PERMIT TO CONSTRUCT

Lenoir County
Municipal Solid Waste
Landfill Facility

Phase 2

Permit No.: 5409-MSWLF
Site Location: 2949 Hodges Farm Road
Kinston, NC 28551

Applicant: Lenoir County
Applicant's Address: 130 South Queen Street
Kinston, NC 27502

MESCO Project Number
G08095

NORTH CAROLINA
PROFESSIONAL
SEAL
6282
ENGINEER
JIMMY D. WOODIE

Jimmy D. Woodie
1/31/2011

APPROVED
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION
DATE 03/16/2011 BY
DOC ID: 13192

Revised January 27, 2011
Revised September 24, 2010
Revised August 19, 2010
Revised August 6, 2010
November 2009

Submitted By:

Municipal Engineering Services Company, P.A.

Garner	Boone	Morehead City
P.O. Box 97	P.O. Box 349	P.O. Box 828
Garner, NC 27529	Boone, NC 28607	Morehead City, NC 28557
(919) 772-5393	(828) 262-1767	(252) 726-9481

Corporate License #: C-0281

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CIVIL/SANITARY/ENVIRONMENTAL ENGINEERS

SOLID WASTE MANAGEMENT

Municipal Services

Engineering Company, P.A.

SITE PLANNING/SUBDIVISIONS

SUBSURFACE UTILITY ENGINEERING (SUE)

January 31, 2010

Ming-Tai Chao, P.E.
Environmental Engineer II
NCDENR – Solid Waste Section
401 Oberlin Rd.
Raleigh, NC 27605

Re: Permit to Construct Phase 2
Lenoir County Municipal Solid Waste Landfill Facility
Permit No. 54-09

Dear Mr. Chao:

In response to your November 17, 2010 letter, we submit the following:

General

The text has been revised as requested.

Section 1.0 – Facility Plan

Response to DWM Comment Number 1: (Drawing F-1/Sheet 3 of 10)

According to the Design Hydro text Phase 1 and Part of Proposed Phase 2 will be sampled at the invert of the existing forcemain at the leachate lagoon, also the other part of Phase 2 will be sampled at the invert of the proposed forcemain at the leachate lagoon. These sampling locations have been revised on Drawing F1, sheet 3 of 10 as requested.

Section 2.0 – Engineering Plan

Response to DWM Comment Number 2: (Section 2.1.6-Cap System Standards)

The text has been revised as requested.

Response to DWM Comment Number 3: (Section 2.1.5 and 2.2.2)

The Erosion and Sedimentation Plan has been resubmitted for review and comment.

Response to DWM Comment Number 4:
(Section 2.2-Leachate Collection System Calculation Summary)

The text in question has been revised to state “200 feet” not “250 feet”.

PO Box 97, Garner, North Carolina 27529 (919) 772-5393
PO Box 828, Morehead City, NC 28557 (252) 726-9481
PO Box 349, Boone, NC 28607 (828) 262-1767

Response to DWM Comment Number 5: (Section 2.2.8)

i. – iii. The additional report, verifying the 2:1 slopes, has been added to Section 2.2.8 as requested.

Section 4.0 – Construction Quality Assurance (CQA) Plan

Response to DWM Comment Number 6:

The text has been revised as requested.

Response to DWM Comment Number 7: (Section 2.4)

Table 1 has been revised as requested.

Response to DWM Comment Number 8: (Section 3.5,page 204)

i. and ii. The text has been revised on page 165 and 170 of the text as requested.

Response to DWM Comment Number 9: (Section 4.1)

The text has been revised as requested.

Response to DWM Comment Number 10: (Section 4.2.2)

i. We have replaced D2488 by D2487 in all applicable places.
ii. The text has been revised as requested.
iii. The text has been revised as requested.

Response to DWM Comment Number 11: (Section 4.2.2(c)-Destructive testing, page 214)

The text has been revised as requested.

Response to DWM Comment Number 12: (Section 4.2.10)

i. The text has been revised as requested.
ii. The text has been revised as requested.
iii. The text has been revised as requested.

Response to DWM Comment Number 13: (Section 4.2.11, page 227)

The text has been revised as requested.

Response to DWM Comment Number 14: (Section 4.2.11(5)(b), page 229)

i. – iii. The text has been revised as requested.

Response to DWM Comment Number 15:

We have changed Section 4.2.10 from "Closure of Cohesive Soil Cap" to "Conformance Testing for Interface Friction Angles of Capping Materials". Subsequently, all remaining subsection numbers have been shifted down one number, for example what was Section 4.2.10 is now 4.2.11.

Section 5.0 – Operation Plan

Response to DWM Comment Number 16: (Section 5.1, page 254)

i. The text has been revised.
ii. The monitoring wells and the surface water monitoring point have been added to Drawing P8, sheet 10 of 11 as requested.

Response to DWM Comment Number 17: (Section 5.2.2)

The text has been revised.

Response to DWM Comment Number 18: (Section 5.2.12)

The text in Section 2.2.6 of the Design Hydrogeologic Study indicates that both samples will come from the lagoon. The northern sump area of Phase 2 will have a forcemain that ties into the existing forcemain from Phase 1 therefore the sample will be a composite sample taken at the invert of said forcemain within the leachate lagoon. The southern sump area of Phase 2 will have a forcemain that also runs to the leachate lagoon, this sample will also be taken at the invert of said forcemain within the leachate lagoon. The two(2) sampling locations have been added to Drawing P8, sheet 10 of 11 as requested.

Section 6.0 – Closure Plan

Response to DWM Comment Number 19: (Section 6.6)

The text has been revised to show that we are using the 250 mil Geonet for all instances sited, and the charts have been revised to show only the eight(8) ounce weight.

Please find enclosed one (1) hard copy of the revised drawings and text, and a CD with the revised Permit to Construct application. If you have any questions or need additional information please don't hesitate to give us a call.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., PA

Lisa H. Crawford

Lisa H. Crawford
Designer

Enclosures

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Beverly Eaves Perdue
Governor
Dexter R. Matthews
Director
Dee Freeman
Secretary

Solid Waste Section

November 17, 2010

Mr. Tom Miller, Solid Waste Director
P.O. Box 3289
130 S. Queen Street
Kinston, North Carolina 28501

Re: Additional Comments on Permit to Construct (PTC) Application – Phase 2
Lenoir County Municipal Solid Waste Landfill (MSWLF)
Lenoir County, North Carolina, Permit No. 54-09, Document ID No. (Doc ID) 12205

Dear Mr. Miller:

On November 5, 2010, the Division of Waste Management (DWM), Solid Waste Section (SWS) received the revised PTC application document (Doc ID 12120) for the Phase 2 development at the above-referenced MSWLF. Municipal Engineering Services Co., Inc. (MESCO) on your behalf submitted the PTC application. The SWS has conducted a review of the engineering related portions of the PTC application and has additional comments on the application. Your responses to the following comments will expedite the review of the permit application:

General:
Please conduct a global search throughout the permit application to ensure the name of **Division of Waste Management, not Division of Solid Waste** is properly provided in the document.

Section 1.0 Facility Plan
1. (Drawings F-1/Sheet 3 of 10) Please verify the identification of the existing leachate sample location at Phase 1 area. The historical data and records indicate the identification of the existing leachate sample location is "Lagoon," not LS-1. Please clarify.

Section 2.0 Engineering Plan
The comments depicted below are presented in the DWM correspondences dated July 21, 2010 (Doc ID 9570) and September 9, 2010 (Doc ID 11554). The revised PTC application (Doc ID 12120) did not properly address these comments; therefore, the DWM reiterates these comments in this letter again.

2. (Section 2.1.6 – Cap System Standards) Please provide the references of "the proper seeding and mulch of the erosive layer and other erosion control devices." The references shall be the approved erosion and sediment control plan and/or the North Carolina Erosion and Sediment Control Planning Design Manual.

3. (Sections 2.1.5 & 2.2.2) Has the appended Erosion Control Plan been approved by the Land Quality Section of the Division of Land Resources? Pursuant to Rule 15A NCAC 13B .1624 (b)(15), Lenoir County must provide **a hard copy of the approval letter** from the Land Quality Section to confirm that the submitted Erosion Control Plan (calculations and drawings) for developing and operating Phase 2 is in compliance with the requirements stated in the Sedimentation Pollution Control Law (15A NCAC 4).

4. (Section 2.2 – Leachate Collection System Calculation Summary, on Page 38) This Section concludes that SDR 17 HDPE pipe can sustain the loads created by at least 250-ft of waste which is inconsistent with the designed waste height of 200 feet as present in the Section 2.2.5. Please clarify.

5. (Section 2.2.8) Please address the following concerns:
   i. The side slope on the south-east side of the final grade for Phase 2 as shown on Drawing E11/Sheet 13 of 15 is likely a 2 (H) to 1(V) slope. Please run slope stability analysis on this 2 to 1 interim slope to ensure the side slope can safely stand prior to waste filling into Phase 3 cell.
   ii. Please provide the reports of bearing capacity analysis and both total and differential settlement analysis for Phase 2 area. The reports must include the assumptions, perimeters used for calculations, calculating processes, and literature references. It is advisable for Lenoir County that the foundation analysis should consider all loadings, including the total waste loads (considering the complete vertical expansions), baseliner systems, and the final cover systems, exerting on the subgrade soil.
   iii. Provide the **output data sheets** generated from the computer program used for the slope stability analysis.

Section 4.0 Construction Quality Assurance (CQA) Plan

6. Since the "project Engineer" is not defined in the Section 4.1, please conduct a global search throughout the permit application to ensure the name of "Project Engineer" is replacing by "**Engineer**," "Project Superintendent" is replacing by "**Flexible Membrane Liner Superintendent**," and "CQA Inspector" is replacing by **Construction Observer**."

7. (Section 2.4) According to the conclusions in Appendix B of the revised Slope Stability Analysis (Section 2.2.8), the interface friction angles between geocomposite drainage net/FML [26 degree], FML/GCL [26 degree], GCL/compacted soil liner [21 degree] shall be used as the minimum criteria (not the 13.0 and 13.5 degrees) in the Table 1 of Section 2.4. Please revise the minimum criteria of the interface friction angles listed in Table 1.

8. (Section 3.5, on page 204) Please address the following concerns for construction and backfilling of the permanent anchor trenches:
   i. Specify the earthen material (type & maximum grain size, etc.) and the minimum compaction effort (determined by ASTM D698) for the compacted backfill in the anchor trenches, which is consistent with the compaction effort noted in the "Permanent Anchor Trench Detail" on Drawing No. E8/Sheet 10 of 15.
   ii. Specify field QC testing methods and frequencies on the compacted backfill in the anchor trenches.

9. (Section 4.1) This CQA Plan shall be prepared for constructing all landfill components described in the permit application including final cover systems; therefore, please revise the Contractor's responsibility by adding "**construction of final cover system and gas venting system**" in the third sentence of the fourth paragraph of this Section.

10. (Sections 4.2.2) Please address the following concerns:
    i. In the Paragraphs (c) & (d), please replace the ASTM Method D2488 by D2487 in consistent with the Section 4.2.10 (c) & (d).
    ii. In the Paragraph (l), please add" and mixed in the field using either a plug mill or a soil stabilizer." to the end of the second sentence in consistent with the Section 4.2.10 (l).
    iii. In the Paragraphs (h) & (n), should the area requires to be reworked or replaced also be retested? Please clarify.

11. (Sections 4.2.2.(c) –Destructive Testing, on page 214) Please add the specification of "the tensiometer that has a constant separation rate of 2.0 inch per minute for peel and shear" to this subparagraph (2) Procedure for Destructive Testing.

12. (Section 4.2.10) Please address the following concerns:
    i. In the Paragraph (i) please add "or other holes created by survey stakes, etc." to the 7th sentence in consistent with the Section 4.2.2 (i).
    ii. In the Paragraph (m) please add "such as tire ruts" to the end of the last sentence in consistent with the Section 4.2.2 (m).
    iii. In the Paragraph (n) please add the retest requirement on the repair cap area in consistent with the Section 4.2.2 (n).

13. (Section 4.2.11 – Preparation for Geomembrane Deployment, Paragraph (c) – Verification, on page 227) The CQA testing properties and frequencies shall be consistent with Section 4.2.4. Therefore, add the following paragraph to the Section 4.2.11.(1) Paragraph (c):

    The Engineer will remove a sample from 1 out of 4 rolls delivered to the site and have a third party lab test for thickness, density, carbon black content & dispersion, and all tensile properties. The lab will have been accredited by the Geosynthetic Accreditation Institute (GAI)."

14. (Section 4.2.11.(5) – Test Seam; (b) Sample Procedures, on page 229) To consistent with the sample procedures described in the Section 4.2.4.(5)(b) please add the following specification to the procedures.
    i. After the first step of the procedure, the second step shall be "Two random samples one (1) inch wide shall be cut from the test seam."
    ii. Add the specification of "the tensiometer that has a constant separation rate of 2.0 inch per minute for peel and shear" to the third step.

15. With respect to the testing of interface friction angles between the components consisting of the final cover system, the technical specification must be prepared and describe: testing methods and frequencies, and the minimum interface friction angles between:
    i. The 24-inch-thick Protective Soil Cover and the 250-mil-double-bounded drainage composite.
    ii. The 250-mil-double-bounded drainage composite and the 40-mil LLDPE.
    iii. The 40-mil LLDPE and the 18-inch-thick compacted clay liner

The specified minimum interface friction angles must be equal to or exceeding those designed values concluded from Section 2.2.9 in the Engineering Plan.

Section 5.0 Operations Plan

16. (Section 5.1, 5th Paragraph, on Page 245) Please address the following concerns:
    i. Since the Section 5.3 -Appendix I describes the Waste Screening and Inspection Plan, the reference of the Appendix I analyte for groundwater and surface water sampling in Section 5.3 of the Operations Plan is incorrect. Please provide the correct reference.
    ii. Please add the locations of new groundwater monitoring wells – MW-19S, MW-19D, & MW-20 and surface water monitoring point SW-3 to the Drawing P8/Sheet 10 of 11.

17. (Section 5.2.2) Please delete "Section 5.4-Appendix II" from the subparagraph b of this subsection which is not relevant to the cover material requirements.

18. (Section 5.2.12) According to the Section 3.6 of the Groundwater and Surface Water Sampling Analysis Plan in the approved Design Hydrogeologic Study, leachate samples will be collected from two locations: Lagoon for Phase 1 area and LE-2 for Phase 2 area. Please describe the sample locations in the Section 5.2.12 and identify and show the sample locations on the Drawing P8/Sheet 10 of 11.

Section 6 Closure Plan

19. (Section 6.6) The material specification of the drainage composite stated in Section 6.6 (Geonet thickness of 220 mils) is inconsistent with that (Geonet thickness of 250 mils) stated in Section 4.2.13 and drawings. Additionally, please specify the weight of geotextile (6, 8 or 10 oz/yd^2) of the selected geocomposite. Please clarify.

Please respond the above-mentioned comments and provide the Solid Waste Section one hard copy of the **revised portions** of the PTC application and the additional information that has not been previously submitted. Please also provide an electronic copy, in the pdf format, of the entire revised PTC application. The Solid Waste Section appreciates your efforts and cooperation in this matter. If you have any questions or would like to schedule a meeting to discuss this matter further, please contact me at (919) 508- 8507.

Sincerely,

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section

cc:
Wayne Sullivan, MESCO
Donna Wilson, DWM
Dennis Shackelford, DWM
Central File
Ed Mussler, Permitting Branch Supervisor
Christine Ritter, DWM
Wes Hare, DWM

Permit No.	Date	Document ID No.
54-09	**September 09, 2010**	**11554**

RECEIVED
September 09, 2010 via an e-mail
Solid Waste Section
Raleigh Central Office

From: Chao, Ming-tai
Sent: Thursday, September 09, 2010 4:34 PM
To: 'Wayne Sullivan'
Cc: 'tmiller@co.lenoir.nc.us'; Mussler, Ed
Subject: comments on revised Facility Plan and Engineering Plan, Lenoir County, Permit 54-09
Attachments: 9570.pdf

Wayne: I have completed a review of the above-referenced submittal - revised Facility Plan and Engineering Plan which are received by the Solid Waste Section on August 23, 2010. The comments on the document are stated below:

1. (Section 1.4, Facility Plan revised 8/19/10) Please address the following concerns:
   i. (Section 1.4.1) Please provide the pretreatment permit & approval document from the City of Kinston which must be appended to the permit application.
   ii. (Section 1.4.2) Layer 4 is the drainage net, not HDPE Liner. Please correct this typographic error.
   iii. (Section 1.4.3) The capacity of lagoon is calculated and placed in Section 2.2.4, not in Section 2.1.7. Please correct the typo.

2. (Drawings) Please provide responses to DWM July 21 2010 comment Nos. 101- i, 102, 103-i, & 105.

3. Please provide responses to DWM July 21 2010 comment Nos. 10, 12, & 13 in the revised Engineering Plan. The DWM July 21 2010 comments are attached to this e-mail message.

4. This Engineer Plan has not been signed, dated, and sealed by a professional engineer registered in the State of North Carolina in compliance with Rule .1620(b). Please comply with Rule requirement when the final permit application is submitted.

5. (Sections 2.1.3 & 2.2.8) Please address the following concerns:
   i. Please provide responses to DWM July 21 2010 comment Nos. 25, 26, & 27.
   ii. The assumed maximum waste height of 115 feet is used in the Slope Stability Analysis and Foundation and Settlement calculations. However, the measured maximum waste height is 131 feet based on the final grade of 226 feet and the base grade of 95 feet as shown on Facility Plan Drawing No. CS1/Sheet 10. Please revise the calculations based on the updated data. Your e-mail dated August 20 2010 concluded that Section 2.2.8 has taken into consideration all of the fill and waste when the settlement calculations has been done. I can't agree with your conclusion.
   iii. Section 2.1.3 concludes that the total settlement of the subgrade under the total waste loads is 0.58 feet (or 7 inches). However, Section 2.2.8 does not include any total settlement calculation processes and assumptions. Please provide settlement analysis and calculation.
   iv. Please also provide the differential settlement calculation processes under the estimated maximum waste loads to demonstrate that (a) the designed minimum post-settlement slope of the landfill bottom subgrade is more than or equal to two percent (%) [Rule .1624(b)(7)]is the post-settlement values and that (b) the piping slopes ranging from 0.89% to 4.6 % in the proposed LCRs, as shown on the Engineering Plan Drawing No. E7/Sheet 9 of 15 are the post-settlement values.
   v. The side slope on the south-east side of the final grade for Phase 2 as shown on Drawing E11/Sheet 13 of 15 is approximately 2 (H) to 1(V). Please run slope stability analysis on this interim slope to ensure the side slope can safely stand prior to waste filling into Phase 3 cell.

6. (Section 2.1.6) Please use the correct name of the Division of Waste Management (DWM), not the Division of Solid Waste throughout this Section.

7. (Section 2.1.7) Please change "Department" to the Division of Waste Management.

8. (Section 2.2, on Page 17) This Section concludes that SDR 17 HDPE pipe can handle the loads created by at least 250-ft of waste. However, in Section 2.2.5, the waste height is 200 feet. Please clarify.

9. (Section 2.2.3) I have doubts if the leachate head on the composite liners is less than one foot for proposed LCRs (3-ft native soil protective layer overlying the 250-mil geocomposite) and intends not to make further comments at this time because the County has exhausted the landfill space and paid high costs in operating transfer station to dispose of MSW. But for the record, I reserve my right to challenge the proposed LCRs in the future phase development, if County intends to use the native soil as the protective cover rather than more pervious material overlying the drainage composite.

10. (Section 2.2.4, on Pages 125 & 126) Please verify and confirm the total length of leachate trench/piping length, 4146 feet or 4156 feet? And recheck the final results, which may not be correct due to the incorrect input data.

11. (Section 2.2.4, on Page 125) Should the porosity of the rock/stone pack be considered in the calculation of "horizontal flow in rock? Please clarify.

12. (Section 2.2.4, on Pages 127-128 & Section 2.2.9, on Page 139) Please address the following concerns of drainage net and geotextile:
    i. Pursuant to Rule .1624(b)(13)(A0(ii), please conduct the filter design for the drainage layer in both bottom cell and final cover to ensure the selected geocomposite (final cover component) and geotextile (bottom cell) material meet the permeability criteria, retention criteria, and long-term service criteria (mitigation of clogging).
    ii. For item i, the filter design to select the proper geotextile that wraps the leachate piping enveloped by granular material inside the drainage trenches shall be done to ensure that the LCRs will not be silted up when the cell is inactive [an approach required for the stormwater & leachate controls for inactive cell (Rule .1625(b)(1)(D))]. I will not request the filter design if County will use geosynthetic material to cover the entire inactive cell (including side slopes) and pump out the collect rainwater on top of the cover to the stormwater conveyance structures/measures. But the approaches to implement this stormwater separation must be address in detail in the Operations Plan and drawings.
    iii. Please provide references and/or research literatures to support the statement made in the "Drainage Net and Geotextile" that leachate that would flow thru the protective cover will not be carrying sediments because it will not have the scouring velocity to do so.
    iv. Please provide detail calculation processes to show how the values of "Peak daily flow from HELP Model" - 97,749 gallons (on page 128) and 2498 ft3/acre (on page 139) are generated.
    v. The concerns of calculating transmissivity of the geocomposite material (on pages 128 and 139): must address (a) flow condition thru the geocomposite material on side slopes – 3 (H) to 1(V) in the bottom cell and 4 (H) to 1 (V) on the final cover in addition to those at the cell bottom and top deck (b) the safety factors recommended by GRI – GC8, "Standard Guide for Determination of Allowable Flow Rate of a Drainage Geocomposite."

13. (Section 2.2.5) The assumed density of waste material in the Section 2.2.8 (70 pcf) is inconsistent with that in Section 2.2.5 (60 pcf). Please clarify.

14. (Section 2.2.6, on Page 135) The calculated result is incorrect. According to the calculation process that T= 137.70 * [(30.63) * (-0.03) - 0.52]; then T = 137.70 *[-0.92 - 0.52] by simplification of the calculation; then T = - 198.14 #/in. Please recheck the calculation processes.

15. (Section 2.2.6, on Page 136) The Section assumes that the smooth 60-mil HDPE liner is used for one of the components of the base liner system. But the specifications and engineering plan drawings indicate the "**double textured**" 60-mil HDPE is selected for this project. Please correct the typo. If the engineering parameters present in Section 2.2.6 are of the smooth 60-mil HDPE liner, please revise the data and re-calculate the self-weight stress of the **double textured** 60-mil HDPE liner during construction.

16. Veneer slope stability calculations.
    i. Please provide a copy of the CETCO Design Manual –Technical Notes 5 & 6 for reference (I have not received the document that you promised in the e-mail dated 8/30/2010).
    ii. Please provide veneer slope stability calculations for the final cover system. I would like to recommend the methods developed by Dr. Koerner R.M. and Soong, T.Y. (1996 & 1997).
    iii. For the designing of the base liner and the final cover system, the interface friction angles (geosynthetic material/soil and geosynthetic material/ geosynthetic material) must be consistent throughout the entire calculations. The inconsistent values are used throughout the Section 2.2.6.

For example – inconsistent critical interface angle of liner system:

Location	Internal friction angles (degree)	Material
Page 135	26	The critical mobilize interface angle of liner
Page 136	17	critical interface angle of liner system

    iv. The minimum or critical <u>internal</u> friction angles must be determined for both the base liner system and final cover system which will be tested according to ASTM methods and specified in the CQA plan.

17. The comments on LCRs. The leachate lines layout must provide easy egress / ingress for the periodical cleanup of LCRs piping and operating the video camera for final inspection and verification.
    i. Increasing the lateral piping size to 8-inches, rather than 6-inches. Several landfill facilities in the State of North Carolina have experienced problems for tools or equipment in and out of the piping size of 6-inches in diameter due to very limited room for operating and maneuvering the tools or equipment. The diameter of piping and fitting at the welded joint areas has been reduced due to the improper welding processes, which result in the piping inaccessible for the cleanup tools.
    ii. Adding cleanout at each end of the leachate piping (both trunk and lateral pipes) adjacent to the haul road. Add cleanout at one end or both ends of the trunk lines toward the sumps is not enough because the lateral pipes are not accessible without their owned cleanouts. Please add cleanouts to all piping which can be accessed at haul road on Engineering Plan Drawing E7/Sheet 9 of 15 and Facility Plan Drawing F3/ Sheet 5 of 10.

Please contact me if you have any questions on the comments.

Best regards,

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section
Division of Waste Management
1646 Mail Service Center
Raleigh, NC 27699-1646
401 Oberlin Road, Suite 150, NC 27605
Tel: 919.508.8507, Fax 919.733.4810
ming.chao@ncdenr.gov
http://portal.ncdenr.org/web/wm/sw

Chao, Ming-tai

From: Chao, Ming-tai
Sent: Monday, August 30, 2010 10:42 AM
To: 'Wayne Sullivan'
Cc: Mussler, Ed; 'tmiller@co.lenoir.nc.us'
Subject: RE: Revisions to the Lenoir PTC

Wayne: I am half-way completing a review of the new submittal. I got two small projects need my commitments last week and will try to complete the review ASAP.

Regarding the veneer slopes, the ones in the landfill cells are not my major concern because they will be filled by wastes in a relatively short duration, and buttressing will provide some resistance in the toe area. The major concerns are the final cover system which will be last for at least 30-years and significantly influenced by the uncontrollable weather patterns and other factors. I understood the situations that you are facing (Geosynthetic material manufactories love to sell you their products but may not help you to touch the hot button – slope and unstable soil conditions. Been there and got burnt before) but please check around some other methods for the purpose of comparison; after all, slope stability analysis 101 is the fraction angle shall not less than the slope angle (angle of repose). I believe the method developed by Dr. Koerner and his Ph.D. student T.Y. Soong in 2003 and published in *Geosynthetics International* dated 12/2005 is more popular one and adopted by the waste industries and consulting professionals recently. Of course this is my personal suggestion, you and your Designing Engineers (P.E.s) are the persons have the absolute right and responsibility to use/defend the method(s) to your projects.

If you can please send me a copy of the CETCO manual that is used for this project.

By the way, MESCO has not responded the comments for the following facilities:

Green County C&DLF; Permit # 40-02, last comment issued 07/01/2010

Lenoir County C&DLF; Permit # 54-03, last comment issued **10/30/2009**

Wayne County C&DLF; Permit # 96-01, last comment issued 07/19/2010

If my memory serves me right, I recalls the total gross capacity issue has been resolved in the meetings while we met in the landfills last month.

Please let me know the status of the C&D on top of the MSWLF. If you need my assistance please feel free to contact me.

Best regards,

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section
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E-mail correspondence to and from this address may be subject to the North Carolina Public Records Law and may be disclosed to third parties.

From: Wayne Sullivan [mailto:wsullivan@mesco.com]
Sent: Friday, August 20, 2010 10:31 AM
To: Chao, Ming-tai
Cc: Tom Miller; thollowe@co.lenoir.nc.us
Subject: Revisions to the Lenoir PTC

Ming,

We have sent to you the revisions to the facility plan that you requested and revisions to the Engineering Plan. You should receive the revisions today. We did not included the pre-treatment agreement with Kinston but can email it to you. Also, we still have to get final erosion control permit.

We did not revise two sections and they are section 2.2.7 because we used the CETCO manual and it does take in consideration of buttressing. The formulas and data used are from the manual. We have contacted CETCO concerning the manual and they have not been able to reproduce it. Regardless, we have used this material on 3:1 slopes for several years and it has never slid down a slope during construction. As a matter of fact, it is very hard to move on a slope if it is not position properly from up slope. I can also send you the CETCO manual we used.

Also, We did not have the settlement and slope calculations, Section 2.2.8 redone because they do take into consideration all of the fill and waste when the settlement calculations is being done.

We have changed the leachate collection system as we have discussed.

Thanks,

D. Wayne Sullivan
Municipal Engineering Services Co., Inc.
Phone: (919) 772-5393
Fax: (919) 772-1176
email: wsullivan@mesco.com

From: Wayne Sullivan [wsullivan@mesco.com]
Sent: Monday, August 16, 2010 8:21 AM
To: Chao, Ming-tai
Subject: RE: Lenoir Co.

Ming,

We are responding to your questions about the facility plan and I hope to have the engineering plan and the facility plan back to you tomorrow.

Permit No.	Date	Document ID No.
54-09	**September 09, 2010**	**11553**

RECEIVED
September 09, 2010 via an e-mail
Solid Waste Section
Raleigh Central Office

D. Wayne Sullivan
Municipal Engineering Services Co., Inc.
Phone: (919) 772-5393
Fax: (919) 772-1176
email: wsullivan@mesco.com

From: Chao, Ming-tai [mailto:ming.chao@ncdenr.gov]
Sent: Friday, August 13, 2010 2:12 PM
To: Wayne Sullivan
Cc: tmiller@co.lenoir.nc.us; Mussler, Ed
Subject: RE: Lenoir Co.

Wayne: I have completed a review the revised facility plan and have some comments shown below:

1. Because there are so many changes in the facility plan from the original permit application in 1998 to the latest one in August 2010, I want to confirm that the Total Gross Capability of the MSWLF which will be transferred to the PTO/PTC. The Total Gross Capability is not defined in the .1600 Rules for MSWLF but is required for the Solid Waste Section for reporting and planning landfill capacity in the State of North Carolina. For the consistency of using the term of "The Total Gross Capability" for all MSWLF and C&DLF, the Total Gross Capability is defined as the volume of the landfill calculated from the elevation of the initial waste placement through the top of the final cover, including any daily or period cover. For Lenoir County MSWLF, the Total Gross Capability will be calculated from the top of the protective cover (bottom of the cell) through the top of the final cover. I like to present the value of the Total Gross Capability based on the revised Facility Plan, and please correct me if mine is wrong.

Phase	Area (acre)	Capacity (cubic yard)	Status
1	10.53	511,000	Fill completed
2	9.23	564,066	To be developed
3	14.43	578,003	Un-developed
4	Vertical expansion	588,208	Un-developed
5	Vertical expansion	398,958	Un-developed
6	4.9	148,936	Un-developed
Total Operating capacity (including daily cover)		2,789,171	
Cover (final)		307,421	
Total Gross Capacity	39.09 (acre)	3,096,592	

If this table is correct, please add the total gross capacity of 3,096,592 cubic yards to the Facility Plan. This value is slight higher than the original approved one, 3,009,339 cubic yards, but I think e can live with it.

2. (Figure 5 of 10) At Phase 2 area, the leachate lines layout must consider the cleanup of LCRs piping and operating the video camera in/out the LCR system. For examples, add clean out to all piping which can be accessed at haul road; not sharp bending of piping.

3. Based on the illustration on Figure 5 of 10, the Phase 2 will be divided into 2 cells. The facility plan and operations plan needs to clearly describe the cell construction sequences (will the cells be constructed the same time or constructed sequentially?) and storm water separations.

4. (Figure 7 of 10) Please add numerical numbers of the contours at Phase 6 area.

In the 07/29/2010 meeting I remembered that you mentioned the revised permit application for Lenoir County MSWLF would be submitted to DWM on 08/15/2010. I am looking forward to receiving the rest portions of the permit application for Phase 2 PTC.

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section
Division of Waste Management
1646 Mail Service Center
Raleigh, NC 27699-1646
401 Oberlin Road, Suite 150, NC 27605
Tel: 919.508.8507, Fax 919.733.4810
ming.chao@ncdenr.gov
http://portal.ncdenr.org/web/wm/sw

From: Wayne Sullivan [mailto:wsullivan@mesco.com]
Sent: Monday, August 09, 2010 9:00 AM
To: Chao, Ming-tai
Cc: Tom Miller; thollowe@co.lenoir.nc.us
Subject: Lenoir Co.

Ming,

Friday we sent you the Facility Plan revised according to your review letter. We are planning on submitting the remainder this week. If ypou need anything else just let me know.

D. Wayne Sullivan
Municipal Engineering Services Co., Inc.
Phone: (919) 772-5393
Fax: (919) 772-1176
email: wsullivan@mesco.com

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

September 8, 2010

Mr. Tom Miller
Solid Waste Director
P.O. Box 3289
130 S. Queen Street
Kinston, North Carolina 28501

Re: Technical Review and Approval Letter
Design Hydrogeologic Report
Lenoir County MSW Landfill, Phase 2
LaGrange, Lenoir County, North Carolina
Permit No. 54-09, Document ID No. 11539

Dear Mr. Miller:

The North Carolina Solid Waste Section has completed a technical review of the August 26, 2010 revisions to the November 2009 Design Hydrogeologic Study of the Lenoir County MSW Landfill Phase 2 expansion. The Section engineer will send comments on the Permit to Construct under separate cover.

The Water Quality Monitoring Plan is amended to include three (3) new groundwater monitoring wells associated with Phase 2. The proposed groundwater monitoring wells to be installed are MW-19S, MW-19D, and MW-20. The total number of groundwater monitoring wells is nine (9) and consist of MW-13, MW-14, MW-15, MW-16, MW-17, MW-18, MW-19S, MW-19D, and MW-20. Existing surface water sampling point SW-3 and one leachate collection point labeled LAGOON will continue to be sampled. Eight piezometers installed during subsurface exploration will need to be abandoned prior to construction activities commence at Phase 2. The 8 piezometers to be abandoned are P2-2, P2-3, P2-5S, P2-5D, P2-6, P2-7, P2-8, and P2-12.

A Landfill Gas Monitoring Plan was reviewed and approved for the areas consisting of the existing Phase 1 and proposed new Phase 2 of the MSW Landfill. Fourteen (14) landfill gas monitoring wells including MP-1 through MP-14 will be sampled quarterly to insure that landfill gas does not exceed the lower explosive limit at the facility boundary and 25% of the lower explosive limit at facility structures. The Section recommends a Professional Geologist be on site during the installation of new landfill gas monitoring wells. The design and construction of the landfill gas monitoring wells shall be in accordance with the applicable North Carolina Well Construction Standards listed in 15A NCAC 2C .0100 and the Section's Methane Monitoring Guidance Document. If methane gas levels exceed the specified limits, the owner or operator must adhere to requirements in 15A NCAC 13B .1626(4).

The Design Hydrogeologic Report (including the Water Quality Monitoring Plan and the Landfill Gas Monitoring Plan) meet the criteria required in 15A NCAC 13B .1623(b), .1624(b)(4), and .1626(4) and therefore, this portion of the Permit to Construct application is approved. Please submit a pdf formatted copy of the final approved Design Hydrogeologic Study to the Solid Waste Section.

Piezometers, groundwater monitoring wells, and borings, located in the proposed phase for construction may be abandoned now or after a Permit to Construct is issued by the Solid Waste Section. Prior to construction of the new phase, all piezometers, groundwater monitoring wells, and borings located within the footprint must be properly abandoned by overdrilling first (exception of non-cased borings) and sealed with grout in accordance with 15A NCAC 2C.0113(d) entitled "Abandonment of Wells".

Well abandonment records (GW-30 form) for each decommissioned piezometer, boring, and groundwater monitoring well must be certified by a Licensed Geologist in accordance with rule .1623(b)(2)(I) and submitted to the Solid Waste Section in accordance with 15A NCAC 02C.0114(b). After the piezometers and/or groundwater wells are abandoned and new landfill gas well(s) constructed, submit an updated monitoring well location drawing.

The new groundwater monitoring wells associated with the new phase must be sampled for the Appendix I constituent list, including Mercury, Chloride, Manganese, Sulfate, Iron, specific conductance, pH, temperature, Alkalinity, Total Dissolved Solids prior to the Solid Waste Section issuing the Permit to Operate. In addition to a hard copy report, provide the Solid Waste Section with an electronic copy of the groundwater and surface water monitoring data collected at the landfill facility. Guidelines for sampling groundwater and surface water, and submitting data electronically can be located at the Solid Waste Section's web site: http://wastenotnc.org/swhome/technical_assistance.asp

Additional Geologic, Ground Water and Monitoring Requirements will be included in the Permit to Construct.

If you have any questions, you may contact me at (919)508-8506.

Sincerely,

Christine Ritter

Christine Ritter
Hydrogeologist
Solid Waste Section

Cc: Mark Brown, Municipal Engineering Services Company
Ming-Tai Chao, DWM
Ed Mussler, DWM
Wes Hare, DWM

Solid Waste Section

July 21, 2010

Mr. Tom Miller
Solid Waste Director
P.O. Box 3289
130 S. Queen Street
Kinston, North Carolina 28501

Re: Comments on Permit to Construct (PTC) Application – Phase 2
Lenoir County Municipal Solid Waste Landfill (MSWLF)
Lenoir County, North Carolina
Permit No. 54-09, Document ID No. (Doc ID) 9570

Dear Mr. Miller:

On December 1, 2009, the Division of Waste Management (DWM), Solid Waste Section (SWS) received the PTC application documents for Phase 2 development at the above-referenced MSWLF. Municipal Engineering Services Co., Inc. (MESCO) on your behalf submitted the PTC application documents which include:

- *Permit to Construct, Lenoir County Municipal Solid Waste Landfill Facility, Phase 2.* Prepared by MESCO in Garner, North Carolina, dated November 2009 (Doc ID 8970).
- *Design Hydrogeologic Study prepared for Lenoir County Subtitle D Landfill, Phase 2.* Prepared by MESCO in Garner, North Carolina, dated November 30, 2009 (Doc ID 8977).

The SWS has conducted a review of compliance with the Solid Waste Management Rule (Rule), 15A NCAC 13B .1600 et seq. The SWS hydrogeologist will review the *Design Hydrogeologic Study* and may request any additional information related to water quality monitoring and hydro-geology in a separate letter upon completion of his or her review. This letter is a review of the engineering related portions of the *Permit to Construct (PTC)* Application – Phase 2, and the SWS has comments on the application. Your responses to the following comments will expedite the review of the permit application:

<u>Section 1.0 Facility Plan</u>

1. (Section 1.2 – Landfill Capacity, on page 8) The proposed total capacity of 3,430,286 cubic yards (cy) for the Lenoir County MSWLF exceeds the permit-approved the total capacity of 3,009,399 cy more than ten percent (%) resulting in a "substantial amendment" in accordance with N.C.G.S. 130A-294(b1)(1). The approved total capacity of waste disposal - 3,009,399 cy is consistent with the volume shown on the PTC - Phase 1 application which was approved by the SWS on May 30, 2003, the 7 May 2003 public notice posted on Kinston Free Press, and the DWM annual report. Lenoir County must either revise the proposed Facility Plan by changing the total capacity in consistent with the previously approved one or conduct a local government approval process in accordance with N.C.G.S. 130A-294(b1)(4) to adopt this new total capacity of 3,430,286 cy. The documents related to local government approval processes must be appended to the Facility Plan and subject to DWM review and approval.

2. Note that response to Comment No. 1 may necessitate changes of the existing phase delineation (both texts and drawings). Additionally, the proposing total capacity of waste disposal for each phase must be adjusted to incorporate the gross capacity of Phase 1 to 658,424 cy from the original approved capacity of 635,200 cy; but the total gross capacity must be the approved one stated in the Comment No. 1. **Gross capacity is defined as the volume of the landfill calculated from the elevation of the waste placement, top of the bottom liner protective layer, through the top of the final cover, including the daily cover.** Revise delineation to describe phases that do not exceed approximately five years of operating capacity.

3. Please provide drawings to show a minimum of two cross sections per operational area (Phase 1 through 6 and Phase 7 alone) delineating subgrade elevations, the base liner elevations, and proposed final grade elevations (lateral and vertical expansions) which are consistent with Drawings F2/ Sheet 4 of 10 through Drawings F8/ Sheet 10 of 10.

4. (Section 1.4) Please describe a routine schedule for leachate removal in accordance with Rule .1680(b)(3) and the information of the treatment facility which receives the leachate including discharge limits and agreement in accordance with Rule .1619 (e)(4)(C)(iii).

5. (Section 1.4.2) Please provide a summary of the final designed leachate volumes - average monthly values and surge volumes created by the synthetic storm events from HELP model in Section 2.

<u>Section 2.0 Engineering Plan</u>

6. (Section 2.1.1.4 on page 14 & Section 2.2.4) Will the Lagoon has sufficient and adequate capacity to store the leachate generated from both Phase 1 and Phase 2 operation? What is the maximum duration for the on-site leachate storage? Please clarify.

7. (Section 2.1.1.4 on page 14) Please describe the proposed Leachate Collection System and summarize the conclusions from Section 2.2.4.

8. (Section 2.1.3) Please describe if the landfill development in compliance with vertical separation requirements based on the conclusions from the foundation and settlement analysis in Section 2.2.8.

9. (Section 2.1.4) There two survey bench marks shown on Drawing No. E1. Have these two established bench marks been used for survey control? If so, please revise the context in this section accordingly.

10. (Section 2.1.6 – Cap System Standards) Please provide the references of “the proper seeding and mulch of the erosive layer and other erosion control devices.” The references can be the approved erosion and sediment control plan and/or the North Carolina Erosion and Sediment Control Planning Design Manual.

11. (Section 2.1.6 – Cap System Standards & Section 6.1 **-** Introduction) Please correct the typographic errors stated below:
    i. Replace “the <u>closed</u> landfill” by “the unclosed landfill” – the last sentence of the 2nd paragraph.
    ii. Replace “the <u>enclosed</u> landfill” by “the unclosed landfill” – the last sentence of the 3rd paragraph.

12. (Section 2.17) Please provide a copy of the current legal agreement document between the Town of Kinston Wastewater Treatment Plan (WWTP) and Lenoir County MSWLF to demonstrate (i) the total quantity of leachate per month can be treated in the WWTP in the normal operating condition; (ii) the total quantity of leachate per month can be treated in the WWTP in the emergency operating condition; and (iii) the leachate pre-treatment standard.

13. (Section 2.2) Pursuant to Rule 15A NCAC 13B .1624 (b)(15), Lenoir County must provide a hard copy of the approval letter from the Land Quality Section of the Division of Land Resources to confirm that the submitted Erosion Control Plan (calculations and drawings) for developing and operating Phase 2 is in compliance with the requirements stated in the Sedimentation Pollution Control Law (15A NCAC 4). An electronic copy of the approved Erosion Control Plan submitted to the Land Quality Section must be appended to the Phase 2 PTC application.

14. (Section 2.2.1) Please provide the detail calculation processes and assumptions resulting in the required soil volumes for constructing components of the base liner (standard and/or alternative ones) and final cover systems.

15. (Section 2.2.1) "Phase 3" that is mentioned in the section is likely a typographic error of "Phase 2". Please make necessary correction.

16. (Section 2.2.3 – HELP Model) Please provide the reasons or assumptions why the default waste characteristics of material texture number 19 – municipal waste with channeling, rather than the default values of material texture number 18 – municipal waste was selected as input data in the model.

17. (Sections 2.24 & 3.6.1) The pipe separation distance of 50-feet is specified in Section 3.6.1 (the first paragraph) and Section 2.2.4 (on page 126); this information is inconsistent with the one (100-feet space, center to center of lateral piping) shown on Drawing E7/ Sheet 9 of 15. Please clarify and make necessary corrections.

18. (Section 2.2.4 on Pages 123 & 124) Please provide a calculation example and/or sources to show how the following quantities are derived from:

    i. 7.2-inch depth of precipitation for a 25-yr and 24-hr storm event;
    ii. Average monthly flows for a 5-year period on a per acre basis – from January to December (on Page 123);
    iii. Flow into perforation of pipe and vertical and horizontal flows through rock fill (on Page 123);
    iv. The daily peak flow as shown by the HELP Model for a five year period, which is 40,953 gallons (on Page 124);
    v. Q_{25} = 1,357.62 gpm & pipe length 144 feet (on Page 124)
    vi. 2,273 lf of 6" leachate line in Cell 1 (on Page 126).

19. (Section 2.2.4 – initial calculation on Page 123 & Section 2.1.1.4 on page 14) The proposed schedule for empty the lagoon is once per 1.9 months. This proposed schedule does not consider the leachate generated from Phase 1 area. Based on the data in the PTC - Phase 1 application, the designed annual leachate amount is approximate 4.5 million gallons. Lenoir County can also provide leachate volume generated from Phase 1 area for the last five years to support the calculation. Please clarify.

20. (Section 2.2.4 on Page 123 – system performance) What is the basis to assume that the largest area without garbage is approximately 5 acres? Will the Phase 2 area (approximately 9.23 acres) be divided into several cells? If so please add the information to the Section 1 – Facility Plan.

21. (Section 2.2.4 on Page 127 – system performance) Please provide the following information associated with the submersible pump:
    i. The detailed hydraulic calculations based on the flow rates and total dynamic heads for sizing the pumps in the both normal operation and storm surge events. The pumps must have adequate capacity to safely remove the leachate volumes generated from for the worst scenario case described in this subsection and reduce leachate head to less than one foot in the LCS within 17.1 hours after a 24-hour, 25-year storm event.

ii. The recommendations for adjustment of pump seating height to avoid intake screen or impeller plugged and level sensor blinded by deposits and routine pump maintenance.
iii. The pump performance curves and specifications for the selected pump must meet the ones shown on Drawing No. E9/Sheet 11 of 15.

22. (Section 2.2.4) Please address the following concerns associate with LCS Design Calculation:
   i. Provide the filter design to meet soil retention criteria, flow criteria, and clogging criteria between the protection layer and non-woven geotextile enveloping the LCS and the protection layer and double bonded HDPE drainage net overlaid 60-mil HDPE geomembrane to comply with requirements stated in Rule .1624(b)(13)(A).
   ii. Provide the design of drainage capacity (transmissivity and safety factor) of the double bonded HDPE drainage net to comply with requirements stated in Rule .1624(b)(12)(A).
   iii. The results from the above-referenced designs must be the bases for selecting and specifying geotextile, geonet, and geocomposite material in Section 4 – Construction Quality Assurance Plan.

23. (Section 2.2.6) Please address the following concerns:
   i. Please explain why no factor of safety (normally 1.2 to 1.5) was applied in the design of the required anchor trench. Please also revise the anchor trench detail on Drawing No. E8/Sheet 10 of 15 if the depth or runout is revised.
   ii. Provide the reference(s) of the tensile strength, 168 psi, used in computing anchor trench for drainage net.

24. (Section 2.2.7) Please address the following concerns:
   i. Please provide the copy of the portion of the reference – "*CETCO Design Manual*" used in the section. The current available design manual titled "Design and Construction of Water Containment Systems Using Bentomat CL" dated February 2009 using a different design approach.
   ii. The reviewer has troubles to believe that designed interface friction angles of GCL/textured HDPE (13.^{o}) and GCL/compacted clay liner (13.5^o) can be safely (with factors of safety 5.53 & 2.71, individually) installed on a 3 (horizontal) to 1 (vertical) slope (slope angle is 18.4^o). The simplest form to calculate a veneer slope (infinite slope) safety factor (FS) is FS = tan δ/tan β, without considering seepage force, cohesion, adhesion, buttress support, gas pore pressure, etc; where δ is the interface friction angle, and β is the slope angle. In this case FS = tan (13.5^o)/tan (18.4^o) = 0.72, which is less than 1, i. g. a slope failure. Please re-examine the theory and design approach.
   iii. The interface friction angles obtained in this section are inconsistent with the values used in Section 2.2.6. Please explain why two sets of data are used in the calculations.

25. (Section 2.2.8) Please provide the reports of foundation analysis (including bearing capacity analysis and settlement analysis) for Phase 2 area because the previous settlement analysis has completed only for Phase 1 area. The reports must include the assumptions, perimeters used for calculations, calculating processes, and literature references. It is advisable for Lenoir County that the foundation analysis should consider all loadings, including the total waste loads (considering the complete vertical expansions), baseliner systems, and the final cover systems, exerting on the subgrade soil.

26. (Section 2.2.8) Please address the concerns of the slope stability analysis:
   i. The descriptions of the final cover system are inconsistent with those in the Sections 4 and 6. Please clarify.
   ii. Based on the differences of the contours of the completed top of protective cover (87 – ft to 95-ft on Drawing E5/Sheet 7 of 15) and the final fill grades of phase 6 (100-ft to 226-ft on Drawing F8/Sheet 10 of 10), the approximately waste heights are ranging from 23-ft to 126-ft. Therefore, the maximum waste height is 126 feet, not 115 feet, which **excludes** the 5-ft-thick the baseliner

and 4.5-ft-thick final cover components. Please make necessary correction in the contexts and re-run the slope stability analysis based on the new waste loading.

iii. Provide the input and output data sheets generated from the computer program used for the slope stability analysis.

27. Please provide final cover system designs including:
    i. The veneer slope stability analysis to demonstrate the composite liner systems can safety stand on the proposed slopes and to determine the critical (lowest) friction angle in the cover system.
    ii. The lateral drainage system design must safely convey percolated flow from the cover system to surface water drainage systems. The designed system must consider the long term performance requirements such as described in GRI-GC8 (2001) and ASTM D4716 -08 and the predicted surcharges or loading conditions.
    iii. Provide the design of drainage capacity (transmissivity and safety factor) and filter design of the double bonded HDPE drainage.
    iv. The results from the design must be used as the bases to select each component consisting of the final cover system and reflected in the specifications in Section 4.

Section 3.0 Materials and Construction Practices

28. (Section 3.4.1 on page 149) The description of the last paragraph says that "Upon request, the Flexible Membrane Liner manufacturer installer shall…." Is the Flexible Membrane Liner manufacturer installer a typographic error of the GCL manufacturer installer? Please clarify.

29. (Sections 3.6 & 4.2.6) The specification indicates that "no permeability, grain size, or other tests are required for this material" to construct protective cover. Lenoir County needs to properly address the following concerns:

    i. If no grain size testing is proposed for the earthen material used for protective cover, what assurance is there to confirm the earthen material containing no particles or objects greater than ¾ inches in largest dimension and to prevent the proposed filter material (250-mil double bonded HDPE drainage net and non-woven geotextile) from physical clogging.? Please clarify.
    ii. If no testing of hydraulic conductivity is required for the constructed protective cover, how the data for the protective layer used in the HELP Model can be verified and confirmed and how to verify that the selected geocomposite material will not be clogged by the fines from the protective cover? Please clarify.

30. (Section 3.10.1) The procedures to develop a permeability "window" are inconsistent to those described in Section 4.2.10 and Section 6.3 (b). Please clarify.

31. Since the Section 3 is almost the duplicate of the Section 4, please revise Section 3 by incorporating all responses of the comments on the Section 4 to Section 3 as well.

Section 4.0 Construction Quality Assurance (CQA) Plan

32. Please provide the specifications associated with excavation, cleaning/grubbing, site protection (including environmentally sensitive areas) and restoration. The specifications must stress that during the courses of these activities, BMPs in the approved Erosion and Sediment Control Plan must be implemented.

33. (Section 4.1- Introduction) Please address the following concerns:

    i. Please define the role and responsibility of "Project Engineer, CQA Engineer, CQA inspector, Project Superintendent, Project Manager" which have been randomly mentioned throughout the Section 4.

ii. Please define the roles and responsibilities of the owner/operator (Lenoir County) and manufacturers.
iii. This CQA Plan shall be prepared for constructing all landfill components described in the permit application including final cover systems; therefore, please revise the Contractor's responsibility accordingly.

34. (Section 4.2.2 – Base Liner System Cohesive Soil Liner) Please describe the construction approaches to tie-in the compacted clay liners in Phase 2 area to the ones underneath the Phase 1, and add the tie-in details to the drawings.

35. (Sections 4.2.2 – Base Liner System Cohesive Soil Liner, 4.2.10 –Closure Cohesive Soil Cap & 6.3 - Cohesive Soil Cap) Please address the following concerns:

i. Provide specification of the percent (%) of fine (% passing of 3/4-inch [Section 2.1], 3/8-inch [Section 4.2.2(m)], #60 sieve [Section 4.2.3 (3.3)], and #200 sieve) and the plastic index (PI) ranges for the selected clay liner material.
ii. Provide explanations why the ASTM Method 2487 is not proposing for classifying soil type on samples from borrow pit, test pad, and in-place compacted clay liner if the soil index tests are proposed to run for this project?
iii. What provisions of surface preparation and protection of compacted soil liner are there in the end of each working day and the final lift [preparing the finished surface stated in Paragraph (m)] ?
iv. In the Paragraphs (h) & (n), should the area requires to be reworked or replaced also be retested? Please clarify.

36. (Sections 4.2.2(o) & 4.2.10(o)) What provisions are there to repair the holes after the survey stakes are pulled out of the soil surfaces? Please clarify.

37. (Section 4.2.3 – Alternative Base Liner System) Please address the following concerns:

i. The qualifications of the third party laboratory to be retained for CQA testing of the GCL must be specified in the Paragraph 1.4.B.
ii. The TR404bm is obsolete specification for Bentomat "ST" please use the current one TR400st.
iii. In Table 1, the ASTM D 6243-09 is the method adopted by the waste industries for testing interface and internal shear strength of GCL, and the ASTM D 5321-08 is the method for testing interface shear strength of soil/geosynthetic or geosynthetic/geosynthetic. Please revise the testing methods. Additionally, the hydration duration, consolidation, normal loading range, and shear rates must be specified.
iv. In Table 1, the specified minimum values of interface friction angles may need to be revised according to the response to Comment No. 24, and the minimum value of the interface shear strength must be specified for preventing geomembrane slipping off GCL on a slope surface while in construction.
v. The proposed CQA testing frequency for each testing item in Table 1 is less than that adopted in the waste industry standard. The Solid Waste Section would like to recommend the testing frequency be increased twice more than the proposed ones in Table 1.
vi. The Paragraph 2.4 must specify procedures to handle and manage the GCL material which fails CQA testing.
vii. Since this section proposes that HDPE material must meet the standard specification stated in GRI test Method GM13 (the last paragraph in page 185 and third paragraph in page 187), please also specify the revision number and issuance date. It is evident that the Table2 (a) in page 186 is not the current one described in GRI-GM13, revision 9, dated June 1, 2009.

38. (Sections 4.2.4, 4.2.11, & 6.4) Please provide product specifications for the flexible membrane liner (FML) - 60-mil double textured HDPE and 40-mil LLDPE including, but not limited to:

i. Product dimensions per roll, label and packing and delivery.
ii. Product on-site inspection and acceptance/rejection.
iii. Product on-site shipping, handling, and storage.

39. (Section 4.2.4) The first sentence of the last paragraph proposes the 60-mil HDPE liner will be placed in direct contact with moist cohesive soil liner. What about the condition of the alternate liners (18-in-thick CCL and GCL)? Please clarify.

40. (Section 4.2.4 – Preparation for Geomembrane Deployment, Paragraph (c) - Verification) The CQA testing properties and frequencies are inconsistent. The Paragraph (c) (the third sentence) proposes to conduct CQA testing in accordance with Table 2(a) of GM13-9 of 12 for each roll delivered to the site. Later, this paragraph (the last sentence) proposes to conduct testing on limited properties for one (1) roll out of four delivered to the site. Please clarify.

41. (Sections 4.2.4, 4.2.11, & 6.4 – Paragraphs 2(b) & 3(d) Weather Conditions) Please specify the allowable ranges of ambient temperatures when the FML panels are deployed and seamed.

42. (Section 4.2.4 (2) – Field Panel Placement) Please address the following concerns:
   i. Specify deployment and installation of the FML panels follow the manufacturer's recommendations and sound and accepted engineering practices.
   ii. When is the time for panel placement? For example, as practical as possible, the FML panel shall be placed over the constructed CCL (Alternate 1) or GCL (Alternate 2) after the Engineer inspected and accepted in writing (certification).
   iii. What is the provision for preventing FML from exposure of unexpected unfavorable environment? For example, unroll only those sections which will be anchored, seamed, and covered in one day.

43. (Section 4.2.4 (3) – Field Seaming) Please provide the drawings to show typical details of the FML panel seam processes – fusion welding and extrusion fillet welding.

44. (Sections 4.2.4 (4), 4.2.11(4), & 6.4(4) – Seam Preparation) Please specify that application of any solvent for cleaning /preparing the seam surface is prohibited.

45. (Sections 4.2.4 (5), 4.2.11(5), & 6.4(5) –Test Seam) Please address the following concerns:
   i. When and how the tensiometer will be calibrated?
   ii. Will there be a stand-by calibrated tensiometer on site while seaming is performing?
   iii. Will the samples (coupons) of test seam be tested in shear as well by a calibrated tensiometer?
   iv. What is the constant separation rate (inch per minute) of the tensiometer while testing?
   v. What are passing/failure criteria for peel and shear testing?

46. (Sections 4.2.4, 4.2.5, 4.2.11, 4.2.12, 6.4, & 6.5) Are there reasons why the ASTM methods – D6392-08 or GRI-GM 19 are not adopted for the destructive seam testing? The ASTM D4437-08 is not applicable to destructive testing according to the scope of the test method. Please clarify.

47. (Sections 4.2.4 (6), 4.2.11(6), & 6.4(6) – General Seaming Procedures) Please address the following concerns:
   i. Specify seaming procedures at locations of sumps and pipe (leachate collection piping or landfill gas vent piping) penetrations and provide the drawings to show typical details of seaming at above-mentioned locations.
   ii. What practices are there to be executed for eliminating cutting and patching of large winkles that become trapped?
   iii. If needed, what tack welds will be used while seaming panels?

iv. What provisions are there to manage/ protect unseamed edges at the end of each working day from unfavorable environment?
v. What provisions are there to manage/ protect the subgrade (CCL and or GCL) of FML from surface water run off and excessive moist?
vi. What provisions are there to dictate the timing/schedule to backfill anchor trenches after the FML panels are installed and seamed?

48. (Sections 4.2.5(a)(3), 4.2.12(a)(3), & 6.5(3)) The specified procedures that must be followed in the event of a non-complying air pressure test are inconsistent between Sections 4.2.5, 4.2.11, and Section 6.5. The detail and completed procedures stated in Section 6.5(3) shall be followed. Please revise the specifications in Sections 4.2.5(a)(3) and 4.2.12(a)(3) accordingly.

49. (Sections 4.2.5 (c)) Please specify the constant separation rate (inch per minute) of the testing machine to determine if the HDPE seam samples pass or fail the specified strength criteria.

50. (Sections 4.2.5 (d) & 4.2.12 (d)) Please specify the pass/fail criteria including assessment of the test results for the destructive seam testing conducted in a third party laboratory. The reviewer does not believe the proposed approach in this Paragraph (d)(1) is sufficient and adequate enough to assure the quality of the constructed landfill base and cover liner systems based on the research results and evolving waste industrial standards. Therefore, the specification - GRI-GM 19 is recommended. The pass/fail criteria stated in the specification has recently been approved for use in the other landfills in the State of North Carolina.

51. (Section 4.2.5 (d)(2)) The Paragraph (c) must address the repair procedures pertaining to the FML underlain by the alternate liner # 2 (CCL and GCL) conditions. Please clarify.

52. If unexpected reasons should HDPE liners be exposed or buried for extended periods of time, prior to their joining to their joining to adjacent, subsequent panels, what provisions are there to protect leading edge of HDPE liners from machinery/equipment operation, construction activities, and weather (UV)? Please clarify.

53. Specify the approaches and documentations associated with constructed HDPE liner acceptance.

54. Please address the following concerns for construction and backfilling anchor trenches:
    i. Specify the earthen material (type & maximum grain size, etc.) and the minimum compaction effort (by ASTM D698) for the compacted backfill in the anchor trenches.
    ii. Specify field QC testing methods and frequencies on the compacted backfill in the anchor trenches.
    iii. Provisions to prevent standing water or softening of the adjacent soils while the trench is open.
    iv. Provisions to protect base liner system components from trench backfilling.
    v. Specify the construction sequences/ schedules for backfilling anchor trenches and the installation of base liner system components [compacted clay liner, geosynthetic clay liner, geomembrane (HDPE liner), and geocomposite].

55. (Section 4.2.6) Please specify the schedule for installing protective cover and LCS after the installation HDPE liner has been completed and acceptance of HDPE liner has been granted.

56. (Section 4.2.6 – Select Backfill, Page 196) The specification requires the select backfill containing no particles or objects greater than ¾ inches in largest dimension, which has been screened. Please provide the specification of earthen material screening processes, if the on-site borrow pit is used. If select backfill will be obtained from off-site borrows, the sieve analysis report from the borrow pit or the quarry must be submitted to Engineer for approval prior to use. The report shall be a portion of the CQA report. Please clarify.

57. (Section 4.2.6, Page 196) To avoid any confusion, please specify the locations to use selected backfill and backfill and incorporate the specified locations on Drawing E8/Sheet 10 of 15 – cohesive soil liner details.

58. (Sections 4.2.6, 4.2.13, & 6.6 - Geocomposite Property Table) please address the following concerns:

    i. Please provide the product trade name of the geocomposite material manufactured by SKAPS industries.
    ii. Please specify the geocomposite testing frequencies.
    iii. The testing of transmissivity of the geocomposite material, testing conditions (vertical loadings, hydraulic gradients, hydration times, and boundary conditions must closely simulate the field conditions and consider long-term performance requirements for both base liner and final cover systems. Please explain how the specified testing conditions (in Note 1) are selected.

59. (Sections 4.2.6, 4.2.13, & 6.6) Please provide specifications for the HDPE geocomposite drainage material including, but not limited to:
    i. Product descriptions, dimensions per roll, label and packing and delivery.
    ii. Product manufacturer specification and confirmation testing results (including testing properties, methods and frequencies).
    iii. Product on-site inspection and acceptance/rejection.
    iv. Product on-site shipping, handling, and storage.

60. (Sections 4.2.6, 4.2.13, & 6.6) Please specify that the patch to be used for repairing the damaged geocomposite must be the same type material of the selected geocomposite.

61. (Section 4.2.6 – Protective Soil Cover) Please address the following concerns:

    i. What is the thickness of the completed erosive layer and how to verify/confirm the final thickness? Please clarify.
    ii. What provisions are there to repair the damaged base liner components – geocomposite, geomembrane, GCL, CCL during the course of constructing 3-feet-thick protective soil cover? Please clarify.

62. (Section 4.2.7) Please provide product data sheet for all HDPE piping including lateral piping, header piping, sump, and risers consistent with the submitted drawings.

63. (Section 4.2.7, Paragraph (2)) Please address the following concerns:
    i. Define “no fines.” Will this mean no stone in any batches have a size less than 1 inch (NC DOT # 5 stone has a size range 1 to 1.5 inches) based on the sieve analysis results? Please clarify.
    ii. The stone size described in Section 4.2.7(2) - NC DOT # 5 is inconsistent with the one - NC DOT # 57 or # 5 (shown on Drawing E9/Sheet 11 of 15 (Details of Typical Sump & Riser Section). Please clarify and make necessary correction.
    iii. Specify the test method and frequency for the proposing sieve analysis test. The test results must be a portion of the CQA report.
    iv. Specify that the stone for encasing leachate pipe shall be a clean washed hard non-carbonaceous mineral (e.g. quartz) which must be chemical compatible with leachate, and the maximum acceptable concentration of calcium carbonate for the stone/rock aggregate per ASTM D4373.
    v. Specify the hydraulic conductivity of the granular material - NC DOT # 5 stone and QA/QC testing protocols (methods and frequencies).

64. (Section 4.2.7) Please identify the locations of gate valves and manholes with invert elevations on the Drawings E7/Sheet 9 of 15 and P1/Sheet 3 of 11.

65. (Section 4.2.7) Please address the following concerns with the Paragraph (6) - leachate collection trenches:
    i. Provide at least two (2) bench marks on the Drawing E7/Sheet 9 of 15.
    ii. Specify the QC testing requirements (methods and frequencies) for the repaired base liner components (CCL, GCL, or FML) or geocomposite drainage nets which are damaged by construction of leachate collection trenches.
    iii. Specify the dimensions of the constructed trench.
    iv. Provisions to prevent standing water or softening of the adjacent soils while the trench is open.

66. (Section 4.2.7 – Paragraphs (3) &(7)) Has the selected geotextile been properly designed for filtration to prevent the stone and leachate piping from clogging by fine particles inside the 3-feet-thick earthen protective layer? Please clarify.

67. (Section 4.2.7) Please provide specifications procedures for installing the leachate piping and backfilling leachate collection trenches and sump construction in consistent with Drawing E9/Sheet 11 of 15.

68. (Section 4.2.7) The specification must include:
    i. The final as-built drawings that are prepared, signed and sealed by a Land Surveyor registered in the State of North Carolina confirm that the thickness of the fill material and the invert elevations, lengths, and slopes of the piping required by the plan, drawings and specifications is actually in place.
    ii. The certification signed by Engineer confirms that the material (properties and dimensions) and construction required by the plan, drawings, and specifications are actually in place.
    iii. The as-built drawings and certification must be appended to the CQA report.

69. (Section 4.2.8) The specification requires installation HDPE containment force main in conformance with ASTM D2321, but the trench details shown on Drawing E8 / Sheet 10 of 15 are not consistent with the requirements specified in ASTM D2321. Please clarify and make necessary corrections.

70. (Section 4.2.8) The Paragraph (3) must specify the methods of testing (e.g. ASTM D2837), applied constant pressures (e.g. 1,600 psi for cell classification 335434C as referenced in ASTM D3350), and testing protocols.

71. (Sections 4.2.10 & 6.3) Please address the following concerns:
    i. Are there specifications to ensure that the 12-inch intermediate soil cover is well prepared and constructed prior to install a compacted clay liner? Additionally, to verify the thickness of the soil clay liner, a baseline survey at 50-ft grid points on top surface of constructed intermediate soil cover must be specified.
    ii. In the Paragraph (d) (on pages 201 & 252) the referenced testing methods for moisture & density testing – ASTM D2488 is incorrect. Please specify the correct testing method ASTM D2487.
    iii. In the Paragraph (g), the effective confine pressure and hydraulic gradient for the ASTM D5084 must be specified. The specified values shall be representative of field conditions.
    iv. In the Paragraph (l), please provide the bentonite and soil mixture procedures.
    v. In the Paragraph (o), the proposed method that is verifying and confirming the thickness of the in-place soil clay liner by surveying at 100-ft grid points over the final cover is inconsistent with the approach depicted in Section 3.10.1 – survey at 50-ft grid points, which is consistent with specifications for baseliner components. Please clarify.

72. (Sections 4.2.11 & 6.4) Please address the following concerns:
    i. Please specify the surface characteristics (smooth, single-sided or double-sided textured) of the LLDPE geomembrane which shall be consistent with the details shown on Drawing E12/Sheet 14 of 15.

ii. The specified properties of the 40-mil LLDPE are not matching those in the standard specification of GRI test Method GM17 (revision 6, dated June 1, 2009). If the intention is using GM17 to specify the LLDPE product properties, please use the current one; otherwise, it is advisable for Lenoir County to ensure that the specified LLDPE products are available in the market.
iii. In Paragraph 1(c) – Verification, what are the QA/QC testing protocols (methods, frequencies, passing criteria, etc)? Please clarify.

73. (Sections 4.2.11(2) & 6.4(2) t) Please address the following concerns:
   i. Specify deployment and installation of the FML panels follow the manufacturer's recommendations and sound and accepted engineering practices.
   ii. When is the time for panel placement?
   iii. What is the provision for preventing FML from exposure of unexpected unfavorable environment? For example, unroll only those sections which will be anchored, seamed, and covered in one day.

74. (Section 4.2.12) Please address the following concerns:
   i. Specify the constant separation rate (inch per minute) of the testing machine to determine if the LLDPE seam samples pass or fail the specified strength criteria in Paragraph (c).
   ii. If unexpected reasons should LLDPE liners be exposed or buried for extended periods of time, prior to their joining to their joining to adjacent, subsequent panels, what provisions are there to protect leading edge of LLDPE liners from machinery/ equipment operation, construction activities, and weather (UV)? Please clarify.
   iii. Specify the approaches and documentations associated with deployed LLDPE liner acceptance.

75. (Sections 4.2.13 & 6.6) Please specify the CQA material confirmation testing requirements including test methods and frequencies by a third party laboratory.

