	FINISH PSI	VAC. TEST Y/N	PASS/ FAIL	COMMENTS

COMMENTS: _____

DAILY TOTALS: Liner_____ sq. ft., Length Seamed _____ ft., No. Destructs marked _____ Anchor Trench: Dug _____

Accepted _____

FORM CQC - 106
PATCH PLACEMENT LOG
(one sheet per day)

DATE: _____ JOB NAME: _____ JOB NO.: _____ MATERIAL: ___

AMBIENT TEMP.: _____AM_____PM_____ WIND: AM_____PM_____ WEATHER: AM_____PM_____

			INSTALLATION			EXTRUSION WELD		
TIME	PATCH NO.	DESCRIPTION LOCATION	TECH.	MACH ID. NO.	MACH. TEMP.	VAC. TEST Y/N	PASS/ FAIL	COMMENTS

COMMENTS: _____

DAILY TOTALS: Liner_____ sq. ft., Length Seamed _____ ft., No. Destructs marked _____ Anchor Trench: Dug _____

Accepted _____

FORM CQC - 107
DESTRUCTIVE TEST LOG

JOB NAME: _____ JOB NO.: _____ MATERIAL: _____

DATE CUT	SAMPLE I.D.	SEAM NO.	MACH. ID NO.	SEAMER INITIALS	PEEL TEST LBS./INCH			SHEAR TEST LBS./INCH			PASS/ FAIL	DATE TO LAB PKG. SLIP NO.	LAB PASS/FAIL	LOCATION/ COMMENT

FORM CQC - 108
DAMAGE AND/OR FAILURE REPORT

JOB NAME: _____ JOB NO.: _____ PAGE: _____

DATE	PANEL NO.	SEAM NO.	LOCATION OF DAMAGE	TYPE OF DAMAGE OR FAILURE	TYPE OF REPAIR	NEW SEAM NO.	NEW PATCH NO.

COMMENTS: _____

_____

_____

FORM CQC - 109
PROTECTIVE COVER
DAILY REPORT

DATE: _____ JOB NAME: _____ JOB NUMBER: _____

PANEL NO.	CELL NO.	SQUARE FEET INSTALLED	HAULING EQUIPMENT	SPREADING EQUIPMENT	COMMENTS

Buncombe County, North Carolina

Buncombe County Solid Waste Management Facility Subtitle D Landfill Phase IV (Cell 7) Permit to Construct Application

Part 5 – Operation Plan

March 2014

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Section 1 - Purpose

Operation Plan

The purpose of this Operations Plan is to provide the Buncombe County Subtitle D Landfill staff with a manual that will serve as a guide for safe and efficient operation of the Subtitle D landfill. This Operations Plan has been prepared in accordance with the North Carolina Solid Waste Rule 15A NCAC 13B .1626, Operational Requirements for MSWLF Facilities, and therefore addresses the following issues.

- Waste Acceptance and Disposal Requirements
- Cover Material Requirements
- Disease Vector Control
- Explosive Gases Control
- Air Criteria
- Access and Safety Requirements
- Erosion and Sediment Control
- Drainage Control and Water Protection Requirements
- Liquids Restrictions
- Recordkeeping Requirements
- Spreading and Compacting Requirements
- Leachate Management Plan

Additionally, **Table 1** is provided to summarize all required documents or documentation (record keeping) which must be maintained by the County and retained at the facility. The operating record may be inserted into a 3-ring binder located at the scale house or main administration building. It is the intent that Table 1 is clearly and visually posted to ensure direction on record keeping.

1.1 Operation Drawings

In accordance with Rule .1625(b)(1), operation drawings have been prepared and are included in **Appendix 5A**.

Table 1. Buncombe County Subtitle D Landfill Operating Record Requirements

Required Recordkeeping	Rule	Reference in Ops Plan	Action
INCOMING WASTE			
Attempted disposal of any prohibited wastes	.1626(1)(a)	2.5	Report to NCDENR within 24 hrs
Attempted disposal of any waste from outside the permitted service area	.1626(1)(a)	2.5	Report to NCDENR within 24 hrs
Records of random waste inspections	.1626(10)(a)(i)	11.1	Complete form
Waste determination records	.1626(10)(a)(i)	11.1	--
Amounts by weight of solid waste received at the Subtitle D landfill	.1626(10)(a)(ii)	11.1	--
DISPOSAL OPERATIONS			
Open burning requests	.1626(5)(b)	6.2	--
Fire and explosion notification	.1626(5)(d)	6.4	Report to NCDENR verbally within 24 hrs and written by 15 days
LEACHATE MANAGEMENT MAINTENANCE AND MONITORING			
Inspect leachate pond	.1626(12)(a)	13.1.2	Annually
Jet clean leachate collection pipes	SB1492 130A-295.6. (h)(3) and Leachate Spill Corrective Action	13.1.3	Annual, note in Operating Record
Remote camera inspection	SB1492 130A-295.6. (h)(3) and Leachate Spill Corrective Action	13.1.3	Once every 5 years
Inspect pump station and audio and visual alarms	Leachate Spill Corrective Action	13.1.3	Weekly
Inspect landfill sideslopes and LCS	Leachate Spill Corrective Action	13.1.3	Weekly or following rainfall events equal to or exceeding ½ inch
Leachate generation records	.1626(12)(b)	13.2.1	Weekly
Leachate quality sampling	.1626(12)(c)	13.2.2	Semi-annual
METHANE MONITORING			
Methane monitoring reports	.1626(10)(a)(iii) .1626(4)(b)	11.1	Quarterly
Exceedance in methane levels – required action within 7	.1626(10)(a)(iii) .1626(4)(c)(ii)	11.1	Include in Operating Record detected levels and description of

days following detection			steps to protect human health
Exceedance in methane levels – required action within 60 days following detection	.1626(10)(a)(iii) .1626(4)(c)(iii)	11.1	Include in Operating Record a remediation plan for gas releases and notify NCDENR that plan has been implemented
GROUNDWATER AND SURFACE WATER MONITORING			
Groundwater and surface water monitoring reports	.1626(10)(a)(iv)	App. C	Semi-annual
TRAINING			
Certificates of training	.1626(10)(a)(i)	11.1	--
Training procedures	.1626(10)(a)(i)	11.1	--
CLOSURE/POST-CLOSURE (NOT APPLICABLE)			
Any closure or post-closure monitoring, testing, or analytical data	.1626(10)(a)(v)	11.1	--
Required Approved Documents to be included in the Operating Record			
Current Operation Plan in accordance with Rule .1626(10)(c)			
Current Water Quality Monitoring Plan in accordance with Rule .1630			
Current Permit to Construct and Permit to Operate			
Current cost estimates and financial assurance documentation in accordance with Rules .1626(10)(a)(vi) and .1628			

Section 2 – Waste Acceptance and Disposal Requirements

Operation Plan

2.1 Waste Definition

Agricultural Waste - waste material produced from raising of plants and animals, including animal manures, bedding plant stalks, hulls, and vegetative matter.

Asbestos Waste - any waste material that is determined to contain asbestos.

Blood Product - all bulk blood and blood products.

Commercial Solid Waste - all types of solid waste generated by retail stores, offices, restaurants, warehouses, and other non-manufacturing activities, excluding residential waste.

Construction/Demolition Waste - solid waste resulting solely from construction, remodeling, repairs or demolition of buildings, structures, or pavement but does not include inert, land-clearing or yard waste.

Hazardous Waste - any solid waste that is defined as hazardous in 15A NCAC 13A 261.3 and that is not excluded from regulation as a hazardous waste from conditionally exempt small quantity generators as defined within 15A NCAC 13A 261.5.

Hot Load - when a waste hauling vehicle is transporting solid waste that is burning or smoldering, it is referred to as a hot load.

Household Waste - any solid waste derived from households including hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas.

Industrial Solid Waste - solid waste generated by manufacturing processes that is not a hazardous waste regulated under Subtitle C of RCRA. Such waste may include, but is not limited to, waste resulting from the following manufacturing processes: electric power generation; fertilizer/agricultural chemicals; food and related products/by-products; inorganic chemicals; iron and steel manufacturing; leather and leather products; nonferrous metals manufacturing/foundries; organic chemicals; plastics and resins manufacturing; pulp and paper industry; rubber and miscellaneous plastic products; stone, glass, clay, and concrete products; textile manufacturing; transportation equipment; and water treatment. This term does not include mining waste or oil and gas waste.

Inert Debris - any solid waste which consists solely of material that is virtually inert, such as brick, concrete, rock, and uncontaminated soil.

Infectious Waste - any solid waste capable of producing an infectious disease. These types of waste include microbiological waste, pathological waste, blood products, and sharps.

Land Clearing Debris - solid waste which is generated solely from land clearing activities such as stumps, trees, limbs, brush, grass, and other naturally occurring vegetative material.

Liquid Hydrocarbons - As defined under Article 21A of Chapter 143 of the North Carolina General Statutes: except that any such oils or other liquid hydrocarbons that meet the criteria for hazardous waste under the Federal Resource Conservation and Recovery Act (P.L. 94-580) as amended.

Liquid Waste - any waste material that is determined to contain free liquid by Method 9095 (Paint Filter Test).

Medical Waste – means any solid waste which is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals, but does not include any hazardous waste identified or listed pursuant to this Article, radioactive waste, household waste as defined in 40 Code of Federal Regulations § 261.4(b)(1) in effect on 1 July 1989.

Regulated Medical Waste – means blood and body fluids in individual containers in volumes greater than 20 ml, microbiological waste, and pathological waste that have not been treated pursuant to .1207. (.1207 is the definition of treatment - see rules on page 22.) Regulated medical waste must be treated prior to disposal. After treatment these wastes may be handled as general solid waste. (.1201(9))

Microbiological Waste - includes cultures and stocks of etiologic agents. The term includes cultures of specimens from medical, pathological, pharmaceutical, research, commercial, and industrial laboratories.

Oils - As defined under Article 21A of Chapter 143 of the North Carolina General Statutes: except that any such oils that meet the criteria for hazardous waste under the Federal Resource Conservation and Recovery Act (P.L. 94-580) as amended.

Pathological Waste - includes: human tissue, organs, body parts, secretions, and excretions, blood, and body fluids that are removed during surgery and autopsies; the carcasses and body parts of all animals that were exposed to pathogens in research, were used in the production of biological or in the in-vitro testing of pharmaceuticals, or that died of known or suspected infectious disease.

Polychlorinated Biphenyls (PCB) - defined as any of several compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine. PCB's were most frequently used as an additive to oil or other liquid in situations where heat is involved. PCB's have been used in paints and lubricants, however the most common application was in electric transformers.

Radioactive Waste - any waste that contains radioactivity as defined by the North Carolina Radiation Protection Act, G.S. 104E-1 through 104E-23. Radioactivity is defined as the property possessed by some elements of spontaneously emitting alpha or beta rays and sometimes gamma rays by the disintegration of the nuclei of atoms.

Sharps - includes needles, syringes with attached needles, capillary tubes, slides and cover slips, and scalpel blades.

Spoiled Food - any food which has been removed from sale by the United States Department of Agriculture, North Carolina Department of Agriculture, Food and Drug Administration, or any other regulatory agency having jurisdiction in determining that food is unfit for consumption.

Treatment or Processing Waste - any waste that is a residual solid from a wastewater treatment or pretreatment facility.

Tires - rubber tires from vehicles.

White Goods - any inoperative and discarded refrigerators, freezers, ranges, washers, dryers, water heaters, and other large domestic commercial appliances.

Yard Trash - solid waste resulting from landscaping and yard maintenance such as brush, grass, tree limbs, and similar vegetative material.

2.2 Acceptable Waste

In accordance with 15A NCAC 13B .1626, a Municipal Solid Waste Landfill Facility (MSWLF) shall only accept those solid wastes which it is permitted to dispose of. In accordance with the North Carolina Solid Waste Management Rules, except where noted, the Buncombe County Sanitary Landfill is permitted to dispose of the following using normal operating procedures:

Agricultural Waste - This waste is acceptable with the exception of animal manures.

Bulk or Non-Containerized Liquid Waste - The waste is acceptable if the waste is a household waste other than septic waste and waste oil or the waste is leachate or gas condensate derived from the MSWLF unit.

Commercial Solid Waste

Containerized Liquid Waste - This waste is acceptable only if the liquid waste is in small containers similar in size to that normally found in household waste, and if the small containers are designed to hold liquids for use other than storage, and the waste is household waste.

Household Waste

Industrial Solid Waste

Animal Carcasses – Dog, cat, and farm animal carcasses will be accepted at the landfill, in accordance with .1626.(1)(c), all animal carcasses delivered to the landfill shall be covered immediately.

2.3 Acceptable Waste Requiring Special Handling

Several components of the acceptable waste stream will require special handling procedures. The waste stream components requiring special handling include, but are not limited to the following:

Asbestos Waste - The County can accept asbestos waste, and is permitted to dispose of it in a designated portion of the C&D landfill, however, in order to maintain an accurate record of asbestos disposal quantities and locations, landfill staff will identify specific locations in each cell that will contain these wastes.

In accordance with .1626.(1)(d), the waste shall be covered immediately with a soil in a manner that will not cause airborne conditions and must 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. Separate areas shall be clearly designated so that asbestos is not exposed by future land disturbing activities.

Barrels and Drums - Barrels and drums may be disposed of if they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained in them.

Construction/Demolition Waste - This waste is to be disposed in accordance with state and federal regulations in the approved location on site.

Hot Loads - Hot loads arriving at the site should be dumped immediately in the designated primary hot load area located near the working face. The designated area must be located only on areas containing compacted refuse covered by at least 6 inches of cover material. The location of the primary hot load area will change along with the landfill development so as to always be near the working face. Hot loads should be extinguished immediately after being dumped by applying water to the burning refuse and by covering the refuse with soil from the stockpile area. If problems are encountered, the local fire department should be called. Once extinguished, the hot load should be observed until it is certain that the fire is out. The remaining refuse should then be compacted and buried at the working face.

Land Clearing Debris/Yard Trash - This waste will be handled at the tub grinder and used as the mulch portion for the mulch/soil alternate daily cover mixture.

Spoiled Food - Spoiled food shall be placed at the bottom of the working face and covered immediately.

Tires - Tires will be accepted, placed immediately in an on-site trailer and removed periodically.

Treatment or Processing Waste - per .1626 (1) (e)

White Goods - All chlorofluorocarbon will be removed and the remainder will be sold for scrap metal.

2.4 Medical Waste Materials Not Accepted by Buncombe County

Sharps generated from a household shall be accepted at the Buncombe County Transfer Station in a specified, puncture proof container. The sharps container is transported to a medical waste disposal company. Buncombe County Solid Waste Management Facility's Landfill does not accept sharps. The Landfill operators and manager have the right to reject properly packaged sharps or treated regulated medical waste for disposal in the landfill, even if state regulations allow landfill disposal of such wastes.

Medical Waste as defined above is not accepted at the Buncombe County Solid Waste Management Facility's Landfill. If a load contains this material, the generator will be determined, if possible, and will be assessed civil penalties and will be required to cover all costs associated with removal, treatment and safe disposal of such material.

2.5 Prohibited Wastes

The following wastes are prohibited from disposal at the Buncombe County Subtitle D Landfill.

Containerized Liquid Waste - Containerized Liquid Waste may not be placed in the landfill unless the container is a small container similar in size to that normally found in household waste. In addition, Containerized Liquid Waste may not be placed in the landfill unless the container is a small container that is designed to hold liquids for use other than storage.

Hazardous Waste – per .1626 (1) (b) (i). Hazardous waste as defined in 15A NCAC 13A 261.3, that is not excluded from regulation as a hazardous waste from conditionally exempt small quantity generators as defined within 15A NCAC 13A 261.5 shall not be accepted at the Buncombe County Subtitle D Landfill.

Inert Debris

Infectious Waste

Liquid Waste per .1626 (1) (b) (iii)

Microbiological Waste

Pathological Waste

Polychlorinated Biphenyls (PCB) per .1626 (1) (b) (ii)

Radioactive Waste

Regulated Medical Waste

2.6 Receiving Prohibited Waste

The Buncombe County Subtitle D Landfill only accepts those solid wastes that it is permitted to receive. The County will notify the North Carolina Department of Environment and Nature Resources Division of Waste Management (NCDENR DWM) within 24 hours of attempted disposal of any waste the C&D and Subtitle D landfills are not permitted to receive.

A report shall be prepared of any attempted delivery of waste of which the landfill is not permitted to receive, including waste from outside the permitted landfill service area. The report will be forwarded to:

Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
1646 Mail Service Center
Raleigh, North Carolina 27699-1646

2.7 Waste Screening Program

The Rule .1626(1)(f) require all MSWLFs implement a program at the facility for detecting and preventing the disposal of hazardous and liquid waste. This program must include, at a minimum:

- Random inspection of incoming loads or other comparable procedures

- Records of inspection
- Training of facility personnel to recognize hazardous and liquid waste.
- Development of a contingency plan to properly manage any identified hazardous and liquid waste addressing identification, removal, storage, and final disposition of the waste.

A copy of the waste screening plan for the Buncombe County Subtitle D Landfill is included in **Appendix 5B** to this Operation Plan.

Section 3 – Cover Material Requirements

Operation Plan

3.1 Daily Cover

In accordance with 15A NCAC 13B .1626 (2), the operator of MSWLF units must cover disposed solid waste with six inches of earthen material (or alternative daily cover (ADC) approved by the Solid Waste Section (SWS)) at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors, blowing litter, and scavenging. The daily cover must:

- be capable of covering solid waste after it is placed without change in its properties and without regard to weather;
- be noncombustible; and,
- not include rock fragments that are greater than six inches in diameter.

3.1.1 Wet Weather Operations

During wet weather, the County may develop a wet weather working face. The wet weather working face will be kept as small as possible. At the end of disposal operations, the County will cover in accordance with Section 3.1.

3.2 Intermediate Cover

In accordance with 15A NCAC 13B .1626 (2), the owner or operator of all MSWLF units must place 12-inches of intermediate cover on all areas which will not have additional waste placed on them for 12 months or more, but where final termination of disposal operations has not occurred. The composition standards of intermediate cover shall be the same as for daily cover in addition to being capable of supporting the germination and propagation of vegetative cover.

3.3 Alternative Daily Cover

Three ADCs are described in this section; Posi-Shell, soil/mulch mixture, and tarps. Each ADC shall provide control for disease vectors, fires, odor, blowing litter, and scavenging. Through SWS required demonstration periods from February 5, 2008 to June 5, 2008 and from August 9, 2008 to November 7, 2008, each ADC has been determined to provide equal or better element control as soil.

3.3.1 Posi-Shell

The Posi-Shell Cover System will be used as an ADC on waste disposed at the Subtitle D landfill. Posi-Shell provides a thin cover that hardens over the covered waste surface.

Posi-shell will be used over disposed waste and may be left as cover for up to 30 days. Any areas that have been left for 30 days will be covered with either a lift of waste or soil. Exposed Posi-shell areas will be visually inspected daily and reapplied when necessary.

County personnel will keep a daily log and field sketch detailing disposal areas and dates of posi-shell application. The daily log is provided following this section.

3.3.1.1 Properties of Posi-Shell

The properties of each component of Posi-Shell are available in the Manufacturer's Usage Guide provided as **Appendix 5C**.

3.3.1.2 Cover System Description

As described in the Manufacturer's Usage Guide, the application rate for short-term coverage (overnight cover for daily cover operations) is approximately 8 to 10 square feet per gallon. Assuming the working face is less than one acre (100 feet wide and 400 feet long), the desired load size would be approximately 4,000 gallons. Posi-shell manufacturers may change recipes and County may use newer or better products as they become available. Currently, at a minimum, the Posi-Shell material quantities for daily use should be the following:

- 3,200 gallons of liquid (water or leachate),
- 8 bags (15 lbs each) of Posi-Pak,
- 40 bags (50 lbs each) of PSM-200 setting agent,
- 80 bags (94 lbs each) of optional Portland cement, and
- Optional waste latex paint (quantity per manufacturer's recommendations)

Posi-Pak is a specially designed plastic fiber with a proprietary finish that provides the reinforcement matrix for the finished cover. PSM-200 setting agent is a blend of clay, polymers, and adhesives that provides thickening, lubrication, and adhesion. Portland cement can be used as a binder component which will help neutralize odors and enhances the durability of the cover system.

3.3.1.3 Cover System Application Procedures

Application Procedure

Application of the Posi-shell will generally follow the manufacturer's recommendation and will employ the following minimum procedures:

- The Posi-shell will be applied in two different directions to avoid spray shadow or wind dispersion;
- The Posi-shell will be applied at the end of each working day;
- The Posi-shell surface will be visually inspected on a daily basis for exposed waste and/or inadequate coverage. Inadequate coverage is generally defined as a thickness of less than 1/8 of an inch.

Areas of exposed waste and/or inadequate coverage will receive an additional application prior to operations ending for that day.

Maximum Daily Area Coverage

Based on the May 2007 Airspace Analysis Report:

- Annual 2007 waste disposal rate (MSW only) = 125,000 tons
- Operating days per year = 284 days

- Approximate daily waste disposal rate = 440 tons
- In-place density = 0.50 tons of MSW per cubic yard
- Daily cubic yards disposed = daily waste disposal rate / in-place density = 880 yd3 or 23,800 ft3

The working face will be restricted to the smallest area feasible. The working lift is typically 4 feet high. Based on a working lift thickness of 4 feet, the working face area is 5,400 square feet (daily cubic yards disposed / working lift thickness), which is equal to the daily coverage area.

Daily Depth and Quantity to be Applied

N/A

Average Monthly Volume of Daily Cover

N/A

List of Equipment

Equipment required for the Posi-Shell consists of a standard hydroseeding unit and a towing unit.

Material and Equipment Storage

The material components of Posi-Shell will be housed in the machine shop to minimize the risk of hydration. The spraying equipment will be parked in a County designated area which will not impede daily operations.

Wet Weather Operation

The application of Posi-shell during heavy rain events will be minimized. If Posi-shell is applied during periods of heavy rain, the surface will be visually inspected following the rain event for exposed waste or inadequate coverage.

Contingency Plans

If, for any reason, the County cannot use Posi-Shell as ADC material, soil, a soil/mulch mixture, or tarps will be used.

Screening Criteria

N/A

3.3.2 Soil/Mulch Mixture

A mulch (30% maximum by volume) and soil mixture is used as another ADC material. Mulch will be hauled from the on-site mulching operations and soil will be provided from the County's on-site borrow area. The soil/mulch mixture will be free of petroleum contaminated soils. The materials will be mixed at the borrow area or the working face.

Soil/mulch mixture shall not be used more than five (5) consecutive days. If soil/mulch mixture is used on four consecutive days, soil cover will be used on the following day.

3.3.2.1 Properties of Soil/Mulch Mixture

At the Buncombe County facility, waste segregation occurs at the scale house to prevent the mulch processing of any unacceptable material, additionally the mulch processing operator segregates waste by placing unacceptable material into a dumpster located near the mulching area. Unacceptable

material includes construction and demolition debris, potentially contaminated debris, etc. Since waste segregation occurs prior to the waste processing into mulch, the resulting mulch is considered inert.

3.3.2.2 Cover System Application Procedures

Application Procedure

Application of the soil/mulch mixture will employ the following minimum procedures:

- The mixture will be prepared by combining three (3) loads of mulch and seven (7) loads of soil;
- Mix soil and mulch load and visually verify that the mixture is adequately commingled, ensure that there are no large clumps (3 inches in diameter or larger) of either soil or mulch in the mixture;
- Load and haul soil/mulch mixture to active working face using an articulating truck; and
- Use dozer to cover working face with six inches of soil/mulch mixture.

The surface will be visually inspected on a daily basis for exposed waste and/or inadequate coverage. Areas of exposed waste and/or inadequate coverage will receive additional cover.

Maximum Daily Area Coverage

See Section 3.3.1.3.

Daily Depth and Quantity to be Applied

As stated above, 6 inches of the soil/mulch mixture will be applied to the daily coverage area of 5,400 square feet. Therefore; the required daily quantity of soil/mulch mixture placed is approximately 100 yd3 (Assuming no other daily cover is used).

Average Monthly Volume of Daily Cover

As stated above, approximately 100 yd3 per day of soil/mulch mixture will be used. Assuming 24 working days per month, the average monthly volume of daily cover required for normal operating conditions is 2,400 yd3.

List of Equipment

An articulating truck and dozer will be used for the application process.

Material and Equipment Storage

Any soil/mulch mixture requiring storage will be stored at the borrow area. Mulch stock pile sizes shall not exceed 30 feet in width and 15 feet in height to avoid spontaneous combustion and to maintain a manageable pile size in the event of a fire. Landfill equipment used for ADC procedures will be stored at County designated areas.

Wet Weather Operation

The soil/mulch mixture wet weather operation will be similar to the operation the County currently follows when using soil as daily cover during wet weather.

Contingency Plans

If, for any reason, the County cannot obtain mulch for the on-site processing area for use as ADC material, soil, Posi-shell, or tarps will be used.

Screening Criteria

Each soil/mulch mixture load will be visually inspected prior to transport to the working face to determine if the material is adequately mixed. The load will not be placed if the mixture is not commingled adequately or if foreign material is observed.

3.3.3 Tarps

Tarps will be used as another ADC. The tarps will be placed either manually or by using an automatic tarping machine which uses a spreader bar to lay and roll up the tarps.

Tarps shall not be used more than five (5) consecutive days. If tarps are used on four consecutive days, soil cover will be used on the following day.

3.3.3.1 Properties of Tarps

N/A

3.3.3.2 Cover System Application Procedures

Application Procedure for Manual Placement

Application of the tarp will employ the following minimum procedures:

- Visually inspect working face to ensure that no sharp objects are protruding from the compacted waste which may tear the tarp;
- If necessary, run compacter over any protruding objections;
- Manually roll out tarp and place over working face, the side cables within the tarp and the metal bars on the short ends shall be heavy enough to weigh down the tarp; and
- Place additional tarps as needed to adequately cover working face.

The tarps will be visually inspected following placement to ensure that uplift will not occur. Additional metals bars will be placed if necessary. Soil will be placed over any areas of exposed waste and/or inadequate coverage.

Application Procedure for Equipment Placement

Application of the tarp will employ the following minimum manufacturer's recommended procedures:

- Visually inspect working face to ensure that no sharp objects are protruding from the compacted waste which may tear the tarp;
- If necessary, run compacter over any protruding objections;
- Using an automatic tarping machine, install tarp directly on working face, the side cables within the tarp and the metal bars on the short ends shall be heavy enough to weigh down the tarp; and
- Lay additional tarps as needed to adequately cover working face.

The tarps will be visually inspected following placement to ensure that uplift will not occur. Additional metals bars will be placed if necessary. Soil will be placed over any areas of exposed waste and/or inadequate coverage.

Maximum Daily Area Coverage

See Section 3.3.1.3.

Daily Depth and Quantity to be Applied

N/A

Average Monthly Volume of Daily Cover

N/A

List of Equipment

An automatic tarping machine and/or dozer will be used for the tarp installation.

Material and Equipment Storage

The automatic tarping machine and tarp will be stored in a County designated area that will not conflict with daily haul and disposal operations.

Wet Weather Operation

The tarping wet weather operation will be similar to the operation the County currently follows when using soil as daily cover during wet weather.

Contingency Plans

If, for any reason, the County cannot use tarps as ADC, soil, Posi-shell, or a soil/mulch mixture will be used.

Screening Criteria

N/A

POSI SHELL RECORD SHEET

DATE	WEATHER CONDITIONS	A.D.C.	LOAD(S)	INITIALS

Section 4 – Disease Vector Control

Operation Plan

In accordance with 15A NCAC 13B .1626 (3), owners or operators of all MSWLF units must prevent or control on-site population of disease vectors using techniques appropriate for the protection of human health and the environment. Disease vectors are defined as any rodent, flies, mosquitoes, or other animals, including insects, capable of transmitting disease to humans.

Effective vector control measures are applied when necessary. Control of vectors is maintained by application of cover material over the compacted solid waste. This will protect against migration of vectors into and from the landfill. Stagnant ponding water is prevented to control mosquito breeding. Filling in low spots is performed regularly, and if necessary, County mosquito control or a licensed exterminator shall be employed to control vectors.

Section 5 – Explosive Gas Control Operation Plan

In accordance with 15A NCAC 13B .1626 (4), the owners or operators of all MSWLF units must ensure that:

- the concentration of methane gas generated by the facility shall not exceed 25 percent of the lower explosive limit for methane in facility structures (excluding gas control or recovery system components); and,
- the concentration of methane gas does not exceed the lower explosive limit for methane at the facility property boundary.

Owners or operators of all MSWLF units must implement a routine methane monitoring program to ensure that the above standards are met. A Methane Monitoring Plan prepared in accordance with this rule is located in **Appendix 5D** of this Operations Plan.

Section 6 – Air Criteria

Operation Plan

6.1 State Implementation Plan

In accordance with 15A NCAC 13B .1626 (5), the owner or operator of all MSWLFs must ensure that units do not violate any applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the U.S. EPA Administrator pursuant to Section 110 of the Clean Air Act, as amended.

All of the SIP requirements are listed in the current Title V Operating Permit for the Subtitle D landfill. The County is in compliance with the Title V Operating Permit thusly are not in violation of any SIP requirements.

6.2 Open Burning of Waste

In accordance with 15A NCAC 13B .1626 (5) (b), open burning of solid waste, except for the infrequent burning of land clearing debris generated on site or debris from emergency clean-up operations, is prohibited at all MSWLF units. Any such infrequent burning must be approved by the Division of Waste Management.

6.3 Fire Protection Equipment

In accordance with 15A NCAC 13B .1626 (5) (c), equipment shall be provided to control accidental fires or arrangements shall be made with the local fire protection agency to immediately provide firefighting services when needed. Fires that break out close to the surface of the fill area should be dug out and smothered with cover material. Deep fires should be smothered out by placing moist soil on the surface and by constructing soil barriers around the fire. Where the smothering technique fails, the burning material must be excavated and smothered or quenched with water once the burning material is brought to the surface. Water is usually not effective unless it can be directly applied to the burning material.

6.4 Notification of Fire

In accordance with 15A NCAC 13B .1626 (5) (d), fires that occur at the MSWLF require verbal notice to the Division of Solid Waste Management within 24 hours and written notification shall be submitted within 15 days. Verbal and written notification shall be submitted to:

Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
1646 Mail Service Center
Raleigh, North Carolina 27699-1646
(919) 508-8400

Section 7 – Access and Safety Requirements

Operation Plan

7.1 Landfill Access and Security

In accordance with 15A NCAC 13B .1626 (6) (a), the Buncombe County Subtitle D Landfill provides adequate security by means of gates, chains, berms, fences and other security measures approved by the Division of Waste Management to prevent unauthorized entry.

All vehicles disposing of waste at the facility enter and leave through the access control gate. All waste entering the landfill must be weighed in at the scalehouse where a full-time Scale Operator verifies compliance with operation requirements. Unauthorized vehicle access to the site is prevented around the remaining portion of the landfill property by woods, natural topography, and storm water ditches.

7.2 Attendant

In accordance with 15A NCAC 13B .1626 (6) (b), an attendant is on duty at the site at all times while the facility is open for public use to ensure compliance with operational requirements.

A full-time Scale Operator is located in the scale house during operating hours. The Scale Operator verifies compliance with operation requirements. In addition, a Facility Supervisor is present on-site at all times during operation.

7.3 Access Road

In accordance with 15A NCAC 13B .1626 (6) (c), the access road to the site was constructed for all-weather conditions and maintained in good condition. Potholes, ruts, and debris on the roads will receive immediate attention in order to avoid damage to vehicles. Access roads are regraded as necessary to maintain positive slope for adequate drainage.

7.4 Dust Control

In accordance with 15A NCAC 13B .1626 (6) (d), dust control measures are implemented when necessary. Minimum dust control includes a water truck for wetting of dusty roads. Petroleum products are not used for dust control.

7.5 Signs

In accordance with 15A NCAC 13B .1626 (6) (e), a sign providing information on disposal procedures, operation hours, tipping fee, permit number, and other pertinent information is clearly posted at the site entrance.

In accordance with 15A NCAC 13B .1626 (6) (f), a sign is clearly posted stating that no hazardous or liquid waste can be received.

In accordance with 15A NCAC 13B .1626 (6) (g), traffic signs or markers are provided as necessary to promote an orderly traffic pattern to and from the discharge area and to maintain efficient operating conditions.

7.6 Waste Removal Scavenging Policy

In accordance with 15A NCAC 13B .1626 (6) (h), the removal of solid waste from the landfill is prohibited unless the County approves and the removal is not on the working face.

7.7 Barrel and Drum Disposal

In accordance with 15A NCAC 13B .1626 (6) (i), barrels and drums are not disposed of unless they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained therein.

Section 8 – Erosion and Sediment Control Requirements Operation Plan

8.1 Control of Sediment

In accordance with 15A NCAC 13B .1626 (7) (a), adequate sediment control measures shall be utilized to capture and control sediment in order to prevent sediment from impacting wetlands and off-site properties.

Surface water runoff passing through the landfill site is diverted to sediment ponds by the use of ditches, berms, and pipes as shown on the Engineering Plan Drawings. Stormwater sediment ponds shall be constructed in accordance with the approved Sediment and Erosion Control Plan for control of on-site stormwater run off and sediment transport from landfill operation.