76. (Sections 4.2.13(2) & 6.6(2)) Please address the following concerns:
   i. Provide the filter design data to meet soil retention criteria, soil flow criteria, and soil clogging criteria (including calculation processes, assumptions, and theories, and references) between the erosive layer and the double bonded HDPE drainage net overlaid 40-mil LLDPE geomembrane.
   ii. Should the earthen material used for constructing erosive layer be selected according to the specified long-term performance of geocomposite drainage net (see Comment No. 27)? Please specify testing methods, frequencies, and selection criteria on earthen material from on-site stockpiles and borrow pits.
   iii. What is the thickness of the completed erosive layer?
   iv. Please specify methods or approaches to verify and confirm the thickness of the completed erosive layer.
   v. What provisions are there to repair the damaged base liner components – geocomposite, geomembrane, GCL, CCL during the course of constructing 3-feet-thick protective soil cover? Please clarify.

77. (Sections 4.2.14(1) & 6.7(1)) The Sections specify that NC DOT No. 5 stone will be used in the construction of gas venting system, but #57 stone is shown in the trench details on Drawings P9/Sheet 11 of 11 and E12/Sheet 14 of 15. Please clarify.

78. Please address the following concerns for construction and backfilling anchor trenches:
   i. Specify the earthen material (type & maximum grain size, etc.) and the minimum compaction effort (by ASTM D698) for the compacted backfill in the anchor trenches.
   ii. Specify field QC testing methods and frequencies on the compacted backfill in the anchor trenches.
   iii. Provisions to prevent standing water or softening of the adjacent soils while the trench is open.

iv. Provisions to protect base liner system components from trench backfilling.
v. Specify the construction sequences/ schedules for backfilling anchor trenches and the installation of final cover system components [compacted clay liner, geomembrane (LLDPE liner), and geocomposite].

79. The granular material proposed to be filled into landfill gas collection trench is not consistent - # 5 stone (in Sections 4.2.14 & 6.7) vs. # 57 stone (on Drawing E12/Sheet 14 of 15). Please clarify and made necessary correction.

80. (Section 4.3) In addition to the components of the CQA Report mentioned in this section, the following components, but not limited to, need to be included the report:
i. All parties (name & contact information) involved the landfill construction and their duties and services.
ii. All QA/QC data (including landfill gas vent system), as-built drawings certified by a surveyor registered in North Carolina pertaining to construction of final cover system.
iii. Completed and signed meetings (pre-construction, progress, and trouble-shooting) minutes
iv. Hydrostatic testing report for non-perforate leachate collection piping.
v. Daily and monthly reports summarized the construction activities and signed by Engineer.
vi. A series of color photographs of major project features.

Section 5.0 Operations Plan

81. (Section 5.1, 3rd Paragraph, on Page 221) Please describe the information (type, capacity, and performance specifications) of the pumps to be routinely used for removing leachate from the sumps to the lagoon and the high-flow pump to remove leachate form a storm surge event. The data for sizing the pump must be consistent with the ones in the Engineering Plan (see Comment No. 21) and Drawing No. E9 / Sheet 11 of 15. How many pumps will be available and functional at the facility? Is the pump stationed or potable (roller-mounted) one? Is there a stand-by pump for emergency or downtime?

82. (Section 5.1, Section 5.2.11.f. & Section 5.6) The Solid Waste Section will not approve the proposed Recirculation Plan because the proposed composite base liner system and the leachate collection system for Phase 2 development and operation do not meet those requirements stated in the Leachate Recirculation Guidance (Guidance), which can downloaded from the web site: http://wastenotnc.org/swhome/lrcg.html. Additionally, the DWM's records indicated that Lenoir County has not submitted the Solid Waste Section a final report on the pilot leachate recirculation project at Phase 1 area for a review and approval. However, if Lenoir County intends to recirculate the on-site leachate as a permanent leachate management tool, please revise the HELP MODEL, the base liner and the leachate collection systems and submit a pilot study plan in accordance with the Guidance. Otherwise, please remove the Section 5.6 and leachate recirculation proposal throughout the PTC application.

83. (Section 5.1, 7th Paragraph, on Page 221) Please add the thickness, at least 6 inches, of the daily soil cover to this paragraph.

84. (Section 5.1, 7th Paragraph, on Page 221 & Section 5.4 – Appendix II) Has this proposing alternative daily cover - synthetic cover been approved by DWM to use at Phase 1 area? If so, please provide the DWM approve letter appended to the Appendix II.

85. (Section 5.1, 7th Paragraph, on Page 221 & Section 5.4 – Appendix II) If this synthetic material is proposed to be used as an alternative daily cover (ADC), please revise Section 5.4 by adding the following minimum requirements:
i. The manufacturer's specifications – material (engineering properties, dimensions, and characteristics) and installation.

ii. The synthetic material must be biodegradable; otherwise, Lenoir County must demonstrate this ADC will not impede leachate downward percolation to the constructed LCS and not enhance the lateral seepage occurring on the side slopes.
iii. Proposal for a 90-day trial schedule and notification requirements.
iv. Demonstration Report: Statements in detail of how this ADC application complies with Rule .1626(2)(b) and any other pertaining information including, but not limited to manufacturer's specifications for the selected ADC, final employment approaches, and photos – employment, in-placed (with anchors/weights) and removal of ADC.

After inspection, the Solid Waste Section may approve Lenoir County to use this ADC according to the approved Demonstration Report for the Lenoir County MSWLF, Solid Waste Permit Number 54-09. Should another types / kinds of ADCs be used at this landfill, prior to employment, a request for permit modification – updated Operations Plan must be submitted by Lenoir County to DWM for a review and approval. Application for a permit modification must be prepared in accordance with applicable statutes and rules in effect on that date and will be subject to a permitting fee

86. (Section 5.1, 6th Paragraph, on Page 222) It is likely the reference of Section 5.3 for groundwater and surface water monitoring frequency is incorrect. Please provide the correct reference.

87. (Section 5.2.4 - Explosive Gases Control, on Page 225) Please address the following concerns:

i. Provide the tentative schedules for the completion of installation of the proposed methane monitoring probes and for conducting the first round quarterly methane gas sampling.
ii. Please add the following minimum requirements of the written report (signed, sealed, and dated by a Professional Engineer or Professional Geologist registered in the State of North Carolina) to this section after the installation of the proposed methane monitoring probes is completed. The report includes, but not limited to (a) a scaled as-built drawing depicting the locations of the gas probes which are surveyed by surveyors register in the State of North Carolina; (b) well construction records (completed GW-1 form), well & boring logs, groundwater tables, and descriptions of any deviations from the original plan; and (c) the report will also describe the schedules (the firm date) for the first methane gas sampling event and the follow-up quarterly sampling events.

88. (Section 5.2.5) Please add the following sentence to the end of the Paragraph b. – "In addition, the Division of Air Quality and local fire department must approve the activity prior to burning."

89. (Section 5.2.11) The Paragraph a. proposes that "the initial lift of solid waste will be placed over cell 1 that … ditch." There is no descriptions of Phase 2 will be divided by cells in the Facility Plan, please clarify. If this is a practice of stormwater and leachate control for active and inactive cells as shown Drawing No. P3/ Sheet No. 5 of 11to pursuant Rule .1625(b)(1)(D), please make detail description in this Section.

90. (Section 5.2.12) Please address the following concerns:

i. Please add record keeping requirement to the Paragraphs b and c.
ii. Please add the following paragraph to this Section:
The leachate collection system must be maintained in accordance with 15A NCAC 13B .1626(12)(a). For any cell(s) constructed utilizing on-site native soil as protective cover, the leachate collection lines shall be cleaned at least once per year and a remote camera inspection completed once every five (5) years. The Division may consider reduction in frequency for cleaning and inspection, upon written request from the Facility, after the first five years, pending the documented results of the cleaning and remote camera inspection.

iii. To facilitate the leachate line cleaning and inspection, the Solid Waste Section strongly recommends that the cleanouts be installed at both ends of the 8-inch header pipes and one end of the 6-inch lateral pipes, tee to the 8-inch header pipes and extended to the areas outside the waste footprints. The smooth bends (cleanout riser bends and all drain bends) must be provided for easy access by the conventional water jet equipment and video camera (with push rods), which are normally able to reach 500 feet inside the pipe from one end of the pipe. To do so, in the event that obstruction is encountered inside a line, the high-pressure jetting equipment can easily reach the blocks from both cleanouts at either ends of the pipe; and the video camera can provide the causes of blockage. If Lenoir County agrees the above-mentioned recommendations, please revise this Leachate Management Plan and Drawings No. E7/ Sheet 9 of 15 & P2/Sheet 4 of 11 accordingly.

iv. What provisions are there to address the sump maintenance and the prevention and cleanup of potential accumulation of the fines in the sump for the normal operation periods and during the courses of maintaining leachate collection piping? Please clarify.

91. (Section 5.4 – Appendix II – Synthetic Cover Operation Plan)

i. What are dimensions for each roll of the synthetic cover?

ii. What are the proposing overlap lengths (sides & ends)?

iii. If tires are used as anchors to weight down the ADC panels, what provisions are there pertaining to tire storage (tire is prohibited from landfill).

92. (Section 5.5 – Appendix III – Explosive Gas Control Plan) The Solid Waste Section suggests that at some locations two probes (one shallow and one deeper) clustered in one boring is required. Shallow probe will be installed at a depth of 6-feet below the grade; the deeper one will be installed above the groundwater table. Because wastes will be disposed of in the cell of Phase 2 at the elevations several feet below the proposed 6-feet well depth. The boring logs indicate the subgrade of Phase 2 is overlain a clayey and silty sand formation. If the preferential paths for landfill gas migration exist in this formation, the shallow-depth probes may not detect the landfill gas migration. Additionally, the Gas Control Plan concludes that “the various depths of the monitoring probes are to ensure a stable monitoring point. Therefore, if Lenoir County agrees with the aforementioned recommendation, please revise the Gas Control Plan accordingly.

93. (Section 5.5 – Appendix III – Explosive Gas Control Plan) This section reports there are four (4) existing gas monitoring probes installed at this landfill, but the existing probes are not shown on the drawings. Please add the locations of existing methane monitoring probes surrounding Phase 1 to the Drawing F-1/Sheet 3 of 10 & Drawing P8/Sheet 10 of 11.

94. (Section 5.6) Please address the following concerns:

i. Provide the approval document to demonstrate that Kinston Wastewater Treatment Plan accepts leachate generated from Lenoir County MSWLF for disposal.

ii. Provide the locations and details of the leachate head detection wells on the drawing (s) which needs to be referenced to this section.

<u>Section 6 Closure Plan</u>

95. (Section 6.1, the 3rd paragraph on Page 250) In this Phase 2 PTC application, the estimated maximum inventory of wastes ever on-site over the active life needs to include the maximum in-placed wastes from both Phases 1 and 2 areas; and the estimated maximum inventory of wastes will be likely more than the reported volume of 511,000 cubic yards. Please clarify.

<u>Section 7 Post-Closure Plan</u>

96. (Section 7.1 – Description of Maintenance Activities on page 269) Please address maintenance and repair requirements pertaining to:

i. Facility security (fencing, gates, and signage),

ii. Roads access to monitoring points,
iii. Components of the on-site monitoring networks (groundwater monitoring wells and landfill gas vents & probes),
iv. Silt up sediment basins and surface drainage features,
v. Leachate seepages and outbreaks,
vi. Fertilization and mow of vegetations and removal of tree saplings.
vii. Protection the permanent benchmarks for waste boundaries.
viii. What provisions are there to repair (may including QA/QC testing if liners are damaged) the reported damaged cap system due to settlement, erosion, animal burrows, etc?
ix. Please provide the references of the monitoring plans for water quality monitoring and landfill gas monitoring programs.

97. (Section 7.1) Maintenance and operation of any leachate collection system must be described in detail in the post-closure plan. This should provide for frequency of monitoring, operating, cleaning of collection lines or other maintenance, and testing of leachate. The post-closure plan should also describe pump maintenance, pump repair and replacement, leachate lagoon repair and maintenance, and leachate removal and treatment, if applicable. If a change in frequency of any activities is planned during the post-closure period, a description of the method used to determine the necessity or feasibility of the change must be described in the plan. Please revise the plan accordingly.

98. (Section 7.1) The Post-Closure Plan must to describe the closure requirements of the on-site leachate lagoon. The lagoon closure plan must be submitted to the Division for a review and approval prior to commencing closure activities. The costs associated with the closure activities and closure certification report must be added to the post-closure care cost estimates. Please revise the Post-Closure Plan and cost estimates accordingly.

99. Please address the recording keeping requirements for inspection, repair, and maintenance activities during the 30-year post-closure care periods. All documents must be placed in the facility operating records in accordance with Rule .1626(10).

100. (Section 7.2) The cost estimates need to add the costs associated with items (roads, fencing, signage, mowing & fertilization of vegetation, maintaining erosion control devices and stormwater / surface drainage systems, etc.) mentioned in Comment No. 96 and costs related to administration/ record keeping and the certification report. Please revise the cost estimates accordingly.

<u>Drawings</u>

101. (Drawing F-1/Sheet 3 of 10) Please add the following features to the drawing in accordance with Rule .1619(d):
   i. Monitoring locations for Phase 1 including methane monitoring probe locations (MP-01 through MP-14), a surface water sample location (SW-3), and a leachate sample locations (Lagoon).
   ii. Scale house, sediment basins & traps, and soil borrow site on the north / northeast side of Phase 1.
   iii. Existing leachate collection and storage system for Phase 1 operation (Rule .1619(d)(3).
   iv. The street/ road name (Hodges Farm Road?) to the site entrance.

102. (Drawings F-1/Sheet 3 of 10 & P8/Sheet 10 of 11) Please add the locations (with identifications) of existing methane monitoring probes surrounding Phase 1.

103. (Drawing E7 / Sheet 9 of 15) Please address the following concerns:
   i. Provide the trench details for the dual containment force main (4-inch carrier by 8-inch containment).
   ii. The 16 oz/sy non-woven geotextile enclosing the sump area is shown on this drawing. What provisions are there to prevent the long-term performance of the geotextile from biological clogging?

104. (Drawing E8/Sheet 10 of 15) Please address the following concerns:
   i. Add the GCL layer to the anchor trench detail and indicate this layer is required for Alternate Base Liner System.
   ii. Add the liners tie-in details of connecting Phase 1 and Phase 2 baseliner systems (see Comment 34).

105. (Drawings No. E12/Sheet 14 of 15 & P9/Sheet 11 of 11) Please address the following concerns:
   i. According the descriptions of the final cover system in Section 2.1.6, the proposed 40-mil <u>*HDPE*</u> FML is likely a typographic error of 40-mil LLDPE FML. Please make necessary correction.
   ii. Correct the inconsistent stone sizes (#57 vs. #5) to be used in the trench.
   iii. Provide details of the properly connection between the geosynthetic liners to the gas vent casing (seal "boots" around the vent pipe) to prevent the final cover system from surface water intrusion/penetration.
   iv. Please add anchor trench detail to the figure consistent with the Sections 3.10.

106. (Drawing P8/Sheet 10 of 11) Please add the identification numbers next to the proposed methane monitoring probes.

107. (Drawing P9/Sheet 11 of 11) The hydraulic conductivity value of the 18-inch thick compacted clay cover is missing. Please make necessary correction.

Lenoir County needs to provide the Solid Waste Section a new submittal (including a written hard copy and an electronic copy) which incorporates requested information, document, revisions, and responses. These comments are intended to expedite the review of the referenced application, and in no way do they restrict the Solid Waste Section's right to request additional information during the technical review process.

The Solid Waste Section appreciates your efforts and cooperation in this matter. If you have any questions or would like to schedule a meeting to discuss this matter further, please contact me at (919) 508- 8507.

Sincerely,

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section

cc:
Wayne Sullivan, MESCO
Donna Wilson, DWM
Dennis Shackelford, DWM
Central File
Ed Mussler, Permitting Branch Supervisor
Christine Ritter, DWM
Wes Hare, DWM

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

February 8, 2010

Mr. Tom Miller
Solid Waste Director
P.O. Box 3289
130 S. Queen Street
Kinston, North Carolina 28501

Re: Technical Review Letter
Design Hydrogeologic Report
Lenoir County MSW Landfill, Phase 2
LaGrange, Lenoir County, North Carolina
Permit No. 54-09, Document ID No. 9564

Dear Mr. Miller:

The North Carolina Solid Waste Section has completed a technical review of the November 2009 Hydrogeologic Study of the Lenoir County MSW Landfill Phase 2 expansion. The Section engineer will send comments on the Permit to Construct under separate cover. Comments on the Design Hydrogeologic Study are as follows:

Wetlands

The April 29, 2002 wetlands determination issued by The U.S. Army Corps of Engineers for the Lenoir County Landfill has expired. The determination states "any changes in the described work resulting in impacts to jurisdictional waters or wetlands or any new work in jurisdictional waters or wetlands outside the area described must be coordinated with Corps of Engineers prior to commencement." Please provide information regarding the impact of landfill expansion activity on the wetlands located at the facility and include an updated wetland determination if necessary.

Section 1.2.1 Drainage

This section includes a statement that "At the landfill facility, surface drainage flows northwesterly towards Fredricks Branch, which flows northeasterly into Falling Creek and subsequently into the Neuse River." There are no maps depicting locations of these drainage features at the landfill facility. Please submit maps illustrating the location of these drainage features in relationship to the landfill property and include discussion regarding influence of these drainage features on surface water and groundwater flow at the site.

Section 6 Groundwater Quality Monitoring System

In order to detect the effects of the facility on surface water in the area, surface water samples need to be collected in upgradient and downgradient locations. The single proposed surface water sampling point, SW-3, located in the wetland area in the eastern corner of the property, is insufficient to determine surface water quality across the entire landfill area. Please identify additional surface water sampling locations to accurately depict surface water quality across the site.

A Water Quality Monitoring Plan must be submitted which satisfies the rule requirements of 15A NCAC 13B .1623 (b)(3). The Groundwater and Surface Water Sampling and Analysis Plan discussed in this section and included as Appendix E of the Design Hydrogeological Report needs to be updated to adhere to the Solid Waste Section Guidelines for Groundwater, Soil and Surface Water Sampling located at http://www.wastenotnc.org/swhome/EnvMonitoring/SolidWasteSamplingGuidance. This guidance document has been updated in the period of time since the last permit was issued for this site.

If you have any questions, you may contact me at (919)508-8506.

Sincerely,

Christine Ritter

Christine Ritter
Hydrogeologist
Solid Waste Section

Cc: Mark Brown, Municipal Engineering Services Company
Ming-Tai Chao, DWM
Ed Mussler, DWM
Wes Hare, DWM

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management

Beverly Eaves Perdue Governor	Dexter R. Matthews Director	Dee Freeman Secretary

Solid Waste Section

December 23, 2009

Mr. Tom Miller
Solid Waste Director
P.O. Box 3289
130 S. Queen Street
Kinston, North Carolina 28501

Re: Determination of Completeness Review of Permit to Construct (PTC) Application – Phase 2
Lenoir County Municipal Solid Waste Landfill (MSWLF), Lenoir County, North Carolina
Permit No. 54-09, Document ID No. (Doc ID) 9094

Dear Mr. Miller:

On December 1, 2009, the Division of Waste Management (DWM), Solid Waste Section received the PTC application for Phase 2 construction at the above-referenced MSWLF. Municipal Engineering Services Co., Inc. (MESCO) on your behalf submitted the PTC application documents which include:

- *Permit to Construct, Lenoir County Municipal Solid Waste Landfill Facility, Phase 2.* Prepared by MESCO in Garner, North Carolina, dated November 2009 (Doc ID 8970).
- *Design Hydrogeologic Study prepared for Lenoir County Subtitle D Landfill, Phase 2.* Prepared by MESCO in Garner, North Carolina, dated November 30, 2009 (Doc ID 8977).

The DWM has performed an administrative review of the above-referenced application document and determined that it is substantially complete in accordance NCGS 295.8(e). A determination of completeness means that the application includes required components, but does not mean that the components provide all the technical information that is required for the division to make a decision on the application. A technical review of your application by the Solid Waste Section will be forthcoming.

If you have any permitting questions, please contact myself at (919) 508- 8507.

Sincerely,

Ming-Tai Chao, P.E. Environmental Engineer II Permitting Branch, Solid Waste Section	Christine Ritter Hydrogeologist Permitting Branch, Solid Waste Section

cc:

Wayne Sullivan, MESCO	Ed Mussler, Permitting Branch Supervisor
Donna Wilson, DWM	Dennis Shackelford, DWM
Wes Hare, DWM	Central File

TABLE OF CONTENTS

SECTION 1.0

FACILITY PLAN

Background

The County currently owns and operates a Subtitle D Sanitary Landfill (Permit No. 5409-MSWLF), a Construction/Demolition and Land Clearing/Inert Debris Landfills and obtaining a permit renewal for the transfer station, located approximately 9 miles northwest of Kinston, North Carolina. All facilities are located on the Owner's property. The new Phase is adjacent to the existing Phase 1. Access to the landfill will be the same as is presently being used. Waste currently received in the existing Phase will be disposed of in the new Phase.

General

The Facility can only accept Municipal Solid Wastes within the County, which includes but is not limited to Household, Industrial, Construction/Demolition and Animal waste. The Facility will not accept any Hazardous or PCB wastes. Tires and White Goods will continue to be processed at the Transfer Station.

The Facility will consist of six (6) phases of development. The first phase already exists, leaving five (5) phases to be built in the future. Phase 2 is adjacent to existing Phase 1 and is approximately 9.23 acres in size. Phase 3 is adjacent to phases 1 and 2 and is approximately 14.43 acres in size. Phases 4 through 5 will be vertical expansions over Phases 1 through 3. Phase 6 will be the stand alone cell that was originally called Phase 4, which is approximately 3.92 acres.

The land use around the proposed facility is mostly agricultural with some rural subdivisions located within two (2) miles of the facility. The landfill will not have any adverse impact on the residents of the County since the proposed landfill is located adjacent to the existing landfill.

1.1 Waste Stream

1.1.1 Waste Types

The Facility will accept Municipal Solid Waste: any solid waste resulting from the operation of residential, commercial, industrial, governmental, or institutional establishments that would normally be collected, processed, and disposed of through a public or private solid waste management service is considered Municipal Solid Waste.

Construction/Demolition waste will continue to be disposed of in the existing Construction/Demolition Landfill. Land Clearing and Inert Debris waste will be disposed at the Land Clearing/Inert Debris Landfill.

Spoiled foods, animal carcasses, abattoir waste, hatchery waste, and other animal waste will be accepted, and covered immediately upon dumping.

Asbestos waste will be accepted and managed in accordance with 40 CFR 61. The waste will be covered immediately with soil in a manner that will not cause airborne conditions and must be disposed of separate and apart from other solid wastes:

i. At the bottom of the working face or;
ii. In an area not contiguous with other disposal areas. Separate areas will be clearly designated so that asbestos is not exposed by future land disturbing activities.

Wastewater treatment sludges must pass the paint filter test and the TCLP test before they may be accepted and co-disposed in the lined area. Hazardous waste as defined within 15A NCAC 13A, to also include hazardous waste from conditional exempt small quantity generators, Polychlorinated biphenyls (PCB) waste as defined in 40 CFR 761 are prohibited.

1.1.2 Disposal Rates

The Facility is open 5.5 days per week. The tonnage per day was approximately 177 tons in the Fiscal year 2007-2008. The life of the Facility will depend on disposal rates and compaction, which can vary throughout the life of the Facility. This variance can either increase or decrease the life of the Facility.

1.1.3 Service Area

The Facility will accept only waste from Lenoir County.

1.1.4 Waste Segregation

The Facility will segregate Municipal Solid Waste, Construction/Demolition Waste, Land Clearing/Inert Debris, Yard Waste, Recyclables, White Goods, and Tires. The Facility will use the current access route from the existing Sanitary Landfill; and the attendant at the existing scale house will direct incoming wastes to their appropriate areas. An attendant is on site to direct segregation of waste during the hours of operation of 8am-5pm, Monday through Friday and 8am-12pm on Saturday. Waste segregation will continue to occur at the existing facility, with MSW being the only type of waste being disposed in the new MSWLF units.

1.1.5 Equipment Requirements

The Facility has and uses the following equipment:

1. Compactor
2. Front-end Loaders
3. Pans
4. Dozers
5. Backhoe

1.2 Landfill Capacity

The Life Expectancy calculations were calculated for Phases 2-6 of development with a vertical expansion being included when a Phase is constructed adjacent to the previous Phase. Each successive phase will vary in size due to being able to expand onto the previously filled areas. The Operation Plan of the Engineering Report will delineate this more clearly. Each individual Phase volume is estimated. The airspace is a net volume excluding the capping requirements. The facility has a permitted total capacity of 3,096,592 cubic yards.

LIFE EXPECTANCY CALCULATIONS PHASES 2-6

Given:

Life expectancy based on actual air space used in Annual Report Fiscal Year 08-09 is as follows:

Life expectancy based on using the annual average of 110,200 cubic yards/year, for the first year and an annual increase of 0.41% for each year thereafter.

Phases	Airspace Available	Years of Life
Phase 2	= 564,066 cubic yards	= 5.12 years
Phase 3	= 578,003 cubic yards	= 5.14 years
Phase 4	= 588,208 cubic yards	= 5.12 years
Phase 5	= 398,958 cubic yards	= 3.40 years
Phase 6	= 148,936 cubic yards	= 1.22 years
	2,278,171 cubic yards	20.03 years

Soil requirements for construction, daily cover and final caps for Phases 2-6
(Assume an 8:1 Trash to soil ratio)

Soil needed for Construction	= 222,479 cubic yards
Soil needed for Daily Cover	= 253,131 cubic yards
Soil needed for Closure	= 307,421 cubic yards
Overall Soil Requirements	= 560,552 cubic yards (soil needed for closure and daily cover)

There is no excess soil available on site. The County also owns property which it will utilize for borrow material as needed. There should be enough borrow material available to complete the landfill. If the need arises the County will purchase additional land to borrow from.

The estimate of the maximum inventory of wastes ever on-site, over the active life to date, of the landfill facility is 511,000 cubic yards.

Estimated schedule of closure will be approximately 20.03 years.

1.3 Containment and Environmental Control Systems

The County MSWLF Phase 2 will be constructed with a Base Liner System consisting of a cohesive soil liner with a permeability no greater than 1.0 x 10^{-7} cm/sec. or 1.0 x 10^{-5} cm/sec. with a reinforced Geosynthetic clay liner, sixty (60) mil High Density Polyethylene (HDPE) liner, 3' of protective cover, 250 mil composite drainage net and leachate collection system consisting of leachate trenches and pipes to collect the leachate. The leachate will be pumped into a leachate lagoon. The waste will be covered daily with on-site soils to control disease vectors. The cap system will consist of twelve inches (12") of bridging material (temporary cover), eighteen inches (18") of soil liner with a permeability no greater than 1.0 × 10^{-5} cm/sec, forty (40) mil Linear Low Density Polyethylene (LLDPE) flexible membrane liner, drainage layer, and twenty four inches (24") of protective/erosive layer. The cap will contain a gas venting system consisting of a series of washed stone trenches below the soil liner that will be vented through pipes that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

1.4 Leachate Management

1.4.1 Performance and Design Concepts

A HELP model has been created for the design of the leachate collection system, along with performance calculations which are located in Section 2.2.3 of this report. Leachate is pumped directly to the City of Kinston sewerage facilities and the water is treated in the City's waste water regional treatment facility. There is no limitations on the daily flow according to the non-significant industrial user pretreatment permit (attached) issued to the landfill by the City of Kinston. Consequently, leachate is continuously pumped from the lagoon until the low water float turns off the pump(s).

1.4.2 Normal Operating Conditions

The average monthly values of leachate generation are located in the HELP model Section 2.2.3 of this report, and performance calculations are in Section 2.2.4 of this report. The average monthly flow collected from layer 4 (HDPE Liner) per acre for a five year period is 1.86 inches for January, 1.90 inches for February, 1.33 inches for March, 0.85 inches for April, 0.67 inches for May, 0.70 inches for June, 1.25 inches for July, 1.70 inches for August, 2.44 inches for September, 1.19 inches for October, 1.00 inches for November and 0.74 inches for December.

Surge Volumes created by storm events are calculated in the HELP model and performance calculations in Section 2.2.3 of this report. The surge or peak daily values for years one thru five are 0.72 inches per acre collected from layer 4 (Drainage Net), average head on layer 5 (HDPE Liner) 0.02 inches and the maximum head on layer 5 is 0.48 inches.

1.4.3 Leachate Management System

Leachate pipeline operation capacity is located in the performance calculations in Section 2.2.4 of this report.

Capacity of the lagoon is located in the performance calculations in Section 2.1.8 of this report.

Final Disposal plans and applicable discharge limits, including documented prior approval of the wastewater treatment plant which may be designated in the plan. Appropriate documentation is located in Section 2.1.8 of this report.

1.4.4 Contingency Plan

In the event the Leachate Lagoon or the City of Kinston Wastewater Treatment Plant (WWTP) cannot handle a storm surge, the flow of leachate will be stopped from the MSWLF facility until such a time as the leachate can either be recirculated, held in the lagoon or sent to the Kinston WWTP. In the case of extreme emergency situations the County will apply for acceptance into a private Treatment Plant and they will pump and haul the leachate to the private WWTP. Any abnormal storm events can be handled. If any rain or other event requires storage of leachate or storm water in the cell, the Division of Waste Management will be notified immediately followed by written communication.

1.5 Special Engineering Features

There are no special engineering features.

1.6 Facility Drawings

1.6.1 Title Sheet
1.6.2 Index and Vicinity Map
1.6.3 Existing Conditions
1.6.4 Proposed Subgrade
1.6.5 Leachate Collection System
1.6.6 Phase 2 Fill
1.6.7 Phase 3 Fill
1.6.8 Phase 4 Fill
1.6.9 Phase 5 and Phase 6 Fill
1.6.10 Baseline Profile and Cross Sections

LENOIR COUNTY
MUNICIPAL SOLID WASTE
LANDFILL FACILITY

REVISED FACILITY PLAN

Permit Number: 5409-MSWLF
Site Location: 2949 Hodges Farm Road
La Grange, NC 28551

Applicant: Lenoir County

Applicant's Address: 130 South Queen Street
Kinston, NC 28502

BOARD OF COMMISSIONERS

George W. Graham, Jr. - Chairman
Claude Stroud - Vice-Chairman
Jackie Brown
Reuben Davis
Chris Humphrey
Thomas A. Pharo
Linda Rouse Sutton

COUNTY MANAGER

Michael W. Jarman

SOLID WASTE DIRECTOR

Tom Miller

Engineer

Municipal Engineering Services Company, P.A.
Garner, NC - Morehead City, NC - Boone, NC

SEAL 6282 ENGINEER JIMMY D. WOODIE

J Woodie 8/6/2010

by ____________________
Professional Engineer
(Garner Office)

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

DATE	BY	NO.	DESCRIPTION
8/6/2010	LCH	1	DRAWINGS REVISED PER SOLID WASTE COMMENTS

SCALE:	1:1
DATE:	10/22/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO.	T1
SHEET NO.	1 OF 10

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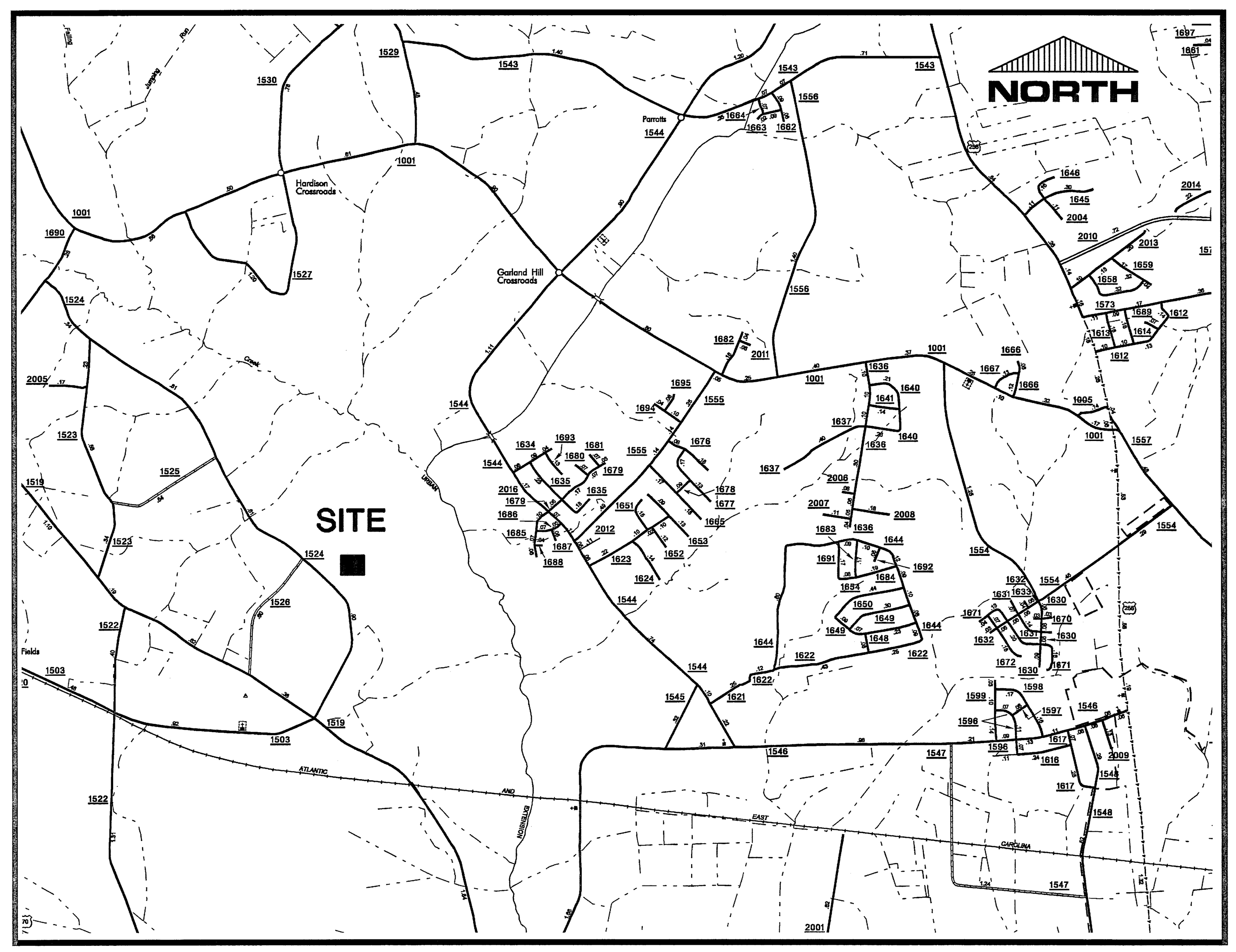
INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION
1	T1	TITLE SHEET
2	T2	INDEX AND VICINITY MAP
3	F1	EXISTING CONDITIONS
4	F2	PROPOSED BASE GRADE
5	F3	LEACHATE COLLECTION SYSTEM
6	F4	PHASE 2
7	F5	PHASE 3
8	F6	PHASE 4
9	F7	PHASE 5 AND PHASE 6
10	CS1	BASELINE PROFILE AND CROSS SECTIONS



VICINITY MAP

LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/6/2010	LCH	1	REVISED INDEX

INDEX AND VICINITY MAP

NORTH CAROLINA PROFESSIONAL SEAL ENGINEER JIMMY D. WOODIE

8/6/2010

SCALE: 1:1
DATE: 10/22/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G08095
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SHEET NO. 2 OF 10

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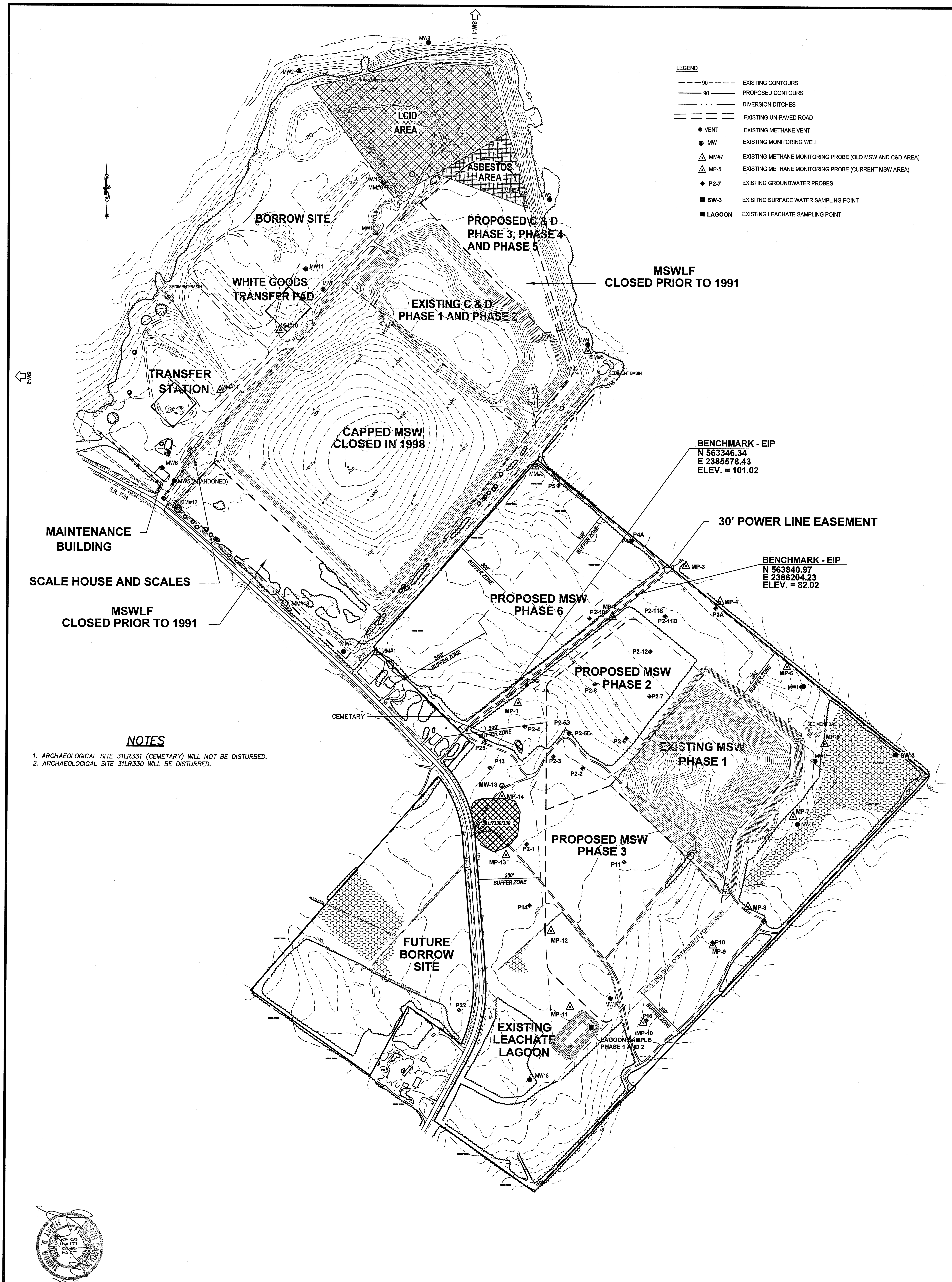


NOTES

1. ARCHAEOLOGICAL SITE 31LR331 (CEMETARY) WILL NOT BE DISTURBED.
2. ARCHAEOLOGICAL SITE 31LR330 WILL BE DISTURBED.

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE

1/31/2011

DATE	BY	REV.	DESCRIPTION
11/19/2010	LHC	3	PER NCDENR COMMENT LETTER DATED 11/17/2010
9/16/2010	LCH	2	PER NCDENR COMMENT LETTERS DATED 7/21/10 AND 9/9/10
8/6/2010	LCH	1	REVISED THE EXISTING CONDITIONS TO SHOW WHOLE FACILITY

SCALE: 1" = 200'
DATE: 9/10/09
DRWN. BY: L. HAMPTON
CHKD. BY: W. SULLIVAN
PROJECT NUMBER: G08095
DRAWING NO. F1
SHEET NO. 3 OF 10

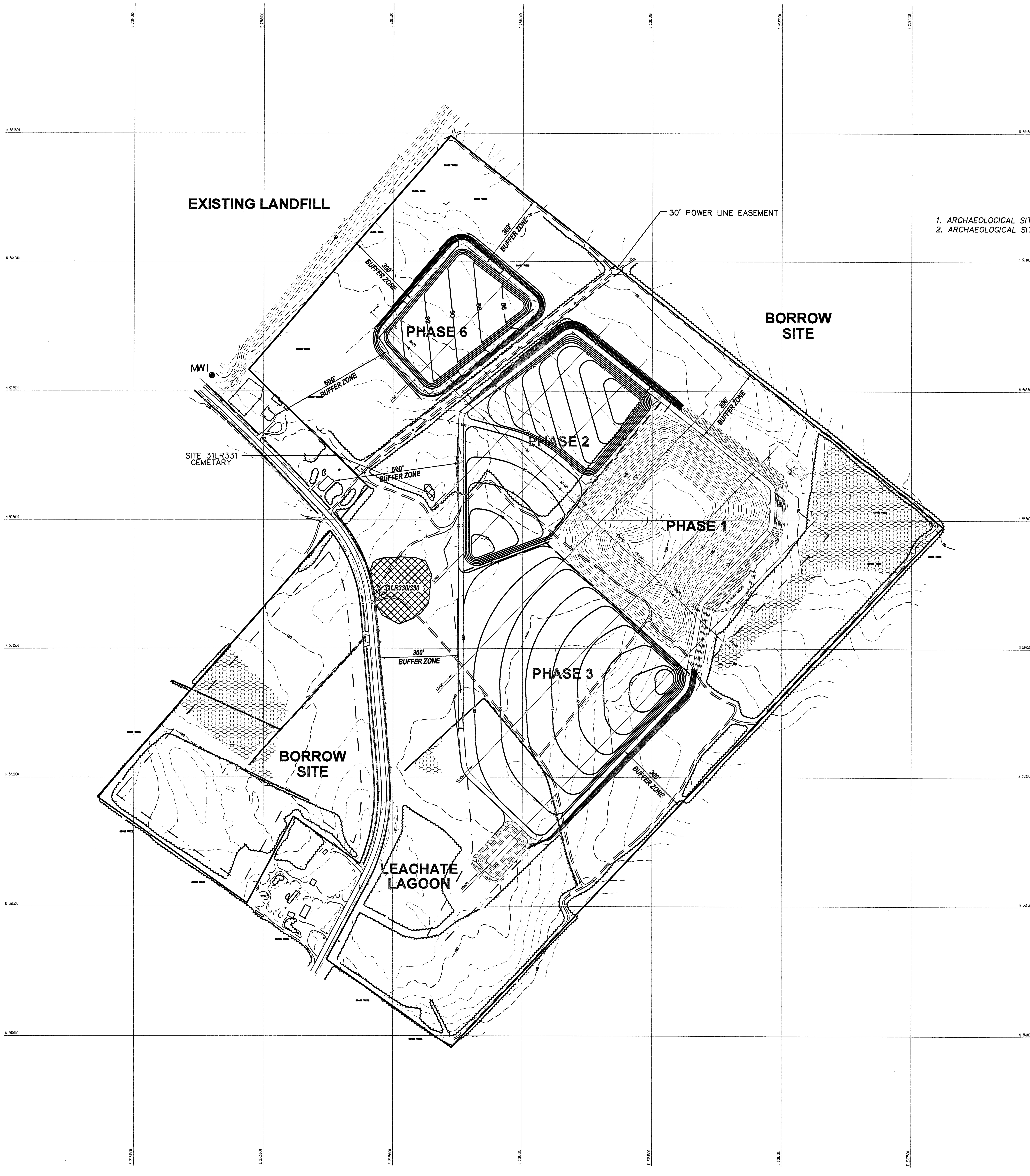
REVISED FACILITY PLAN
EXISTING CONDITIONS

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

LICENSE NUMBER: C-0281
Municipal Services Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

LEGEND

- EXISTING CONTOURS
- 90 — PROPOSED BASE GRADE
- PROPERTY LINE
- EXISITING PATH
- BUFFER ZONE
- PHASES OF OPERATION
- REF # — ARCHAEOLOGICAL SITES
- WETLANDS



NOTES

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2. ARCHAEOLOGICAL SITE 31LR330 WILL BE DISTURBED.

Municipal Engineering Services Company, P.A.
LICENSE NUMBER: C-0281
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
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P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/6/2010	LCH	1	ADDED BASELINE WITH CROSS SECTIONS

REVISED FACILITY PLAN
PROPOSED BASE GRADES

SCALE:	1" = 200'
DATE:	9/10/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G08095
DRAWING NO.	SHEET NO.
F2	4 OF 10

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE
8/6/2010

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···········	EXISTING CONTOURS
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-·-·-·-·-	BUFFER ZONE
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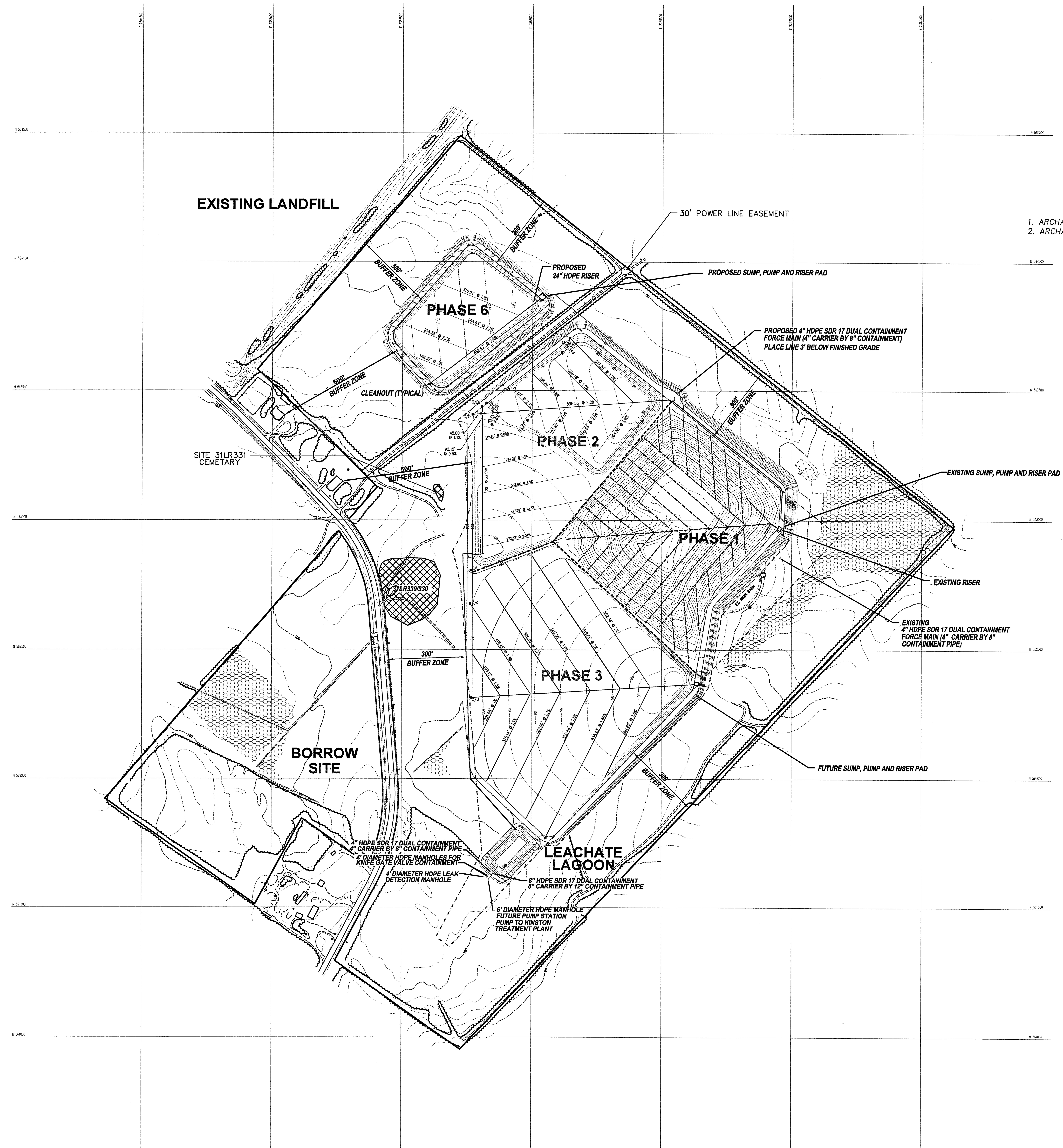
REF #	ARCHAEOLOGICAL SITES
	WETLANDS



NOTES

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LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/16/2010	LCH	2	REVISED LEACHATE SYSTEM IN PHASES 2, 3 AND 6
8/6/2010	LCH	1	REVISED PHASING

REVISED FACILITY PLAN
LEACHATE COLLECTION SYSTEM

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE 8/16/2010

SCALE:	1"=200'
DATE:	9/10/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G08095
DRAWING NO.	F3
SHEET NO.	5 of 10

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- EXISTING CONTOURS
- PROPERTY LINE
- EXISITING PATH
- BUFFER ZONE
- PHASES OF OPERATION
- REF # ARCHAEOLOGICAL SITES
- WETLANDS

NOTES

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2. ARCHAEOLOGICAL SITE 31LR330 WILL BE DISTURBED.

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/6/2010	LCH	1	REVISED FILL PLAN

REVISED FACILITY PLAN PHASE 2 FILL

SCALE: 1"=200'
DATE: 9/10/09
DRWN. BY: L. HAMPTON
CHKD. BY: W. SULLIVAN
PROJECT NUMBER G08095
DRAWING NO. F4
SHEET NO. 6 of 10

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6202 JIMMY D. WOODIE
8/6/2010

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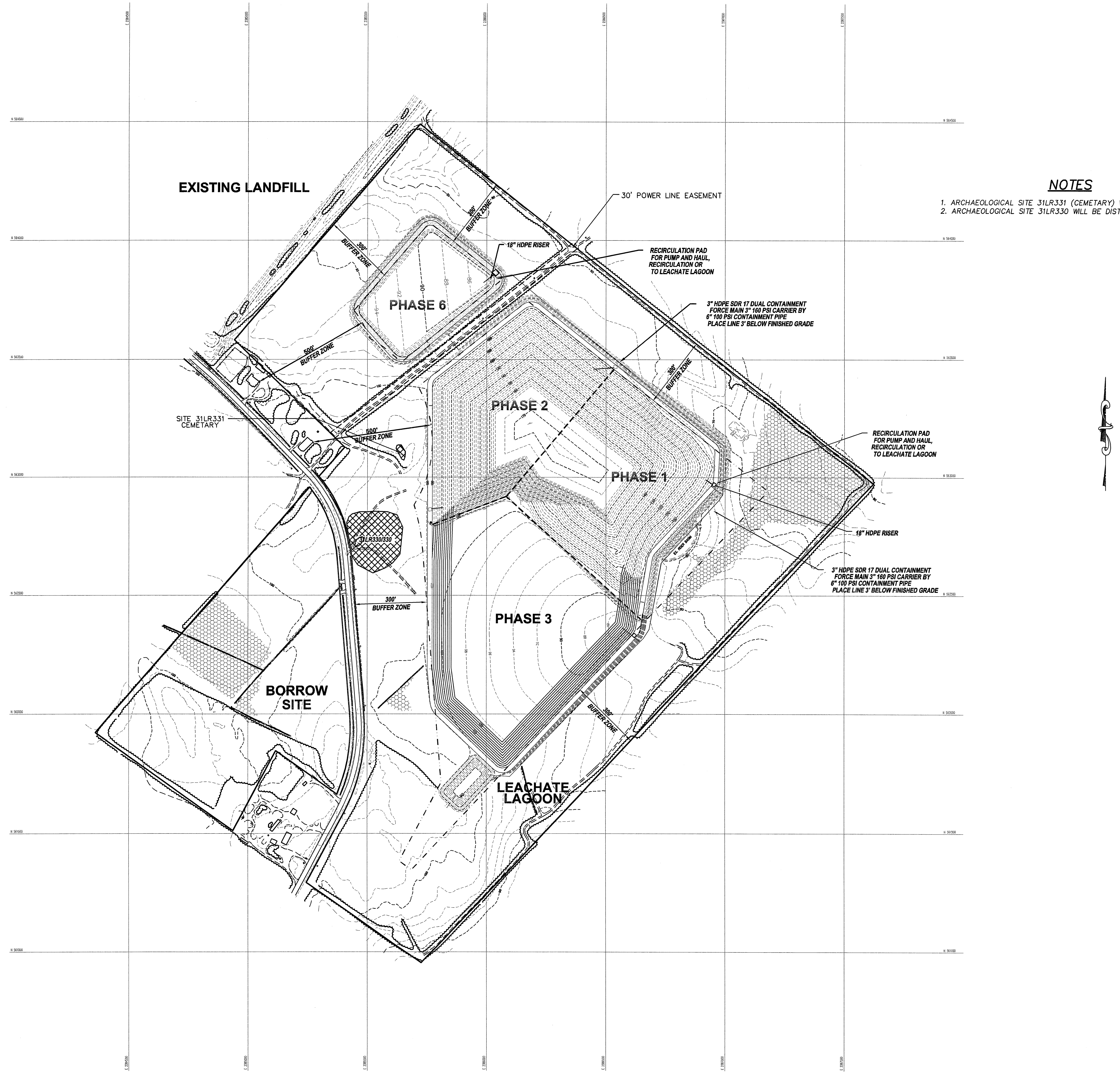

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REF #	ARCHAEOLOGICAL SITES
	WETLANDS

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LICENSE NUMBER: C-0281

Municipal Services
Engineering Company, P.A.
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(919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607
(828) 262-1767

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/16/2010	LCH	2	ADDED CONTOUR LABELS
8/6/2010	LCH	1	REVISED FILL PLAN

REVISED FACILITY PLAN
PHASE 3 FILL

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

8/16/2010

SCALE:	1"=200'
DATE:	9/10/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN

PROJECT NUMBER
G08095

DRAWING NO.	SHEET NO.
F5	7 of 10

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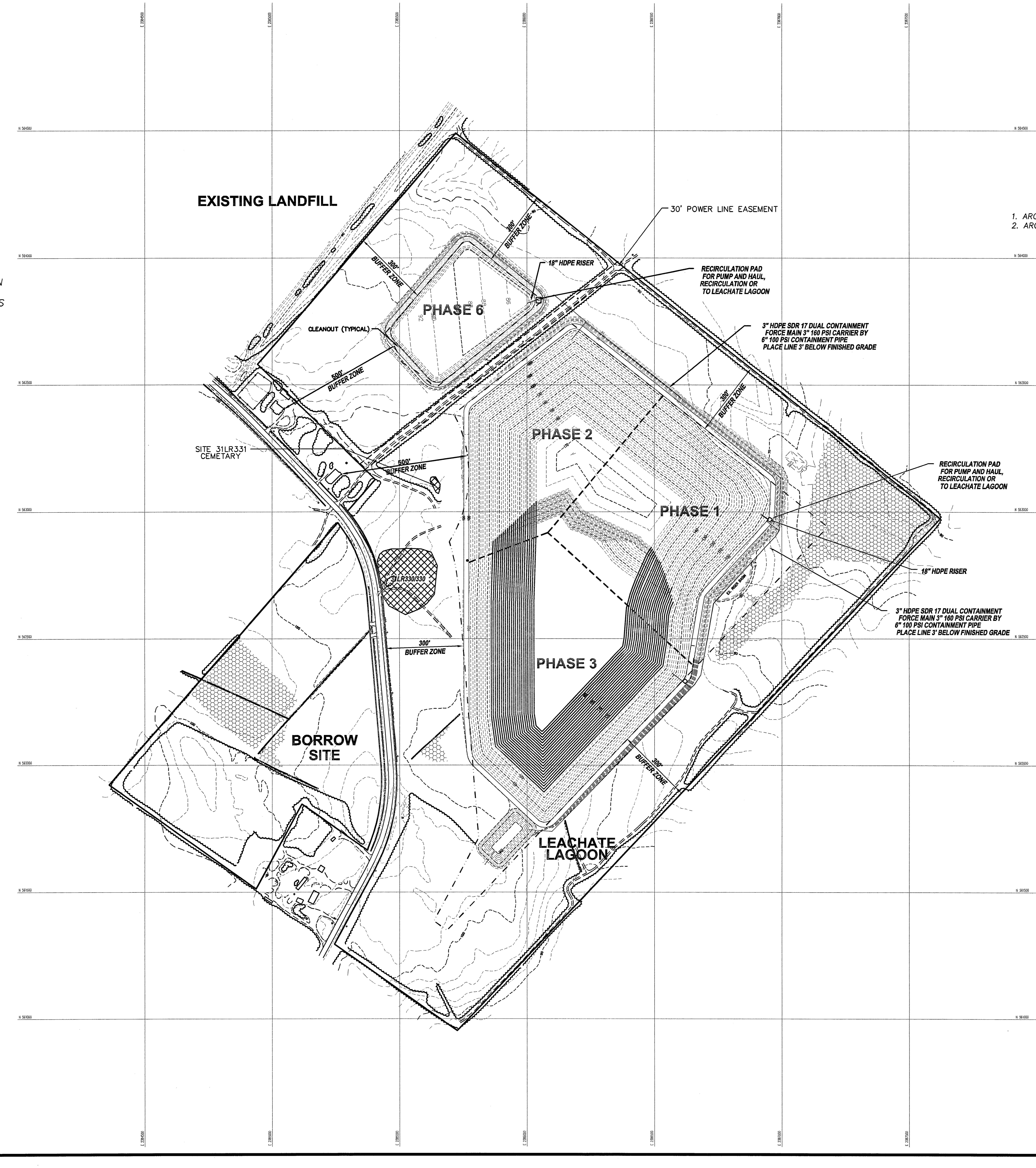

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- EXISTING CONTOURS
- PROPERTY LINE
- EXISITING PATH
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- REF # ARCHAEOLOGICAL SITES
- WETLANDS

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LICENSE NUMBER: C-0281

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P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

MUNICIPAL SOLID WASTE LANDFILL FACILITY LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/6/2010	LCH	1	REVISED FILL PLAN

REVISED FACILITY PLAN PHASE 4 FILL

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 8282 JIMMY D. WOODIE 8/6/2010

SCALE:	1"=200'
DATE:	9/10/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G08095
DRAWING NO. F6	SHEET NO. 8 of 10

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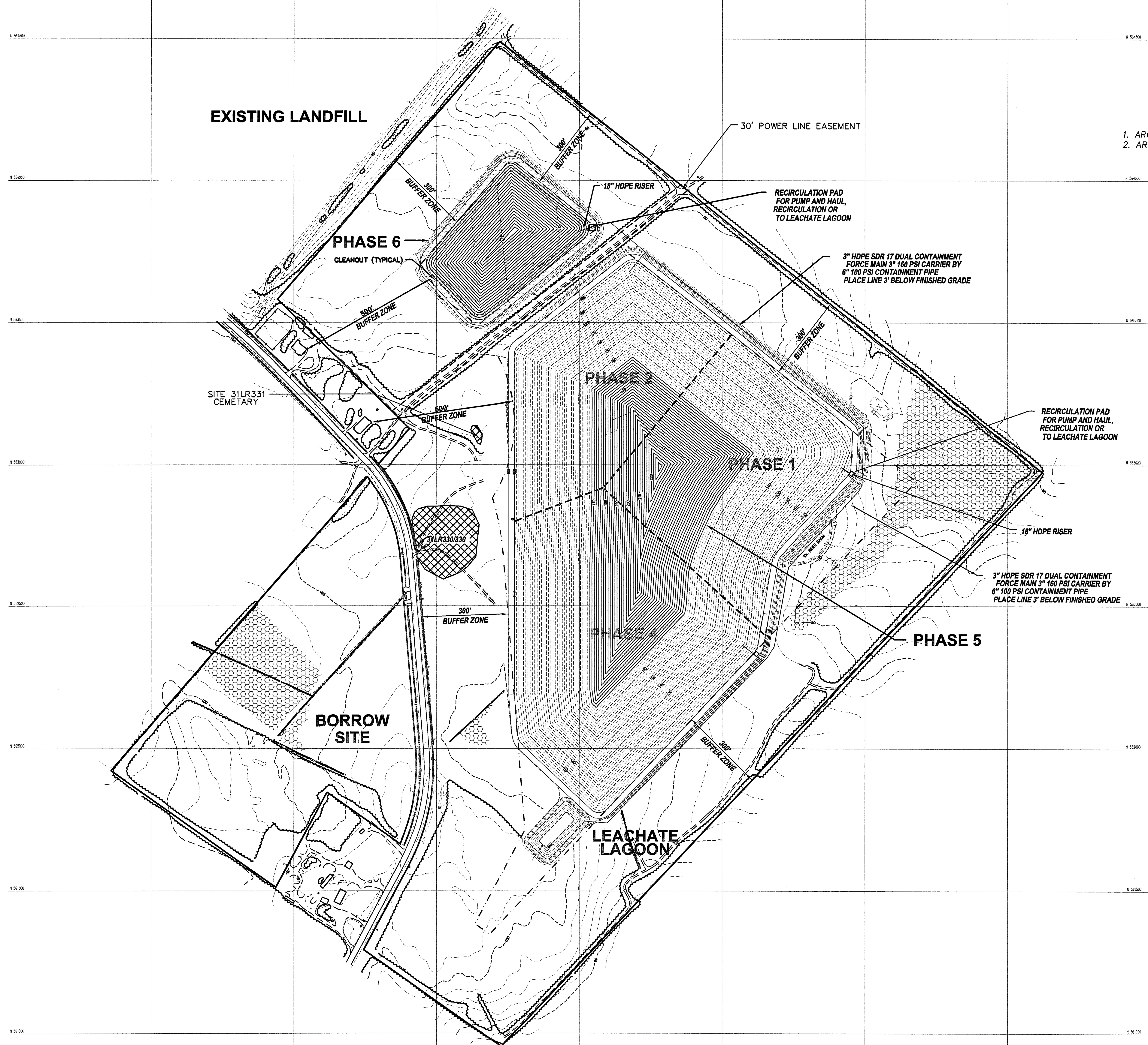
———	EXISTING CONTOURS
———	PROPERTY LINE
= = = =	EXISITING PATH
—··—··—	BUFFER ZONE
- - - - -	PHASES OF OPERATION
REF #	ARCHAEOLOGICAL SITES
	WETLANDS



NOTES

1. ARCHAEOLOGICAL SITE 31LR331 (CEMETARY) WILL NOT BE DISTURBED.
2. ARCHAEOLOGICAL SITE 31LR330 WILL BE DISTURBED.

8/6/2010

LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393

P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

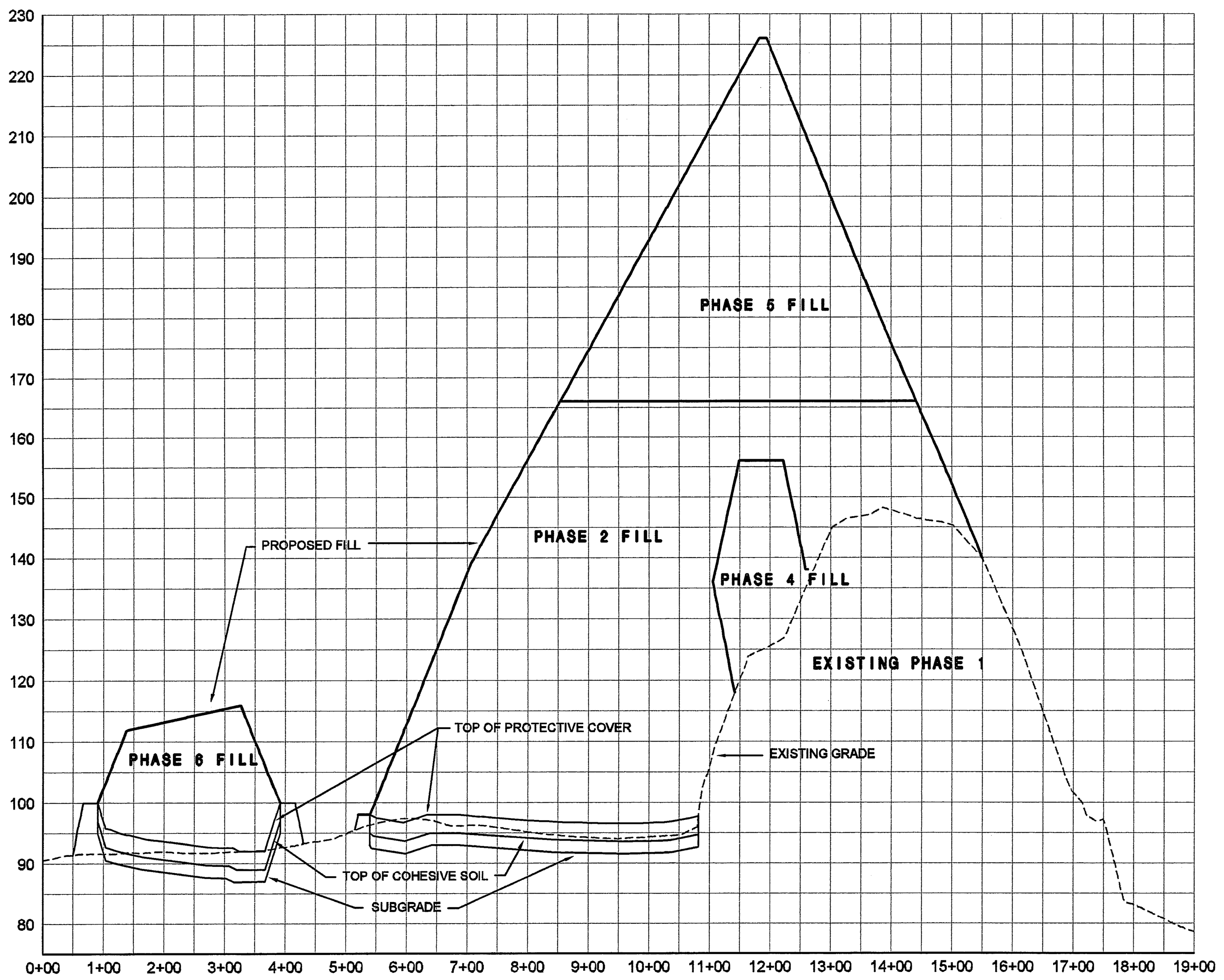
MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/6/2010	LCH	1	ADJUSTED PHASING AND SHEET NUMBERS

REVISED FACILITY PLAN
PHASE 5 AND PHASE 6 FILL

SCALE:	1"=200'
DATE:	9/10/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G08095
DRAWING NO. F7	SHEET NO. 9 of 10

P:\SolidWaste\G08095-Lenoir-Co. PTC Phase 2\dwg\facility\08095-f09a.dwg, 8/6/2010 12:59:09 PM, lch,lch

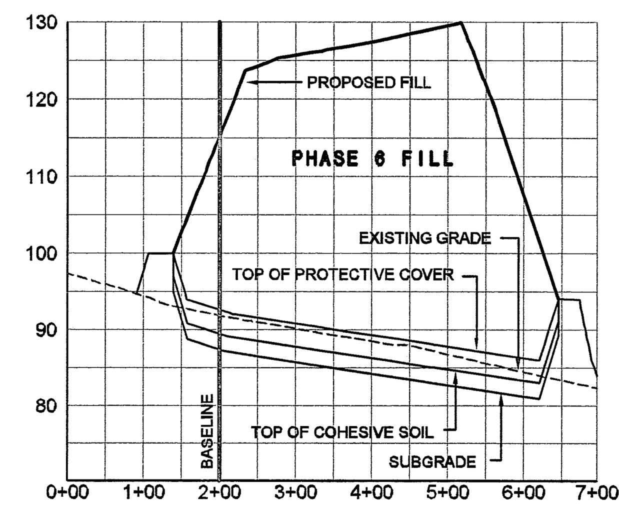


BASELINE PROFILE

SCALE: HORIZ.: 1" = 200'
VERT.: 1" = 20'

NOTE

THESE CROSS SECTIONS ARE INTENDED TO SHOW THE CROSS SECTIONS AT SPECIFIC POINTS AS DEFINED BY THE BASELINE GRID ON SHEET 4 OF 10.