The sediment ponds have been designed in such a manner that releases will not overload downstream drainage features or damage adjacent property. Sediment accumulated in the ponds shall be removed as specified in the approved Erosion Control permit. Silt gages shall be installed in all ponds as shown on the Detail Sheets in the Engineering Plan. Ditches require frequent inspection for sediment buildup. At a minimum, the sediment buildup should be assessed after all significant rain events.

8.2 On-Site Erosion Control

In accordance with 15A NCAC 13B .1626 (7) (b), adequate erosion control measures, shall be utilized to prevent excessive on-site erosion of slopes and roadways.

Erosion control measures shall include:

A. Disturbing as little area as practical at any one time for landfilling operations.

B. Seeding/mulching of all disturbed areas commencing as soon as practically possible. Employing erosion netting or sod on steep slopes and other erosion prone areas.

C. Use of earthen berms, hay bales, silt fences, riprap or equivalent devices down- gradient of disturbed areas, stockpiles, around drainage pipes inlets and outlets and at intervals along grassed waterways, until such time as permanent vegetation is established.

D. Placement of riprap at the inlets and outlets of storm water piping.

8.3 Vegetative Cover

In accordance with 15A NCAC 13B .1626 (7) (c), vegetative ground cover sufficient to restrain erosion must be established within 30 working days or 120 calendar days upon completion of any phase of landfill development.

Riprap, haybales, or other acceptable temporary methods of erosion control may be required until permanent cover is established. Areas where final grade has been reached can be stabilized by mulching until a vegetative cover is established. 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.

Temporary seeding shall be applied in accordance with the current NC Erosion and Sediment Control Planning and Design Manual.

Section 9 – Drainage Control and Water Protection Requirements

Operation Plan

9.1 Surface Water Diverted From Operation Area

In accordance with 15A NCAC 13B .1626 (8) (a), surface water shall be diverted from the operational area. Excessive surface water at the working face creates difficulties for maneuvering equipment and prevents the operator from achieving maximum compaction of the waste. To divert surface runoff away from the working face, temporary diversion berms shall be installed on the current lift, up-gradient from the working face and in other locations as dictated by the direction of grade. The area between the temporary berm and the working face should be limited to one acre to prevent excessive ponding. The soil cover in the areas beyond the diversion berms shall be uniformly graded and compacted to prevent the formation of erosion channels. In the event that channels do form, the cover shall be promptly repaired. During the formation of the initial lift of each disposal unit additional measures shall be employed to divert surface water.

For portions of the disposal unit that have not yet received waste, surface water will be diverted by the stormwater segregation system located in the southern half of Phase IV as shown on the Engineering Plan Drawings. Since the surface water that will pond at the stormwater segregation area is clean stormwater, it can pumped from the disposal unit to the stormwater management system.

Prior to disposal activity moving into the southern area, County staff will remove the stormwater segregation berm, tarp, and pumping system.

9.2 Surface Water Shall Not Be Impounded Over Waste

In accordance with 15A NCAC 13B .1626 (8) (b), surface water shall not be impounded over or in waste. Completed areas shall be adequately sloped at a minimum of 4% to allow surface water runoff in a controlled manner.

9.3 Waste Shall Not Be Disposed Of In Water

In accordance with 15A NCAC 13B .1626 (8) (c), solid waste shall not be disposed of in water. Based on design, the minimum four foot separation from the seasonal high groundwater table to the bottom of the liner system will be maintained at all times.

9.4 Leachate Collection and Disposal

In accordance with 15A NCAC 13B .1626 (8) (d), leachate shall be contained on-site or properly treated prior to discharge. An NPDES permit is required for surface discharge prior to discharge of leachate to surface waters.

Leachate generated will be collected and disposed in accordance with the leachate management plan provided in Section 13.

9.5 Leachate Discharge

In accordance with 15A NCAC 13B .1626 (8) (e) (i), MSWLF units shall not cause a discharge of pollutants into waters of the United States, including wetlands, that violate any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements, pursuant to Section 402.

In accordance with 15A NCAC 13B .1626 (8) (e) (ii), MSWLF units shall not cause a discharge of a nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirement of an area-wide or State wide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended.

Leachate generated is contained on-site. The management system is discussed in Section 13.

Section 10 – Liquid Restrictions

Operation Plan

Liquid waste is defined as any waste material that is determined to contain "free liquid" as defined by Method 9095 (Paint Filter Liquids Test). A description of how to conduct a paint filter test is included in Section 10.3.

10.1 Bulk or Non-Containerized Liquid Waste

In accordance with 15A NCAC 13B .1626 (9) (a), bulk or non-containerized liquid waste may not be placed in a MSWLF unit unless:

- The waste is liquid household waste other than septic waste and waste oil.
- The waste is leachate or gas condensate from gas recovery derived from the MSWLF unit, whether it is a new or existing MSWLF unit or lateral expansion, is designed with a composite liner and leachate collection system per North Carolina Solid Waste Management Rules (Rule .1624).

10.2 Containerized Liquid Waste

In accordance with 15A NCAC 13B .1626 (9) (b), containers holding liquid wastes may not be placed in MSWLF units unless:

- The container is small and similar in size to that normally found in household waste containing liquid waste,
- The container is designed to hold liquids for use other than storage; and,
- The waste is household waste.

10.3 Paint Filter Test

According to 40 CFR 264.314 and 265.314, the placement of any liquid which is not a hazardous waste in a landfill is prohibited unless the owner or operator of such landfill demonstrates to the Regional Administrator, or the Regional Administrator determines that:

- The only reasonably available alternative to the placement in such landfill is placement in a landfill or unlined surface impoundment, whether or not permitted or operating under interim status, which contains, or may reasonably be anticipated to contain, hazardous waste.
- Placement in such landfill will not present a risk of contamination of any underground source of drinking water.

To demonstrate the absence or presence of free liquids in either a containerized or bulk waste, the following test must be used: Method 9095 (Paint Filter Test). This method is used to determine compliance with 40 CFR 264.314 and 265.314.

To conduct the Paint Filter Tests, a pre-determined amount of material is placed in a paint filter. If any portion of the material passes through and drops from the filter within the 5-minute test period, the material is deemed to contain free liquids. The test apparatus and materials are presented in Figure 10-1. The paint filter is required to be a conical paint filter mesh number 60 (fine meshed size). If the paint filter, with the waste, cannot sustain its weight on the ring stand, then a fluted glass funnel or glass funnel with a mouth large enough to allow at least 1 inch of the filter mesh to protrude should be used to support the filter. The funnel is to be fluted or have a large open mouth in order to support the paint filter yet not interfere with the movement, to the graduated cylinder, of the liquid that passes through the filter mesh.

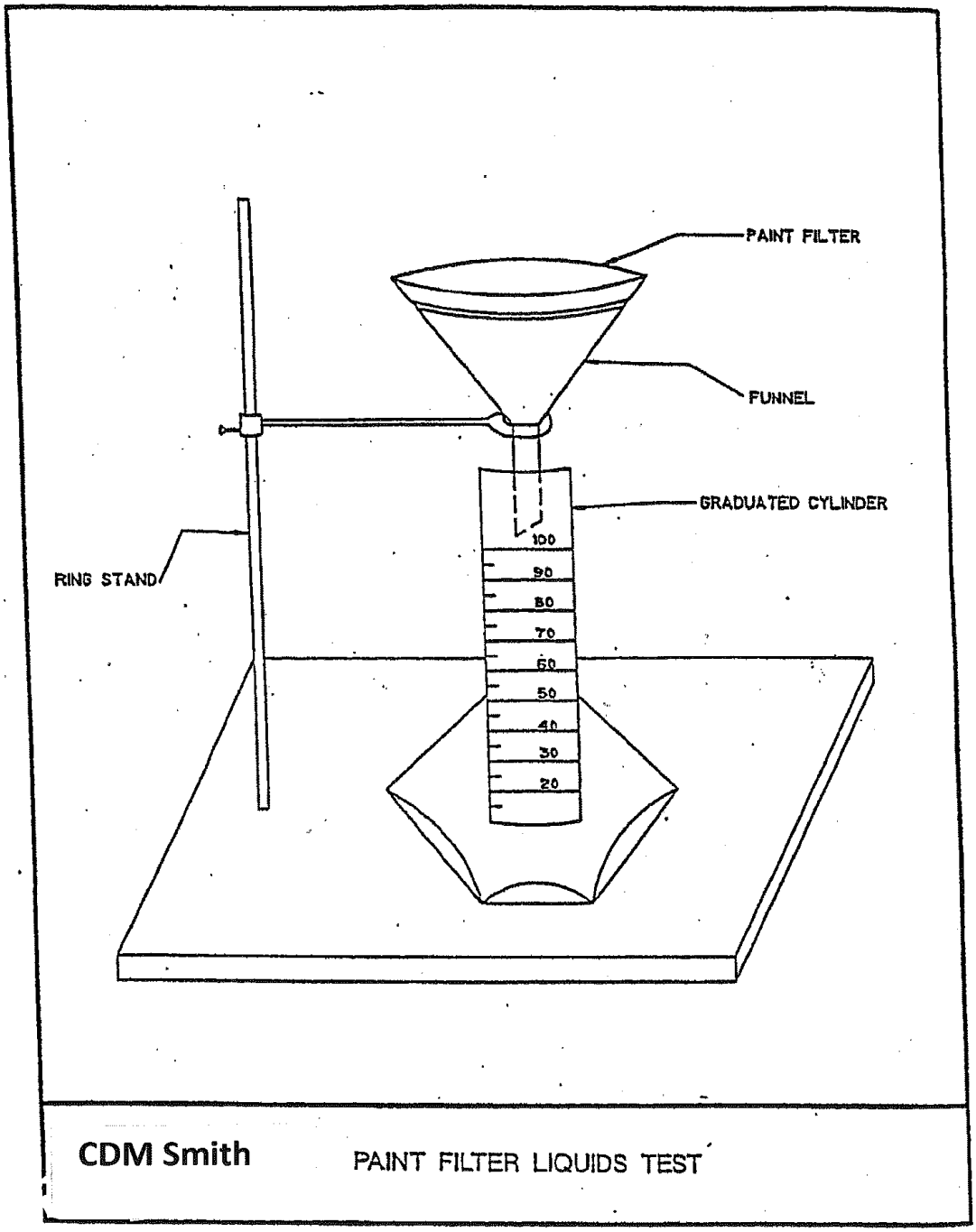

PAINT FILTER
FUNNEL
GRADUATED CYLINDER
RING STAND
100
90
80
70
60
50
40
30
20
CDM Smith
PAINT FILTER LIQUIDS TEST

Figure 10-1

Section 11 – Recordkeeping Requirements

Operation Plan

11.1 Regulatory Requirements

In accordance with 15A NCAC 13B .1626 (10), the owner or operator of a MSWLF unit must record and retain at the facility, or an alternative location near the facility approved by the Division, the following information as it becomes available:

- Inspection records, waste determination records, and training procedures;
- Amount by weight of solid waste received at the facility to include source of generation;
- Gas monitoring (methane monitoring) results and any remediation plans;
- Any demonstration, certification, findings, monitoring, testing, or analytical data required for groundwater monitoring requirements, groundwater monitoring systems, groundwater sampling and analysis requirements, detection monitoring, assessment monitoring, assessment of corrective measures, selection of remedy, and implementation of corrective action program;
- Any monitoring, testing, or analytical data required for Closure and Post-Closure Plans;
- Any cost estimates and financial assurance documentation required by financial assurance requirements;

All information contained in the operating record must be furnished upon request to the Division or be made available at all reasonable times for inspection by the Division. The owner or operator must maintain a copy of the operation plan required by Rule .1625 at the facility.

The County will keep all required documentation either at the scale house or administration building at the facility entrance.

11.2 Permit File

A file containing all appropriate permits should be kept on site. The file shall include the following permits at the minimum:

- Current solid waste permits (Permit to Construct and Permit to Operate);
- Sediment and Erosion Control Permits;
- Applicable NPDES Stormwater Permits; and
- Applicable leachate disposal permit

Section 12 – Spreading and Compacting of Waste Operation Plan

12.1 Solid Waste Working Area

In accordance with 15A NCAC 13B .1626 (11) (a), operators shall restrict solid waste within MSWLF units to the smallest area feasible. The working face is defined as where waste is unloaded, inspected, spread, compacted, and ultimately covered with cover material. The working face shall be wide enough to prevent a backlog of vehicles waiting to unload and to allow adequate working space for landfill equipment. At a maximum, the width of the working face shall not exceed 100 feet.

12.2 Solid Waste Compaction

In accordance with 15A NCAC 13B .1626 (11) (b), solid waste shall be compacted as densely as practical into cells. After solid waste is discharged from vehicles, it shall be inspected for unacceptable items and subsequently spread on the working face not steeper than four feet horizontal to one foot vertical in layers not to exceed 2 feet in thickness. All areas of each layer shall be compacted by at least four passes of a compactor in order to achieve a minimum waste density of approximately 1,000 pounds per cubic yard.

12.3 Controlling Wind Blown Material

In accordance with 15A NCAC 13B .1626 (11) (c), appropriate methods such as fencing and diking shall be provided as needed within the landfill area to confine solid waste subject to be blown by the wind.

Portable litter screens shall be placed downwind of the working face as needed. The screens shall be kept as close to the working area as possible without unduly interfering with landfill operations. The screens shall be moved promptly when required by change in wind direction or progress of the fill. Additional screens or alternative measures may be required to prevent blowing litter from escaping the working area.

At the conclusion of each day of operation, windblown material at the landfill site shall be collected and returned to the working face.

Section 13 – Leachate Management Plan

Operation Plan

This plan has been prepared in accordance with Rule .1626 (12) and the Leachate Spill Corrective Action/Permit to Operate dated July 2008.

13.1 Maintenance and Inspection of the Leachate Pond and Collection System

The maintenance plan has been prepared in accordance with Rule .1626 (12) (a).

13.1.1 System Design

The leachate collection pipes within the municipal solid waste landfill (MSWLF) cells convey collected leachate by gravity to a sump area, where a submersible pump pumps leachate to the lined leachate pond located south of the landfill. Cleanouts are located at the upstream ends of the collection pipes, and at the sump area low point. A submersible pump at the leachate pond can pump leachate through a flow metering vault, to a truck loading station, where tank trucks can be filled to haul leachate to the Metropolitan Sewerage District (MSD) wastewater treatment plant. The pond serves as an equalization basin to absorb peak flows coming from the submersible pumps in each cell.

Each leachate pump station is provided with numerical identification at the leachate pump control panel. One pump control panel is provided for each submersible leachate pump station and is provided in a common enclosure. The control panel is programmed to respond to the liquid level sensor to automatically start and stop pumps in response to changes in liquid levels and to allow manual control of the sump when needed. Each control panel is equipped with visual and audible high level alarms programmed to activate when the leachate levels exceed one foot of head.

13.1.2 Leachate Pond

Inspection of the leachate pond constructed, visible surfaces are made on an annual basis by County staff. Any stored leachate and sediment in the pond is removed so that the pond bottom is visible. The inspector performs a thorough walkover of the pond bottom, surveying the protective layer for any signs of damage, such as cracks, tears, gouges, uplift, or soft spots. Observations are recorded and photographs taken of the areas of concern and placed in the operating record.

If damage or potential problems are discovered, they should be reported to the facility supervisor so that repairs may be made as soon as possible. All repair activities should be recorded. The pond should be put back on-line as soon as possible, to minimize leachate storage time within the sump areas in the cells.

13.1.3 Leachate Collection System

The perforated leachate collection piping will be pressure cleaned and flushed to remove any accumulation of debris, sediment, or organic growth, which will be achieved by inserting a self-propelled, high pressure jetting system into the collection pipes by way of the clean-out ports. Remote camera inspections and cleaning of the leachate collection lines shall occur, following after construction, and at least once every five years thereafter.

The sump control panels are visually inspected during weekly leachate quantity data collection to ensure proper audio and visual alarm operations, reset functions and normal operations performance. Any components not properly functioning shall be promptly repaired or replaced.

Flow meter operation is validated by comparing the recorded flows at each individual sump. Flow meters not properly operating will be removed and replaced.

The operator also, on a weekly basis, visually observes the landfill sideslopes for leachate breakouts and the perimeter berm for staining, which would indicate a potential pipe failure. All exposed leachate piping shall also be monitored for leaks.

In addition to weekly observations, the operator, after substantial rainfall events equal to or exceeding ½ inch, observes the landfill sideslopes for leachate breakouts, leaks or pipe failures.

13.2 Leachate Monitoring

13.2.1 Quantitative Monitoring

Per Rule .1626 (12) (b), the County maintains leachate generation records. Each sump pump station is designed with a flow meter to measure the leachate generated from each cell. The operator reads and registers the leachate flows on a weekly basis at each of the sump pump stations.

The information collected includes the date, time, leachate quantity (in gallons), pump run time, leachate levels, and the name of the person taking measurements. Weekly measurements recorded at each sump pump station are used to detect potential pump malfunction. While taking weekly sump readings the operator also records the leachate level within the leachate pond. Should the leachate pond minimum freeboard level of 12 inches be exceeded, the NCDENR will be notified immediately.

Leachate that is trucked off-site is also recorded.

13.2.2 Qualitative Monitoring

Per Rule .1626 (12) (c) semi-annual leachate quality sampling is required and is completed by the County.

13.2.3 Recordkeeping

All records are maintained at the landfill by the operator and made available to Solid Waste Section (SWS) personnel for inspection when requested.

13.3 Leachate Disposal Approval

Per Rule .1626 (12) (d), approval for final leachate disposal is required. Leachate from the landfill is pumped from the leachate pond to the truck loading station, which fills trucks used to haul the leachate to the MSD sanitary sewer system for final disposal. An approval letter from MSD stating that they will accept the landfill leachate is included in the operating records.

13.4 Leachate Management Contingency Plan

The leachate management contingency plan is prepared in accordance with Rule .1626 (12) (e).

13.4.1 Leachate Sump Pump Station

Should a pump station not appear to be functioning properly, based upon weekly monitoring records, the pump will be removed and evaluated in accordance with manufacturer recommendations. If troubleshooting techniques do not provide a prompt resolution, one of the spare pumps located on-site will be installed in its place and necessary repairs will be made.

Should power be lost at the site, the pump station control panels are equipped with receptacles for a portable emergency generator to operate the pump stations until power is restored. A portable emergency generator will be available within 12 hours and used in the event of a power outage.

13.4.2 Leachate Storage

During periods when components of the leachate pond pump station are inoperative or down for maintenance, or when storm flows are extremely high, excessive leachate will be dealt with using either of two contingency plans.

The storage capacity of the leachate pond is approximately 1,000,000 gallons, when completely full to within 12 inches of the top of the pond liner. This will provide up to 17 days of storage during peak leachate flow periods, and about 69 days storage for average annual daily flows. If surface evaporation rates are considered, even longer storage periods can be achieved. This volume is also adequate to capture the leachate from the peak rainfall event from the five years of rainfall data used in the HELP model leachate projections (assuming several acres of open cell area with only the first solid waste lift installed) and still have reserve capacity for additional daily flows. Therefore, considerable storage capability is provided by the leachate pond for periods of unusually high precipitation or unusual operating conditions.

Should a period of substantial rainfall persist, and the leachate pond approach full stage, the pumping stations can be turned off. The leachate would be temporarily stored in the disposal cells until the level in the pond is adequately reduced. The cells would be monitored daily to ensure that overflow does not occur. If the leachate pond encroaches to within 6 inches of the ponds 12-inch freeboard (18 inches from the top of the pond liner), leachate hauling will be increased to a frequency adequate to deplete the leachate volume in the storage pond to an acceptable level.

Should power be lost at the site, the pump station control panel at the leachate pond is equipped with receptacles for a portable emergency generator, to operate the pumps long enough to control leachate flow volumes. A portable emergency generator will be available within 12 hours of a power outage.

13.4.3 Leachate Breakout

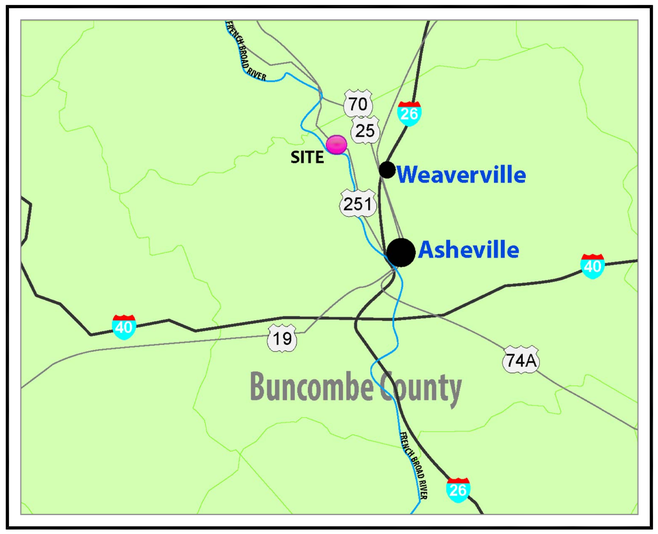
In the event of a breakout, leak or pipe failure, the County will immediately notify SWS and identify the areas contaminated by the breakout/leak/pipe failure, if any. Should leachate collect in a sediment pond or other surface waters, the County will analyze the contaminated water for the Appendix 1 list of constituents and BOD5, COD, phosphate, nitrate and sulfate. The sample results will be forwarded to SWS and used to determine whether the pond or surface waters are impacted by the release.

Operation Plan

Appendix 5A – Operation Drawings

BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION
SUBTITLE D LANDFILL - PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

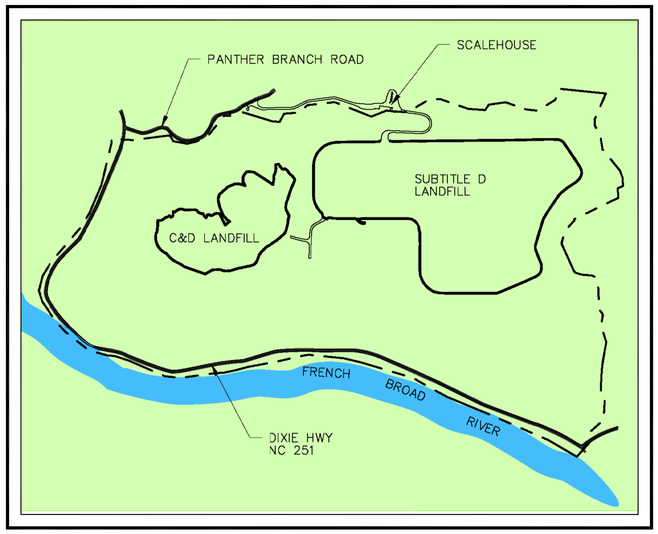


LOCATION MAP

NOT TO SCALE

INDEX OF DRAWINGS

OP-1	EXISTING CONDITIONS
OP-2	PROGRESSION OF CONSTRUCTION CELLS
OP-3	LEACHATE AND STORMWATER CONTROL
OP-4	OPERATION PLAN I – YEAR ONE
OP-5	OPERATION PLAN II – CELL 7 NORTH MAXIMUM ELEVATION
OP-6	OPERATION PLAN III – YEAR TWO
OP-7	OPERATION PLAN IV – YEAR THREE
OP-8	OPERATION PLAN V – YEAR FOUR
OP-9	OPERATION PLAN VI – YEAR FIVE



VICINITY MAP

NOT TO SCALE

APRIL 2014

PREPARED BY

CDM Smith

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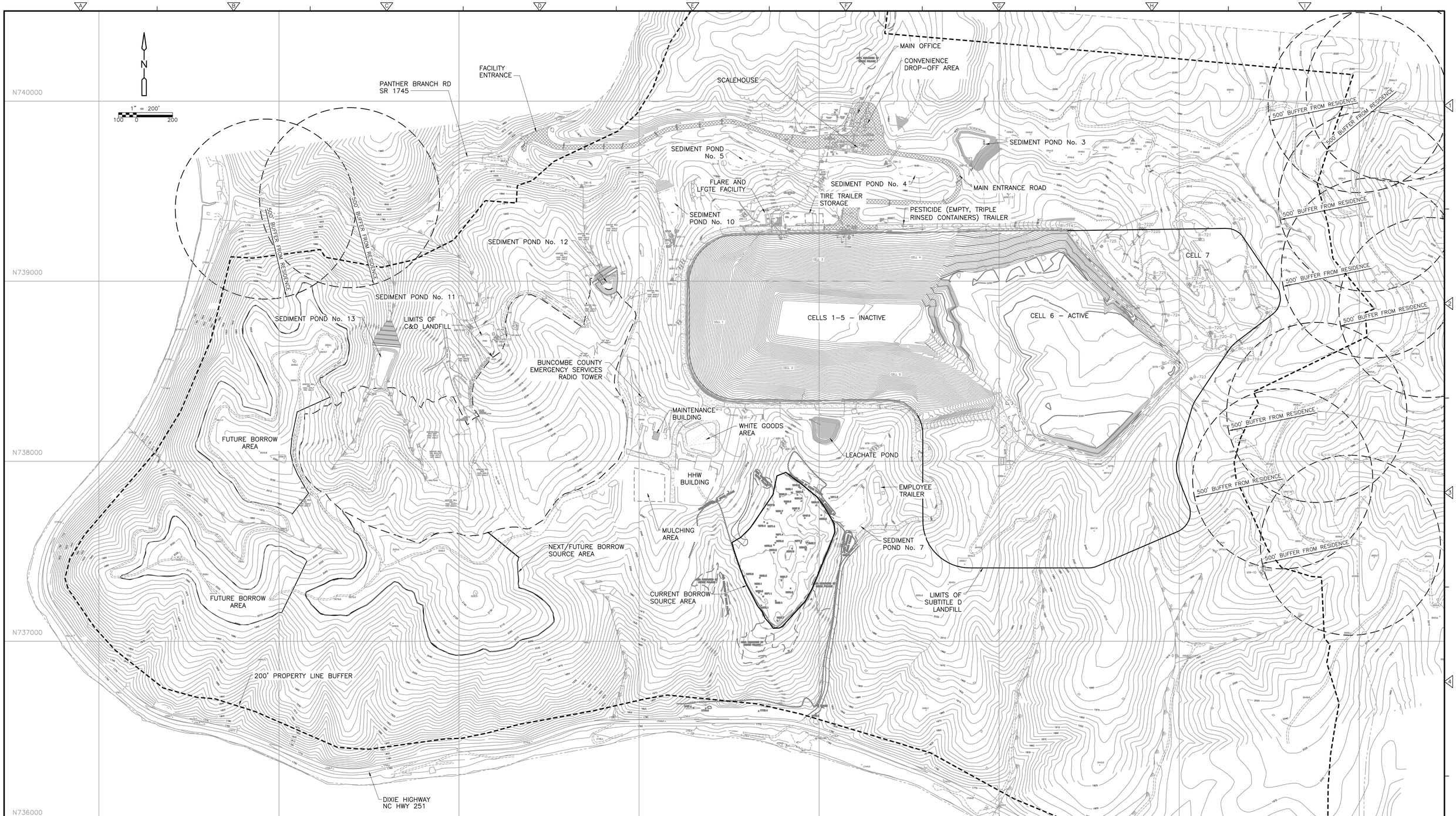
NC F-1255

6447–97693

PERMIT DRAWINGS



NOTES

1. SURVEY OF MSW LANDFILL (CELLS 1-5) BY ED HOLMES AND ASSOCIATES DATED APRIL 2008. SURVEY OF MSW LANDFILL (CELL 6) BY ED HOLMES AND ASSOCIATES DATED AUGUST 2010. SURVEY C&D LANDFILL BY ED HOLMES AND ASSOCIATES DATED JUNE 2008. SURVEY OF MSW LANDFILL (CELL 7) BY ED HOLMES AND ASSOCIATES DATED SEPTEMBER 2012.
2. TOPOGRAPHY OUTSIDE OF MSW AND C&D BOUNDARY LIMITS DERIVED FROM AERIAL SURVEY PROVIDED BY AERODYNAMICS, CHARLOTTE, N.C. JULY 1993.
3. NORTH CAROLINA 1983 GRID DATUM.
4. THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS FOR 1"=100' SCALE, 10' CONTOUR INTERVAL.
5. CONTOURS WITHIN DENSE FOLIAGE AREAS INDICATE DOUBTFUL ACCURACY DUE TO OBSCURED VIEW FROM VEGETATION, SHADOWS, ETC.

LEGEND

- 2010 — INDEX CONTOUR
- PROPERTY LINE
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE
- 200' PROPERTY LINE BUFFER
- MW-10 — EXISTING GROUNDWATER MONITORING WELL
- M-3 — EXISTING METHANE MONITORING WELL
- SW-2 — SURFACE WATER MONITORING LOCATOIN

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

EXISTING CONDITIONS

PROJECT NO. 6447-97693
FILE NAME: OP-1.DWG
SHEET NO.
OP-1

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NOTES:

1. TOPOGRAPHY OUTSIDE OF MSW AND C&D BOUNDARY LIMITS DERIVED FROM AERIAL SURVEY PROVIDED BY AERODYNAMICS, CHARLOTTE, N.C. JULY 1993.
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CONSTRUCTION SEQUENCE
CELL 7
CELL 9
CELL 10
CELL 8

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
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APPROVED BY: K. YANG
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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

PROGRESSION OF CONSTRUCTION CELLS

PROJECT NO. 6447-97693
FILE NAME: OP-2.DWG
SHEET NO.
OP-2

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REMOVE BLIND FLANGES/CAP AND CONNECT NEW 24-INCH GAS, 6-INCH LEACHATE, 6-INCH LEACHATE RECIRC, AND 1-INCH COMPRESSED AIR TO EXISTING PIPING

CONDENSATE RECOVERY SYSTEM

END 1-INCH COMPRESSED AIR AT CONDENSATE RECOVERY SYSTEM

PERIMETER BERM PIPING
24-INCH GAS
6-INCH LEACHATE
6-INCH LEACHATE RECIRC
1-INCH COMPRESSED AIR

LEACHATE PUMP STATION

END 6-INCH LEACHATE RECIRC WITH WELDED END CAP

SPRING HOUSE

LEACHATE CLEANOUT/GAS MAIN CONNECTION

375 LF -10" HDPE PERFORATED PIPE

390 LF -10" HDPE PERFORATED PIPE

LEACHATE COLLECTION PIPE (TYP)

SUMP

EXISTING PIPING:
24-INCH GAS
6-INCH LEACHATE
6-INCH LEACHATE RECIRC
1-INCH COMPRESSED AIR

LIMITS OF GROUNDWATER MONITORING SYSTEM

LEACHATE COLLECTION PIPE (TYP)

24-INCH GAS

DIVERSION BERM

LEACHATE CLEANOUT (TYP 7)

STORMWATER PUMPING SYSTEM

950 LF -10" HDPE PERFORATED PIPE

470 LF -10" HDPE PERFORATED PIPE

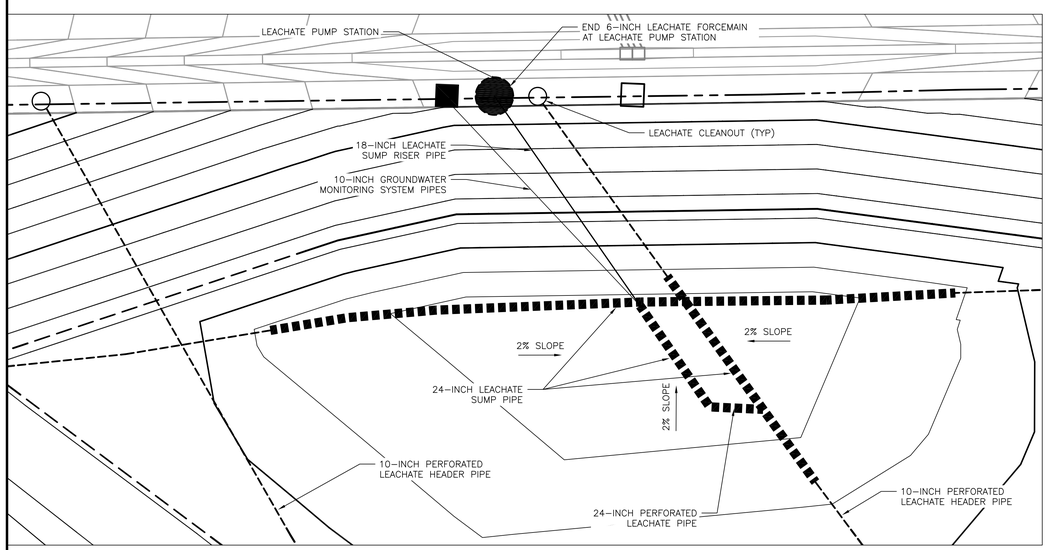
CELL 6
(ACTIVE)

PHASE IV
(CELL 7)

296 LF -10" HDPE PERFORATED PIPE

635 LF -10" HDPE PERFORATED PIPE

END 24-INCH GAS WITH WELDED CAP



SUMP
DETAIL A
1" = 20'

1" = 20'
10 0 20

N
1" = 40'
20 0 40

LEGEND

- EXISTING INDEX CONTOUR
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE

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REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