STATION 3+00

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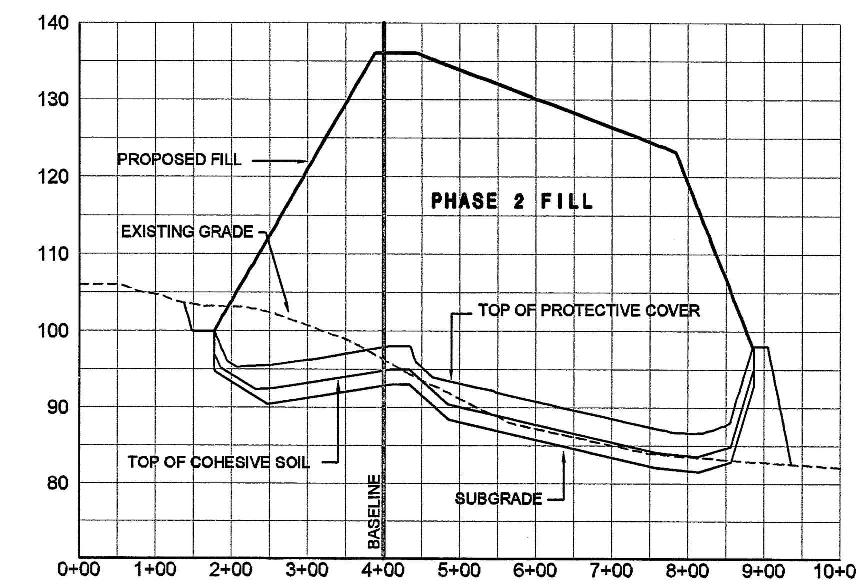
VERT.: 1" = 20'



STATION 7+00

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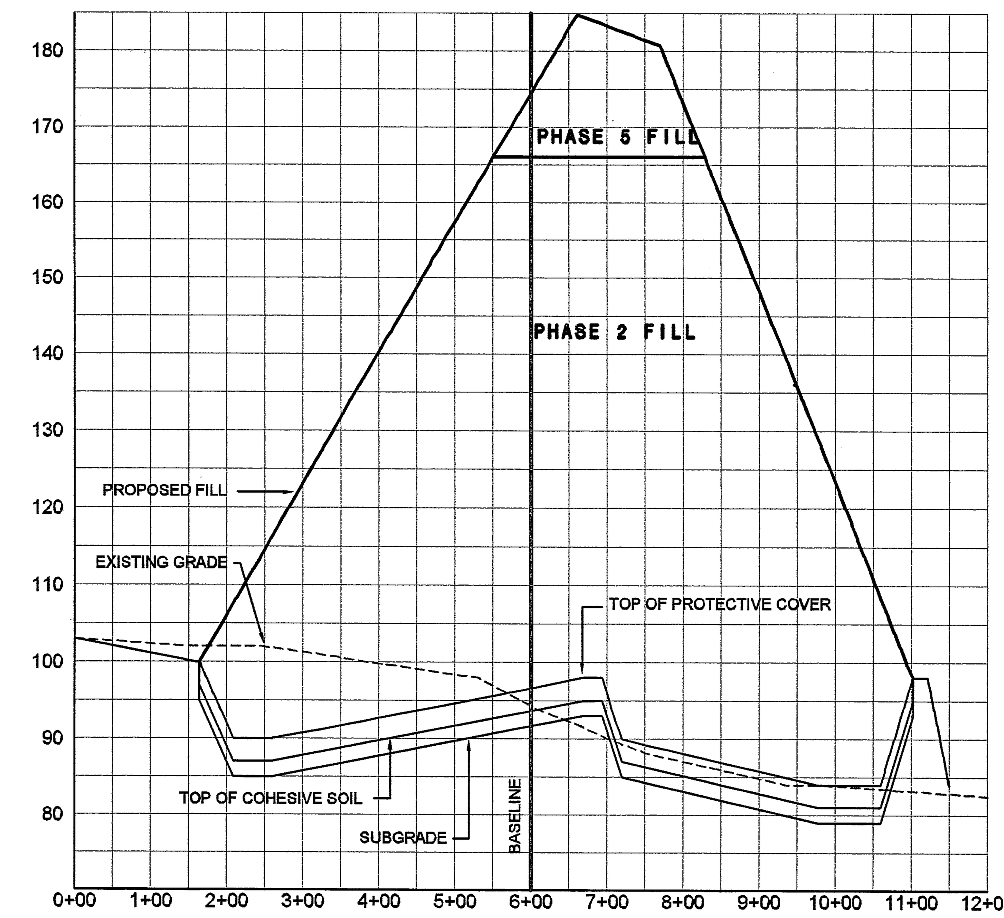
VERT.: 1" = 20'



STATION 9+00

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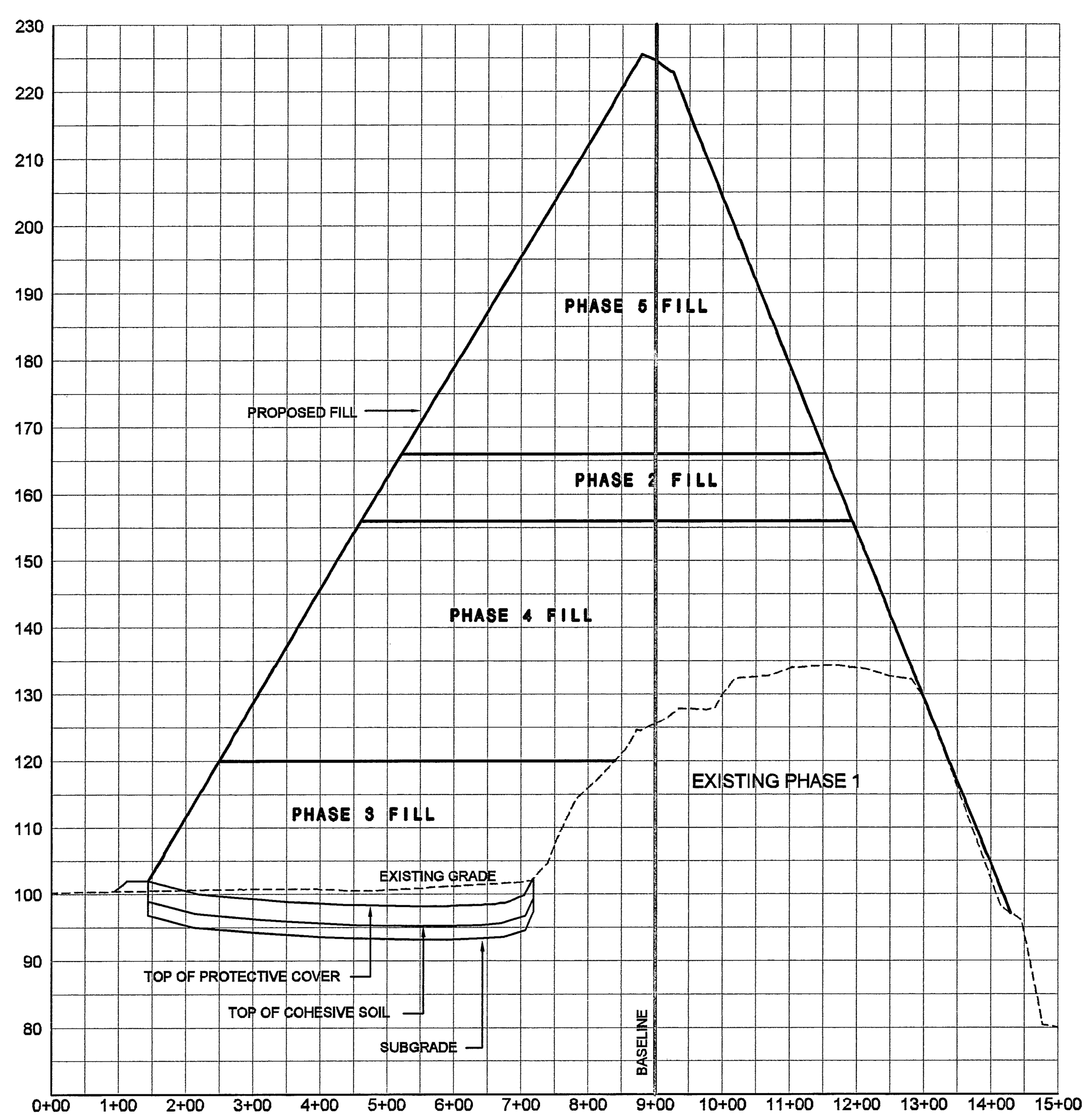
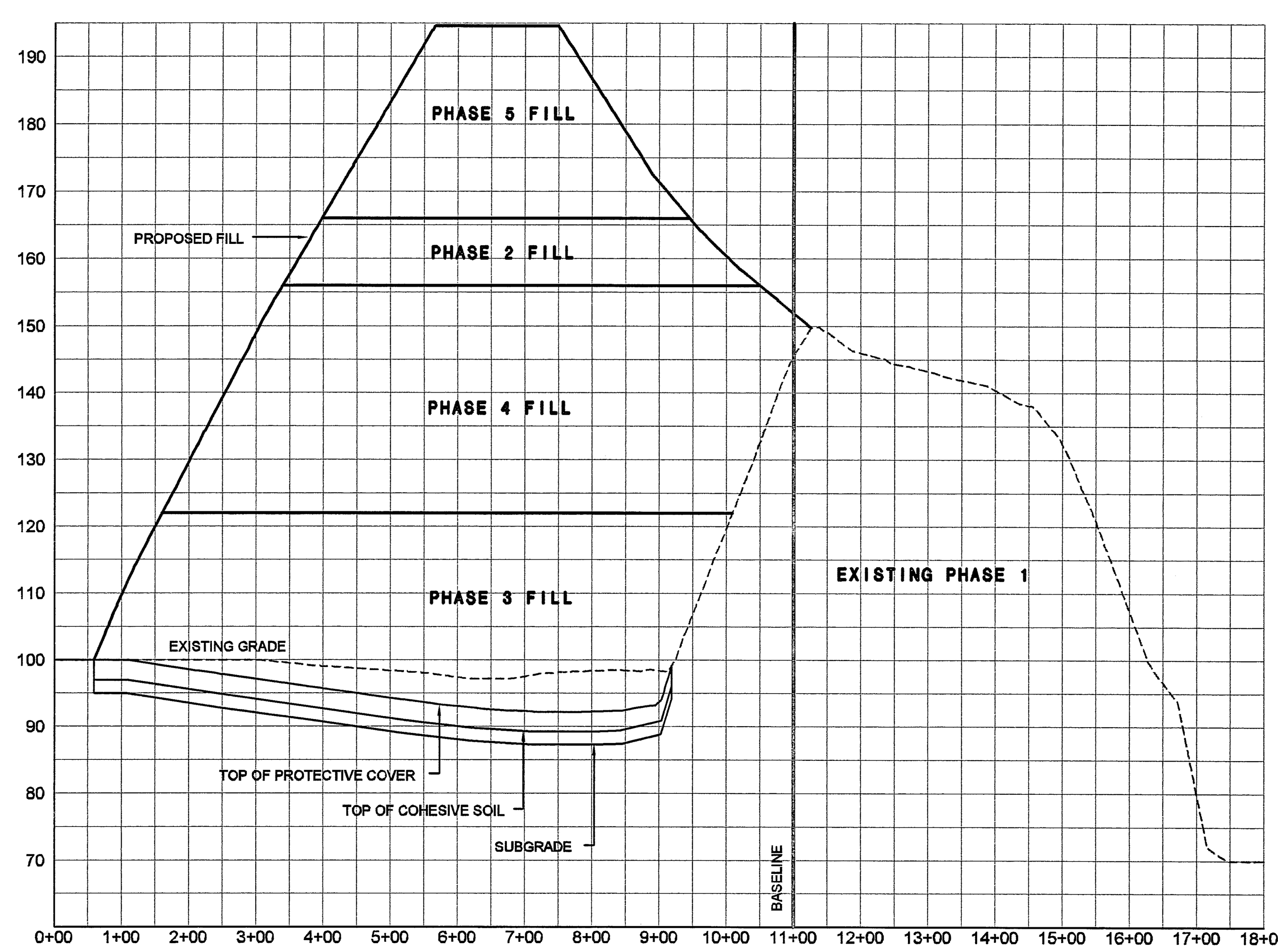
VERT.: 1" = 20'



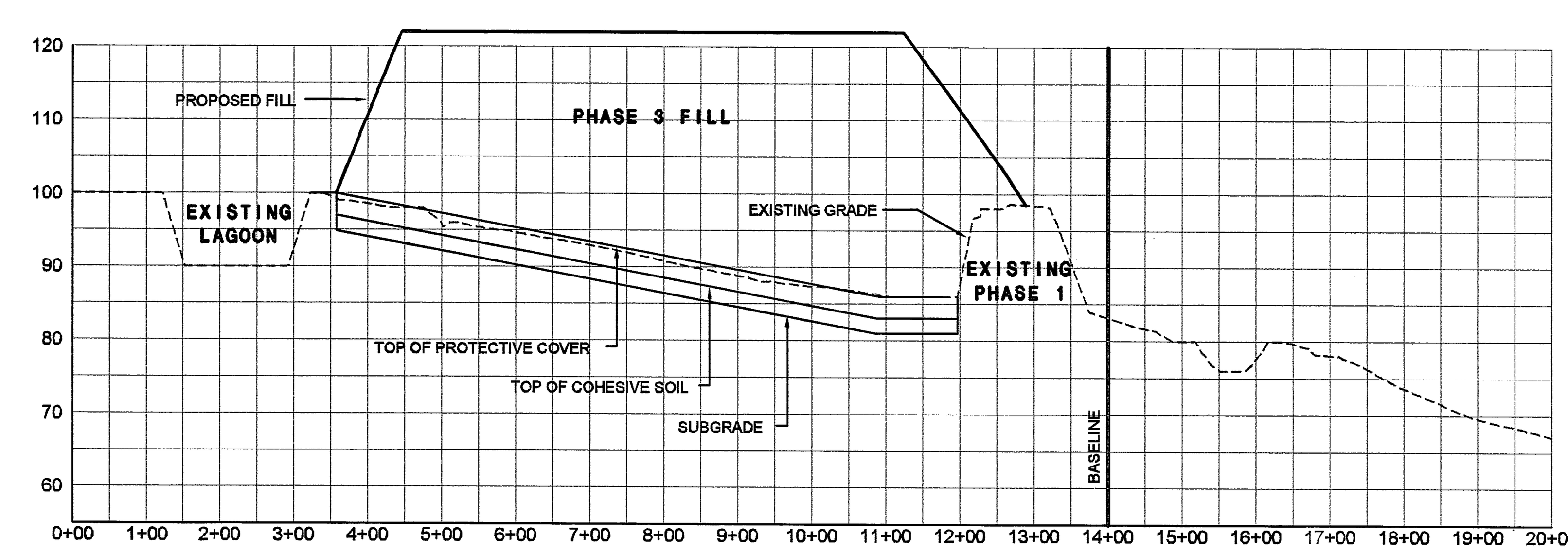
STATION 12+00

SCALE: HORIZ.: 1" = 200'
VERT.: 1" = 20'



STATION 15+00

SCALE: HORIZ.: 1" = 200'
VERT.: 1" = 20'



STATION 18+00

SCALE: HORIZ.: 1" = 200'
VERT.: 1" = 20'

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/6/2010	LCH	1	REPLACED ORIGINAL SHEET 10 WITH THIS SHEET

REVISED FACILITY PLAN
BASELINE PROFILE AND CROSS SECTIONS

SCALE:	AS SHOWN
DATE:	6/2/2010
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G08095
DRAWING NO. CS1	SHEET NO. 10

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE
8/6/2010

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SECTION 2.0

ENGINEERING PLAN

CERTIFICATION

This plan was prepared by the undersigned Professional Engineer. This plan meets all the requirements of Rule 0.1620.

NORTH CAROLINA
PROFESSIONAL
SEAL
6282
ENGINEER
JIMMY D. WOODIE

1/31/2011

Jimmy D. Woodie, PE
License No. 6282

2.1 Analysis of the Facility Design

The MSWLF unit shall be located a minimum of 300' from the property lines, 500' from existing residences/wells, and 50' from any stream, river or lake, and the post settlement subbase elevation shall be prepared a minimum of four feet above the seasonal high groundwater table and bedrock. The landfill subgrade shall be adequately free of organic material and consist of on site soils.

The base liner system consists of a 60 mil HDPE geomembrane liner which is installed above and in direct uniform contact with a compacted clay liner.

The alternate liner system consists of a 60 mil HDPE geomembrane liner which is installed above and in direct contact with a geosynthetic clay liner (GCL) and a compacted clay liner.

The County will cap their landfill within 180 days after the final receipt of solid waste. The cap system will consist of 12 inches bridging material (temporary cover), 18 inches of soil liner with a permeability no greater than 1.0×10^{-5} cm/sec, 40 mil. Linear Low Density Polyethylene (LLDPE), drainage layer, 24 inches of protective/erosive layer. The cap contains gas venting system consisting of a series of washed stone trenches below the soil liner that will be vented through pipes that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

2.1.1 Base Liner System Standards

The base liner system consists of a geomembrane liner which is installed above and in direct uniform contact with a compacted clay liner.

1. The site shall meet the following design requirements for Landfill subgrade.

   The landfill subgrade shall be adequately free of organic material and consist of on site soils.

2. The site shall meet the following material requirements for the Base Liner System:

   The soil materials used in construction of the compacted clay liner may consist of on-site sources and may possess adequate native properties or may require bentonite conditioning to meet the permeability requirement. However, if on-site soils are not available, the offsite soils will be used. The soil shall be free of particles greater than ¾ inch in dimension.

   The compacted clay liner shall be 24 inches (0.61 m) thick with a permeability not to exceed 1.0×10^{-7} cm/sec.

   The geomembrane liner material shall be high density polyethylene geomembrane with a thickness of 60 mils. which has a demonstrated water vapor transmission rate of not more than 0.03 gm/m^2 day. The liner and seaming materials shall have chemical and physical resistance not adversely affected by environmental exposure, waste placement and leachate generation.

3. The site shall meet the following material requirements for the Alternate Liner System:

   The soil materials used in construction of the compacted clay liner may consist of on-site sources and may possess adequate native properties or may require bentonite conditioning to meet the permeability requirement. However, if on-site soils are not available, the offsite soils will be used. The soil shall be free of particles greater than ¾ inch in dimension.

   The compacted clay liner shall be 18 inches thick with a permeability not to exceed 1.0×10^{-5} cm/sec and a reinforced GCL.

The geomembrane liner material shall be high density polyethylene geomembrane with a thickness of 60 mils. which has a demonstrated water vapor transmission rate of not more than 0.03 gm/m^2-day. The liner and seaming materials shall have chemical and physical resistance not adversely affected by environmental exposure, waste placement and leachate generation.

4. The site shall meet the following design requirements for the Leachate Collection System:

The design of the leachate collection system is to have path for leachate to move that does require it to flow thru any type of geotextile. This allows for some redundancy in the system. The leachate is going to follow the path of least resistance to the low point (sump) of the landfill. The path will be vertical or near vertical flow thru the waste to the three feet of protective cover. Some of the leachate will percolate thru the protective cover to the drainage net; however, the largest volume will flow along the interface of the protective cover and the in-place waste. It will flow along this interface until the flow is intercepts by a leachate trench where the geotextile has been folded back to expose the stone in the trench. The leachate flows vertically thru the rock to the drainage net. A portion of the flow will be in the drainage net; but, the majority will flow on top of the net thru the stone until the flow is deep enough to flow thru the holes in the pipe that is part of the leachate collection line. Once the leachate is deep enough in the trench to flow into the pipe, it will flow in the pipe to the sump. In the times of low flow, this may not happen until the leachate is near or reaches the sump. Once the leachate is in the sump, it will be stored until the pump is automatically turned on and the leachate is pumped to the lagoon.

The leachate that is collect in the drainage net will also flow to the sump. During low flows, the drainage net may convey the majority of the liquid until it reaches the sump. Once it reaches the sump, it will flow back thru the geotextile covering the drainage net and fill the sump in the same manner as if the leachate flowed thru the stone and/or pipe network.

The critical flow capacity of the system is not for leachate that has flowed thru waste but for storm water that has come in contact with waste. The Lenoir County landfill is divided into two drainage areas with two separate sumps. Once waste is placed into one of the sumps, the storm water in the drainage area becomes leachate because there are no diversions for storm water until the height of the waste reaches the surrounding berm height. Once the waste has reached the surrounding berm height, it can be diverted as surface runoff as long as it has not come in contact with waste.

The geometry of the landfill shall control and contain the volume of leachate generated by the 24-hour, 25-year storm.

The collection pipe along with the drainage net flow capacity shall drain the critical volume of leachate generated by the 24-hour, 25-year storm.

The Leachate Collection System includes a pipe network with clean-outs and geotextile and filter fabrics.

The Leachate Collection Piping has a minimum nominal diameter of six inches.

The chemical properties of the pipe and all materials used in installation shall not be adversely affected by waste placement or leachate generated by the landfill.

The pipe provides adequate structural strength to support the maximum static and dynamic loads and stresses imposed by the overlying materials and any equipment used in construction and operation of the landfill.

The Geosynthetic filter materials have adequate permeability and soil particle retention, and chemical and physical resistance which is not adversely affected by waste placement, and overlying material or leachate generated by the landfill.

2.1.2 <u>Horizontal Separation Requirements</u>

1. The MSWLF units are located a minimum of 300' from the property lines.
2. The MSWLF units are located a minimum of 500' from existing residences/wells.
3. The MSWLF units are located a minimum of 50' from any stream, river, or lake.

2.1.3 <u>Vertical Separation Requirements</u>

Phase 2 has a minimum vertical separation between subgrade and seasonal high ground water of 6.78 ft. and 5.28 ft. from long tern seasonal high. Considering settlement of .58 ft. (7 ins.), the subgrade elevation exceeds the minimum requirement of four feet above the seasonal high ground-water table and there is no bedrock.

2.1.4 <u>Location Coordinates and Survey Control</u>

Survey control coordinates are shown on the drawings and any additional information will be furnished upon request.

2.1.5 <u>Sedimentation and Erosion Control Plan</u>

The Sedimentation and Erosion control plan has been completed for the 24-hour, 25-year storm. A copy is submitted under Section 2.2.2 of this application.

2.1.6 <u>Cap System Standards</u>

The County will cap their landfill within 180 days after the final receipt of solid waste. The cap system will consist of 12 inches bridging material (temporary cover), 18 inches of soil liner with a permeability no greater than 1.0×10^{-5} cm/sec, 40 mil. Linear Low Density Polyethylene (LLDPE), drainage layer, 24 inches of protective/erosive layer. The cap contains a gas venting system that consists of a series of washed stone trenches below the soil liner that will be vented through pipes with membrane boots that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices, as approved by the NCDENR - Land Quality Section, as indicated in the NC Erosion and Sediment Control Planning Design Manual.

Prior to beginning closure, the County will notify the Division of Waste Management that a notice of the intent to close the unit has been placed in the operating record. The County will begin closure activities no later than thirty (30) days after the date on which the landfill receives the final wastes or if the landfill has remaining capacity and there is a reasonable likelihood that the landfill will receive additional wastes, no later than one year after the most recent receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Division of Waste Management if the County demonstrates that the landfill has the capacity to receive additional waste and the County has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed landfill.

The County will complete closure activities in accordance with the closure plan within 180 days following the final receipt of waste. Extensions of the closure period may be granted by the Division of Waste Management if the County demonstrates that closure will, of necessity, take longer than one hundred eighty (180) days and the County has taken and will continue to take all steps to prevent threats of human health and environment from the unclosed landfill.

Following closure of the landfill, the County will record a notation on the deed to the landfill property and notify the Division of Waste Management that the notation has been recorded and a copy has been placed in the operating record. The notation on the deed will in perpetuity notify any potential purchaser of the property that the land has been used as a landfill and its use is restricted under the closure plan approved by the Division of Waste Management. The County may request permission from the Division to remove the notation from the deed if all waste is removed from the landfill.

2.1.7 Leachate Storage Requirements

The County's existing leachate lagoon was designed and built with a minimum of two feet of freeboard. Odor and vector controls are practiced when necessary. A groundwater monitoring system has been installed. The lagoon is protected from external damage by an 8' high chain link fence.

The management of leachate is a major daily operational task. The generation of leachate should always be kept to a minimum. The leachate that is generated will be pumped to the Town of Kinston Wastewater Treatment Plant. The leachate is treated according to the pre-treatment agreement with the City of Kinston which is Non-Significant Industrial User (NSIU-3). The reason for this testing is to assure the City that the leachate will not harm the biological processes in their treatment facility. The County also records rainfall events as they occur and leachate generation to track the effect rainfall amounts have on the amount of leachate that is generated.

The leachate will be collected in the existing double lined lagoon which will hold approximately 624,000 gallons at 8 feet deep. The Lagoon is 10 feet deep which allows for 2 feet of free board. In the event that the lagoon fills up faster than it can be pumped to the City of Kinston WWTP, the valves can be turned off which will allow the lagoon to be drained. Once the leachate levels have been lowered, the valves can be opened. Leachate will be a management problem from the time the garbage is placed in the landfill until long after closure has taken place. Consequently, it is imperative that storm water be diverted away from any solid waste and managed properly.

All storm water falling outside of the existing lined areas will be diverted away from the lined section through the use of diversion berms and ditches. Storm water that falls within the lined area but does not come in contact with solid waste can be diverted to the perimeter areas of the landfill.

The County will close the leachate lagoon within 180 days after liquid collection has ceased.

All solid waste will be removed from the leachate lagoon, connecting sewer lines, and manholes. All solid waste removed will be properly handled and disposed of according to Federal and State requirements. All connecting lines will be disconnected and securely capped or plugged.

All waste residues, contaminated system components (composite liner system), contaminated subsoil, structures and equipment contaminated with waste will be removed and appropriately disposed. If the groundwater surrounding the impoundment is contaminated, other corrective actions to remediate a contaminant plume may be required by the Department. If the groundwater surrounding the lagoon is found not to be contaminated, the liner system may remain in place if drained and cleaned to remove all traces of waste, and both liners punctured so that drainage is allowed. The lagoon is to be backfilled and re-graded to the surrounding topography.

2.1.8 Existing Landfill Leachate Permit and Flow Data

KINSTON PUBLIC SERVICES

Buildings & Grounds, Business Office, Electric, Engineering, Environmental Services, Fleet Maintenance, Meter Reading, Stormwater, Streets, Wastewater, and Water

Kinston, the right place ... Kinston Public Services, the right choice.

March 2, 2009

Tom Miller
Solids Waste Director
Lenoir County Landfill
P.O. Box 3289
Kinston, NC 28551

Re: Transmittal Letter for Lenoir County Landfill Leachate Permit, #NSIU-3

Dear Mr. Miller:

Your Landfill Leachate Permit(IUP #NSIU-3) is enclosed. This permit is issued in response to your Industrial User Wastewater Survey and Application which was received by the POTW on February 12, 2009. This permit is issued pursuant to the requirements of North Carolina General Statute 143-215.1 and the local Sewer Use Ordinance.

The following modification has been made:

- Updated wording throughout permit (highlighted in red)

PLEASE READ THIS PERMIT CAREFULLY.

If any parts, measurement frequencies, or sampling requirements contained in this permit are unacceptable to you, you have the right to an adjudicatory hearing upon written request within thirty (30) days following receipt of this letter. Unless such demand is made, this decision shall be final and binding.

If I can be of any further assistance, please call me at 252-939-3306 or email at Kenneth.Stevens@ci.kinston.nc.us.

Sincerely,

Kenneth R. Stevens, Jr.
Pretreatment Coordinator

C: Charles Cauley- *Kinston RWRF Superintendent*
File

Enclosure

Kinston Regional Water Reclamation Facility

2101 Becton Farm Rd Kinston, North Carolina 28501 Phone (252) 939-3306 Fax (252) 939-3741

CITY OF KINSTON, NORTH CAROLINA

PERMIT

Non-Significant Industrial User Pretreatment Permit (NSIUP)
To Discharge Wastewater Under the
Industrial Pretreatment Program

___NSIU-3___
NSIUP Number

In compliance with the provisions of the City of Kinston City Code, North Carolina General Statute 143-215.1, any applicable City pretreatment regulations, all other lawful standards and regulations promulgated and adopted by the North Carolina Environmental Management Commission, and the City of Kinston,

LENOIR COUNTY LANDFILL

is hereby authorized to discharge landfill leachate from a facility located at

2949 Hodges Farm Road
LaGrange, NC

into the City of Kinston sanitary sewer system in accordance with effluent limitations, monitoring requirements, and all other conditions set forth in Parts I, II, and III of this Non-Significant Industrial User Pretreatment Permit (NSIUP).

This permit shall become effective at midnight on April 1, 2009

This permit and the authorization to discharge shall expire at midnight on April 1, 2012

2-25-09
Date

Rhonda F. Barwick
Director of Public Services

NSIUP BASIC INFORMATION

Receiving POTW name:	Kinston Regional Water Reclamation Facility
POTW NPDES #:	NC0024236
NSIUP Name:	Lenoir County Landfill
NSIUP Number:	NSIU-3
NSIUP Effective Date:	April 1, 2009
Pipe Number(s):	01
NSIUP Expiration Date:	April 1, 2012

NSIUP MODIFICATION HISTORY

Date Modified:	**April 1, 2004-** Issued permit.
Date Modified:	**August 9, 2004-** Added electronic submission of monthly report criteria. Redefined pretreatment needs.
Date Modified:	**April 1, 2006-** Renewed permit. Increased sampling from once every six months to quarterly.
Date Modified:	**December 1, 2006-** Changed receiving POTW from Peachtree to Kinston Regional Water Reclamation Facility.
Date Modified:	**April 1, 2009-** Renewed permit. Updated wording throughout permit (highlighted in red)

PART I
INDUSTRIAL USER SPECIFIC CONDITIONS

1. AUTHORIZATION STATEMENT:

The permittee is hereby authorized to:

a. operate a groundwater leachate facility as needed to meet final pretreatment limitations, if applicable.
Treatment Unit(s) : N/A

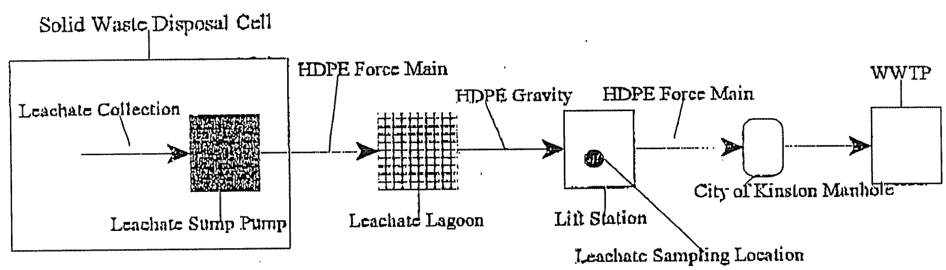
b. discharge from said treatment works into the Kinston Regional Water Reclamation Facility, NPDES Permit Number NC0024236

c. **after receiving authorization to construct from the City of Kinston, construct and operate pretreatment units as needed to meet final effluent limitations (once they have been established in this permit). After the City of Kinston establishes limits, with the exception of pH, Lenoir County shall have 36 months to have designed and installed adequate pretreatment to meet those limits.**

2. DESCRIPTION OF IUP DISCHARGE(S):

Pipe	Description of Discharge
01	Total Flow - leachate. Sample may be collected at Lift Station (if discharging) or Leachate Lagoon (if not discharging).

3. SCHEMATIC AND MONITORING LOCATIONS:



4. EFFLUENT LIMITS AND MONITORING REQUIREMENTS - FINAL

The permittee may discharge from the pipe number specified in Part I (2) according to these effluent limits and monitoring requirements. Parameters not limited in this permit shall be discharged in accordance with the City of Kinston Sewer Use Ordinance.

PARAMETER	EFFLUENT LIMITATION-DAILY MAXIMUM	SAMPLE TYPE	PERMITTEE MONITORING FREQUENCY
FLOW	N/A	Discharge pump readings	*Daily
BOD	N/A	Composite	Quarterly
TSS	N/A	Composite	Quarterly
pH	6-9 (units)	Grab	*Daily
TOTAL PHOSPHORUS	N/A	Composite	Quarterly
AMMONIA NITROGEN	N/A	Composite	Quarterly
TOTAL KJELDAHL NITROGEN	N/A	Composite	Quarterly
CYANIDE	N/A	Grab	Quarterly
ARSENIC	N/A	Composite	Quarterly
CADMIUM	N/A	Composite	Quarterly
CHROMIUM	N/A	Composite	Quarterly
COPPER	N/A	Composite	Quarterly
LEAD	N/A	Composite	Quarterly
MERCURY	N/A	Composite	Quarterly
MOLYBENDUM	N/A	Composite	Quarterly
NICKEL	N/A	Composite	Quarterly
SELENIUM	N/A	Composite	Quarterly
SILVER	N/A	Composite	Quarterly
ZINC	N/A	Composite	Quarterly
BTEX	N/A	Grab	Quarterly
VOLATILES, ORGANIC EPA Method 8260B	N/A	Grab	Once every six months
VOLATILES, SEMI EPA Method 625	N/A	Composite	Once every six months

BOD - Biological Oxygen Demand
TSS - Total Suspended Solids
*See Part II, Industrial User General Conditions 1. Reporting.

5. DEFINITIONS

In addition to the definitions in the Control Authority Sewer Use Ordinance the following definitions and requirements apply:

a. Composite Sample:
A composite sample is defined as the automatic or manual collection of one grab sample of constant volume, not less than 100 ml. collected every hour during the entire discharge period on the sampling day. Sampling day shall be a typical production, and discharge day.

b. Grab Sample:
A grab sample is defined as a single "dip and take" sample collected at a representative point in the discharge stream.

c. Instantaneous Measurement:
An instantaneous measurement is defined as a single reading, observations, or measurement.

d. Daily Monitoring Frequency
Daily monitoring frequency as specified in this permit shall mean each day of discharge.

PART II
INDUSTRIAL USER GENERAL CONDITIONS

1. REPRESENTATIVE SAMPLING

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other wastestream, body of water, or substance. Monitoring points shall not be changed without notification to, and approval by, the permit issuing authority.

2. REPORTING

a. Monitoring results obtained by the permittee shall be reported on forms specified by the Control Authority and/or Municipality, postmarked or electronically submitted no later than the twentieth day of the month following the month in which the samples were taken. If no discharge occurs during the reporting period, "no discharge" shall be reported. Copies of these and all other reports required herein shall be submitted to the authorized representative of the Control Authority and/or Municipality and shall be sent to the following address:

Kenneth R. Stevens, Jr.
Pretreatment Coordinator
Kinston Regional Water Reclamation Facility
2101 Becton Farm Road
Kinston, N.C. 28501

Electronic Submission:
Kenneth.Stevens@ci.kinston.nc.us

b. If the sampling performed by the permittee indicates a violation, the permittee shall notify the Control Authority within 24 hours of becoming aware of the violation:

Kenneth R. Stevens, Jr.:	Office:	(252) 939-3306
Charles Cauley (alternate):	Office:	(252) 939-3375
	Cell:	(252) 560-0252

The permittee shall also repeat the sampling and analysis and submit the results of the repeat analysis to the Control Authority within 30 days after becoming aware of the violation.

c. If no self-monitoring is required by this IUP, and the sampling performed by the Control Authority and/or Municipality indicates a violation, the Control Authority and/or Municipality shall notify the permittee within 24 hours of becoming aware of the violation, and the permittee shall sample for the applicable parameter and submit the results of this analysis within 30 days after the POTW became aware of the violation.

3. TEST PROCEDURES

Test procedures for the analysis of pollutants shall be performed in accordance with the techniques prescribed in 40 CFR part 136 and amendments thereto unless specified otherwise in the monitoring conditions of this permit

4. ADDITIONAL MONITORING BY PERMITTEE

If the permittee monitors any pollutant at the locations(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be submitted to the Control Authority. The Control Authority may require more frequent monitoring or the monitoring of other pollutants not required in this permit by written notification.

5. DUTY TO COMPLY

The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the City of Kinston Sewer Use Ordinance and is grounds for possible enforcement action.

6. DUTY TO MITIGATE - PREVENTION OF ADVERSE IMPACT

The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health, the POTW, the waters receiving the POTW's discharge, or the environment.

7. FACILITIES OPERATION, BYPASS

The permittee shall at all times maintain in good working order and operate as efficiently as possible, all control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit. Bypass of treatment facilities is prohibited except when approved in advance by the Control Authority. Bypass approval shall be given only when such bypass is in compliance with 40 CFR 403.17.

8. REMOVED SUBSTANCES

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutants from such materials from entering the sewer system. The permittee is responsible for assuring its compliance with any requirements regarding the generation, treatment, storage, and/or disposal of "Hazardous waste" as defined under the Federal Resource Conservation and Recovery Act.

9. UPSET CONDITIONS

An "upset" means an exceptional incident in which there is an unintentional and temporary noncompliance with the effluent limitations of this permit because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed or inadequate treatment facilities, lack of preventative maintenance, or careless or improper operations.
An upset may constitute an affirmative defense for action brought for the noncompliance. The permittee has the burden of proof to provide evidence and demonstrate that none of the factors specifically listed above were responsible for the noncompliance.

10. RIGHT OF ENTRY

The permittee shall allow the staff of the State of North Carolina Department of Environment and Natural Resources, Division of Water Quality, the Regional Administrator of the Environmental Protection Agency, the Control Authority, and/or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where a real or potential discharge is located or in which records are required to be kept under the terms and conditions of this permit; and
b. At reasonable times to have access to and copy records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

11. AVAILABILITY OF RECORDS AND REPORTS

The permittee shall retain records of all monitoring information, including all calibration and maintenance records as well as copies of reports and information used to complete the application for this permit for at least three years. All records that pertain to matters that are subject to any type of enforcement action shall be retained and preserved by the permittee until all enforcement activities have concluded and all periods of limitation with respect to any and all appeals have expired. Except for data determined to be confidential under the Sewer Use Ordinance, all reports prepared in accordance with terms of this permit shall be available for public inspection at the Control Authority. As required by the Sewer Use Ordinance, effluent data shall not be considered confidential.

12. DUTY TO PROVIDE INFORMATION

The permittee shall furnish to the Director of Public Services or his designees, within a reasonable time, any information which the Director, his designee, or the Division of Water Quality may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The permittee shall also furnish, upon request, copies of records required to be kept by this permit.

13. SIGNATORY REQUIREMENTS

All reports or information submitted pursuant to the requirements of this permit must be signed and certified by the Authorized Representative as defined under the Sewer Use Ordinance. If the designation of an Authorized Representative is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, or overall responsibility for environmental matters for the company, a new authorization satisfying the requirements of this section must be submitted to the POTW Director prior to or together with any reports to be signed by an authorized representative. *See *Part III, 2. Electronic Submission* for emailed reports requirements to the Control Authority.

14. TOXIC POLLUTANTS

If a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307 (a) of the Federal Clean Water Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit may be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

15. CIVIL AND CRIMINAL LIABILITY

Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

16. FEDERAL AND/OR STATE LAWS

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable Federal and/or State law or regulation.

17. PENALTIES

The Sewer Use Ordinance of the Control Authority provides that any person who violates a permit condition is subject to a civil penalty not to exceed $25,000 dollars per day of such violation. Under State law (NCGS 143-215.6B), under certain circumstances it is a crime to violate terms, conditions, or requirements of pretreatment permits. It is a crime to knowingly make any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance. The City of Kinston Sewer Use Ordinance provides that any person who knowingly makes any false statement, representation, or certification in any record or their document submitted or required to be maintained under this permit, including monitoring reports shall be in violation of the City Ordinance. These crimes are enforced at the prosecutorial discretion of the local District Attorney.

18. NEED TO HALT OR REDUCE NOT A DEFENSE

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity to maintain compliance with the conditions of the permit.

19. TRANSFERABILITY

This permit shall not be reassigned or transferred or sold to a new user, different premises, or a new or changed operation without approval of the City.

20. PROPERTY RIGHTS

This permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

21. SEVERABILITY

The provisions of this permit are severable and, if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected thereby.

22. PERMIT MODIFICATION, REVOCATION, TERMINATION

This permit may be modified, revoked and reissued or terminated with cause in accordance to the requirements of the City of Kinston Sewer Use Ordinance and North Carolina General Statute or implementing regulations.

23. REAPPLICATION FOR PERMIT RENEWAL

The permittee is responsible for filing an application for reissuance of this permit at least 90 days prior to its expiration date.

24. DILUTION PROHIBITION

The permittee shall not increase the use of potable or process water or in any other way attempt to dilute the discharge as a partial or complete substitute for adequate treatment to achieve compliance with the limitations contained in this permit.

25. REPORTS OF CHANGED CONDITIONS

The permittee shall give notice to the Control Authority and/or Municipality, if any planned significant changes to the permittee's operations or system which might alter the nature, quality, or volume of its wastewater at least 180 days before the change. The permittee shall not begin the changes until receiving written approval from the Control Authority and/or Municipality. Also see Part II, 30 below for additional reporting requirements for spill/slug issues.

26. CONSTRUCTION

No construction of pretreatment facilities or additions thereto shall be begun until Final Plans and Specifications have been submitted to the Control Authority and written approval and an Authorization to Construct have been issued.

immediately upon the first awareness of the commencement of the discharge.

Notification shall include location of the discharge, type of waste, concentration and volume if known and corrective actions taken by the permittee. A written follow-up report thereof shall be filed by the permittee within five (5) days, unless waived by the Control Authority. Such notification shall not relieve the permittee from any liability which may be incurred as a result of the discharge.

27. REOPENER

The permit shall be modified or, alternatively, revoked and reissued to comply with any applicable effluent standard or limitation for the control of any pollutant shown to contribute to toxicity of the WRF effluent, any pollutant that is otherwise limited by the POTW discharge permit or any nonlimited parameters including, but not exclusively; Zinc, Copper, Nickel, Chromium, Lead and Total Phosphorus. The permit as modified or reissued under this paragraph may also contain any other requirements of City or Federal pretreatment regulations then applicable.

28. CATEGORICAL REOPENER

This permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under Sections 302(b)(2)(C) and (D), 304(b)(2), and 307(a)(2) of the Clean Water Act, if the effluent standard or limitation so issued or approved:

a. contains different conditions or is otherwise more stringent than any effluent limitation in this permit; or

b. controls any pollutant not limited in this permit.

The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

29. GENERAL PROHIBITIVE STANDARDS

The permittee shall comply with the general prohibitive discharge standards in 40 CFR 403.5(a) and (b) of the Federal pretreatment regulations.

30. REPORTS OF POTENTIAL PROBLEMS

The permittee shall provide protection from accidental and slug discharges of prohibited materials and other substances regulated by this permit. The permittee shall also notify the POTW immediately of any changes at its facility affecting the potential for spills and other accidental discharge, discharge of a non-routine, episodic nature, a non-customary batch discharge, or a slug load as defined in the Sewer Use Ordinance.

Additionally, the permittee shall notify by telephone the Control Authority and/or Municipality immediately of all discharges that could cause problems to the POTW including any slug loadings as defined in the Sewer Use Ordinance. If the permittee experiences such a discharge they shall inform the Control Authority and/or Municipality

PART III
SPECIAL CONDITIONS

1. FLOW MEASUREMENT REQUIREMENTS

The permittee shall maintain appropriate discharge flow measurement devices (Certified wastewater pumps) and methods consistent with approved scientific practices to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated, and maintained to ensure accuracy. The pumps shall be calibrated/checked for accuracy annually. Any modifications to the flow metering equipment shall be approved by the City prior to installation. If a required flow measurement device fails, the City shall be notified within 24 hours.

2. ELECTRONIC SUBMISSION REQUIREMENTS

Reports or information that is electronically submitted (emailed) does not require a signature from the duly authorized agent of the permittee. All reports submitted electronically shall be considered certified accurate and truthful from the permittee and shall be regarded as the equivalent of a signed mailed copy. All data (lab sheets, self monitoring results, etc.) submitted shall be kept on site for verification at the annual inspection, along with a signed "hard" copy of the original report.

LENOIR COUNTY LANDFILL

IUP PERMIT NO: NSIU-3 DISCHARGE NO: 01 Month: August YEAR: 2008
FACILITY NAME: Lenoir County Landfill DISCHARGES TO: Kinston RWRF
CONTACT PERSON(S): Tom Miller/Mike Jarman PHONE: 252-566-4194
CERTIFIED LABORATORIES: ______
* If required to sample other than pH and temperture Person(s) collecting Sample: Gene Stallings

Mail ORIGINAL to:
CITY OF KINSTON-PUBLIC SERVICES (WWTP)
ATTN: KENNETH R. STEVENS, JR.
P.O. DRAWER 339
KINSTON, NC 28502
Email: Kenneth.Stevens@ci.kinston.nc.us

X
(SIGNATURE OF PERSON AUTHORIZED TO REPRESENT THIS FIRM IN OFFICIAL DEALINGS WITH THE CITY)
BY THIS SIGATURE, I CERTIFY THAT THIS REPORT IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE

DATE	OPERATION HOURS	FLOW Discharge Pumps	pH		TIME			SPECIAL NOTES
#	HRS	GALLONS	UNITS		AM/PM			
1								No Discharge
2								No Discharge
3								No Discharge
4								No Discharge
5								No Discharge
6								No Discharge
7								No Discharge
8								No Discharge
9								No Discharge
10								No Discharge
11								No Discharge
12	8.27	56897.6	7.28		8:00			Rain
13	6.43	44238.4	7.27		8:00			Rain
14	7.38	50774.4	7.27		8:00			Rain
15								No Discharge
16								No Discharge
17								No Discharge
18								No Discharge
19								No Discharge
20								No Discharge
21								No Discharge
22								No Discharge
23								No Discharge
24								No Discharge
25								No Discharge
26								No Discharge
27								No Discharge
28								No Discharge
29								No Discharge
30								No Discharge
31								

	GALLONS	UNITS
AVERAGE	4900.335484	7.2733
MAXIMUM	56897.6	7.28
MININUIM	44238.4	7.27
COMP/GRAB	Cont	GRAB
DAILY LIMIT	N/A	N/A
WEEKLY LIMIT	N/A	N/A
MONTHLY LIMIT	N/A	>=6, <=9
COMLPIANT	N/A	YES
TOTAL	151910.4	

LENOIR COUNTY LANDFILL

IUP PERMIT NO: NSIU-3 DISCHARGE NO: 01 Month: NOV YEAR: 2008
FACILITY NAME: Lenoir County Landfill DISCHARGES TO: Kinston RWRF
CONTACT PERSON(S): Tom Miller/Mike Jarman PHONE: 252-566-4194
CERTIFIED LABORATORIES: ____
* If required to sample other than pH and temperture Person(s) collecting Sample: Gene Stallings

Mail ORIGINAL to:
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ATTN: KENNETH R. STEVENS, JR.
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Email: Kenneth.Stevens@ci.kinston.nc.us

X ____
(SIGNATURE OF PERSON AUTHORIZED TO REPRESENT THIS FIRM IN OFFICIAL DEALINGS WITH THE CITY)
BY THIS SIGATURE, I CERTIFY THAT THIS REPORT IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE

DATE	OPERATION HOURS	FLOW Discharge Pumps	pH		TIME			SPECIAL NOTES
#	HRS	GALLONS	UNITS		AM/PM			
1								Did Not Pump
2								Did Not Pump
3								Did Not Pump
4								Did Not Pump
5								Did Not Pump
6								Did Not Pump
7								Did Not Pump
8								Did Not Pump
9								Did Not Pump
10								Did Not Pump
11								Did Not Pump
12								Did Not Pump
13								Did Not Pump
14								Did Not Pump
15								Did Not Pump
16								Did Not Pump
17	9.49	48968.4	7.28		8:00			3" Rain
18	7.41	38184	7.27		8:00			0
19	6.67	34417.2	7.28		8:00			0
20	6.37	32869.2	7.28		8:00			0
21								Did Not Pump
22								Did Not Pump
23								Did Not Pump
24								Did Not Pump
25								Did Not Pump
26								Did Not Pump
27								Did Not Pump
28								Did Not Pump
29								Did Not Pump
30								Did Not Pump
AVERAGE		5147.96	7.2775					
MAXIMUM		48968.4	7.28					
MININUIM		32869.2	7.27					
COMP/GRAB		Cont	GRAB					
DAILY LIMIT		N/A	N/A					
WEEKLY LIMIT		N/A	N/A					
MONTHLY LIMIT		N/A	>=6, <=9					
COMLPIANT		N/A	YES					
TOTAL		154438.8						

LENOIR COUNTY LANDFILL

IUP PERMIT NO: NSIU-3 DISCHARGE NO: 01 Month: Nov YEAR: 2009
FACILITY NAME: Lenoir County Landfill DISCHARGES TO: Kinston RWRF
CONTACT PERSON(S): Tom Miller/Mike Jarman PHONE: 252-566-4194
CERTIFIED LABORATORIES:
* If required to sample other than pH and temperture Person(s) collecting Sample:

Mail ORIGINAL to:
CITY OF KINSTON-PUBLIC SERVICES (WWTP)
ATTN: KENNETH R. STEVENS, JR.
P.O. DRAWER 339
KINSTON, NC 28502
Email: Kenneth.Stevens@ci.kinston.nc.us

(SIGNATURE OF PERSON AUTHORIZED TO REPRESENT THIS FIRM IN OFFICIAL DEALINGS WITH THE CITY)
BY THIS SIGATURE, I CERTIFY THAT THIS REPORT IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE

DATE	OPERATION HOURS	FLOW Discharge Pumps	pH		TIME			SPECIAL NOTES
#	HRS	GALLONS	UNITS		AM/PM			
1								No Discharge
2								No Discharge
3								No Discharge
4								No Discharge
5								No Discharge
6								No Discharge
7								No Discharge
8								No Discharge
9								No Discharge
10								No Discharge
11								No Discharge
12								No Discharge
13								No Discharge
14								No Discharge
15								No Discharge
16	8.84	45614.4	7.29		8:00 AM			Pumped
17	7.66	39525.6	7.30		8:00 AM			Pumped
18	7.67	39577.2	7.30		8:00 AM			Pumped
19	5.64	29102.4	7.30		8:00 AM			Pumped
20	1.88	9700.8	7.30		8:00 AM			Pumped
21								No Discharge
22								No Discharge
23								No Discharge
24								No Discharge
25								No Discharge
26								No Discharge
27								No Discharge
28								No Discharge
29								No Discharge
30								No Discharge

	GALLONS	pH
AVERAGE	5450.68	7.29
MAXIMUM	45614.4	7.29
MININUIM	9700.8	7.29
COMP/GRAB	Cont	GRAB
DAILY LIMIT	N/A	N/A
WEEKLY LIMIT	N/A	N/A
MONTHLY LIMIT	N/A	>=6, <=9
COMLPIANT	N/A	YES
TOTAL	163520.4	

LENOIR COUNTY LANDFILL

IUP PERMIT NO: NSIU-3
DISCHARGE NO: 01
Month: Jan YEAR: 2010
FACILITY NAME: Lenoir County Landfill
DISCHARGES TO: Kinston RWRF
CONTACT PERSON(S): Tom Miller/Mike Jarman
PHONE: 252-566-4194
CERTIFIED LABORATORIES: ______
* If required to sample other than pH and temperture
Person(s) collecting Sample: ______

Mail ORIGINAL to:
CITY OF KINSTON-PUBLIC SERVICES (WWTP) X Tom Miller
ATTN: KENNETH R. STEVENS, JR.
P.O. DRAWER 339
KINSTON, NC 28502
Email: Kenneth.Stevens@ci.kinston.nc.us

(SIGNATURE OF PERSON AUTHORIZED TO REPRESENT THIS FIRM IN OFFICIAL DEALINGS WITH THE CITY)
BY THIS SIGATURE, I CERTIFY THAT THIS REPORT IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE

DATE	OPERATION HOURS	FLOW Discharge Pumps	pH		TIME			SPECIAL NOTES
#	HRS	GALLONS	UNITS		AM/PM			
1								No Discharge
2								No Discharge
3								No Discharge
4								No Discharge
5								No Discharge
6	15.58	80392.8	7.29		8:00 AM			No Rain
7	10.27	52793.2	7.28		8:30 AM			No Rain
8	10.16	52425.6	7.28		8:00 AM			No Rain
9	9.11	47007.6	7.28		8:00 AM			No Rain
10	8.67	44737.2	7.28		8:00 AM			Rain 2"
11	10.27	52993.2	7.30		8:00 AM			No Rain
12	11.59	59804.4	7.30		8:30 AM			No Rain
13	7.86	40557.6	7.30		8:00 AM			No Rain
14	********Turned off pumps at 8:00 A.M********.							No Rain
15								No Discharge
16								No Discharge
17								No Discharge
18								No Discharge
19								No Discharge
20								No Discharge
21								No Discharge
22								No Discharge
23								No Discharge
24								No Discharge
25								No Discharge
26								No Discharge
27								No Discharge
28								No Discharge
29								No Discharge
30								No Discharge
31								No Discharge

	FLOW	pH
AVERAGE	13893.92258	7.282
MAXIMUM	80392.8	7.29
MININUIM	40557.6	7.28
COMP/GRAB	Cont	GRAB
DAILY LIMIT	N/A	N/A
WEEKLY LIMIT	N/A	N/A
MONTHLY LIMIT	N/A	>=6, <=9
COMLPIANT	N/A	YES
TOTAL	430711.6	

2.2 Summary of the Facility Design

Several factors have been looked at in the design and stability of the landfill. The first is earthwork calculations to see if the facility will need to borrow material from another source. For the construction of Phase 2 the facility will need 30,860 cubic yards of off-site soil. An additional 62,136 cubic yards will be needed for daily cover and an additional 74,455 cubic yards will be needed for closure. An Erosion Control plan has been developed and approved by the Land Quality Section of NCDENR, and the calculations are in section 2.2.2.

HELP Model Summary

A "Hydrologic Evaluation of Landfill Performance" (HELP) Model has been performed to simulate precipitation and leachate generation under certain conditions. The output can be found in Section 2.2.3. The analysis is done through the landfill with 8 ft. of solid waste with no runoff for the 1st year of operation and with 25 ft. of solid waste with no runoff for the 1st through the 5th year of operation. Simulation was also done on a closed landfill. The peak daily head on the liner of 0.312 inches occurs after 1 year of operation with 8 ft. of solid waste and no surface runoff. The peak daily head on the liner for the 1st five years is 0.479 inches. The drainage layer (layer 5) is a double bonded 250 mil thick drainage net.

Leachate Collection System Calculations Summary

The leachate collection system consists of a 250 mil double bonded drainage net that is the drainage layer, stone filled trenches and collection pipes. The adequacy of the drainage layer is demonstrated in the HELP models (see sec.2.2.3).

Calculations have been performed for the Leachate Collection Pipes, and are located in Section 2.2.4. The calculations uses Manning's equation and the orifice equation to determine the adequacy of the leachate piping system to drain the leachate. The system adequately drains the 24hr 25yr storm. See calculations in section 2.2.4.

Strength of the HDPE leachate pipe calculations have been done and are located in section 2.2.5. The SDR 17 HDPE pipe can handle the loads created by at least 200' of waste. See section 2.2.5 for calculations.

Liner System Calculation Summary

Several calculations were done for the stress on the textured flexible geomembrane liner during construction. The thermal stress on the liner created by the temperature changing 100°F is 0.67% which is well within the 13% elongation yield limit. (see sec. 2.2.6) The self-weight stress on the textured flexible geomembrane liner shows that on a 3:1 slope the total length of slope allowed far exceeds the longest slope design (see sec. 2.2.6).

The Anchor trench has also been analyzed and the design depth of the Anchor trench is 4.0 ft. which allows pullout just prior to liner failure. (see sec. 2.2.6). An analysis of the drainage net for anchor trench requirements was analyzed and no anchor trench was required; however, the drainage net will be placed in the same anchor trench as the flexible membrane liner.(see sec.2.2.6).

The factor of safety for the sliding of the protective soil cover was analyzed showing a factor of safety greater than 1 for the interface between the soil and double bonded drainage net. (see sec. 2.2.6). The stresses due to the placement of protective cover were also analyzed (see sec. 2.2.6). Soil placed on the 3:1 embankment 50 ft. high does not affect the drainage net or the liner. The soil is buttressed enough at the base to have a negative effect on the slopes.

The geotechnical evaluation report by ECS, Ltd. states that the proposed plan is suitable and falls within acceptable safety factors. The report is located in Section 2.2.8.

2.2.1 Earthwork Calculations

*Required soil for:	
Subbase preparation Phase 2:	18,557 cubic yards
Composite Liner System Phase 2:	30,616 cubic yards
Protective Cover Phase 2:	45,139 cubic yards
Total Soil required for Construction Phase 2:	**94,312 cubic yards**
Required soil for:	
Daily Cover Phase 2:	62,136 cubic yards
Closure System Phase 2:	74,455 cubic yards
Total Soil required To build, operate and close Phase 2:	**230,903 cubic yards**

*Determined by AutoCADD computer program.

2.2.2 Erosion Control

REVISION TO APPROVED EROSION CONTROL PLAN

for

Lenoir County Municipal Solid Waste Landfill Facility

Landfill Permit No.: 5409-MSWLF

Site Location: 2949 Hodges Farm Road
Kinston, NC 28551

Applicant: Lenoir County

Applicant's Address: 130 South Queen Street
Kinston, NC 27502

MESCO Project Number
G08095

November 2009

Submitted By:

Municipal Engineering Services Company, P.A.

Garner	Boone	Morehead City
P.O. Box 97	P.O. Box 349	P.O. Box 828
Garner, NC 27529	Boone, NC 28607	Morehead City, NC 28557
(919) 772-5393	(828) 262-1767	(252) 726-9481

DRAINAGE/DISTURBED AREAS

Drainage/ Disturbed Areas

Area Designation	Acres	C factor
D1	11.99	0.50
D2	1.96	0.50
D3	2.81	0.35
D4	3.59	0.35

Total Disturbed
13.95 acres

Runoff Coefficient
NC Erosion Control Manual Table 8.03b
C = varies (see above)

Rainfall Intensity

NC Erosion Control Manual Fig. 8.03c
Rainfall Intensity Chart for Raleigh

I = 6.19

Raleigh, North Carolina 35.8706N, 78.7864W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	5.58	4.46	3.74	2.58	1.62	0.94	0.66	0.40	0.24	0.14
10	7.08	5.66	4.78	3.46	2.25	1.33	0.95	0.58	0.34	0.021
25	7.78	6.19	5.24	3.88	2.58	1.54	1.11	0.68	0.41	0.24
100	8.64	[illegible].86	5.78	4.43	3.05	1.85	1.36	0.84	0.51	0.30

USE
6.19

Design Sediment Basin 1

Disturbed/Drainage area to Basin 1

Area Designation	Acres	C factor
D1	11.99	0.50
D2	1.96	0.50
D3	2.81	0.35
D4	3.59	0.35

Find Composite C:

13.95	x 0.50	= 6.98
6.40	x 0.35	= 2.24
20.35		9.22

Combined C factor ÷ acreage = Composite C = 9.22 ÷ 20.35 = 0.45 = Composite C

$Q_{(25)}$ = CIA= (.45)(6.19)(20.35) = 56.68 cfs

Surface area needed: : 435 Sq. Ft./Peak cfs

Surface area S = 435(56.68) = 24,656 ft^2
Use 6:1 Length:width ratio = $(24{,}656l6)^{.5}$ = 64.10'
use 69' x 448' min. surface area dimension

Surface Area required = 24,656 square feet
Surface Area Provided = 26,000 square feet

Depth of basin:

depth = Capacity/disturbed area

Capacity needed is 1800 ft^3/acre.
Capacity = (1800)(20.35) = 36,630 ft^3 of storage needed

Use a storage depth of 2'
Bottom area = 36,630 ft^3 ÷ 2' = 18,315 ft^2

Use 6:1 length:width ratio
$(18315 \div 6)^{.5}$ = 55.25 ft. use 57 ft.

Bottom Area Required = 56' x 336'
Bottom Area Provided= 57' x 392'

Storage volume required = 36,630 cubic feet
Storage Volume Provided = 53,256 cubic feet

The actual storage capacity of the basin is adequate to contain the runoff.

Principal spillway barrel size:

Size for a 25 year storm:
C = 0.45 (composite C)
I = 6.19
A = 20.35 acres (total drainage area)

$Q_{(25)}$ = CIA= (0.45)(6.19)(20.35) = 56.68 cfs

Q = 56.68 cfs   n = .024   s = .015

$D = 16 (Q\,n \div \sqrt{s})^{.375}$ Use corrugated metal pipe
$D = 16[(56.68)(.024) \div \sqrt{.015}]^{.375} = 39.46"$ Use 42" CMP

Outlet Protection: L =20'   W = 23.5' d_{50} = 12"   27" min. thickness

Riser pipe for Principal spillway:

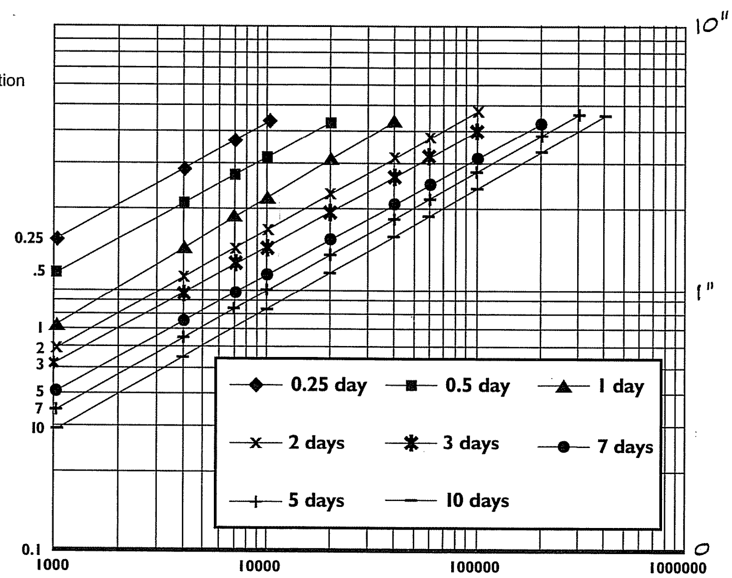
1.5 times the required min. barrel size = 1.5(39.46") = 59.19"
Use 60" pipe diameter

Footing for riser pipe:

Weight of water: $\pi r^2 h(62.4)$ = 2450.44
Concrete: 150 lbs per ft^3
16.33 ft^3 of concrete needed
use 36 ft^3 of concrete
1'x6'x6' footing.

Skimmer: Use skimmer designed with 4" orifice diameter. (Determined by using chart below found in NC Erosion Control Manual) Based on Basin Volume of 53,256 cubic feet and 2 day dewatering time.

Figure 6.64b Skimmer orifice diameter as a function of the basin volume and basin dewatering time.



Emergency Spillway:

n =	0.032	9" stone
B =	20.00	
S =	0.015	
Y =	1	
M =	3	
Depth =	1	

W =	26			
R =	0.873709	R value		
Q =	119.5511	Flow		
A =	23	Adjusted Area of flow		
P =	26.32456	Adjusted Wetted Perimeter		
V =	5.197873		Va =8	
Shear Stress	0.936		0-.45	jute netting
			.46-1.45	straw with net
			1.45-2.00	synthetic mat
			2.00max.	6" stone
			<u>3.00max.</u>	<u>9" stone</u>

Elevations:

Top of Dam	68.0'
Emergency Spillway	67.0'
Riser Crest	66.0'
Conduit Inlet	64.0'
Conduit Outlet	63.5.0'
Bottom Elevation	64.0'

Design Diversion Ditch #1 :

Areas Draining Into Diversion Ditch #1

Area Designation	Acres	C factor	Intensity
D1	11.99	0.50	6.19

$$Q_{(25)} = CIA = (.50)(6.19)(11.99) = 37.11 \text{ cfs}$$

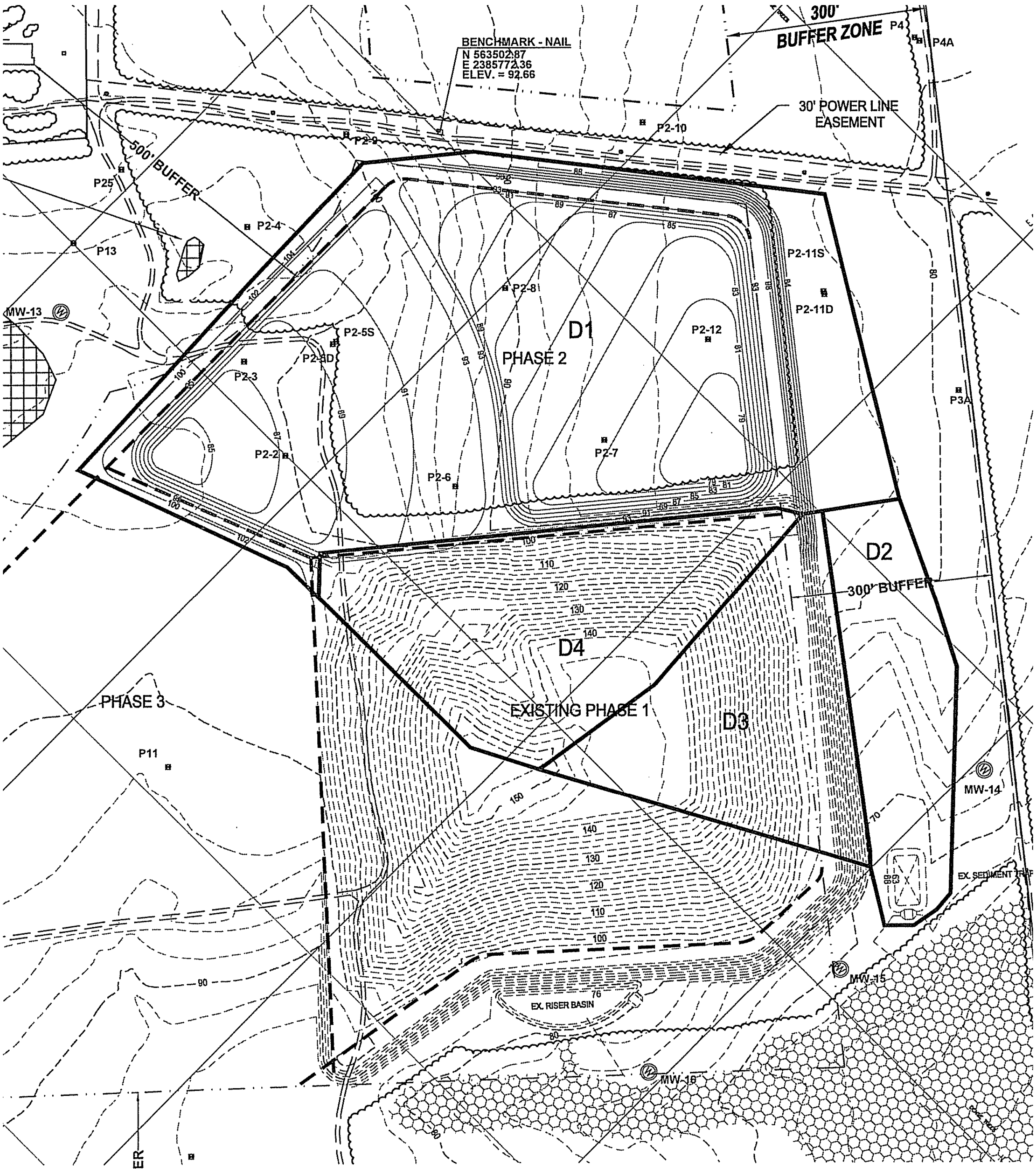
Ditch Calculation:

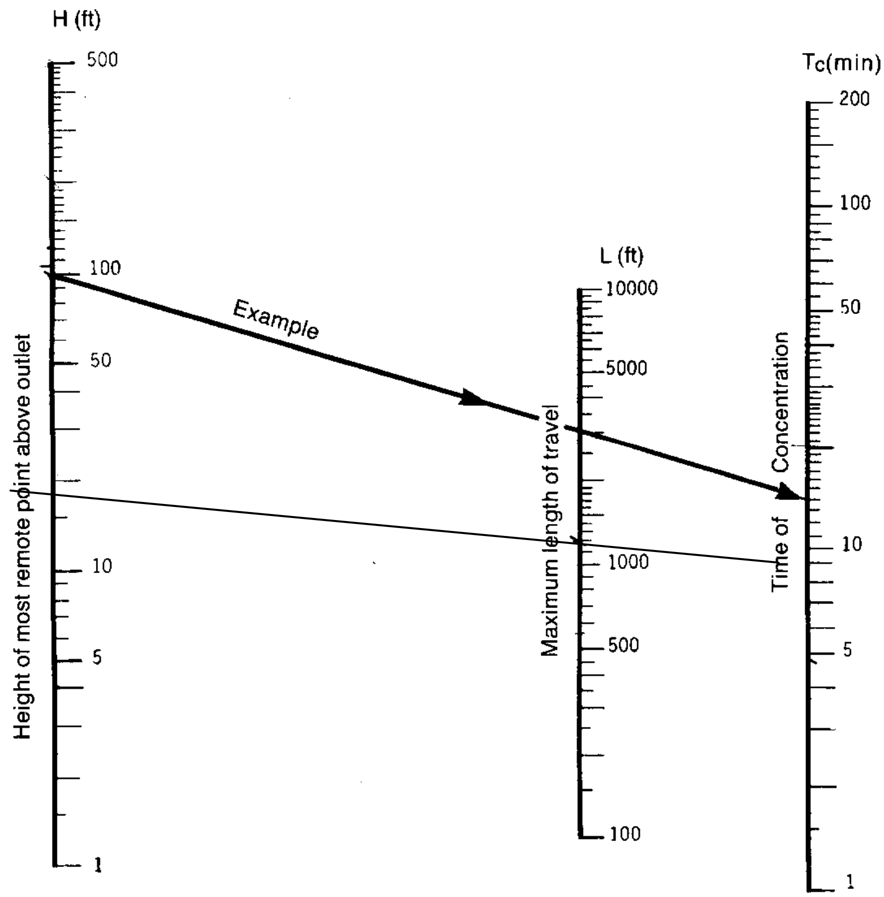
n =	0.03	grass lined
B =	7.00	
S =	0.01	
Y =	1	
M =	3	
Depth =	1	

W =	13	
R =	0.750494	R value
Q =	40.90682	Flow
A =	10	Adjusted Area of flow
P =	13.32456	Adjusted Wetted Perimeter

V =	4.090682	Va =5.0	
Shear Stress	0.624	0-.45	jute netting
		.46-1.45	straw with net
		1.45-2.00	synthetic mat
		2.00max.	6" stone

Reference Materials


300' BUFFER ZONE
P4
P4A
BENCHMARK - NAIL
N 563502.87
E 2385772.36
ELEV. = 92.66
30' POWER LINE EASEMENT
P2-10
P2-9
500' BUFFER
P25
P2-4
P13
MW-13
P2-11S
P2-11D
P2-8
D1
P2-12
P2-5S
P2-5D
PHASE 2
P2-3
P3A
P2-2
P2-7
P2-6
D2
300' BUFFER
D4
EXISTING PHASE 1
D3
PHASE 3
P11
MW-14
EX. SEDIMENT TRAP
MW-15
EX. RISER BASIN
MW-16



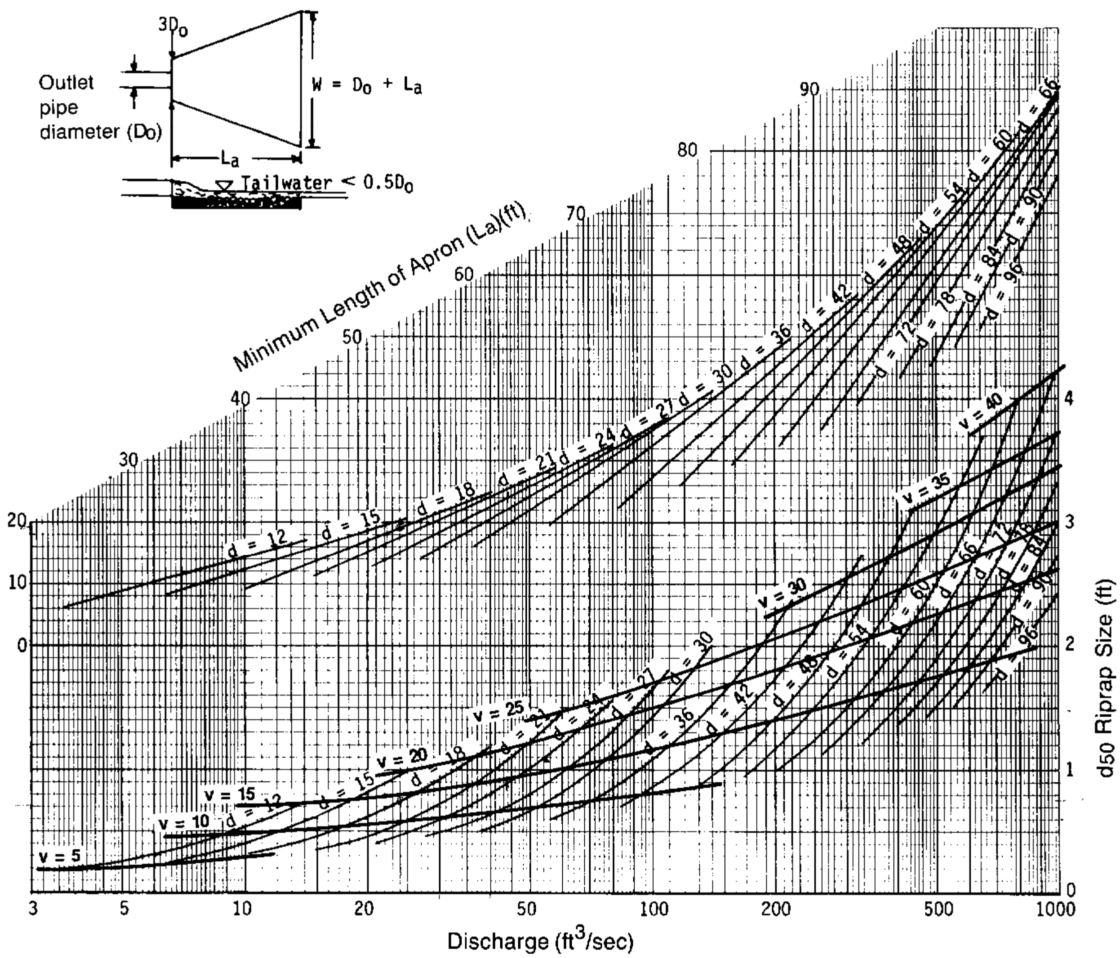
Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.



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).

2.2.3 HELP Model

INSERT FIRST HELP MODEL
STANDARD LINER SYSTEM (Alt. 1)
PHASE 2 OPEN 1st YEAR

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04    (13 MARCH 1995)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\LENOIR.D4
TEMPERATURE DATA FILE:        C:\HELP3\Lenoir.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\Lenoir.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\Lenoir.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\Lenoir.D10
OUTPUT DATA FILE:             C:\HELP3\Lenoir1.OUT
```

Time: 11:33 Date: 10/10/2009

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

Title: Lenoir County Phase 2 Open 1st Year (Alt. 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  12
        THICKNESS                  =     12.00    INCHES
        POROSITY                   =      0.4710 VOL/VOL
        FIELD CAPACITY             =      0.3420 VOL/VOL
        WILTING POINT              =      0.2100 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.3106 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	96.00	INCHES
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0726	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00	INCHES
POROSITY	=	0.4790	VOL/VOL
FIELD CAPACITY	=	0.3710	VOL/VOL
WILTING POINT	=	0.2510	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4313	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0574	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

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	=	4.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	4.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #12 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	91.70	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.421	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.332	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.710	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	36.488	INCHES
TOTAL INITIAL WATER	=	36.488	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM RALEIGH NORTH CAROLINA

```
STATION LATITUDE                             =  35.87 DEGREES
MAXIMUM LEAF AREA INDEX                      =   3.50
START OF GROWING SEASON (JULIAN DATE)        =     86
END OF GROWING SEASON (JULIAN DATE)          =    310
EVAPORATIVE ZONE DEPTH                       =  22.0  INCHES
AVERAGE ANNUAL WIND SPEED                    =   7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY        =  66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY        =  70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY        =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY        =  72.00 %
```

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.11	3.66	3.96	3.39	4.42	5.39
6.20	5.76	5.30	3.06	2.92	3.42

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.80	43.60	51.40	61.00	68.40	74.90
78.70	78.10	72.80	61.80	52.50	44.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.13 DEGREES

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.69	4.39	3.13	1.63	2.14	8.50
	7.20	7.75	2.85	3.84	0.72	5.12

RUNOFF	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	1.383 6.447	1.891 4.289	2.948 2.814	2.478 3.416	3.036 0.420	5.925 0.810
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.6587 0.2401	0.4137 2.2378	2.0998 1.6912	0.6726 1.8216	0.2942 0.6605	0.0073 1.3076
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.002 0.000	0.001 0.002	0.002 0.002	0.001 0.002	0.000 0.001	0.000 0.001
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.001 0.000	0.000 0.002	0.002 0.001	0.000 0.002	0.000 0.000	0.000 0.003

****

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.96	177724.844	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	35.855	130152.031	73.23
DRAINAGE COLLECTED FROM LAYER 4	13.1053	47572.070	26.77
PERC./LEAKAGE THROUGH LAYER 6	0.000003	0.011	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0012		
CHANGE IN WATER STORAGE	0.000	0.692	0.00
SOIL WATER AT START OF YEAR	36.488	132451.344	
SOIL WATER AT END OF YEAR	36.488	132452.031	
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	0.037	0.00

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.69	4.39	3.13	1.63	2.14	8.50
	7.20	7.75	2.85	3.84	0.72	5.12
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
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	1.383	1.891	2.948	2.478	3.036	5.925
	6.447	4.289	2.814	3.416	0.420	0.810
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
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.6587	0.4137	2.0998	0.6726	0.2942	0.0073
	0.2401	2.2378	1.6912	1.8216	0.6605	1.3076
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0018	0.0005	0.0022	0.0007	0.0003	0.0000
	0.0003	0.0024	0.0019	0.0019	0.0007	0.0014
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

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

	INCHES		CU. FEET	PERCENT
PRECIPITATION	48.96	(0.000)	177724.8	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	35.855	(0.0000)	130152.03	73.232
LATERAL DRAINAGE COLLECTED FROM LAYER 4	13.10525	(0.00000)	47572.070	26.76726
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.011	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.001	(0.000)		
CHANGE IN WATER STORAGE	0.000	(0.0000)	0.69	0.000

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	2.85	10345.500
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.30297	1099.77881
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00017
AVERAGE HEAD ON TOP OF LAYER 5	0.010	
MAXIMUM HEAD ON TOP OF LAYER 5	0.312	
SNOW WATER	1.63	5916.4204

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2670
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1232

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

****

****

FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	3.7289	0.3107
2	6.9729	0.0726
3	15.5240	0.4312
4	0.0143	0.0573
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

****
****

INSERT SECOND HELP MODEL
STANDARD LINER SYSTEM (Alt. 1)
PHASE 2 OPEN 5 YEARS w/25 FT. OF SOLID WASTE

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04    (13 MARCH 1995)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\LENOIR.D4
TEMPERATURE DATA FILE:        C:\HELP3\Lenoir.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\Lenoir.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\Lenoir.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\LENOIR2.D10
OUTPUT DATA FILE:             C:\HELP3\Lenoir2.OUT
```

Time: 12:31 Date: 10/10/2009

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

Title: Lenoir County Phase 2 Open 5 Years w/ 25 ft. Waste (Alt. 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  12
           THICKNESS                 =      12.00    INCHES
           POROSITY                  =       0.4710 VOL/VOL
           FIELD CAPACITY            =       0.3420 VOL/VOL
           WILTING POINT             =       0.2100 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.3107 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =   0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	300.00 INCHES
POROSITY	=	0.1680 VOL/VOL
FIELD CAPACITY	=	0.0730 VOL/VOL
WILTING POINT	=	0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0729 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4790 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4467 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04 CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	100.0 FEET

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              =       4.00   HOLES/ACRE
FML INSTALLATION DEFECTS         =       4.00   HOLES/ACRE
FML PLACEMENT QUALITY            =  3 - GOOD


                              LAYER  6
                              --------

                   TYPE 3 - BARRIER SOIL LINER
                   MATERIAL TEXTURE NUMBER  16
THICKNESS                        =      24.00    INCHES
POROSITY                         =       0.4270 VOL/VOL
FIELD CAPACITY                   =       0.4180 VOL/VOL
WILTING POINT                    =       0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT       =       0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.100000001000E-06 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF  200. FEET.

SCS RUNOFF CURVE NUMBER             =      91.70
FRACTION OF AREA ALLOWING RUNOFF    =      50.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =       1.000   ACRES
EVAPORATIVE ZONE DEPTH              =      22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =       4.425   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =       7.332   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =       2.710   INCHES
INITIAL SNOW WATER                  =       0.000   INCHES
INITIAL WATER IN LAYER MATERIALS    =      51.927   INCHES
TOTAL INITIAL WATER                 =      51.927   INCHES
TOTAL SUBSURFACE INFLOW             =       0.00    INCHES/YEAR


             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         RALEIGH                    NORTH CAROLINA
```

```
STATION LATITUDE                              =  35.87 DEGREES
MAXIMUM LEAF AREA INDEX                       =   3.50
START OF GROWING SEASON (JULIAN DATE)         =     86
END OF GROWING SEASON (JULIAN DATE)           =    310
EVAPORATIVE ZONE DEPTH                        =  22.0  INCHES
AVERAGE ANNUAL WIND SPEED                     =   7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY         =  66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY         =  70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY         =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY         =  72.00 %
```

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.11	3.66	3.96	3.39	4.42	5.39
6.20	5.76	5.30	3.06	2.92	3.42

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.80	43.60	51.40	61.00	68.40	74.90
78.70	78.10	72.80	61.80	52.50	44.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR RALEIGH NORTH CAROLINA AND STATION LATITUDE = 35.13 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.69	4.39	3.13	1.63	2.14	8.50
	7.20	7.75	2.85	3.84	0.72	5.12

RUNOFF	0.024	0.201	0.094	0.000	0.067	0.513
	0.658	0.795	0.103	0.277	0.013	0.455
EVAPOTRANSPIRATION	1.387	1.893	2.950	2.554	2.869	5.896
	6.419	4.291	2.817	3.420	0.368	0.814
LATERAL DRAINAGE COLLECTED FROM LAYER 4	2.1708	0.4291	1.8354	0.6745	0.2714	0.0190
	0.0748	0.9028	1.2214	1.4691	0.7060	0.3114
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.002	0.001	0.002	0.001	0.000	0.000
	0.000	0.001	0.001	0.002	0.001	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.002	0.000	0.002	0.000	0.000	0.000
	0.000	0.001	0.001	0.001	0.000	0.001

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.96	177724.844	100.00
RUNOFF	3.200	11616.245	6.54
EVAPOTRANSPIRATION	35.679	129513.109	72.87
DRAINAGE COLLECTED FROM LAYER 4	10.0857	36611.102	20.60
PERC./LEAKAGE THROUGH LAYER 6	0.000003	0.009	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0009		
CHANGE IN WATER STORAGE	-0.004	-15.620	-0.01
SOIL WATER AT START OF YEAR	51.927	188496.016	
SOIL WATER AT END OF YEAR	51.923	188480.391	
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	-0.009	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.83	2.30	5.14	3.78	9.70	10.52
	5.47	1.76	1.45	8.97	1.43	1.63
RUNOFF	0.453	0.093	0.220	0.069	1.463	1.315
	0.465	0.173	0.042	1.255	0.002	0.035
EVAPOTRANSPIRATION	1.105	1.698	2.782	4.163	5.817	4.146
	4.813	3.013	1.054	3.008	1.499	0.982
LATERAL DRAINAGE COLLECTED FROM LAYER 4	2.6468	1.1639	1.1808	0.9334	0.8064	2.8500
	3.1049	0.7303	0.5017	0.8673	2.2869	0.4220
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.003	0.001	0.001	0.001	0.001	0.003
	0.003	0.001	0.001	0.001	0.003	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.002	0.001	0.001	0.000	0.001	0.003
	0.003	0.000	0.000	0.002	0.002	0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	54.98	199577.391	100.00
RUNOFF	5.585	20273.453	10.16

EVAPOTRANSPIRATION	34.080	123709.836	61.99
DRAINAGE COLLECTED FROM LAYER 4	17.4943	63504.293	31.82
PERC./LEAKAGE THROUGH LAYER 6	0.000004	0.014	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0016		
CHANGE IN WATER STORAGE	-2.179	-7910.161	-3.96
SOIL WATER AT START OF YEAR	51.923	188480.391	
SOIL WATER AT END OF YEAR	49.744	180570.234	
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

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.81	3.17	6.82	1.16	2.13	5.54
	10.76	21.29	8.25	4.81	2.02	2.19
RUNOFF	1.289	0.174	0.652	0.035	0.034	0.753
	1.513	4.949	2.057	0.406	0.108	0.170
EVAPOTRANSPIRATION	1.711	2.118	2.858	2.497	2.207	2.944
	7.181	5.396	2.334	3.056	1.453	0.942
LATERAL DRAINAGE COLLECTED	0.9719	6.1603	2.0721	1.3133	0.5571	0.1675
FROM LAYER 4	0.9356	6.1825	8.9298	1.1095	1.1543	1.2025
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.007	0.002	0.001	0.001	0.000

TOP OF LAYER 5	0.001	0.007	0.010	0.001	0.001	0.001
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.001	0.004	0.002	0.001	0.000	0.000
	0.002	0.007	0.007	0.000	0.001	0.001

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	77.95	282958.469	100.00
RUNOFF	12.140	44067.172	15.57
EVAPOTRANSPIRATION	34.697	125948.898	44.51
DRAINAGE COLLECTED FROM LAYER 4	30.7564	111645.586	39.46
PERC./LEAKAGE THROUGH LAYER 6	0.000006	0.021	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0028		
CHANGE IN WATER STORAGE	0.357	1296.804	0.46
SOIL WATER AT START OF YEAR	49.744	180570.234	
SOIL WATER AT END OF YEAR	50.101	181867.031	
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	-0.021	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.94	3.35	4.50	2.16	4.28	4.38
	7.06	4.14	6.25	1.06	4.01	3.99

RUNOFF	0.047	0.242	0.245	0.033	0.012	0.310
	0.662	0.051	1.037	0.000	0.275	0.417
EVAPOTRANSPIRATION	1.623	2.011	2.927	3.738	4.578	4.055
	4.713	3.932	2.667	2.412	1.298	0.995
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.9159	1.2525	1.3016	0.6137	0.2793	0.0220
	0.0223	0.2065	0.6208	1.4680	0.3667	0.6123
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.001	0.002	0.001	0.001	0.000	0.000
	0.000	0.000	0.001	0.002	0.000	0.001
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.000	0.001	0.001	0.000	0.000	0.000
	0.000	0.000	0.002	0.001	0.000	0.001

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.12	174675.578	100.00
RUNOFF	3.331	12092.490	6.92
EVAPOTRANSPIRATION	34.949	126864.789	72.63
DRAINAGE COLLECTED FROM LAYER 4	7.6816	27884.281	15.96
PERC./LEAKAGE THROUGH LAYER 6	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0007		
CHANGE IN WATER STORAGE	2.149	7799.133	4.46
SOIL WATER AT START OF YEAR	50.101	181867.031	
SOIL WATER AT END OF YEAR	52.250	189666.172	
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	0.0096	34.879	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.63	1.80	3.90	6.60	3.00	10.89
	1.82	5.68	3.68	2.40	4.65	2.89
RUNOFF	0.000	0.000	0.278	0.476	0.032	1.573
	0.034	0.389	0.452	0.079	0.357	0.328
EVAPOTRANSPIRATION	1.418	1.708	2.834	4.082	4.199	6.328
	2.724	2.275	2.717	2.772	1.609	1.329
LATERAL DRAINAGE COLLECTED FROM LAYER 4	2.5870	0.4808	0.2447	0.7331	1.4471	0.4435
	2.1321	0.4903	0.9118	1.0259	0.4852	1.1496
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.003	0.001	0.000	0.001	0.002	0.001
	0.002	0.001	0.001	0.001	0.001	0.001
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.002	0.000	0.000	0.001	0.001	0.000
	0.002	0.000	0.001	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.94	177652.187	100.00
RUNOFF	3.998	14514.175	8.17

EVAPOTRANSPIRATION	33.994	123398.742	69.46
DRAINAGE COLLECTED FROM LAYER 4	12.1309	44035.285	24.79
PERC./LEAKAGE THROUGH LAYER 6	0.000003	0.011	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0011		
CHANGE IN WATER STORAGE	-1.183	-4296.002	-2.42
SOIL WATER AT START OF YEAR	52.250	189666.172	
SOIL WATER AT END OF YEAR	51.066	185370.172	
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	-0.033	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.78	3.00	4.70	3.07	4.25	7.97
	6.46	8.12	4.50	4.22	2.57	3.16
STD. DEVIATIONS	3.43	1.00	1.40	2.21	3.17	2.92
	3.24	7.68	2.73	3.01	1.69	1.40
RUNOFF						
TOTALS	0.363	0.142	0.298	0.123	0.321	0.893
	0.666	1.271	0.738	0.403	0.151	0.281
STD. DEVIATIONS	0.550	0.096	0.210	0.199	0.638	0.535
	0.538	2.075	0.837	0.502	0.159	0.176
EVAPOTRANSPIRATION						
TOTALS	1.449	1.885	2.870	3.407	3.934	4.674
	5.170	3.781	2.318	2.934	1.245	1.012
STD. DEVIATIONS	0.236	0.185	0.069	0.821	1.427	1.404
	1.726	1.199	0.729	0.373	0.503	0.191

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.8585	1.8973	1.3269	0.8536	0.6723	0.7004
	1.2539	1.7025	2.4371	1.1879	0.9998	0.7395
STD. DEVIATIONS	0.8550	2.4129	0.7084	0.2836	0.4865	1.2140
	1.3422	2.5181	3.6402	0.2705	0.7798	0.4132

PERCOLATION/LEAKAGE THROUGH LAYER 6

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0020	0.0023	0.0014	0.0009	0.0007	0.0008
	0.0013	0.0018	0.0027	0.0013	0.0011	0.0008
STD. DEVIATIONS	0.0009	0.0028	0.0008	0.0003	0.0005	0.0013
	0.0014	0.0027	0.0040	0.0003	0.0009	0.0004

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

	INCHES	CU. FEET	PERCENT
PRECIPITATION	55.79 (12.690)	202517.7	100.00
RUNOFF	5.651 (3.7492)	20512.71	10.129
EVAPOTRANSPIRATION	34.680 (0.6893)	125887.07	62.161
LATERAL DRAINAGE COLLECTED FROM LAYER 4	15.62978 (9.19839)	56736.109	28.01538
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.013	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.001 (0.001)		
CHANGE IN WATER STORAGE	-0.172 (1.6389)	-625.17	-0.309

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.77	24575.100
RUNOFF	2.586	9387.6406
DRAINAGE COLLECTED FROM LAYER 4	0.71604	2599.20947
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00036
AVERAGE HEAD ON TOP OF LAYER 5	0.024	
MAXIMUM HEAD ON TOP OF LAYER 5	0.479	
SNOW WATER	1.63	5916.4204

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2703
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1232

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	3.8049	0.3171
2	22.8243	0.0761
3	14.1864	0.3941
4	0.0025	0.0100
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

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INSERT FINAL HELP MODEL
STANDARD LINER SYSTEM (Alt. 1)
PHASE 2 CLOSED

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.04    (13 MARCH 1995)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**        FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                   **
**                                                                          **
**                                                                          **
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```
PRECIPITATION DATA FILE:      C:\HELP3\LENOIR.D4
TEMPERATURE DATA FILE:        C:\HELP3\Lenoir.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\Lenoir.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\Lenoir.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\LENOIRC.D10
OUTPUT DATA FILE:             C:\HELP3\LenoirC.OUT
```

Time: 13:15 Date: 10/10/2009

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Title: Lenoir County Phase 2 Closed (Alt. 1)

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     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  12
            THICKNESS                  =     24.00    INCHES
            POROSITY                   =      0.4710 VOL/VOL
            FIELD CAPACITY             =      0.3420 VOL/VOL
            WILTING POINT              =      0.2100 VOL/VOL
            INITIAL SOIL WATER CONTENT =      0.3496 VOL/VOL
            EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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                    LAYER  2
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             TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                   =       0.20    INCHES
POROSITY                    =       0.8500 VOL/VOL
FIELD CAPACITY              =       0.0100 VOL/VOL
WILTING POINT               =       0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.0279 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =    10.0000000000     CM/SEC
SLOPE                       =       5.00    PERCENT
DRAINAGE LENGTH             =     300.0     FEET


                    LAYER  3
                    --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =       0.04    INCHES
POROSITY                    =       0.0000 VOL/VOL
FIELD CAPACITY              =       0.0000 VOL/VOL
WILTING POINT               =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =       4.00    HOLES/ACRE
FML INSTALLATION DEFECTS    =       4.00    HOLES/ACRE
FML PLACEMENT QUALITY       =   3 - GOOD


                    LAYER  4
                    --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  23
THICKNESS                   =      18.00    INCHES
POROSITY                    =       0.4610 VOL/VOL
FIELD CAPACITY              =       0.3600 VOL/VOL
WILTING POINT               =       0.2030 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.4610 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   0.900000032000E-05 CM/SEC


                    LAYER  5
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TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4710 VOL/VOL
FIELD CAPACITY	=	0.3420 VOL/VOL
WILTING POINT	=	0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.419999997000E-04 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	360.00 INCHES
POROSITY	=	0.1680 VOL/VOL
FIELD CAPACITY	=	0.0730 VOL/VOL
WILTING POINT	=	0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4790 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3710 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04 CM/SEC

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	100.0 FEET

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          =       4.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       4.00    HOLES/ACRE
FML PLACEMENT QUALITY        =   3 - GOOD
```

LAYER 10

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

```
THICKNESS                    =      24.00    INCHES
POROSITY                     =       0.4270 VOL/VOL
FIELD CAPACITY               =       0.4180 VOL/VOL
WILTING POINT                =       0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   0.100000001000E-06 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
POOR STAND OF GRASS, A SURFACE SLOPE OF 2.%
AND A SLOPE LENGTH OF 200. FEET.

```
SCS RUNOFF CURVE NUMBER            =     91.70
FRACTION OF AREA ALLOWING RUNOFF   =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000   ACRES
EVAPORATIVE ZONE DEPTH             =     22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      7.627   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     10.362   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      4.620   INCHES
INITIAL SNOW WATER                 =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS   =     70.685   INCHES
TOTAL INITIAL WATER                =     70.685   INCHES
TOTAL SUBSURFACE INFLOW            =      0.00    INCHES/YEAR
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EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.11	3.66	3.96	3.39	4.42	5.39
6.20	5.76	5.30	3.06	2.92	3.42

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.80	43.60	51.40	61.00	68.40	74.90
78.70	78.10	72.80	61.80	52.50	44.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.13 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.69 7.20	4.39 7.75	3.13 2.85	1.63 3.84	2.14 0.72	8.50 5.12
RUNOFF	0.060 1.301	0.502 1.626	0.225 0.224	0.000 0.640	0.131 0.026	0.987 0.969
EVAPOTRANSPIRATION	1.458 6.251	1.931 4.148	2.997 2.746	2.705 3.423	3.665 1.451	5.741 0.922
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.3419 0.0030	0.5529 0.0033	1.4962 0.3970	0.0051 1.2745	0.0012 0.0000	0.0015 0.7550
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.001 0.000	0.002 0.000	0.005 0.001	0.000 0.004	0.000 0.000	0.000 0.003
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.001 0.000	0.006 0.000	0.006 0.002	0.000 0.007	0.000 0.000	0.000 0.005
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.96	177724.844	100.00
RUNOFF	6.691	24286.932	13.67

EVAPOTRANSPIRATION	37.438	135898.812	76.47
DRAINAGE COLLECTED FROM LAYER 2	4.8315	17538.311	9.87
PERC./LEAKAGE THROUGH LAYER 4	0.000086	0.311	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.310	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.000	0.415	0.00
SOIL WATER AT START OF YEAR	70.685	256587.672	
SOIL WATER AT END OF YEAR	70.685	256588.094	
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	0.053	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.83	2.30	5.14	3.78	9.70	10.52
	5.47	1.76	1.45	8.97	1.43	1.63
RUNOFF	0.983	0.210	0.510	0.160	3.007	2.662
	0.910	0.346	0.083	2.480	0.007	0.092
EVAPOTRANSPIRATION	1.160	1.739	2.824	4.198	5.871	5.111
	5.915	3.135	1.062	3.076	1.435	0.941
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1.2869	0.1341	1.1743	0.4855	1.4163	0.7637
	0.5029	0.0000	0.0001	0.8757	0.3173	0.5609
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.004	0.001	0.004	0.002	0.005	0.003
	0.002	0.000	0.000	0.003	0.001	0.002
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.005	0.001	0.003	0.002	0.008	0.005
	0.003	0.000	0.000	0.005	0.002	0.002
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	54.98	199577.391	100.00
RUNOFF	11.452	41571.547	20.83
EVAPOTRANSPIRATION	36.468	132379.062	66.33
DRAINAGE COLLECTED FROM LAYER 2	7.5178	27289.729	13.67
PERC./LEAKAGE THROUGH LAYER 4	0.000135	0.492	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0022		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.491	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.458	-1663.399	-0.83
SOIL WATER AT START OF YEAR	70.685	256588.094	
SOIL WATER AT END OF YEAR	70.227	254924.687	

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

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.81	3.17	6.82	1.16	2.13	5.54
	10.76	21.29	8.25	4.81	2.02	2.19
RUNOFF	2.912	0.402	1.425	0.075	0.064	1.499
	2.958	10.325	4.343	0.881	0.264	0.378
EVAPOTRANSPIRATION	1.680	2.089	2.834	2.847	3.187	2.553
	7.036	5.366	2.285	3.037	1.416	0.922
LATERAL DRAINAGE COLLECTED FROM LAYER 2	3.6591	2.2787	1.5415	0.4575	0.0132	0.0003
	0.0010	3.9575	2.8780	0.2120	1.3199	0.8198
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.013	0.009	0.005	0.002	0.000	0.000
	0.000	0.014	0.010	0.001	0.005	0.003
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.016	0.008	0.007	0.002	0.000	0.000
	0.000	0.013	0.017	0.001	0.002	0.003
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 9	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	77.95	282958.469	100.00
RUNOFF	25.525	92657.109	32.75
EVAPOTRANSPIRATION	35.251	127962.703	45.22
DRAINAGE COLLECTED FROM LAYER 2	17.1384	62212.418	21.99
PERC./LEAKAGE THROUGH LAYER 4	0.000284	1.031	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0050		
DRAINAGE COLLECTED FROM LAYER 8	0.0003	1.031	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.001	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.035	125.235	0.04
SOIL WATER AT START OF YEAR	70.227	254924.687	
SOIL WATER AT END OF YEAR	70.262	255049.922	
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	-0.034	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

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

PRECIPITATION	2.94	3.35	4.50	2.16	4.28	4.38
	7.06	4.14	6.25	1.06	4.01	3.99
RUNOFF	0.127	0.556	0.538	0.074	0.024	0.615
	1.279	0.099	2.153	0.000	0.549	0.940
EVAPOTRANSPIRATION	1.608	1.995	2.913	3.690	5.578	3.788
	4.638	3.632	2.566	3.418	1.316	0.806
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.6796	1.4127	0.6597	0.0042	0.0140	0.0020
	0.0005	0.0004	0.2960	0.0850	0.0004	1.6669
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.002	0.005	0.002	0.000	0.000	0.000
	0.000	0.000	0.001	0.000	0.000	0.006
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.003	0.005	0.002	0.000	0.000	0.000
	0.000	0.000	0.002	0.001	0.000	0.011
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.12	174675.578	100.00
RUNOFF	6.955	25245.174	14.45
EVAPOTRANSPIRATION	35.947	130489.352	74.70

DRAINAGE COLLECTED FROM LAYER 2	4.8214	17501.805	10.02
PERC./LEAKAGE THROUGH LAYER 4	0.000086	0.311	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.310	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.387	1404.121	0.80
SOIL WATER AT START OF YEAR	70.262	255049.922	
SOIL WATER AT END OF YEAR	70.648	256454.047	
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	0.0096	34.822	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.63	1.80	3.90	6.60	3.00	10.89
	1.82	5.68	3.68	2.40	4.65	2.89
RUNOFF	0.000	0.003	0.575	1.080	0.079	3.038
	0.068	0.755	0.984	0.180	0.754	0.730
EVAPOTRANSPIRATION	1.256	1.617	2.787	3.970	5.248	6.035
	3.738	2.149	2.460	3.111	1.636	1.290
LATERAL DRAINAGE COLLECTED	0.3165	0.2689	0.2563	1.5714	0.4318	0.0693
FROM LAYER 2	0.2865	0.0000	0.3256	0.2499	0.4835	0.5591
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.001	0.001	0.001	0.006	0.001	0.000
	0.001	0.000	0.001	0.001	0.002	0.002
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.001	0.001	0.001	0.005	0.002	0.001
	0.002	0.000	0.001	0.001	0.002	0.001
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.94	177652.187	100.00
RUNOFF	8.246	29932.645	16.85
EVAPOTRANSPIRATION	35.298	128131.203	72.12
DRAINAGE COLLECTED FROM LAYER 2	4.8188	17492.143	9.85
PERC./LEAKAGE THROUGH LAYER 4	0.000092	0.333	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.333	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.577	2095.880	1.18
SOIL WATER AT START OF YEAR	70.648	256454.047	
SOIL WATER AT END OF YEAR	71.226	258549.922	
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	-0.020	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.78	3.00	4.70	3.07	4.25	7.97
	6.46	8.12	4.50	4.22	2.57	3.16
STD. DEVIATIONS	3.43	1.00	1.40	2.21	3.17	2.92
	3.24	7.68	2.73	3.01	1.69	1.40
RUNOFF						
TOTALS	0.816	0.334	0.655	0.278	0.661	1.760
	1.303	2.630	1.557	0.836	0.320	0.622
STD. DEVIATIONS	1.238	0.227	0.453	0.452	1.312	1.052
	1.051	4.340	1.760	0.984	0.327	0.379
EVAPOTRANSPIRATION						
TOTALS	1.432	1.874	2.871	3.482	4.710	4.645
	5.515	3.686	2.224	3.213	1.451	0.976
STD. DEVIATIONS	0.223	0.193	0.084	0.671	1.205	1.454
	1.317	1.194	0.671	0.191	0.116	0.183
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	1.2568	0.9295	1.0256	0.5048	0.3753	0.1674
	0.1588	0.7922	0.7793	0.5394	0.4242	0.8723
STD. DEVIATIONS	1.3988	0.9034	0.5558	0.6404	0.6100	0.3347
	0.2286	1.7694	1.1829	0.5126	0.5424	0.4591
PERCOLATION/LEAKAGE THROUGH LAYER 4						
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

LATERAL DRAINAGE COLLECTED FROM LAYER 8

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

PERCOLATION/LEAKAGE THROUGH LAYER 10

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0043	0.0035	0.0035	0.0018	0.0013	0.0006
	0.0005	0.0027	0.0028	0.0018	0.0015	0.0030
STD. DEVIATIONS	0.0048	0.0034	0.0019	0.0023	0.0021	0.0012
	0.0008	0.0061	0.0042	0.0018	0.0019	0.0016

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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

	INCHES	CU. FEET	PERCENT
PRECIPITATION	55.79 (12.690)	202517.7	100.00
RUNOFF	11.774 (7.9171)	42738.68	21.104
EVAPOTRANSPIRATION	36.081 (0.9097)	130972.22	64.672
LATERAL DRAINAGE COLLECTED FROM LAYER 2	7.82559 (5.33511)	28406.881	14.02686

PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00014 (	0.00009)	0.496	0.00024
AVERAGE HEAD ON TOP OF LAYER 3	0.002 (	0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00014 (	0.00009)	0.495	0.00024
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000 (	0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (	0.000)		
CHANGE IN WATER STORAGE	0.108 (	0.3987)	392.45	0.194

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.77	24575.100
RUNOFF	5.236	19006.6582
DRAINAGE COLLECTED FROM LAYER 2	0.68827	2498.41602
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000010	0.03471
AVERAGE HEAD ON TOP OF LAYER 3	0.073	
MAXIMUM HEAD ON TOP OF LAYER 3	2.561	
DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03471
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.014	
SNOW WATER	1.63	5916.4204

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4269

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2100

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

****

****

FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	8.9217	0.3717
2	0.0157	0.0783
3	0.0000	0.0000
4	8.2980	0.4610
5	4.1040	0.3420
6	26.2800	0.0730
7	13.3560	0.3710
8	0.0025	0.0100
9	0.0000	0.0000
10	10.2480	0.4270
SNOW WATER	0.000	

****
****

INSERT FIRST HELP MODEL
ALTERNATE LINER SYSTEM (Alt. 2)
PHASE 2 OPEN 1st YEAR

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************
```

```
PRECIPITATION DATA FILE:      C:\HELP3\LENOIR.D4
TEMPERATURE DATA FILE:        C:\HELP3\Lenoir.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\Lenoir.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\Lenoir.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\LENOIRA.D10
OUTPUT DATA FILE:             C:\HELP3\LenoirA.OUT
```

Time: 13:25 Date: 10/10/2009

****

Title: Lenoir County Phase 2 Open 1st Year (Alt. 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  12
           THICKNESS                  =     12.00    INCHES
           POROSITY                   =      0.4710 VOL/VOL
           FIELD CAPACITY             =      0.3420 VOL/VOL
           WILTING POINT              =      0.2100 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.3106 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	96.00	INCHES
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0726	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00	INCHES
POROSITY	=	0.4790	VOL/VOL
FIELD CAPACITY	=	0.3710	VOL/VOL
WILTING POINT	=	0.2510	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4313	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0574	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

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           =       4.00    HOLES/ACRE
FML INSTALLATION DEFECTS      =       4.00    HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                        LAYER  6
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  17
THICKNESS                     =       0.24    INCHES
POROSITY                      =       0.7500 VOL/VOL
FIELD CAPACITY                =       0.7470 VOL/VOL
WILTING POINT                 =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.7470 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.300000003000E-08 CM/SEC


                        LAYER  7
                        --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  23
THICKNESS                     =      18.00    INCHES
POROSITY                      =       0.4610 VOL/VOL
FIELD CAPACITY                =       0.3600 VOL/VOL
WILTING POINT                 =       0.2030 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.4610 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.900000032000E-05 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF  200. FEET.

SCS RUNOFF CURVE NUMBER             =     91.70
FRACTION OF AREA ALLOWING RUNOFF    =      0.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000   ACRES
EVAPORATIVE ZONE DEPTH              =     22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      4.421   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      7.332   INCHES
```

LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.710	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	34.717	INCHES
TOTAL INITIAL WATER	=	34.717	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.11	3.66	3.96	3.39	4.42	5.39
6.20	5.76	5.30	3.06	2.92	3.42

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.80	43.60	51.40	61.00	68.40	74.90
78.70	78.10	72.80	61.80	52.50	44.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.13 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.69	4.39	3.13	1.63	2.14	8.50
	7.20	7.75	2.85	3.84	0.72	5.12
RUNOFF	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	1.383	1.891	2.948	2.478	3.036	5.925
	6.447	4.289	2.814	3.416	0.420	0.810
LATERAL DRAINAGE COLLECTED	1.6588	0.4137	2.0998	0.6726	0.2942	0.0073
FROM LAYER 4	0.2401	2.2378	1.6912	1.8216	0.6605	1.3076
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.002	0.001	0.002	0.001	0.000	0.000
TOP OF LAYER 5	0.000	0.002	0.002	0.002	0.001	0.001
STD. DEVIATION OF DAILY	0.001	0.000	0.002	0.000	0.000	0.000
HEAD ON TOP OF LAYER 5	0.000	0.002	0.001	0.002	0.000	0.003
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT

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PRECIPITATION	48.96	177724.844	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	35.855	130152.031	73.23
DRAINAGE COLLECTED FROM LAYER 4	13.1053	47572.082	26.77
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0012		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	0.000	0.692	0.00
SOIL WATER AT START OF YEAR	34.897	126674.406	
SOIL WATER AT END OF YEAR	34.897	126675.094	
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	0.031	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.69	4.39	3.13	1.63	2.14	8.50
	7.20	7.75	2.85	3.84	0.72	5.12
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
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	1.383	1.891	2.948	2.478	3.036	5.925
	6.447	4.289	2.814	3.416	0.420	0.810
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

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.6588	0.4137	2.0998	0.6726	0.2942	0.0073
	0.2401	2.2378	1.6912	1.8216	0.6605	1.3076
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 5

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

PERCOLATION/LEAKAGE THROUGH LAYER 7

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0018	0.0005	0.0022	0.0007	0.0003	0.0000
	0.0003	0.0024	0.0019	0.0019	0.0007	0.0014
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

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.96 (0.000)	177724.8	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	35.855 (0.0000)	130152.03	73.232
LATERAL DRAINAGE COLLECTED FROM LAYER 4	13.10526 (0.00000)	47572.082	26.76727
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.001 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.000 (0.0000)	0.69	0.000

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	2.85	10345.500
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.30297	1099.77893
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 5	0.010	
MAXIMUM HEAD ON TOP OF LAYER 5	0.312	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
SNOW WATER	1.63	5916.4204

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2670
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1232

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	3.7289	0.3107
2	6.9729	0.0726
3	15.5240	0.4312
4	0.0143	0.0573
5	0.0000	0.0000
6	0.1793	0.7470
7	8.2980	0.4610
SNOW WATER	0.000	

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INSERT SECOND HELP MODEL
ALTERNATE LINER SYSTEM (Alt.2)
PHASE 2 OPEN 5 YEARS w/25 FT. OF SOLID WASTE

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\LENOIR.D4
TEMPERATURE DATA FILE:        C:\HELP3\Lenoir.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\Lenoir.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\Lenoir.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\LENOIR2A.D10
OUTPUT DATA FILE:             C:\HELP3\Lenoir2A.OUT
```

Time: 13:40 Date: 10/10/2009

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******************************************************************************
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Title: Lenoir County Phase 2 Open 5 Years w/ 25 ft. Waste (Alt. 2)

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


     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  12
          THICKNESS                  =     12.00   INCHES
          POROSITY                   =      0.4710 VOL/VOL
          FIELD CAPACITY             =      0.3420 VOL/VOL
          WILTING POINT              =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.3107 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	300.00 INCHES
POROSITY	=	0.1680 VOL/VOL
FIELD CAPACITY	=	0.0730 VOL/VOL
WILTING POINT	=	0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0729 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4790 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4467 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04 CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	100.0 FEET

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          =      4.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                        LAYER  6
                        --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.24    INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7470 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC


                        LAYER  7
                        --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  23
THICKNESS                    =     18.00    INCHES
POROSITY                     =      0.4610 VOL/VOL
FIELD CAPACITY               =      0.3600 VOL/VOL
WILTING POINT                =      0.2030 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.4610 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.900000032000E-05 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF  200. FEET.

SCS RUNOFF CURVE NUMBER            =      91.70
FRACTION OF AREA ALLOWING RUNOFF   =      50.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =       1.000  ACRES
EVAPORATIVE ZONE DEPTH             =      22.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =       4.425  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =       7.332  INCHES
```

LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.710	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	50.157	INCHES
TOTAL INITIAL WATER	=	50.157	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.11	3.66	3.96	3.39	4.42	5.39
6.20	5.76	5.30	3.06	2.92	3.42

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.80	43.60	51.40	61.00	68.40	74.90
78.70	78.10	72.80	61.80	52.50	44.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.13 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.69	4.39	3.13	1.63	2.14	8.50
	7.20	7.75	2.85	3.84	0.72	5.12
RUNOFF	0.024	0.201	0.094	0.000	0.067	0.513
	0.658	0.795	0.103	0.277	0.013	0.455
EVAPOTRANSPIRATION	1.387	1.893	2.950	2.554	2.869	5.896
	6.419	4.291	2.817	3.420	0.368	0.814
LATERAL DRAINAGE COLLECTED FROM LAYER 4	2.1708	0.4291	1.8354	0.6745	0.2714	0.0190
	0.0748	0.9028	1.2214	1.4691	0.7060	0.3114
PERCOLATION/LEAKAGE THROUGH LAYER 5	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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.002	0.001	0.002	0.001	0.000	0.000
	0.000	0.001	0.001	0.002	0.001	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.002	0.000	0.002	0.000	0.000	0.000
	0.000	0.001	0.001	0.001	0.000	0.001
AVERAGE DAILY HEAD ON TOP OF LAYER 7	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT

PRECIPITATION	48.96	177724.844	100.00
RUNOFF	3.200	11616.245	6.54
EVAPOTRANSPIRATION	35.679	129513.109	72.87
DRAINAGE COLLECTED FROM LAYER 4	10.0857	36611.109	20.60
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0009		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-0.004	-15.620	-0.01
SOIL WATER AT START OF YEAR	50.336	182719.078	
SOIL WATER AT END OF YEAR	50.332	182703.453	
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	-0.011	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.83	2.30	5.14	3.78	9.70	10.52
	5.47	1.76	1.45	8.97	1.43	1.63
RUNOFF	0.453	0.093	0.220	0.069	1.463	1.315
	0.465	0.173	0.042	1.255	0.002	0.035
EVAPOTRANSPIRATION	1.105	1.698	2.782	4.163	5.817	4.146
	4.813	3.013	1.054	3.008	1.499	0.982
LATERAL DRAINAGE COLLECTED	2.6468	1.1639	1.1808	0.9334	0.8064	2.8500
FROM LAYER 4	3.1049	0.7303	0.5017	0.8673	2.2869	0.4220
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.003 0.003	0.001 0.001	0.001 0.001	0.001 0.001	0.001 0.003	0.003 0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.002 0.003	0.001 0.000	0.001 0.000	0.000 0.002	0.001 0.002	0.003 0.000
AVERAGE DAILY HEAD ON TOP OF LAYER 7	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 7	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	54.98	199577.391	100.00
RUNOFF	5.585	20273.453	10.16
EVAPOTRANSPIRATION	34.080	123709.836	61.99
DRAINAGE COLLECTED FROM LAYER 4	17.4943	63504.297	31.82
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0016		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-2.179	-7910.147	-3.96
SOIL WATER AT START OF YEAR	50.332	182703.453	
SOIL WATER AT END OF YEAR	48.152	174793.312	
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	-0.049	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.81	3.17	6.82	1.16	2.13	5.54
	10.76	21.29	8.25	4.81	2.02	2.19
RUNOFF	1.289	0.174	0.652	0.035	0.034	0.753
	1.513	4.949	2.057	0.406	0.108	0.170
EVAPOTRANSPIRATION	1.711	2.118	2.858	2.497	2.207	2.944
	7.181	5.396	2.334	3.056	1.453	0.942
LATERAL DRAINAGE COLLECTED	0.9719	6.1603	2.0721	1.3133	0.5571	0.1675
FROM LAYER 4	0.9356	6.1825	8.9298	1.1095	1.1543	1.2025
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.007	0.002	0.001	0.001	0.000
TOP OF LAYER 5	0.001	0.007	0.010	0.001	0.001	0.001
STD. DEVIATION OF DAILY	0.001	0.004	0.002	0.001	0.000	0.000
HEAD ON TOP OF LAYER 5	0.002	0.007	0.007	0.000	0.001	0.001
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	77.95	282958.469	100.00
RUNOFF	12.140	44067.172	15.57
EVAPOTRANSPIRATION	34.697	125948.898	44.51
DRAINAGE COLLECTED FROM LAYER 4	30.7564	111645.594	39.46
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0028		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	0.357	1296.804	0.46
SOIL WATER AT START OF YEAR	48.152	174793.312	
SOIL WATER AT END OF YEAR	48.510	176090.109	
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

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.94	3.35	4.50	2.16	4.28	4.38
	7.06	4.14	6.25	1.06	4.01	3.99
RUNOFF	0.047	0.242	0.245	0.033	0.012	0.310
	0.662	0.051	1.037	0.000	0.275	0.417

EVAPOTRANSPIRATION	1.623	2.011	2.927	3.738	4.578	4.055
	4.713	3.932	2.667	2.412	1.298	0.995
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.9159	1.2525	1.3016	0.6137	0.2793	0.0220
	0.0223	0.2065	0.6208	1.4680	0.3667	0.6123
PERCOLATION/LEAKAGE THROUGH LAYER 5	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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.001	0.002	0.001	0.001	0.000	0.000
	0.000	0.000	0.001	0.002	0.000	0.001
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.000	0.001	0.001	0.000	0.000	0.000
	0.000	0.000	0.002	0.001	0.000	0.001
AVERAGE DAILY HEAD ON TOP OF LAYER 7	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.12	174675.578	100.00
RUNOFF	3.331	12092.490	6.92
EVAPOTRANSPIRATION	34.949	126864.789	72.63
DRAINAGE COLLECTED FROM LAYER 4	7.6816	27884.285	15.96
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.003	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0007		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.003	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	2.149	7799.133	4.46

SOIL WATER AT START OF YEAR	48.510	176090.109	
SOIL WATER AT END OF YEAR	50.658	183889.250	
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	0.0096	34.880	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.63	1.80	3.90	6.60	3.00	10.89
	1.82	5.68	3.68	2.40	4.65	2.89
RUNOFF	0.000	0.000	0.278	0.476	0.032	1.573
	0.034	0.389	0.452	0.079	0.357	0.328
EVAPOTRANSPIRATION	1.418	1.708	2.834	4.082	4.199	6.328
	2.724	2.275	2.717	2.772	1.609	1.329
LATERAL DRAINAGE COLLECTED	2.5870	0.4808	0.2447	0.7331	1.4471	0.4435
FROM LAYER 4	2.1321	0.4903	0.9118	1.0259	0.4852	1.1496
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.003	0.001	0.000	0.001	0.002	0.001
TOP OF LAYER 5	0.002	0.001	0.001	0.001	0.001	0.001
STD. DEVIATION OF DAILY	0.002	0.000	0.000	0.001	0.001	0.000
HEAD ON TOP OF LAYER 5	0.002	0.000	0.001	0.000	0.000	0.000
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000

TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 7	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.94	177652.187	100.00
RUNOFF	3.998	14514.175	8.17
EVAPOTRANSPIRATION	33.994	123398.742	69.46
DRAINAGE COLLECTED FROM LAYER 4	12.1309	44035.289	24.79
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0011		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-1.183	-4296.016	-2.42
SOIL WATER AT START OF YEAR	50.658	183889.250	
SOIL WATER AT END OF YEAR	49.475	179593.234	
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

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

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

PRECIPITATION						
TOTALS	3.78	3.00	4.70	3.07	4.25	7.97
	6.46	8.12	4.50	4.22	2.57	3.16
STD. DEVIATIONS	3.43	1.00	1.40	2.21	3.17	2.92
	3.24	7.68	2.73	3.01	1.69	1.40
RUNOFF						
TOTALS	0.363	0.142	0.298	0.123	0.321	0.893
	0.666	1.271	0.738	0.403	0.151	0.281
STD. DEVIATIONS	0.550	0.096	0.210	0.199	0.638	0.535
	0.538	2.075	0.837	0.502	0.159	0.176
EVAPOTRANSPIRATION						
TOTALS	1.449	1.885	2.870	3.407	3.934	4.674
	5.170	3.781	2.318	2.934	1.245	1.012
STD. DEVIATIONS	0.236	0.185	0.069	0.821	1.427	1.404
	1.726	1.199	0.729	0.373	0.503	0.191
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.8585	1.8973	1.3269	0.8536	0.6723	0.7004
	1.2539	1.7025	2.4371	1.1879	0.9998	0.7395
STD. DEVIATIONS	0.8550	2.4129	0.7084	0.2836	0.4865	1.2140
	1.3422	2.5181	3.6402	0.2705	0.7798	0.4132
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 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5						
AVERAGES	0.0020	0.0023	0.0014	0.0009	0.0007	0.0008

	0.0013	0.0018	0.0027	0.0013	0.0011	0.0008
STD. DEVIATIONS	0.0009	0.0028	0.0008	0.0003	0.0005	0.0013
	0.0014	0.0027	0.0040	0.0003	0.0009	0.0004

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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

	INCHES		CU. FEET	PERCENT
PRECIPITATION	55.79	(12.690)	202517.7	100.00
RUNOFF	5.651	(3.7492)	20512.71	10.129
EVAPOTRANSPIRATION	34.680	(0.6893)	125887.07	62.161
LATERAL DRAINAGE COLLECTED FROM LAYER 4	15.62978	(9.19839)	56736.113	28.01539
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.001	(0.001)		
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000	(0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000	(0.000)		
CHANGE IN WATER STORAGE	-0.172	(1.6389)	-625.17	-0.309

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.77	24575.100
RUNOFF	2.586	9387.6406
DRAINAGE COLLECTED FROM LAYER 4	0.71604	2599.20996
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00004
AVERAGE HEAD ON TOP OF LAYER 5	0.024	
MAXIMUM HEAD ON TOP OF LAYER 5	0.479	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00004
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
SNOW WATER	1.63	5916.4204
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2703	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1232	

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	3.8049	0.3171
2	22.8243	0.0761
3	14.1864	0.3941
4	0.0025	0.0100
5	0.0000	0.0000
6	0.1793	0.7470
7	8.2980	0.4610
SNOW WATER	0.000	

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INSERT FINAL HELP MODEL
ALTERNATE LINER SYSTEM (Alt. 2)
PHASE 2 CLOSED

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP3\LENOIR.D4
TEMPERATURE DATA FILE:        C:\HELP3\Lenoir.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\Lenoir.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\Lenoir.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\LENOIRCA.D10
OUTPUT DATA FILE:             C:\HELP3\LenoirCA.OUT
```

Time: 13:56 Date: 10/10/2009

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Title: Lenoir County Phase 2 Closed (Alt. 2)

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     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  12
           THICKNESS                   =     24.00    INCHES
           POROSITY                    =      0.4710 VOL/VOL
           FIELD CAPACITY              =      0.3420 VOL/VOL
           WILTING POINT               =      0.2100 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.3496 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.419999997000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0279	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	5.00	PERCENT
DRAINAGE LENGTH	=	300.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	4.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	4.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 23

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4610	VOL/VOL
FIELD CAPACITY	=	0.3600	VOL/VOL
WILTING POINT	=	0.2030	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4610	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.900000032000E-05	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4710 VOL/VOL
FIELD CAPACITY	=	0.3420 VOL/VOL
WILTING POINT	=	0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.419999997000E-04 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	360.00 INCHES
POROSITY	=	0.1680 VOL/VOL
FIELD CAPACITY	=	0.0730 VOL/VOL
WILTING POINT	=	0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4790 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3710 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04 CM/SEC

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	100.0 FEET

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	=	4.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	4.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7470	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 11

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 23

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4610	VOL/VOL
FIELD CAPACITY	=	0.3600	VOL/VOL
WILTING POINT	=	0.2030	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4610	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.900000032000E-05	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
POOR STAND OF GRASS, A SURFACE SLOPE OF 2.%

AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	91.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.627	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.362	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	4.620	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	68.915	INCHES
TOTAL INITIAL WATER	=	68.915	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	86	
END OF GROWING SEASON (JULIAN DATE)	=	310	
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00	%

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.11	3.66	3.96	3.39	4.42	5.39
6.20	5.76	5.30	3.06	2.92	3.42

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.80	43.60	51.40	61.00	68.40	74.90
78.70	78.10	72.80	61.80	52.50	44.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.13 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.69	4.39	3.13	1.63	2.14	8.50
	7.20	7.75	2.85	3.84	0.72	5.12
RUNOFF	0.060	0.502	0.225	0.000	0.131	0.987
	1.301	1.626	0.224	0.640	0.026	0.969
EVAPOTRANSPIRATION	1.458	1.931	2.997	2.705	3.665	5.741
	6.251	4.148	2.746	3.423	1.451	0.922
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.3419	0.5529	1.4962	0.0051	0.0012	0.0015
	0.0030	0.0033	0.3970	1.2745	0.0000	0.7550
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 9	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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.001	0.002	0.005	0.000	0.000	0.000
	0.000	0.000	0.001	0.004	0.000	0.003
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.001	0.006	0.006	0.000	0.000	0.000
	0.000	0.000	0.002	0.007	0.000	0.005
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000

TOP OF LAYER 9	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE DAILY HEAD ON TOP OF LAYER 11	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 11	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.96	177724.844	100.00
RUNOFF	6.691	24286.932	13.67
EVAPOTRANSPIRATION	37.438	135898.812	76.47
DRAINAGE COLLECTED FROM LAYER 2	4.8315	17538.311	9.87
PERC./LEAKAGE THROUGH LAYER 4	0.000086	0.311	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.310	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	0.000	0.388	0.00
SOIL WATER AT START OF YEAR	69.094	250810.750	
SOIL WATER AT END OF YEAR	69.094	250811.141	
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	0.080	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.83 5.47	2.30 1.76	5.14 1.45	3.78 8.97	9.70 1.43	10.52 1.63
RUNOFF	0.983 0.910	0.210 0.346	0.510 0.083	0.160 2.480	3.007 0.007	2.662 0.092
EVAPOTRANSPIRATION	1.160 5.915	1.739 3.135	2.824 1.062	4.198 3.076	5.871 1.435	5.111 0.941
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1.2869 0.5029	0.1341 0.0000	1.1743 0.0001	0.4855 0.8757	1.4163 0.3173	0.7637 0.5609
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 9	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	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.004 0.002	0.001 0.000	0.004 0.000	0.002 0.003	0.005 0.001	0.003 0.002
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.005 0.003	0.001 0.000	0.003 0.000	0.002 0.005	0.008 0.002	0.005 0.002
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
AVERAGE DAILY HEAD ON TOP OF LAYER 11	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. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 11	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	54.98	199577.391	100.00
RUNOFF	11.452	41571.547	20.83
EVAPOTRANSPIRATION	36.468	132379.062	66.33
DRAINAGE COLLECTED FROM LAYER 2	7.5178	27289.729	13.67
PERC./LEAKAGE THROUGH LAYER 4	0.000135	0.492	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0022		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.491	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	-0.458	-1663.399	-0.83
SOIL WATER AT START OF YEAR	69.094	250811.141	
SOIL WATER AT END OF YEAR	68.636	249147.750	
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

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.81	3.17	6.82	1.16	2.13	5.54
	10.76	21.29	8.25	4.81	2.02	2.19
RUNOFF	2.912	0.402	1.425	0.075	0.064	1.499
	2.958	10.325	4.343	0.881	0.264	0.378
EVAPOTRANSPIRATION	1.680	2.089	2.834	2.847	3.187	2.553
	7.036	5.366	2.285	3.037	1.416	0.922
LATERAL DRAINAGE COLLECTED FROM LAYER 2	3.6591	2.2787	1.5415	0.4575	0.0132	0.0003
	0.0010	3.9575	2.8780	0.2120	1.3199	0.8198
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 9	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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.013	0.009	0.005	0.002	0.000	0.000
	0.000	0.014	0.010	0.001	0.005	0.003
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.016	0.008	0.007	0.002	0.000	0.000
	0.000	0.013	0.017	0.001	0.002	0.003
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE DAILY HEAD ON TOP OF LAYER 11	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 11	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	77.95	282958.469	100.00
RUNOFF	25.525	92657.109	32.75
EVAPOTRANSPIRATION	35.251	127962.703	45.22
DRAINAGE COLLECTED FROM LAYER 2	17.1384	62212.418	21.99
PERC./LEAKAGE THROUGH LAYER 4	0.000284	1.031	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0050		
DRAINAGE COLLECTED FROM LAYER 8	0.0003	1.031	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.001	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.001	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	0.035	125.235	0.04
SOIL WATER AT START OF YEAR	68.636	249147.750	
SOIL WATER AT END OF YEAR	68.670	249272.984	
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	-0.034	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.94	3.35	4.50	2.16	4.28	4.38

	7.06	4.14	6.25	1.06	4.01	3.99
RUNOFF	0.127	0.556	0.538	0.074	0.024	0.615
	1.279	0.099	2.153	0.000	0.549	0.940
EVAPOTRANSPIRATION	1.608	1.995	2.913	3.690	5.578	3.788
	4.638	3.632	2.566	3.418	1.316	0.806
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.6796	1.4127	0.6597	0.0042	0.0140	0.0020
	0.0005	0.0004	0.2960	0.0850	0.0004	1.6669
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 9	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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.002	0.005	0.002	0.000	0.000	0.000
	0.000	0.000	0.001	0.000	0.000	0.006
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.003	0.005	0.002	0.000	0.000	0.000
	0.000	0.000	0.002	0.001	0.000	0.011
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE DAILY HEAD ON TOP OF LAYER 11	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 11	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT

PRECIPITATION	48.12	174675.578	100.00
RUNOFF	6.955	25245.174	14.45
EVAPOTRANSPIRATION	35.947	130489.352	74.70
DRAINAGE COLLECTED FROM LAYER 2	4.8214	17501.805	10.02
PERC./LEAKAGE THROUGH LAYER 4	0.000086	0.311	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.310	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	0.387	1404.121	0.80
SOIL WATER AT START OF YEAR	68.670	249272.984	
SOIL WATER AT END OF YEAR	69.057	250677.094	
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	0.0096	34.822	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.63	1.80	3.90	6.60	3.00	10.89
	1.82	5.68	3.68	2.40	4.65	2.89
RUNOFF	0.000	0.003	0.575	1.080	0.079	3.038
	0.068	0.755	0.984	0.180	0.754	0.730
EVAPOTRANSPIRATION	1.256	1.617	2.787	3.970	5.248	6.035
	3.738	2.149	2.460	3.111	1.636	1.290

LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.3165 0.2865	0.2689 0.0000	0.2563 0.3256	1.5714 0.2499	0.4318 0.4835	0.0693 0.5591
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 9	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	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.001 0.001	0.001 0.000	0.001 0.001	0.006 0.001	0.001 0.002	0.000 0.002
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.001 0.002	0.001 0.000	0.001 0.001	0.005 0.001	0.002 0.002	0.001 0.001
AVERAGE DAILY HEAD ON TOP OF LAYER 9	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 9	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
AVERAGE DAILY HEAD ON TOP OF LAYER 11	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. DEVIATION OF DAILY HEAD ON TOP OF LAYER 11	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	48.94	177652.187	100.00
RUNOFF	8.246	29932.645	16.85
EVAPOTRANSPIRATION	35.298	128131.203	72.12
DRAINAGE COLLECTED FROM LAYER 2	4.8188	17492.143	9.85

PERC./LEAKAGE THROUGH LAYER 4	0.000092	0.333	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.333	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	0.577	2095.880	1.18
SOIL WATER AT START OF YEAR	69.057	250677.094	
SOIL WATER AT END OF YEAR	69.634	252772.984	
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	-0.020	0.00

****

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.78	3.00	4.70	3.07	4.25	7.97
	6.46	8.12	4.50	4.22	2.57	3.16
STD. DEVIATIONS	3.43	1.00	1.40	2.21	3.17	2.92
	3.24	7.68	2.73	3.01	1.69	1.40
RUNOFF						
TOTALS	0.816	0.334	0.655	0.278	0.661	1.760
	1.303	2.630	1.557	0.836	0.320	0.622
STD. DEVIATIONS	1.238	0.227	0.453	0.452	1.312	1.052
	1.051	4.340	1.760	0.984	0.327	0.379

```
EVAPOTRANSPIRATION
------------------
  TOTALS                    1.432     1.874     2.871     3.482     4.710     4.645
                            5.515     3.686     2.224     3.213     1.451     0.976

  STD. DEVIATIONS           0.223     0.193     0.084     0.671     1.205     1.454
                            1.317     1.194     0.671     0.191     0.116     0.183

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
  TOTALS                    1.2568    0.9295    1.0256    0.5048    0.3753    0.1674
                            0.1588    0.7922    0.7793    0.5394    0.4242    0.8723

  STD. DEVIATIONS           1.3988    0.9034    0.5558    0.6404    0.6100    0.3347
                            0.2286    1.7694    1.1829    0.5126    0.5424    0.4591

PERCOLATION/LEAKAGE THROUGH LAYER  4
------------------------------------
  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

LATERAL DRAINAGE COLLECTED FROM LAYER  8
----------------------------------------
  TOTALS                    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                            0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

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

PERCOLATION/LEAKAGE THROUGH LAYER  9
------------------------------------
  TOTALS                    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                            0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

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

PERCOLATION/LEAKAGE THROUGH LAYER 11
------------------------------------
  TOTALS                    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                            0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

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

-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------

DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
  AVERAGES                  0.0043    0.0035    0.0035    0.0018    0.0013    0.0006
```

	0.0005	0.0027	0.0028	0.0018	0.0015	0.0030
STD. DEVIATIONS	0.0048	0.0034	0.0019	0.0023	0.0021	0.0012
	0.0008	0.0061	0.0042	0.0018	0.0019	0.0016

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 11

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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