LEACHATE AND STORMWATER CONTOL

PROJECT NO. 6447-97693
FILE NAME: OP-3.DWG
SHEET NO.
OP-3

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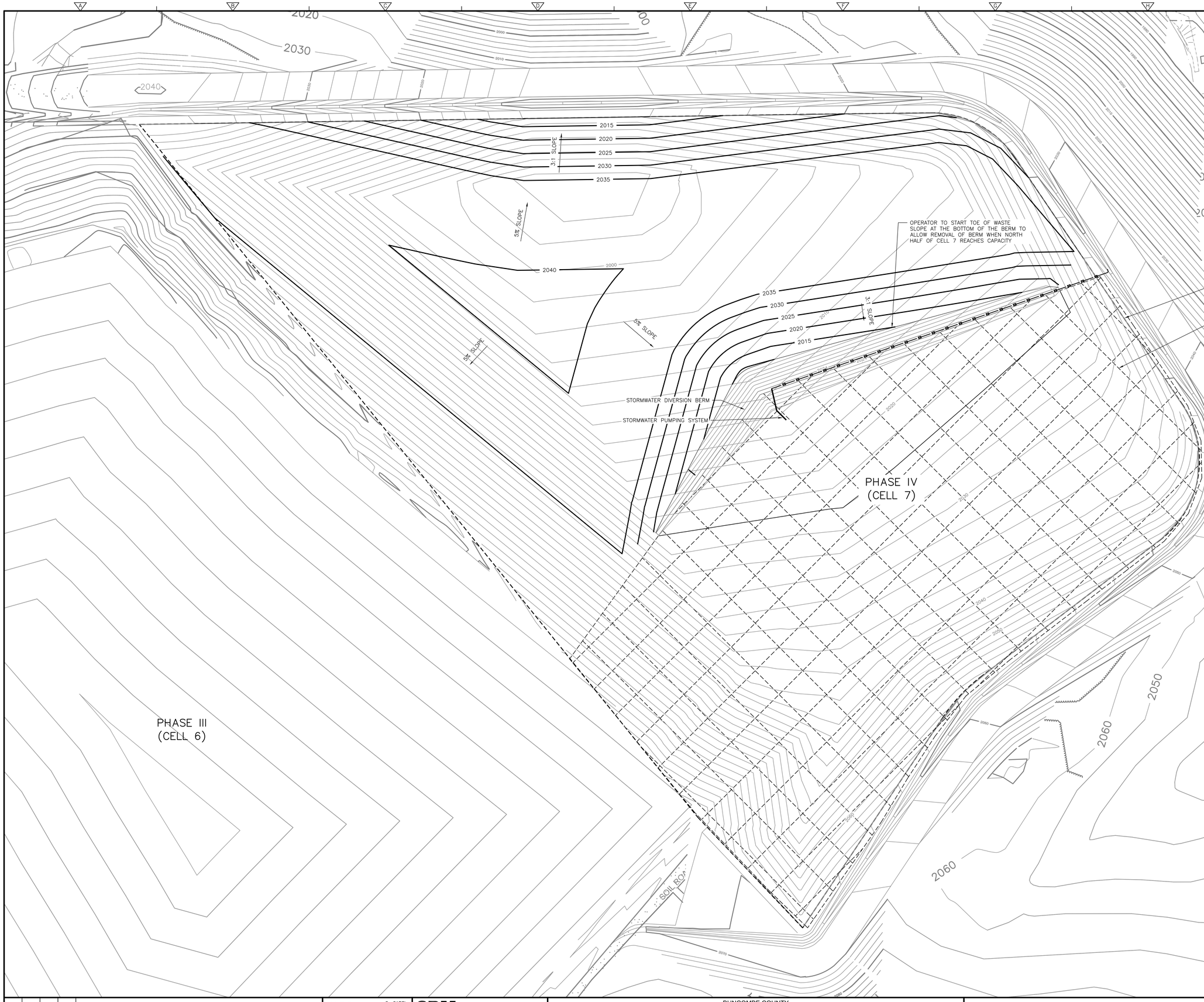

N

1" = 40'

20 0 40

LEGEND

2020	PROPOSED CONTOUR
2010	EXISTING INDEX CONTOUR
	STONE ROAD

NOTES:

1. OPERATION PLAN I VOLUME = 220,000 CU YDS.
2. PROPOSED CONTOURS SHOWN ARE TOP OF INTERMEDIATE COVER.
3. EXISTING CELL 7 CONTOURS SHOWN ARE TOP OF PROTECTIVE COVER.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

OPERATION PLAN I - YEAR ONE

PROJECT NO. 6447-97693
FILE NAME: OP-4.DWG

SHEET NO.
OP-4

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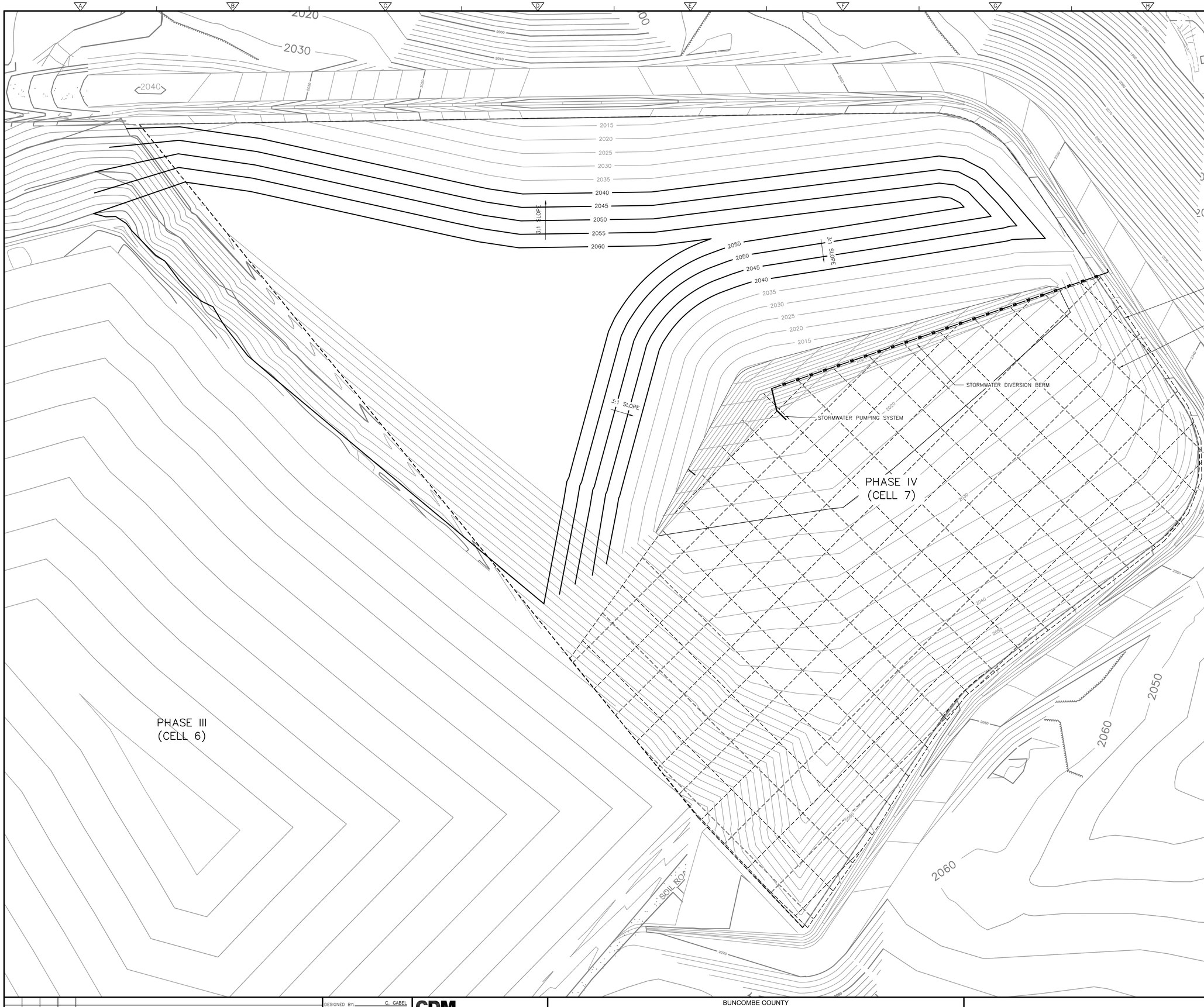

N

1" = 40'

20 0 40

LEGEND

2020	PROPOSED CONTOUR
2010	EXISTING INDEX CONTOUR
	STONE ROAD

NOTES:

1. OPERATION PLAN II VOLUME = 124,000 CU YDS.
2. PROPOSED CONTOURS SHOWN ARE TOP OF INTERMEDIATE COVER.
3. EXISTING CELL 7 CONTOURS SHOWN ARE TOP OF PROTECTIVE COVER.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
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PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

OPERATION PLAN II - CELL 7 NORTH MAXIMUM ELEVATION

PROJECT NO. 6447-97693
FILE NAME: OP-5.DWG

SHEET NO.
OP-5

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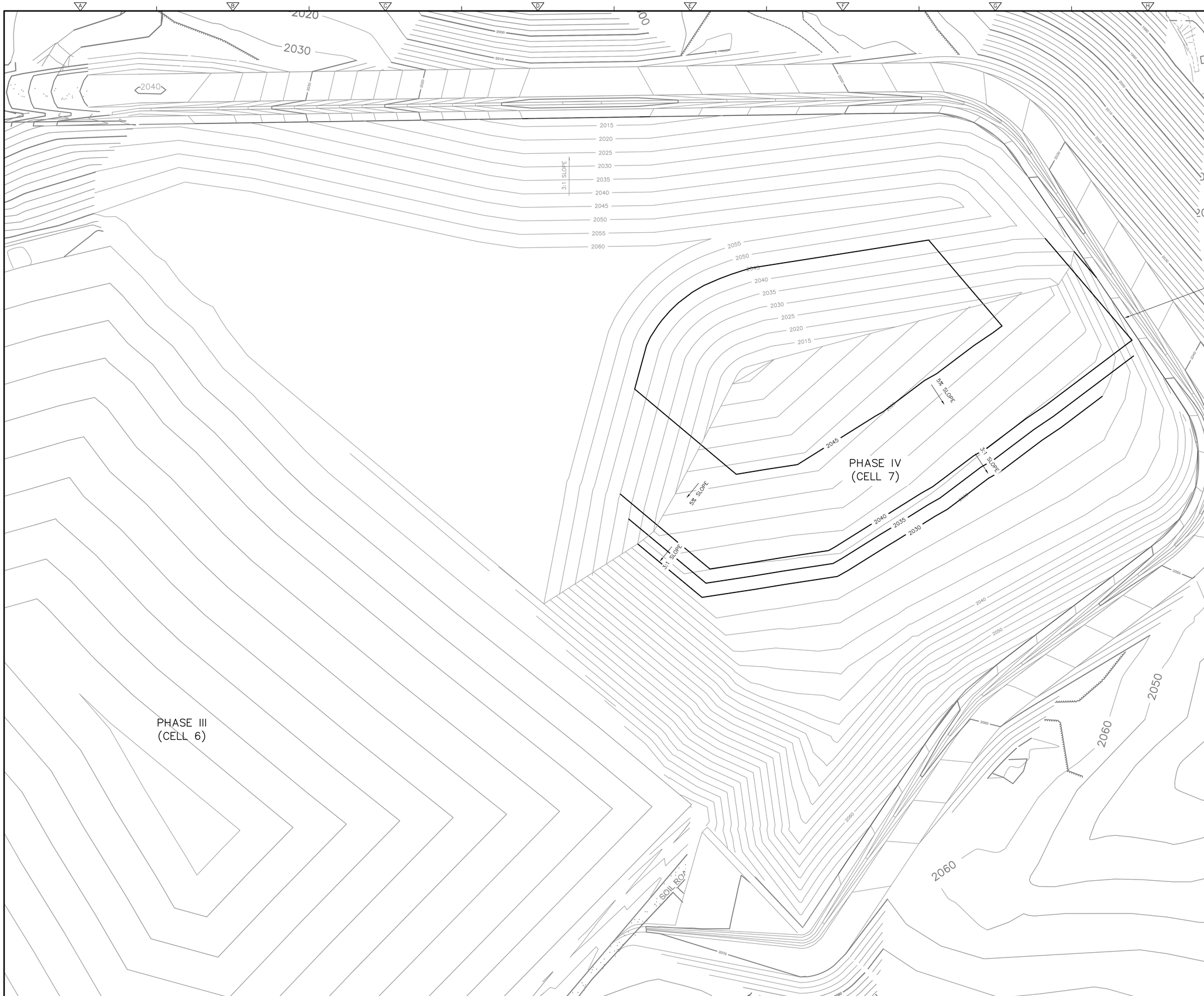

N

1" = 40'

20 0 40

LEGEND

2020	PROPOSED CONTOUR
2010	EXISTING INDEX CONTOUR
	STONE ROAD

NOTES:

1. OPERATION PLAN III VOLUME = 102,000 CU YDS.
2. PROPOSED CONTOURS SHOWN ARE TOP OF INTERMEDIATE COVER.
3. EXISTING CELL 7 CONTOURS SHOWN ARE TOP OF PROTECTIVE COVER.
4. REMOVE STORM WATER SEGREGATION SYSTEM.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

CDM Smith
Camp Dresser McKee & Smith
5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612 | Tel: (919) 787-5620
NC F-1255

BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

OPERATION PLAN III - YEAR TWO

PROJECT NO. 6447-97693
FILE NAME: OP-6.DWG

SHEET NO.
OP-6

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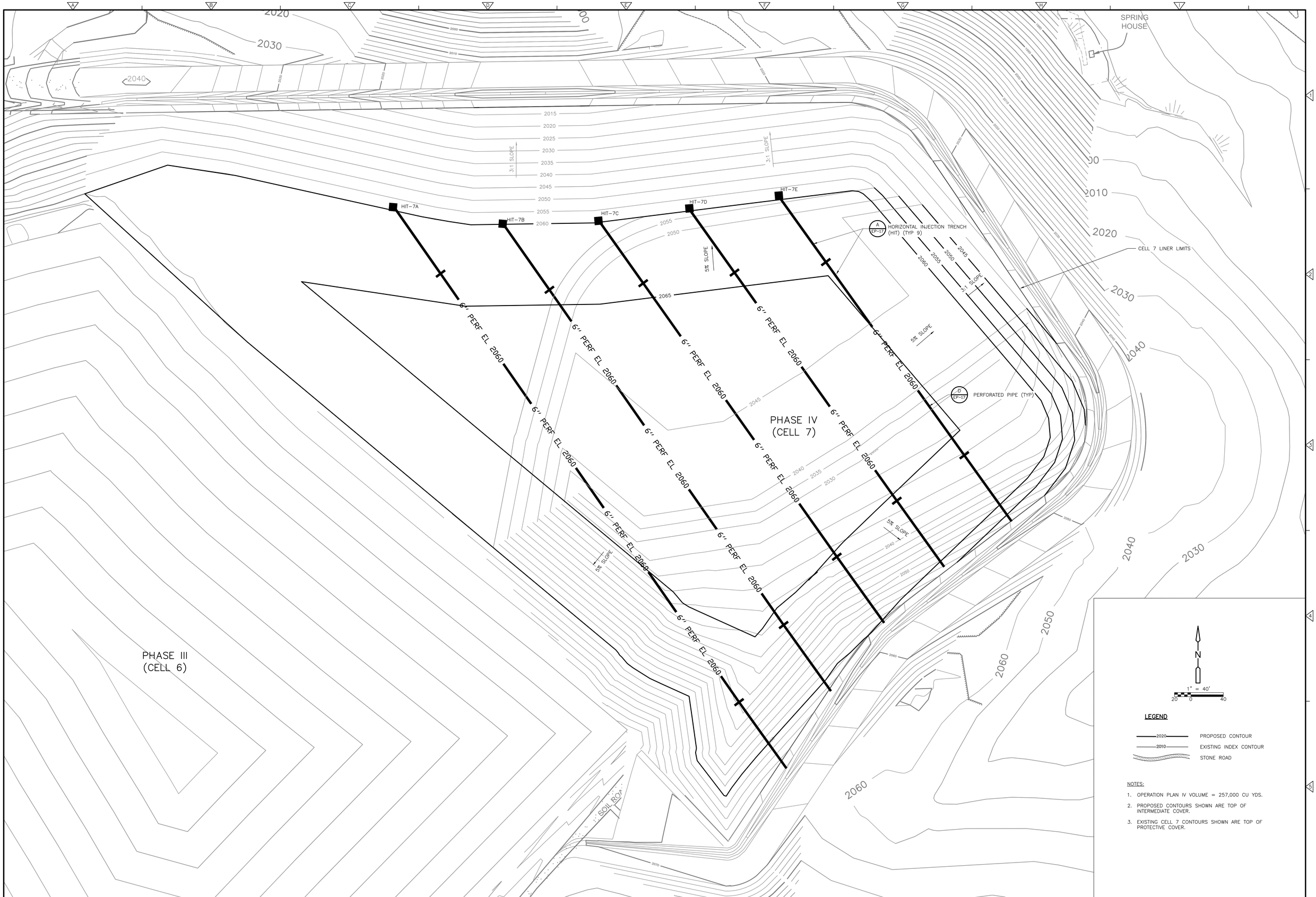

NOTES:

1. OPERATION PLAN IV VOLUME = 257,000 CU YDS.
2. PROPOSED CONTOURS SHOWN ARE TOP OF INTERMEDIATE COVER.
3. EXISTING CELL 7 CONTOURS SHOWN ARE TOP OF PROTECTIVE COVER.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

OPERATION PLAN IV - YEAR THREE

PROJECT NO. 6447-97693
FILE NAME: OP-7.DWG
SHEET NO.
OP-7

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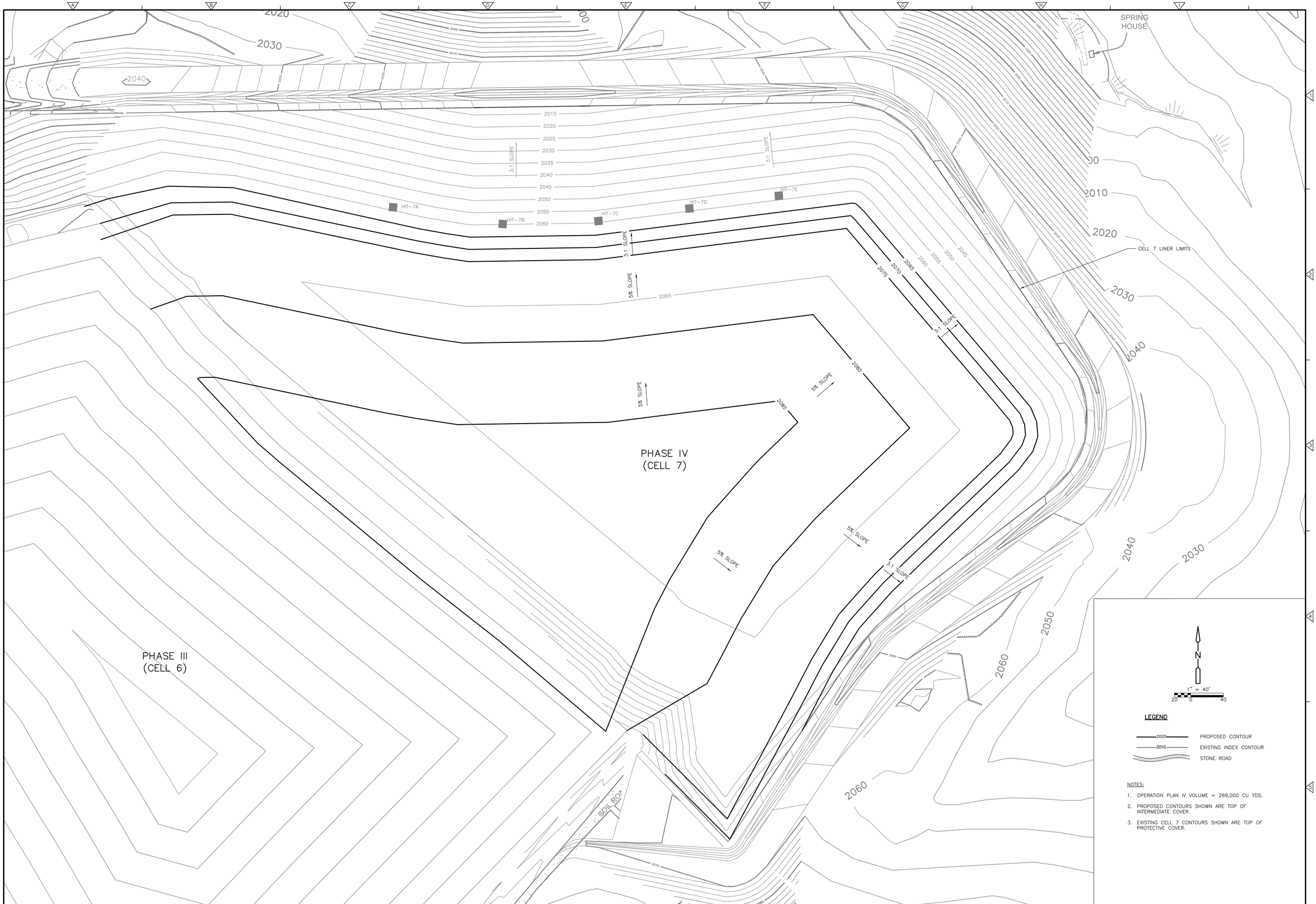

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REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: C. GABEL
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CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
DATE: APRIL 2014

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BUNCOMBE COUNTY
NORTH CAROLINA
BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY
PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

OPERATION PLAN V - YEAR FOUR

PROJECT NO. 6447-97693
FILE NAME: OP-8.DWG
SHEET NO.
OP-8

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REV. NO.	DATE	DRWN	CHKD	REMARKS

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DRAWN BY: M. KOSKI
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: C. GABEL
APPROVED BY: K. YANG
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BUNCOMBE COUNTY
NORTH CAROLINA
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PERMIT AMENDMENT APPLICATION, SUBTITLE D LANDFILL-PHASE IV (CELL 7)
OPERATION PLAN DRAWINGS

OPERATION PLAN VI - YEAR FIVE

PROJECT NO. 6447-97693
FILE NAME: OP-9.DWG
SHEET NO.
OP-9

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Operation Plan

Appendix 5B – Waste Screening Plan

CDM Smith

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Section 5B: 1 – Introduction

Appendix 5B – Waste Screening Plan
Operation Plan

This Waste Screening Plan sets forth the procedures and programs implemented by the solid waste management staff of Buncombe County to identify and safely dispose of unauthorized wastes brought to the County owned landfill. This plan also presents the procedures and policies established by the County that comply with state and federal regulations requiring random waste screening by owners of Municipal Solid Waste Landfills (MSWLF).

Buncombe County solid waste management staff manages the disposal of solid wastes in accordance with state and federal regulations and in a manner that protects the public health, safety, and welfare of the residents of Buncombe County. Some of the standard operating procedures at the landfill are designed to insure that unauthorized wastes, as defined by state and federal regulations, are not landfilled.

Current County programs and procedures fulfill some state and federal regulations for waste screening to detect or prevent landfilling of prohibited or unauthorized solid wastes. Some of these programs and facilities include:

- Hazardous waste awareness certification training for landfill staff
- County owned and operated drop-off facilities for lead acid batteries, yard wastes, white goods, and whole scrap tires

Section 5B: 2 – Overview of Waste Screening Plan

Appendix 5B – Waste Screening Plan
Operation Plan

This Waste Screening Plan presents the standard operating procedures at the County landfill. It presents the procedures and contingency plan that the County will implement to comply with applicable state and federal regulations.

This Waste Screening Plan:

- identifies the federal and state regulatory authority for prohibiting the landfilling of certain categories of solid waste;
- identifies and defines the wastes to which waste screening applies;
- describes the required training for facility personnel; and, describes the designated area to be used to screen waste loads;
- presents the procedures, decisions, and actions which will be taken if a waste load is suspected of containing or is found to contain a waste covered by this plan;
- explains how records of inspections will be kept and how notification of the proper authorities will take place if prohibited waste is discovered; and
- clarifies the financial and legal responsibility of the County and the waste haulers who brings the prohibited waste to the landfills.

Section 5B: 3 – Regulatory Background

Appendix 5B – Waste Screening Plan
Operation Plan

Federal, state, and county regulations each prohibit certain categories of waste from being landfilled. This section presents the regulatory authority prohibiting certain categories of waste from being landfilled and the requirement for waste screening.

5B: 3.1 Federal and State Regulations

US EPA Subtitle D, Subpart C Operating Criteria, 40 CFR Section 258.20 (Procedures for Excluding the Receipt of Hazardous Waste) and North Carolina State Solid Waste Management Rules Title 15A NCAC 13B .1626 (1)(f) require that owners or operators of all MSWLF units to implement a program at the facility for detecting and preventing the disposal of regulated quantities of hazardous wastes and polychlorinated biphenyls (PCB) waste. This program must include:

- random inspections of incoming loads,
- records of any inspections,
- training of facility personnel to recognize regulated hazardous waste and PCB waste, and,
- a contingency plan including notification to authorized state or EPA RCRA Subtitle C administrator if a regulated hazardous waste is discovered at the facility.

5B: 3.2 Materials Prohibited From MSW Landfilling

By North Carolina and federal regulations, a MSWLF shall only accept for landfilling those solid wastes which it is permitted to receive. According to Rule .1626(1)(b), the following wastes are prohibited from disposal at a MSWLF unit:

- Hazardous waste as defined within 15A NCAC 13 A, to also include hazardous waste from conditionally exempt small quantity generators.
- PCB wastes as defined in 40 CFR 761.
- Liquid wastes unless it is household waste other than septic tank waste or waste oil.
- Containers holding liquid waste unless the container is a small container similar in size to those normally found in household wastes.

5B: 3.3 County Regulations

Buncombe County only accepts materials for disposal it is permitted to receive by the state solid waste permit. This is limited to materials which comply with federal and state regulations as acceptable for MSW landfilling. Special wastes which receive state approval as described in Section 5B: 5 of this plan are accepted.

Buncombe County reserves the right to turn away any waste hauling vehicle containing materials it is not permitted to accept based on federal or state regulations and which in its judgment require special handling and cannot safely be managed by the operating staff of the Buncombe County landfill.

Cardboard disposal is prohibited based on County Ordinance No. 95-1-2. Section III, No. 2., states that corrugated cardboard in trucks, roll-offs, or flat beds which contain more than 5% by weight or volume is prohibited and the hauler will be fined. Also prohibited from disposal are sharps and medical waste.

Sharps generated from a household shall be accepted at the Buncombe County Transfer Station in a specified, puncture proof container. The sharps container is transported to a medical waste disposal company. Buncombe County Solid Waste Management Facility's Landfill does not accept sharps. The Landfill operators and manager have the right to reject properly packaged sharps or treated regulated medical waste for disposal in the landfill, even if state regulations allow landfill disposal of such wastes.

Medical Waste as defined above is not accepted at the Buncombe County Solid Waste Management Facility's Landfill. If a load contains this material, the generator will be determined, if possible, and will be assessed civil penalties and will be required to cover all costs associated with removal, treatment and safe disposal of such material.

Section 5B: 4 - Applicability

Appendix 5B – Waste Screening Plan
Operation Plan

This Waste Screening Plan and related programs apply to all wastes regulated as hazardous waste as defined by Subpart D of 40 Code of Federal Register (CFR) Part 261; wastes which exhibit hazardous characteristics (including ignitability, corrosivity, reactivity, and toxicity) as defined in Subpart C of 40 CFR 261; wastes which are a mixture of hazardous and non-hazardous wastes; and PCB wastes as defined by 40 CFR Section 761.60.

This plan does not address: residential solid waste; waste that is exempt as a conditional small quantity as defined by 40 CFR Section 261.4(b) and 261.5; or, small quantities of PCB's found in items such as fluorescent ballasts and small capacitors typically found in consumer electric appliances. This plan does not apply to yard waste and scrap tires which are prohibited from landfilling primarily for recycling and waste reduction reasons. This plan does not apply to wastes that have been conditionally approved for landfilling by Buncombe County based on approval by North Carolina Department of Environment, and Natural Resources (NCDENR) through the "waste determination" process as described in Section 5B: 5 of this plan.

Section 5B: 5 – North Carolina Solid Waste Determination Process

Appendix 5B – Waste Screening Plan
Operation Plan

Some industrial and manufacturing solid wastes that may, by definition, be regulated and prohibited from being landfilled can be accepted for landfilling by Buncombe County if determined to be safe by the North Carolina Department of Environment and Natural Resources (NCDENR). A letter detailing the waste determination and the associated appropriate laboratory analysis must be completed by the generator, approved by NCDENR, and submitted to Buncombe County to receive this conditional approval for landfilling. When this waste is hauled to the landfill, the hauler must provide a letter verifying that the County has agreed to accept the waste.

Special waste disposal requires prior approval.

Section 5B: 6 - Training

Appendix 5B – Waste Screening Plan
Operation Plan

The Buncombe County Solid Waste Inspector should be certified by satisfactorily completing SWANA's Landfill Operations Specialist Course or similar. All County solid waste management staff are encouraged to complete this training. The Solid Waste Inspector has been instructed in the procedures, as described in this plan, to follow if hazardous or regulated waste is identified or suspected in a waste load received at the landfill.

Section 5B: 7 – Designated Area for Waste Screening

Appendix 5B – Waste Screening Plan
Operation Plan

Waste screening occurs at the working face of the landfill and in general accordance with the following:

- inside the landfill site on property owned and managed by the County;
- accessible to truck traffic;
- at least 100 feet within the landfill's disposal boundaries; and
- on leveled ground.

Waste loads selected for random screening and suspicious waste loads are visually observed at the working face. The composition of the load is visually observed and documented; if any items are required to be recycled or disposed of separately (such as tires, televisions, paint, etc.), the driver will be asked to offload those in the designated area. If the load contains hazardous or other wastes prohibited from being landfilled, the driver is questioned as to the origin of the load and, if necessary, the originator of such waste will be required to cover all costs associated with removal, treatment, and safe disposal of that waste load as well as any contaminated soil and surrounding natural features which occurred because of the prohibited waste. Verification of proper disposal of the waste and any additional and reasonable testing of the soil and water in the designated area, necessary to insure that no contamination remains, are the legal and financial responsibility of the party who brought the waste to the landfill.

Section 5B: 8 – Identifying Suspicious Waste Loads Via Standard Landfill Operation

Appendix 5B – Waste Screening Plan
Operation Plan

As part of the standard operating procedures at Buncombe County landfill, all drivers of incoming loads are questioned about the content and source of their wasteload. Scale house operators and landfill staff, trained as per Section 5B: 6 to recognize hazardous waste and wastes prohibited from being landfilled, have the authority to:

- detain a waste load from being unloaded at the working face of the landfill,
- request additional information from the driver about the wasteload,
- divert the driver,
- temporarily prohibit the wasteload from being deposited at the working face, and
- contact the landfill supervisor who has the authority to reject the waste load.

The procedure begins with a visual observation by landfill staff and a questioning of the driver as to the contents of the wasteload. Drivers of suspicious loads are asked if they have an approved waste determination letter as described in Section 5B: 5. Files are searched to verify whether or not this letter exists for the load in question. Depending on the satisfactory answering of these questions and the judgment of the landfill staff, either the load is disposed of at the working face or the landfill supervisor is contacted, a waste screening form/record of inspection is completed, and a further screening of the waste load takes place. If a wasteload is suspected of containing hazardous or prohibited materials covered by this plan, the waste hauler and the Buncombe County Solid Waste Inspector are immediately contacted and requested to send an authorized representative to the site of the wasteload. The driver and truck are released as soon as they have adequately completed their sections on the waste screening form and the waste hauler has been reached. If the wasteload was deposited at the working face, the wasteload is not moved or altered. Landfill operations will be moved away from the load until a final disposition can take place. Based on the discretion of the landfill supervisor and the County's Solid Waste Inspector, Buncombe County Emergency Management (BCEM) may be contacted to come to the site and determine if the materials are hazardous or prohibited waste.

If the waste is determined to be non-hazardous and is permitted for landfilling under state, federal, and county laws, the County will absorb the cost for the testing by BCEM. If the waste is found to be hazardous or prohibited, the hauler will be billed for the testing by BCEM and be required to immediately remove the waste and demonstrate to the County and the State that it was disposed of properly. The hauler will also be required to cover all costs associated with site clean-up and verification that the site is safe. If the waste is not removed within 24 hours as required, the County

shall have the waste removed and disposed of properly and bill the waste hauler for all the costs associated with its removal and site cleanup and repair.

Within one business day, the County will notify NCDENR and the waste hauler, make documentation of the load and contents and generator, the attempted illegal disposal of prohibited waste, the actions taken by the County, and the disposition of the waste. All future waste loads from a hauler found to be in violation by attempting to dispose of hazardous and prohibited materials in the Buncombe County sanitary landfill, may be subject to additional waste screening. This additional screening may include screening every load of the hauler who has been previously found to be in violation.

Section 5B: 9 – Random Inspections of Incoming Loads

Appendix 5B – Waste Screening Plan
Operation Plan

While all loads entering the landfill are visually screened by landfill staff, they are generally not inspected in detail. Therefore random inspections are used to provide a reasonable means to adequately control the receipt of prohibited wastes.

5B: 9.1 Selecting Loads for Sampling

In accordance with SWANA training courses, random inspections of incoming loads is based on 1% of weight received per day.

5B: 9.2 Screening the Wasteloads

Waste loads selected for random screening will be visually inspected at the working face. The waste screening form will be completed for all loads selected for screening. Upon answering the necessary questions for the waste screening form and unloading the waste load, the driver and truck may be released. Because this load has been randomly selected for waste screening, this release of the driver and vehicle is not intended to imply the County accepts the waste load.

The waste will be spread over the area for easy visual observation. Care should be used not to break open any containers or drums. Containers and drums that are not easily identifiable or whose contents cannot be seen should be opened by properly trained waste screening personnel. Only trained waste screening personnel, wearing protective safety equipment should come in physical contact with the waste contained in the load selected for screening.

Upon verification that the solid waste passes the screening and is acceptable, Buncombe County will officially accept it for disposal.

All wastes suspected of being hazardous will be handled and stored as hazardous until proven otherwise. Some hazardous and prohibited waste testing at the landfill will be conducted by BCEM if hazard warrants or other registered hazardous waste contractor hired by the County.

5B: 9.3 Procedures

If a waste load is suspected of containing materials covered by this plan, the waste hauler and County Solid Waste Inspector are immediately to be contacted and requested to send an authorized representative to the site of the wasteload. The driver and truck are released when the waste hauler has been reached and the solid waste manager authorizes. Based on the discretion of the landfill supervisor and the County Solid Waste Inspector, BCEM may be contacted to come to the site and determine if the materials are hazardous or prohibited wastes.

If the wastes are determined to be non-hazardous and are permitted for landfilling under state, federal, and county laws, the County absorbs the cost for the testing. If the wastes are found to be hazardous or prohibited, the hauler will be billed for the testing and be required to immediately remove the wastes and demonstrate to the County and the State that they were disposed of properly. The hauler will also be required to cover all costs associated with site clean-up and verification that the site is safe. If the wastes are not removed within 24 hours, as required by the County, the County shall have the wastes removed and disposed of properly and bill the waste hauler for all the costs associated with their removal and site cleanup and repair.

The landfill owner or operator shall notify the Division with 24 hours of attempted disposal of prohibited waste. If a hauler is found to have attempted to dispose of hazardous or prohibited materials in the Buncombe County sanitary landfill, future additional waste screening for that hauler may be required. This additional screening could include screening every load of the hauler who has been previously found to be in violation. The County also reserves the right to refuse all future waste loads from a hauler found to be in violation.

Section 5B: 10 – Records of Inspections

Appendix 5B – Waste Screening Plan
Operation Plan

Figure 5B: 10-1 presents a sample waste screening inspection form. It, or a similar form, will be completed for every wasteload screened through the random inspection program and for every incident where landfill staff suspect a waste load contains prohibited or hazardous waste and the driver cannot verify that these suspicions are false. The form will be completed by landfill staff, waste screening staff, and if appropriate signed by the waste driver. One copy will be kept on file at the landfill where the wasteload was received. If the waste load is found to contain materials that are prohibited or hazardous based on this plan, copies of the form will be sent to the NCDENR and the waste hauler.

WASTE SCREENING

FINED: YES NO

AREA: 1 2 3 4

DATE: _____

HAULER: _____TRUCK #_____BOX #_____

DRIVER: _____TIME:_____INSPECTION: VISUAL OFF-LOADED

CONTAINER TYPE: ROLLOFF COMPACTOR OTHER_____

GROSS WEIGHT: _____ **TARE WEIGHT:** _____NET WEIGHT: _____

ORIGIN OF LOAD: _____

LOAD COMPOSITION (BY %)

ALUMINUM	NON-FERROUS	TEXTILES
CARDBOARD	PAPER	TIRES
FERROUS	PLASTIC	WOOD/PALLETS
GLASS	TEXTILES	OTHER
ITEMS PULLED OUT OF LOAD:		

DESCRIPTION OF DUMPED LOAD: _____

_____

_____

SOLID WASTE INSPECTOR NAME

BUNCOMBE COUNTY LANDFILL, 81 PANTHER BRANCH ROAD, ALEXANDER, NC

SOLID WASTE DEPARTMENT

Section 5B: 11 – Contingency Plan

Appendix 5B – Waste Screening Plan
Operation Plan

If during a random screening or during regular operation of the landfill, hazardous materials or materials defined by this waste screening plan as dangerous are discovered at the landfill, the landfill supervisor on duty has the authority to contact appropriate emergency personnel (911) and request their immediate action to remove and safely dispose of the prohibited waste. All telephone and written notification will take place within the first business day of the discovery of such materials. A completed waste screening form, letters of notification, and test results will be filed as required in Section 5B: 10.

Section 5B: 12 – Responsibility Party

Appendix 5B – Waste Screening Plan

Operation Plan

Legal responsibility for all waste entering the landfill remains with the waste hauler until such a time that it is determined to be permitted solid waste and is accepted by the County. The County does not accept the legal responsibility for waste which is prohibited from being landfilled in a sanitary landfill. The hauler is defined as the responsible party who attempted to, either knowingly or unknowingly, illegally deposited the prohibited waste in the landfill. The hauler shall be billed by the County for all costs associated with illegal disposal non-acceptable of solid waste. This includes, but is not limited to, costs in testing the waste, removing the waste from the sanitary landfill, for the cost of transporting the waste to an appropriate waste management facility, for the disposal fee, and for all necessary and related site clean-up and testing.

If after testing at the landfill by BCEM or the County's authorized contractor, the waste load is found to be materials which can legally be landfilled, the County will accept legal responsibility for it. The County or their contractor (as per contract agreement) will absorb all costs for testing and removal or disposal of the waste.

If BCEM or the County's authorized contractor, finds that the waste load contains hazardous or regulated materials that should not be landfilled, the County will not absorb the costs for any further testing either at the landfill or at another laboratory. If further testing by other laboratories indicate the materials could legally be landfilled, the County will be assumed to have "acted in good faith" to protect the public health and safety by refusing to landfill the waste. The County will not reimburse any cost associated with removal of the materials from the landfill site or its subsequent testing or disposal.

Section 5B: 13 – Fines and Penalties

Appendix 5B – Waste Screening Plan

Operation Plan

Buncombe County reserves the right to institute fines and penalties to any person found to have attempted to landfill waste prohibited from being landfilled by state or federal regulations. These fines and penalties are in addition to the costs identified in Section 5B: 12.

Operation Plan

Appendix 5C – ACM Documentation

CDM Smith

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Apalachin, NY 13732
Ph: 800-800-7671
Fx: 607-625-2689
www.landfill.com

ADVANCED FORMULATION USAGE GUIDE

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This guide gives you specific, easy to follow instructions for the safe and efficient usage of Landfill Service Corporation's Posi-Shell® Cover System Advanced Formulation. For best results and to ensure safety, please follow the instructions carefully.

1.0 Definition of Posi-Shell Cover System Advanced Formulation

The Posi-Shell Cover System is a low-cost alternative to the conventional six inches of soil used as daily cover at most landfills. Posi-Shell Advanced Formulation is a noncombustible blend of materials providing a thin cover (approximately one-quarter inch) that hardens over the surface of the material to be covered, such as the working face of the landfill. Non-toxic, the stucco-like coating performs all functions of landfill daily and intermediate cover. Applied with a standard hydroseeding unit, this system provides increased landfill capacity while providing a more environmentally effective cover system for the landfill.

1.1 Background and Concept

Landfilled solid waste must be covered each day to control vectors, fires, odors, blowing litter, and scavenging. Cover material is generally defined as a six inch soil layer or other suitable material, or a combination of same, that is used to cover compacted solid waste in a landfill.

The Posi-Shell Cover System Advanced Formulation is an alternative to traditional landfill daily cover materials. The coating is a spray-on slurry composed of water, Posi-Pak Type P-100, PSM-200 Setting Agent, and optional Portland cement that forms an approximately one-quarter-inch coating for various types of landfill cover. The Posi-Shell Cover System Advanced Formulation is designed for use by a landfill operator at the close of each operating day for compliance with cover regulations. The material meets and exceeds regulatory requirements for the control of landfill vectors, fires, odors, blowing litter, and scavenging.

Posi-Shell Advanced Formulation (AF) provides cover ranging from 4 to 10 square feet per gallon of slurry. The coverage area is dependent upon the desired thickness and the actual texture of the covered surface. Application of the Posi-Shell AF is a one-man operation.

1.2 Environmental and Economic Benefits

The Posi-Shell Cover System conserves natural resources. Additionally, use of the Posi-Shell Cover System conserves energy and improves air quality by eliminating the use of heavy earth-moving equipment for the transporting, laying, and reworking of daily soil cover. Traffic congestion to and from the landfill site, vehicle exhaust, and fugitive dust emissions are also reduced proportionately to the reduction of landfill soil hauling for daily cover.

Soil, a valuable natural resource, is conserved by the Posi-Shell Cover System AF. In many areas, soil is an expensive natural resource that is in short supply. Use of the Posi-Shell Cover System AF can eliminate the waste of this precious commodity.

The major benefit of the use of the Posi-Shell Cover System AF is the conservation of extremely valuable landfill capacity, commonly known as "air space". Landfill air space is a valuable asset and the need to conserve capacity is paramount to achieve environmental and economic objectives for both landfill operators and regulatory agencies. Efficient use of air space today can directly translate into longer landfill life, decreased operating costs, and increased revenue generation. An increase in air space efficiency can delay or even eliminate the need for the siting and construction of new facilities that ultimately may have severe environmental and economic impacts.

For comparison purposes using daily cover for a working face area of 5,000 square feet for a period of one year with Posi-Shell AF as opposed to six inches of top soil will realize an air space savings of about 24,000 cubic yards. Use of Posi-Shell AF as opposed to soil will result in a direct increase in the amount of airspace available in a landfill.

1.3 Equipment

The equipment used for the Posi-Shell Cover System AF consists of a standard hydroseeding unit, a towing unit, and a water source. The towing unit is used for moving the hydroseeding unit around the landfill site. If a nearby hydrant or other water source is not available, then a water trailer or truck is required.

1.4 Personnel

One operator is required for the Posi-Shell Cover System AF. This operator must be capable of operating heavy equipment and be familiar with the mechanics of all equipment used. The operator will be trained by Landfill Service Corporation in the use of Posi-Shell AF. If preferred, a two man operation may be used to expedite coverage time.

1.5 Materials

1.5.1 Water

Potable water, non-potable water and landfill leachate can be used as the liquid portion of the Posi-Shell Cover System AF. Use of leachate requires a site-specific regulatory approval to assure proper health and safety practices are implemented.

Approximately 1,600 gallons of water is used for each 2000 gallon load of Posi-Shell AF. The water can either be supplied by a hydrant, pumped from a nearby pond, or brought to and stored adjacent to the hydroseeding unit by water truck or trailer. The sizing of the specific water supply method should be adequate to ensure that the filling of the hydroseeding unit occurs within a few minutes' time.

As stated, leachate can be used as a water source if specific regulatory approval is obtained. It is not recommended that a high-strength leachate be used due to odor concerns and the added safety precautions required to assure worker safety. However, use of relatively dilute leachate is an effective method for reducing a portion of a landfill's total leachate production. The inherent odor-neutralizing properties of Posi-Shell AF mitigate the potential odor problems of leachate when it is used as a water source.

1.5.2 Posi-Paks

Posi-Paks are an important constituent of Posi-Shell AF and give the cover its fiber reinforced rigidity and weather resistance. Posi-Paks are lightweight, easy to handle, and ready to use. Posi-Pak is a specially designed plastic fiber with a proprietary finish that provides the reinforcement matrix for the finished cover. Four Posi-Paks are used for each 2000 gallon load. See the back of this manual for a material safety data sheet for this material.

1.5.3 Dye

Optional dyes can be added to the Posi-Shell AF mixture to create a soil-like brown coloring or a grass-like green coloring.

1.5.4 PSM 200 Setting Agent

A proprietary blend of natural bentonite clay, synthetic polymers, and adhesives provide thickening, lubrication, and adhesion in the Posi-Shell AF mixture. See the back of this manual for a Material Safety Data Sheet for this material.

1.5.5 Portland Cement

Optional Portland cement can be used as the cementitious mineral binder component of Posi-Shell AF. On average, approximately 4,000 lbs. of this material is used for each 2000 gallon Posi-Shell AF load. The Portland Cement further helps neutralize odors and contaminants found in leachate and enhances the durability of the Posi-Shell.

2.0 Safety

Posi-Shell AF is nonhazardous and is composed of nonhazardous materials. Certain safety measures are recommended during different aspects of Posi-Shell AF use. **Follow safety procedures specific to your hydroseeding unit, towing unit, or other equipment used.**

3.0 Operator Attire

The operator should, at all times, wear appropriate protective clothing. Jewelry and loose fitting clothing should be avoided. Recommended protective clothing includes the following:

- Safety glasses with side shields
- Leather gloves
- Industrial grade work coveralls
- Leather steel-toed shoes
- Dust particulate mask

If leachate is being used as the liquid portion of the Posi-Shell AF mixture, protective clothing in accordance with site regulations should be worn.

4.0 Towing Units

See table on page 11 for Posi-Shell AF total material weights. To determine the total load weight, add the Posi-Shell AF total material weight to the weight of your hydroseeding unit. Ensure that the towing unit and hitch arrangement are capable of handling the total of these weights.

5.0 Loading and Mixing Procedure

It is important to add the Posi-Shell Advanced Formulation materials in the order specified.

5.1 Liquid Addition (Step 1)

Before placing any dry material in the mixing tank, the tank must be filled with the appropriate amount of liquid (water or leachate). See chart on page 11. If your hydroseeding unit has a reserve water tank, fill at this time with clean water. It is not recommended to use leachate as the clean out water.

All bags of material (Posi-Pak Type P-100, PSM-200 Setting Agent, Portland cement) can be loaded through the side rails of hydroseeding unit onto mixing deck from the ground. Ensure that they do not obstruct the ladder area. Never attempt to carry up or down ladders. To avoid back injuries, always use proper lifting practices when handling bags. Wet or frozen materials should not be used.

5.2 Posi-Pak Addition (Step 2)

With mixer paddles of hydroseeding unit turning slowly open the Posi-Pak, Type P-100 bag and dump contents into inlet hopper (discard bag). Posi-Paks are designed such that the plastic covering may be torn away with the bare hands. If a knife is used take care not to drop into mixing tank. See chart on page 11 for Posi-Pak, Type P-100 quantities.

5.3 Optional Dye (Step 3)

Various dyes are available for Posi-Shell Advanced Formulation to alter the color of the finished product to best suit the application. Most commonly used are brown and green. Brown and green dye is available in powder form and comes in dissolvable "Mix Ready" bags which can be placed directly in the mixing tank. Green is also available in liquid form that can be poured in the tank.

Powdered Dye

Liquid Dye

5.4 PSM-200 Setting Agent (Step 4)

When handling PSM-200 Setting Agent or Portland cement a dust mask is recommended to prevent inhalation, and coveralls and gloves to prevent skin contact. Safety glasses should be worn to keep dust from entering the eyes. Should eyes or skin come in physical contact any Posi-Shell AF ingredients thoroughly rinse with water.

With mixer paddles running at medium speed add PSM-200 Setting Agent material by cutting open bag and dumping contents into the mixing tank (discard bag). See chart on page 14 for quantities. Allow PSM-200 Setting Agent and Posi-Pak to mix at medium speed for about 5 minutes until a gravy-like consistency is achieved and no clumps are visible (see photo below at left).

5.5 Optional Portland Cement Addition (Step 5)

With mixer paddles still running at medium speed add Type I Portland cement material **(regular Portland cement, NOT concrete.)** by cutting open bag and dumping contents into the mixing tank (discard bag). See chart on page 11 for quantities. Posi-Shell AF material is now ready to be applied (see photo below at right).

After Adding PSM-200 Setting Agent

After Adding Portland Cement

6.0 Transporting

Close inlet hopper lid prior to transportation and leave mixer paddles turning at medium speed.

6.1 Cold Weather Transport

To prevent freezing during extremely cold weather (below 20°F), with discharge gun attached to recirculation fitting, run pump in low-speed forward to circulate slurry from mixing tank, through pumping and discharge system, and back to mixing tank.

6.2 Traversing Slopes

The proper procedure for traversing slopes is to approach the slope with machine parallel with fall line of slope. Machine should always be backed down the slope and towed up. Following this procedure eliminates any possibility of the machine "jack-knifing" around the towing unit.

7.0 Application of Posi-Shell AF

Conventional end-of-day waste surface preparation and grooming are normally adequate prior to Posi-Shell AF application. A smoother surface will require less slurry due to reduced surface area. Also, the functional performance of the coating is enhanced by a smoother receiving surface. Therefore, it may be desirable to spread available materials such as sludge, ash, or processed wastes at the end of the day to function as surface leveling agents to economize on Posi-Shell AF slurry consumption. Each gallon of slurry will coat approximately 4 to 10 square feet depending on surface roughness and application thickness.

Methods of application and the desired appearance of daily coatings are shown on the photographs which follow. In general, the operator should position the Applicator upwind, and should select the spray nozzle appropriate to the distance from the waste pile. A uniform coating of approximately one-quarter-inch thickness will normally accomplish the daily cover functional criteria. In some cases, it will be necessary to spray a given area from two directions to compensate for "spray shadow" effects or wind dispersion.

The most effective method of coverage will vary with each site, but generally, spraying the working face from the bottom of the waste slope, toward the top, is most effective. A minimal amount of "shadowing" occurs if applied in this manner.

Application of Posi-Shell AF cover is not typically affected by weather conditions. Normal operations can be performed during windy, rainy, or cold weather conditions. During cold weather periods, the hydroseeding unit tank and pump must be drained at the end of the day to avoid freezing. It is desirable, but not necessary, to bring the machinery into a building for overnight storage. The application process is typically not affected by severe cold weather.

When high winds are encountered, it may be necessary to position the hydroseeding unit in an upwind position. Since the hydroseeding unit pumps emit a high pressure stream of slurry, it is not generally affected by light winds; however, wind direction should always be considered with respect to airborne dispersion of overspray.

During light rains, Posi-Shell AF will not wash away and will retain its stucco consistency. However, during extremely heavy rains, some washing of the material may occur prior to its curing. During extremely cold weather, Posi-Shell AF will freeze before curing. After a thaw the material will cure. Cured Posi-Shell AF material typically can retain integrity up to one year or longer depending upon its initial application thickness.

Application of Posi-Shell AF via
Deck -Mounted Discharge Wand

Application of Posi-Shell AF via
Extension Hose

Daily and Intermediate Cover

Close-Up View of Cured Posi-Shell AF Coating

7.1 Odor Control

The Posi-Shell AF formulation has an inherent capability to suppress odors. By applying the material as a daily cover, typical landfill odors will be reduced by the thick layer of Posi-Shell that is applied. Additionally, if Portland Cement is used the calcium oxide (lime) applied to putrid waste further suppresses odors by sealing the outer face of the waste with an alkaline surface layer.

Posi-Shell AF allows an opportunity for the optional addition of approved odor-masking agents where excessive odors warrant such action.

7.2 Vector Control

Application of Posi-Shell AF to the working face of waste piles is an extremely effective vector deterrent. Shortly after the Posi-Shell AF coating is applied, temperatures within the waste pile will increase due to initial aerobic and subsequent anaerobic decomposition. The Posi-Shell AF layer forms a seal that inhibits flies from laying additional larvae.

Other vectors such as rodents and birds are discouraged by the Posi-Shell AF seal. Posi-Shell AF cover has proven effective in inhibiting the attraction of vectors to waste piles.

7.3 Scavenging

General animal scavenging is reduced since the Posi-Shell Cover System AF seals in odors and hides the visible food source beneath the covering shell. Scavenging by humans is inhibited by the complete visual coverage of the waste pile and by the viscid coating of slurry applied upon all available surface objects.

7.4 Litter Control

Posi-Shell AF cover is highly effective for litter control. Due to the sticky consistency of the material, a shell is formed over the garbage which prevents litter from being blown away by high winds. A thin layer of Posi-Shell AF cover is recommended for preventing litter generation.

In extremely windy situations, Posi-Shell AF coating can be applied to waste as it is being unloaded from garbage trucks. This technique has been proven highly effective.

7.5 Fire Control

Posi-Shell AF cover is an extremely effective fire control material. Independent laboratory testing of Posi-Shell AF by D-4982 method has certified that Posi-Shell AF is non-fuel contributing, non-smoke producing, and non-combustible. When an acetylene torch is applied directly to the Posi-Shell AF cover, ignition of the Posi-Shell AF cover or underlying waste does not occur.

In addition to the non-flammable characteristic of Posi-Shell AF cover, your hydroseeding unit can be used to fight landfill fires. Direct application of Posi-Shell AF material to an open flame will smother it. If a subterranean landfill fire occurs, Posi-Shell AF coating can be applied to the waste pile's surface and will form a fire smothering seal.

7.6 Additional Applications

Posi-Shell AF cover fulfills the relevant performance criteria for various additional applications including erosion control, ditch lining, coating of sludge piles, contaminated soil piles, compost piles and temporary waste piles and excavations of various types. If has been successfully applied to coal piles, salt piles, cement clinker piles and used at remediation sites to suppress volatile emissions. Posi-Shell AF may also be used as the tackifier in hydroseeding mixtures.

Ditch Lining

Finished Appearance of Posi-Shell AF Intermediate and Daily Cover at a Major Municipal Landfill

Erosion Control

Odor Control

Posi-Shell Cover System AF
Application Minimum Requirements

	SHORT TERM COVER OVERNIGHT COVER	MEDIUM TERM COVER INTERMEDIATE COVER, EROSION CONTROL, ODOR CONTROL, ETC.	LONG TERM COVER EROSION CONTROL, COMPOST COVER, STOCKPILE COVER, ETC.
SLURRY MIXTURE	See chart below.	See chart below. Additional Portland cement may be necessary.	See chart below. Additional Portland cement may be necessary.
APPLICATION RATE	Approx. 8-10 sq.ft./gal.	Approx. 6-8 sq.ft./gal.	Approx. 4-6 sq.ft./gal.
COVERAGE METHOD	Apply from two directions to eliminate spray shadow.	Apply from two directions to eliminate spray shadow.	Apply from two directions to eliminate spray shadow. For slope coverage extend cover 3-4 feet beyond crest of slope.
COVERAGE THICKNESS	Finished cover should be 1/8-3/16 inch.	Finished cover should be 3/16-1/4 inch.	Finished cover should be 1/4-5/16 inch.
COVERAGE APPEARANCE	No waste/soil visible from any angle.	No waste/soil visible from any angle. Cover should have a "stucco-like" texture.	No waste/soil visible from any angle. Cover should have a "stucco-like" texture.
COVERAGE MAINTENANCE	None. Waste is placed over cover next working day.	Cover should be inspected daily and touched up if waste/soil becomes visible.	Cover should be inspected daily and touched up if waste/soil becomes visible.

Posi-Shell Cover System AF Material Quantities

Materials	***Desired Load Size***			
	500 GAL	1000 GAL	1500 GAL	2000 GAL
Water or Leachate	400 gals	800 gals	1200 gals	1600 gals
Posi-Pak, Type P-100 (15 lb bags)	1 bag	2 bags	3 bags	4 bags
Optional Brown Dye (5 lb bags)	2 bags	4 bags	6 bags	8 bags
Optional Green Dye (1 qt bottles)	.5 bottle	1 bottle	1.5 bottle	2 bottles
PSM-200 Setting Agent (50 lb bags)	5 bags	10 bags	15 bags	20 bags
Optional Portland cement (94 lb bags)	10 bags	20 bags	30 bags	40 bags
Total Material Weight	5,355 lbs	10,710 lbs	16,065 lbs	21,420 lbs

7.7 Discharge Nozzle Selection

While other nozzles may be used, Landfill Service Corporation offers three types of discharge nozzles providing the capability of effectively spraying Posi-Shell AF at a variety of ranges. Experience and operator discretion will determine which nozzle to use in each situation.

Long Range
for Distances of 75ft -150ft

Medium Range
for Distances of 25ft -75ft

Short Range
for Distances of 5ft -25ft

7.8 Handling the Discharge Spray Boom

Care must be taken to use the proper discharge nozzle in order to attain the desired spray range, as being too close to the surface will cause the Posi-Shell AF stream to overturn waste on contact. At long range distances the Posi-Shell AF stream will break up, causing the desired spray effect. At ranges under 75 ft. the medium or short nozzle should be used and are designed to spray in a wide ribbon pattern.

Blockages may occur in nozzles due to foreign objects in the raw materials. Refer to Section 11.1 for procedure on removing foreign object from discharge nozzle.

With the desired nozzle securely in place, firmly grasp discharge spray handle in one hand and point discharge nozzle in desired direction of spray. With the other hand move pump control lever to full speed forward and begin covering area. For desired spray effect operator may adjust pump/throttle speed.

Never disconnect nozzles when pump is running. Never engage pump with discharge spray boom left unattended. Never put hands in front of discharge nozzles.

Do not spray at or near other persons. Spray exits nozzle at a high velocity and could cause injury.

Do not spray toward power lines, transformers or other high voltage conductors. Avoid spraying into wind. When unavoidable, be sure to keep direction of spray near to ground. Safety glasses should be worn during spraying operation.

7.9 Coverage of Large Area

Coverage of a large area will require moving the hydroseeding unit to several spray locations. Inspect the area from several perspectives to ensure that the spray has covered all areas.

7.10 Thicker Coats

Thicker coats may be applied by letting the first coat partially dry before recoating the area. Several thin applications provide a more durable shell than a single very thick application.

8.0 Cleaning

It is recommended that you clean the hydroseeding unit after each load. Due to the variety of hydroseeding units on the market a generic procedure for cleaning follows. Some steps may need to be altered to apply to your hydroseeding unit.

1. When all Posi-Shell AF is removed from mixing tank, immediately bring pump and mixer control levers to neutral position. Engine should remain at full throttle.
2. Open all inlet lids on hydroseeding unit.
3. Firmly grasp clean-off hose in one hand and turn on water.
4. With both hands on hose perform initial rinse down of all inlets and any residue visible in mixing tank. This process should take approximately one minute and use about 50-100 gallons of water depending on the size of the mixing tank.
5. Turn water off.
6. With a spray nozzle in place (to retain cam and groove gasket) run pump control lever full speed forward for 5 seconds. Return to neutral when complete. Repeat with all nozzles used during application.
7. Close all inlet lids and bring mixer control lever to full speed reverse and allow to run for at least one minute.
8. Return mixer control lever to neutral then to full speed forward for at least one minute.
9. With mixer control lever in full speed forward, climb down ladder and remove drain cap and allow initial rinse water to completely drain.
10. Replace pump drain cap.
11. Return to deck of unit and move mixer control lever to neutral and repeat steps 2-9. During this secondary rinse make sure all external surfaces are thoroughly rinsed.

A properly cleaned hydroseeding unit will remain free of any built-up product internally and externally, and all decals and labels remain clearly readable.

9.0 Winter Care

In extreme cold it is imperative that engines and hydraulic systems are thoroughly warmed before introducing a load. Refer to the operations manual for your hydroseeding unit for proper winter usage and care.

9.1 Posi-Shell AF Winterizing Procedure

1. After cleanout, drain the mixing tank thoroughly. DO NOT REPLACE DRAIN CAP.
2. If your hydroseeding unit is equipped with a reserve water tank and/or pump, drain thoroughly. DO NOT REPLACE DRAIN CAPS.
3. Pour approximately one half gallon of anti-freeze into pump or tank and slowly run through pump and lines to prevent freezing.

10.0 Materials Storage

All materials are inert, and can be stored on, or off, the boundaries of lined landfill cells.

10.1 Posi-Shell Material Storage

10.1.1 Posi-Paks

Posi-Paks should be kept dry, particularly when freezing is possible. The Gaylord boxes are water-resistant, but not waterproof. Boxes can be easily covered with a tarp or plastic to keep the Posi-Paks dry.

10.1.2 PSM-200 Setting Agent

PSM-200 Setting Agent should be kept dry. Stretch wrapped pallets can be easily covered with a tarp or plastic.

10.1.3 Optional Portland Cement & Dye

Portland Cement & dye should be kept dry. Stretch wrapped pallets can be easily covered with a tarp or plastic.

11.0 Troubleshooting (may not apply to all hydroseeding units)

11.1 Removing Foreign Object from Discharge Nozzle

1. Immediately move pump control lever to neutral position.
2. Move pump control lever to *slow speed reverse.*
3. Run pump in reverse for 5 seconds to relieve pressure in discharge line.
4. Return pump control lever to neutral position.
5. Remove nozzle and clear obstruction.
6. Reconnect nozzle and continue spraying.

11.2 Removing Foreign Object from Mixing Tank

1. Move throttle, mixer, pump, control levers to slow/neutral position.
2. Shut engine off.
3. Move hydroseeding unit to area appropriate for dumping load.
4. Remove pump cleanout plug and allow load to drain.
5. Visually inspect pump for foreign object. Remove if found, replace plug and return to operations.
6. If object is not found in pump, remove exit pipe cleanout cap.
7. Inspect this section of pump for object. Remove if found, replace cap and pump cleanout plug and return to operations.
8. If object is not found in this section, remove two pipe couplers and removable section of tank exit pipe.
9. Visually inspect flange section of pump and mixing tank (flashlight may be necessary). Remove object if found, replace removable pipe and cleanout cap, pump cleanout plug, and return to operations.
10. If object is in mixing tank use appropriate length grapple through tank exit pipe.

11.3 Clearing Clogged Mixing Tank

1. If Posi-Shell AF slurry has thickened in the mixing tank to the point that the mixer paddles will not turn, move mixer control lever to neutral. Trying to force mixer shaft back and forth at this point will only result in possible damage to the mixer shaft components. If the pump was not running, immediately connect the recirculation hose and move the pump control lever to slow speed forward (slightly above neutral). Slowly running the pump will prevent the Posi-Shell AF from setting up in the pump. If Posi-Shell AF is so thick that it is not flowing freely to pump, then the slurry must be liquefied at the mixing tank outlet to the pump in order to establish pump flow.
2. A reserve of 300-500 gallons of water should be available while mixing loads of Posi-Shell AF. In the event of a clogged mixing tank, water should immediately be introduced through the liquid inlets to the Posi-Shell AF mixture to thin the slurry and establish pump flow. By injecting water through a 2-3" diameter hose and directing the flow at the surface of the slurry it may be possible to loosen the product enough to free the mixing shaft. While trying to free the mixing shaft, gently move the mixer control lever from slow speed forward to slow speed reverse. Abrupt movements to full speed forward and full speed reverse could cause damage.
3. **Use a slurry pump and water pick hose to loosen stiffened mixture.** This can be attached on the spray tower in the same manner as a spray nozzle and used as a high-pressure, high-volume water pick which will cut the slurry away from the mixing shaft and liquefy it as it goes through the pump system. This spraying should be performed through the inlet hoppers. Excess slurry can be discharged out of the tank and new water introduced as required. Continue cutting away and liquefying with the water pick hose until mixer is free. Care should be taken as the water exits this hose at a high rate of speed. Also safety goggles and rain gear should be worn as splashing will occur. Immediately rinse any slurry off skin.
4. If the slurry will not flow through the pump, then water may be injected directly into pump drain and moved through the hydroseeding unit's pumping system and sprayed back into the mixing tank. To prevent cavitation of the pump, water must be injected at a rate equal or greater than the discharge rate. Once pump flow is established, then proceed with Step 3 above.
5. If the mixture is so hardened that the water pick will not cut it, move mixer and pump control levers to neutral and the throttle control lever to low, and shut off engine. Remove key from ignition and lock out control panel enclosure. Remove deck plates starting with right rear section. After removing all sections, thickened slurry will need to be removed from around mixing shaft using shovels and hoes. Rubber boots, goggles, gloves, and coveralls should be worn if entry into the tank is necessary. It may not be necessary to remove all of the slurry from the tank. First, simply free the mixing shaft and if the Posi-Shell AF is still soft, add water and after replacing deck plates, mix rapidly in tank to loosen and drain out the cleanout. Never allow mixed Posi-Shell AF to set in tank more than one hour.

11.4 Clearing Clogged Discharge Pipe/Hose

1. Immediately move pump control lever to neutral position. Move pump control lever to *slow speed reverse.*
2. Run pump in reverse for 10 seconds to relieve pressure in discharge line.
3. Return pump control lever to neutral position.
4. Disconnect discharge hose quick-connect from discharge elbow and allow discharge pipe and hose to drain.
5. To ensure that obstruction is not in pump and exit piping, move throttle and pump control levers to very slow speed forward for 5 seconds. If product is discharging at top of discharge elbow, obstruction is not in pump.
6. If pump and exit piping are clear, disconnect discharge hose from discharge pipe and visually inspect discharge hose for obstruction. Clear if found, reconnect hose and return to operations.
7. If discharge hose is clear, it will be necessary to snake out discharge piping.
8. When obstruction is found and cleared, reconnect discharge hose and return to operations.

11.5 Clearing Obstruction from Pump

1. Immediately move pump and throttle control levers to neutral position.
2. Shut engine off.
3. Move hydroseeding unit to area appropriate for dumping load.
4. Remove pump cleanout plug and allow load to drain.
5. Visually inspect pump for foreign object. Remove if found, replace plug and return to operations.
6. If object cannot be removed via pump cleanout, disassembly of stator will be required. See hydroseeding unit operations manual for procedure.

12.0 Contingency Soil Supply

In the event that you are unable to apply Posi-Shell AF, the landfill operator should have a three-day supply of soil for daily cover material available on-site.