	INCHES	CU. FEET	PERCENT
PRECIPITATION	55.79 (12.690)	202517.7	100.00
RUNOFF	11.774 (7.9171)	42738.68	21.104
EVAPOTRANSPIRATION	36.081 (0.9097)	130972.22	64.672
LATERAL DRAINAGE COLLECTED FROM LAYER 2	7.82559 (5.33511)	28406.881	14.02686
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00014 (0.00009)	0.496	0.00024
AVERAGE HEAD ON TOP OF LAYER 3	0.002 (0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00014 (0.00009)	0.495	0.00024
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (0.00000)	0.000	0.00000

```
AVERAGE HEAD ON TOP                 0.000 (     0.000)
  OF LAYER 11

CHANGE IN WATER STORAGE             0.108   (  0.3987)        392.45       0.194

******************************************************************************
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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.77	24575.100
RUNOFF	5.236	19006.6582
DRAINAGE COLLECTED FROM LAYER 2	0.68827	2498.41602
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000010	0.03471
AVERAGE HEAD ON TOP OF LAYER 3	0.073	
MAXIMUM HEAD ON TOP OF LAYER 3	2.561	
DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03471
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.001	
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 11	0.000	
SNOW WATER	1.63	5916.4204

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4269

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2100

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	8.9217	0.3717
2	0.0157	0.0783
3	0.0000	0.0000
4	8.2980	0.4610
5	4.1040	0.3420
6	26.2800	0.0730
7	13.3560	0.3710
8	0.0025	0.0100
9	0.0000	0.0000
10	0.1793	0.7470
11	8.2980	0.4610
SNOW WATER	0.000	

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2.2.4 <u>Leachate Collection System Design Calculations</u>

Initial Calculations

25 yr. 24 hr. Storm = 7.61" (NOAA Website)

Lagoon storage capacity = 624,000 gallons

Based on the HELP Model with the conservative waste characteristics (Texture No. 19), the average monthly flows collected from layer 4 for a 5 year period on a per acre basis are as follows:

Sample Calculation = in. from layer 4/12 in./ft. x 43,560 ft.^{2}/acre x 7.48 gals/ft.^{3} = gals./acre

1.	January	=	50,503 gallons/acre
2.	February	=	51,590 gallons/acre
3.	March	=	36,112 gallons/acre
4.	April	=	23,079 gallons/acre
5.	May	=	18,192 gallons/acre
6.	June	=	19,007 gallons/acre
7.	July	=	33,941 gallons/acre
8.	August	=	46,159 gallons/acre
9.	September	=	66,252 gallons/acre
10.	October	=	32,311 gallons/acre
11.	November	=	27,152 gallons/acre
12.	December	=	<u>20,093 gallons/acre</u>
	Total	=	424,391 gallons/acre

Annual Flow based on 9.23 acres = 3,917,129 gallons

The leachate lagoon holds 624,000 gallons of leachate. The HELP Model predicts 3,917,129 gallons of leachate per year. According to the County records, there has been 900,581 gallons of leachate pumped to the Kinston WWTP from August 2008 thru January 2010. It was pumped on four separate months during this period. The months were August 2008 (151,910.4 gals.), November 2008 (154,438.8 gals.), November 2009 (163,520.4 gals.) and January 2010 (430,711.6 gals.) The largest flow which is January 2010 was completed in 8 days beginning on the 6th. The pumps operated each day with the longest day being 15.58 hrs. and the total for all 8 days being 83.51 hours for an average flow for the month of January of 86 gpm. The pumps are manually operated on as needed basis until the lagoon is empty.

Leachate Collection System Components

Leachate lagoon

Pipe and rock surrounding it

Pumps

Drainage net

System Performance

Assume a annual worst case scenario for lagoon storage of 1,000,000 gals from Phase 1, the HELP model predicted flow for the entire landfill and one 25 yr. storm over half of the landfill with no waste.

The largest area with no garbage will be approximately 5.0 acres which is approx. ½ of Phase 2..

Q_{25} = (5 ac)(43,560 sq.ft./ac)(7.61"/12")(7.48 gal/cu.ft.) = 1,033,150 gal./day

Q_{25} = 43,048 gal./hr.

Lagoon size without the 2 feet of freeboard = 624,000 gallons

The annual worst case scenario for the lagoon is 1,000,000 from Phase 1, 3,917,129 gallons predicted for Phase 2 and 1,033,150 gallons from a onetime storm event. The total flow into the lagoon for this scenario is 5,950,279 gallons.

∴ Lagoon will hold 624,000 and would have to be emptied 9.5 times in the year of the worst case scenario. There is no maximum flow restriction from the Kinston WWTP and the pumps from the lagoon to the plant can pump a minimum of 86 gpm. If the pump station was run twenty four hours a day, 7 days a week and 52 weeks a year, it could pump 45,077,760 gallons in one year. Consequently, this system has considerable unused capacity.

<u>Flow Through the Rock in the Leachate trench</u>

Darcy's Law
Q = kiA

Q= flow thru the stone
k = hydraulic conductivity of the stone
i = hydraulic gradient
A = area over which flow occurs

For vertical Flow:
i = (h + D)/D
h = leachate head over stone
D = thickness of the stone

For Horizontal Flow:
i = Diff head/lengh

25 yr. 24 hr. storm = 7.61"

Assume no evaporation or soil retained water:
- everything is runoff
- assume 7.61" rainfall in 24 hours.

∴ 10.0 acres lined x 43560 ft^2/acres x 7.61"/12"
= 276,243 ft^3 x 7.48 gal/ft^3 = 2,066,298 gpd.
= 1,435 gpm

Vertical Flow in the Rock

What is the required hydraulic conductivity (k) of trench is required to allow the 25 yr. storm to flow through the rock at the surface of the protective cover in 24 hours?

k= Q/iA

Total length of leachate trench available is 4,146 ft. and it is 2 ft. wide.

. Q = 276,243 ft^3/day
A = 4,156 ft. x 2 ft. = 8,312 $ft.^2$
I = (0 + 3)/3 = 1

Required k = 276,243/8,312 = 33.23 ft./day = 0.005 in/sec = 1.3 x 10^{-2} cm/sec

Permeability of stone in trench is approximately = 0.04 in/sec = 1.0 x 10^{-1} cm/sec

Factor of Safety = 8

Flow (Q) for 4,146 ft. of trench 2 ft. wide with a k = 0.04 in./sec.

Q = 0.04 in,/sec/12in./ft. x 8,312 $ft.^2$ x 1 = 27.71 cfs = 17,906,042 gpd

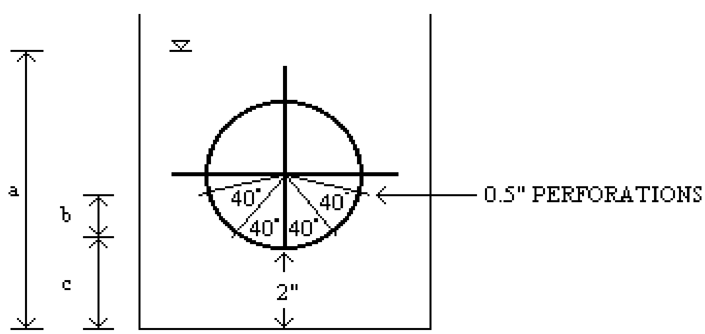
Horizontal Flow in the Rock

Flow thru a leachate trench 2 ft. by 3 ft. with a 2% slope and a k = 0.04 in./sec.

Q= 0.04/12 x 2/100/100 x 6 = 0.04 ft^3./sec = 25,900 gpd

The horizontal flow thru the stone is restrictive; therefore, high flow will flow into the perforations of the pipes to the sump.

Flow in the Pipe



r = Radius, a = 1.0' Head

C = r - rCos40° + 2"

BC = r -rCos80° + 2"

C_6 = 2.70" BC_6 = 4.48"
C_8 = 2.94" BC_8 = 5.31"

∴ Head on the 40° perforation @ 1.0 overall head on liner:

(6") = 12"- 2.70" = 9.30"

(8") = 12" - 2.94" = 9.06"

∴ Head on the 80° perforation @ 1.0 overall head on liner:

(6") = 12"- 4.48" = 7.52"

(8") = 12" - 5.31" = 6.69"

Use the orifice equation to determine the flow into the holes w/ 1.0' of head on the liner.

$Q = CA\sqrt{(2gh)}$ where: C = 0.95 A = 0.0014ft^2 g = 32.2 ft/sec. H = head (ft.)
Q = cfs

$Q_{40°}$

$Q_6 = 0.95(0.0014)\sqrt{(2(32.2)((12-2.70)\div 12)} = 0.0094$ cfs

$Q_8 = 0.95(0.0014)\sqrt{(2(32.2)((12-2.94)\div 12)} = 0.0093$ cfs

$Q_{80°}$

$Q_6 = 0.95(0.0014)\sqrt{(2(32.2)((12-4.48)\div 12)} = 0.0084$ cfs

$Q_8 = 0.95(0.0014)\sqrt{(2(32.2)((12-5.31)\div 12)} = 0.0080$ cfs

Flow per foot of 6" leachate line:
4(0.0094) + 4(0.0084) = .0712 cfs

Flow per foot of 8" leachate line:
4(0.0093) + 4(0.0080) = .0692 cfs

Worst case scenario for entire 10 acres is the 25 year storm with no waste.

The 25 yr. 24 hr storm is 276,243 ft.^{3}/day = 3.20 cfs:

The length of 6 inch line required = 3.20 cfs/0.0712 cfs/ft. = 45 ft.

The length of 8 inch line required = 3.20 cfs/0.0692 cfs/ft. = 46 ft.

It would take 45 ft. of 6 inch line or 46 ft. of 8 in. to empty the landfill from the 25 yr 24 hr. storm in one day. There is a total of 4,156 ft. of perforated pipe in the landfill. This is more than ample pipe to drain all leachate generated.

Assume worst case scenario:

7.61" rain on 5.0 acres and nothing is discharged from the landfill until rain has stopped.

∴ Volume of water retained = 7.61/12 x 5.0 x 43,560
= 138,122 ft^3
= 1,033,153 gallons

The most restrictive component in the system other than the pump is the 8" leachate line at the lowest point which is designed w/ a slope of 2%. Consequently, the maximum water that can be discharged through this pipe is:

Maximum Flow Through 8" pipe @2% (Manning's Equation)

n = 0.009   s = 0.02 ft/ft   A= 0.3110 ft^2 P= 1.9774 ft   R = A/P

$$Q = \frac{1.486\,(AR^{2/3}s^{1/2})}{n}$$

$$Q = \frac{1.486\,(.3110)(.1573)^{2/3}(.02)^{1/2}}{0.009}$$

Q = 2.12 cfs = 950 gpm

Volume to Discharge = 1,033,153 gals.

1,033,153 gals ÷ 950 gpm = 1,088 min. = 18.1 hours

This is an extreme condition that cannot happen because the storm event would be discharged as it was occurring and not after it happened.

Pump Design

Minimum Pump Flow = 75 gpm @ approximately 35 ft. TDH

Worst case scenario is the 25 yr. 24 hr. storm w/ no runoff and no water retained within waste. There are two sumps within the landfill and the most that can affect one pump is 5 acres.

25 yr. 24 hr. storm over 5 acres generates 133,122 $ft.^3$ = 1,033,153 gals.

It will take the pump 9.6 days to pump the water out from the 25 yr. storm.

It will easily handle the flow predicted by the HELP Model which is approx. 4,000,000 gals. annually.

Divide the flow into two parts it is 2,000,000 annually = 8 gpm and the pump will remove 75 gpm.

The Peak Daily Flow predicted by the HELP Model for years 1 thru 5 is 0.72 ins./acre.
5 acres x 43,560 $ft.^2$/acre x 0.72 ins/12 ins./ft. x 7.48 gals/$ft.^3$ = 97,749 gals.

The pump station will remove the peak flow predicted by the HELP Model in 21.7 hrs.

Drainage Net and Geotextiles

The non-woven geotextiles that are used in the landfill are there to protect drainage devices such as the stone around the leachate piping from sedimentation. They are not intended to act as any filter under waste because filters will eventually become clogged with whatever they are filtering from the liquid. The fabric around the stone is a light weight fabric with an Apparent Opening Size (AOS) of 70 mm. that will allow water to pass thru it but filter out sediment that is carried by the runoff within the landfill prior to waste being place over the trench. The fabric is folded back so that waste is indirect contact with the stone in the trench and/or sump. Leachate that would flow thru the protective cover will not be carrying sediments because it will not have the scouring velocity to do so; consequently, this liquid can pass thru either the side of the leachate trench geotextile or the drainage net on the bottom of the landfill.

The drainage net is a minimum of 250 mil. The Peak daily Value of maximum head on the liner for years 1 thru 5 as predicted by the HELP Model is 0.479 inches. The maximum allowable head is 1.0 ft. The minimum transmissivity of the composite geonet is 3.0×10^{-5} m^2/sec and using Darcy's Law:

Transmissivity (θ) = permeability (k) x saturated thickness (t)

Darcy's Law

$$Q = k\ I\ A$$
$$A = t \times 1 \text{ ft. unit width}$$

$$Q = \theta/t \times i \times t$$

$$Q = \theta \times i$$

$$Q = 0.00003\ m^{2/}sec \times 10.764\ ft^2/m^2 \times 2ft./100.ft./100\ ft.(2\%\ slope\ for\ 100\ ft.)$$
$$= 0.0006\ ft.^3/sec./ft.$$

Peak daily Flow from HELP Model = 97,749 gallons = 13,068 ft^3

Drainage net 1 ft. wide 100 ft. long on a slope of 2% will take 21,780,000 seconds = 252 days to drain the Peak Day. The entire landfill of 9.23 acres is covered with the composite drainage net which is more than adequate to drain the peak flow predicted by the HELP Model. It would take just over 252 ft. of the drainage net to handle the peak daily flow in less than a day. The only liquid that will reach the drainage net has to permeate thru the soil cover. The other areas the liquid will flow in other parts of the leachate collection system. They are adequate to handle a 25 yr. 24 hr. storm event.

2.2.5 Strength of Pipe

Rinker Materials PolyPipe Division Design and Engineering Guide for Polyethylene Piping

PolyPipe®

C Earthloading Critical Buckling

$$P_t = P_b + P_L + P_s$$

$$P_{CB} = \frac{1}{SF}\sqrt{\frac{2.67 \times B \times RW \times \Sigma_s \times \Sigma}{SDR^3}}$$

$$P_{CB} \geq P_t$$

See Page C-5 Thru C-8

09/17/2009

Rho	60	lbs/ft^3
H	200	ft
PL	21	psi
PS	0	psi
HW	5	ft
SF	2	
DR	17	
E	30000	psi
Es	3000	psi
Pt	104.33	psi
Pcb	110.12	

Variable descriptions

Note: If Pcb is less than Pt, critical buckling of the pipe may occur.
DR = standard dimension ratio
Pcb = critical buckling stress
SF = safety factor (recommend SF = 2)
Rw = water buoyancy factor
' Rw = (1-(0.33*hw/h))
' Note: hw must be less than h
H = height of soil cover above pipe
Hw = height of water table above pipe
B = empirical coefficient of elastic support
e = 2.718
Es = soil modulus (see table C-4)
E = pipe modulus of elasticity
Ps = surface load exerted by a permanent structure in close proximity to buried pipe. See page C-6 for value calculation
PL = live load exerted by heavy equipment on surface above the pipe. See page C-7 for table of values. If depth of bury is greater than 4ft. then H20 load is 3psi and E80 load is 21psi. For depth of bury greater than 10ft. E80 load is 9psi.
Rho = Density of backfill meterial

Using this CD for Design Purposes

Due to wide variations in service conditions, quality of installation, etc., no warranty or guarantee, expressed or implied, is given in conjunction with the use of the calculations and analytical solutions

Select the appropriate soil modulus Es (psi). For crushed rock bedding use 3000 psi.

PolyPipe®

C Earthloading % Deflection

$$\% \text{ Deflection} = \frac{\Delta x}{D} \times 100$$

$$\text{where } \Delta x = \frac{DI \times K \times W}{\frac{2E}{3 \times SDR^3} + 0.61 \times E_s}$$

$$\text{where } W = \frac{C_d \times \rho \times B_d \times D}{144}$$

See Page C-4

09/17/2009

CD	3.0	
Rho	60	lbs/ft³
Bd	2	ft
D	6.625	in
DR	17	
H	200	ft
DI	1.50	
K	0.1	
E	30000	psi
Es	3000	psi
W	16.563	psi
delta X	0.013546	
% deflection	0.20446	

Variable descriptions

W = earthload
Cd = trench coefficient (See figure 15)
Rho = soil density
D = outside diameter of pipe
DR = Standard Dimension Ratio
Bd = trench width at top of pipe
H = height of backfill above top of pipe
delta x = vertical defection of pipe
DI = deflection lag factor (1.50)
K = bending constant (0.10)
E = modulus of pipe elasticity
Es = soil modulus

Using this CD for Design Purposes

Due to wide variations in service conditions, quality of installation, etc., no warranty or guarantee, expressed or implied, is given in conjunction with the use of the calculations and analytical solutions. PolyPipe® has checked the calculations in this CD and to the best of our knowledge these calculations are accurate. However, users of this CD assume all responsibility for the accuracy of the analytical solutions. In all cases, third party verification or a licensed professional engineer should be consulted prior to any actual selection of product or material specification or use.

Contact our Technical Services Group at (800) 433-5632 for further assistance.

Maximum allowable safe deflection for flexible polyethylene pipe w/DR 17 is 5%.

PolyPipe®

C Earthloading % Deflection

$$\% \text{ Deflection} = \frac{\Delta x}{D} \times 100$$

$$\text{where } \Delta x = \frac{DI \times K \times W}{\frac{2E}{3 \times SDR^3} + 0.61 \times E_s}$$

$$\text{where } W = \frac{C_d \times \rho \times B_d \times D}{144}$$

See Page C-4

09/17/2009

CD	3.0	
Rho	60	lbs/ft³
Bd	2	ft
D	8.625	in
DR	17	
H	200	ft
DI	1.50	
K	0.1	
E	30000	psi
Es	3000	psi
W	21.563	psi
delta X	0.017635	
% deflection	0.20446	

Variable descriptions

W = earthload
Cd = trench coefficient (See figure 15)
Rho = soil density
D = outside diameter of pipe
DR = Standard Dimension Ratio
Bd = trench width at top of pipe
H = height of backfill above top of pipe
delta x = vertical defection of pipe
DI = deflection lag factor (1.50)
K = bending constant (0.10)
E = modulus of pipe elasticity
Es = soil modulus

Using this CD for Design Purposes

Due to wide variations in service conditions, quality of installation, etc., no warranty or guarantee, expressed or implied, is given in conjunction with the use of the calculations and analytical solutions. PolyPipe® has checked the calculations in this CD and to the best of our knowledge these calculations are accurate. However, users of this CD assume all responsibility for the accuracy of the analytical solutions. In all cases, third party verification or a licensed professional engineer should be consulted prior to any actual selection of product or material specification or use.

Contact our Technical Services Group at (800) 433-5632 for further assistance.

Maximum allowable safe deflection for flexible polyethylene pipe w/DR 17 is 5%.

PolyPipe®

C Earthloading % Deflection

$$\% \text{ Deflection} = \frac{\Delta x}{D} \times 100$$

$$\text{where } \Delta x = \frac{Dl \times K \times W}{\frac{2E}{3 \times SDR^3} + 0.61 \times E_s}$$

$$\text{where } W = \frac{C_d \times \rho \times B_d \times D}{144}$$

See Page C-4

09/17/2009

CD	3.0	
Rho	60	lbs/ft^3
Bd	2	ft
D	10.75	in
DR	17	
H	200	ft
DI	1.50	
K	0.1	
E	30000	psi
Es	3000	psi
W	26.875	psi
delta X	0.02198	
% deflection	0.20446	

Variable descriptions

W = earthload
Cd = trench coefficient (See figure 15)
Rho = soil density
D = outside diameter of pipe
DR = Standard Dimension Ratio
Bd = trench width at top of pipe
H = height of backfill above top of pipe
delta x = vertical defection of pipe
DI = deflection lag factor (1.50)
K = bending constant (0.10)
E = modulus of pipe elasticity
Es = soil modulus

Maximum allowable safe deflection for flexible polyethylene pipe w/DR 17 is 5%.

2.2.6 Base Liner Calculations

Reference: Designing w/ Geosynthetics Robert M. Koerner

T_{allow}	$= F_u + F_L + 2F_{at}$
T_{allow}	$= \sigma_{allow}\ t$
σ_{allow}	= the mobilized allowable geomembrane stress = $\sigma_{ult} \div FS$
FS	= Factor of Safety
t	= Geomembrane Thickness
F_u	= the friction force above geomembrane(assumed to be negligible, since the cover soil probably moves along with the liner as it deforms)
q	= the surcharge pressure = $d_{cs}\gamma_{cs}$
d_{cs}	= the depth of cover soil
γ_{cs}	= the unit weight of cover soil
δ	= the friction angle between geomembrane and soil or geomembrane and drainage net
L_{RO}	= length of run out
F_{AT}	$= (\sigma_h)_{ave} \tan \delta (d_{at})$
σ_h	= the average horizontal stress in anchor trench = $K_0\sigma_v$
σ_v	$= \gamma H_{ave}$
γ	= the unit weight of backfill soil
H_{ave}	= the average depth of anchor trench (requires an estimate)
K_0	$= 1-\sin\phi$
ϕ	= the angle of shearing resistance of backfill soil
d_{at}	= the (unknown) depth of anchor trench

Allowable Stress in Liner

$T_{allow} = \sigma_{allow} t$

$\sigma_{allow} = \sigma_{ult}/FS$

σ_{ult} = 2,100 psi (from N.S.F. 54)

$\sigma_{allow} = \sigma_{ult} \div FS = 2{,}100 \text{ psi} \div 1.0$

$\therefore T_{allow}$ = 2,100 psi x 0.06 in.

= 126 lbs/in.

= 1,512 lbs/ft.

Compute Forces below Liner (F_L)

$F_L = q\tan\delta(L_{ro})$

L_{ro} = 3.0 ft.

d_{cs} = 3.0 ft.

γ_{cs} = 110 pcf

δ = 25° textured liner

$q = d_{cs}\gamma_{cs}$

= (3.0)(110)

= 330 lbs/ft^2

$\therefore F_L$ = (330)tan 25° (3.0)

= 461.64 lbs/ft.

Compute Forces Due to Anchor Trench (F_{at})

F_{at} $= (\sigma_h)_{ave} \tan \delta \, (d_{at})$
$= (1-\sin\phi)(\gamma)(H_{ave}) \tan \delta \, (d_{at})$
ϕ $= 30°$
γ $= 110 \text{ lbs/ft}^3$
H_{ave} $= 5$ ft.
δ $= 25°$

$\therefore F_{at}$ $= (1-\sin30°)(110 \text{ lbs/ft}^3)(5\text{ft})(\tan25°)(d_{at})$
$= 128.23d_{at}$

Compute Required Anchor Trench Depth for FML

T_{allow} $= F_u + F_c + 2F_{at}$

1512 lbs/ft = 0 + 461.64 lbs/ft. + 2(128.23 d_{at})
$\therefore d_{at}$ = (1512.00-461.64)÷256.46
= 4.10ft provide maximum 4.0 ft. deep anchor trench because the liner will fail before pull out if it exceeds 4.10 ft.

Check Anchor Trench for Drainage Net

T_{allow} = 75 lbs/in tensile strength per SKAPS Industries Transnet 270-2-7.1 F.S. = 1.3
= 75 lbs./in /1.3 = 58 lbs/in
= 696 lbs/ft.

Compute Forces Below Drainage Net (F_L)

F_L $= q \tan \delta (L_{ro})$
δ = 24° Friction angle between textured liner and double bonded geonet.
q $= d\gamma = 3'(110\text{lbs/ft}^3)$
= (3.0)(110)(tan24°)(3.0)
= 440.78 lbs/ft.

Compute Forces Due to Anchor Trench

$F_{at} = (1-\sin30°)(110)(5)(\tan24°)(d_{at})$
$= 122.44 \, d_{at}$

Compute Required Anchor Trench

696 lbs./ft. = 0 + 440.78 lbs./ft. +122.24d_{at}
$\therefore d_{at} = 2.09$ ft.

Note: The drainage net will be anchored in F.M.L. anchor trench @ 4.00 ft.

Check Sliding Forces of Soil Cover

F.S. = (tanδ)÷(tanβ)
δ = Friction Angle = 26° for soil to double bonded geonet
β = Slope Angle = 3:1 slope = 18.418°

F.S. = (tanδ)÷(tanβ)
= (tan 26°)÷(tan18.418°)
= 1.46 > 1 ∴ O.K.

Check Stress Due to Placement of Protective Cover

Ref: Giroud and Beech (1989)

$T = (\gamma_p Z^2_p \div \sin 2\beta)[((2H_p\cos\beta \div Z_p)-1)((\sin(\beta-\phi_{cm})\div\cos\phi_{cm})-(\sin\phi_{pm}\div\cos(\beta+\phi_{pm}))]$

T	= Tension generated by placement of Cover (lbs/in width)
γ_p	= unit weight of protective cover (lbs/in^3)
Z_p	= thickness of protective cover (in.)
β	= Slope angle of the liner (degrees)
H_p	= Vertical height of protective cover (in.)
ϕ_{cm}	= Critical mobilized interface friction angle of liner (degrees) = 26°
ϕ_{pm}	= mobilized internal friction angle of protective cover (degs.) = 30°

Assume worst case of 50 ft deep on a 3:1 slope with a factor of safety of 1.3

ϕ_{cm}	= ϕ_c÷F.S. = 26°÷1.3 = 20°
ϕ_{pm}	= ϕ_p÷F.S. = 30°÷1.3 = 23.1°
γ_p	= 0.0637 lbs/in^3.
Z_p	= 36 in.
β	= 18.418° (for 3:1 slope)
H_p	= 600 in.

T = (0.0637x36^2) ÷ sin (2)18.418°)[((2x600cos18.418°÷36)-1)((sin(18.418°-20.0°)÷cos20.0°)-(sin23.1°÷cos(18.418°+23.1°))]

T = 137.70[(30.63)(-0.03)-0.52]
= 137.70(-092) - 0.52
= -127.20 lb/in. < T_{allow} 50 ft. 3:1 Embankment O.K.

Conclusion: Highest and steepest slope can have protective cover installed during the construction of the cell. Therefore, any of the other slopes will be o.k.

Self-Weight Stress during Construction

Tensile stress due to self-weight of the Smooth 60mil HDPE liner

T = γ x H x L x (sinβ - cosβtanδ)

T	= Tension due to self-weight (lbs/in.)
H	= thickness of liner system component (in.)
L	= length of liner system component (in.)
β	= Slope angle of the liner (degrees)
δ	= critical interface friction angle of liner system
γ	= unit weight of liner system component (lbs/in^3)
W	= weight per square area of membrane (lbs/in^2)

Assume worst condition:
The length of the liner on a 3:1 slope that would induce failure in the liner.

T = F_p = 126 lbs/in

Solve for L (Length)

L = T ÷ (γ x H x (sinβ-cosβtanδ))

γ = W x .06 in = 0.00012 lbs/in^3
H = 0.06 in. (60mil Smooth HDPE)
β = 18.418° (for 3:1 slope)
δ = 17°
L = 126 ÷((0.00012x0.06(sin18.418°-cos18.418°tan17°))

= 67,628 in.

= 5,636ft. far exceeds any requirement

∴Self Weight stress is O.K.

Thermal Stress during Construction

ε = ΔL ÷ L = Strain

ε = Strain in the liner system (percent)
ΔL = Change in length of liner due to change in temperature
L = Length of liner before temperature change
ΔL = (α)L(ΔT)
α = Coefficient of liner thermal expansion (°F^{-1})
ΔL = Change in length of liner due to change in temperature
ΔT = Change in Temperature (°F°)

Assume:

α = Coefficient of liner thermal expansion (°F^{-1}) = 6.7x10^{-5} °F^{-1}
ΔT = 100°F Conservative assumption
L = 1 ft.
ε = αLΔT ÷ L
= $\alpha\Delta$T
= 0.0067 ft. or 0.67%

Allowable elongation @ yield = 13%
∴allowable > design thermal stress o.k.

2.2.7 Alternate Base Liner Calculations

Geosynthetic Clay Liner (GCL) Calculations
Ref: CETCO Design Manual Technical Notes 5 and 6

FS = factor of safety
T = the allowable long-term tensile strength in the layer above the critical surface being analyzed.
L = the slope length.
S = the shear strength along the surface being analyzed.
β = slope angle (degrees).
γ = the unit weight of cover soil
z = the thickness of the cover soil layer.
ϕ = the internal or interface friction angle along the surface being analyzed.
C = the apparent cohesion along the surface being analyzed.

$$FS = \frac{[(T \div L) + S]}{[(z)(\gamma)(\sin\beta)]}$$

$$S = (\gamma)(z)(\cos\beta)(\tan\phi) + C$$

Check interface between cohesive soil liner and Bentomat (Reinforced GCL):

$\phi = 13.5°$
$\gamma = 110$ lbs./ft^3
$z = 3$ ft.
$\beta = 18.4°$ (3:1 slopes)

$C = 500$ lbs./ft^2
$T = 90$ lbs./ft.
$L = 150$ ft.

$\therefore S = (110)(3)(0.9489)(0.2401) + 500$
$S = 575.18$ lbs/ft^2

$$\therefore FS = \frac{(90 \div 150) + 575.18}{(3)(110)(\sin 18.4°)}$$

FS = 5.53 OK

Check interface between Bentomat (Reinforced GCL) and 60 mil Textured HDPE Liner:

$$FS = \frac{[(T \div L) + S]}{[(z)(\gamma)(\sin \beta)]}$$

$$S = (\gamma)(z)(\cos \beta)(\tan \phi) + C$$

$\phi = 13°$
$\gamma = 110$ lbs./ft^3
$z = 3$ ft.
$\beta = 18.4°$ (3:1 slopes)

$C = 200$ lbs./ft^2
$T = 1{,}512$ lbs./ft.
$L = 150$ ft.

$\therefore S = (110)(3)(0.9489)(0.2309) + 200$
$S = 272.29$ lbs/ft^2

$$\therefore FS = \frac{(1{,}512 \div 150) + 272.29}{(3)(110)(\sin 18.4°)}$$

FS = 2.71 OK

2.2.8 Foundation, Settlement, and Slope Stability Analysis

ECS CARLINAS, LLP
"Setting the Standard for Service"
Geotechnical • Construction Materials • Environmental • Facilities NC Registered Engineering Firm F-1078

November 5, 2010

Mr. Wayne Sullivan, PLS
Municipal Engineering Services Co. PA
PO Box 97
Garner, NC 27529

RE: Report of Geotechnical Services
Lenoir County Landfill, Phase 2
2949 Hodges Farm Road
Kinston, North Carolina
ECS Project No. 06:17047-A

Dear Mr. Sullivan:

ECS Carolinas, LLP (ECS) has completed the revised geotechnical analysis for the proposed Phase 2 of the Lenoir County Landfill as requested by Municipal Engineering Services Company, PA (MESCO). ECS previously analyzed the proposed project and presented our findings in a report dated November 20, 2009 under ECS Project No. 16717. The revised analysis includes a change in the liner modeling in the slope stability analysis to better represent the planned system and an increase in the final slope to 3 horizontal to 1 vertical.

Project Information

The Lenoir County Landfill is located at 2949 Hodges Farm Road in Kinston, North Carolina. Based on information and the Engineering Plan dated October 5, 2009 for the landfill prepared and provided by MESCO, the proposed approximately 9-acre Phase 2 of the landfill will be located north-northwest of and adjacent to the existing Phase 1. Based on the information provided to us, two possible liner systems are being considered. The first system is a standard system consisting of a 2 foot thick conventional clay liner overlain by a 60 mil thick HDPE flexible membrane liner (FML), a 250 mil thick drainage net, and a 3 foot thick layer of protective cover soil. The second system consists of an 1.5 foot thick alternate clay liner overlain by a 0.24 inch thick geosynthetic clay liner (GCL), a 60 mil thick HDPE flexible membrane liner, a 250 mil thick drainage net, and a 3 foot thick layer of protective cover soil. In both cases the landfill will be capped with an 18 inch thick clay liner, a 40 mil thick LLDPE flexible membrane liner and a 2-foot thick cap of protective soil.