MATERIAL SAFETY DATA SHEET

MATERIAL: **OSHA 29CFR 1910.1200**

POSI-PAK® TYPE P-100 **DATE OF PREPARATION:** **SEPTEMBER 2004**

SECTION I -- IDENTITY

Distributor's Name and Address:	Landfill Service Corporation 2183 Pennsylvania Avenue Apalachin, NY 13732
Emergency Telephone:	(607) 625-3050
Chemical Name and Synonyms:	
Generic Name:	Polyester Staple
Trade Name:	Posi-Pak® Type P-100

SECTION II -- HAZARDOUS INGREDIENTS

Ingredient:	Polyethylene terephthalate polymer and one or more surface finishes (organic lubricants).
CAS No.:	25038-59-9
Hazard:	No known physical or health hazards associated with this product.
Note:	Polyester Staple is a family of fiber products having similar hazard and physical property characteristics. The polymer immobilizes the constituents of the polymer system (delusterants, catalyst residues, etc.) which, therefore, present no likelihood of exposure under normal conditions of processing and handling. However, exposure to chemical substances may occur as a result of processing these fibers. Processing may release and aerosolize the residual moisture and surface finishes. Heating the fibers may volatilize the finishes or produce a chemical change. Landfill Service Corporation recommends a 3 mg/m³ 8-hour TWA exposure limit on finish mists.

SECTION III -- PHYSICAL DATA

Melting Point:	Approx. 500º F (260º C)

SECTION IV -- CHEMICAL DATA

Polyethylene terephthalate is chemically stable and resistant to attack by oils, solvents, weak acids, and weak alkalis.

SECTION V -- FIRE AND EXPLOSION HAZARD DATA

Polyester Staple will burn if exposed to flame. Decomposition products generated from molten polymer may be subject to autoignition. Combustion products will be comprised of carbon, hydrogen, and oxygen. The exact composition will depend on the conditions of combustion.

SECTION VI -- HEALTH HAZARD DATA

This product has not been fully evaluated for toxicological properties. Preliminary evaluation of chemical components used in the finish and toxicological testing of the polymer have given no indication that health problems would occur in normal handling and use.

Similar products have given no indication that health problems would occur in normal handling and use.

SECTION VII -- REACTIVITY DATA

N/A

SECTION VIII -- SPILL PROCEDURES

N/A

SECTION IX -- EXPOSURES OF CONCERN

Inhalation of finish mist above the recommended 3 mg/m³ 8-hour TWA would be an exposure of concern.

SECTION X -- HANDLING AND USE PRECAUTIONS

Personal hygiene measures, such as washing hands and face immediately after working with the fibers and before eating, smoking, or using lavatory facilities, are recommended.

SECTION XI -- INDUSTRIAL HYGIENE CONTROL MEASURES

Adequate ventilation is recommended to maintain finish mist levels below 3 mg/m³ 8-hour TWA and minimize exposure.

Fire fighters should protect themselves from decomposition and combustion products that may include carbon monoxide and other toxic gases.

SECTION XII -- SPECIAL PRECAUTIONS

N/A

SECTION XIII -- DISPOSAL AND SHIPPING INFORMATION

These products are not classified as hazardous wastes under the Resource Conservation and Recovery Act, and unless prohibited by state or local regulation, can be disposed of in a municipal landfill or incinerated. Any finish oils contained in plant wastewater should be biodegradable in conventional biological wastewater treatment systems.

These fibers are not classified by the Department of Transportation as a hazardous material.

N/A = Not Applicable. **N/D = Not Determined

All information presented herein is believed to be accurate; however, it is the user's responsibility to determine in advance of need that the information is current and suitable for their circumstances.
No warranty or guarantee, expressed or implied, is made by Landfill Service Corporation as to this information or as to the safety, toxicity, or effect of the use of this product.

MATERIAL SAFETY DATA SHEET

MATERIAL:		**OSHA 29CFR 1910.1200**
EARTHTONE DYE	**DATE OF PREPARATION:**	**SEPTEMBER 1997**

SECTION I -- IDENTITY

Distributor's Name and Address:	Landfill Service Corporation 2183 Pennsylvania Avenue Apalachin, NY 13732
Emergency Telephone:	(607) 625-3050
Chemical Name and Synonyms:	Brown ferrous oxide
Generic Name:	Earthtone Coloring Agent
Trade Name:	Earthtone Dye

SECTION II -- HAZARDOUS INGREDIENTS

N/A

SECTION III -- PHYSICAL DATA

Boiling Point (ºF):	N/A
Vapor Pressure (mm. Hg):	N/A
Vapor Density (Air=1):	N/A
Solubility in Water:	Slight (0.1 - 1.0%)

Specific Gravity (H2O=1):	4.4 - 4.8
Evaporation Rate:	N/A
Appearance and Odor:	Brown, odorless dry powder

SECTION IV -- CHEMICAL DATA

Chemical Family:	Metal oxide
Formula:	Fe2O3; Balance MnO2 and silicates
Product Class:	CAS# 1317-61-9, 51274-00-1, 1309-37-1
Bulk Density:	0.5 - 0.8 g/ml

SECTION V -- FIRE AND EXPLOSION HAZARD DATA

Nonexplosive; Nonflammable

SECTION VI -- HEALTH HAZARD DATA

Threshold Limit Value:	N/D
Effects of Overexposure:	None observed.
Emergency and First Aid Procedures:	Irrigate eyes with water, consult eye physician. Wash exposed skin areas with soap and water.

SECTION VII -- REACTIVITY DATA

Stability:	Product is stable.
Hazardous Polymerization:	Will not occur.
Incompatibility:	None known.
Hazardous Decomposition Products:	None known.

SECTION VIII -- SPILL PROCEDURES

Steps to be Taken if Material is Released or Spilled:	Handle as normal solid waste. Minimum fugitive dust release.

SECTION IX -- EXPOSURES OF CONCERN

N/A

SECTION X -- HANDLING AND USE PRECAUTIONS

Store dry at ambient temperature away from food and drink.

SECTION XI -- INDUSTRIAL HYGIENE CONTROL MEASURES

Ventilation Requirements:	Local exhaust may be used.
Respiratory Protection:	A NIOSH approved respirator is recommended during mixing procedure.
Eye Protection:	Use of safety glasses is recommended.
Skin Protection:	Wear leather, plastic, or cloth gloves.

SECTION XII -- SPECIAL PRECAUTIONS

N/A

SECTION XIII -- DISPOSAL AND SHIPPING INFORMATION

Shipping Name:	Earthtone Dye is not hazardous under US Dept. of Transportation (DOT) regulations.
Hazardous Substance:	N/A
Hazard Class:	N/A
Caution Labeling:	N/A

Identification Number:	N/A
Disposal Method:	Dispose at approved facility.

N/A = Not Applicable. **N/D = Not Determined

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No warranty or guarantee, expressed or implied, is made by Landfill Service Corporation as to this information or as to the safety, toxicity, or effect of the use of this product.

MATERIAL SAFETY DATA SHEET

MATERIAL:

GREEN DYE **DATE OF PREPARATION: JUNE 2002**

SECTION I -- IDENTITY

Distributor's Name and Address:	Landfill Service Corporation 2183 Pennsylvania Avenue Apalachin, NY 13732
Emergency Telephone:	(607) 625-3050
Chemical Name and Synonyms:	Organic Colorants
Generic Name:	Color Additive
Trade Name:	Blue Vail

SECTION II -- HAZARDOUS INGREDIENTS

N/A

SECTION III -- PHYSICAL DATA

Boiling Point (ºF):	212°F
Vapor Pressure (mm. Hg):	20
Vapor Density (Air=1):	ND
Solubility in Water:	Soluble

Specific Gravity (H2O=1):	1.2
Evaporation Rate:	<1
Appearance and Odor:	Dark blue colored solution with bland odor.

SECTION IV -- FIRE AND EXPLOSION HAZARD DATA

Nonexplosive; Nonflammable

SECTION V -- HEALTH HAZARD DATA

Permissable concentrations (air):	N/A
Effects of Overexposure:	ND
Emergency and First Aid Procedures:	Irrigate eyes with water, consult eye physician. Wash exposed skin areas with soap and water.

SECTION VI -- REACTIVITY DATA

Stability:	Under normal storage and handling conditions; this is a stable material when kept in a closed container.
Hazardous Polymerization:	Will not occur.
Incompatibility:	None known.
Hazardous Decomposition Products:	None known.

SECTION VII -- SPILL PROCEDURES

Steps to be Taken if Material is Released or Spilled:	If dry, shovel vacuum or sweep color up for disposal. Wet surfaces may become slippery or sticky. Mop, sweep, or absorb, and hold for disposal. Spills should be thoroughly flushed with soapy water until all apparent color is removed.

SECTION IX -- EXPOSURES OF CONCERN

N/A

SECTION X -- HANDLING AND USE PRECAUTIONS

Keep away from children. Store in tightly stored container.

SECTION XI -- INDUSTRIAL HYGIENE CONTROL MEASURES

Respiratory Protection:	No respiratory protection required, but dust masks are suggested.
Eye Protection:	Use of safety glasses is recommended.
Skin Protection:	Non required. To minimize clean-up, wear gloves when handling materil. Some dyes may temporarily stain skin.

N/A = Not Applicable. **N/D = Not Determined

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MATERIAL SAFETY DATA SHEET

MATERIAL: **OSHA 29CFR 1910.1200**

PSM 200 SETTING AGENT **DATE OF PREPARATION:** **JUNE 2005**

SECTION I -- IDENTITY

Distributor's Name and Address:	Landfill Service Corporation 2183 Pennsylvania Avenue Apalachin, NY 13732
Emergency Telephone:	(607) 625-3050
Chemical Name and Synonyms:	Sodium Montmorillonite Clay (SMC) (CAS No. 1318-93-0)
Generic Name:	SMC with proprietary additives (CAS No. 1318-93-0)
Trade Name:	Posi-Shell® PSM 200 Setting Agent

SECTION II -- HAZARDOUS INGREDIENTS

Ingredient:	Crystalline Silica (SiOz) as Quartz
CAS No.:	14808-60-7
Hazard:	Low concentrations of crystalline silica in the form of quartz may be present in airborne SMC dust. See Section VI for discussion of health hazard.
Note:	Although the typical quartz content of western SMC is in the range of 2 to 6% most of the quartz particles are larger than the 10µ respirable threshold size. The actual respirable quartz concentration in airborne SMC dust will depend upon SMC source, fineness of product, moisture content of product, local humidity and wind condition at point of use and other use specific factors.

SECTION III -- PHYSICAL DATA

Boiling Point (ºF):	N/A
Vapor Pressure (mm. Hg):	N/A
Vapor Density (Air=1):	N/A
Solubility in Water:	Insoluble, forms colloidal suspension
Density (at 20º C):	55 lbs/cu ft as product
Specific Gravity (H2O=1):	2.45-2.55
Melting Point:	Approx. 1450º C
Evaporation Rate (Butyl Acetate=1):	N/A
pH:	8-10 (5% aqueous suspension)

SECTION IV -- CHEMICAL DATA

N/A

SECTION V -- FIRE AND EXPLOSION HAZARD DATA

Flash Point:	N/A
Special Fire Fighting Procedures:	N/A
Unusual Fire and Explosion Hazards:	None. Product will not support combustion.
Extinguishing Media:	None for product. Any media can be used for the packaging. Product becomes slippery when wet.
Flammable Limits:	LEL: N/A UEL: N/A

SECTION VI -- HEALTH HAZARD DATA

Routes of Exposure and Effects:

Skin:	Possible drying resulting in dermatitis.
Eyes:	Mechanical irritant.
Inhalation:	*Acute (short term) exposure to dust levels exceeding the PEL may cause irritation of respiratory tract resulting in a dry cough.* *Chronic (long term) exposure to airborne SMC dust containing respirable size (=10µ) quartz particles, where respirable quartz particle levels are higher than TLVs, may lead to development of silicosis or other respiratory prolems. Persistent dry cough and labored breathing upon exertion may be symptomatic.*
Ingestion:	No adverse effects.

Permissible Exposure Limits:
(for air contaminants)

	OSHA PEL (8 HR. TWA)	ACGIH TLV
SMC as "Particulates not otherwise regulated" (formerly nuisance dust)		
Total dust	15mg/m³	N/D
Respirable dust	5mg/m³	N/D
Crystalline Quartz (respirable)	0.1mg/m³	0.1mg/m³

Carcinogenicity: SMC is not listed by ACGIH, IARC, NTP, or OSHA. IARC, 1997, concludes that there is sufficient evidence in humans for the carcinogenicity of inhaled crystalline silica from occupational sources (IARC Class 1), that carcinogenicity was not detected in all industrial circumstances studied and that carcinogenicity may depend on characteristics of the crystalline silica or on external factors affecting its biological activity. NTP classifies respirable crystalline silica as "known to be a human carcinogen" (NTP 9th Report on Carcinogens - 2000). ACGIH classifies crystalline silica quartz as a suspected human carcinogen (A2).

Acute Oral LD50:	N/D
Acute Dermal LD50:	N/D
Aquatic Toxicology LC50:	N/D

Emergency and First Aid Procedures:

Skin:	Wash with soap and water until clean.
Eyes:	Flush with water until irritation ceases.
Inhalation:	Move to area free from dust. If symptoms of irritation persist, contact physician. Inhalation may aggravate existing respiratory illness.

SECTION VII -- REACTIVITY DATA

Stability:	Stable
Hazardous Polymerization:	None
Incompatibility:	None
Hazardous Decomposition Products:	None

SECTION VIII -- SPILL PROCEDURES

Steps to be Taken if Material is Released or Spilled:	Avoid breathing dust; wear respirator approved for silica bearing dust. Vacuum up to avoid generating airborne dust. Avoid using water. Product slippery when wetted.

SECTION IX -- EXPOSURES OF CONCERN

N/A

SECTION X -- HANDLING AND USE PRECAUTIONS

Waste Disposal Methods:	Product should be disposed of in acordance with applicable local, state, and federal regulations.
Handling and Storage Precautions:	Use NIOSH/MSHA respirators approved for silica bearing dust when free silica containing airborne SMC dust levels exceed PEL/TLVs. Clean up spills promptly to avoid making dust. Storage area floors may become slippery if wetted.

SECTION XI -- INDUSTRIAL HYGIENE CONTROL MEASURES

Ventilation Requirements:	Mechanical, general room ventilation. Use local ventilation to maintain PELs/TLVs.
Respirator:	Use respirators approved by NIOSH/MSHA for silica bearing dust.
Eye Protection:	Generally not necessary. Personal preference.
Gloves:	Generally not necessary. Personal preference.
Other Protective Clothing or Equipment:	None.

ECTION XII -- SPECIAL PRECAUTIONS

Avoid prolonged inhalation of airborne dust.

SECTION XIII -- DISPOSAL AND SHIPPING INFORMATION

Shipping Name:	N/A (Not Regulated)
Hazardous Substance:	N/A
Hazard Class:	N/A
Caution Labeling:	N/A

N/A = Not Applicable. **N/D = Not Determined

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MATERIAL SAFETY DATA SHEET

MATERIAL: **OSHA 29CFR 1910.1200**

PORTLAND CEMENT **DATE OF PREPARATION:** **MARCH 2006**

SECTION I -- IDENTITY

Distributor's Name and Address:	Landfill Service Corporation 2183 Pennsylvania Avenue Apalachin, NY 13732
Emergency Telephone:	(607) 625-3050
Chemical Name and Synonyms:	Portland Cement
Generic Name:	Also known as hydraulic cement
Trade Name:	Portland Cement Type I, IA, II III, V

SECTION II -- HAZARDOUS INGREDIENTS

Component (percentage)	CAS No.	OSHA PEL (8-hour TWA)	ACGIH TLV-TWA (2002)
Tri-calcium silicate (20-70)	12168-85-3	see Nuisance Dust PEL	see Nuisance Dust TLV
Di-calcium silicate (10-60)	10034-77-2	see Nuisance Dust PEL	see Nuisance Dust TLV
Tetra-calcium-alumino-ferrite (5-15)	12068-35-8	see Nuisance Dust PEL	see Nuisance Dust TLV
Calcium sulfate (2-10)	N/D	see Nuisance Dust PEL	see Nuisance Dust TLV
Tri-calcium Aluminate (1-15)	12042-78-3	see Nuisance Dust PEL	see Nuisance Dust TLV
Magnesium oxide (0-4)	1309-48-4	see Nuisance Dust PEL	see Nuisance Dust TLV
Nuisance Dusts	N/D	15 mg/m³ (total dust) 5 mg/m³ (respirable dust)	10 mg/m³ (total dust) 3 mg/m³ (respirable dust)
Crystalline Silica (Quartz)* (0-1)	14808-60-7	10mg/m³ /percent silica + 2 (respirable dust) 30 mg total dust/m³/percent silica + 2 (total dust)	0.10 mg/m³
Hexavalent Chromium (measured as chromic acid and chromates)	18540-29-9	(100 mg/m³)	N/D

***Trace Constituents:** Portland cement has a variable composition depending upon the cementitious products produced in the cement kiln. Small amounts of naturally occurring, but potentially harmful, chemical compounds might be detected during chemical analysis. These trace compounds might include free crystalline silica, potassium, and sodium compounds; heavy metals, including cadmium, chromium, nickel, and lead; and organic compounds. Other trace constituents may include calcium oxide (also known as free lime or quick lime).*

SECTION III -- PHYSICAL DATA

Boiling Point (ºF) (Aqueous Portion):	N/A
Vapor Pressure (mm. Hg):	N/A
Vapor Density (Air=1):	N/A
Solubility in Water:	Slight (0.1-1.0%)
pH (in water):	12-13
Specific Gravity (H2O=1):	2.9-3.15
Evaporation Rate:	N/A
Appearance and Odor:	Gray or white powder, no distinct odor

SECTION IV -- CHEMICAL DATA

N/A

SECTION V -- FIRE AND EXPLOSION HAZARD DATA

Portland cement is non-combustible and not explosive.
Special firefighting procedures are not applicable. (Although Portland cement poses no fire-related hazards, a self-contained breathing apparatus is recommended to limit exposure to combustion products when fighting any fire.)

SECTION VI -- HEALTH HAZARD DATA

Threshold Limit Value: N/A

Effects of Overexposure:

Acute: Wet cement on unprotected skin, whether direct or through saturated clothing, can cause severe, third-degree caustic burns.
NOTE: Portland cement burns skin with little warning; discomfort or pain cannot be relied upon to alert a person to a hazardous skin exposure. The severity of the burn may not be detected until several hours after the damage begins.
Dry Portland cement can produce mild irritation to severe burns of the eye; it can irritate the upper respiratory system.

Chronic: Dry Portland cement can cause inflammation of the lining of the nose and the cornea. Repeated exposure to Portland cement may result in drying of the skin and may lead to thickening, cracking, or fissuring, of the skin. Hypersensitive individuals may develop an allergic dermatitis (possibly due to trace amounts of hexavalent chromium at less than 0.005%). This reaction may appear in several forms including a mild rash to severe skin ulcers. Persons already sensitized may react to their first contact with the product. Other persons may experience this effect after years of exposure to Portland cement products.
While Portland cement typically has less than 0.2% crystalline silica, other additives to Portland cement and those components (e.g. aggregates) added to produce Portland cement concrete may significantly increase the amount of crystalline silica that is present. Exposure to respirable crystalline silica without the use of a respirator can cause silicosis and may aggravate other lung conditions.

Signs and Symptoms of Exposure: Burning sensation around moist tissue areas (i.e., eyes, nose, upper respiratory system); painful burning on exposed skin that can develop with little warning. *Exposure of sufficient duration to wet Portland cement can cause serious, potentially irreversible tissue (skin or eye) destruction in the form of chemical (caustic) burns, including third-degree burns. The same kind of destruction can occur if wet or moist areas of the body are exposed for sufficient duration to dry Portland cement.*
Do not allow wet Portland cement to get inside boots, shoes, or gloves, and do not allow wet, saturated clothing to remain against the skin.

Emergency and First Aid Procedures:	● Irrigate eyes immediately and repeatedly with large amount of clean water for at least 15 minutes and get prompt medical attention. ● Wash exposed skin areas with pH-neutral soap and clean water. ● Apply sterile dressings; seek medical treatment in all cases of prolonged exposure to wet Portland cement, Portland cement mixtures, liquids from fresh Portland cement products, or prolonged wet skin exposure to dry Portland cement. ● If ingested, consult a physician immediately. ● Do not induce vomiting. If conscious, have the victim drink plenty of water and call a physician immediately. ● In the event of inhalation, remove to fresh air. ● Seek medical attention if coughing and other symptoms do not subside. ● Inhalation of gross amounts of Portland cement requires immediate medical attention.

SECTION VII -- REACTIVITY DATA

Stability:	Product is stable. Keep dry until used.
Hazardous Polymerization:	Will not occur.
Incompatibility:	Aluminum powder and other alkali and alkaline earth elements will react in wet mortar or concrete, liberating hydrogen gas. Portland cement is highly alkaline and will react with acids to produce a violent, heat-generating reaction. Toxic gases or vapors may be given off, depending on the acid involved.
Hazardous Decomposition Products:	None known.

SECTION VIII -- SPILL PROCEDURES

Steps to be Taken if Material is Released or Spilled:	Use dry cleanup methods that do not disperse the dust into the air. Avoid breathing the dust. Emergency procedures are not required.

SECTION IX -- EXPOSURES OF CONCERN

Medical Conditions Generally Aggravated by Exposure:	Pre-existing skin conditions may be worsened. Silicosis may aggravate other chronic pulmonary conditions and may increase the risk of pulmonary tuberculosis infection.

Chemical Listed as Carcinogenic or Potential Carcinogen:	Portland cements are not considered carcinogenic. However, the International Agency for Research on Cancer (IARC) has determined, primarily through animal studies, that silica is a known human carcinogen. The National Toxicology Program (NTP) has characterized respirable quartz silica as reasonably anticipated to be a carcinogen. OSHA does not regulate silica as a carcinogen.

SECTION X -- HANDLING AND USE PRECAUTIONS

Portland cement should only be used by knowledgeable persons. While the information provided in the material safety data sheet is believed to provide a useful summary of the hazards of Portland cement, as it is commonly used, the sheet cannot anticipate and provide all of the information that might be needed in every situation. Inexperienced product users should obtain proper training before using this product.

A key to using the product safely requires the user to recognize that Portland cement chemically reacts with water, and that some of the intermediate products of this reaction (that is, those present while a Portland cement product is "setting") pose a more severe hazard than does Portland cement itself. These hazards include potential injuries to eyes and skin.

The data furnished in this sheet do not address hazards that may be posed by other materials mixed with Portland cement to produce Portland cement products. Users should review other relevant material safety data sheets before working with this Portland cement or with Portland cement products, including, for example, Portland cement concrete.

SECTION XI -- INDUSTRIAL HYGIENE CONTROL MEASURES

Ventilation Requirements:	Local exhaust can be used to control airborne dust levels.
Respiratory Protection:	Avoid actions that cause dust to become airborne. Use local or general ventilation to control exposures below applicable exposure limits. Use NIOSH/MSHA-approved (under 30 CFR 11) or NIOSH-approved (under 42 CFR 84) respirators in poorly ventilated areas, or if an applicable exposure limit is exceeded, or when dust causes discomfort or irritation. *(Advisory: Respirators and filters purchased after July 10, 1998, must be certified under 42 CFR 84.)*
Eye Protection:	When engaged in activities where Portland cement dust or wet Portland cement or concrete could contact the eye, wear goggles or safety glasses with side shields. In extremely dusty environments and unpredictable environments, wear unvented or indirectly vented goggles to avoid eye irritation or injury. Contact lenses should not be worn when working with Portland cement or wet Portland cement products.

Skin Protection:	Prevention is essential to avoiding potentially severe skin injury. Avoid contact with unhardened (wet) Portland cement products. If contact occurs, promptly wash affected area with soap and water. *Do Not Allow Wet Portland Cement to Get Inside Boots, Shoes, or Gloves; and Do Not Allow Wet, Saturated Clothing to Remain Against the Skin.* *Do not rely on barrier creams. Barrier creams should not be used in place of gloves. Use impervious, abrasion- and alkali-resistant gloves, boots, and protective clothing to protect the skin from prolonged contact with wet Portland cement in plastic concrete, mortar, or slurries.*

SECTION XII -- SPECIAL PRECAUTIONS

Work/Hygienic Practices:	● Periodically wash areas contacted by dry Portland cement, or by wet Portland cement, or concrete fluids with a pH neutral soap and clean, uncontaminated water. ● Wash again at the end of the work. ● If irritation occurs, immediately wash the affected area and seek treatment. ● If clothing becomes saturated with wet Portland cement or concrete, it should be removed and replaced with clean, dry clothing. ● Follow listed precautions as appropriate, during repair or maintenance work on contaminated equipment.

SECTION XIII -- DISPOSAL AND SHIPPING INFORMATION

Shipping Name:	Portland cement is not hazardous under US Dept. of Transportation (DOT) regulations.
Hazardous Substance:	N/A
Hazard Class:	N/A
Caution Labeling:	N/A
Identification Number:	N/A
Disposal Method:	Small amounts of material can be returned to the container for later use if it is not contaminated. Dispose of waste material in accordance with Federal, State, and Local requirements. Portland cement is not a hazardous waste as defined by the Resource Conservation and Recovery Act (40 CFR 261).

SECTION XIV -- OTHER REGULATORY INFORMATION

Status under USDOL--OSHA Hazard Communication Standard (29 CFR 1910.1200):

Portland cement is considered a "hazardous chemical" under this regulation and should be a part of any Hazard Communication Program.

Status under CERCLA / Superfund (40 CFR 117 and 302):

Not listed.

Status under SARA (Title III, Sections 311 and 312):

Portland cement qualifies as a "hazardous substance" with delayed health effects.

Status under SARA (Title III, Section 313):

This product may contain constituents listed under SARA (Title III, Section 313,) but not in amounts requiring supplier notification under 40 CFR Part 372 Subpart C.

Status under TSCA (as of May 1997):

Portland cement and some of the substances in Portland cement are on the TSCA inventory list.

Status under the Federal Hazardous Substances Act:

Portland cement is a "hazardous substance" subject to statutes promulgated under the subject act.

Status under California Proposition 65:

Portland cement contains chemicals (trace metals) including silica and hexavalent chromium, known to the State of California to cause cancer, birth defects or other reproductive harm. California law requires the manufacturer to give the above warning in the absence of definitive testing to prove that the defined risks do not exist.

Status under the Canadian Environmental Protection Act:

Not listed.

Workplace Hazardous Material Information System (Canada):

Portland cment is considered to be a hazardous material under the Hazardous Product Act as defined by the Controlled Products Regulations (Class E - Corrosive Material), and is therefore, subject to the labeling and MSDS requirements of the Workplace Hazardous Materials Information System (WHMIS).

N/A = Not Applicable. **N/D = Not Determined

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MATERIAL SAFETY DATA SHEET

MATERIAL:		**OSHA 29CFR 1910.1200**
POSI-SHELL® SYNTHETIC COVER ADVANCED FORMULATION	**DATE OF PREPARATION:**	**APRIL 2006**

SECTION I -- IDENTITY

Distributor's Name and Address:	Landfill Service Corporation 2183 Pennsylvania Avenue Apalachin, NY 13732
Emergency Telephone:	(607) 625-3050
Chemical Name and Synonyms:	Aqueous alkaline slurry
Generic Name:	N/A
Trade Name:	Posi-Shell® Synthetic Cover Advanced Formulation

SECTION II -- HAZARDOUS INGREDIENTS

N/A

SECTION III -- PHYSICAL DATA

Boiling Point (ºF) (Aqueous Portion):	212
Vapor Pressure (mm. Hg):	N/A
Vapor Density (Air=1):	N/A

Solubility in Water:	N/A
Percent Volatile by Volume (%):	N/A
Specific Gravity (H2O=1):	1.21
Evaporation Rate:	N/A
Appearance and Odor:	Brown viscid liquid slurry with a smell similar to wet Portland cement and liquid clay.

SECTION IV -- CHEMICAL DATA

Chemical family:	N/A
Formula:	The major constituents are water, Portland cement, and PSM-200 Setting Agent, a blend of sodium montmorillinite clay with synthetic polymers and a processed starch. The slurry also contains P.E.T. fibers, water (or landfill leachate), and optional iron oxide coloring agent.
Hazardous mixtures of other liquids, solids, or gases:	N/A

SECTION V -- FIRE AND EXPLOSION HAZARD DATA

Non-explosive, Non-flammable

SECTION VI -- HEALTH HAZARD DATA

Threshold Limit Value: N/A

Effects of Overexposure:

Acute:	Can dry skin and cause alkali burns. May cause eye and skin irritation to those with sensitive skin.
Chronic:	Non-observed, if properly handled. If cured material is pulverized and dispersed, fugitive dust can cause inflammation of the lining tissue of the interior of the nose and inflammation of the cornea. Hypersensitive individuals may develop an allergic dermatitis.

Emergency and First Aid Procedures: Irrigate eyes with water. Wash exposed skin areas with soap and water.

SECTION VII -- REACTIVITY DATA

Stability:	Product is stable.
Hazardous Polymerization:	Will not occur.
Incompatibility:	None known.
Hazardous Decomposition Products:	None known.

SECTION VIII -- SPILL PROCEDURES

Steps to be Taken if Material is Released or Spilled:	Handle as normal non-hazardous solid waste.

SECTION IX -- EXPOSURES OF CONCERN

N/A

SECTION X -- HANDLING AND USE PRECAUTIONS

Waste Disposal Methods:	Material can be disposed of as common waste in approved landfill.

SECTION XI -- INDUSTRIAL HYGIENE CONTROL MEASURES

Ventilation Requirements:	Local exhaust may be used.
Respiratory Protection:	A dust mask is recommended during mixing procedures.
Eye Protection:	Use of tight-fitting goggles is recommended.
Skin Protection:	Avoid skin contact with wet slurry. Wear rubber or plastic gloves.
Other Protective Clothing or Equipment:	Use barrier creams; wear coveralls; shower with soap and water.

SECTION XII -- SPECIAL PRECAUTIONS

No special precautions need to be taken in handling and storing.

SECTION XIII -- DISPOSAL AND SHIPPING INFORMATION

Shipping Name:	N/A (Not Regulated)
Hazardous Substance:	N/A
Hazard Class:	N/A
Caution Labeling:	N/A

N/A = Not Applicable. **N/D = Not Determined

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FLI FRIEND LABORATORY INC

32 ITHACA STREET
TELEPHONE (607) 565-3500

WAVERLY, NY 14892 - 1532
FAX (607) 565 - 4083

NY 10252 NJ 73168
PA 68180 EPA NY00033

Certificate of Analysis

Landfill Service Corp.
2183 Pennsylvania Ave
Apalachin, NY 13732
Attn: Nancy Crane

Order Number: 0607-01218
Date Reported: 7/26/2006
Date Received: 7/25/2006
Invoice Number: 32761
Customer Number: L083
Customer PO:
Certification Date: 7/26/2006

Subject:
Flamabilitiy

SMP	Analysis Performed	Result	Units	Detection Limit	Method	Analysis Information
001	**Posi-Shell Advanced Formulation**	**7/11/2006 13:00**	**Client**			
	Flamability Potential	negative			ASTM D 4982	7/25/06, 14:22, JHR

RECEIVED JUL 31 2006

Approved By: Richard Hammer, Managing Director

Key: E = estimated value
ND or U = analyte not detected
B = analyte was detected in the method or trip blank
< = less than the indicated value
ug/L = micrograms per liter (equivalent to parts per billion)
mg/L = milligrams per liter (equivalent to parts per million)
mg/Kg = milligrams per kilogram (equivalent to parts per million)

The information in this report is accurate to the best of our knowledge and ability. In no event shall our liability exceed the cost of these services. Your sample will be discarded after 14 days unless we are advised otherwise.

Adirondack Environmental Services, Inc.
Experience is the solution
314 North Pearl Street ♦ Albany, New York 12207
(800) 848-4983 ♦ (518) 434-4546 ♦ Fax (518) 434-0891

RECEIVED JUL 17 2006

July 13, 2006

Joel E. Lanz
Landfill Service Corporation
2183 Pennsylvania Avenue
Apalachin, NY 13732

Work Order No: 060630045

TEL: (607) 625-3050
FAX: (607) 625-2689

RE: Product testing

Dear Joel E. Lanz:

Adirondack Environmental Services, Inc received 3 samples on 6/30/2006 for the analyses presented in the following report.