Based on the proposed finished cap grades for Phase 2 from the facility plan, we understand that the maximum waste height will be approximately 115 feet. The design shows that the permanent side slopes for the cap will have an inclination of 4H:1V (horizontal to vertical). For the purpose of this analysis, we have been asked to assume maximum slopes of 3H:1V in case additional storage capacity is desired.

Soil borings in the Phase 2 area were conducted by Derry's Well Drilling under subcontract to MESCO. ECS has been provided with the boring logs (the Boring Logs and the Slope Stability

Location Diagram are presented in Appendix A). The Lenoir County Landfill lies in the Coastal Plains Province, and consists of sands overlaying Black Creek Formations Clay. The soils encountered on the site generally consist of medium dense to very dense Clayey to Silty SANDS. Groundwater was encountered within most of the borings ranging from approximately 12 to 26 feet below the prevailing ground surface.

Engineering Analyses

Analyses were performed on Phase 2 to determine settlement of the subgrade soils and local slope stability of the proposed embankment and global slope stability of the landfill. These analyses were based on the design drawings provided by MESCO. Shear strength and compressibility of the soil were estimated based on the soil descriptions on the provided boring logs and our previous experience. The analyses were performed by engineers specializing in geotechnical engineering and copies of the slope stability analyses are attached in Appendix B.

The approximately 115-foot maximum height of proposed waste, including the liner system and cap, will apply a foundation load of approximately 8,435 psf or 4.2 tsf. The maximum fill height was determined to be in the vicinity of boring P2-6 where the proposed final fill elevations are approximately 115 feet higher than proposed subgrade elevations. An average in-place moist density of the compacted waste and daily cover of 70 pounds per cubic foot was assumed based on the typical values published by National Solid Wasted Management Association and several studies consulted by this office. Based on our experience with similar soil conditions, the silty sands at the proposed subgrade elevations are suitable for support of the applied loads.

The total and differential settlement of the foundation soils from the applied solid waste loads were estimated using an elastic analysis and estimated compressibility based on the Standard Penetration Test N-values obtained form the Boring Logs provided to us. The borings performed within the proposed landfill area were advanced to depths ranging from approximately 25 to 51 feet below the prevailing ground surface.

Based on available boring information provided by MESCO, settlements were estimated for locations along section B-B’ shown on Figure 1 included in the Appendix to this report. The maximum waste fill height occurred in the vicinity of boring P2-6 along section B-B’. The thickness of the soil profile underlying the waste and clay liner is approximately 8 feet of fill material, assumed to be onsite clayey to silty sand borrow material, and 30 feet of natural clayey to silty sands in the vicinity of P2-6. The applied load is approximately 8,435 psf, resulting in estimated settlements on the order of 7 inches.

Based on the provided boring results, the soil conditions across the site are reasonably uniform. Settlement will typically be proportional to the waste and embankment height, with little abrupt differential movements.

The waste fill and perimeter embankment were evaluated for slope stability analysis using circular potential failure mechanism. Two sections were selected for the stability analysis, which is considered representative of the most unfavorable conditions. The locations of the analyzed sections are shown on the Slope Stability Location Diagram in Appendix A. Each section was analyzed using the two liner options. The slope stability analysis was performed using the proprietary Slide 5.0 computer program. The modeled slope configuration was generally based on the topographic information and site grading plan provided to us by the client with the face slopes steepened to 3H:1V, while the soil strata information, index properties and engineering properties used in these analyses were estimated based on the soil descriptions on the provided boring logs and our previous experience.

The factors of safety were determined for both static and seismic loading, using the pseudo-static method. For the pseudostatic analysis of the slope, we used an earthquake ground motion having a 2-percent probability of exceedance within a 50-year period (2,475 year return period). According to the USGS Map, October 2002, the seismic acceleration at the bedrock level based on the probabilistic earthquake (2,475 year return period) for this site is 0.08g. The seismic coefficient, k_s, for the site is 0.04g.

The resulting minimum factors of safety were computed to be 1.5 for permanent slopes under static loading conditions and 1.3 for seismic conditions. The failure planes with the lowest factors of safety were through the waste material and the type of liner system did not affect the results of the analysis. Analyses that forced the failure plane through the liner system calculated higher factors of safety. The results of the slope stability analysis are presented in Appendix B.

In conclusion, the results of the geotechnical analysis indicate that permanent slope configurations of 3H:1V or flatter and the proposed configuration of perimeter embankment fill slopes will be stable and provide an appropriate factor of safety.

Construction Considerations

Based on the provided boring logs and the design drawings, we expect that dewatering will not be necessary during any excavation into natural site soils. If groundwater is encountered during construction, it probably can be controlled through the use of ditches, sumps, and pumps. If water is encountered that cannot be controlled by such procedures, ECS should be further consulted. Earthwork and trench excavation in saturated materials may require sheeting and shoring, slope flattening, or benching to control sloughing of soils. Seasonal variations in groundwater levels should be anticipated due to precipitation changes, evaporation, surface water runoff, and other factors.

The soils encountered within the test borings should generally be able to be excavated with conventional earth moving equipment such as pans/scrapers, loaders, bulldozers, rubber tired backhoes, etc. On-site soils used as earth fill should have a well-graded grain size distribution with rock and soil particles ranging from clay or silt size particles to a maximum size of 6 inches in diameter. Particles larger than this should be broken by mechanical compaction equipment to achieve the desired grain size distribution, and the samples shall have a minimum of 20 percent passing the No. 200 sieve and 50 percent passing the No. 40 sieve. Variations from these requirements shall be approved by the geotechnical engineer in the field at the time the samples are prepared.

This report has been prepared in order to aid in the evaluation of this property and to assist the architect and/or engineer in the design of this project. The scope is limited to the specific project and locations described herein and our description of the project represents our understanding of the significant aspects relative to soil and foundation characteristics. In the event that any changes in the nature or location of the proposed construction outlined in this report are planned, we should be informed so that the changes can be reviewed and the conclusions of this report modified or approved in writing by the geotechnical engineer. It is recommended that all construction operations dealing with earthwork and foundations be reviewed by an experienced geotechnical engineer to provide information as to whether the design requirements are fulfilled in the actual construction. If you wish, we would welcome the opportunity to provide field construction services for you during construction.

The data submitted in this report are based upon the information obtained from the soil borings and tests performed by others at the locations as indicated on the information referenced in this report. This report does not reflect any variations which may occur between the borings. In the performance of the subsurface exploration, specific information is obtained at specific locations at specific times. However, it is a well known fact that variations in soil conditions exist on most sites between boring locations and also such situations as groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction. If site conditions vary from those identified during the explorations, the recommendations contained in this report may require revision.

Thank you for the opportunity to work with you on this project. Should you have any questions or if we could be of further assistance, please do not hesitate to contact us.

Respectfully,
ECS CAROLINAS, LLP represented by;
Firm License Number: F-1078

NORTH CAROLINA PROFESSIONAL SEAL 036537 ENGINEER MATTHEW B. OLSEN
11/5/10

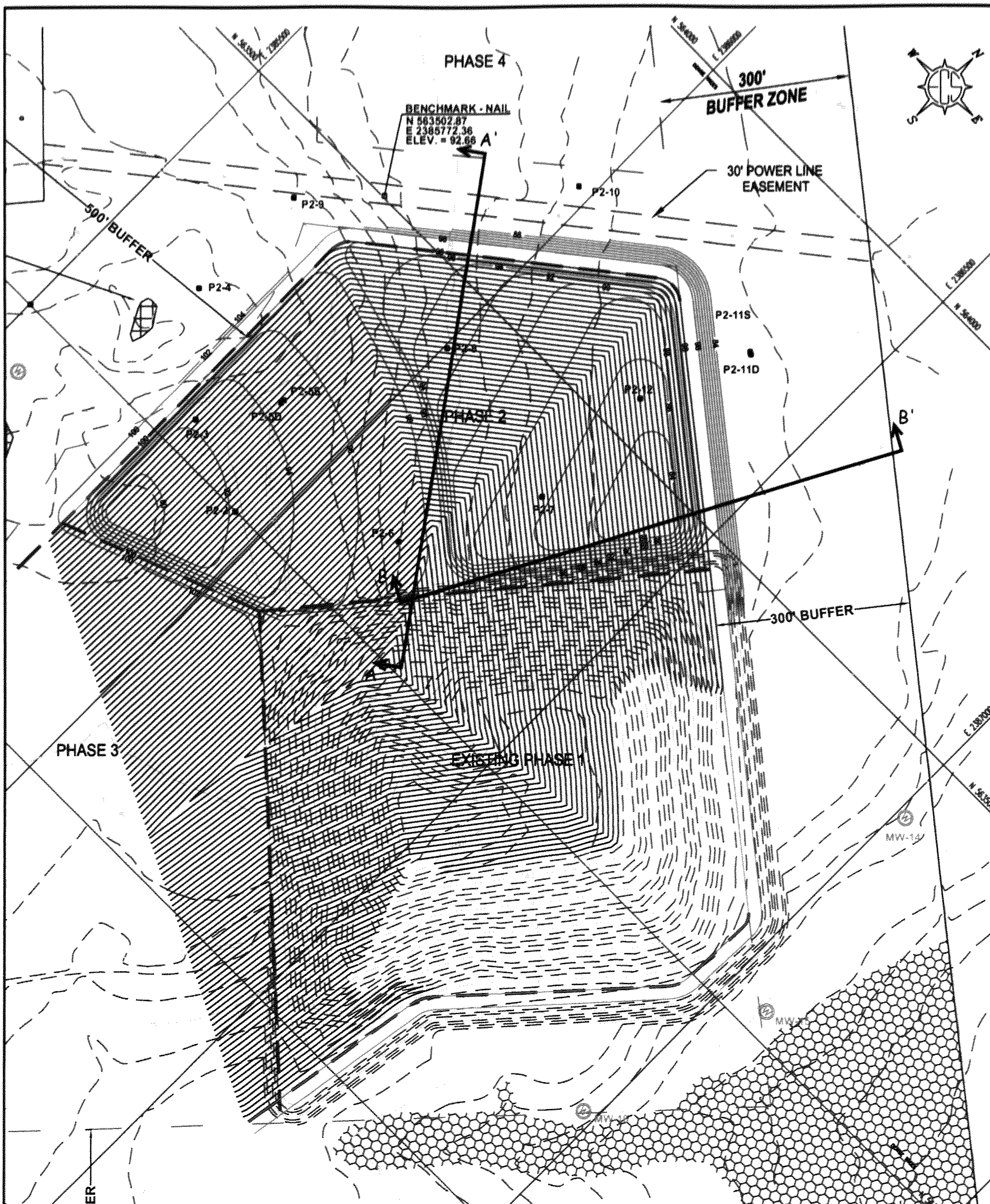
Matthew B. Olsen, PE	C. (Nathan) Nallainathan, PE
Manager of Engineering Services	Principal Engineer
NC PE License No. 036537	NC PE License No. 019937

APPENDICES

APPENDIX A

EXPLORATION LOCATION DIAGRAM

SELECTED BORING LOGS



REFERENCE DRAWING PROVIDED BY: MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

SLOPE STABILITY LOCATION DIAGRAM	ECS LLP CAROLINAS — SETTING THE STANDARD FOR SERVICE	**LENOIR COUNTY LANDFILL - PHASE 2**	ENGINEER HAH	SCALE 1"=200'
			DRAFTSMAN DAH	PROJECT NO. 06:17047-A
			REVISIONS	SHEET FIGURE 1
MUNICIPAL ENGINEERING SERVICES CO., P.A.		**LENOIR COUNTY, NORTH CAROLINA**		DATE 11-19-09

LOG OF BORING: P2-1

Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor: Derry's Well Drilling
Drill rig & method: 7.75" OD HSA, SPT
Logged by: J. Pfohl

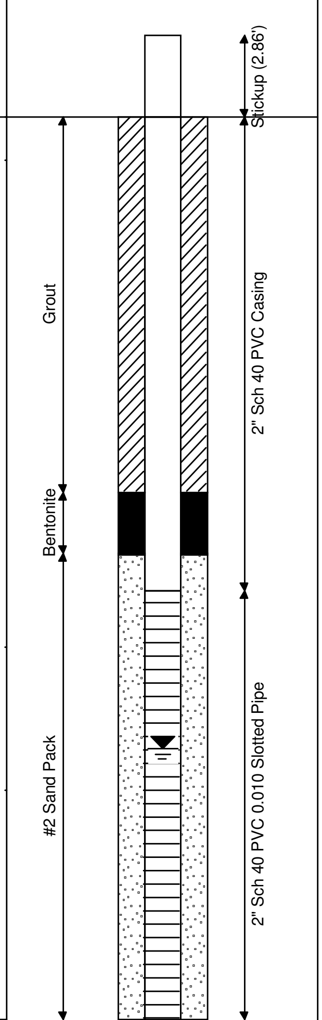
Date started: 9/2/2008
Date ended: 9/2/2008
Completion depth: 31.52 ft
Stickup height: 2.86 ft

Surface elevation: 102.12 ft (MSL)
Top of pipe elevation: 104.98 ft (MSL)
Depth to water (TOB): 22.00 ft
Depth to water (24hrs): 22.07 ft

SPT (bpf)	Description of Material & Remarks
14	Top Soil; light grey organic silty sand, root debris, dry
12	Clayey Sand; red brown, cohesive, homogeneous, moist
52	Clayey Sand; red brown, fine to medium grained cemented sand, dense, cohesive, moist
52	Clayey Sand; same as above
73	Silty Sand; light brown, poorly graded cemented sand, few smooth translucent quartz fragments, dense, dry
15	Clayey Sand; medium to dark grey fine grained sand with cohesive grey clay, wet
17	Clayey Sand; medium to dark grey, fine to medium grained sand with cohesive clay, saturated
	Boring terminated at 31.5 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

LOG OF BORING: P2-2

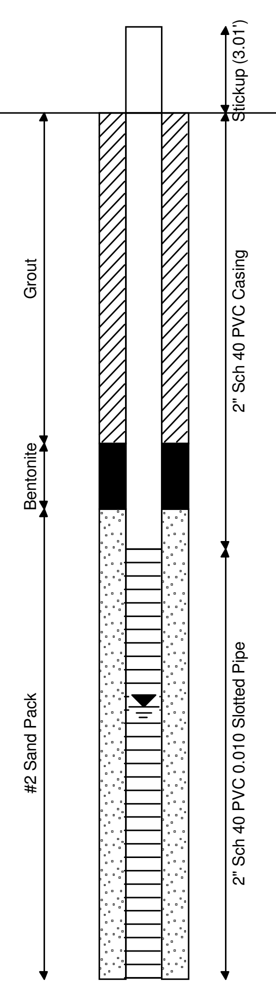
Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor: Derry's Well Drilling	Date started: 9/3/2008	Surface elevation: 97.47 ft (MSL)
Drill rig & method: 7.75" OD HSA w/ SPT	Date ended: 9/3/2008	Top of pipe elevation: 100.48 ft (MSL)
Logged by: J. Pfohl	Completion depth: 30.11 ft	Depth to water (TOB): 20.00 ft
	Stickup height: 3.01 ft	Depth to water (24hrs): 20.76 ft

SPT (bpf)	Description of Material & Remarks
13	Clayey Sand; red brown, fine grained,moist
19	Clayey Sand; red brown to orange, cohesive, mosit
	Clayey Sand (CL) orange, Gravel=0.02%, Sand=73.85%, Silt & Clay=26.13%, LL=27%, PL=18%, PI=9%
29	Clayey Sand; red brown, fine to medium grained, homogeneous, cohesive, dry
22	Clayey Sand; same as above
18	Silty Sand; light brown, poorly graded fine to gravel size sand, damp
18	Silty Sand; same as above
19	Silty Sand; light brown, fine grained, trace clay nodules, wet
	Boring terminated at 30.1 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



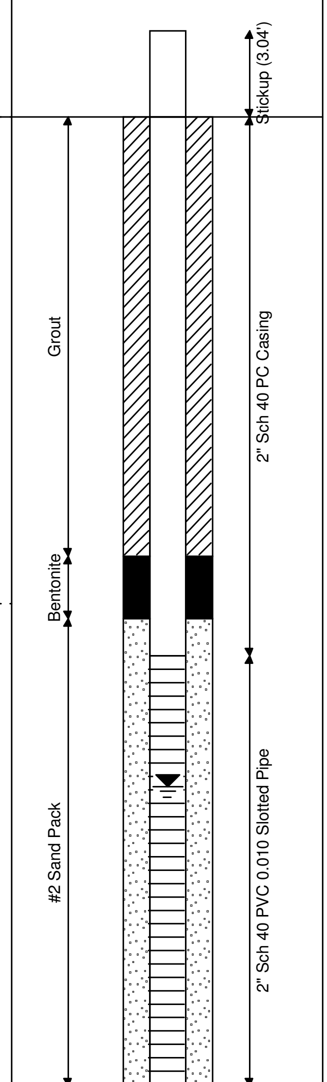
LOG OF BORING: P2-3

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/2/2008	Surface elevation:	101.24 ft (MSL)
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	9/2/2008	Top of pipe elevation:	104.28 ft (MSL)
Logged by:	J.Pfohl	Completion depth:	33.84 ft	Depth to water (TOB):	24.00 ft
		Stickup height:	3.04 ft	Depth to water (24hrs):	23.40 ft

SPT (bpf)	Description of Material & Remarks
14	Clayey Sand; reddish brown, fine graind, highly cohesive, moist
56	Clayey Sand; red brown, fine grained cemented sand laminated with cohesive clay, very dense, moist
61	Clayey Sand; same as above
34	Clayey Sand; red brown, poorly graded sand, trace silt, dry
19	Sand with Silt; poorly graded, red brown to orange, coarse grained, homogeneous, dry
30	Silty Sand; light brown, poorly graded sand fine to gravel sand size, moist
24	Silty Sand; same as above
	Boring terminated at 33.8 feet

Well Diagram



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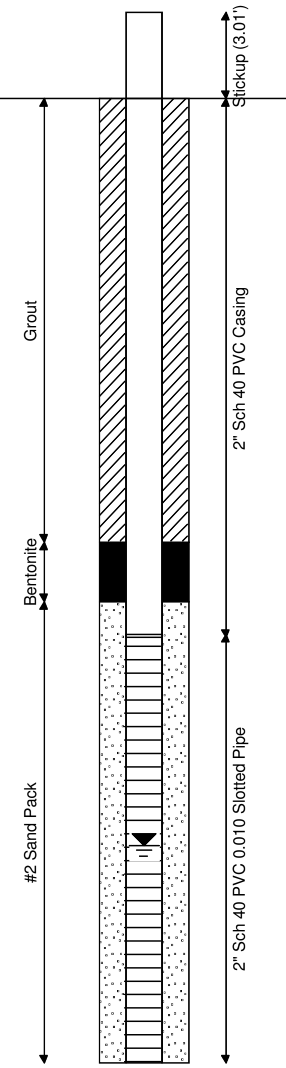
LOG OF BORING: P2-4

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/3/2008	Surface elevation:	104.61 ft (MSL)
Drill rig & method:	7.75" OD HSA w/SPT	Date ended:	9/3/2008	Top of pipe elevation:	107.62 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	33.72 ft	Depth to water (TOB):	24.00 ft
		Stickup height:	3.01 ft	Depth to water (24hrs):	26.10 ft

Depth (ft)	SPT (bpf)	Description of Material & Remarks
0	14	Clayey Sand; red brown, few grey clay nodules, dry
3.5	18	Clayey Sand; red brown, cohesive clay nodules, dry
8.5	52	Silty Sand; red brown, homogeneous, dense cemented sand, trace clay nodules, dry
12		Silty Sand (SM) light brown, Gravel=0%, Sand=64.41%, Silt & Clay=35.59%
14.5	59	Silty Sand; light brown, poorly graded, coarse to fine grained, cohesive clay nodules, dry
18.5	53	Silty Sand; light brown, poorly graded, trace silt and clay, dry
23.5	24	Sand with Silt; poorly graded, red brown to orange, coarse grained, homogeneous, dry
28.5	16	Silty Sand; light brown, poorly graded with trace silt, moist
33.7		Boring terminated at 33.7 feet

Well Diagram



LOG OF BORING: P2-5S

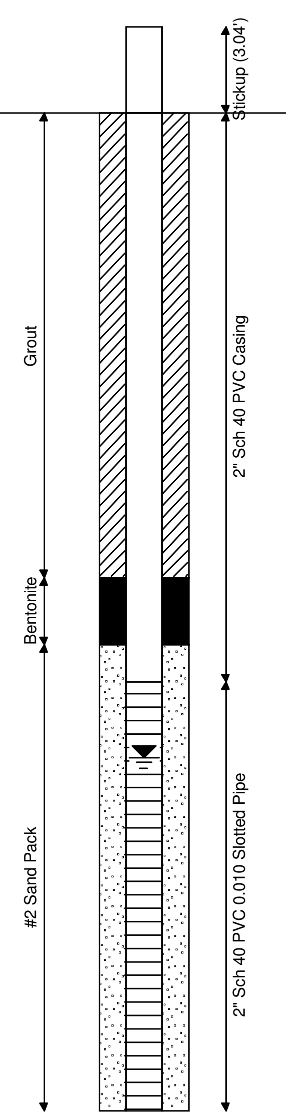
Lenoir County MSWLF Phase 2 **Project No. G08095.6**

Drilling contractor: Derry's Well Drilling	Date started: 8/29/2008	Surface elevation: 98.42 ft (MSL)
Drill rig & method: 7.75" OD HSA	Date ended: 8/29/2008	Top of pipe elevation: 101.46 ft (MSL)
Logged by: J. Pfohl	Completion depth: 34.85 ft	Depth to water (TOB): 25.00 ft
	Stickup height: 3.04 ft	Depth to water (24hrs): 22.52 ft

SPT (bpf)	Description of Material & Remarks
18	Clayey Sand; brown, fine to medium grained sand laminated with red brown clay, moist
13	Clayey Sand; red brown, fine to medium grained, cohesive, moist
20	Clayey Sand; same as above
21	Clayey Sand; red brown, fine to medium grained, dry
28	Silty Sand; dark brown, medium to coarse grained, trace cohesive clay nodules, dry
30	Silty Sand; dark brown, medium to coarse grained, trace cohesive clay nodules, damp
31	Silty Sand; same as above
17	Silty Sand; brown, poorly graded sand, trace clay nodules, homogeneous, moist
	Boring terminated at 34.9 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



LOG OF BORING: P2-5D

Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor: Derry's Well Drilling
Drill rig & method: 7.75" OD HSA w/ SPT
Logged by: J. Pfohl

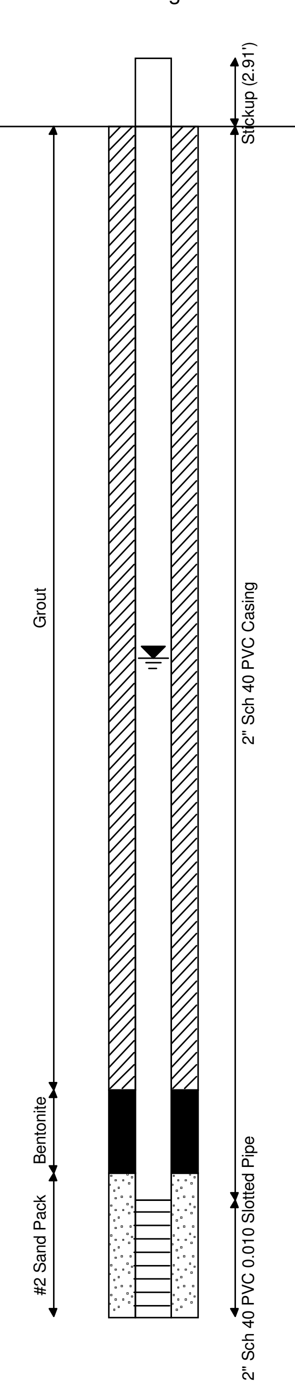
Date started: 8/30/2008
Date ended: 8/30/2008
Completion depth: 50.81 ft
Stickup height: 2.91 ft

Surface elevation: 98.34 ft (MSL)
Top of pipe elevation: 101.25 ft (MSL)
Depth to water (TOB): 25.00 ft
Depth to water (24hrs): 22.69 ft

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55

SPT (bpf)	Description of Material & Remarks
18	Clayey Sand; brown, fine to medium grained sand laminated with red brown clay, moist
13	Clayey Sand; red brown, fine to medium grained, cohesive, moist
20	Clayey Sand; same as above
21	Clayey Sand; red brown, fine to medium grained, dry
28	Silty Sand; dark brown, medium to coarse grained, trace cohesive clay nodules, dry
30	Silty Sand; dark brown, medium to coarse grained, trace cohesive clay nodules, damp
31	Silty Sand; same as above
17	Silty Sand; brown, poorly graded sand, trace clay nodules, homogeneous, moist
18	Silty Sand; brown, poorly graded sand, trace clay nodules, homogeneous, wet
21	Silty Sand; same as above
	Clayey Sand; black, cohesive, thinly laminated black clay with grey, fine to medium grained sand, some lignitic wood, moist
	Boring terminated at 50.8 feet

Well Diagram



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LOG OF BORING: P2-6

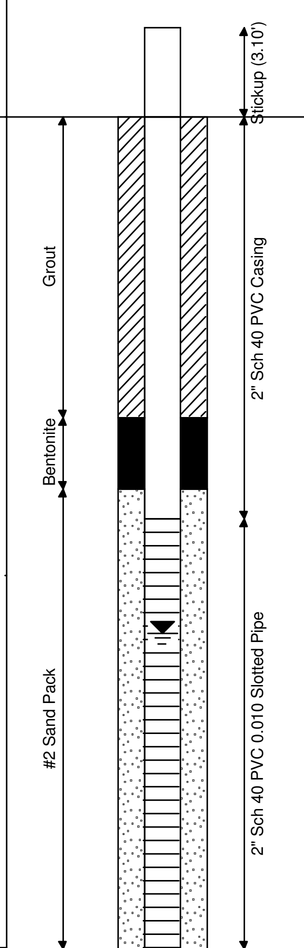
Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/2/2008	Surface elevation:	92.20 ft (MSL)
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	9/2/2008	Top of pipe elevation:	95.29 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	29.05 ft	Depth to water (TOB):	18.00 ft
		Stickup height:	3.10 ft	Depth to water (24hrs):	18.05 ft

SPT (bpf)	Description of Material & Remarks
17	Clayey Sand; brown yellow, fine to medium grained sand laminated with cohesive light grey clay, moist
17	Clayey Sand; brown to brown yellow, fine to medium grained, cohesive, moist
22	Clay Sand; brown to brown yellow, fine grained, few black silt partings, dry
20	Clayey Sand; same as above
37	Silty Sand; brown yellow, poorly graded, trace silt, moist
19	Silty Sand; brown yellow, poorly graded, less dense, wet
	Boring terminated at 29.1 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



LOG OF BORING: P2-7

Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor: Derry's Well Drilling
Drill rig & method: 7.75" HSA w/ SPT
Logged by: J. Pfohl

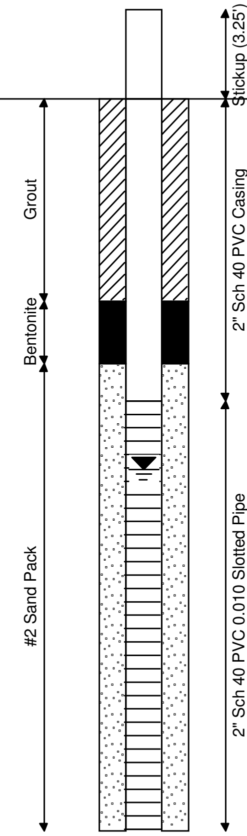
Date started: 9/3/2008
Date ended: 9/3/2008
Completion depth: 25.56 ft
Stickup height: 3.25 ft

Surface elevation: 84.95 ft (MSL)
Top of pipe elevation: 88.20 ft (MSL)
Depth to water (TOB): 13.00 ft
Depth to water (24hrs): 12.95 ft

SPT (bpf)	Description of Material & Remarks
21	Clayey Sand; brown to brown yellow, fine grained, trace organic top soil with root debris, dry
14	Clayey Sand; brown to brown yellow, fine grained, dry
21	Clayey Sand; same as above
38	Silty Sand; light brown, poorly graded, trace silt, moist
	Silty Sand (ML) tan, Gravel=0.0%, Sand=59.48%, Silt & Clay=40.52%, LL=45%, PL=29%, PI=16%
19	Silty Sand; light brown, fine grained, wet
20	Silty Sand; brown yellow, poorly graded, wet
	Boring terminated at 25.6 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



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LOG OF BORING: P2-8

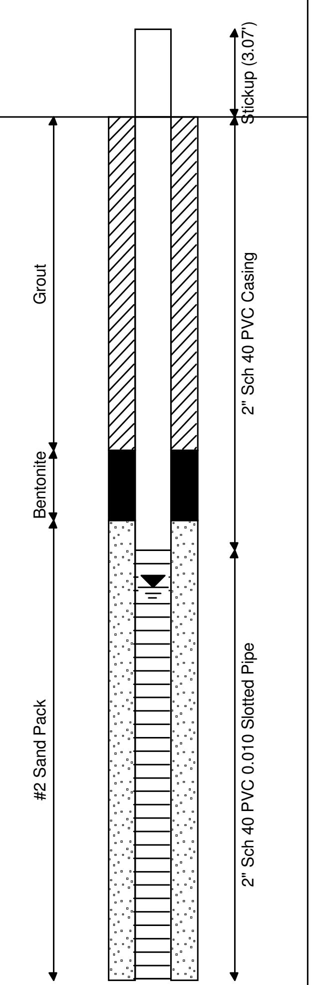
Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008
Drill rig & method:	7.75" HSA w/ SPT	Date ended:	8/30/2008
Logged by:	J. Pfohl	Completion depth:	30.15 ft
		Stickup height:	3.07 ft

Surface elevation:	89.51 ft (MSL)
Top of pipe elevation:	92.58 ft (MSL)
Depth to water (TOB):	16.50 ft
Depth to water (24hrs):	16.45 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
				Silty Sand; tan grey, wet, medium dense, coarse grained
5	11		X	
				Clayey Sand; tan and grey layers, moist, medium dense
10	46		X	
15	15		X	Clayey Sand; wet, medium dense, less clay
				Silty Sand; grey brown, wet, medium dense, fine grained
20	10		X	
25				Soil description (0'-27.5') taken from log for overdrilled well P-7
30	13		X	Silty Sand; grey brown, fine grained, saturated
				Boring terminated at 30.1 feet
35				
40				
45				

Well Diagram



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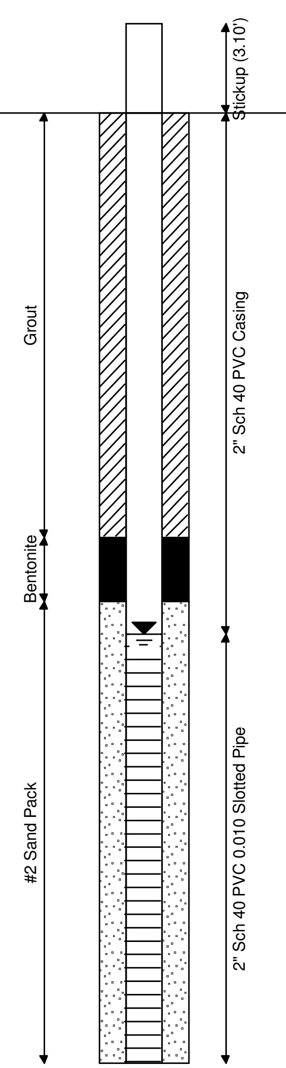
LOG OF BORING: P2-9

Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008	Surface elevation:	98.84 ft (MSL)
Drill rig & method:	7.75" OD HSA w/SPT	Date ended:	8/30/2008	Top of pipe elevation:	101.95 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	33.19 ft	Depth to water (TOB):	23.00 ft
		Stickup height:	3.10 ft	Depth to water (24hrs):	18.21 ft

SPT (bpf)	Description of Material & Remarks
17	Clayey Sand; red brown, few grey clay nodules, dry
18	Clayey Sand; red brown, fine grained sand laminated with cohesive clay, moist
62	Silty Sand; red brown, homogeneous, dense cemented sand, dry
39	Sand with Silt; poorly graded, red brown to orange, coarse grained, dry
36	Silty Sand; light brown, poorly graded dry
23	Silty Sand; light brown to orange, few cobble size smooth translucent quartz fragments, damp
21	Silty Sand; light brown, poorly graded with trace silt, wet
	Boring terminated at 33.2 feet

Well Diagram



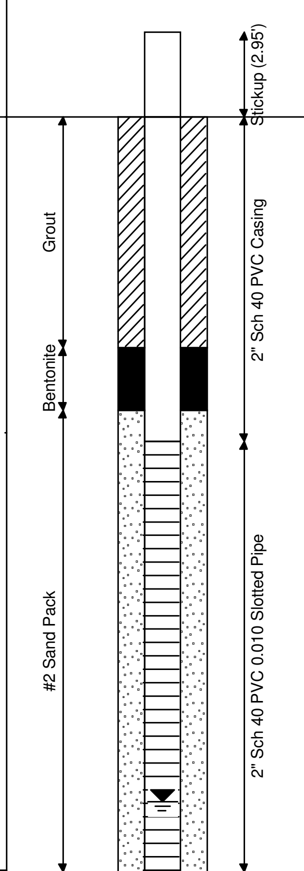
LOG OF BORING: P2-10

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008	Surface elevation:	85.18 ft (MSL)
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	8/30/2008	Top of pipe elevation:	88.14 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	26.36 ft	Depth to water (TOB):	14.00 ft
		Stickup height:	2.95 ft	Depth to water (24hrs):	23.91 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	9			Clayey Sand; orange, medium grained, loose, dry
	18			Clayey Sand; red brown, medium grained, moderately dense, slight relict structure, dry
5				Clayey Sand (CL) orange brown, Gravel=0.0%, Sand=73.55%, Silt & Clay=26.45%, LL=29%, PL=15%, PI=14%
	80			Clayey Sand; red brown, medium to fine grained, very dense, dry
10				
	37			Silty Sand; tan, medium grained, damp
15				
	28			Silty Sand; tan, medium grained, moderately dense, moist
20				
	26			Silty Sand; tan, medium grained, moderately dense, few black silt partings, wet
25				
				Boring terminated at 26.4 feet
30				
35				
40				
45				

Well Diagram



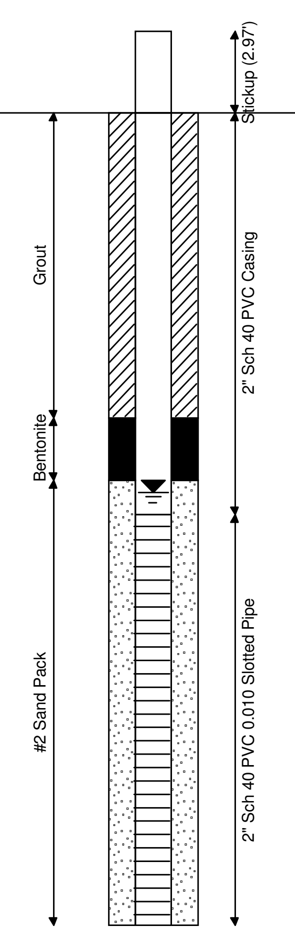
LOG OF BORING: P2-11S

Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling
Drill rig & method:	7.75" OD HSA
Logged by:	J. Pfohl
Date started:	8/30/2008
Date ended:	8/30/2008
Completion depth:	29.66 ft
Stickup height:	2.97 ft
Surface elevation:	82.80 ft (MSL)
Top of pipe elevation:	85.76 ft (MSL)
Depth to water (TOB):	14.00 ft
Depth to water (24hrs):	13.85 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
0	13			Clayey Sand; light brown, fine grained sand laminated with grey cohesive clay, moist
5	18			Clayey Sand; light brown, medium grained sand laminated with brown to grey cohesive clay, moist
10	49			Clayey Sand; red brown, poorly graded sand with cohesive clay, dry
15	32			Clayey Sand; brown, medium grained sand with cohesive grey clay, moist
20	17			Silty Sand with Clay, light brown, fine to medium grained sand with cohesive clay, moist
25	31			Silty Sand with Clay; light brown, clay lense, cohesive, wet
30	26			Silty Sand with Clay; same as above
				Boring terminated at 29.7 feet
35				
40				
45				

Well Diagram



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LOG OF BORING: P2-11D

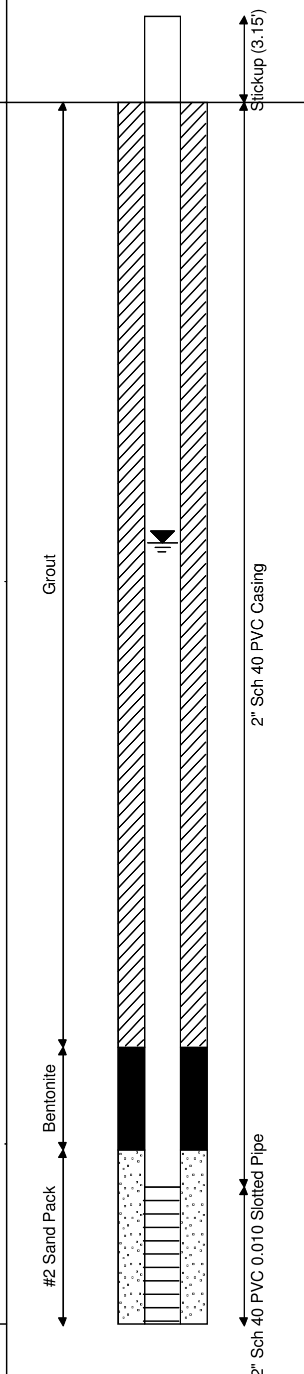
Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008	Surface elevation:	82.72 ft (MSL)
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	8/30/2008	Top of pipe elevation:	85.87 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	44.62 ft	Depth to water (TOB):	14.00 ft
		Stickup height:	3.15 ft	Depth to water (24hrs):	16.05 ft

SPT (bpf)	Description of Material & Remarks
13	Clayey Sand; light brown, fine grained sand laminated with grey cohesive clay, moist
18	Clayey Sand; light brown, medium grained sand laminated with brown to grey cohesive clay, moist
49	Clayey Sand; red brown, poorly graded sand with cohesive clay, dry
	Clayey Sand (CL) brown, Gravel=0.0%, Sand=72.06%, Silt & Clay=27.94%, LL=36%, PL=19%, PI=17%
32	Clayey Sand; brown, medium grained sand with cohesive grey clay, moist
17	Silty Sand with Clay, light brown, fine to medium grained sand with cohesive clay, moist
31	Silty Sand with Clay; light brown, clay lense, cohesive, wet
26	Silty Sand with Clay; same as above
24	Silty Sand with Clay; same as above
23	Clayey Sand; black, thinly laminated black clay interbedded with grey fine to medium grained sand, some lignitic wood, moist
	Boring terminated at 44.6 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



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LOG OF BORING: P2-12

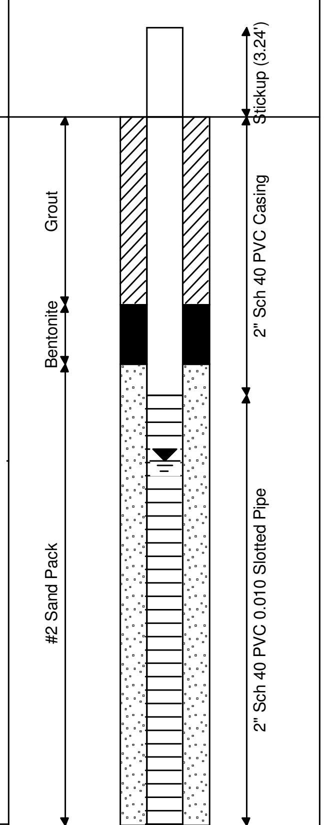
Lenoir County MSWLF Phase 2 **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	8/30/2008
Logged by:	J. Pfohl	Completion depth:	24.75 ft
		Stickup height:	3.24 ft

Surface elevation:	82.52 ft (MSL)
Top of pipe elevation:	85.77 ft (MSL)
Depth to water (TOB):	12.00 ft
Depth to water (24hrs):	12.01 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	8		X	Clayey Sand; light brown, fine grained sand laminated with grey cohesvie clay, moist
5	14		X	Clayey Sand; light brown, medium grained sand laminated with gray cohesive clay, moist
10	62		X	Clayey Sand; red brown, poorly graded sand, few smooth cobble size translucent quartz fragments, dry
15	22		X	Silty Sand; light brown, poorly graded sand, few grey clay nodules, moist
20	16		X	Silty Sand; light brown, fine grained, homogeneous, wet
25				Boring terminated at 24.8 feet
30				
35				
40				
45				

Well Diagram

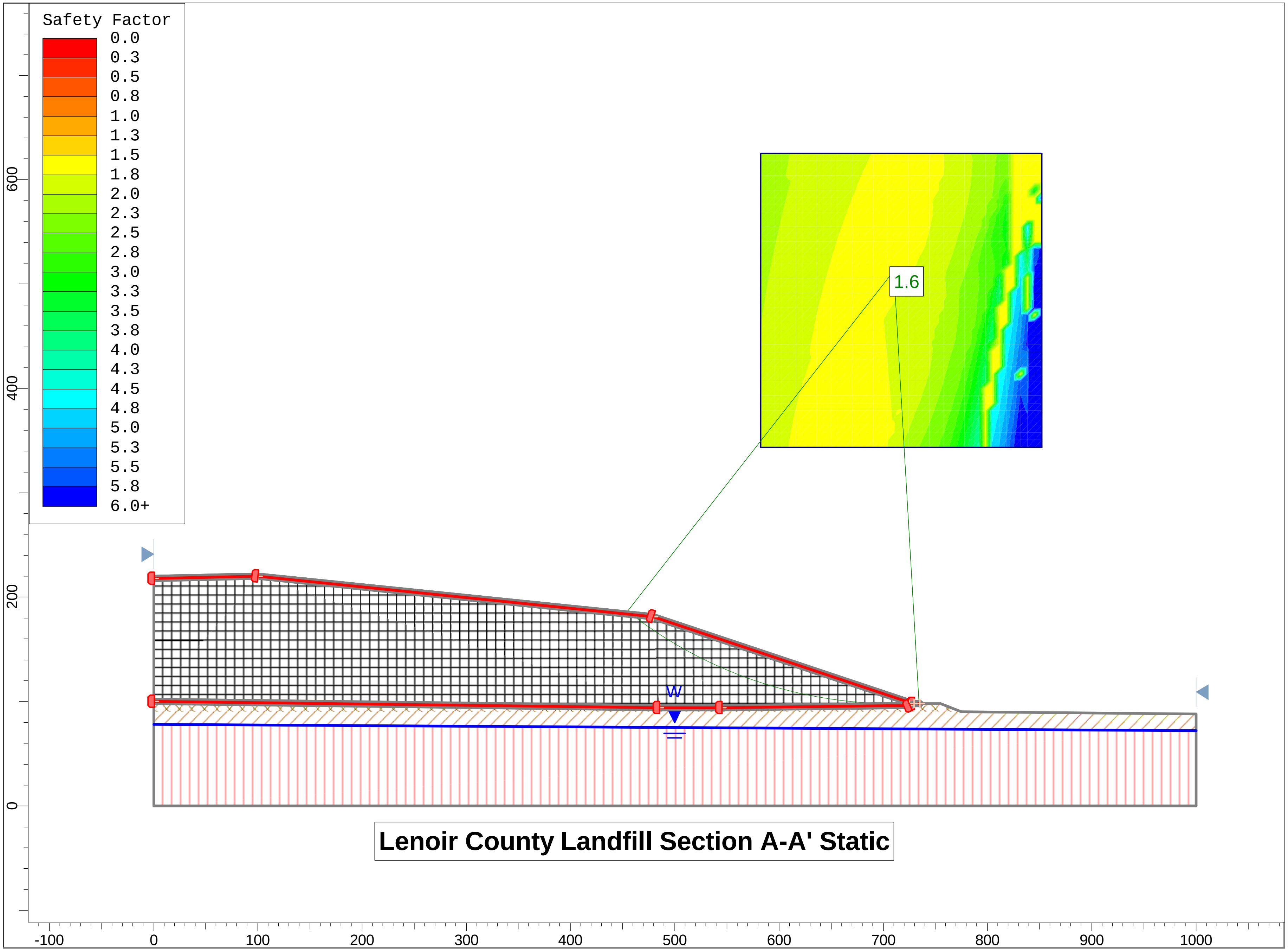


APPENDIX B

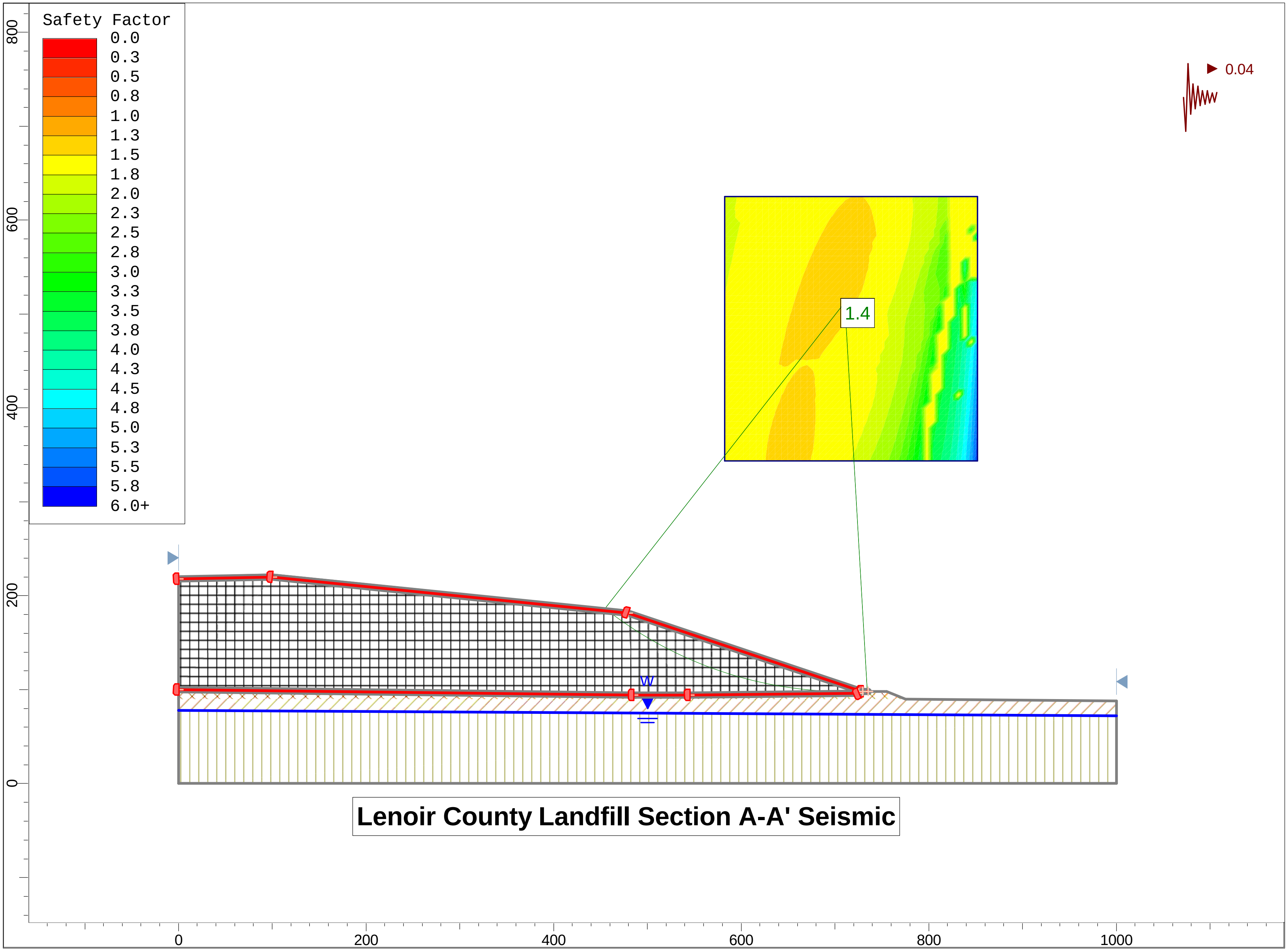
SLOPE STABILITY ANALYSES RESULTS

Material Property Legend

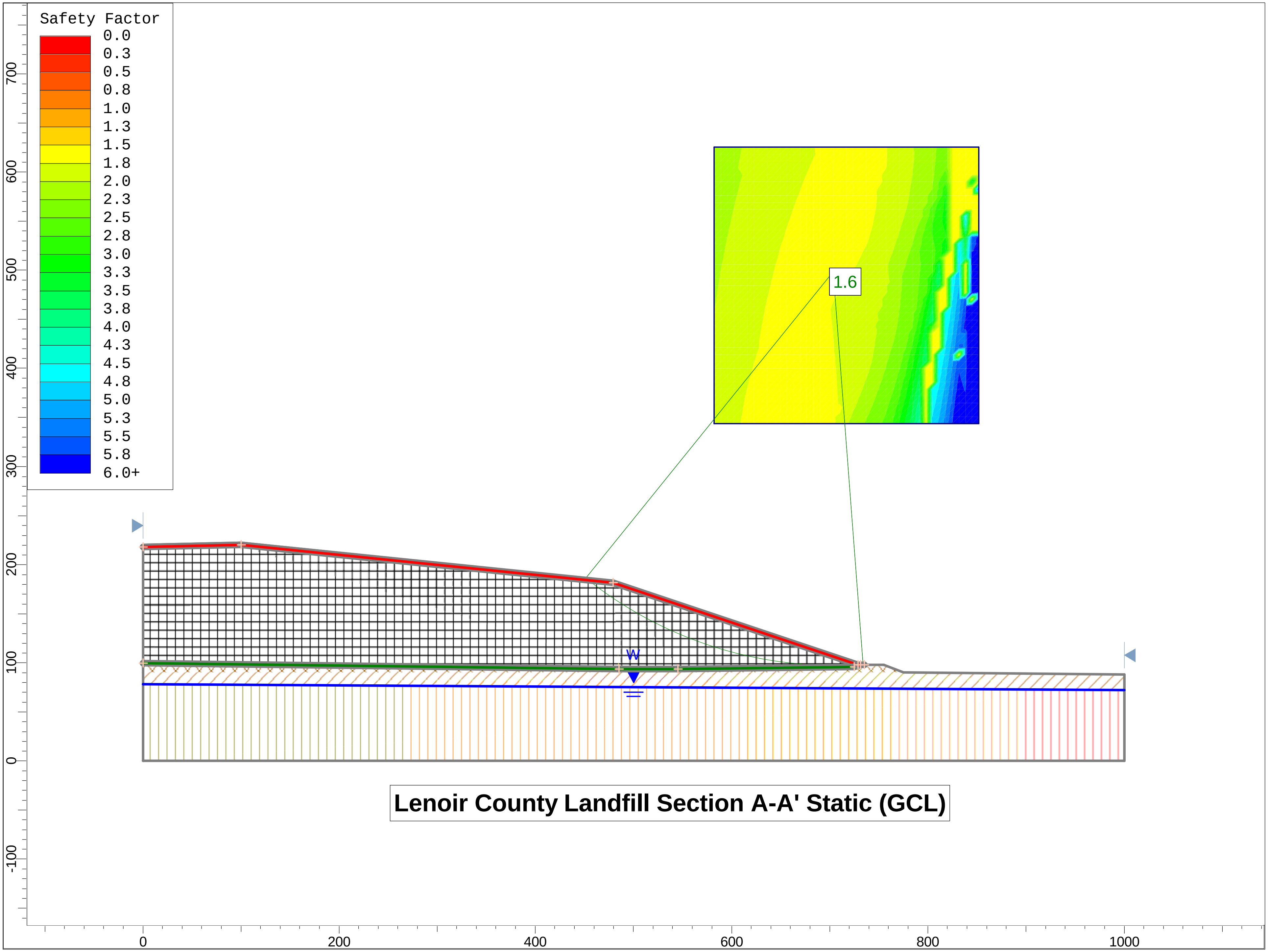
Soil Layer/Material	Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)
Waste	70	20	200
Protective Soil	125	30	0
Clay Liner	125	20	400
Fill: Silty to Clayey SAND	125	32	150
Clayey SAND	125	32	150
Silty SAND	125	32	100
HDPE Liner, LLDPE Liner, & Drainage Net	-	26	0
Geosynthetic Clay Liner	-	21	0



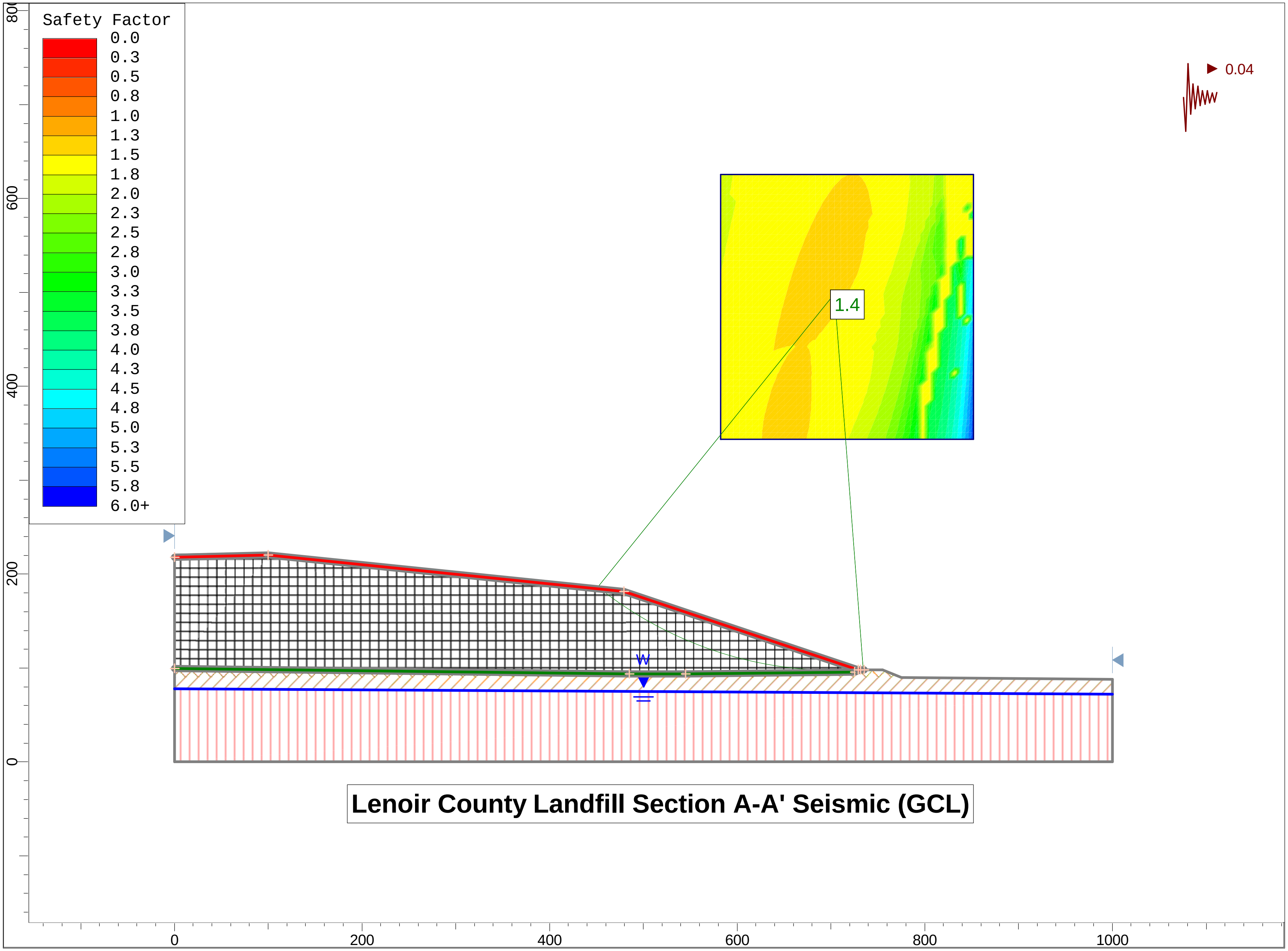
Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
1.6
W
600
400
200
0
-100
0
100
200
300
400
500
600
700
800
900
1000
Lenoir County Landfill Section A-A' Static



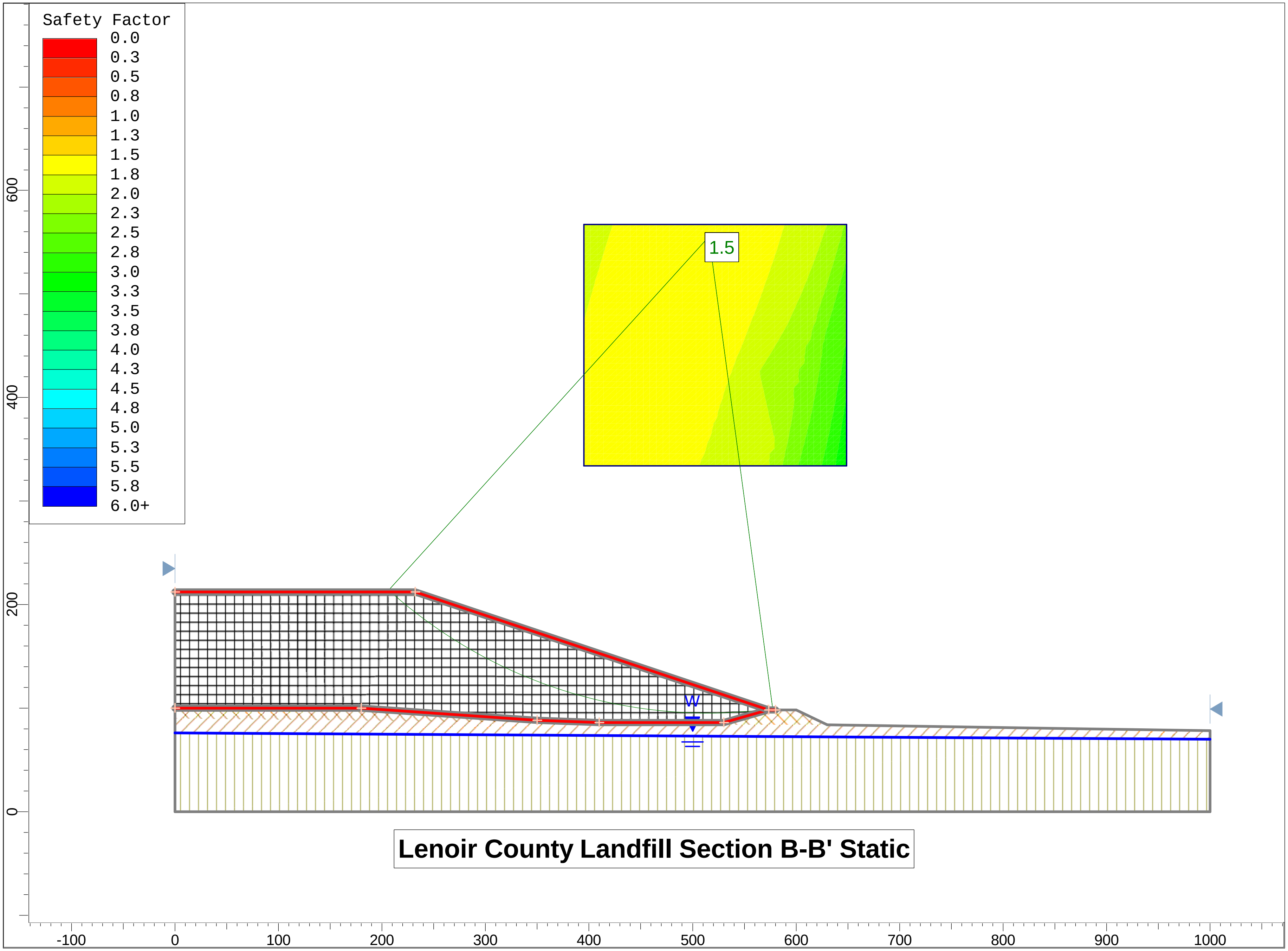
Lenoir County Landfill Section A-A' Seismic



Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
1.6
W
700
600
500
400
300
200
100
0
-100
0
200
400
600
800
1000
Lenoir County Landfill Section A-A' Static (GCL)



Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
0.04
1.4
W
600
400
200
0
0
200
400
600
800
1000
Lenoir County Landfill Section A-A' Seismic (GCL)



Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
1.5
W
600
400
200
0
-100
0
100
200
300
400
500
600
700
800
900
1000
Lenoir County Landfill Section B-B' Static

Slide Analysis Information

Document Name

File Name: Section B-B' Static.sli

Project Settings

Project Title: Lenoir County Landfill Section B-B' Static
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: Waste
Strength Type: Mohr-Coulomb
Unit Weight: 70 lb/ft3
Cohesion: 200 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay Liner
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3

Cohesion: 400 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty, Clayey FILL
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clayey SAND
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty SAND
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

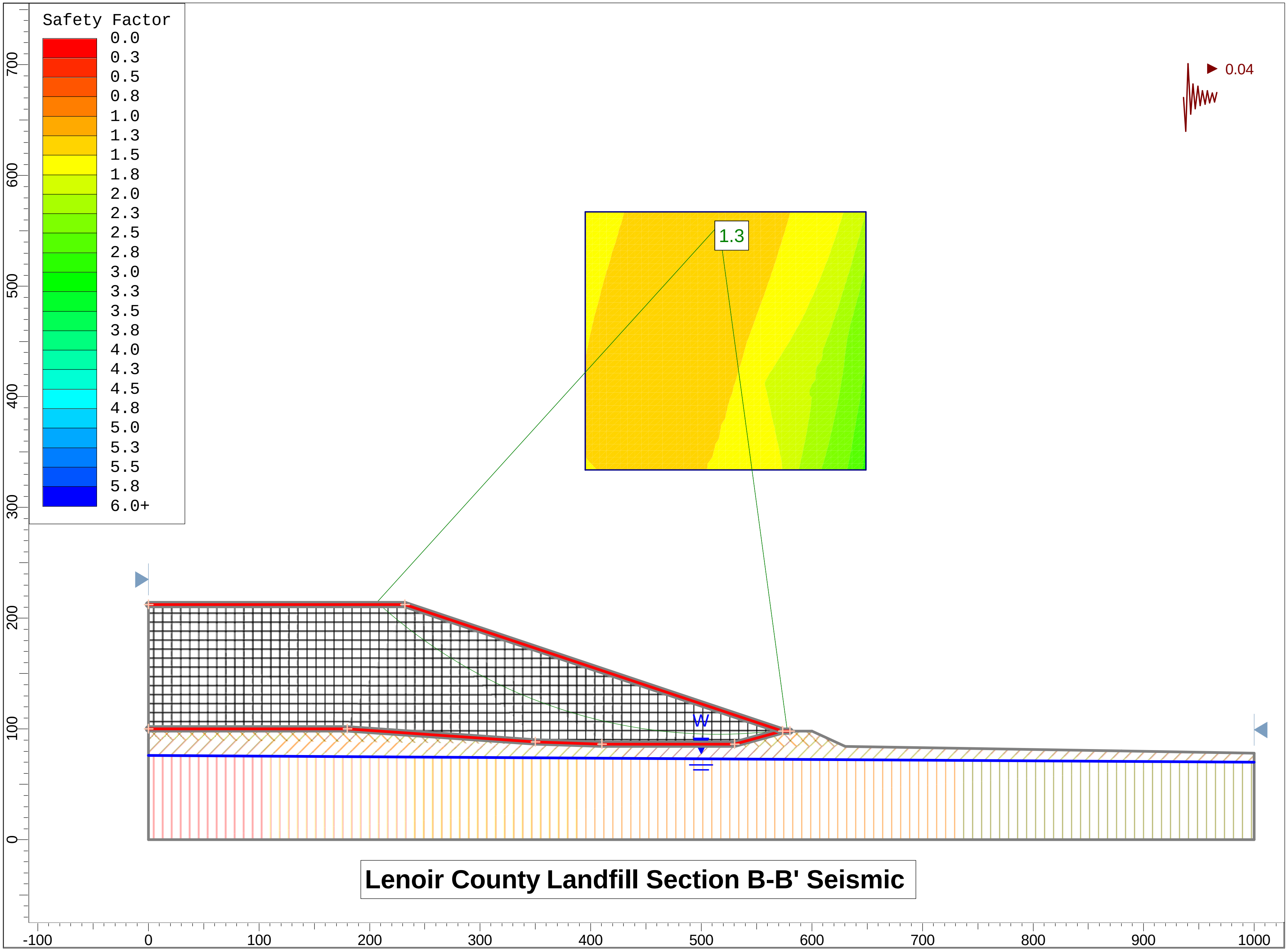
Material: Protective
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1

Support Properties

Support: Support 1
Support 1
Support Type: GeoTextile
Force Application: Passive
Force Orientation: Bisector of Parallel and Tangent
Anchorage: None
Shear Strength Model: Linear
Strip Coverage: 100 percent
Tensile Strength: 0 lb/ft
Pullout Strength Adhesion: 0 lb/ft2
Pullout Strength Friction Angle: 26 degrees

Global Minimums

Method: bishop simplified
FS: 1.511790
Center: 515.724, 555.148
Radius: 460.509
Left Slip Surface Endpoint: 206.391, 214.000
Right Slip Surface Endpoint: 577.568, 98.811
Resisting Moment=1.93537e+008 lb-ft
Driving Moment=1.28018e+008 lb-ft



Safety Factor
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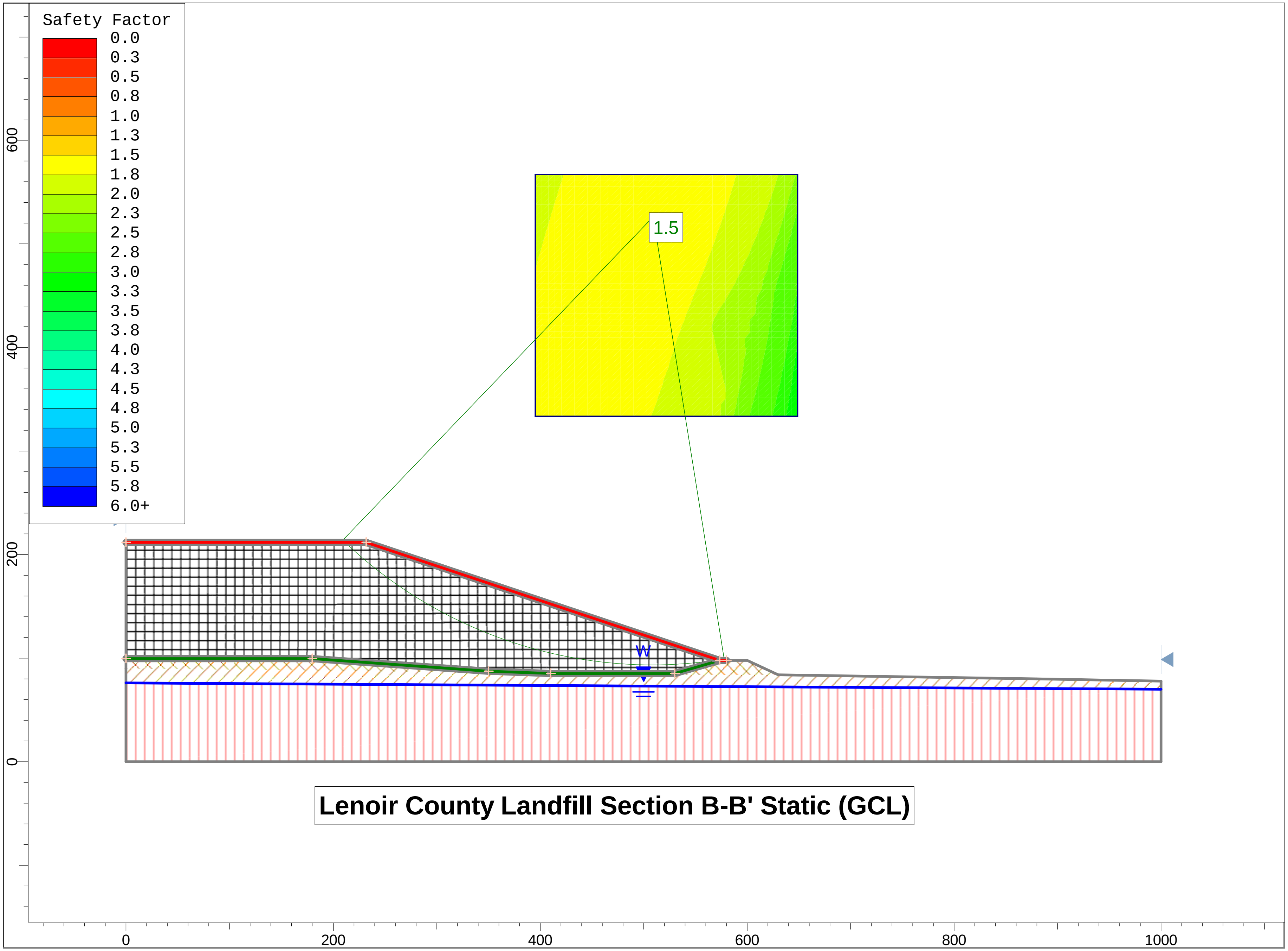
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
0.04
1.3
W
Lenoir County Landfill Section B-B' Seismic



Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
1.5
W
600
400
200
0
0
200
400
600
800
1000
Lenoir County Landfill Section B-B' Static (GCL)

Slide Analysis Information

Document Name

File Name: Section B-B' Static GCL.sli

Project Settings

Project Title: Lenoir County Landfill Section B-B' Static (GCL)
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: Waste
Strength Type: Mohr-Coulomb
Unit Weight: 70 lb/ft3
Cohesion: 200 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay Liner
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 400 psf
Friction Angle: 20 degrees

Water Surface: Water Table
Custom Hu value: 1

Material: Silty, Clayey FILL
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clayey SAND
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty SAND
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Protective
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1

Support Properties

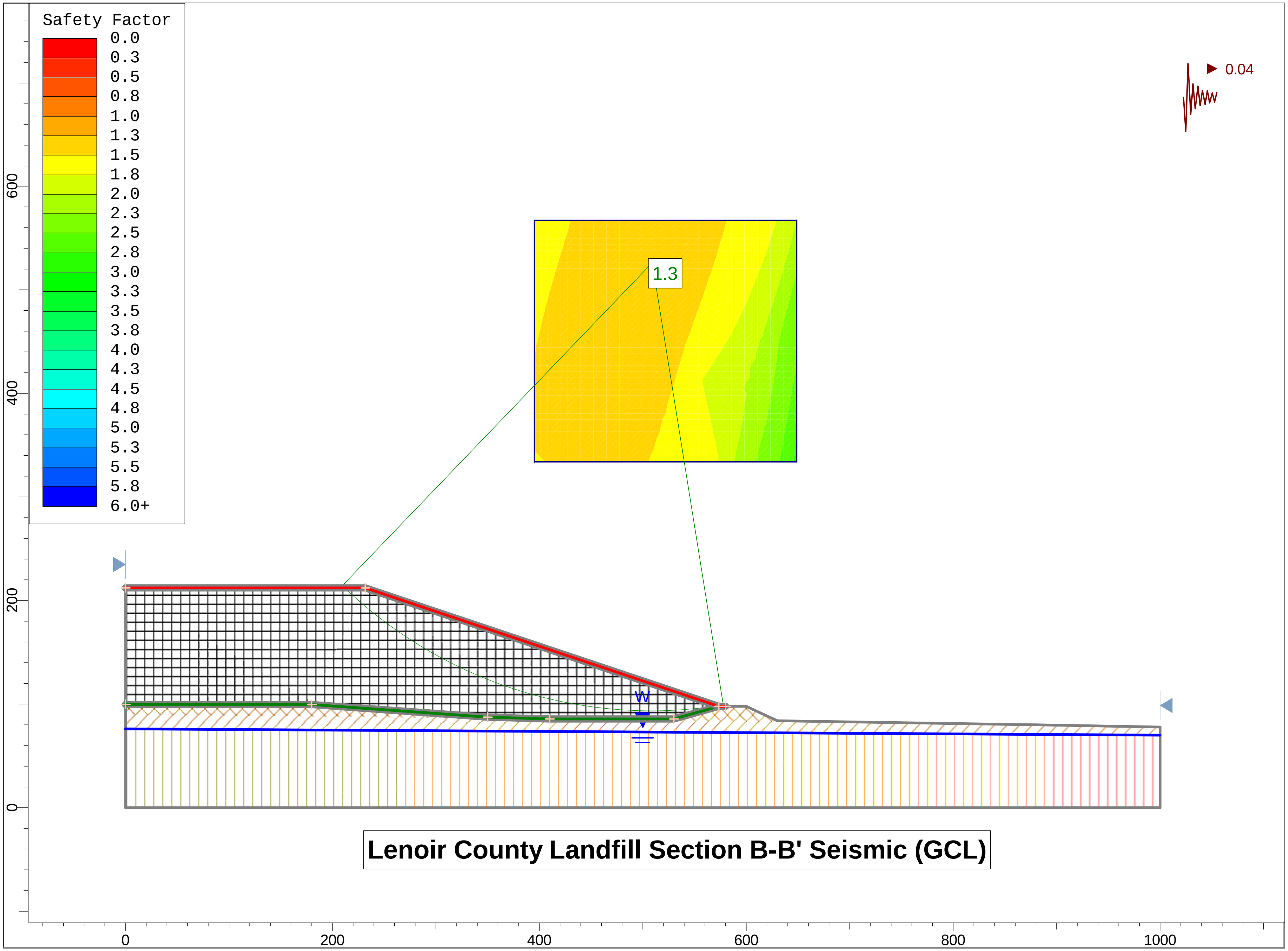
Support: Support 1
Support 1
Support Type: GeoTextile
Force Application: Passive
Force Orientation: Bisector of Parallel and Tangent
Anchorage: None
Shear Strength Model: Linear
Strip Coverage: 100 percent
Tensile Strength: 0 lb/ft
Pullout Strength Adhesion: 0 lb/ft2
Pullout Strength Friction Angle: 26 degrees

Support: Support 2
Support 2
Support Type: GeoTextile
Force Application: Passive
Force Orientation: Bisector of Parallel and Tangent
Anchorage: None
Shear Strength Model: Linear

Strip Coverage: 100 percent
Tensile Strength: 0 lb/ft
Pullout Strength Adhesion: 0 lb/ft2
Pullout Strength Friction Angle: 21 degrees

Global Minimums

Method: bishop simplified
FS: 1.510650
Center: 509.381, 526.012
Radius: 432.850
Left Slip Surface Endpoint: 209.367, 214.000
Right Slip Surface Endpoint: 578.064, 98.645
Resisting Moment=1.86639e+008 lb-ft
Driving Moment=1.23549e+008 lb-ft



Lenoir County Landfill Section B-B' Seismic (GCL)

January 6, 2011

Mr. Wayne Sullivan, PLS
Municipal Engineering Services Co. PA
PO Box 97
Garner, NC 27529

RE: Report of Geotechnical Services
Phase 2 Intermediate Slopes
Lenoir County Landfill
2949 Hodges Farm Road
Kinston, North Carolina
ECS Project No. 06:17047-B

Dear Mr. Sullivan:

ECS Carolinas, LLP (ECS) has completed the geotechnical analysis for the proposed intermediate slopes for Phase 2 of the Lenoir County Landfill as requested by Municipal Engineering Services Company, PA (MESCO). ECS previously analyzed the permanent slopes for the project and presented our findings in a report dated November 5, 2010 under ECS Project No. 17047-A.

Project Information

The Lenoir County Landfill is located at 2949 Hodges Farm Road in Kinston, North Carolina. Based on information and the Engineering Plan dated August 6, 2010 for the landfill prepared and provided by MESCO, the proposed Phase 2 of the landfill will be located north-northwest of the existing Phase 1 and will partially overlay Phase 1. It is our understanding that during construction of Phase 2 intermediate (temporary) slopes steeper than the final slopes will be used in construction. Based on the proposed intermediate grading plan provided, we understand that the intermediates slopes will have a maximum waste height of approximately 64 feet at slopes of 2H:1V (horizontal to vertical) or flatter.

Soil borings in the Phase 2 area were conducted by Derry's Well Drilling under subcontract to MESCO. ECS has been provided with the boring logs (the Boring Logs and the Slope Stability Location Diagram are presented in Appendix A). The Lenoir County Landfill lies in the Coastal Plains Province, and consists of sands overlaying Black Creek Formations Clay. The soils encountered on the site generally consist of medium dense to very dense Clayey to Silty SANDS. Groundwater was encountered within most of the borings ranging from approximately 12 to 26 feet below the prevailing ground surface.

Engineering Analyses

Analyses were performed on Phase 2 to determine the global slope stability of the intermediate slopes. The analyses were based on the design drawings provided by MESCO. Engineering properties of the soil and waste were estimated based on the soil descriptions on the provided boring logs and our previous experience. The analyses were performed by engineers specializing in geotechnical engineering and copies of the slope stability analyses are attached in Appendix B.

An average in-place moist density of the compacted waste and daily cover of 70 pounds per cubic foot was assumed based on the typical values published by National Solid Wasted Management Association and several studies consulted by this office. Based on our experience with similar soil conditions, the silty sands at the proposed subgrade elevations are suitable for support of the applied loads.

The waste fill was evaluated for slope stability analysis using circular potential failure mechanism. One section was selected for the stability analysis, which is considered representative of the most unfavorable conditions. The location of the analyzed section is shown on the Slope Stability Analysis Diagram in Appendix A. The section was analyzed using a standard liner system as previously analyzed. The slope stability analysis was performed using the proprietary Slide 5.0 computer program. The modeled slope configuration was generally based on the topographic information and site grading plan provided to us by the client with a face slope of 2H:1V, while the soil strata information, index properties and engineering properties used in these analyses were estimated based on the soil descriptions on the provided boring logs and our previous experience.

The factors of safety were determined for both static and seismic loading, using the pseudo-static method. For the pseudostatic analysis of the slope, we used an earthquake ground motion having a 2-percent probability of exceedance within a 50-year period (2,475 year return period). According to the USGS Map, October 2002, the seismic acceleration at the bedrock level based on the probabilistic earthquake (2,475 year return period) for this site is 0.08g. The seismic coefficient, k_s, for the site is 0.04g.

The resulting minimum factors of safety were computed to be 1.3 for intermediate slopes under static loading conditions and 1.2 for seismic conditions. The results of the slope stability analyses are presented in Appendix B.

In conclusion, the results of the geotechnical analysis indicate that intermediate slope configurations of 2H:1V or flatter for heights up to 64 feet will be stable and provide an appropriate factor of safety for a temporary slope.

General comments

This report has been prepared in order to aid in the evaluation of this property and to assist the architect and/or engineer in the design of this project. The scope is limited to the specific project and locations described herein and our description of the project represents our understanding of the significant aspects relative to soil and foundation characteristics. In the event that any changes in the nature or location of the proposed construction outlined in this report are planned, we should be informed so that the changes can be reviewed and the conclusions of this report modified or approved in writing by the geotechnical engineer. It is recommended that all construction operations dealing with earthwork and foundations be reviewed by an experienced geotechnical engineer to provide information as to whether the design requirements are fulfilled in the actual construction.

The data submitted in this report are based upon the information obtained from the soil borings and tests performed by others at the locations as indicated on the information referenced in this report. This report does not reflect any variations which may occur between the borings. In the performance of the subsurface exploration, specific information is obtained at specific locations at specific times. However, it is a well known fact that variations in soil conditions exist on most sites between boring locations and also such situations as groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction. If site conditions vary from those identified during the explorations, the recommendations contained in this report may require revision.

Thank you for the opportunity to work with you on this project. Should you have any questions or if we could be of further assistance, please do not hesitate to contact us.

Respectfully,
ECS CAROLINAS, LLP;
Firm License Number: F-1078

NORTH CAROLINA PROFESSIONAL SEAL 036537 ENGINEER MATTHEW B. OLSEN
1/6/11

Matthew B. Olsen, PE	C. (Nathan) Nallainathan, PE
Manager of Engineering Services	Principal Engineer
NC PE License No. 036537	NC PE License No. 019937

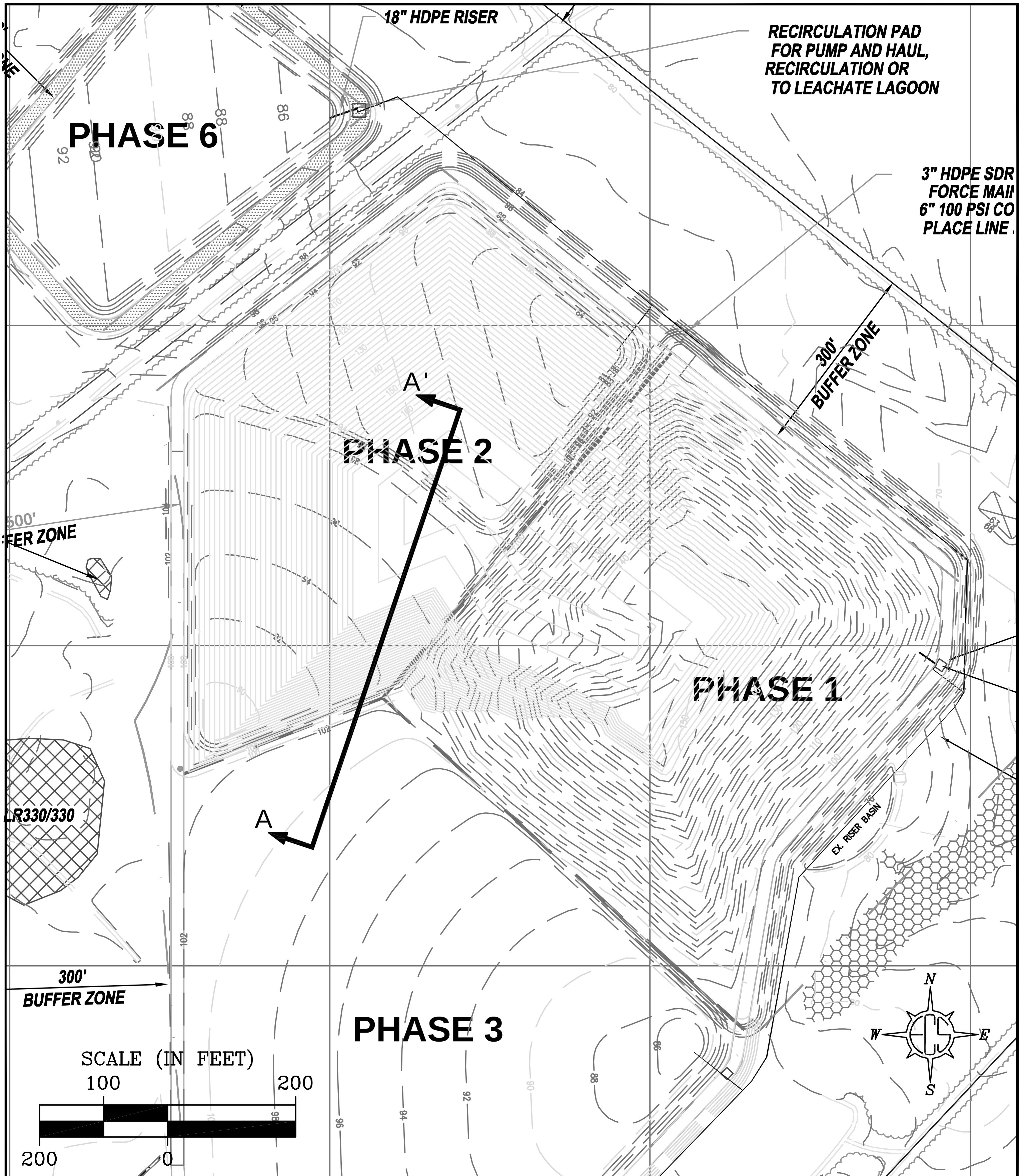
APPENDICES

APPENDIX A

EXPLORATION LOCATION DIAGRAM

SELECTED BORING LOGS

VICINITY MAP **MUNICIPAL ENGINEERING SERVICES CO., P.A.**	ECS LLP CAROLINAS SETTING THE STANDARD FOR SERVICE	LENOIR COUNTY LANDFILL INTERMEDIATE SLOPES **LENOIR COUNTY, NORTH CAROLINA**	ENGINEER MBO	SCALE NTS
			DRAFTSMAN DAH	PROJECT NO. 17047-B
			REVISIONS	SHEET FIGURE 1
				DATE 1-03-11



SLOPE STABILITY ANALYSIS DIAGRAM	ECS LLP CAROLINAS SETTING THE STANDARD FOR SERVICE	LENOIR COUNTY LANDFILL INTERMEDIATE SLOPES	ENGINEER MBO	SCALE 1"=200'
			DRAFTSMAN DAH	PROJECT NO. 17047-B
			REVISIONS	SHEET FIGURE 2
MUNICIPAL ENGINEERING SERVICES CO., P.A.		LENOIR COUNTY, NORTH CAROLINA		DATE 1-03-11

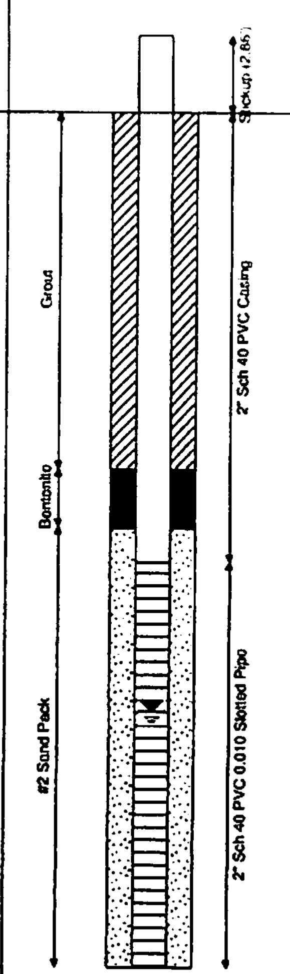
LOG OF BORING: P2-1

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/2/2008	Surface elevation:	102.12 ft (MSL)
Drill rig & method:	7.75" OD HSA, SPT	Date ended:	9/2/2008	Top of pipe elevation:	104.98 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	31.52 ft	Depth to water (TOB):	22.00 ft
		Stickup height:	2.86 ft	Depth to water (24hrs):	22.07 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	14		X	Top Soil; light grey organic silty sand, root debris, dry
5	12		X	Clayey Sand; red brown, cohesive, homogeneous, moist
10	52		X	Clayey Sand; red brown, fine to medium grained cemented sand, dense, cohesive, moist
15	52		X	Clayey Sand; same as above
20	73		X	Silty Sand; light brown, poorly graded cemented sand, few smooth translucent quartz fragments, dense, dry
25	15		X	Clayey Sand; medium to dark grey fine grained sand with cohesive grey clay, wet
30	17		X	Clayey Sand; medium to dark grey, fine to medium grained sand with cohesive clay, saturated
35				Boring terminated at 31.5 feet
40				
45				

Well Diagram



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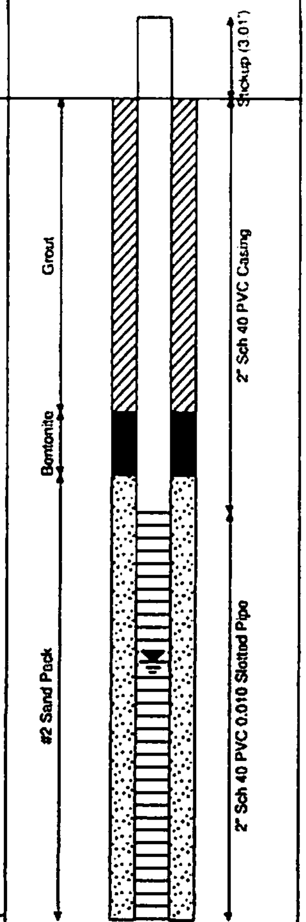
LOG OF BORING: P2-2

Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/3/2008	Surface elevation:	97.47 ft (MSL)
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	9/3/2008	Top of pipe elevation:	100.48 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	30.11 ft	Depth to water (TOB):	20.00 ft
		Stickup height:	3.01 ft	Depth to water (24hrs):	20.76 ft

Depth (ft)	SPT (bpf)	Description of Material & Remarks
0	13	Clayey Sand; red brown, fine grained,moist
	19	Clayey Sand; red brown to orange, cohesive, mosit
5		Clayey Sand (CL) orange, Gravel=0.02%, Sand=73.85%, Silt & Clay=26.13%, LL=27%, PL=18%, PI=9%
	29	Clayey Sand; red brown, fine to medium grained, homogeneous, cohesive, dry
10		
	22	Clayey Sand; same as above
15		
	18	Silty Sand; light brown, poorly graded fine to gravel size sand, damp
20		
	18	Silty Sand; same as above
25		
	19	Silty Sand; light brown, fine grained, trace clay nodules, wet
30		Boring terminated at 30.1 feet
35		
40		
45		

Well Diagram



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LOG OF BORING: P2-3

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor: Derry's Well Drilling
Drill rig & method: 7.75" OD HSA w/ SPT
Logged by: J.Plohl

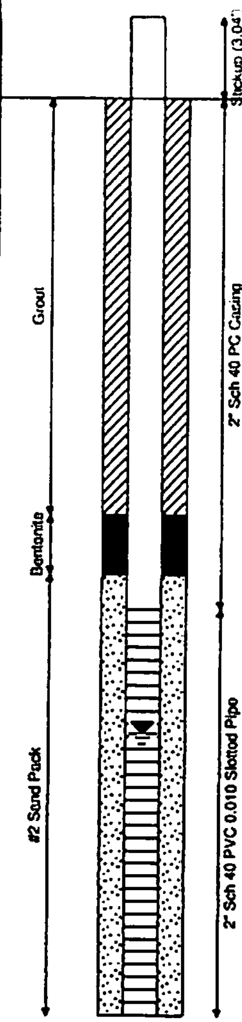
Date started: 9/2/2008
Date ended: 9/2/2008
Completion depth: 33.84 ft
Stickup height: 3.04 ft

Surface elevation: 101.24 ft (MSL)
Top of pipe elevation: 104.28 ft (MSL)
Depth to water (TOB): 24.00 ft
Depth to water (24hrs): 23.40 ft

Depth (ft) scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

SPT (bpf)	Description of Material & Remarks
14	Clayey Sand; reddish brown, fine graind, highly cohesive, moist
56	Clayey Sand; red brown, fine grained cemented sand laminated with cohesive clay, very dense, moist
61	Clayey Sand; same as above
34	Clayey Sand; red brown, poorly graded sand, trace silt, dry
19	Sand with Silt; poorly graded, red brown to orange, coarse grained, homogeneous, dry
30	Silty Sand; light brown, poorly graded sand fine to gravel sand size, moist
24	Silty Sand; same as above
	Boring terminated at 33.8 feet

Well Diagram



LOG OF BORING: P2-4

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

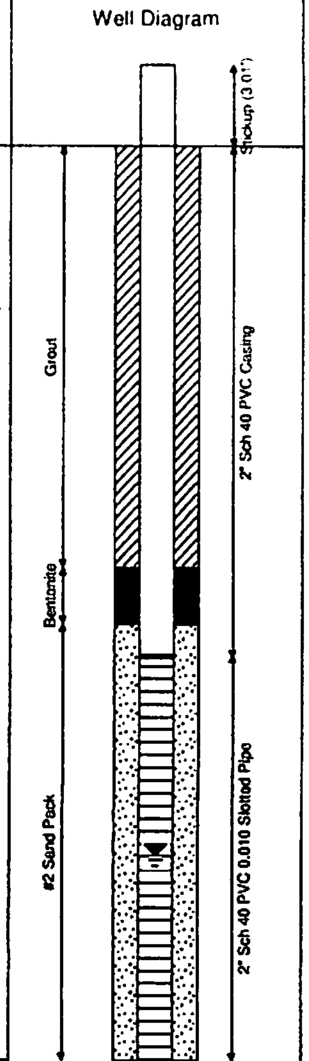
Drilling contractor: Derry's Well Drilling
Drill rig & method: 7.75" OD HSA w/SPT
Logged by: J. Pfohl

Date started: 9/3/2008
Date ended: 9/3/2008
Completion depth: 33.72 ft
Stickup height: 3.01 ft

Surface elevation: 104.61 ft (MSL)
Top of pipe elevation: 107.62 ft (MSL)
Depth to water (TOB): 24.00 ft
Depth to water (24hrs): 26.10 ft

SPT (bpf)	Description of Material & Remarks
14	Clayey Sand; red brown, few grey clay nodules, dry
18	Clayey Sand; red brown, cohesive clay nodules, dry
52	Silty Sand; red brown, homogeneous, dense cemented sand, trace clay nodules, dry
	Silty Sand (SM) light brown, Gravel=0%, Sand=64.41%, Silt & Clay=35.59%
59	Silty Sand; light brown, poorly graded, coarse to fine grained, cohesive clay nodules, dry
53	Silty Sand; light brown, poorly graded, trace silt and clay, dry
24	Sand with Silt; poorly graded, red brown to orange, coarse grained, homogeneous, dry
16	Silty Sand; light brown, poorly graded with trace silt, moist
	Boring terminated at 33.7 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45



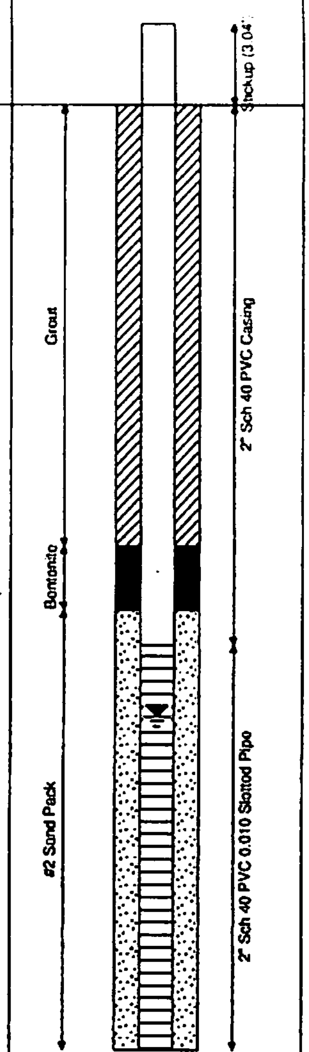
LOG OF BORING: P2-5S

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/29/2008	Surface elevation:	98.42 ft (MSL)
Drill rig & method:	7.75" OD HSA	Date ended:	8/29/2008	Top of pipe elevation:	101.46 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	34.85 ft	Depth to water (TOB):	25.00 ft
		Stickup height:	3.04 ft	Depth to water (24hrs):	22.52 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	18			Clayey Sand; brown, fine to medium grained sand laminated with red brown clay, moist
	13			Clayey Sand; red brown, fine to medium grained, cohesive, moist
5				
	20			Clayey Sand; same as above
10				
	21			Clayey Sand; red brown, fine to medium grained, dry
15				
	28			Silty Sand; dark brown, medium to coarse grained, trace cohesive clay nodules, dry
20				
	30			Silty Sand; dark brown, medium to coarse grained, trace cohesive clay nodules, damp
25				
	31			Silty Sand; same as above
30				
	17			Silty Sand; brown, poorly graded sand, trace clay nodules, homogeneous, moist
35				
				Boring terminated at 34.9 feet
40				
45				

Well Diagram



LOG OF BORING: P2-5D

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

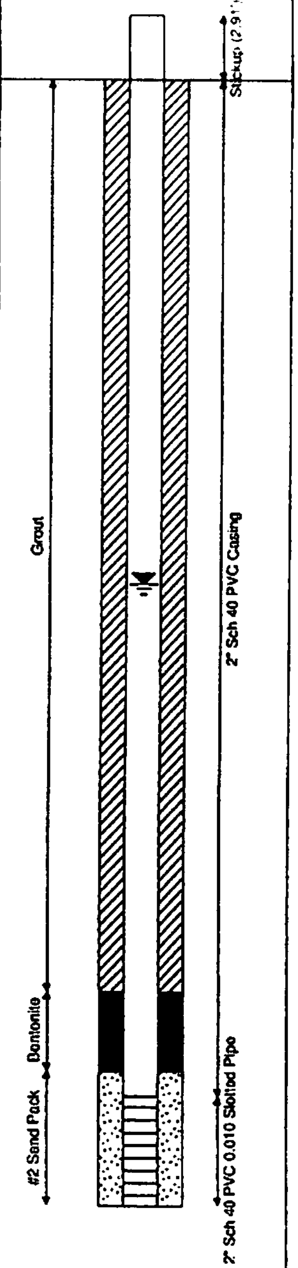
Drilling contractor: Derry's Well Drilling
Drill rig & method: 7.75" OD HSA w/ SPT
Logged by: J Pfohl

Date started: 8/30/2008
Date ended: 8/30/2008
Completion depth: 50.81 ft
Stickup height: 2.91 ft

Surface elevation: 98.34 ft (MSL)
Top of pipe elevation: 101.25 ft (MSL)
Depth to water (TOB): 25.00 ft
Depth to water (24hrs): 22.69 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	18			Clayey Sand; brown, fine to medium grained sand laminated with red brown clay, moist
	13			Clayey Sand; red brown, fine to medium grained, cohesive, moist
5				
	20			Clayey Sand; same as above
10				
	21			Clayey Sand; red brown, fine to medium grained, dry
15				
	28			Silty Sand; dark brown, medium to coarse grained, trace cohesive clay nodules, dry
20				
	30			Silty Sand; dark brown, medium to coarse grained, trace cohesive clay nodules, damp
25				
	31			Silty Sand; same as above
30				
	17			Silty Sand; brown, poorly graded sand, trace clay nodules, homogeneous, moist
35				
	18			Silty Sand; brown, poorly graded sand, trace clay nodules, homogeneous, wet
40				
	21			Silty Sand; same as above
45				
50				Clayey Sand; black, cohesive, thinly laminated black clay with grey, fine to medium grained sand, some lignitic wood, moist
				Boring terminated at 50.8 feet
55				

Well Diagram



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LOG OF BORING: P2-6

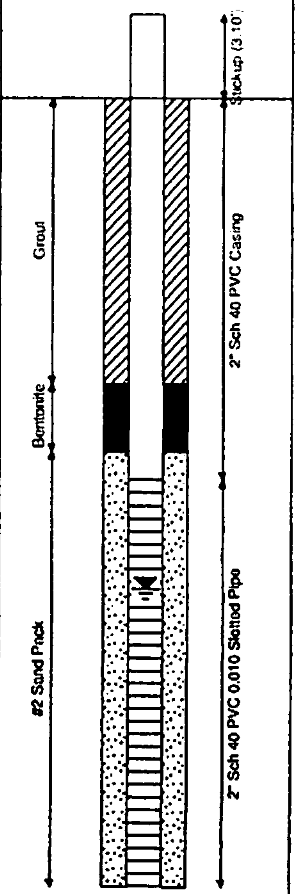
Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/2/2008	Surface elevation:	92.20 ft (MSL)
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	9/2/2008	Top of pipe elevation:	95.29 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	29.05 ft	Depth to water (TOB):	18.00 ft
		Stickup height:	3.10 ft	Depth to water (24hrs):	18.05 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
0	17		X	Clayey Sand; brown yellow, fine to medium grained sand laminated with cohesive light grey clay, moist
4	17		X	Clayey Sand; brown to brown yellow, fine to medium grained, cohesive, moist
9	22		X	Clay Sand; brown to brown yellow, fine grained, few black silt partings, dry
14	20		X	Clayey Sand; same as above
19	37		X	Silty Sand; brown yellow, poorly graded, trace silt, moist
24	19		X	Silty Sand; brown yellow, poorly graded, less dense, wet
29.1				Boring terminated at 29.1 feet

Depth (ft) scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



LOG OF BORING: P2-7

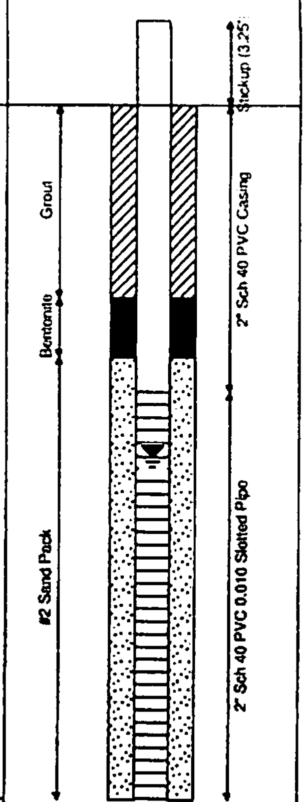
Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/3/2008
Drill rig & method:	7.75" HSA w/ SPT	Date ended:	9/3/2008
Logged by:	J. Plohl	Completion depth:	25.56 ft
		Stickup height:	3.25 ft

Surface elevation:	84.95 ft (MSL)
Top of pipe elevation:	88.20 ft (MSL)
Depth to water (TOB):	13.00 ft
Depth to water (24hrs):	12.95 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	21			Clayey Sand; brown to brown yellow, fine grained, trace organic top soil with root debris, dry
	14			Clayey Sand; brown to brown yellow, fine grained, dry
5				
	21			Clayey Sand; same as above
10				
	38			Silty Sand; light brown, poorly graded, trace silt, moist
15				Silty Sand (ML) tan, Gravel=0.0%, Sand=59.48%, Silt & Clay=40.52%, LL=45%, PL=29%, PI=16%
	19			Silty Sand; light brown, fine grained, wet
20				
	20			Silty Sand; brown yellow, poorly graded, wet
25				
				Boring terminated at 25.6 feet
30				
35				
40				
45				

Well Diagram



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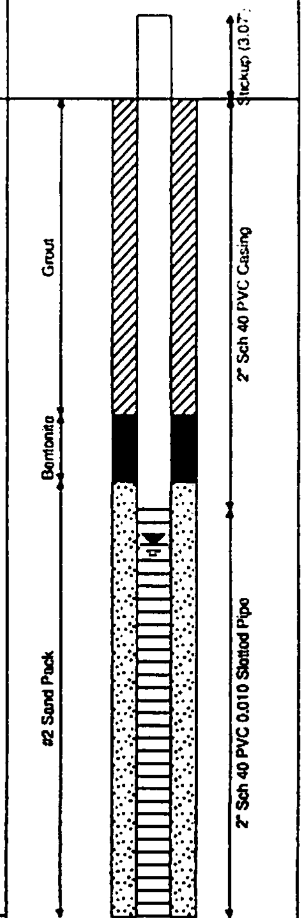
LOG OF BORING: P2-8

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008	Surface elevation:	89.51 ft (MSL)
Drill rig & method:	7.75" HSA w/ SPT	Date ended:	8/30/2008	Top of pipe elevation:	92.58 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	30.15 ft	Depth to water (TOB):	16.50 ft
		Stickup height:	3.07 ft	Depth to water (24hrs):	16.45 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
0		Silty Sand		Silty Sand; tan grey, wet, medium dense, coarse grained
5	11		X	
7		Clayey Sand		Clayey Sand; tan and grey layers, moist, medium dense
10	46		X	
15	15		X	Clayey Sand; wet, medium dense, less clay
17.5		Silty Sand		Silty Sand; grey brown, wet, medium dense, fine grained
20	10		X	
25				Soil description (0'-27.5') taken from log for overdrilled well P-7
30	13		X	Silty Sand; grey brown, fine grained, saturated
30.1				Boring terminated at 30.1 feet
35				
40				
45				

Well Diagram



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LOG OF BORING: P2-9

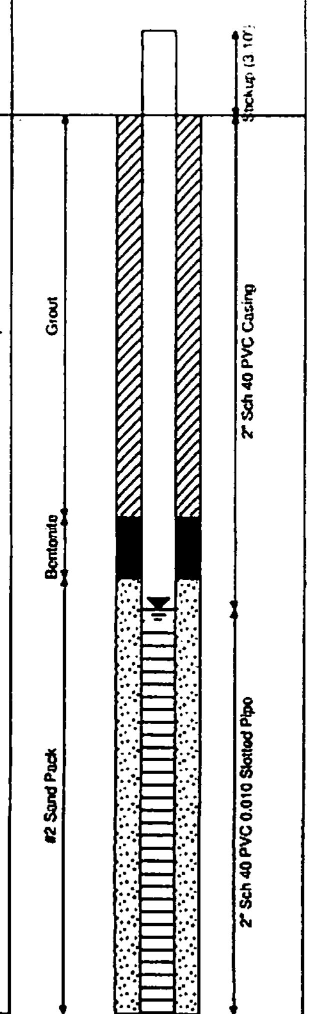
Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008	Surface elevation:	98.84 ft (MSL)
Drill rig & method:	7.75" OD HSA w/SPT	Date ended:	8/30/2008	Top of pipe elevation:	101.95 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	33.19 ft	Depth to water (TOB):	23.00 ft
		Stickup height:	3.10 ft	Depth to water (24hrs):	18.21 ft

SPT (bpf)	Description of Material & Remarks
17	Clayey Sand; red brown, few grey clay nodules, dry
18	Clayey Sand; red brown, fine grained sand laminated with cohesive clay, moist
62	Silty Sand; red brown, homogeneous, dense cemented sand, dry
39	Sand with Silt; poorly graded, red brown to orange, coarse grained, dry
36	Silty Sand; light brown, poorly graded dry
23	Silty Sand; light brown to orange, few cobble size smooth translucent quartz fragments, damp
21	Silty Sand; light brown, poorly graded with trace silt, wet
	Boring terminated at 33.2 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram

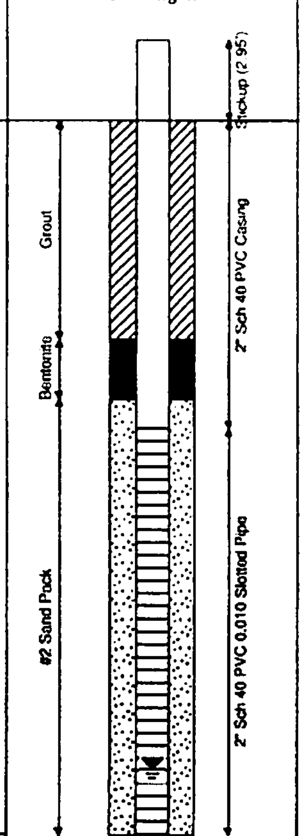


LOG OF BORING: P2-10

Lenoir County MSWLF Phase 2 — **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008	Surface elevation:	85.18 ft (MSL)
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	8/30/2008	Top of pipe elevation:	88.14 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	26.36 ft	Depth to water (TOB):	14.00 ft
		Stickup height:	2.95 ft	Depth to water (24hrs):	23.91 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	9		X	Clayey Sand; orange, medium grained, loose, dry
	18		X	Clayey Sand; red brown, medium grained, moderately dense, slight relict structure, dry
5			■	Clayey Sand (CL) orange brown, Gravel=0.0%, Sand=73.55%, Silt & Clay=26.45%, LL=29%, PL=15%, PI=14%
	80		X	Clayey Sand; red brown, medium to fine grained, very dense, dry
10				
	37		X	Silty Sand; tan, medium grained, damp
15				
	28		X	Silty Sand; tan, medium grained, moderately dense, moist
20				
	26		X	Silty Sand; tan, medium grained, moderately dense, few black silt partings, wet
25				
				Boring terminated at 26.4 feet
30				
35				
40				
45				



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LOG OF BORING: P2-11S

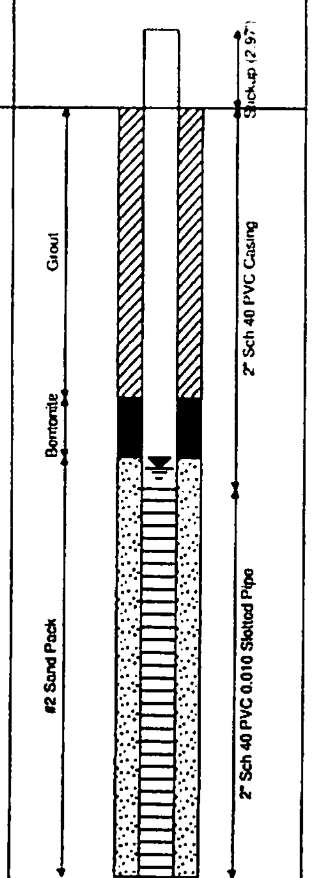
Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008
Drill rig & method:	7.75" OD HSA	Date ended:	8/30/2008
Logged by:	J. Plohl	Completion depth:	29.66 ft
		Stickup height:	2.97 ft
Surface elevation:	82.80 ft (MSL)		
Top of pipe elevation:	85.76 ft (MSL)		
Depth to water (TOB):	14.00 ft		
Depth to water (24hrs):	13.85 ft		

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
0	13		X	Clayey Sand; light brown, fine grained sand laminated with grey cohesive clay, moist
	18		X	Clayey Sand; light brown, medium grained sand laminated with brown to grey cohesive clay, moist
	49		X	Clayey Sand; red brown, poorly graded sand with cohesive clay, dry
	32		X	Clayey Sand; brown, medium grained sand with cohesive grey clay, moist
	17		X	Silty Sand with Clay, light brown, fine to medium grained sand with cohesive clay, moist
	31		X	Silty Sand with Clay; light brown, clay lense, cohesive, wet
	26		X	Silty Sand with Clay; same as above
29.7				Boring terminated at 29.7 feet

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



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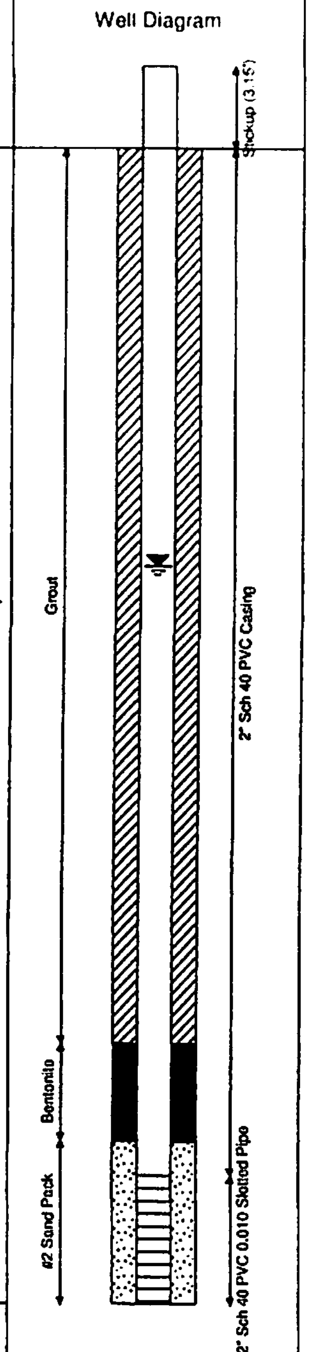
LOG OF BORING: P2-11D

Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	8/30/2008
Logged by:	J. Pfohl	Completion depth:	44.62 ft
		Stickup height:	3.15 ft
Surface elevation:	82.72 ft (MSL)	Top of pipe elevation:	85.87 ft (MSL)
Depth to water (TOB):	14.00 ft	Depth to water (24hrs):	16.05 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	13			Clayey Sand; light brown, fine grained sand laminated with grey cohesive clay, moist
5	18			Clayey Sand; light brown, medium grained sand laminated with brown to grey cohesive clay, moist
10	49			Clayey Sand; red brown, poorly graded sand with cohesive clay, dry
				Clayey Sand (CL) brown, Gravel=0.0%, Sand=72.06%, Silt & Clay=27.94%, LL=36%, PL=19%, PI=17%
15	32			Clayey Sand; brown, medium grained sand with cohesive grey clay, moist
20	17			Silty Sand with Clay, light brown, fine to medium grained sand with cohesive clay, moist
25	31			Silty Sand with Clay; light brown, clay lense, cohesive, wet
30	26			Silty Sand with Clay; same as above
35	24			Silty Sand with Clay; same as above
40	23			Clayey Sand; black, thinly laminated black clay interbedded with grey fine to medium grained sand, some lignitic wood, moist
45				Boring terminated at 44.6 feet



LOG OF BORING: P2-12

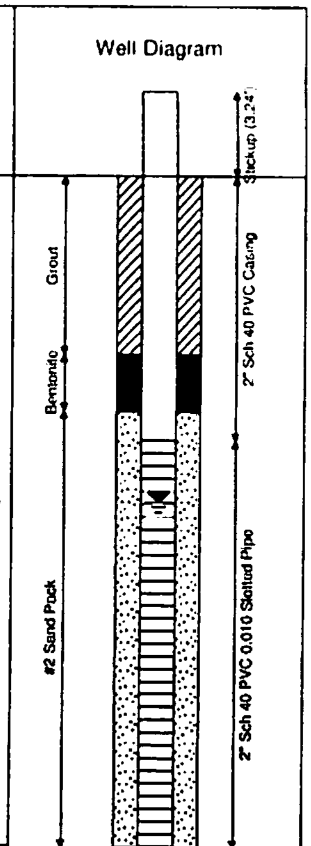
Lenoir County MSWLF Phase 2 | **Project No. G08095.6**

Drilling contractor:	Derry's Well Drilling	Date started:	8/30/2008
Drill rig & method:	7.75" OD HSA w/ SPT	Date ended:	8/30/2008
Logged by:	J. Pfohl	Completion depth:	24.75 ft
		Stickup height:	3.24 ft

Surface elevation:	82.52 ft (MSL)
Top of pipe elevation:	85.77 ft (MSL)
Depth to water (TOB):	12.00 ft
Depth to water (24hrs):	12.01 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
0	8		X	Clayey Sand; light brown, fine grained sand laminated with grey cohesvie clay, moist
3	14		X	Clayey Sand; light brown, medium grained sand laminated with gray cohesive clay, moist
8	62		X	Clayey Sand; red brown, poorly graded sand, few smooth cobble size translucent quartz fragments, dry
13	22		X	Silty Sand; light brown, poorly graded sand, few grey clay nodules, moist
18	16		X	Silty Sand; light brown, fine grained, homogeneous, wet
24.8				Boring terminated at 24.8 feet

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

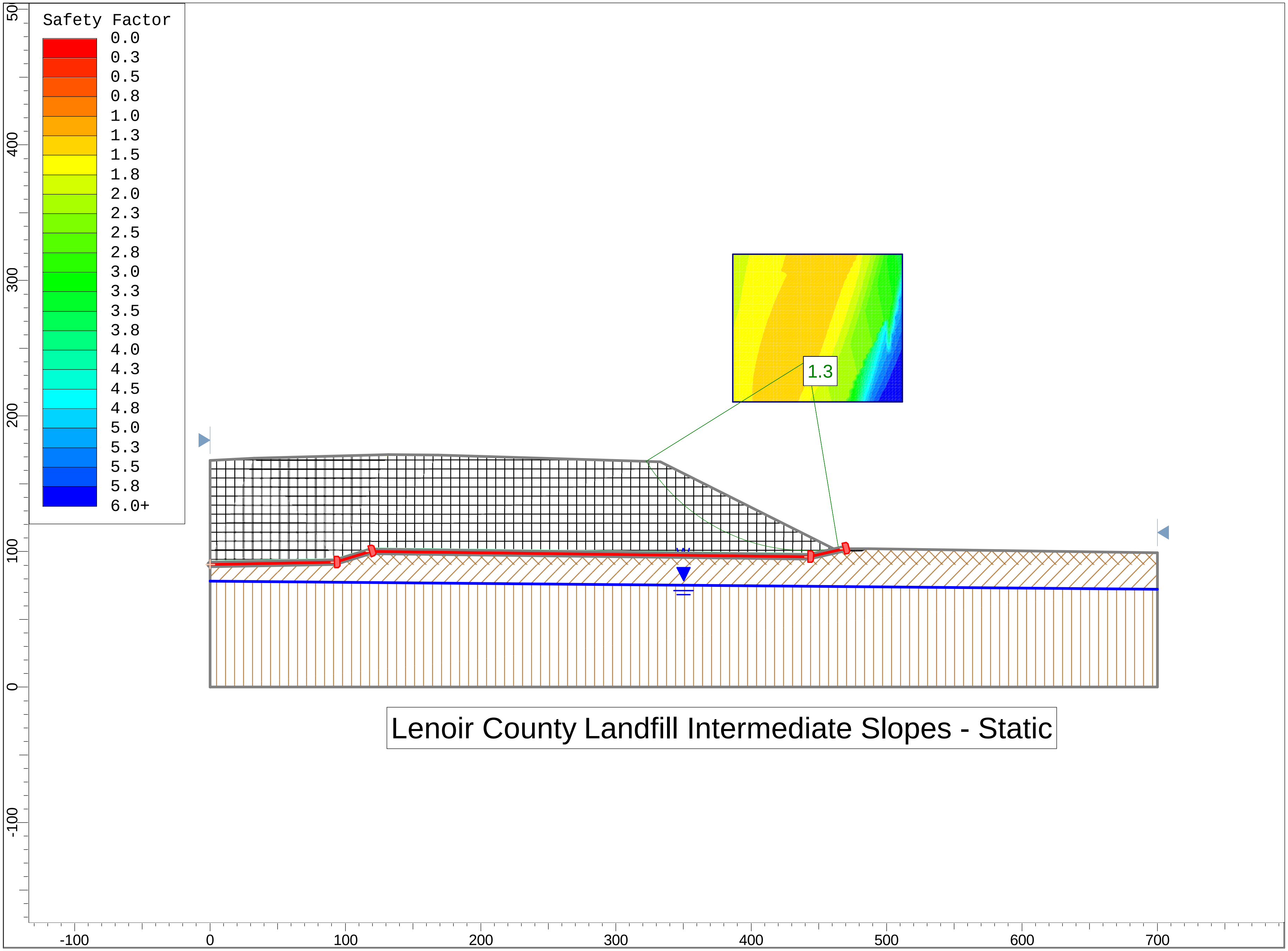


APPENDIX B

SLOPE STABILITY ANALYSES RESULTS

Material Property Legend

Soil Layer/Material	Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)
Waste	70	20	200
Clay Liner	125	20	400
Fill: Silty to Clayey SAND	125	32	150
Clayey SAND	125	32	150
Silty SAND	125	32	100
HDPE Liner, LLDPE Liner, & Drainage Net	-	26	0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1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
1.3
Lenoir County Landfill Intermediate Slopes - Static
500
400
300
200
100
0
-100
-100
0
100
200
300
400
500
600
700

Slide Analysis Information