There were no problems with the analyses and all associated QC met EPA or laboratory specifications, except if noted.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

ELAP#: 10709
AIHA#: 100307

Tara Daniels
Laboratory Manager

Qualifiers:		
	ND - Not Detected at the Reporting Limit	S - Spike Recovery outside accepted recovery limits
	J - Analyte detected below quanititation limits	R - RPD outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	T - Tentitively Identified Compound-Estimated Conc.
	X - Value exceeds Maximum Contaminant Level	E - Value above quantitation range

Adirondack Environmental Services, Inc

Date: *13-Jul-06*

CLIENT: Landfill Service Corporation
Work Order: 060630045
Project: Product testing
PO#:

Client Sample ID: Posi-AF Petri#2
Collection Date:
Lab Sample ID: 060630045-002
Matrix: SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
TCLP ICP METALS SW6010B/1311 (Prep: SW1311 - 7/5/2006)						Analyst: **SM**
Aluminum-TCLP	< 1.0	1.0		mg/L	1	7/13/2006 1:18:00 PM
Antimony-TCLP	< 0.60	0.60		mg/L	1	7/13/2006 1:18:00 PM
Arsenic-TCLP	< 0.050	0.050		mg/L	1	7/13/2006 1:18:00 PM
Barium-TCLP	1.3	0.10		mg/L	1	7/13/2006 1:18:00 PM
Beryllium-TCLP	< 0.050	0.050		mg/L	1	7/13/2006 1:18:00 PM
Boron-TCLP	< 0.50	0.50		mg/L	1	7/13/2006 1:18:00 PM
Cadmium-TCLP	< 0.050	0.050		mg/L	1	7/13/2006 1:18:00 PM
Chromium-TCLP	0.16	0.050		mg/L	1	7/13/2006 1:18:00 PM
Cobalt-TCLP	< 0.50	0.50		mg/L	1	7/13/2006 1:18:00 PM
Copper-TCLP	< 0.050	0.050		mg/L	1	7/13/2006 1:18:00 PM
Iron-TCLP	< 0.50	0.50		mg/L	1	7/13/2006 1:18:00 PM
Lead-TCLP	< 0.050	0.050		mg/L	1	7/13/2006 1:18:00 PM
Magnesium-TCLP	< 0.50	0.50		mg/L	1	7/13/2006 1:18:00 PM
Manganese-TCLP	< 0.20	0.20		mg/L	1	7/13/2006 1:18:00 PM
Molybdenum-TCLP	< 0.10	0.10		mg/L	1	7/13/2006 1:18:00 PM
Nickel-TCLP	< 0.20	0.20		mg/L	1	7/13/2006 1:18:00 PM
Selenium-TCLP	< 0.050	0.050		mg/L	1	7/13/2006 1:18:00 PM
Silver-TCLP	< 0.10	0.10		mg/L	1	7/13/2006 1:18:00 PM
Thallium-TCLP	< 0.10	0.10		mg/L	1	7/13/2006 1:18:00 PM
Titanium-TCLP	< 0.10	0.10		mg/L	1	7/13/2006 1:18:00 PM
Vanadium-TCLP	< 0.20	0.20		mg/L	1	7/13/2006 1:18:00 PM
Zinc-TCLP	< 0.10	0.10		mg/L	1	7/13/2006 1:18:00 PM
Zirconium-TCLP	< 0.50	0.50		mg/L	1	7/13/2006 1:18:00 PM

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quanititation limits
B - Analyte detected in the associated Method Blank
X - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
T - Tentitively Identified Compound-Estimated Conc.
E - Value above quantitation range

Operation Plan

Appendix 5D – Methane Monitoring Plan

CDM Smith

Professional Certification

The certification statement below must be signed and sealed by a Professional Geologist and submitted with the Landfill Gas Monitoring Plan.

> The landfill gas monitoring plan for this facility has been prepared by a qualified geologist who is licensed to practice in the State of North Carolina. The plan has been prepared based on first-hand knowledge of site conditions and familiarity with North Carolina solid waste rules and industry standard protocol. This certification is made in accordance with North Carolina Solid Waste Regulations, indicating this Landfill Gas Monitoring Plan should provide early detection of any release of hazardous constituents to the uppermost aquifer, so as to be protective of public health and the environment. No other warranties, expressed or implied, are made.

Signed _____

Printed MATHEW F. COLONE

Date 3/5/2014

Not valid unless this document bears the seal of the above mentioned licensed professional.

NORTH CAROLINA LICENSED SEAL 1851 GEOLOGIST MATHEW F. COLONE

3/5/2014

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Section 1
Introduction

Landfill gas (LFG) is a natural by-product of the anaerobic decomposition of landfilled bio-degradable waste. LFG can present a danger to human health and the environment and therefore must be monitored. For these reasons, LFG is regulated by Federal and North Carolina state legislation. This Plan describes the systems and programs needed to fulfill federal and state regulations concerning LFG. In addition, this Plan describes the characteristics of LFG and its migration patterns; and provides alternative methods to control and destroy its harmful components. This additional background information is presented in the Plan to insure it is readily available should a situation occur that requires information and action beyond that described in this Plan.

1.1 Purpose

This Plan fulfills the requirements set forth in Rule .1626(4) for monitoring and controlling LFG. This Plan:

- Describes the necessary LFG monitoring systems,
- Sets forth the monitoring procedures and programs, and
- Identifies the actions needed if levels of methane exceed regulatory limits.

1.2 General Characteristics of LFG and Methane Generation

LFG can be an energy resource as well as a source of environmental pollution. The methane content is what makes LFG valuable as an energy resource. LFG is composed of approximately 50 percent methane in contrast to natural gas which consists of approximately 95 percent methane. LFG programs which focus on recovering gas as an energy resource include collection and extraction systems used to maximize its recovery. What makes LFG a source of environmental pollution is its odor, its potentially explosive properties, and its contribution to global warming. LFG programs which focus on the environmental hazards of landfill gas include collection systems to monitor the migration of gas and control or neutralize its environmental impacts.

LFG is composed of 50 to 55 percent methane (CH4); 45 to 50 percent carbon dioxide (CO2); and, less than one percent non-methane organic compounds (NMOC). These individual gases remain co-mingled and do not naturally separate.

1.2.1 Decomposition Rate and Volume

The decomposition of biodegradable waste begins with aerobic decomposition that typically lasts 3 to 18 months until the oxygen in the landfill is depleted. Following this, the anaerobic phase begins which results in LFG production. This anaerobic phase continues until all of the carbon-based materials are broken down or oxygen is reintroduced. Some historical LFG production generation models suggest that LFG generation continues for as long as 20 years. However, recent LFG recovery projects have demonstrated that production may continue beyond these 20 year estimates.

A reintroduction of oxygen does not stop the production of LFG, it just retards it. The volume of LFG generated over the life of a landfill is a function of the total volume of organic waste in the landfill as Influenced by age, moisture, compaction, and pH.

1.2.2 LFG Migration

The production of LFG creates a positive pressure within the landfill that forces the gas to migrate. LFG is lighter than air and moves upward unless there is a barrier. LFG will move laterally along the path of least resistance or lowest pressure. LFG migration is a function of soil conditions, hydrogeologic conditions, and weather conditions. LFG moves through porous soils, along underground pipes, and through trenches. In some cases the LFG migration path can be observed at the surface through observations of stressed vegetation. In these instances, LFG replaces the oxygen in root structures and eventually destroys the plants.

If tightly capped, LFG will move downward or laterally. Unless LFG is collected, it may migrate laterally, off the landfill site. If the landfill does not have an impermeable cover cap, LFG may migrate upward, through the landfill surface and cause odor and air quality problems. The lining and capping of a landfill does not affect the production of gas, it only improves the potential to collect and control it.

Section 2

Regulatory Background

2.1 Introduction

Because of the real and potential dangers from LFG and the methane in landfill gas, to the public health and safety and to the environment, existing and pending federal and state regulations require owners of municipal solid waste landfills (MSWLFs) to monitor and control it. The regulations are contained in Title 15A NCAC Subchapter 13 B Section .1626 (4).

2.2 Subtitle D and North Carolina Regulations

Methane gas is explosive when present within the range of 5 percent to 15 percent by volume in air. When present in concentrations greater than 15 percent, the mixture will not explode. The five percentage mixture is referred to as the Lower Explosive Limit (LEL) while the 15 percentage concentration is referred to as the Upper Explosive Limit (UEL). The State of North Carolina, through its 15A NCAC 13B .1626 (4) (a) requires that owners or operators of all MSWLF units ensure that the concentration of methane gas generated by the facility does not exceed:

- 25 percent of the lower explosive limit for methane in facility structures; and
- the lower explosive limit at the facility property boundary.

The lower explosive limit means the lowest percent by volume of a mixture of explosive gases in air that will promulgate a flame at 25° C and atmospheric pressure.

Paragraph (4)(b) of Section .1626 of the North Carolina regulations require that a routine methane monitoring program be implemented to ensure that these standards are met. A methane monitoring program typically involves sampling LFG emissions using a specially designed meter through a system of strategically located and specifically designed monitoring wells on a regularly scheduled basis. The time and frequency of monitoring must be determined based on soil conditions, hydrogeologic conditions and hydraulic conditions surrounding the facility, and locations of structures and property boundaries. However, compliance with Subtitle D requires that the minimum frequency of monitoring be quarterly. Buncombe County has been conducting an on-going methane monitoring program for the Subtitle D Landfill. The County has been monitoring methane concentrations in on-site structures and a network of monitoring wells along the perimeter of the landfill property. The County currently conducts the quarterly monitoring with a GEM 2000 landfill gas meter.

Part (4)(c) of Section .1626 of the North Carolina regulations require that if methane levels exceed the specified limits, the owner or operator must:

- immediately take all necessary steps to ensure the protection of human health;
- immediately notify the State (it is assumed that this will be the DWM Compliance officer);
- within seven days of detection, place in the operating record the methane gas levels detected;

- within seven days of detection, provide a description of the steps taken to protect human health;
- within 60 days of detection, implement a remediation plan for the methane gas release; the plan shall describe the nature and extent of the problem and the proposed remedy;
- within 60 days of detection, place a copy of the plan in the operating record of the landfill; and
- within 60 days of detection, notify the State that the plan has been implemented.

Section 3

Gas Control Plan

The gas control plan includes a schedule for reading or monitoring LFG emission levels at designated locations quarterly and a system for reporting the concentration levels.

The requirements for quarterly monitoring, and the plan for actions if readings exceed safe levels should, at a minimum, be based on compliance with federal and state regulations.

3.1 Frequency of Routine Monitoring

Subtitle D regulations require that a quarterly methane monitoring program be implemented to ensure that the concentration of methane or other explosive gases do not exceed regulatory limits.

3.2 Monitoring Well Installation and Construction

Existing landfill gas monitoring wells M-1 through M-4 monitor Cells 1 through 6 of the Subtitle D landfill for LFG migration. Wells M-5 and M-6 will be used to monitor the Cell 7 expansion. Existing and proposed landfill gas monitoring wells, including those associated with future expansions, are provided on **Sheet 1**.

The new monitoring wells will be constructed with 2-inch diameter schedule 40 PVC with threaded couplings with a minimum of 10 feet of 0.010-inch slotted screen with a #2 sand filter pack extending 1 foot above the top of the screen. A 1 to 2-foot thick bentonite seal will be placed on top of the sand filter pack and hydrated. The remainder of the borehole annulus was completed with a Portland cement/bentonite grout. Screen length will be selected based on groundwater and bedrock elevations observed during well installation.

Similar to the existing and proposed groundwater monitoring wells at the facility, the landfill gas monitoring wells will be installed within the dominant drainage features associated with the Cell 7 expansion. Well locations are in or adjacent to low-lying drainage feature areas down-gradient of the landfill unit where seasonal high groundwater elevations are typically within the partially weathered rock or alluvium. Because of the existing topography at the site, well screens will likely be 10-feet or more below the base of the landfill. CDM Smith believes that in the case of the Buncombe County landfill, it is unreasonable to install landfill gas monitoring wells into the fractured bedrock. If groundwater data in fractured bedrock or other indicators such as distressed vegetation indicate that a landfill gas migration problem may exist, additional deeper monitoring wells may be installed to assess gas migration.

All landfill gas monitoring wells will be constructed in accordance with the North Carolina Well Construction Standards described in 15A NCAC 2C and will be completed with locking above grade protective covers and 2-foot by 2-foot concrete pads. Following installation, the wells will be surveyed to State Plane coordinates.

The wellhead caps will be fitted with a stopcock type fitting or quick-connect that is of sufficient quality to facilitate sampling in accordance with industry and federal standards. **Figure 3-1** includes a typical landfill gas monitoring well detail. Flooded wells will be replaced with dry wells, if necessary.

3.3 Staffing

LFG monitoring requires a trained technician using calibrated equipment that is designed to determine the level of methane escaping the landfill through monitoring wells and inside structures on the landfill site. Available options include training existing staff, hiring a special contractor, or hiring and training part-time staff to perform this task.

3.4 Monitoring Procedures

Each regular quarterly monitoring event should begin by checking methane levels in the scale-house and any occupied structure on the landfill site. Next, the non-occupied buildings at the landfill should be checked. Finally, the landfill gas monitoring wells around the Subtitle D landfill should be checked.

The following monitoring procedures, as described in the Solid Waste Section Guidance Documentation for landfill gas monitoring, shall be followed:

- The technician using the landfill gas monitoring instrument must understand the principles of operation and follow the manufacturer's instructions. This includes calibrating the instrument according to the manufacturer's specifications.
- The following shall be included on the top portion of the landfill gas monitoring form: facility name, permit number, type and serial number of gas monitoring instrument, calibration date of the instrument, date and time of field calibration, type of gas used for field calibration (15/15 or 35/50), expiration date of field calibration gas canister, date of landfill gas monitoring event, name and position of sample collector, pump rate of instrument being used, ambient air temperature, and general weather conditions.
- Verification that the equipment was calibrated in accordance with the manufacturer's specifications is required. When determining which field calibration gas to use, take into consideration the expected levels of methane in the landfill gas monitoring wells. If the methane levels are expected to be low, use the 15/15 gas canister (15% CO2/15% CH4). If the methane levels are expected to be high, use the 35/50 gas canister (35% CO2/50% CH4).

For every landfill gas monitoring well, verify sample tube purge prior to each sample taken (should be one minute), the time pumped in seconds (should be at least one minute), barometric pressure, time stabilized reading collected, percent lower explosive limit, percent methane by volume, percent oxygen, percent carbon dioxide, and any observations or comments.

The landfill gas monitoring data form and results should be retained in the operating record unless an exceedance has occurred and/or is requested by the Solid Waste Section.

3.4.1 Monitoring Times

Monitoring times are also important when conducting landfill gas monitoring. Proper landfill gas monitoring should include sampling during times when landfill gas is most likely to migrate. Landfill gas can migrate and accumulate not only in landfill gas monitoring wells; it can also migrate and accumulate in buildings and other structures. Because subsurface gas pressures are considered to be at a maximum during the afternoon hours, monitoring should be conducted in the afternoon or whenever the barometric pressure is low.

Scientific evidence also indicates that weather and soil conditions influence the migration of landfill gas. Barometric pressure and precipitation have significant effects on landfill gas migration. Increased barometric pressure generates decreased landfill gas venting from the subsurface, until the pressure within the subsurface is greater than the atmospheric (barometric) pressure. On the other hand, when the barometric pressure decreases, the landfill will vent the stored gas until a pressure equilibrium is reached. Capping of a landfill can influence the effect of barometric pressure on landfill gas migration. Generally, a more permeable landfill cap will allow greater influence by barometric pressure than a less permeable landfill cap. As a result, landfill gas monitoring should be conducted when the barometric pressure is low and soils are saturated. During the winter season when snow cover is just beginning to melt or when the ground is frozen or ice covered, landfill gas monitoring should be conducted when the barometric pressure is low.

3.4.2 Sampling Procedures

Any accumulation of landfill gas in the landfill gas monitoring wells may be the result of landfill gas migration. The following procedure is a recommended example for conducting landfill gas monitoring well monitoring, but always read and follow the manufacturer's instructions because each instrument will be different.

Step 1 – Calibrate the instrument according to the manufacturer's specifications. In addition, prepare the instrument for monitoring by allowing it to properly warm up as directed by the manufacturer. Make sure the static pressure shows a reading of zero on the instrument prior to taking the first sample.

Step 2 – Purge sample tube for at least one minute prior to taking reading. Connect the instrument tubing to the landfill gas monitoring well cap fitted with a stopcock valve or quick connect coupling.

Step 3 – Open the valve and record the initial reading and then the stabilized reading. A stable reading is one that does not vary more than 0.5 percent by volume on the instrument's scale.

Step 4 - Record the stabilized reading including the oxygen concentration and barometric pressure. A proper reading should have two percent oxygen by volume or less. If levels of oxygen are higher, it may indicate that air is being drawn into the system giving a false reading.

Step 5 – Turn the stopcock valve to the off position and disconnect the tubing.

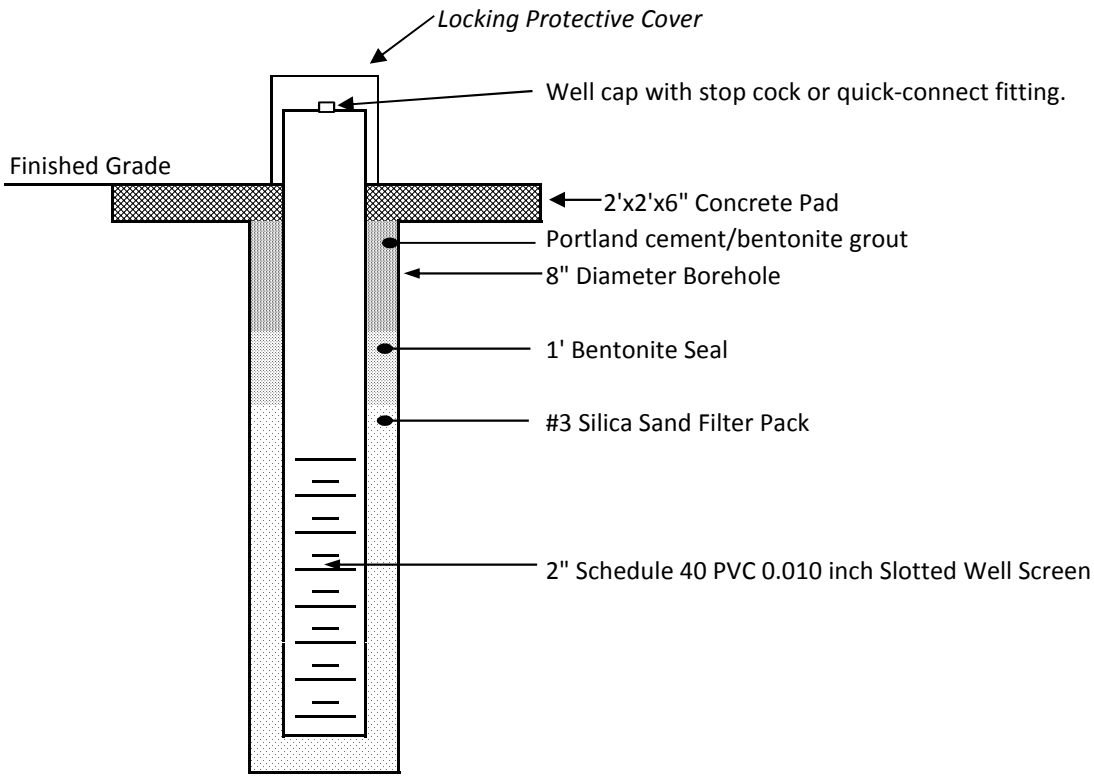
Step 6 – Proceed to the next landfill gas monitoring well and repeat Steps 2 – 5.

If methane levels detected at the wells exceeds the lower explosive limit, the technician shall immediately follow the action plan presented in Section 4. If the methane levels detected within on-site buildings are greater than 25 percent of the lower explosive limit, the technician shall immediately follow the actions presented in Section 4 of this report.

3.5 Record Keeping

All readings will be recorded on a standard methane monitoring log form. A sample methane monitoring log is provided at the end of this section. These forms will be reviewed and initialed by the landfill supervisor and then placed in the landfill operating records.

These quarterly methane monitoring logs will remain on file at the landfill with other landfill records. These readings should be available for review by the State upon request.



Notes:
Stick-up will extend between 2.5 and 3 feet above finished grade.
Silica sand filter pack will extend at least 1 feet above top of screen elevation.
Well depth and screen length will vary upon depth to groundwater or bedrock.

Figure 3-1
Typical Landfill Gas Monitoring Well Detail

NC Division of Waste Management - Solid Waste Section

Landfill Gas Monitoring Data 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).

Facility Name: _____ Permit Number: _____

Date of Sampling: _____ NC Landfill Rule (.0500 or .1600): _____

Name and Position of Sample Collector: _____

Type and Serial Number of Gas Meter: _____ Calibration Date of Gas Meter: _____

Date and Time of Field Calibration: _____

Type of Field Calibration Gas (15/15 or 35/50): _____ Expiration Date of Field Calibration Gas Canister: _____

Pump Rate of Gas Meter: _____

Ambient Air Temperature: _____ Barometric Pressure: _____ General Weather Conditions: _____

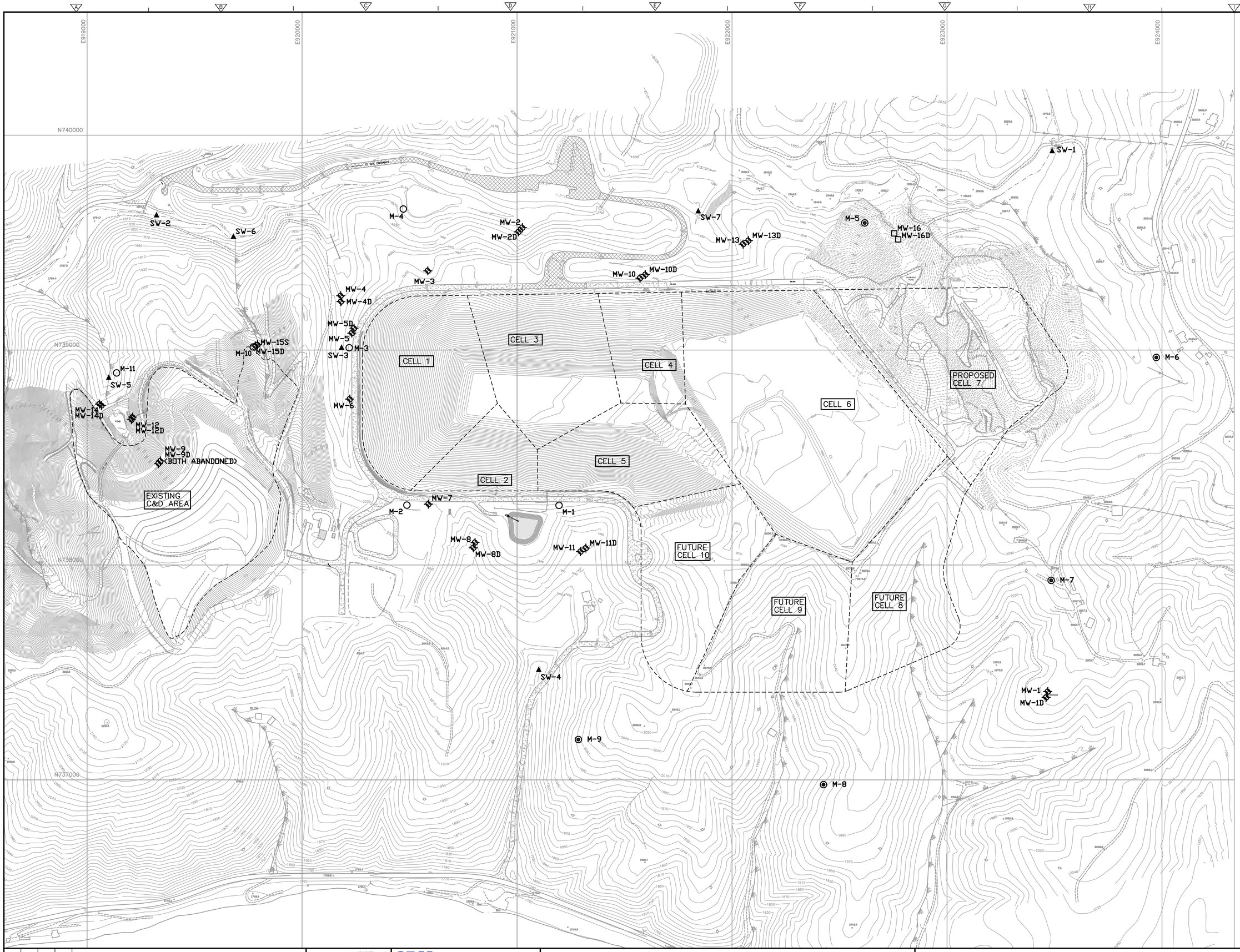
Instructions: Under "Location or LFG Well" identify the monitoring wells or describe the location for other tests (e.g., inside buildings). A drawing showing the location of test must be attached. Report methane readings in both % LEL and % methane by volume. A reading in percent methane by volume can be converted to % LEL as follows: % methane by volume = % LEL/20

Location or LFG Well ID	Sample Tube Purge	Time	Time Pumped (s)	Initial %LEL	Stabilized %LEL	%CH4 by Volume	%O2	%CO2	Notes

If your facility has more gas monitoring locations than there is room on this form, please attach additional sheets listing the same information as contained on this form.

Certification
To the best of my knowledge, the information reported and statements made on this data submittal and attachments are true and correct. I am aware that there are significant penalties for making any false statement, representation, or certification including the possibility of a fine and imprisonment.

_____ _____
SIGNATURE TITLE



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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY

GROUNDWATER AND METHANE MONITORING WELL LOCATION MAP

PROJECT NO. 6447-93318
FILE NAME: SITE MAP.DWG
SHEET NO.
1

Section 4

Detection Plan

Both Subtitle D and the North Carolina Solid Waste Management Rules require a contingency plan for action if methane levels exceed the regulatory concentration limits. The plan for action includes the specific step by step actions needed should regulatory limits be detected.

4.1 Actions if Regulatory Limits Detected in Structures

If any structures on the landfill property have detections of methane equal to or greater than 25 percent of the LEL the following actions should be taken:

- the building should be immediately evacuated;
- the landfill supervisor should be immediately contacted;
- all individuals in and around the structure should be ordered to immediately stop smoking;
- all space heaters and similar appliances should be immediately disconnected from their power source;
- all doors and windows in the structure which gave the reading should be opened to permit the methane to escape;
- as a precautionary measure, the landfill operator will open doors and windows in all structures on the landfill property; and
- equipment used to take the readings should be tested immediately to verify it was giving accurate readings.

The technician will then proceed to take readings at all methane monitoring wells at the landfill. All levels should be verified and recorded on the methane monitoring log form. This information, including the verification that the equipment is providing accurate readings, the current readings, and the levels at all monitoring locations for the previous three quarters should be provided to the County's landfill supervisor. The Buncombe County landfill supervisor will make the decision to return to business as usual; temporarily evacuate the site; or follow the plan proposed in Section 4.3.

4.2 Actions if Regulatory Limits Detected at Monitoring Wells

If any of the methane monitoring wells measure a level equal to or more than the 100 % lower explosive limit (5% methane) as defined by Subtitle D, the technician should:

- immediately contact the landfill supervisor; and
- recheck the methane levels inside the facility structures. (If levels are close to or exceed 25 percent of the lower explosive level the actions in Section 4.1 should be followed.)

Once it is verified that levels inside the buildings are safe, the technician should check and record readings at all remaining methane monitoring wells on the site. In addition, the equipment used to take the readings should be tested to verify it is giving accurate readings.

This information, the current readings, and the levels for the previous three quarters should be provided to the Buncombe County landfill supervisor who will make the decision to: return to business as usual; temporarily evacuate the site; or, follow the plan proposed in Section 4.3.

4.3 Compliance Action Plan

If upon verification as described in Sections 4.1 and 4.2, the methane monitoring levels are equal to or exceed the regulatory limits as defined by Solid Waste Rule .1626(4)(a), the following actions are proposed to both comply with the regulations as well as protect the health and safety of the individuals at or near the landfill site.

4.3.1 Immediate Action

If methane levels exceed the specified limits, the landfill operator or the landfill supervisor will take immediate action to ensure the protection of human health and safety. This will include:

- evacuate all buildings on the site;
- open all doors and windows in buildings on the landfill site;
- notify the Buncombe County Manager's Office about the concentration levels;
- if warranted by the degree of intensity of the methane concentration, check the methane levels in structures near the landfill yet outside the facility boundary;
- if warranted by the degree of intensity of the methane concentration, evacuate the landfill area or evacuate the area adjacent to the landfill;
- notify the State compliance program about the reading;
- begin to identify or narrow down the source of the methane causing the readings exceeding the regulatory limits (i.e. the path that the methane is taking to the monitoring location);
- begin to identify the extent of the methane problem; and,
- as appropriate, begin to take corrective action to control the methane levels in building at the landfill site, at the boundaries to the landfill, and at the landfill site.

4.3.2 Actions Within Seven Days

If methane levels exceed the regulatory limits, in order to comply with the Solid Waste rules, the County must take the following actions within seven days:

- place in the operating records of the landfill, the gas levels detected; and,
- provide a description to the Solid Waste Section of the steps taken to protect human health.

It is also suggested that at this time, the operator begin to develop a plan which:

- describes the nature and extent of the problem, and
- proposes the remedy for the problem.

4.3.3 Actions Within Sixty Days

If methane levels exceed the specified limits, the County must take the following actions within 60 days:

- implement a remediation plan for the methane gas release;
- place a copy of the plan in the operating record of the landfill; and
- notify the appropriate Solid Waste Section official that the plan has been implemented.

4.4 Public Relations and Information

As with any potentially dangerous situation, it is important to keep the public, public service agencies, and the media informed. False information, inaccurate information, or the lack of information concerning potential explosions at a public facility could create panic.

If the County Manager determines that a potentially dangerous situation exists, it is recommended that a one page explanation of the situation be written and distributed to all homes and businesses within a one-half mile radius of the landfill. This should be done within the first two to four hours of making the determination that a potential danger to human health and safety exists. It is recommended that the County Manager appoint one individual to provide information to; the media; the police authorities with jurisdiction in the area; and area medical facilities. Area hospitals and police departments may receive calls once the local media releases the story. Centralizing the flow of information will avoid conflicting information and inaccurate information. Providing detailed and honest facts about the situation being under control is critical.

Operation Plan

Appendix 5E – Water Quality Monitoring Plan

CDM Smith

CERTIFICATION OF EFFECTIVENESS

The following statement is based on existing site conditions as of March 5, 2014 and data currently available on subsurface conditions and groundwater flow at the Buncombe County Solid Waste Management Facility Subtitle D landfill site. Additionally, it is our professional opinion that construction of a landfill may alter subsurface conditions.

In accordance with North Carolina Solid Waste Management Rule .1631(d)1, I hereby state to the best of my knowledge, information and belief and in my professional opinion as a geological professional, that the water quality monitoring system will be effective in providing detection of a release of hazardous constituents from the Buncombe County Solid Waste Management Facility Subtitle D Landfill to the uppermost aquifer, provided the system is operated and maintained properly.

NORTH CAROLINA LICENSED SEAL 1851 GEOLOGIST MATTHEW R. BOLONE

3/5/2014

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Section 1
Introduction

1.1 Purpose

The purpose of this Water Quality Monitoring Plan is to address the requirements in Rule .1623(b)(3)(B), and to present a plan for groundwater and surface water monitoring for the proposed Buncombe County Subtitle D Landfill, Cell 7. The Water Quality Monitoring Plan includes information on the expansion of the existing groundwater monitoring network, surface water monitoring plan, sampling and analysis requirements, and detection monitoring requirements. The groundwater monitoring network was designed based on information obtained from recent and previous subsurface investigations and a review of literature pertaining to regional geology and groundwater resources. A detailed discussion of the geologic and hydrogeologic conditions at the Cell 7 area is presented in both the facility Site Plan Application and the Design Hydrogeologic Report for the Cell 7 area.

1.2 Scope

The Water Quality Monitoring Plan includes the following elements, in accordance with Rules .1630 through .1637 of the North Carolina Administrative Code:

- Design and installation of a groundwater monitoring system, based on site-specific information, to yield groundwater samples from the uppermost aquifer that represents the quality of the background groundwater that has not been affected by landfill activities or other man-made activities.
- Design and installation of groundwater monitoring system, based on site-specific information, to yield groundwater samples from the uppermost aquifer that represent the quality of groundwater passing the relevant point of compliance.
- Monitor wells designed and constructed in accordance with the applicable North Carolina Well Construction Standards as found in 15A NCAC 2C.
- A Sampling and Analysis Plan that includes procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, chain-of-custody procedures, and quality assurance and quality control.
- A certification of effectiveness of the water quality monitoring plan is provided in Appendix A.

Section 2

Geologic Setting

The Buncombe County Landfill site is located in the Blue Ridge Mountains approximately 9 miles north of Asheville, North Carolina. The entire landfill site consists of 557 acres bounded by the French Broad River to the south and west, Blevin Branch to the north, and Flat Creek to the east. The site consists of moderate to steep slopes separating narrow hills and ridges from small incised secondary drainages.

2.1 Geology

The Geologic Map of North Carolina shows the site to be underlain by a Precambrian Migmatitic biotite-hornblende gneiss unit (NCGS 1985). The site vicinity was mapped as primarily granite gneiss (Weiner 1970), but is referred to as both granitic and undifferentiated gneiss throughout previous site investigation reports.

The residuum soils (saprolite) generally consist of stiff sandy silts and dense clayey, silty sands with occasional clay lenses. Small deposits of alluvium are typically encountered in the bottoms of the secondary drainage features and typically found to overly saprolite, when encountered. The saprolite grades into partially weathered rock (PWR). PWR was encountered in the borings as indicated by a blow count greater than 50 blows per six inch interval. The thickness of saprolite and PWR was greatest in upland areas, and least in the bottom of secondary drainage features. Depth to bedrock in the Cell 7 area, defined as depth to auger refusal, ranges from 31 feet bgs (B-722) to 64 feet bgs (B-726). The average bedrock depth was about 45 feet, which is slightly deeper than bedrock depths in the Cell 1-6 Area (CDM 2004). The top of bedrock is a subdued reflection of surface topography, with shallow bedrock in the secondary drainage features, and deeper bedrock in upland areas.

2.1 Hydrogeology

As with bedrock, the potentiometric surface is a subdued reflection of surface topography. As shown in the Design Hydrogeologic Report, groundwater flow in the Cell 7 area is convergent to the secondary drainage feature towards the north with discharge to Blevin Branch. Groundwater is typically present above the bedrock surface. Only in the western portion of the Cell, on the ridge adjacent to Cell 6, was groundwater not present in the saprolite or PWR. The bedrock fracture flow system behaves similar to an anisotropic porous media, based on the results of pumping tests presented in the Design Hydrogeologic Report (for Cells 1-3, CDM, 1995). The depth of groundwater circulation beneath the Cell 7 area is estimated at approximately 100 feet below ground surface (bgs), based on analysis of the regional flow system as discussed in the Design Hydrogeologic Report. Thus, groundwater monitoring can be focused on depths of less than 100 feet bgs. As discussed previously, groundwater flow converges into the secondary drainage features at the site, therefore the secondary drainage features are an important target for groundwater monitoring.

Section 3

Proposed Groundwater Monitoring Network

This section presents the proposed groundwater monitoring network for the Cell 6 Area. Section 3.1 presents proposed monitoring well locations; Section 3.2 discusses monitoring well installation and construction specifications; Section 3.3 discusses hydraulic conductivity testing of the monitoring wells; Section 3.4 discusses the alternate groundwater monitoring system; and Section 3.5 is the surface water quality monitoring plan.

3.1 Monitoring Well Locations

The SWS regulations require that upgradient monitoring well(s) be located so that groundwater samples collected from the uppermost aquifer provide an indication of background groundwater quality. Upgradient wells MW-1s and MW-1d have already been installed to monitor background water quality. No additional background wells are proposed for the Cell 7 area. The downgradient monitoring wells must represent groundwater quality at the relevant point of compliance. The wells must be located in similar geologic units so that upgradient and downgradient groundwater quality data can be compared. Existing groundwater locations for the facility are provided on **Sheet 1**.

As the groundwater beneath the site is a three dimensional system, nested point of compliance wells are proposed. In locations in which saturation occurs above the bedrock surface, the shallow monitoring well will be completed in the saprolite or PWR. If a sufficient thickness of saturated saprolite/PWR zone is found, then the well will be installed in this zone. The zone should be of sufficient thickness to account for seasonal fluctuations in the water table. If a sufficient saturated thickness is not present, then the boring will be advanced into the bedrock and the well will be screened across the saprolite and bedrock contact. As discussed in the Design Hydrogeologic Report, saturated conditions above bedrock are found in the bottom of secondary drainage features. In locations in which no saturation is encountered above the bedrock surface, the shallowest completion will be in bedrock. The bedrock monitoring wells at each location will target the shallowest water-bearing fracture zones encountered. Drilling observations and air lift yield tests will be utilized to identify fractured zones.

The following nomenclature will be used for the new nested monitoring wells:

MW-16s – Shallow monitoring well at location # 16, with the screened interval in saprolite/PWR or at the PWR/bedrock contact.

MW-16d – Deep monitoring well at location # 16, with the screened interval at PWR/bedrock contact or first conductive fracture zone in the bedrock aquifer.

The groundwater monitoring system is shown in **Sheet 1**. This sheet shows the existing landfill Cells 1-6 and the relationship of the monitor wells to the cells. Monitoring wells MW-2 through MW-8, MW-10, MW-11, and MW-13 nests are located around Cells 1-6. Monitoring well nests MW-12, 14, and 15 are located downgradient of the C&D landfill. The location of the background well nest (MW-1/1d) is shown on **Sheet 1**. **Table 3-1** lists the existing monitoring well network, the proposed monitoring well nest for the Cell 7 area, the approximate depth of completion for the proposed wells, and the rationale for each location.

3.2 Monitoring Well Installation and Construction

The monitoring wells will be constructed in accordance with standard industry procedures and will meet the requirements of 15A NCAC 2C. Examples of shallow and deep monitoring wells are shown on **Figure 3-1 and 3-2**. The monitoring wells at locations of potentially saturated saprolite or PWR (MW-16s) will be installed by advancing the borehole through the water table using hollow-stem augering techniques. Soil samples will be collected at five-foot intervals with a split spoon sampler in accordance with ASTM D-1586. Soil lithology will be described in the field by an onsite geologist to develop a borehole log. If saturated conditions are not evident upon refusal of hollow stem auger drilling, then a temporary well screen will be placed in the hole for a period up to 48 hours to determine whether the well will yield water.

If no saturation is expected or encountered during hollow stem auger drilling, then the shallowest well will be installed in the upper portion of the bedrock aquifer utilizing air rotary drilling techniques. During air rotary drilling, drilling observations will be recorded by an onsite geologist, including observed fractures and lithologic descriptions from cuttings. Drilling will proceed until the first water-bearing fracture is encountered. Upon observing a fracture (an evident drop of the drill rod and/or a change in drill chatter), then an air lift yield test will be conducted. The drill rod will be raised at least 10 feet, and operations will cease for a period of 30 minutes. After the 30 minute period, the drill rod will be lowered to the bottom of the hole, and air will be blown for a period of 10 minutes. The amount of water coming from the hole at this time (if any) will be estimated in gallons per minute. If the borehole is dry, then the drill rig will be moved approximately 20 feet, and the above procedure repeated.

At locations in which a deeper well is desired (MW-16d), the deep well will be drilled after the shallow well and installed at least 10 feet deeper than the bottom of the shallow borehole. If sufficient saturated thickness is observed in the PWR for well installation and to maintain separation from the shallow well screen, the deeper well will be screened at the base of the PWR just above the top of the fractured bedrock. If the thickness of the saturated overburden is not sufficient to accommodate both a shallow and deep well, the deeper well will target the more conductive fracture zones encountered at depth. The above procedure for observing fractures and performing air lift yield tests will be applied. If no evident fractures are encountered at a depth between 10 and 35 feet below the bottom of the shallow well, then drilling will continue to until a fracture zone is encountered. Based on subsurface conditions observed during piezometer installations in the proposed well location, it is anticipated that the wells will be completed within 60 feet of ground surface. Also, based on observed subsurface conditions, it appears that the more conductive fracture zones will be encountered within the upper 100 feet of the bedrock. However, if subsurface conditions dictate that a deeper completion is required, then the wells will be installed at that depth. The deeper monitoring well will target the most conductive fracture zones, regardless of depth.

The monitoring wells will be constructed using 2-inch ID Schedule 40 PVC well casing with threaded flush joints. The shallow monitoring well will be constructed with ten to fifteen feet of 0.010-inch slot screen at the end of the casing string placed so that it brackets the water table. The deeper monitoring well will be constructed with a five to ten foot screen interval. The PVC casing string will extend approximately two feet above ground surface. A sand pack will be placed around the screen interval to a maximum of two feet above the top of the screen. A two foot thick bentonite seal consisting of hydrated bentonite pellets will be placed on top of the sand to hydraulically seal the completion interval. The remainder of the annulus will be sealed with a bentonite-Portland cement grout to ground surface. A protective outer casing with a lockable cap will be placed over the PVC casing and into the grout, extending 2.5 to 3 feet below ground surface.

If the deeper well is constructed in the shallow fractured bedrock, a 6-inch PVC outer casing will be installed from ground surface to the top of bedrock.

Following completion, the monitor wells will be developed to remove the residual effects of drilling. The wells will be developed using a combination of overpumping or surging and air lifting. All drilling and downhole equipment will be decontaminated by steam cleaning between borings. Well development equipment will be decontaminated by washing in a non-phosphate detergent solution followed by a potable water rinse, then a distilled water rinse, and allowed to air dry.

The horizontal location of all new monitor wells will be surveyed in State Plane Coordinates by a Registered Land Surveyor to the nearest 0.1 foot. The vertical control or elevation of the ground surface and top of PVC casing (the well measuring point) will be surveyed to the nearest 0.01 foot accuracy to mean sea level (msl). Anticipated well depths for the proposed monitoring wells for Cell 7 are provided on **Table 3-1**.

3.3 Hydraulic Conductivity Testing

Following installation and development of the new monitor wells, the hydraulic conductivity of the aquifer material surrounding each well will be determined by conducting slug falling head and/or recovery tests on each well.

3.4 Alternate Groundwater Monitoring System

Similar to Cells 1-6, an alternate groundwater monitoring system has been designed for installation under the critical portions of Cell 7. The applicability of alternative monitoring has been evaluated and a system has been designed that, in conjunction with the groundwater monitoring wells and the surface water sampling locations, should provide adequate means to monitor groundwater quality on the site. The alternate monitoring system is designed to detect contamination where it is most likely to first occur, i.e. to supplement conventional groundwater monitoring wells. The proposed system consists of a high permeability stone layer underlain by a scrim reinforced plastic tarp, located below the sump areas within each cell. The stone layer will provide a preferential pathway where any leakage from the landfill units will be collected. An outlet pipe with a capped end will be installed from the low point of the stone layer through the landfill embankment (sloped for positive drainage). Note that some infiltration of stormwater may occur, as is the case with conventional monitoring wells, therefore the presence of water in the system will not necessarily indicate a leak. Analytical testing of any water collected will be used to determine if a leak has occurred.

To accommodate the alternative monitoring system, minor revisions have been made to the base grading in each cell. The grading revisions will provide a larger, flatter sump area in each cell. The revisions will allow a meaningful alternative monitoring system area to be defined and will lower the maximum head on the liner in a sump area if a pump failure occurs. The plan view area covered by the Alternate Monitoring System is defined by the area at each cell that would pond stormwater from a 25 year storm event if a sump pump failure occurred. This would be an extreme condition, but is potentially the only area of the cell where greater than one foot of head on the liner system could occur. The inlet of the monitoring system outlet pipe is located in the lowest point of the sump area and is sloped to drain through the landfill embankment. A three foot compacted soil layer has been designed on top of the 6-inch stone collection layer to provide an adequate thickness of compacted subgrade to ensure integrity of the clay layer. The cell grading revisions and incorporation of an alternative monitoring system will further improve the integrity of the liner system and will enhance environmental protection.

3.5 Surface Water Quality Monitoring Plan

No alterations are required to the surface water quality monitoring plan currently in place at the landfill.

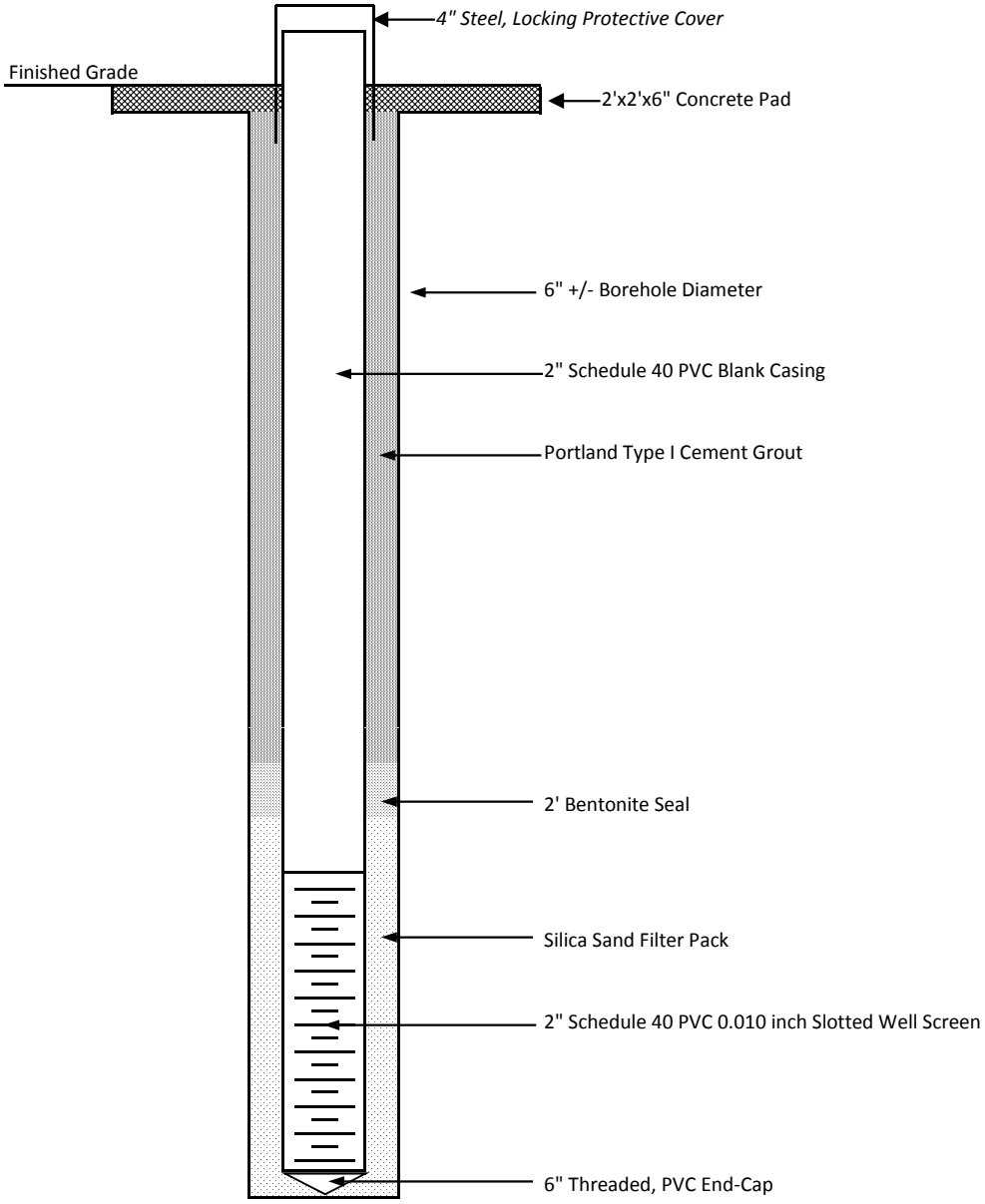
Table 3-1
Monitoring Well Construction Summary
Buncombe County Subtitle D Landfill
Water Quality Monitoring Plan

Piezometer I.D.	Construction Date	Top of Casing Elevation (feet AMSL)	Ground Elevation (feet AMSL)	Screen Interval Lithology	Drilling Method	Depths (feet bls)				Borehole Diameter (inches)	Casing Diameter (inches)	Elevation (feet AMSL)	
						Borehole Depth	Screen Interval	Top of Sand Filter	Top of Bentonite Seal			Top of Screen Interval	Bottom of Screen Interval
Subtitle D Landfill Monitoring Wells													
MW-1	1990'S	2021.22	2019.28	Saprolite/PWR	Air	76	61-76	59	57	8	2	1958.28	1943.28
MW-1d	1990'S	2021.57	2019.97	Bedrock	Air	200	85-95	81	78	8	2	1934.97	1924.97
MW-2	1990'S	1920.86	1918.54	Saprolite/PWR	Air	20	5-20	3	1	8	2	1913.54	1898.54
MW-2d	1990'S	1920.51	1918.63	Bedrock	Air	55	45-55	42	39	8	2	1873.63	1863.63
MW-3	1990'S	1987.66	1985.48	Saprolite/PWR	Air	38	23-38	21	18.5	8	2	1962.48	1947.48
MW-4	1990'S	1944.35	1942.48	Saprolite/PWR	Air	25	9-24	7	5	8	2	1933.48	1918.48
MW-4d	1990'S	1944.64	1942.79	Bedrock	Air	55	45-55	43	40	8	2	1897.79	1887.79
MW-5	1990'S	1977.12	1975.39	Saprolite/PWR	Air	50	35-50	33	31	8	2	1940.39	1925.39
MW-5d	1990'S	1976.92	1975.31	Bedrock	Air	81	71-81	68.5	66.5	8	2	1904.31	1894.31
MW-6	1990'S	1987.34	1985.39	Saprolite/PWR	Air	50	35-50	27	24.5	8	2	1950.39	1935.39
MW-7	1990'S	2022.83	2020.72	Saprolite/PWR	Air	61	42-57	40	38	8	2	1978.72	1963.72
MW-8	1990'S	1962.06	1959.85	Saprolite/PWR	Air	70	55-70	53	51	8	2	1904.85	1889.85
MW-8d	1990'S	1962.47	1960.57	Bedrock	Air	95	85-95	82.5	79	8	2	1875.57	1865.57
MW-10	3/6/2002	2010.54	2007.5	Saprolite/PWR	Air	73	58-73	56	54	6	2	1949.50	1934.50
MW-10d	3/6/2002	2010.56	2007.5	Bedrock	Air	117	102-117	100	98	6	2	1905.50	1890.50
MW-11	3/5/2002	1966.71	1963.7	Bedrock	Air	50	35-50	33	31	6	2	1928.70	1913.70
MW-11d	3/5/2002	1966.15	1963.2	Bedrock	Air	70	60-70	58	56	6	2	1903.20	1893.20
MW-13	6/24/2012	1953.92	1951.3	Bedrock	Air	16	6-16	4	2	6	2	1945.30	1935.30
MW-13d	6/23/2005	1953.82	1951.4	Bedrock	Air	44	39-44	37	35	6	2	1912.40	1907.40
MW-13	6/24/2012	1953.92	1951.3	Bedrock	Air	16	6-16	4	2	6	2	1945.30	1935.30
MW-13d	6/23/2005	1953.82	1951.4	Bedrock	Air	44	39-44	37	35	6	2	1912.40	1907.40
C&D Landfill Monitoring Wells													
MW-9	*1990'S*	*1966.54*	*1963.70*	*Bedrock*	*HSA/Core*	*26*	*11-26*	*8*	*6*	*6*	*2*	*1952.70*	*1937.70*
MW-9d	*1990'S*	*1966.34*	*1963.70*	*Bedrock*	*HSA/Core*	*40*	*35-40*	*32*	*29*	*6*	*2*	*1928.70*	*1923.70*
MW-12	6/25/2002	1947.39	1944.7	Saprolite/PWR/ Bedrock	Air	17	7-17	5	3	6	2	1937.70	1927.70
MW-12d	6/25/2002	1947.1	1944.3	Bedrock	Air	37	27-37	25	23	6	2	1917.30	1907.30
MW-14	4/5/2006	1952.77	1949.8	Bedrock	Air	49	39-49	36	33	6	2	1910.80	1900.80
MW-14d	4/6/2006	1953.76	1950.7	Bedrock	Air	88	78-88	74	71	6	2	1872.70	1862.70
MW-15	6/27/2012	1973.29	1970.21	Saprolite/PWR	Air	26	16-26	14	12	6	2	1954.21	1944.21
MW-15d	6/27/2012	1973.51	1970.25	Bedrock	Air	43	33-43	31	27	6	2	1937.25	1927.25

Proposed Monitoring Wells				
Nest	Well	Drilling Method	Screen Interval Depth (feet) **	Rationale
MW-16	MW-16	HSA	*10-20*	Downgradient of Cell 7 sump within drainage feature; screened in saprolite or PWR or PWR/bedrock contact
	MW-16d	Air Rotary	*30-45*	Downgradient of Cell 7 sump within drainage feature; screened interval at PWR/bedrock contact or first conductive bedrock fracture

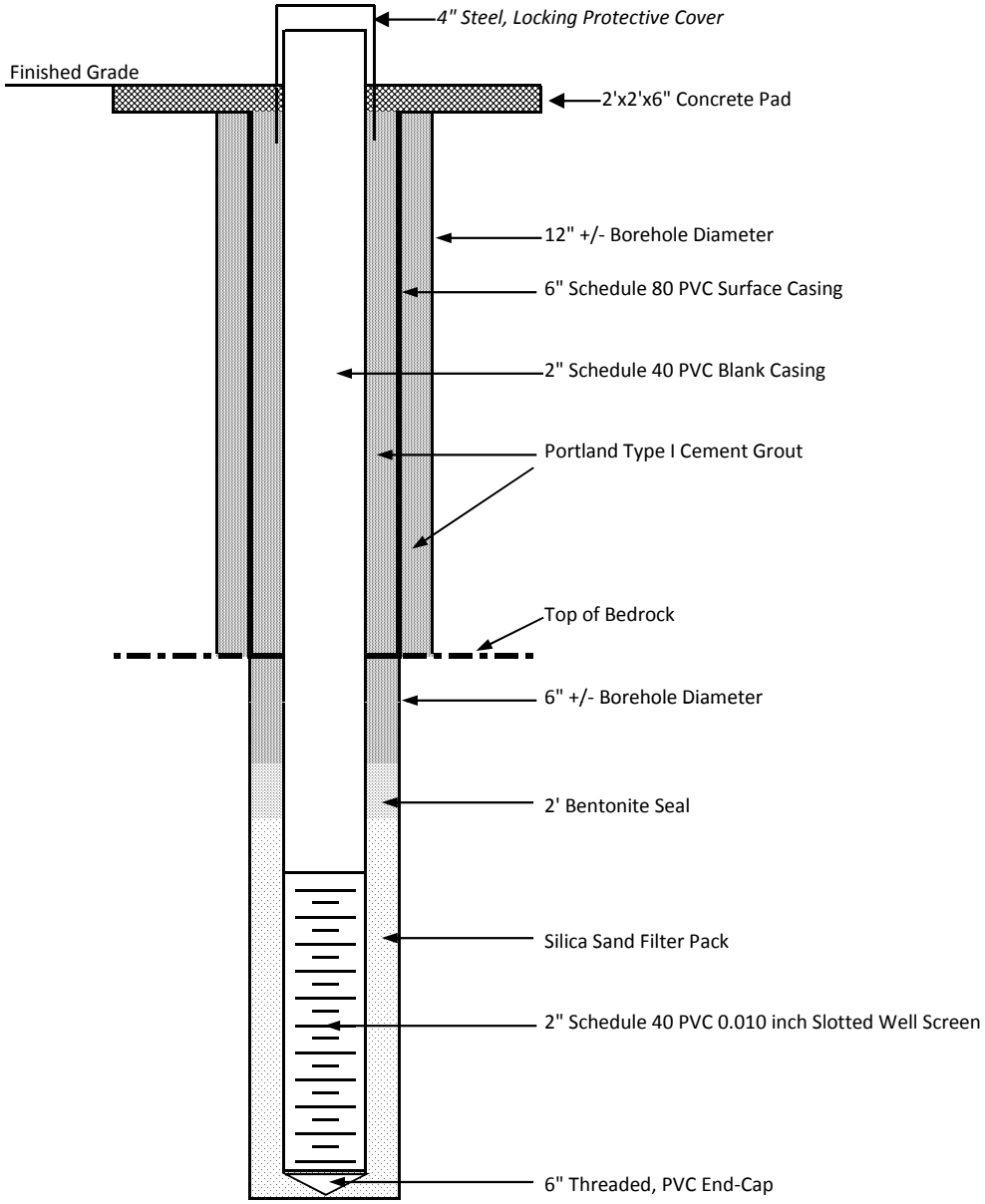
Notes:

** - screen intervals represent anticipated depths.
1. AMSL - Above Mean Sea Level
2. PWR - Partially Weathered Rock
3. bls - Below Land Surface
4. HSA - Hollow-Stem Auger
5. Bold - Piezometers installed during the Cell 7 design hydrogeologic investigation.
6. Italic - Abandoned piezometers/monitoring wells
7. Monitoring wells MW-9/9d were abandoned to accomodate the Phase I and II C&D Landfill expansions.
8. (cd) - C&D Landfill monitoring wells
9. Horizontal Control - NAD 83
10. Vertical Control - NAVD 29 and 88



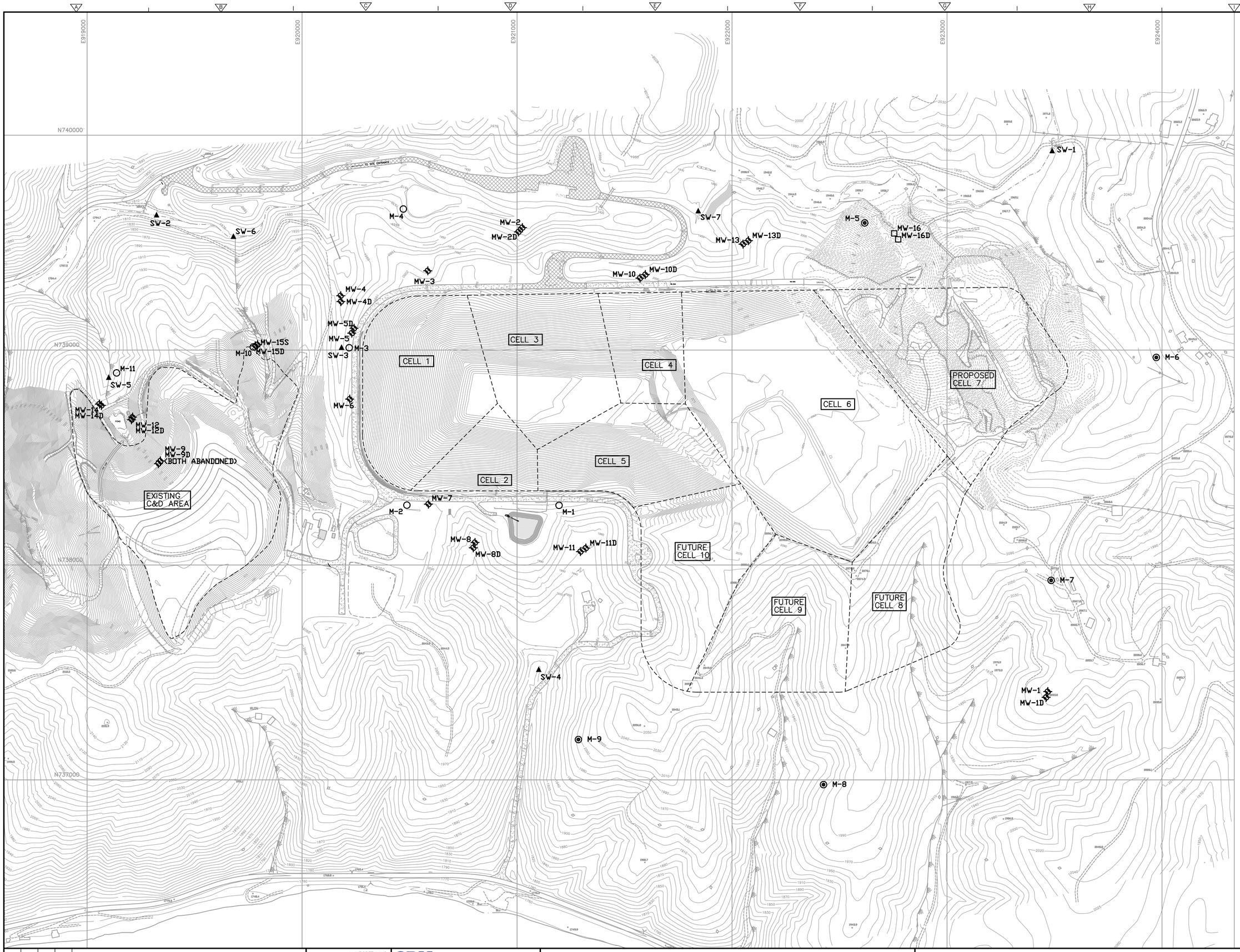
Notes:
Stick-up will extend between 2.5 and 3 feet above finished grade.
Silica sand filter pack will extend at least 2 feet above top of screen elevation.
Screen length will vary according to groundwater elevation, bedrock elevation, or fracture frequency.

Figure 3-1
Typical Type II Groundwater Monitoring Well



Notes:
Stick-up will extend between 2.5 and 3 feet above finished grade.
Silica sand filter pack will extend at least 2 feet above top of screen elevation.
Screen length will vary according to groundwater elevation, bedrock elevation, or fracture frequency.
Length of 6" surface casing will vary depending on bedrock elevation and fracture frequency.

Figure 3-2
Typical Type III Groundwater Monitoring Well



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BUNCOMBE COUNTY
NORTH CAROLINA

BUNCOMBE COUNTY SOLID WASTE MANAGEMENT FACILITY

GROUNDWATER AND METHANE MONITORING WELL LOCATION MAP

PROJECT NO. 6447-93318
FILE NAME: SITE MAP.DWG
SHEET NO.
1

Section 4

Sampling and Analysis Plan

4.1 Introduction

Rule .1632 (a) specifies that the owner/operator must provide, as part of the groundwater monitoring program, a groundwater and surface water sampling and analysis (S&A) plan. The S&A plan should be designed to provide accurate results of groundwater quality at the upgradient and downgradient sampling locations. The S&A plan will address the following subjects:

- Groundwater sample collection,
- Sample preservation and shipment,
- Analytical procedures,
- Chain-of-custody,
- Quality assurance/quality control (QA/QC).

4.2 Groundwater and Surface Water Sample Collection

Upon completion of well construction, development, and a well stabilization period, the sampling plan will be instituted. Groundwater samples will be collected from each of the monitoring wells. The proposed frequency of sampling will include one sample to be collected from each monitoring well prior to the Cell 7 receiving waste and three additional samples within six months of issuance of the Permit To Operate as required by Rule .1633(b). These samples will comprise the baseline sampling. Groundwater samples from each of the monitoring wells will be sampled on a semi-annual basis, along with the existing wells and surface water sample locations.

4.2.1 Static Water Level Measurements

Static water level elevations will be measured prior to any purging or sampling activities. Static water level data will be used to monitor changes in site hydrogeologic conditions. The following measurements will be recorded in a dedicated field book prior to sample collection:

- Height of the well measuring point above ground surface;
- Depth of water in the well from the TOC measuring point (to the nearest 0.01 foot);
- Total depth of the well; and
- Height of the water column in the well casing.

An electronic water level indicator will be used to accurately measure water elevations to within 0.01 foot within the same day in as short a period of time as possible. Each well will have a permanent, easily identified reference point from which all water level measurements will be taken. The reference point will be marked and the elevation surveyed by a North Carolina Registered Land Surveyor.

4.2.2 Detection of Immiscible Layers

USEPA's Technical Manual for Solid Waste Disposal Facility Criteria outlines specifications for groundwater sampling and analysis. One of these specifications outlines the establishment of provisions for detecting immiscible fluids, if applicable. Typically, immiscible fluids are categorized as either, (1) light, non-aqueous phase liquids (L-NAPLs), or (2) dense, non-aqueous phase liquids (D-NAPLs). L-NAPLs are more commonly referred to as "floaters" due to their relatively lighter specific gravity, while D-NAPLs are typically referred to as "sinkers" due to their relatively denser specific gravity.

In most instances, the probability of immiscible fluids being present and subsequently detected in groundwater monitoring wells surrounding sanitary landfills is somewhat remote because chemical products (such as industrial solvents) are not accepted for storage or disposal at Subtitle D solid waste management facilities. However, for those rare instances where a separate immiscible phase is believed to be present, EPA suggests that provisions for detecting these types of fluids should be developed.

The following procedure is proposed to address these concerns in the event that the SWS ever requires this test to be performed. In those instances where the monitoring well's screened interval encompasses the water table surface, the ability to detect and sample light nonaqueous phase liquids (LNAPLs) prior to implementation of routine groundwater sampling activities may exist. To accomplish this objective, a transparent teflon bailer will be lowered into the well to just below the water table surface. The bailer will then be removed from the well and the contents examined to identify if any immiscible fluids are present. If any immiscible fluids are determined to be potentially present, an interface probe is proposed to be used. The depth of the light phase immiscible layer, as determined by the interface probe, will then be recorded in a field logbook. The interface probe will continue to be lowered until it intersects the groundwater table surface. The depth of the organic/water interface zone also will be recorded. From these two measurements, the thickness of the light phase immiscible layer can be readily determined.

The potential presence of dense phase immiscible layer will be determined by the examination of laboratory analytical results. Analytical results above a percentage of a given chemicals solubility limit can indicate the potential presence of DNAPLs.

As mentioned above, monitoring for immsicible phase fluids is not envisioned to be performed during typical sampling events, but is provided here to document how the test will be performed if the SWS requires it at a future date.

4.2.3 Monitoring Well Evacuation

Following measurement of the static water level in all of the wells, individual wells will be purged of all stagnant water. The stagnant water, which is not representative of true aquifer conditions, will be removed to ensure that fresh formation water can be sampled. A minimum of three well casing volumes will be removed prior to sampling the well. The well volume for 2-inch diameter wells will be calculated using the following equation: one well volume in gallons equals the height of the water column (in feet) times 0.1632 (slightly less than 0.5 gallons per foot water for 3 casing volumes). During the well purging process, field measurements (pH, temperature, and specific conductance) will be collected at regular intervals, and reported in a tabular format. The well will be purged until field measurements stabilize within approximately 10 percent between subsequent readings or until the well is dry. Stabilization of these measurements will indicate that fresh formation water is present in the well. Field measurements of pH,

temperature, and conductivity should be obtained by using a YSI 556 Multiparameter Water Quality Meter or equivalent.

If the well is purged to dryness, the samples will be collected after a sufficient volume of water has entered the well to allow collection of the sample. Wells will be purged using a decontaminated teflon bailer with new nylon rope or an acceptable pumping device approved by the SWS. Field measurements collected during purging activities will be recorded in the field logbook.

4.2.4 Groundwater and Surface Water Sample Collection

After purging activities are complete, groundwater samples will be collected for laboratory analysis. The wells will be sampled using laboratory decontaminated teflon or polyethylene bailers equipped with new nylon rope or through SWS approved pumps. Bailers will be used for one well only. Field decontamination of bailers will not be permitted. Disposable bailers will only be used if laboratory decontaminated standard teflon bailers or dedicated sampling systems are not available. The bailers will be lowered slowly into the well to minimize sample agitation. Sample water will be placed directly into sample bottles provided by the analytical laboratory, using the following method:

1. Retrieve bailer and slowly transfer sample water to the appropriate sample container. The bailer or pump tubing should not be allowed to touch the sample container.
2. The sample container for the volatile organic compounds should be filled first, leaving no headspace or air bubbles. The container should then be tightly sealed. The sample container will come with preservative already added by the laboratory.
3. The sample container for the metals should then be filled. This container will also come with preservative added by the laboratory. This container should be filled to the bottle shoulder.

Surface water samples will be obtained from areas of minimal turbulence and aeration. The following procedure will be implemented regarding sampling of surface waters:

1. Hold the bottle near the bottom with one hand, and with the other, remove the cap.
2. Push the sample container slowly into the water and tilt up towards the current to fill. A depth of about six inches is satisfactory. Avoid breaching the surface while filling the container.
3. The container should be moved slowly, in a lateral direction, if there is little current movement.
4. If the stream depths are too shallow to allow submersion of the sample container, a pool may be scooped out of the channel bottom and allowed to clear prior to sampling.
5. Lift the container from the water and place the uncontaminated cap on the container.

The wells and surface water stations will be sampled in the order of potential for increasing contamination levels beginning with the upgradient (background) sampling locations. The individual water samples will be collected and bottled in the order of parameter volatility. The collection order for the samples will be as follows:

- Volatile organic compounds (VOCs)

- Total metals.

The samples will be transferred from the sampling equipment directly into a prepared sample container provided by the laboratory. Field filtering of samples is not permitted. There will be a specific size and type of container provided for each constituent to be analyzed. For VOC analysis, the containers provided will be 40-ml glass vials. For metals analysis, the samples will be collected in 0.5-liter HDPE bottles. Extra containers should be available in case of accidental breakage. All field personnel will wear protective latex or nitrile disposable gloves in order to prevent extrinsic contamination from clothing, body oils, dirt, and other various contaminants. Sample documentation requirements to ensure sample integrity, will included sample locations, date and time of sample collection, proper analysis, and preservative (if applicable).

4.2.5 Decontamination Procedures

All sampling and purging equipment that will come in contact with the well casing and water will be decontaminated. All sampling equipment will be laboratory cleaned. The following decontamination procedures will be used for sampling equipment, if needed:

1. Clean item with tap water and phosphate-free laboratory detergent (Liquinox or equivalent), using a brush if necessary to remove particulate matter and surface films,
2. Rinse thoroughly with tap water,
3. Rinse thoroughly with deionized or distilled water and allow to air dry,
4. Wrap with aluminum foil, if necessary, to prevent contamination of equipment during storage or transport.

4.3 Sample Preservation and Shipment

In order to ensure sample integrity, preservation and shipment procedures will be carefully monitored. Generally, ice and chemical additives will be used as sample preservatives, as recommended by the commercial laboratory. For VOC analysis, hydrochloric acid will be used as the preservation method as well as maintaining the samples at a temperature of 4°C. Nitric acid will be used as the preservative for samples needing metals analysis. If the analytical laboratory is located some distance from the site, samples shall be shipped via a 24-hour delivery service to ensure holding times are not exceeded. Shipment of samples will be coordinated with the laboratory.

Proper storage and transport conditions must be maintained in order to preserve the integrity of the sample. Once taken, samples will be placed on ice and cooled to a temperature of 4°C. Samples are to be packed in iced coolers so as to inhibit breakage or accidental spills. Custody seals will be placed on the outside of the cooler, in a manner to detect tampering of the samples. The laboratory shall immediately notify the owner/operator of any samples that arrive with custody seals broken.

4.4 Analytical Procedures

The samples taken from each well and from the surface water sampling locations will be analyzed for the constituents listed in 40 CFR Part 258, Appendix 1. The analytical procedures for the indicated parameters will be conducted using the following methods:

Analysis	EPA Method Number
Volatile organic compounds	8260
Total metals	6010

4.5 Chain of Custody

It is imperative that an accurate record of sample collection, transport, analysis, and disposal be maintained and documented. Therefore, chain-of-custody procedures will be instituted and followed throughout the sampling program. It is necessary to establish documentation to trace sample possession from the time of collection until disposal. The chain-of-custody program shall include the following requirements:

- Samples shall be accompanied by a chain-of-custody record that notes the date and time of collection as well as sampling personnel.
- All samples shall be properly labeled to prevent misidentification of samples.
- Field notes shall be included to provide pertinent information about each sample.
- A sample analysis sheet shall accompany all samples to the laboratory.
- Sample custody seals shall be used to indicate any tampering of samples.
- All records pertaining to the shipment of a sample shall be retained (ie: freight bills, post office receipts, and bills of lading).

The laboratory shall not accept samples for analysis without a correctly prepared chain of custody form. The laboratory shall be responsible for maintaining chain-of-custody of the sample(s) from time of receipt to disposal. The chain-of-custody form shall be signed by each individual who possesses the samples.

To prevent sample misidentification, a label will be affixed to each sample container in a manner as to prevent the label from becoming dislodged during transport which will contain the following information:

- Sample identification number,
- Name and signature of sample collector,
- Date and time of collection,
- Place of collection,
- Parameters requested,
- Type of preservative.

In addition the container itself should be labeled with the sample identification number (at a minimum) to allow for identification should the label fall off.

4.6 Quality Assurance/Quality Control

The reliability and validity of the field and analytical laboratory data will be monitored as part of the QA/QC program used in the laboratory. Field duplicates and sample blanks will be collected to check sampling protocol and to account for any changes that occur after sampling. The QA/QC program will stipulate the use of standards, laboratory blanks, and duplicates for identification of matrix interferences.

4.6.1 Field Duplicates

Field duplicates provide a measure of field and laboratory precision. Field duplicates will be collected from identical locations using proper sampling procedures. The duplicate samples will be collected at a frequency of one per day per sampling event.

4.6.2 Equipment Rinsate Blanks

To evaluate the effectiveness of the decontamination procedures, equipment rinsate blanks will be collected. The sample will be collected by passing distilled water through the sampling equipment after decontamination has been completed. Equipment blanks will be collected at a minimum of one per day of groundwater sampling activities.

4.6.3 Trip/Travel Blanks

A trip/ travel blank shall be prepared to account for any sample contamination that may occur during transport to and from the site. The sample will be prepared in the laboratory with deionized or distilled water and shall accompany the sample shipping container to the field. The trip/travel blank shall remain unopened until receipt by the lab for analysis. One trip blank per sampling event will be collected.

4.7 Reporting

Following semi-annual groundwater sample collection and analysis, a report shall be submitted to the SWS which includes the following information:

- Field observations related to the condition of the monitoring wells,
- Field data,
- Laboratory data,
- Sampling methodologies,
- Quality assurance/quality control data,
- Information on groundwater flow,
- Wells with constituents exceeding groundwater standards,
- Other pertinent information.

Section 5
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Buncombe County, North Carolina

Buncombe County Solid Waste Management Facility Subtitle D Landfill Phase IV (Cell 7) Permit to Construct Application

Part 6 – Closure/Post-Closure Plan

April 2014

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Section 1

Closure Plan

Rule .1617 (a)(1)(E) of the North Carolina Solid Waste Regulation Section 15A NCAC 13B .1600, requires municipal solid waste landfill (MSWLF) owners/operators to prepare a closure plan that describes the steps necessary to partially close a MSWLF at any point during its active life as well as the steps necessary to facilitate final closure. Partial closure refers to the closure of a landfill phase, while final closure is the closure of an entire landfill. In providing this information, the closure plan will assist the County towards achieving the goals of closure implementation, which are: to prevent exposure of the disposed solid waste, minimize leachate generation, and control landfill gas in order to protect public health and the environment. Specifically, this closure plan establishes: design criteria for the closure cap system and the landfill gas collection system, a closure sequence and construction schedule, construction cost estimates, and other important information relating to closure. This plan was prepared in accordance with Rule .1629.

1.1 Final Cover System

In accordance with Rule .1629 (b)(1)(A), the final cover system has been designed to minimize the amount of storm water infiltration into the landfill and to resist erosive forces. The final cover system consists of an erosion layer, protective soil layer, drainage layer, barrier layer, and gas venting layer. The multi-layered cap system will provide a permeability less than or equal to the bottom liner system of the landfill.

The cap system will consist of the following layers (listed from top to bottom):

- A six-inch Erosion (Vegetative Soil) Layer consisting of soil capable of supporting native plant growth;
- An 18-inch Protective Soil Layer to prevent damage due to freezing or puncture to the Drainage and Barrier Layers;
- A Drainage Layer consisting of a geocomposite. The geocomposite is designed to horizontally drain storm water that has percolated through the Erosion and Protective Soil Layers in order to prevent the build-up of water over the Barrier Layer (thus minimizing infiltration);
- A Barrier Layer consisting of a geomembrane; and
- A Gas Venting Layer placed over a compacted soil subgrade.

Due to the highly elastic nature of the geomembrane, the final cover system will accommodate the differential settlement during the post-closure period. Detail A on Sheet EP-12 provides a detail of the final cover system.

1.2 Landfill Gas Collection System

Per Rule .1627 (c)(3)(B) a gas collection system will be installed to minimize uplift pressure exerted on the final cover system. To prevent uplift of the closure cap, horizontal gas collection trenches and vertical gas wells will be used in conjunction with a gas venting layer below the closure cap geomembrane.

The horizontal gas collection trenches consist of perforated plastic pipe surrounded by a clean gravel backfill. Near the surface of the closure cap, a bentonite seal and synthetic boot will be installed around the pipe to prevent storm water infiltration. The length of the trenches will vary from elevation to elevation with the longest trenches positioned near the bottom of the landfill. **Figure 1-1** provides a section detail of the horizontal collection trench design. Generally, the spacing between trenches will be 100-feet horizontal and 30-feet vertical.

As with the horizontal gas collection trenches, a bentonite seal and synthetic boot will be installed around the vertical gas well to prevent storm water infiltration. The depth of the vertical gas wells will extend from final grade to within 15 feet of the bottom liner. **Figure 1-2** provides a section detail of the vertical gas well design. The exact location of the vertical gas wells will be determined at the time of closure. Generally, one vertical well per acre is anticipated to be installed.

Also, negative pressure will be induced in the leachate collection system to eliminate formation of deep gas pockets. The horizontal gas collection trenches, vertical gas wells, and the leachate collection system will be connected to a gas header that will be installed along the perimeter of the landfill that will deliver the gas to the flare station/LFTE facility where the gas will be combusted.

1.3 Estimate of Largest Closure

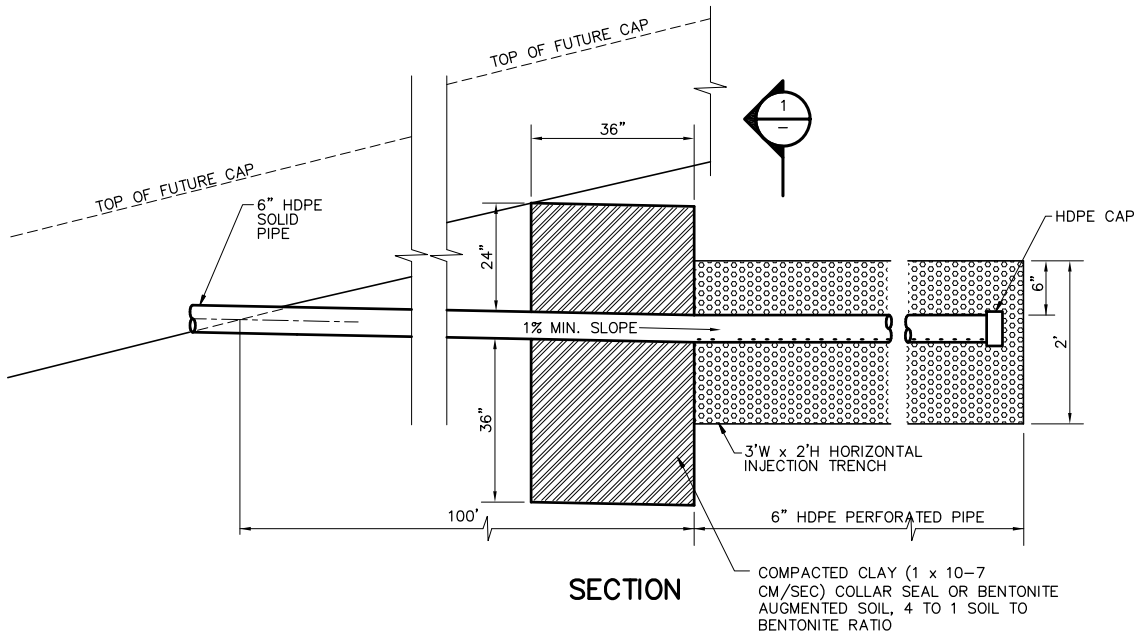
The construction of the landfill will occur in 6 phases, with each phase providing approximately 5 years of capacity. Existing Phases I and III (Cells 1 through 6) are a total of 56 acres, whereas Phase IV (Cell 7) is approximately 13 acres. Thusly, Phases I through IV would be the largest closure to date, covering an area of approximately 69 acres.

1.4 Estimate of Maximum Inventory of Waste On-Site

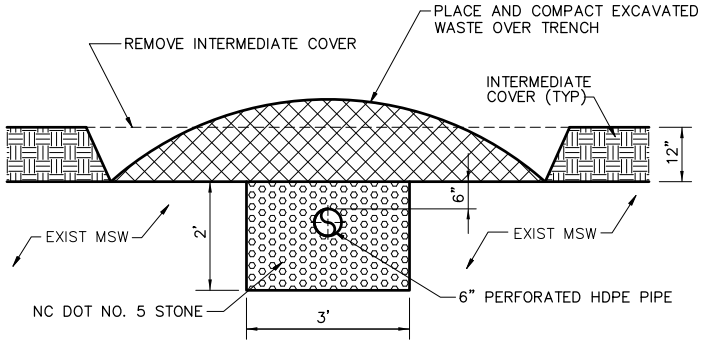
The maximum amount of waste that is expected to be landfilled at the Buncombe County Subtitle D Landfill through final build-out was calculated using the Earthworks Module of Softdesk. The total gross airspace available between the top of base liner protective cover to proposed top of intermediate cover is approximately 11,804,000 cubic yards. This volume is available for waste and intermediate and daily cover.

1.5 Landfill Closure Sequence

The development of the landfill will be integrated so that one phase will be in operation while another phase is being constructed. Additionally, closure activities may be initiated in phases. Although not mandatory, the County may elect to complete a partial closure for an area or may complete a final closure at the end of operations. The steps for implementing the closure process are described in the following subsections. The steps are the same for partial closure and final closure.



SECTION



SECTION 1
NTS

CDM Smith

Figure No. 1-1
HORIZONTAL GAS COLLECTION TRENCH

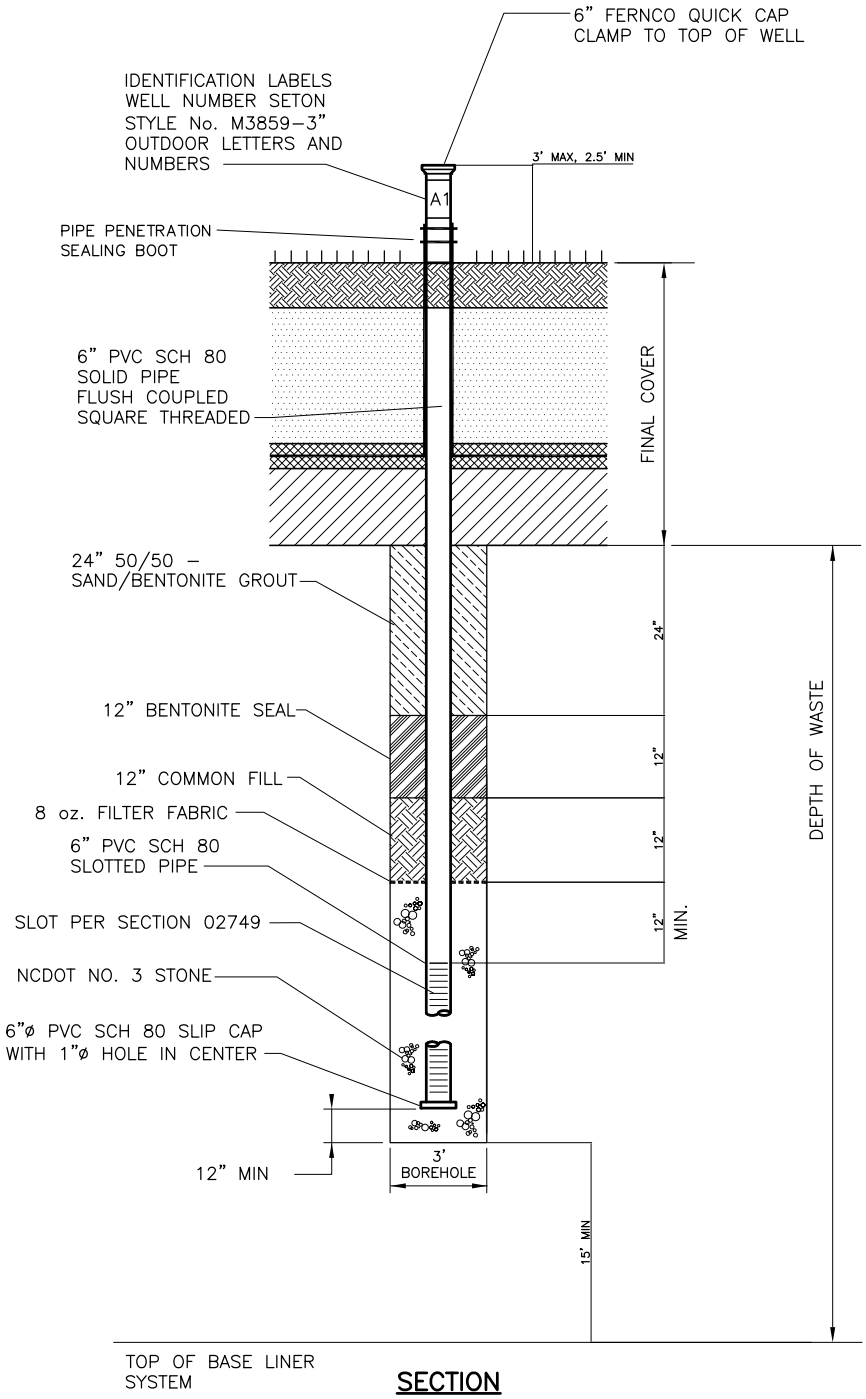


Figure No. 1-2
VERTICAL GAS WELL

1.5.1 Determination of Closure Area

The County will determine the location and acreage of areas to be closed. Closure procedures should not be instituted until an adequate area (approximately 10 acres or more) of the landfill has reached final grade. An estimate of landfill area that has reached final grade should be determined periodically by the surveyor for the site during the active life of the facility.

1.5.2 Notification of Intent to Close

Per Rule .1627(c)(4), once the County has determined that an area will be closed, a Notice of Intent to Close must be placed in the operating record and the Solid Waste Section (SWS) must be notified of the action, including location, acreage, and scheduling of the closure activities. The final cover design, area to be closed, and scheduling of closure activities presented in this Permit Application shall be reviewed and updated as necessary.

1.5.3 Develop Closure Schedule

The County will prepare a schedule for bidding and construction of the closure activities. Per Rule .1627(c)(6), closure activities must be completed within 180 days of beginning closure activities unless the County gains approval from the SWS by demonstrating that the construction period, by necessity, will require an extended schedule and that measures to protect human health and the environment have been implemented in the interim.

1.5.4 Prepare Construction Contract Documents

For the purpose of bidding, construction documents will be prepared for the area to be closed. The bidding documents will allow contractors to estimate the quantity of materials needed to properly implement the closure plan, as well as estimating the construction costs.

1.5.5 Develop Closure Schedule

Once the SWS has reviewed and commented on the closure schedule, the County will prepare a final schedule for bidding and construction of the closure activities.

1.5.6 Selecting a General Contractor

After receiving sealed bids, a contractor will be awarded the job of constructing the final cover according to the approved closure plan. The contractor will be required to complete all closure activities within 180 days of beginning such activities, or as otherwise approved by the SWS.

1.5.7 Securing Borrow Material for Landfill Cover

The material to be used for construction of the closure cap system will be obtained from on-site sources. Once usable on-site material has been exhausted, borrow material will be obtained from off-site sources.

1.5.8 Certification of Closure Construction

Per Rule .1627(c)(7), the project engineer shall provide certification at the completion of construction to verify that closure has been completed in accordance with the closure CQA plan. The County shall place the certification in the operating record and forward a copy of the certification to the SWS.

1.5.9 Record Notation to Deed

Per Rule .1627(c)(8), after final closure of the property, a notation will be placed on the deed to the property stating that the property was used as a landfill facility, and its use is restricted under the closure plan approved by the SWS.

Closure Sequence	
Activity	**Process Date**
Determination of Closure Area and Initiate Closure Process	No later than 30 Days after the final receipt of waste
Notification of Intent to Close	Once an area has been determined to be closed
Develop Closure Schedule for Closure Activities	-
Prepare Construction Contract Documents	-
Develop Closure Schedule	Once the SWS has commented on the closure schedule
Select a General Contractor	After receiving sealed bids
Closure Construction	Closure activities must be completed within 180 Days of beginning closure activities or as otherwise approved
Certification of Closure Construction	At completion of construction
Record Notation to Deed	After final closure of property

1.6 Financial Assurance

Per Rule .1629 (b)(3), a detailed cost estimate based on current costs has been prepared for closure of the largest active area of the landfill facility at any time during the life of the facility and is provided in **Table 1-1**. A copy of the cost estimate has been placed in the operating record. The cost estimate will be annually adjusted to account for inflation and any changes in conditions at the facility or in the design. If conditions call for a reduction in the amount to be financially assured, approval of the SWS must be obtained prior to officially reducing the amount.

Table 1-1

Closure Cost Estimate
Buncombe County Subtitle D Landfill
Buncombe County, North Carolina
April 2014

	Quantity	Unit	Cost	Total
Final Cover System (Phases I through IV)				
Grade Intermediate Cover	69	ac	$2,000.00	$138,000
Cap System Components:				
a. 6″ Vegetative Layer	55,660	cy	$20.00	$1,113,200
b. 18″ Protective Cover	166,980	cy	$16.50	$2,755,170
c. Drainage Net	333,960	sy	$7.00	$2,337,720
d. 40-mil text. LLDPE Geomembrane	333,960	sy	$6.30	$2,103,948
Seeding, Fertilizing & Mulching	333,960	sy	$0.45	$150,282
Temporary Erosion Control	69	ac	$1,000.00	$69,000
Permanent Erosion Control				
Diversion Berms/Downdrains	69	ac	$30,000.00	$2,070,000
Landfill Gas Management				
Vertical Gas Wells (69 @ Avg. Depth of 75′)	5,175	vf	$125.00	$646,875
Horizontal Gas Collection Trenches	6	ea	$50,000.00	$300,000
Surveys	69	ac	$500.00	$34,500
Final Landscaping				
Seeding, Fertilizing & Mulching	69	ac	$3,000.00	$207,000
Indemnification	1	ls	$5,000.00	$5,000
Subtotal				$11,930,695
Bonds and Mobilization/Demobilization (5% of Subtotal)				$596,535
Engineering Services, CQA/CQC (12% of Subtotal)				$1,789,604
Contingency (25% of Subtotal)				$2,982,674

TOTAL	**$17,299,508**
COST PER ACRE	**$250,718**

Section 2

Post-Closure Plan

Rule .1617(a)(1)(E), of the North Carolina Solid Waste Regulation Section 15A NCAC 13B .1600, requires owners/operators of municipal solid waste landfill (MSWLF) units to prepare a post-closure plan. The purpose of the plan is to provide the necessary information for preserving the integrity of the landfill facility in its post-closure life. This post-closure plan specifically addresses maintenance activities for the closure cap, landfill gas control system, leachate collection system, groundwater monitoring wells, and erosion and sedimentation control system. This plan also addresses certification and financial assurance requirements.

Post-closure care will begin immediately following final closure of the landfill. Post-closure care may be decreased from the minimum time period of 30 years specified in the regulations if the County can demonstrate that the reduced period will pose no threat to human health or the environment. However, the Solid Waste Section (SWS) reserves the right to increase the post-closure care period if it is deemed necessary to protect human health and the environment.

2.1 Maintenance and Monitoring Activities

Per Rule .1629 (c)(1), post-closure maintenance and monitoring activities for the Subtitle D Landfill will include the activities discussed in the following sections.

2.1.1 Final Cover System

Per Rule .1627 (d)(1)(A), maintaining the integrity and effectiveness of the cap system is required. Inspection of the final cover system will take place quarterly and encompass the entire landfill. Items of concern to be noted by the inspector include but are not limited to: signs of erosion (ruts, sediment deposits, etc.), patches of stressed or dead vegetation, animal burrows, recessed areas or ponding, upheaving, leachate seepage stains and/or flowing leachate, cracks in the cap, damaged gas vents and tree saplings (especially species with tap roots). Following each inspection, a summary report of the condition of the cover and the items of concern should be recorded in the post-closure log book of the facility. Areas that require further attention should be photographed and delineated on a map of the facility. These items should also be entered in the log book. Since post-closure inspection personnel will most likely change during the post-closure period, the post-closure log book should be kept in a standardized format that allows for new inspection personnel to easily review the results of past post-closure inspections of the site.

Action should be taken immediately to address any items of concern identified during the inspection. Obvious repair items should be performed under the supervision of the post-closure maintenance manager. If an item of concern requires further study to determine a course of action, the engineer responsible for closure design should be contacted for consultation.

As part of general maintenance, the vegetative cover should be mowed at least twice a year to suppress weed and brush growth. If vegetative cover is not adequate in any particular area, soil amendments should be applied as necessary and the area re-seeded in order to re-establish vegetation. Insecticides may be used to eliminate insect populations that are detrimental to the

vegetation. Animal burrows and eroded or depressed areas should be filled in with compacted soil and reseeded.

2.1.2 Leachate Collection System

Per Rule .1627 (d)(1)(B), maintenance of the leachate collection system is required. Inspection of the accessible items of the leachate collection system (ie. clean-outs, pond, and pump stations) will be made on a quarterly basis. Inspection of the collection lines will be performed concurrent with the annual cleaning service. As part of the quarterly inspection the leachate holding pond will be inspected for damage to the liner system. Depending on seasonal conditions, the pond may be drained so that a thorough inspection may be made (a complete inspection should be made at least once a year). The inspector should survey the pond for items of damage such as tears in the protective layer and/or liner, heaving, and exposed liner in the anchor trench. The outside slope of the pond should be inspected for leachate seepage. Signs of leachate seepage may include damage to vegetation, staining of the soil and vegetation, or actual leachate flow.

The pump stations and flow meter vault should be inspected quarterly by a qualified inspector who is knowledgeable in the construction and operation of pump stations and flow meters. The inspector should manually operate each pump to ensure that they are working properly. The high and low level alarms should be checked at this time, and the overall condition of the wiring and support structures should be inspected also. The flow meter calibration shall be checked (and scheduled for recalibration as required) quarterly and flow meter records shall be monitored and placed in the post-closure log book. The pump control panel shall be fully inspected at the same time, to ensure proper alarm operations, reset functions, and normal operations performance. Run time readings shall be recorded for each pump. A summary report of the condition of the leachate pond, pump station and metering facilities should be recorded in the post-closure log book along with photographs of any items of concern.

The clean-outs should be inspected for damage on a quarterly basis. The protruding portion of each clean-out should be checked for damage and the cap should be checked for proper operation.

If problems with the leachate collection system are discovered, or abnormally high or low flows are recorded from the pump station, assessment and/or repairs should begin immediately.

All piping of the leachate collection system will be pressure cleaned and flushed annually to remove the build-up of biological growth and sediments.

2.1.3 Groundwater Monitoring Wells

Per Rule .1627 (d)(1)(C), maintenance of the groundwater monitoring wells is required. Inspection of the ground water monitoring wells will take place semi-annually during sampling events. The inspection will consist of verifying the condition of the monitoring wells to ensure that they are providing representative samples of the ground water. The inspector should note the following:

1) The total depth of the well should be recorded every time a water sample is collected or a water level reading is taken to check if sediment has accumulated at the bottom. If sediment build-up has occurred, the sediment should be removed by pumping or bailing.

2) If turbid samples are collected from a well, redevelopment of the well will be necessary.

3) The above-ground protective casing should be inspected for damage. The protective casing should be of good structural integrity and free of any cracks or corrosion. The lockable cover and lock should also be checked at this time.

4) The surface seals should be inspected for settling and cracking. If the seal is damaged in any way, the seal should be replaced.

5) The well casing and cap should be inspected. The casing and cap should be of good structural integrity and free of any cracks or corrosion. Any debris should be removed from around the cap to prevent it from entering the well.

The condition of the ground water monitoring system should be recorded in the post-closure log book following each sampling event. Monitoring of the groundwater wells shall be conducted as described in the groundwater monitoring plan.

2.1.4 Landfill Gas Monitoring and Control System

Per Rule .1627 (d)(1)(D), maintenance of the landfill gas monitoring system is required. Inspection of the landfill gas monitoring and control system should take place at least quarterly. The inspection should consist of verifying the condition and operation of the vents, collection well, and monitoring wells. The full depth of all vents, collection wells, and monitoring wells should be checked for blockage that may be caused by settlement or cracks in the casing. The summary of each inspection of the landfill gas monitoring and control system should be recorded in the post-closure log book along with photographs of any items of concern.

Testing of the monitoring wells and on-site buildings shall be conducted as described in the monitoring plan provided in the Operation Plan.

If any vents or wells are not properly working, they should be flushed and pressure cleaned. If all attempts to repair a vent or well are unsuccessful, a replacement will be installed.

2.2 Erosion and Sedimentation Control System

Inspection of the erosion and sedimentation control system should occur semi-annually and after major storm events. During each inspection, the elements of the system including ditches, pipes, ponds, and inlet/outlet structures should be checked for obstructions and damage. The ditches should be inspected for obstructions, erosion of side slopes, loss of vegetative cover, shifting of riprap, excessive buildup of sediment, or any other item that may prevent the proper functioning of the ditch. Drainage piping should be checked for blockages and the inlets/outlets should be inspected for undercutting and rutting. The sediment level in the detention ponds should be measured to determine if removal is required. The condition of the riser/barrel should be checked to ensure that adequate gravel surrounds the riser and that the barrel is not filled with sediment. The berms of each pond should be inspected for stability. Following each inspection, a summary report should be entered in the post-closure log book along with photographs of any items of concern.

Maintenance and/or repairs should be performed as prescribed by the inspectors review.

2.3 Certification of Post-Closure

Following completion of the post-closure care period, a certification verifying that post-closure care was performed in accordance with the post-closure plan and signed by a registered professional

engineer will be made part of the operating record. The County will notify the SWS that the certification has been placed in the operating record.

2.4 Name of Individual Responsible for Post-Closure Maintenance of the Site

Mr. Jon Creighton of Buncombe County will be responsible for operations and maintenance of the site during the post-closure period. Mr. Creighton can be reached at the following address:

Buncombe County
Planning and Development
46 Valley Street
Asheville, NC 28801
828-250-4830

Mr. Creighton most likely will not be employed with Buncombe County throughout the entire 30 year post-closure period. A new individual will be appointed at the time Mr. Creighton's employment with the County ends.

2.5 Planned Use of Landfill After Closure

There are no planned uses for the landfill site after closure. The property will remain County property, maintained by the County, with public access prohibited.

2.6 Financial Assurance

The County will submit a financial assurance package to SWS in accordance with the criteria set forth under Rule .1628. A detailed cost estimate for post-closure care has been prepared and is provided herein (**Table 2-1**) and a copy has been placed in the operating record. The cost estimate is based on 30 years of post-closure care. Each year, the estimate will be adjusted for inflation and any changes to the activities of post-closure care.

Table 2-1

Post Closure Cost Estimate
Buncombe County Subtitle D Landfill
Buncombe County, North Carolina
April 2014

	Quantity	Unit	Cost	Total
Administration	30	yr	$2,500	$75,000
Monitoring				
20 Groundwater Monitoring Wells Sampled and Analyzed Semi-Annually for 30 years	1200	events	$750	$900,000
1 Surface Water Locations Sampled and Analyzed Semi-Annually for 30 years	60	events	$750	$45,000
12 Landfill Gas Wells Sampled and Analyzed Quarterly for 30 years	1440	events	$500	$720,000
Maintenance				
Fencing, Gates, Signs, etc.	30	yr	$500	$15,000
Access Roads	30	yr	$2,000	$60,000
Mowing	30	yr	$4,000	$120,000
Repair Sideslopes and Seeding	30	yr	$2,000	$60,000
Stormwater Structures	30	yr	$2,000	$60,000
Leachate Collection and Storage	30	yr	$5,000	$150,000
Final Cover System Maintenance	30	yr	$20,000	$600,000
Groundwater and Gas Monitoring Wells	30	yr	$1,500	$45,000
Leachate Pond Cleanout	30	yr	$5,000	$150,000
Leachate Closeout				
Cleanout and Demo Leachate Pond	1	ls	$300,000	$300,000
Subtotal				$3,300,000
Contingency (15%)				$495,000

TOTAL	**$3,795,000**
ANNUAL COST	**$126,500**