Document Name

File Name: Section A-A' Static2to1.sli

Project Settings

Project Title: Lenoir County Landfill Section A-A' Static
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: Waste
Strength Type: Mohr-Coulomb
Unit Weight: 70 lb/ft3
Cohesion: 200 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay Liner
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 400 psf

Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty, Clayey FILL
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clayey SAND
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty SAND
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Protective
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1

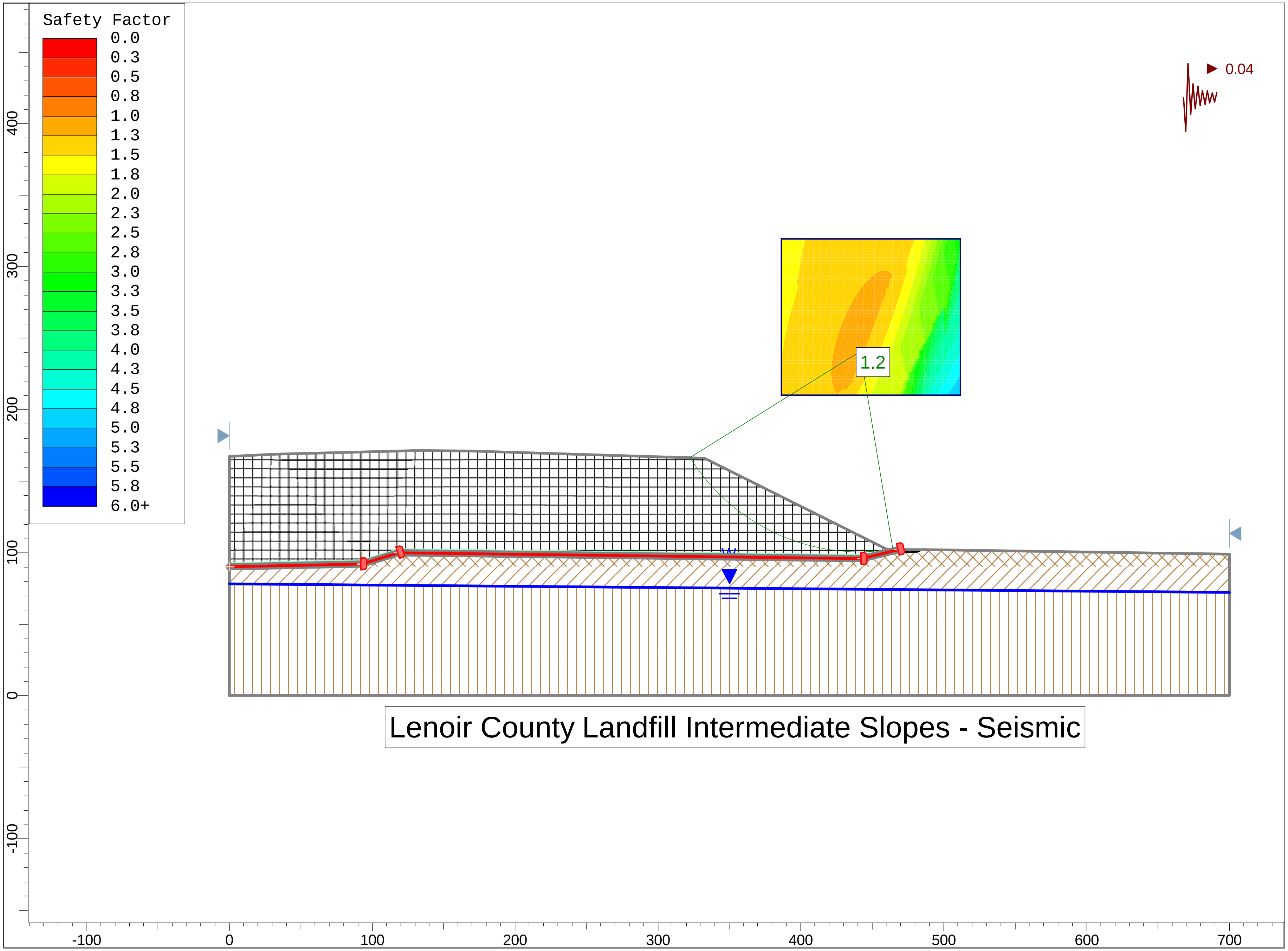
Support Properties

Support: Support 1
Support 1
Support Type: GeoTextile
Force Application: Passive
Force Orientation: Bisector of Parallel and Tangent
Anchorage: Slope Face
Shear Strength Model: Linear
Strip Coverage: 100 percent
Tensile Strength: 0 lb/ft
Pullout Strength Adhesion: 0 lb/ft2
Pullout Strength Friction Angle: 26 degrees

Global Minimums

Method: bishop simplified
FS: 1.298710
Center: 441.413, 240.714

Radius: 140.597
Left Slip Surface Endpoint: 322.112, 166.318
Right Slip Surface Endpoint: 464.347, 102.000
Resisting Moment=1.35535e+007 lb-ft
Driving Moment=1.04361e+007 lb-ft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1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
0.04
1.2
Lenoir County Landfill Intermediate Slopes - Seismic
-100
0
100
200
300
400
500
600
700

Slide Analysis Information

Document Name

File Name: Section A-A' Seismic2to1.sli

Project Settings

Project Title: Lenoir County Landfill Section A-A' Static
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.04

Material Properties

Material: Waste
Strength Type: Mohr-Coulomb
Unit Weight: 70 lb/ft3
Cohesion: 200 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay Liner
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 400 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty, Clayey FILL
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clayey SAND
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty SAND
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Protective
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1

Support Properties

Support: Support 1
Support 1
Support Type: GeoTextile
Force Application: Passive
Force Orientation: Bisector of Parallel and Tangent
Anchorage: Slope Face
Shear Strength Model: Linear
Strip Coverage: 100 percent
Tensile Strength: 0 lb/ft
Pullout Strength Adhesion: 0 lb/ft2
Pullout Strength Friction Angle: 26 degrees

Global Minimums

Method: bishop simplified
FS: 1.187530
Center: 441.413, 240.714
Radius: 140.597
Left Slip Surface Endpoint: 322.112, 166.318
Right Slip Surface Endpoint: 464.347, 102.000
Resisting Moment=1.34086e+007 lb-ft
Driving Moment=1.12911e+007 lb-ft

2.2.9 Capping Materials

Geosynthetic capping materials consist of textured 40 mil LLDPE liner and 250 mil double bonded drainage net.

Check Sliding Forces of Soil Cover and Geonet

F.S. = (tanδ)÷(tanβ)
δ = Friction Angle = 26° for soil to double bonded geonet
= 24° for double bonded geonet to textured liner
β = Slope Angle = 4:1 slope = 14.036°

F.S. = (tanδ)÷(tanβ) (Soil and Geonet)
= (tan 26°)÷(tan18.418°)
= 1.95 > 1 ∴ O.K.

F.S. = (tanδ)÷(tanβ) (Geonet and Liner)
= (tan 24°)÷(tan18.418°)
= 1.78 > 1 ∴ O.K.

Transmissivity of Draianage Net

Transmissivity (ɵ) = permeability (k) x saturated thickness (t)

Darcy's Law

Q= k I A
A = t x 1 ft. unit width

Q = ɵ/t x i x t

Q = ɵ x i

Q = 0.00001 $m^{2/}$sec x 10.764 ft^2/m^2 x 5ft./100.ft./100 ft.(5% slope for 100 ft.)
= 0.0005 $ft.^3$/sec./ft.

Peak daily drainage from HELP Model for 5 years thru drainage net (layer 2) is 2498 $ft.^3$/acre
Total area of the capped landfill is approximately 10 acres 435,600 $ft.^2$
Total Peak Daily Flow = 24,980 $ft.^3$

100 $ft.^2$ of drainage net = 0.0005 $ft.^3$/sec.
435,600 $ft.^2$/100 $ft.^2$ x 0.0005 $ft.^3$/sec.= 217.8 $ft.^3$/sec.
Drainage net at minimum slope of 5% over the entire foot print will drain the Peak Daily Volume in less than 2 min.

24,980 $ft.^3$/217.8 $ft.^3$/sec = 115 sec. = 1.9 mins.

Creep in the geonet composite is not considered because there is only two feet of soil over the geonet.

2.2.10 Technical References

1. "Lining of Waste Impoundment and Disposal Facilities", (U.S.) Environmental Protection Agency, March 1983.

2. "NSF International (NSF) Standard 54 Flexible Membrane Liner", The NSF Joint Committee on Flexible Membrane Liners, 1991.

3. "Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments", S & M E Inc. for the USEPA, December 1987, pgs EPA III-21 to EPA III-49.

4. James K. Mitchell, Raymond B. Seed, and H. Bolton Seed, "Kettleman Hill Waste Landfill Slope Failure I: Liner-System Properties" in Journal of Geotechnical Engineering, April 1 1990, pgs 647-668.

5. Design, Construction and Monitoring of Landfills, Second Edition, Amalendu Bagchi, Wisconsin Department of Natural Resources, Pages 178- 238.

2.2.11 Applicable Location Restriction Demonstrations

All location restrictions, if any, were handled in the site study with the exception of the seismic impact zone. See map in this section.

The County Landfill is located in a seismic impact zone, all safety factors have been applied to insure site stability.

There are no other features that impact the site.

2.3 Engineering Drawings

2.3.1 Title Sheet
2.3.2 Index and Vicinity Map
2.3.3 Existing Conditions
2.3.4 Erosion Control Plan
2.3.5 Erosion Control Details
2.3.6 Proposed Subgrade
2.3.7 Top of Cohesive Soil Liner
2.3.8 Top of Protective Cover
2.3.9 Leachate Collection System
2.3.10 Construction Details
2.3.11 Sump, Riser, Pad and Details
2.3.12 Initial Placement of Waste
2.3.13 Final Fill and Methane Venting
2.3.14 Operation Details
2.3.15 Baseline Profile and Cross Sections

LENOIR COUNTY
MUNICIPAL SOLID WASTE
LANDFILL FACILITY

ENGINEERING PLAN - PHASE 2

Permit Number: 5409-MSWLF
Site Location: 2949 Hodges Farm Road
La Grange, NC 28551

Applicant: Lenoir County
Applicant's Address: 130 South Queen Street
Kinston, NC 28502

BOARD OF COMMISSIONERS

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Claude Stroud - Vice-Chairman
Jackie Brown
Reuben Davis
Chris Humphrey
Thomas A. Pharo
Linda Rouse Sutton

COUNTY MANAGER

Michael W. Jarman

SOLID WASTE DIRECTOR

Tom Miller

Engineer
Municipal Engineering Services Company, P.A.
Garner, NC - Morehead City, NC - Boone, NC

NORTH CAROLINA PROFESSIONAL SEAL 6262 ENGINEER JIMMY D. WOODIE
11/25/2009

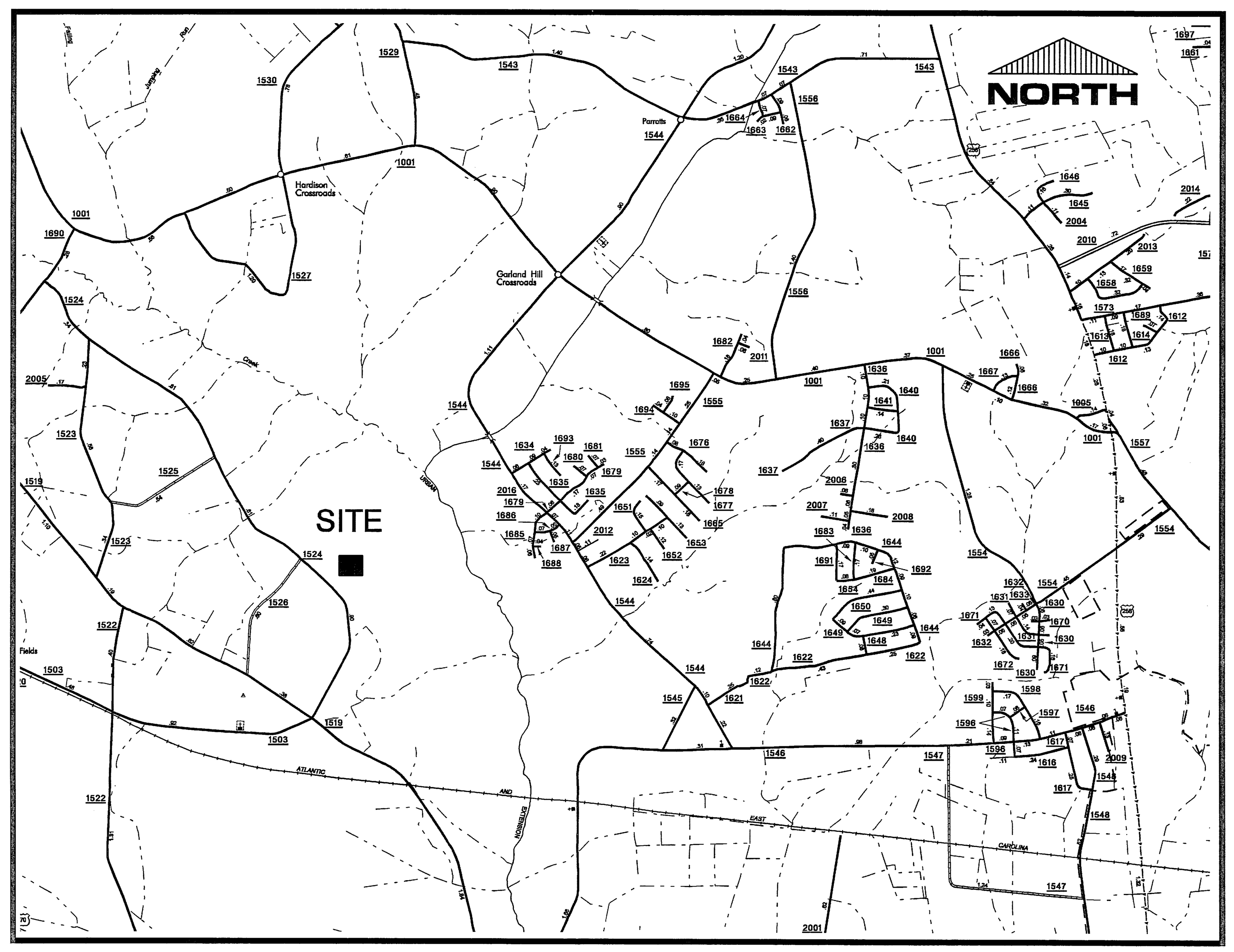
by
Professional Engineer
(Garner Office)

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

SCALE:	1:1
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. T1	SHEET NO. 1 OF 15

INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION
1	T1	TITLE SHEET
2	T2	INDEX AND VICINITY MAP
3	E1	EXISTING CONDITIONS
4	E2	EROSION CONTROL PLAN
5	E3	EROSION CONTROL DETAILS
6	E4	SUBGRADE
7	E5	TOP OF COHESIVE SOIL LINER
8	E6	TOP OF PROTECTIVE COVER
9	E7	LEACHATE COLLECTION SYSTEM
10	E8	CONSTRUCTION DETAILS
11	E9	SUMP, PUMP, RISER, PAD AND DETAILS
12	E10	INITIAL PLACEMENT OF WASTE AND STORM WATER DIVERSION
13	E11	FINAL FILL WITH METHANE VENTING
14	E12	OPERATION DETAILS
15	E13	BASELINE PROFILE AND CROSS SECTIONS



VICINITY MAP

LICENSE NUMBER: C-0281
Municipal Services
Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

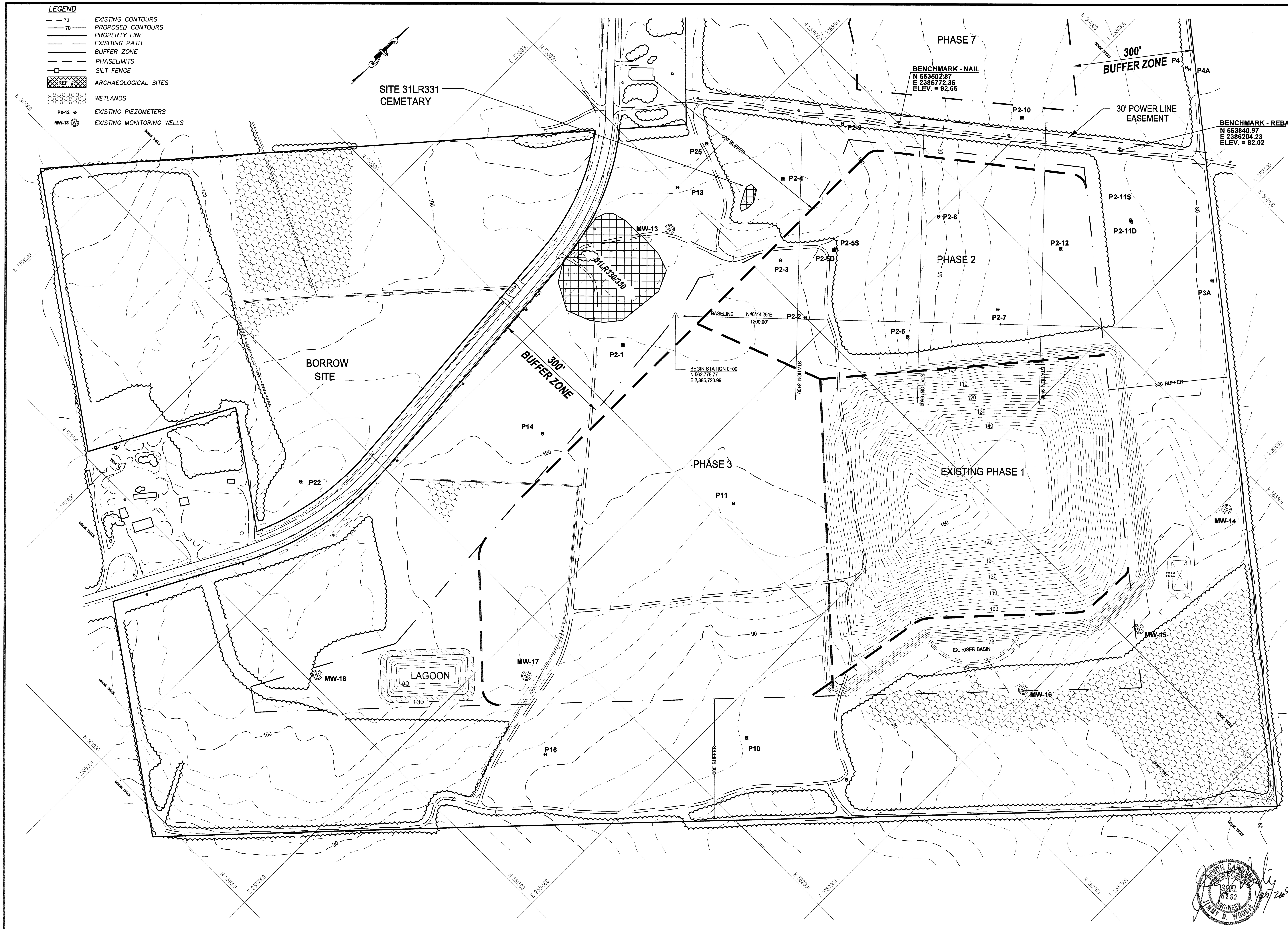
DATE	BY	REV.	DESCRIPTION

INDEX AND VICINITY MAP

SCALE: 1:1
DATE: 10/22/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G08095
DRAWING NO. T2
SHEET NO. 2 OF 15

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL JIMMY D. WOODIE

P:\SolidWaste\G08095-Lenoir-Co. PTC Phase 2\dwg\engineering\G8095E-02.dwg, 11/10/2009 11:46:32 AM, lch,lch



LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393

P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

ENGINEERING PLAN – PHASE 2
EXISTING CONDITIONS

SCALE:	1" = 100'
DATE:	10/5/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. E1	SHEET NO. 3 OF 15

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

1/25/2009

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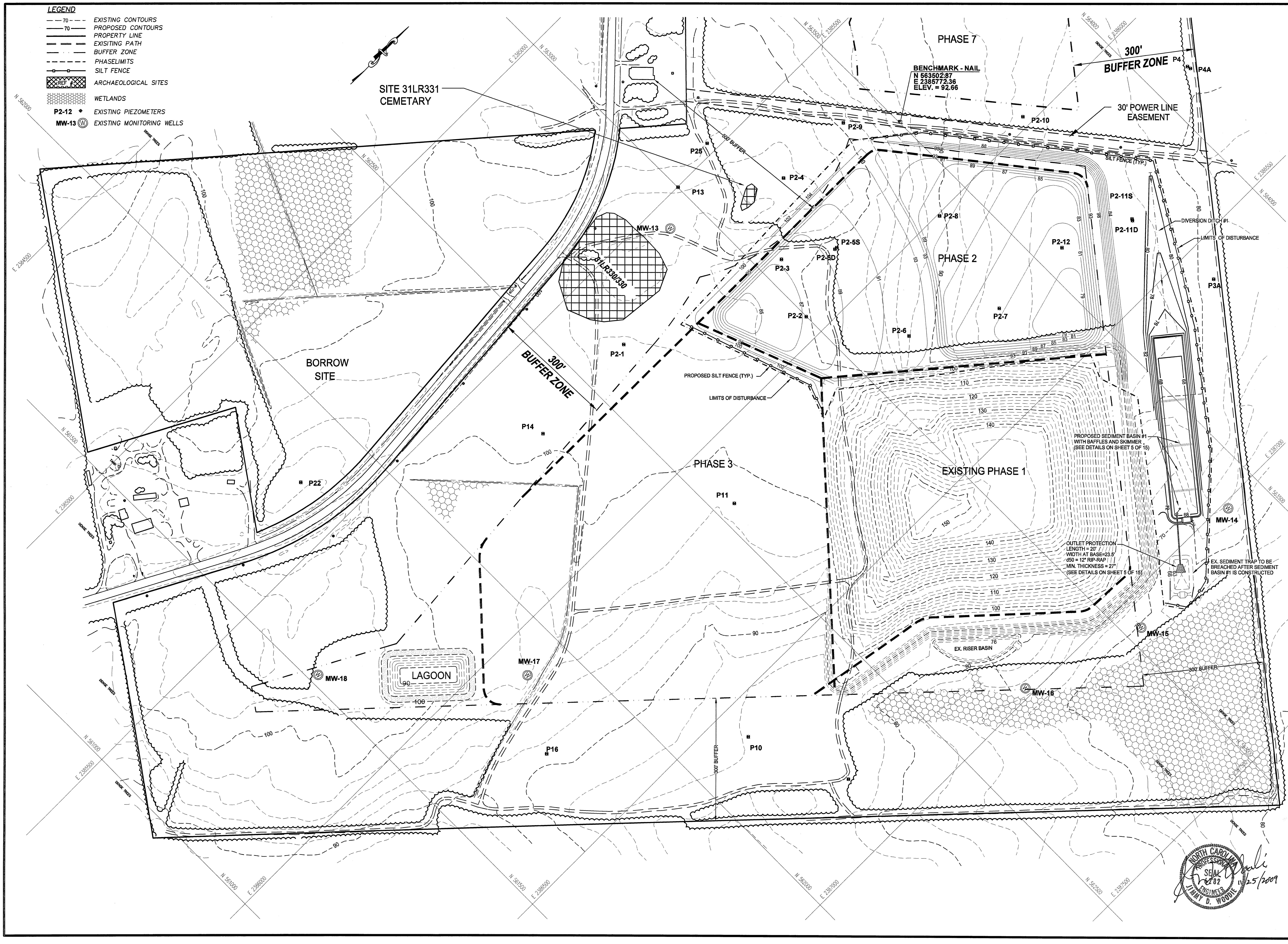

LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

REV.	DATE	BY	DESCRIPTION

ENGINEERING PLAN – PHASE 2
EROSION CONTROL PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 022782 JIMMY D. WOODIE
11-25-2009

SCALE:	1" = 100'
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. E2	SHEET NO. 4 OF 15

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SEEDBED PREPARATION (SP)

SP-1 FILL SLOPES 3:1 OR STEEPER TO BE SEEDE BY A HYDRAULIC SEEDER (PERMANENT SEEDING)

1) Leave the last 4-6 inches of fill loose and uncompacted, allowing rocks, roots, large clods and other debris to remain on the slope.
2) Roughen slope faces by making grooves 2-3 inches deep, perpendicular to the slope.
3) Spread lime evenly over slopes at rates recommended by soil tests.

SP-2 Fill slopes 3:1 or steeper (temporary seedings)

1) Leave a loose, uncompacted surface. Remove large clods, rocks, and debris which might hold netting above the surface.
2) Spread lime and fertilizer evenly at rates recommended by soil tests.
3) Break up large clods and rake into a loose, uniform seedbed.
4) Rake to loosen surface just prior to applying seed.

SP-4 Gentle or flat slopes where topsoil is not used.

1) Remove rocks and debris.
2) Apply lime and fertilizer at rates recommended by soil tests; spread evenly and incorporate into the top 6" with a disk, chisel plow, or rotary tiller.
3) Break up large clods and rake into a loose, uniform seedbed.
4) Rake to loosen surface just prior to applying seed.

SEEDING METHODS (SM)

SM-1 Fill slopes steeper than 3:1 (permanent seeding)

Use hydraulic seeding equipment to apply seed and fertilizer, a wood fiber mulch at 45 lb./1,000 s.f., and mulch tackifer.

SM-2 Gentle to flat slopes or temporary seedings

1) Broadcast seed at the recommended rate with a cyclone seeder, drop spreader, or cultipacker seeder.
2) Rake seed into the soil and lightly pack to establish good contact.

MULCH (MU)

MU-1 Steep slopes (3:1 or greater)

In mid-summer, late fall or winter, apply 100 lb./1,000 s.f. grain straw, cover with netting and staple to the slope. In spring or early fall use 45lb. / 1,000 s.f. wood fiber in a hydroseeder slurry.

MU-2 High-maintenance vegetation and temporary seedings

Apply 90 lb./1,000 s.f. (4000 lb./acre) grain straw and tack with 0.1 gal./s.y. asphalt (11 gal./1,000 s.f.).

MU-3 Grass-lined channels

Install excelsior mat in the channel, extend up the channel banks to the highest calculated depth of flow, and secure according to manufactur's specifications.
On channel shoulders, apply 100 lb./1,000 s.f. grain straw and anchor with 0.1 gal./s.y. (11 gal./1,000 s.f.) asphalt.

MAINTENANCE (MA)

MA-1 Refertilize in late winter or early spring the following year. Mow as desired.

MA-3 Inspect and repair mulch and lining. Refertilize in late winter of the following year with 150 lb./acre 10-10-10 (3.5 lb./1,000 s.f.). Mow regularly to a height of 3-4 inches.

MA-4 Topdress with 10-10-10 fertilizer if growth is not fully adequate.

MA-5 Topdress with 50 lb./acre (1 lb./1,000 s.f.) nitrogen in March. If cover is needed through the following summer, overseed with 50 lb./acre Kobe lespedeza.

PERMANENT SEEDING REQUIREMENTS (N.C. NO. 1CP)

SEEDING MIXTURE

Species	Rate (lb./acre)
Tall fescue	80
Pensacola Bahiagrass	50
Sericea lespedeza	30
Kobe lespedeza	10

SEEDING NOTES

1. From Sept.1-Mar.1, use unscarified sericea seed.
2. On poorly drained sites omit sericea and increase Kobe to 30 lb/acre.
3. Where a neat appearance is desired, omit sericea and increase Kobe to 40 lb/acre.

NURSE PLANTS

Between Apr.15 and Aug.15, add 10lb/acre German millet or 15 lb/acre Sudangrass. Prior to May1 or after Aug.15, add 25 lb/acre rye (grain).

SEEDING DATES

	BEST	POSSIBLE
Early spring:	Aug.25-Sept.15	Aug.20-Oct.25
Fall:	Sept. 1-Sept.30	Sept. 1-Oct.31

SOIL AMENDMENTS

Apply lime and fertilizer according to soil tests, or apply 3000-5000 lb/acre ground agricultural limestone (use the lower rate on sandy soils) and 1,000 lb/acre 10-10-10 fertilizer.

MULCH

Apply 4,000 lb./acre small grain straw or equivalent cover of another suitable mulch. Anchor straw by tacking with asphalt, netting, or roving or by crimping with a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.

MAINTENANCE

If growth is less than fully adequate, refertilize in the second year, according to soil tests or topdress with 500 lb/acre 10-10-10 fertilizer. Mow as needed when sericea is omitted from the mixture. Reseed, fertilize and mulch damaged areas immediately.

TEMPORARY SEEDING SPECIFICATIONS

TEMPORARY SEEDING RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

Seeding Mixture

species	Rate(lb./acre)
Rye (grain)	120
Annual lespedza (Kobe in Piedmont and Coastal Plain,Korean in Mountains)	50

Omit annual lespedeza when duration of temporary cover is not to extend beyond June.

SEEDING DATES

Mountains-Above 2500ft.:Feb. 15 - May 15
Below 2500ft.:Feb. 1 - May 1
Piedmont-Jan. 1 - May 1
Coastal Plain-Dec. 1 - Apr. 15

SOIL AMENDMENTS

Follow recommendations of soil tests or apply 2,000 lb./acre ground agricultural limestone and 750 lb./acre 10-10-10 fertilizer.

MULCH

Apply 4,000 lb./acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulching tool.

MAINTENANCE

Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

TEMPORARY SEEDING RECOMMENDATIONS FOR SUMMER

Seeding Mixture

species	Rate(lb./acre)
German millet	40

In the Piedmont and Mountains, a small-stemmed Sudangrass may be substituted at a rate of 50 lb./acre.

SEEDING DATES

Mountains-May 15 - Aug.15
Piedmont-May 1 - Aug. 15
Coastal Plain-Apr. 15 - Aug. 15

SOIL AMENDMENTS

Follow recommendations of soil tests or apply 2,000 lb./acre ground agricultural limestone and 750 lb./acre 10-10-10 fertilizer.

MULCH

Apply 4,000 lb./acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulching tool.

MAINTENANCE

Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

TEMPORARY SEEDING RECOMMENDATIONS FOR FALL

Seeding Mixture

species	Rate(lb./acre)
Rye (grain)	120

SEEDING DATES

Mountains-Aug.15 - Dec. 15
Coastal Plain and Piedmont-Aug. 15 - Dec. 30

SOIL AMENDMENTS

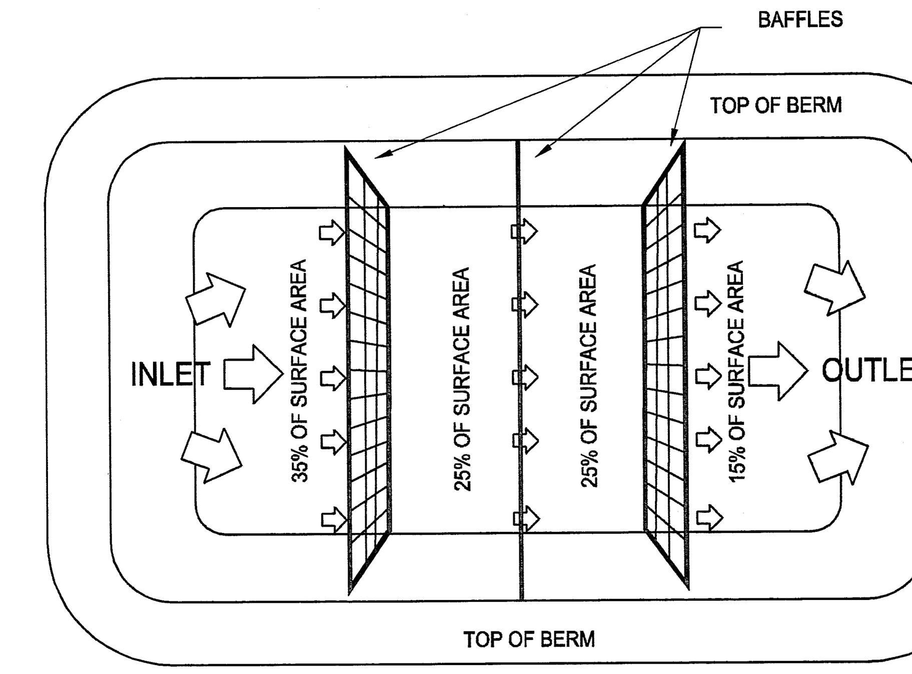
Follow recommendations of soil tests or apply 2,000 lb./acre ground agricultural limestone and 1,000 lb./acre 10-10-10 fertilizer.

MULCH

Apply 4,000 lb./acre straw. Anchor straw by tacking with asphalt, straight can be used as a mulching tool.

MAINTENANCE

Repair and refertilize damaged areas immediately. Topdress with netting, or a mulch anchoring tool. A disk with blades set nearly 50 lb./acre of nitrogen in March. If it is necessary to extend temporary cover beyond June 15, overseed with 50 lb./acre Kobe (Piedmont and Coastal Plain) or Korean (Mountains)lespedeza in late February or early March.

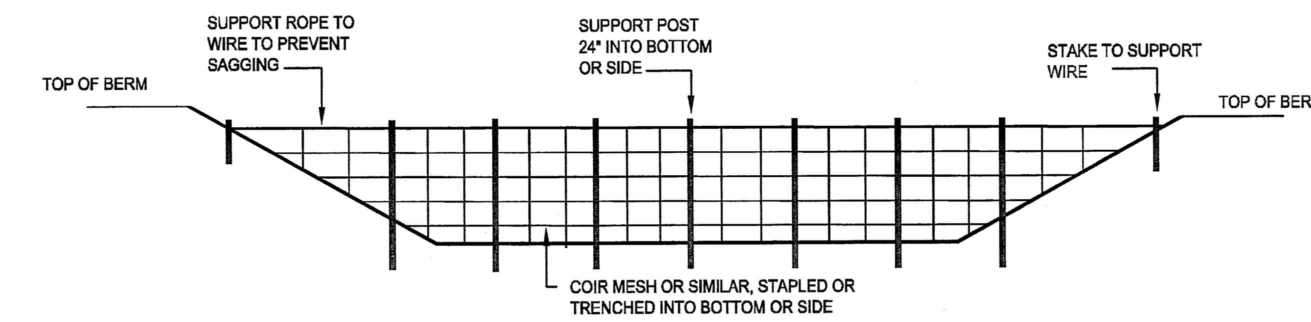


NC EROSION CONTROL MANUAL FIGURE 6.65a

NOTE: BAFFLES NEED TO BE INSTALLED CORRECTLY IN ORDER TO FULLY PROVIDE THEIR BENEFITS. REFER TO FIGURE 6.65b AND THE FOLLOWING KEY POINTS:

THE BAFFLE MATERIAL NEEDS TO BE SECURED AT THE BOTTOM AND SIDES USING STAPLES OR BY TRENCHING AS FOR SILT FENCE.

MOST OF THE SEDIMENT WILL ACCUMULATE IN THE FIRST BAY, SO THIS SHOULD BE READILY ACCESSIBLE FOR MAINTENANCE.



NC EROSION CONTROL MANUAL FIGURE 6.65b
CROSS-SECTION OF A POROUS BAFFLE IN A SEDIMENT BASIN.

RISER BASIN BAFFLE DETAIL

NOT TO SCALE

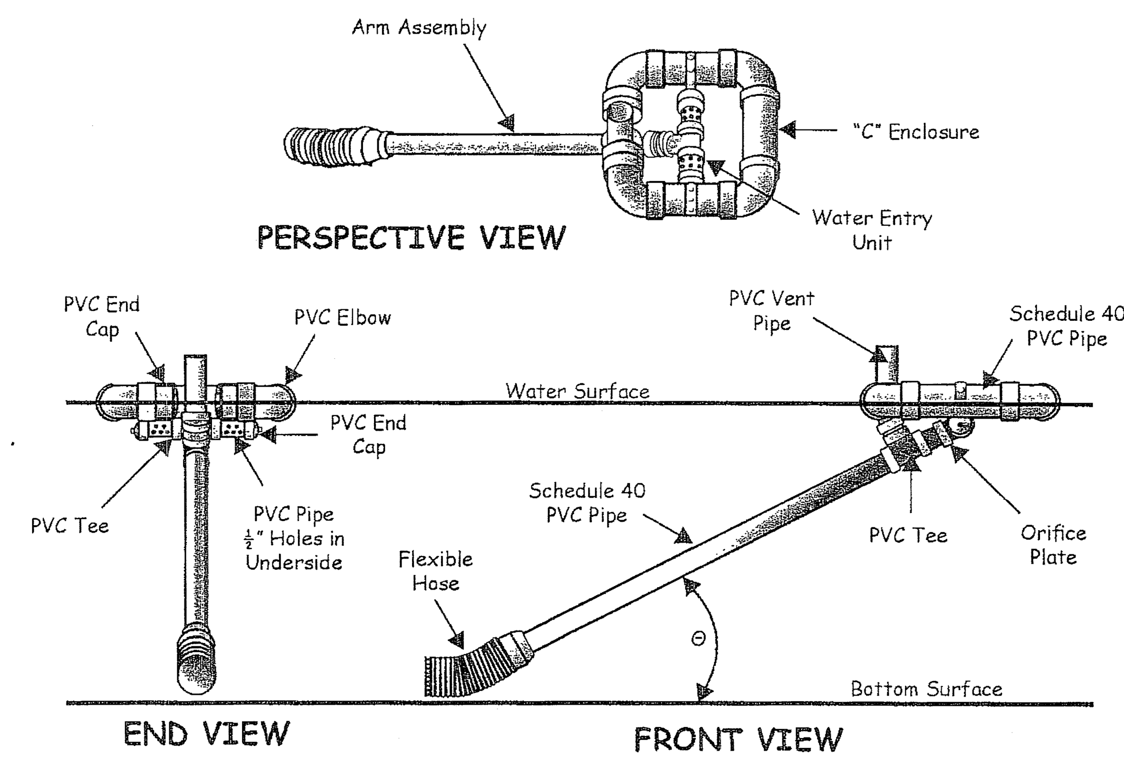
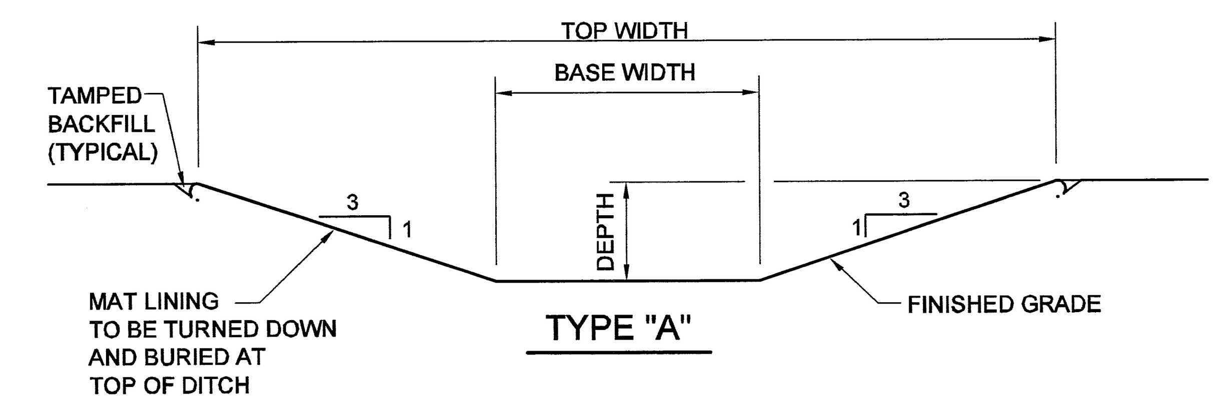


Figure 6.64a Schematic of a skimmer, from Pennsylvania Erosion and Sediment Pollution Control Manual, March, 2000.

SKIMMER DEWATERING DEVICE DETAIL

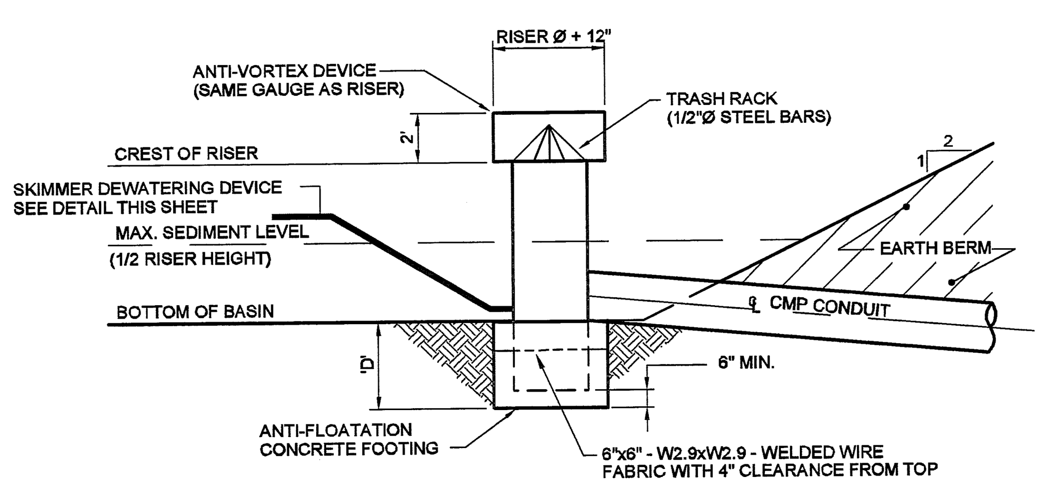
NOT TO SCALE



DIVERSION DITCH SCHEDULE									
DITCH NO.	TYPE	TOP WIDTH	DEPTH	BASE WIDTH	VELOCITY (f.p.s.)	RIP RAP d50	RIP RAP THICK.	TEMP. LINER
1	A	13'	1	7'	4.09	-	-	STRAW W/NET

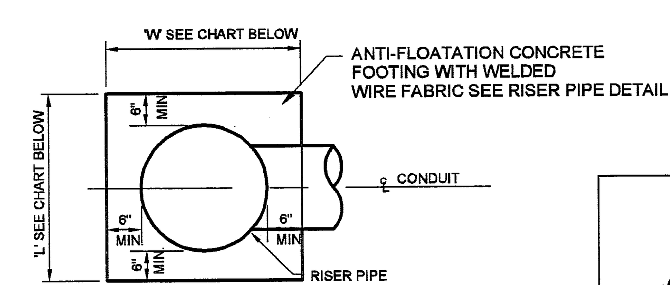
DIVERSION DITCH DETAIL

NOT TO SCALE



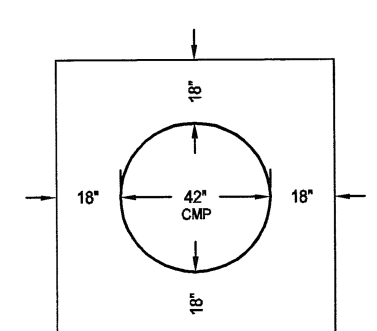
RISER PIPE DETAIL

NOT TO SCALE



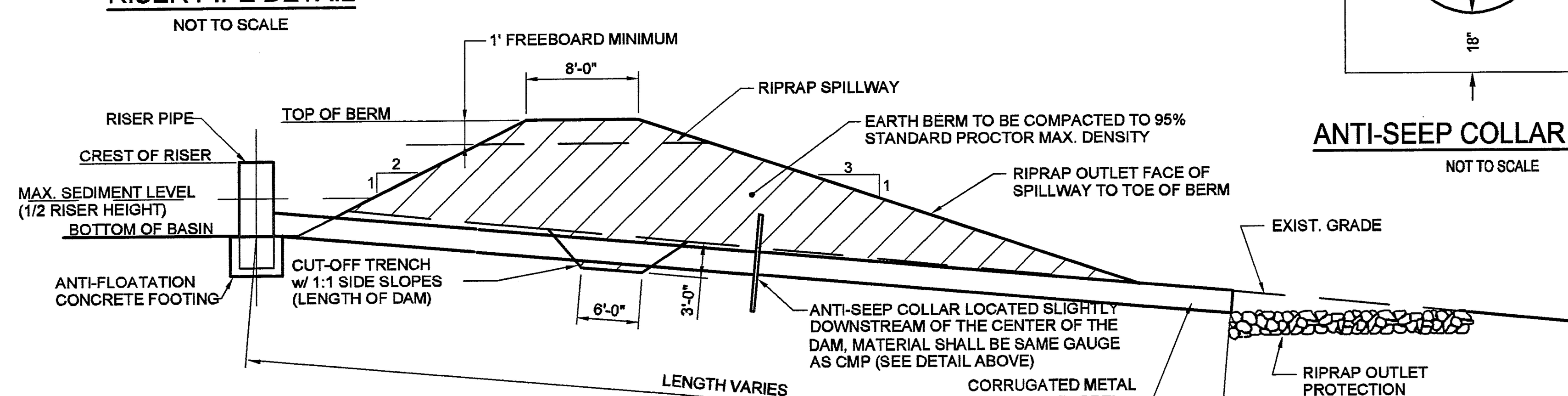
RISER FOOTING DETAIL

NOT TO SCALE



ANTI-SEEP COLLAR DETAIL

NOT TO SCALE



DAM - SECTION

BASIN NO.	BOTTOM		SPILLWAY		BERM EL.	RISER		BARREL			FOOTING FOR RISER PIPE				BARREL OUTLET PROTECTION					SKIMMER DEWATERING DEVICE			BAFFLES
	SIZE	EL.	WIDTH	EL.		DIA.	INV. IN	DIA.	LENGTH	INV.IN	TOP EL.	'L'	'W'	'D'	'L'	'W'	d_{50}	THICK.	EL.	BASIN VOLUME (CU. FT.)	ORIFICE DIA.SIZE	DEWATERING TIME (DAYS)	NUMBER REQUIRED
#1	57'x392'	64.0'	20'	67.0'	68.0'	60"	66.0'	42"	124'	64.0'	64.0'	6'	6'	1'	20'	23.5'	12"	27" MIN.	63.5'	53,256	4"	2	3

SEDIMENT BASIN DETAIL

NOT TO SCALE

LICENSE NUMBER: C-0281
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P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

ENGINEERING PLAN - PHASE 2
EROSION CONTROL DETAILS

SCALE:	NOT TO SCALE
DATE:	11/2/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO.	SHEET NO.
E3	5 OF 15

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

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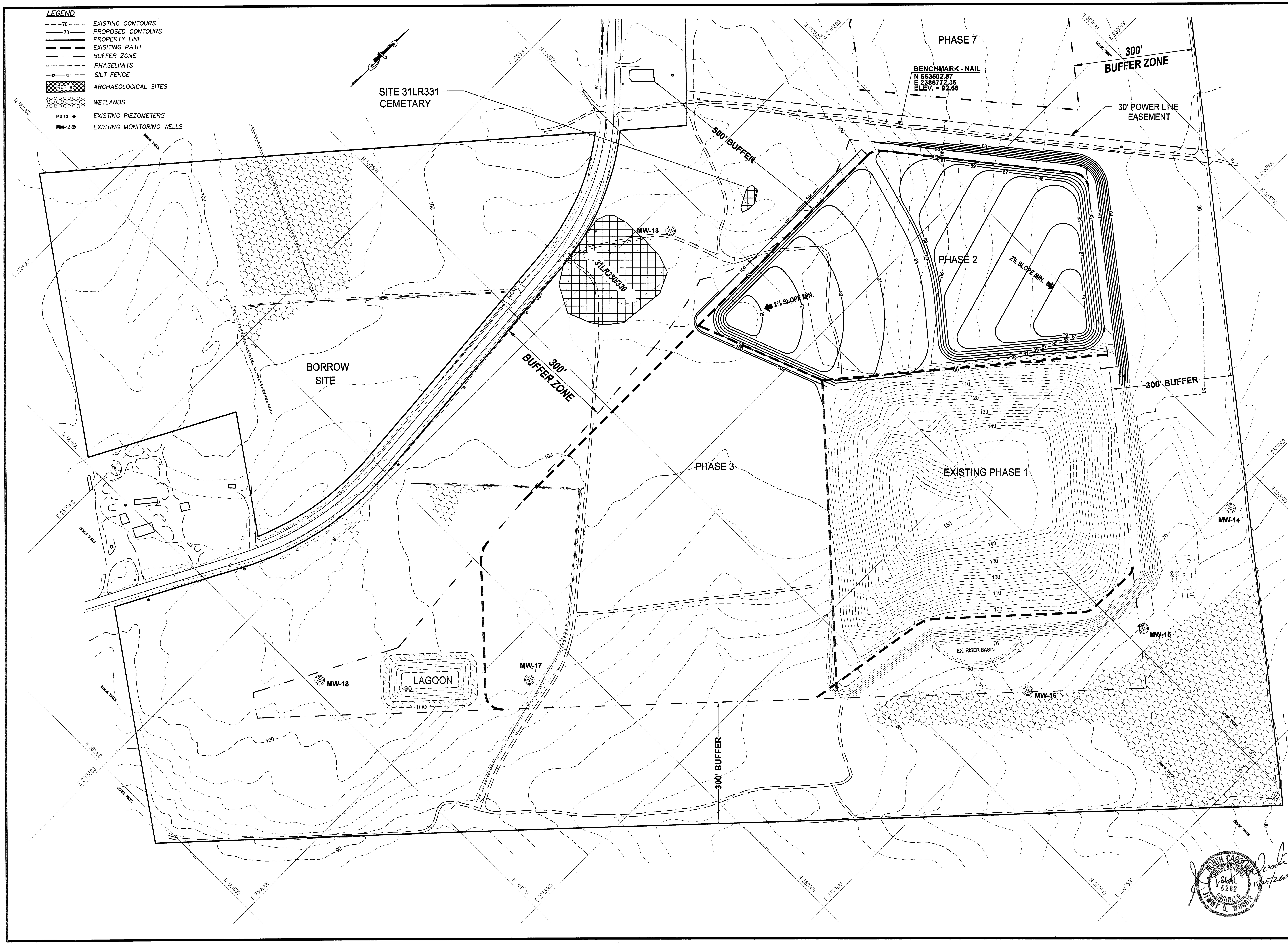

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

LICENSE NUMBER: C-0281
Municipal Services
Engineering Company, P.A.
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DATE	BY	REV.	DESCRIPTION

ENGINEERING PLAN – PHASE 2
PROPOSED SUBGRADE

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE
11/25/2009

SCALE:	1" = 100'
DATE:	10/5/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO.	E4
SHEET NO.	6 OF 15

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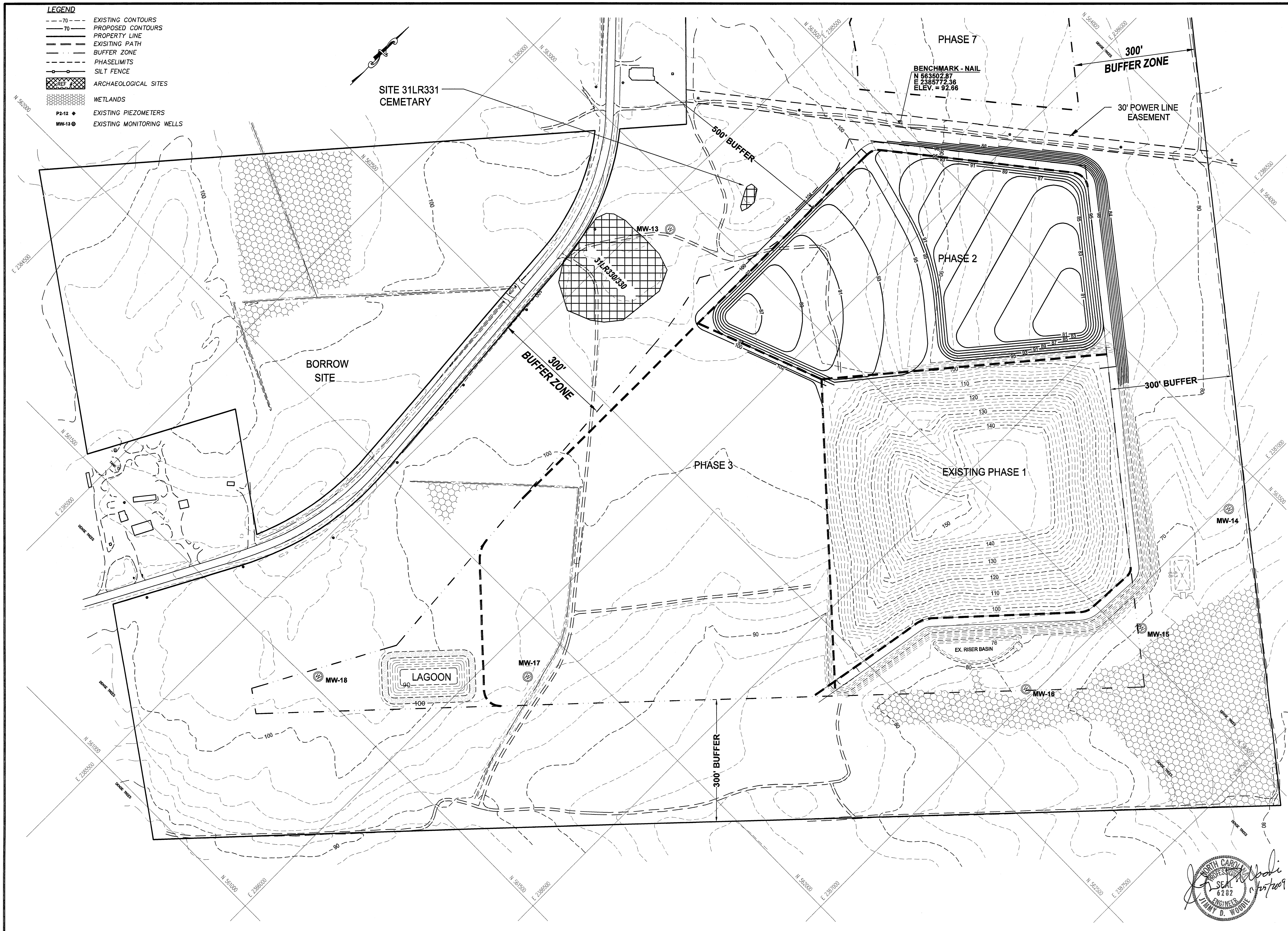

LICENSE NUMBER: C-0281

Municipal Services Engineering Company, P.A.

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(828) 262-1767

P.O. BOX 828 MOREHEAD CITY, N.C. 28557
(252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

ENGINEERING PLAN – PHASE 2
TOP OF COHESIVE SOIL LINER

SCALE:	1" = 100'
DATE:	10/5/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. E5	SHEET NO. 7 OF 15

NORTH CAROLINA PROFESSIONAL SEAL 6262 ENGINEER JIMMY D. WOODIE

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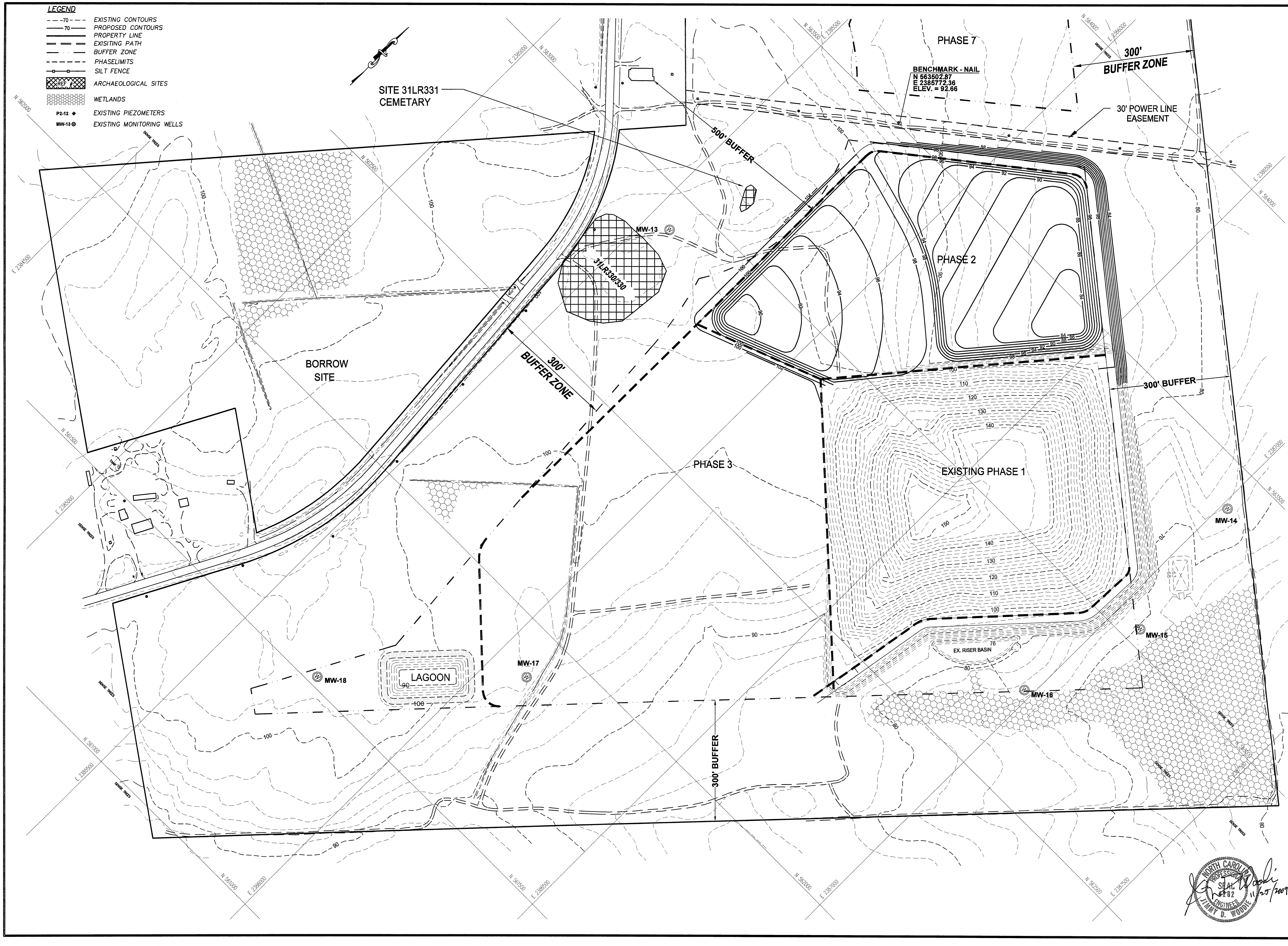

LICENSE NUMBER: C-0281	
Municipal Services	Engineering Company, P.A.
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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

ENGINEERING PLAN – PHASE 2
TOP OF PROTECTIVE COVER

SCALE:	1" = 100'
DATE:	10/5/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. E6	SHEET NO. 8 OF 15

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 022282 JIMMY D. WOODIE 11/25/2009

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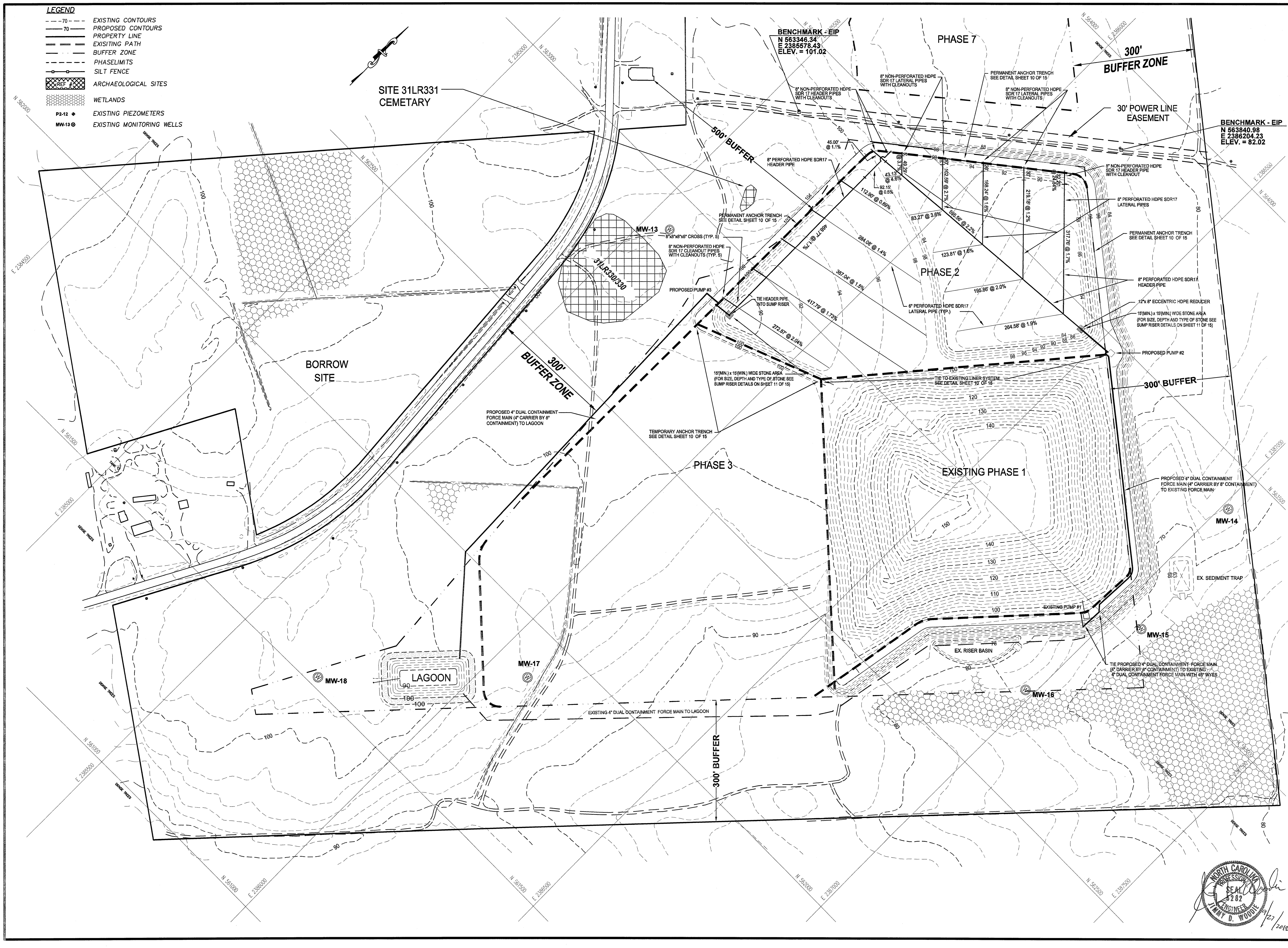

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LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

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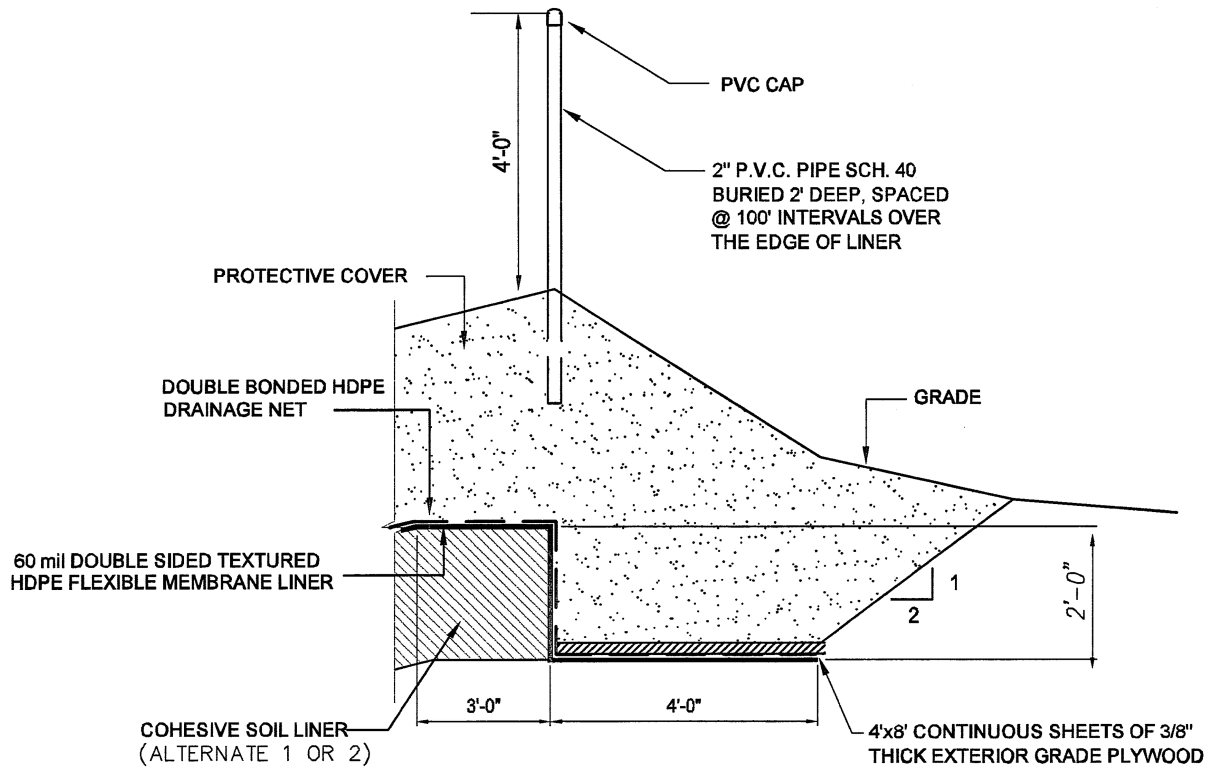
MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
9/16/2010	LCH	2	PER NCDENR LETTERS DATED 7/21/10 AND 9/9/10
8/11/2010	LCH	1	REVISED LEACHATE PIPING AND SUMP AREA

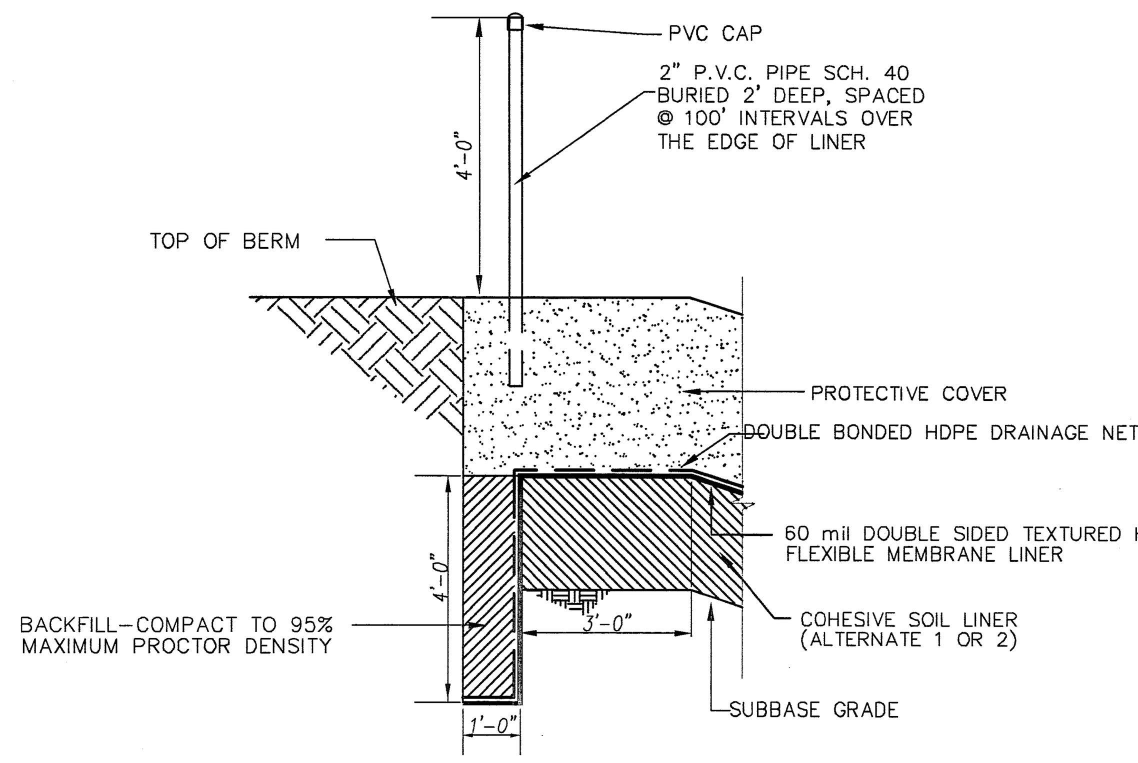
ENGINEERING PLAN – PHASE 2 LEACHATE COLLECTION SYSTEM

SCALE: 1" = 100'
DATE: 10/5/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G08095
DRAWING NO. E7
SHEET NO. 9 OF 15



TEMPORARY ANCHOR TRENCH DETAIL

N.T.S.



PERMANENT ANCHOR TRENCH DETAIL

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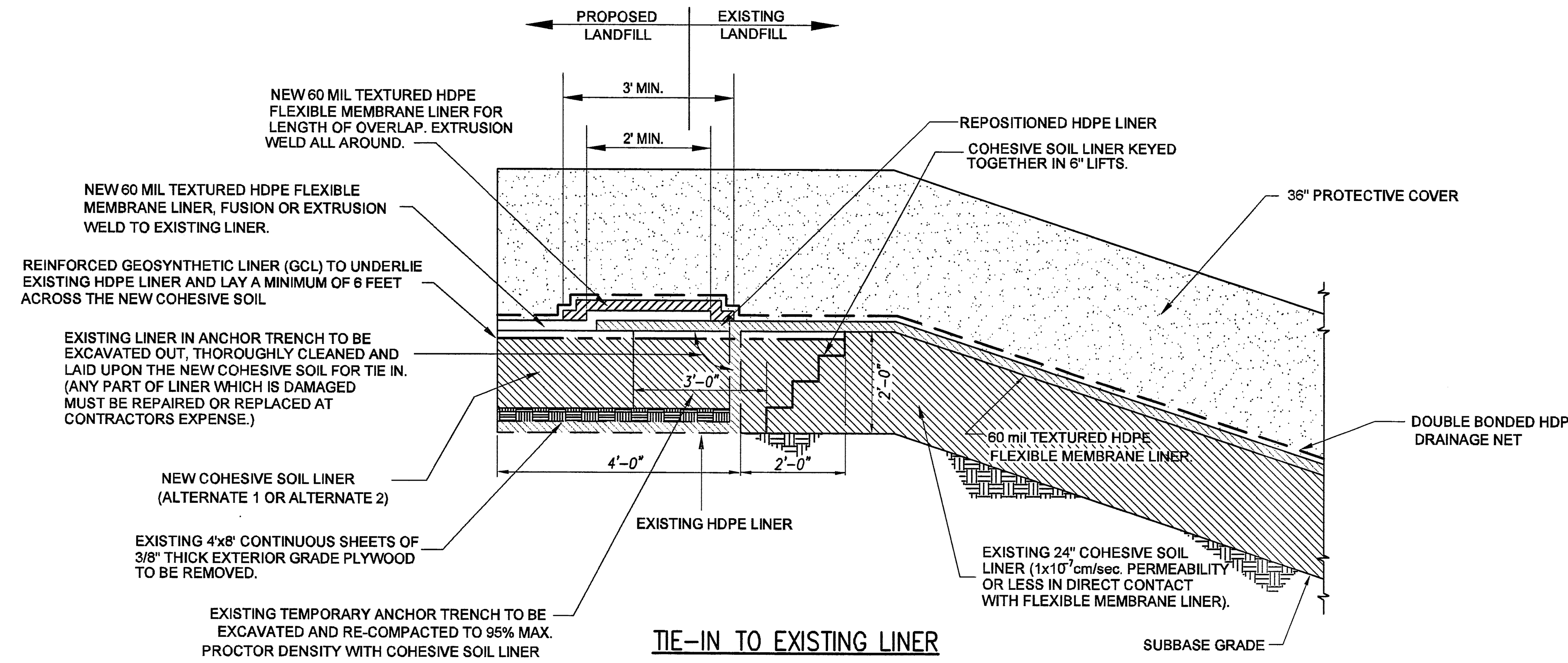
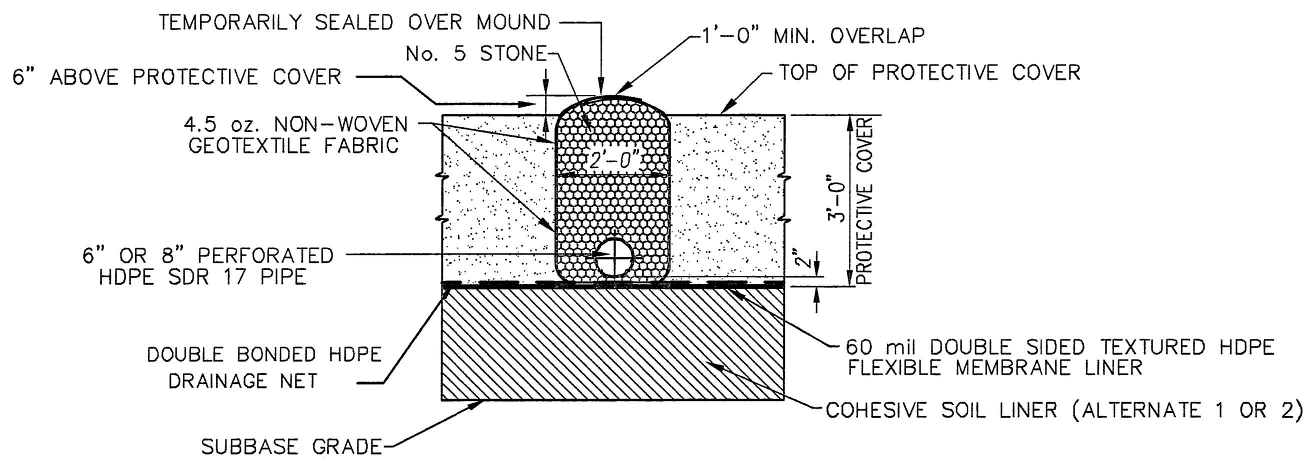


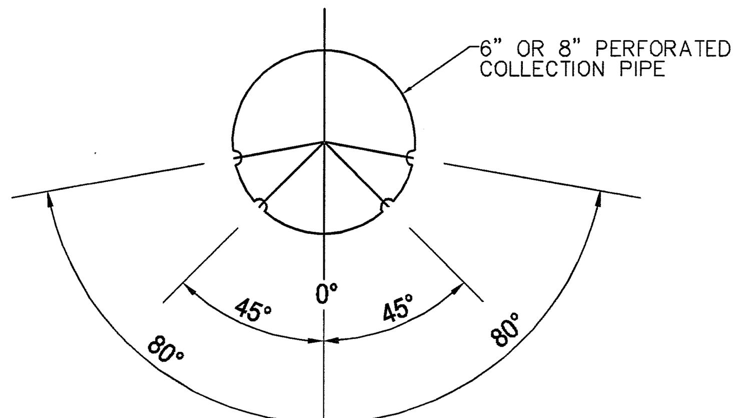
TIE-IN TO EXISTING LINER

N.T.S.



LEACHATE COLLECTION TRENCH DETAIL

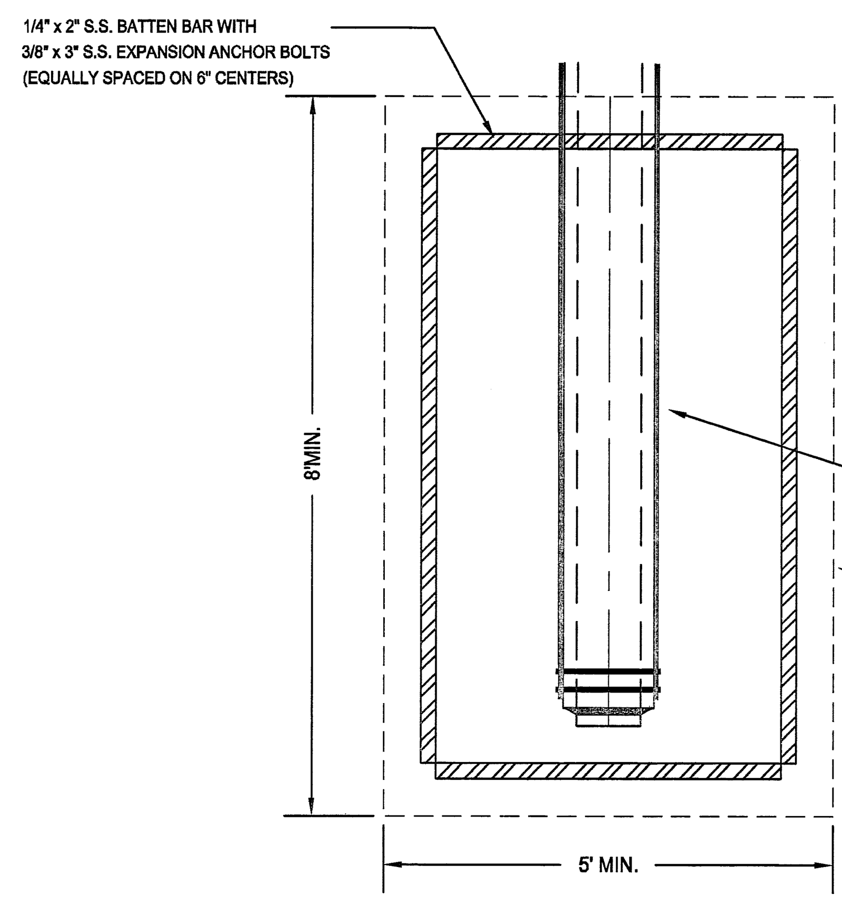
N.T.S.



1. 0° CORRESPONDS TO PIPE INVERT.
2. PROVIDE FOUR 1/2" DIAMETER PERFORATIONS AS SHOWN; 6" O.C.

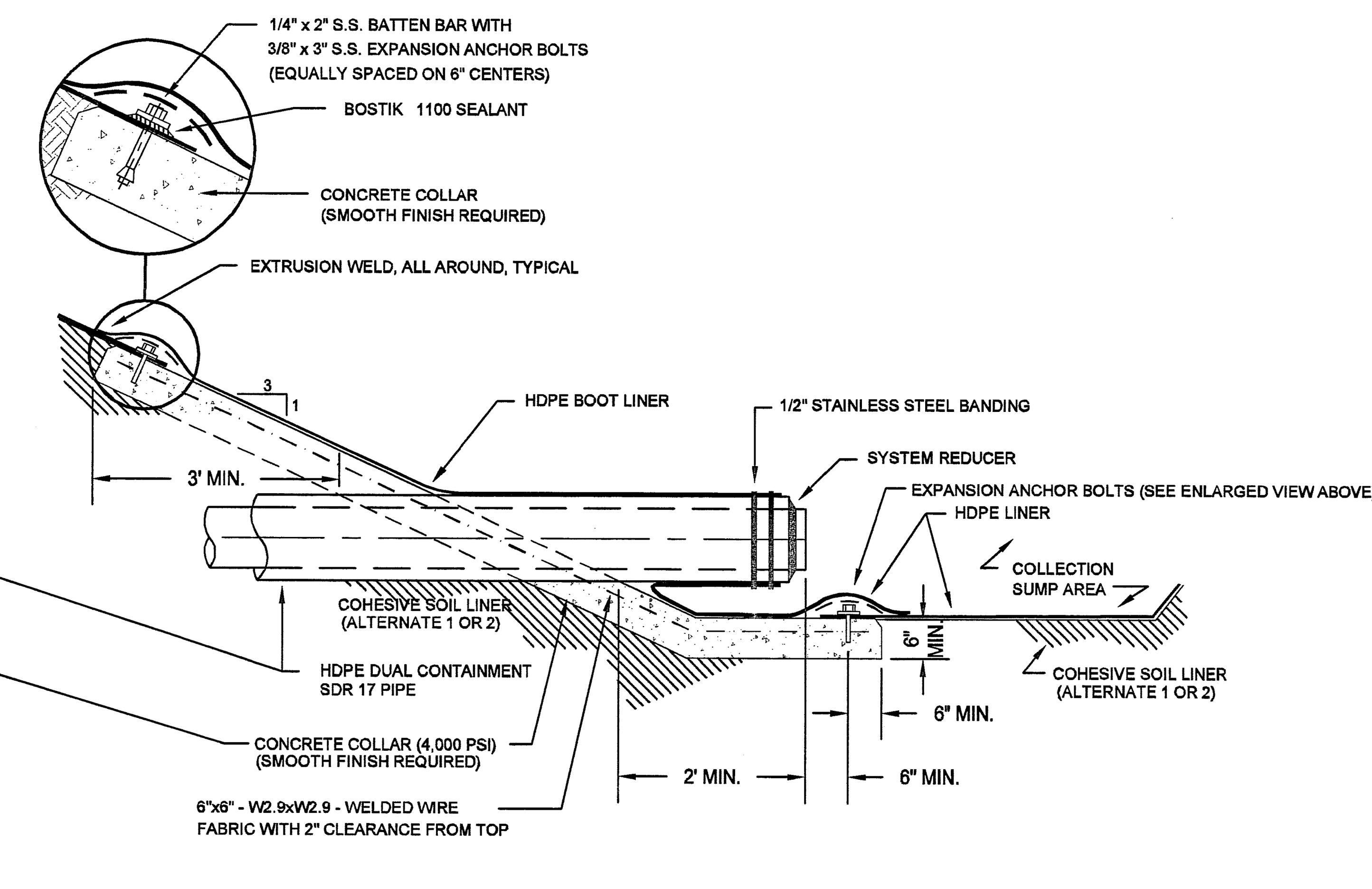
LEACHATE COLLECTION SYSTEM PERFORATION PATTERN DETAIL

N.T.S.



PLAN VIEW

N.T.S.



SECTION VIEW

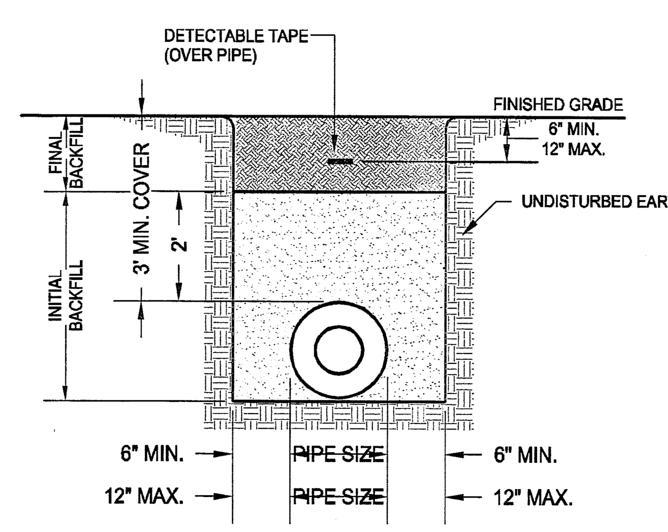
N.T.S.

NOTE:

EARTH ADJACENT TO THE CONCRETE COLLAR SHALL BE COMPACTED TO 95 % MAX. PROCTOR DENSITY TO PREVENT FUTURE DIFFERENTIAL SETTLEMENT. ALL CONCRETE COLLARS ARE TO BE SMOOTH AND CHAMFERED A MINIMUM OF 1" (TYP.) AT ALL CORNER THAT ARE IN CONTACT WITH THE LINER.

TYPICAL PIPE PENETRATION DETAIL

N.T.S.

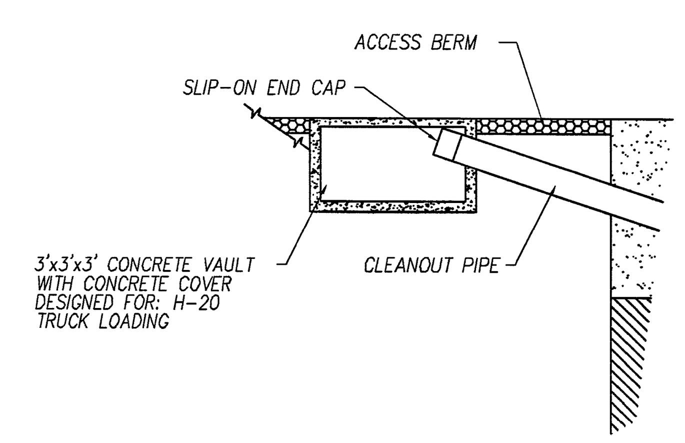


NOTES:

1. EXCAVATE UNDER EACH BELL OR JOINT TO PREVENT ANY LOAD ON BELL OR JOINT.
2. FOR TRENCHES REQUIRING SHORING OR BRACING, DIMENSIONS SHALL BE TAKEN FROM THE INSIDE FACE OF THE SHORING OR BRACING.
3. NO ROCKS OR BOULDERS 4" OR LARGER SHALL BE USED IN THE INITIAL BACKFILL.
4. ALL BACKFILL MATERIAL SHALL BE SUITABLE MATERIAL.
5. BACKFILL SHALL BE TAMPED IN 6" LIFTS IN TRAFFIC AREAS, AND 12" LIFTS IN NON-TRAFFIC AREAS.
6. WHERE ROCK IS ENCOUNTERED IN TRENCH BOTTOM, A CUSHION OF #67 STONE AT LEAST 6" THICK SHALL BE PLACED BETWEEN THE ROCK AND THE PIPE UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. WHERE UNSTABLE SOIL IS ENCOUNTERED, EXCAVATE TO A MINIMUM 6" BELOW THE BOTTOM OF THE PIPE BARREL AND REFILL WITH #67 STONE UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

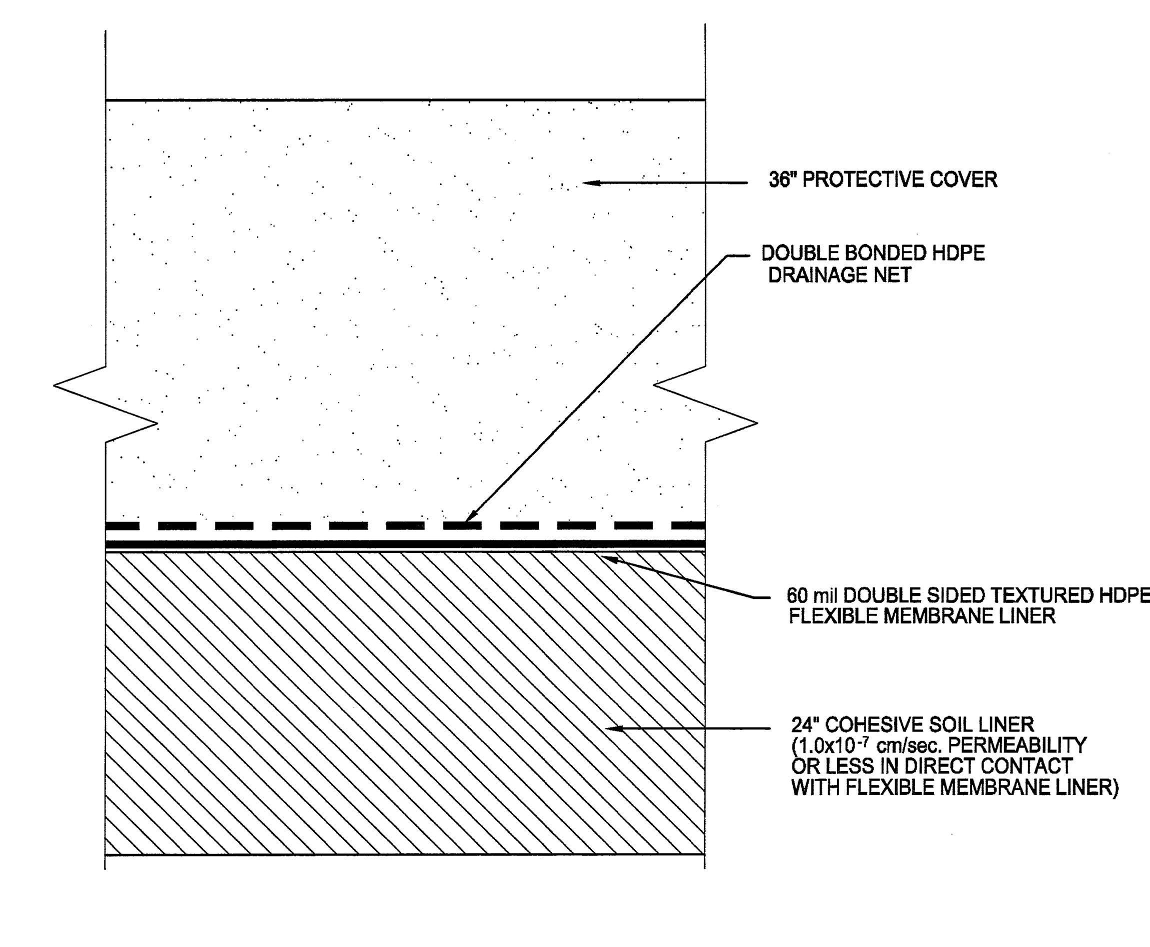
TYPICAL PRESSURE PIPE TRENCH DETAIL

NOT TO SCALE



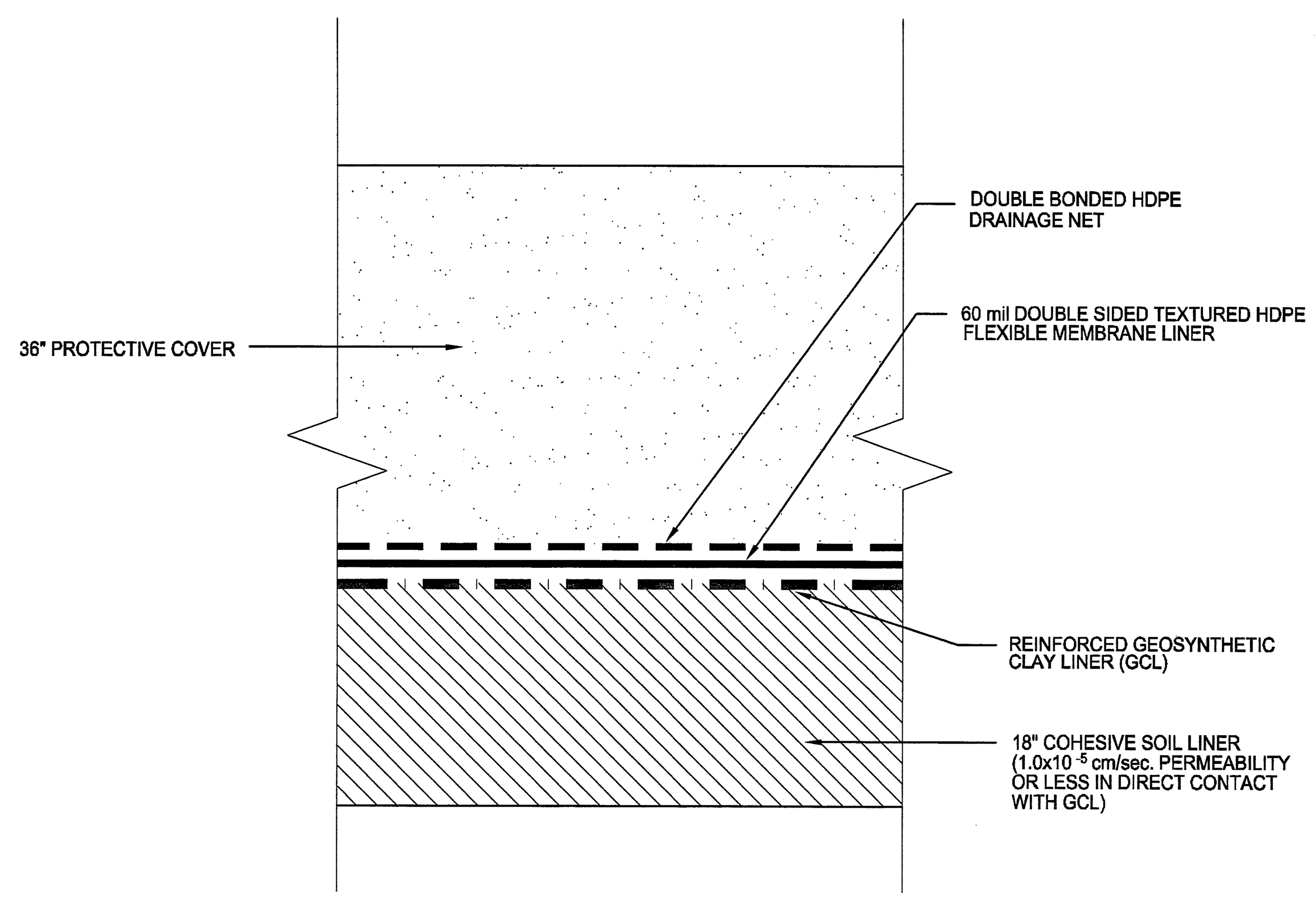
TYPICAL LEACHATE SYSTEM CLEANOUT DETAIL

N.T.S.



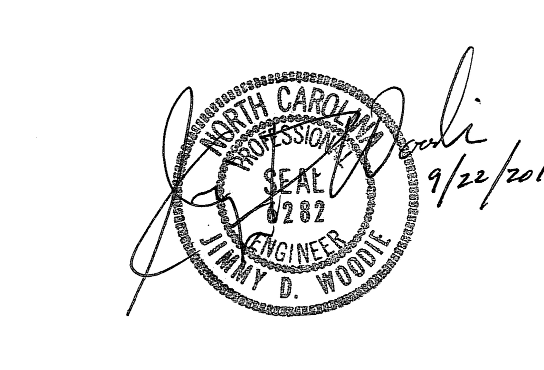
COHESIVE SOIL LINER ALTERNATE 1 DETAIL

N.T.S.



COHESIVE SOIL LINER ALTERNATE 2 DETAIL

N.T.S.



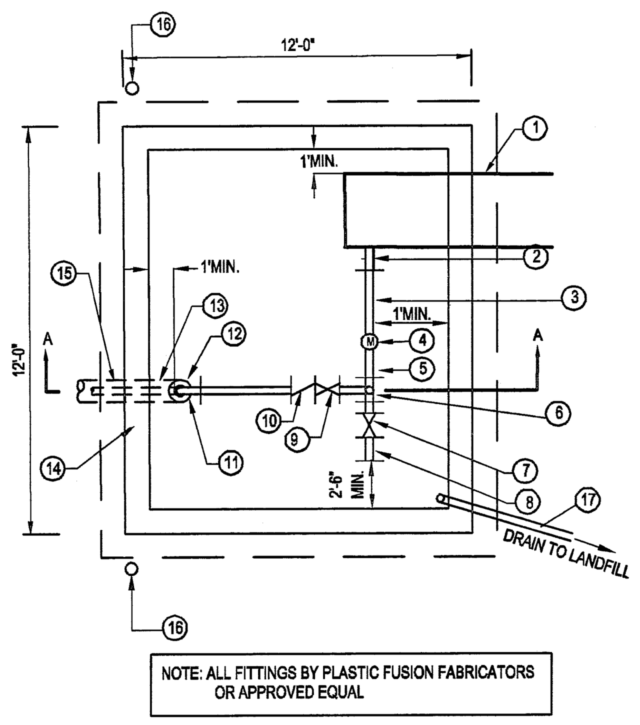
LICENSE NUMBER: C-0281
Municipal Services Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
9/16/2010	LCH	1	PER NCDENR COMMENT LETTERS DATED 7/21/10 AND 9/9/10

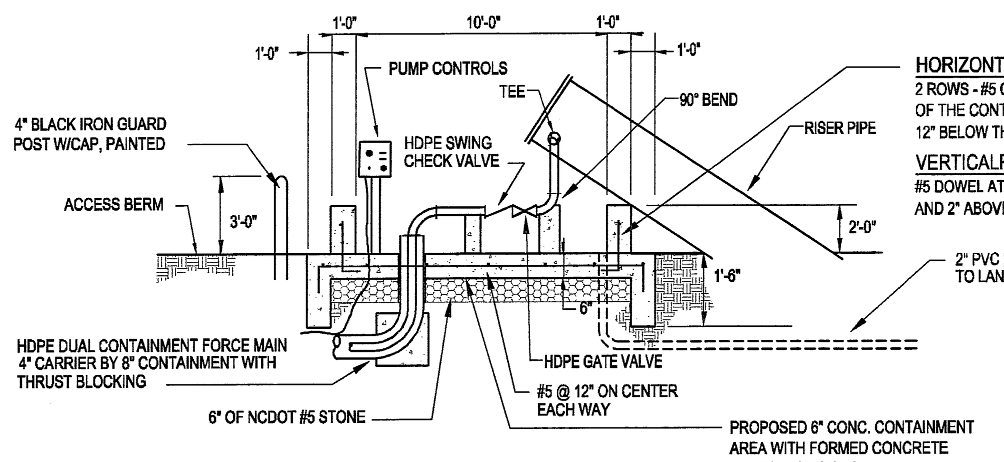
ENGINEERING PLAN - PHASE 2
CONSTRUCTION DETAILS

SCALE:	AS SHOWN
DATE:	10/8/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO.	E8
SHEET NO.	10 OF 15



1. 24" HDPE SDR 17 SUMP RISER
2. EXIT ASSEMBLY WITH PRESSURE GAUGE AND 3/4" SAMPLE TAP
3. MIN. 18" LONG 4" FLANGED HDPE PIPE
4. 4" BRONZE TURBINE METER, KENT SERIES 3000, MASTER METER, OR APPROVED EQUAL
5. MIN 18" LONG 4" FLANGED HDPE PIPE
6. 4" x 4" FANGED HDPE TEE WITH 2" FLANGED HDPE 90° VERTICAL BEND BELOW TEE
7. 4" FLANGED HDPE GATE VALVE
8. 4" STAINLESS QUICK-DISCONNECT FITTING
9. 4" FLANGED HDPE GATE VALVE
10. 4" FLANGED HDPE SWING CHECK VALVE
11. 1 - 90°, 4" FLANGED HDPE VERTICAL BEND
12. HDPE DUAL CONTAINMENT SOLID STOP WITH WATER STOP BEGIN DUAL CONTAINMENT FORCE MAIN
13. HDPE DUAL CONTAINMENT 90° VERTICAL BEND
14. CONCRETE CONTAINMENT AREA
15. HPDE DUAL CONTAINMENT FORCE MAIN (4" CARRIER BY 8" CONTAINMENT)
16. GUARD POST
17. 2" PVC DRAIN PIPE

NOTE: ALL FITTINGS BY PLASTIC FUSION FABRICATORS OR APPROVED EQUAL



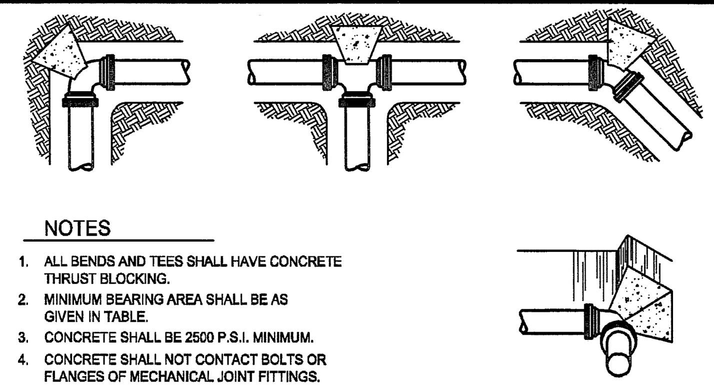
HORIZONTAL REINFORCING:
2 ROWS - #5 CONTINUOUS, ONE 4" BELOW THE TOP OF THE CONTAINMENT WALL AND ANOTHER ONE 12" BELOW THE FIRST ONE (TYPICAL)

VERTICALREINFORCING:
#5 DOWEL AT 12" ON CENTER, 2" BELOW THE TOP OF WALL AND 2" ABOVE THE BOTTOM OF SLAB

SECTION A-A
NOT TO SCALE

SUMP RISER PAD AND PIPING DETAIL

NOT TO SCALE



NOTES

1. ALL BENDS AND TEES SHALL HAVE CONCRETE THRUST BLOCKING.
2. MINIMUM BEARING AREA SHALL BE AS GIVEN IN TABLE.
3. CONCRETE SHALL BE 2500 P.S.I. MINIMUM.
4. CONCRETE SHALL NOT CONTACT BOLTS OR FLANGES OF MECHANICAL JOINT FITTINGS.

REACTION BEARING AREAS FOR HORIZONTAL WATER PIPE BENDS
BASED ON TEST PRESSURE OF 200 P.S.I. AND SAFETY FACTOR OF 1.5

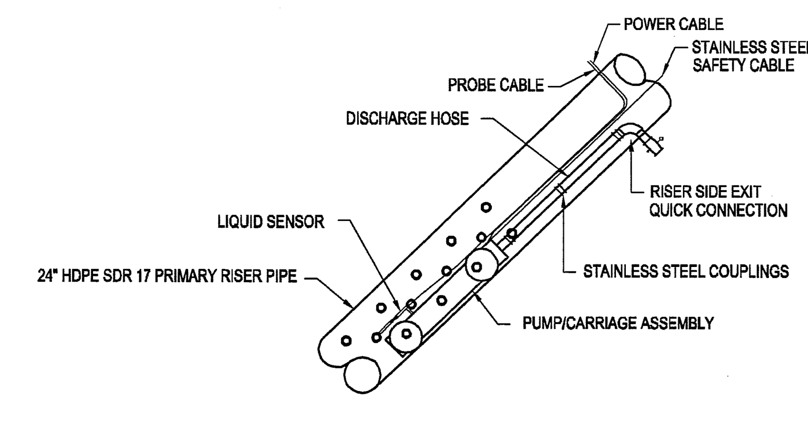
SIZE AND DEGREE OF PIPE BEND		STATIC THRUST IN POUNDS	S_b	SOFT CLAY (#/SF)	SILT (#/SF)	GRAVEL OR COURSE SAND (#/SF)	SANDY SILT (#/SF)	SAND (#/SF)	SANDY CLAY (#/SF)	HARD CLAY (#/SF)
				1,000	1,500	1,600	3,000	4,000	6,000	9,000
			BEARING AREA (A_r) IN SF							
8" PIPE	11 1/4°	2,521		4	3	2	1	1	1	0
8" PIPE	22 1/2°	5,018		8	5	5	3	2	1	1
8" PIPE	45°	9,843		15	10	9	5	4	2	2
8" PIPE	90°	18,187		27	18	17	9	7	5	3
8" PIPE	PLUG & BRANCH	12,860		19	13	12	6	5	3	2

REACTION BEARING AREAS ARE IN SQUARE FEET MEASURED IN A VERTICAL PLANE IN THE TRENCH SIDE AT AN ANGLE OF 90 DEGREES TO THE THRUST VECTOR.

USE 6"-90 DEGREE BEND VALUE FOR THE HYDRANTS FOR ADDITIONAL SAFETY FACTOR.

THRUST BLOCKING DETAIL

NOT TO SCALE

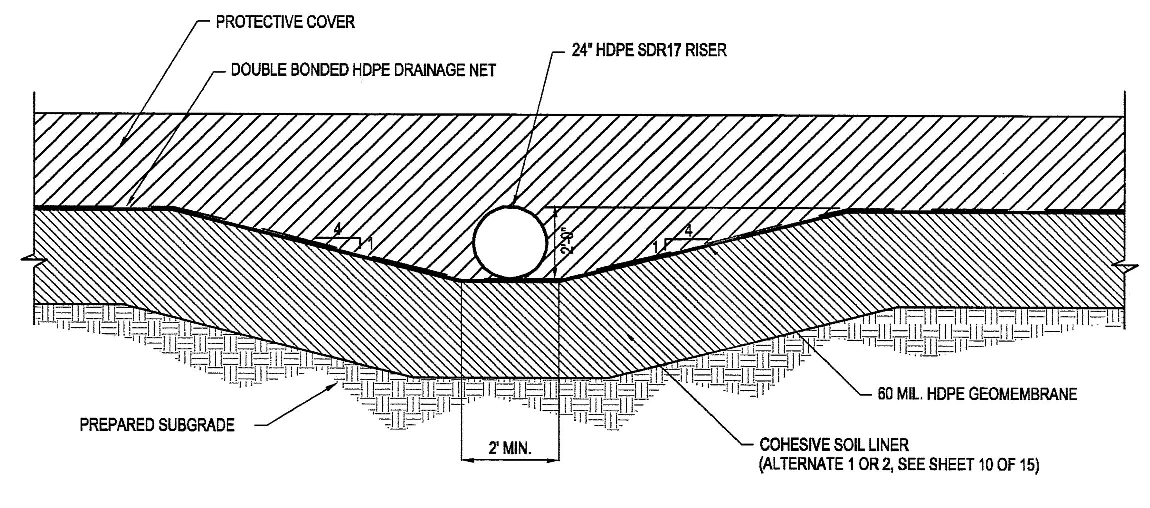


LEACHATE SUMP RISER SCHEMATIC

NOT TO SCALE

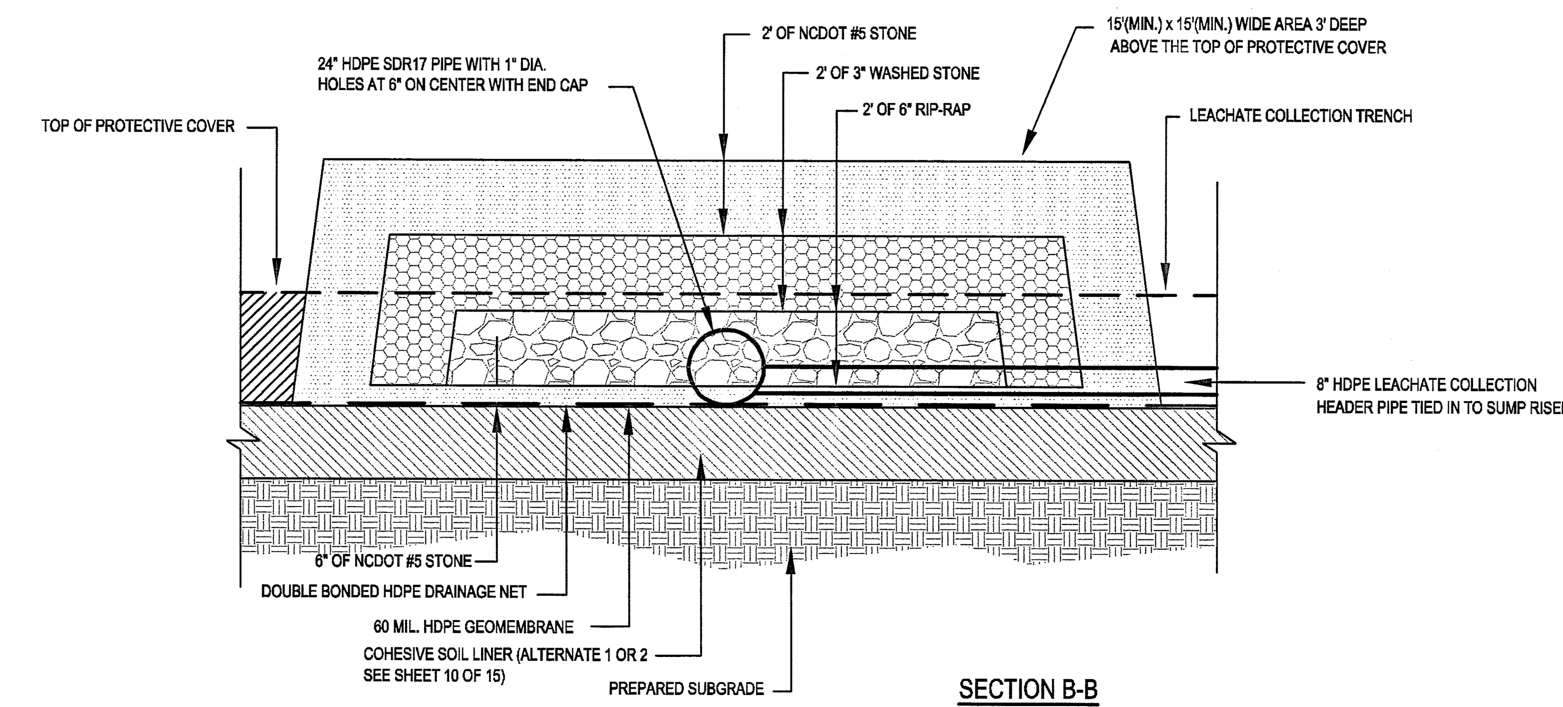
THE PUMP SHALL BE CONSTRUCTED OF ALL 304 STAINLESS STEEL MATERIALS WITH A TEFLON IMPELLER SEAL RING, AND INTERMEDIATE BEARINGS. THE MOTOR SHALL BE AT LEAST 2 H.P., SINGLE PHASE, 230 VOLT, CONSTRUCTED OF STAINLESS STEEL WETTED PARTS.

THE PUMP SHALL INCLUDE A PATENTED STAINLESS STEEL CARRIAGE. THE CARRIAGE SHALL BE DESIGNED FOR SIDE SLOPE RISER LEACHATE APPLICATIONS. THE PUMP ASSEMBLY SHALL HAVE A LOW CENTER OF GRAVITY AND ALL WHEELS OF THE CARRIAGE SHALL REMAIN IN CONTACT WITH THE INSIDE SURFACE OF THE RISER PIPE. THE PUMP SHALL BE EASILY REMOVED FROM THE CARRIAGE SHOULD THE PUMP OR MOTOR REQUIRE SERVICE OR REPLACEMENT. THE PUMP AND CARRIAGE SHALL BE CAPABLE OF ENTRY INTO AN 24" HDPE SDR 17 PIPE AND MUST BE ABLE TO TRAVEL OVER ANY WELDING BEADS AND PERFORATIONS WHICH ARE COMMON TO LEACHATE COLLECTION RISER PIPE FABRICATION. A RETRIEVABLE CABLE ASSEMBLY OF 1/4" STAINLESS STEEL WITH SNAP HOOK AND EYE BOLT SHALL BE PROVIDED.



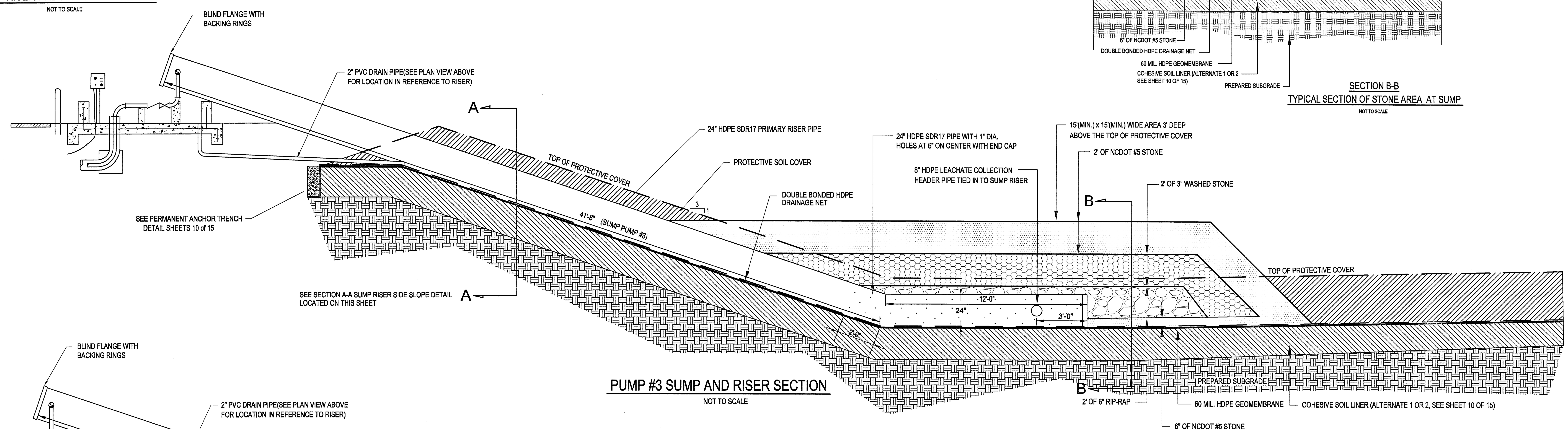
SECTION A-A
SUMP RISER SIDE SLOPE DETAIL

NOT TO SCALE



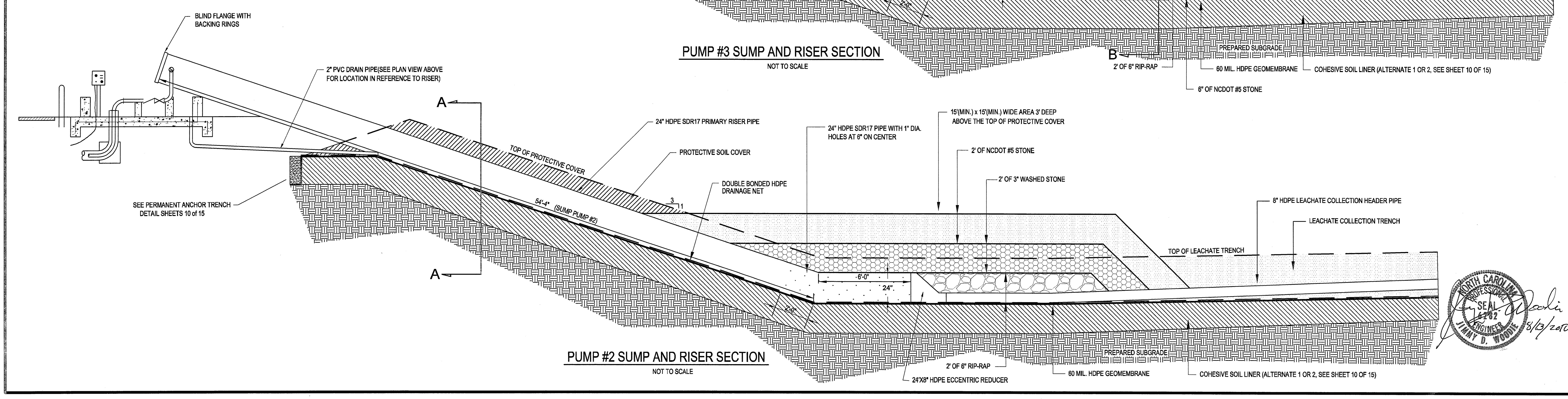
SECTION B-B
TYPICAL SECTION OF STONE AREA AT SUMP

NOT TO SCALE



PUMP #3 SUMP AND RISER SECTION

NOT TO SCALE



PUMP #2 SUMP AND RISER SECTION

NOT TO SCALE

LICENSE NUMBER: C-0281
Municipal Services
Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
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P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
8/11/2010	LCH	1	REVISED SUMP AND RISER DETAIL

ENGINEERING PLAN – PHASE 2
SUMP, PUMP, RISER, PAD AND DETAILS

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6782 JIMMY D. WOODIE
8/13/2010

SCALE:	AS SHOWN
DATE:	10/8/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. E9	SHEET NO. 11 OF 15

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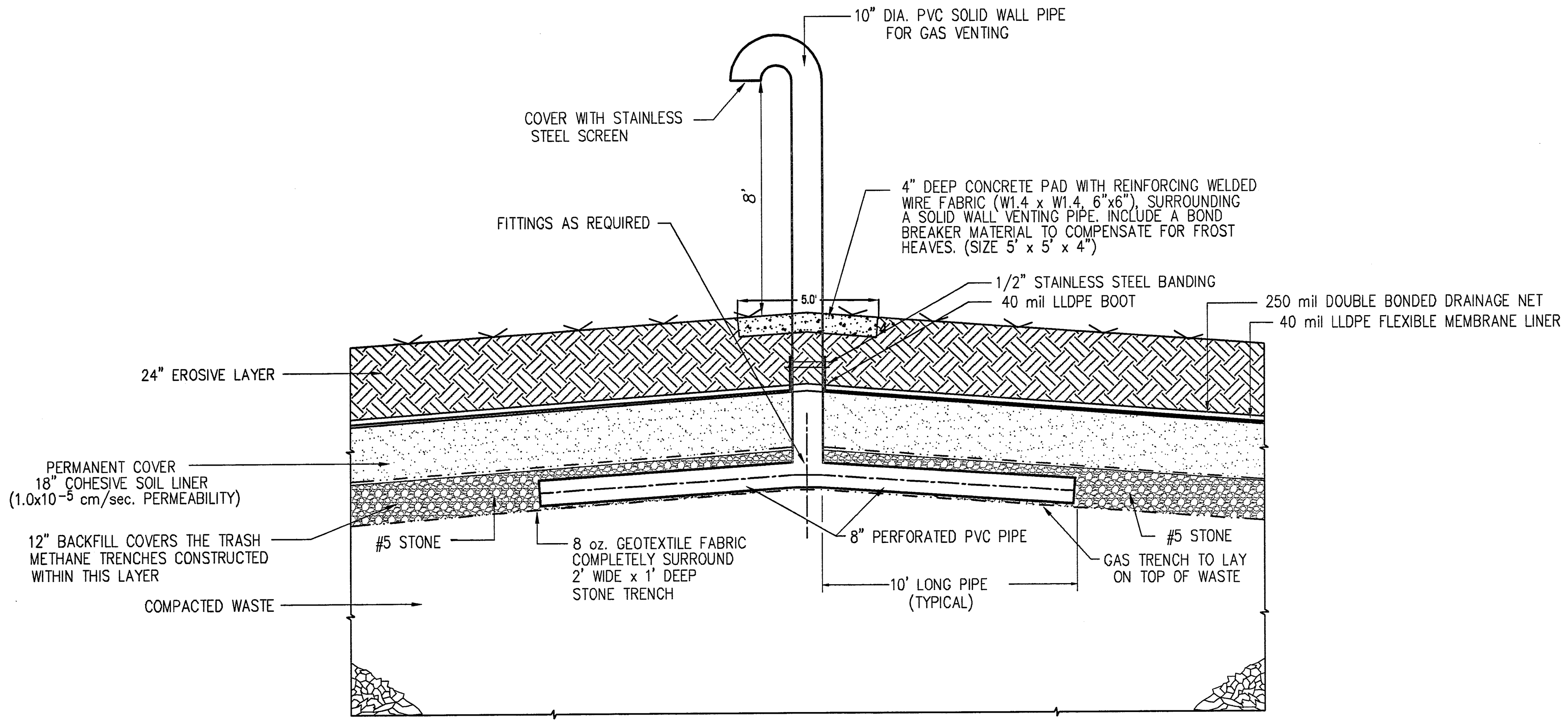
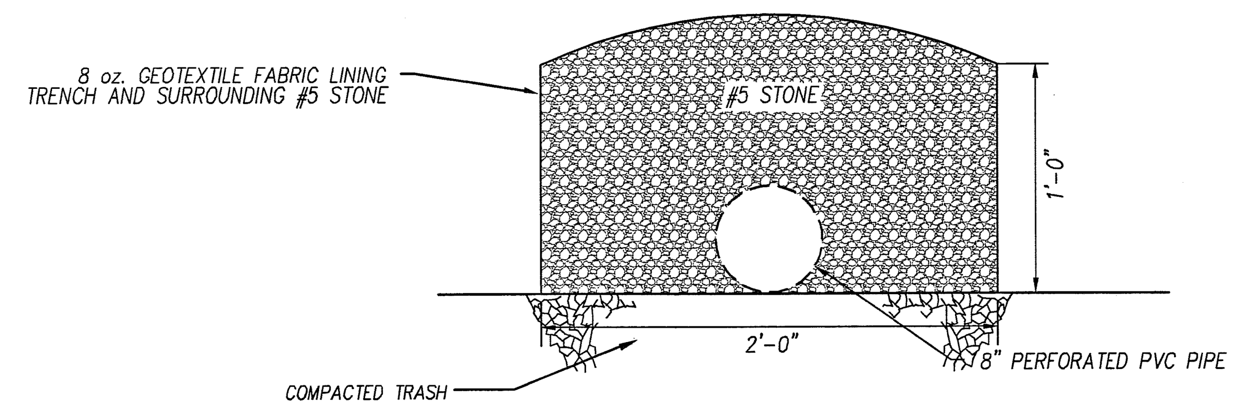
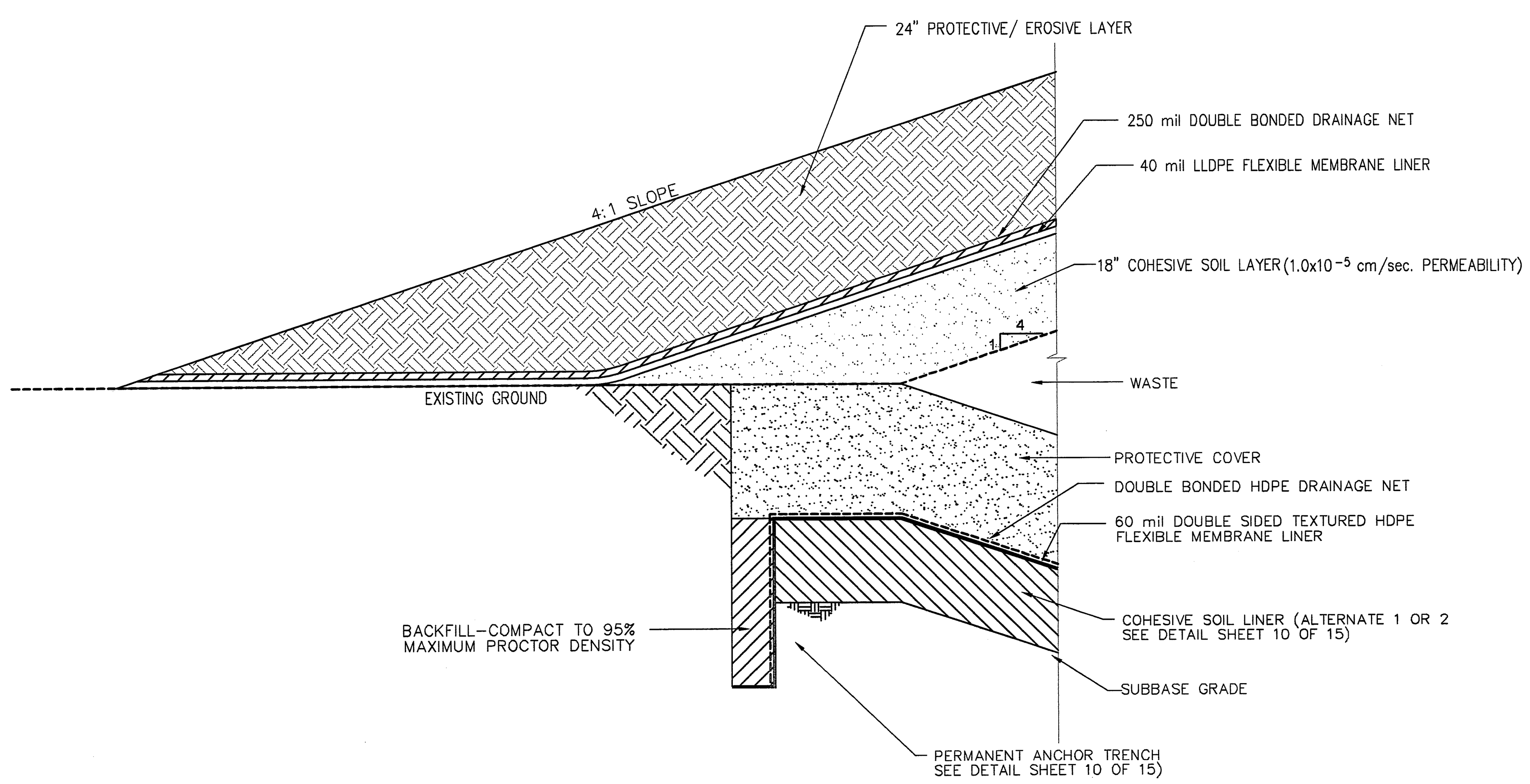


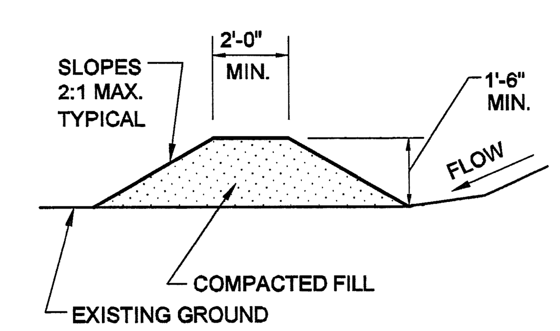
TYPICAL METHANE GAS COLLECTION TRENCH AND CAP CLOSURE DETAIL
N.T.S.



PERMANENT METHANE TRENCH DETAIL
N.T.S.



TYPICAL CAP CLOSURE DETAIL
N.T.S.



TEMPORARY STORMWATER DIVERSION BERM DETAIL
N.T.S.

LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
9/15/10	LCH	1	PER NC SOLID WASTE SECTION LETTERS DATED 7/21/10 AND 9/9/10

ENGINEERING PLAN–PHASE 2
OPERATION DETAILS

SCALE: 1:1
DATE: 10/22/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G08095
DRAWING NO. E12
SHEET NO. 14 OF 15

NORTH CAROLINA PROFESSIONAL SEAL 8282 ENGINEER JIMMY D. WOODIE
9/22/2010

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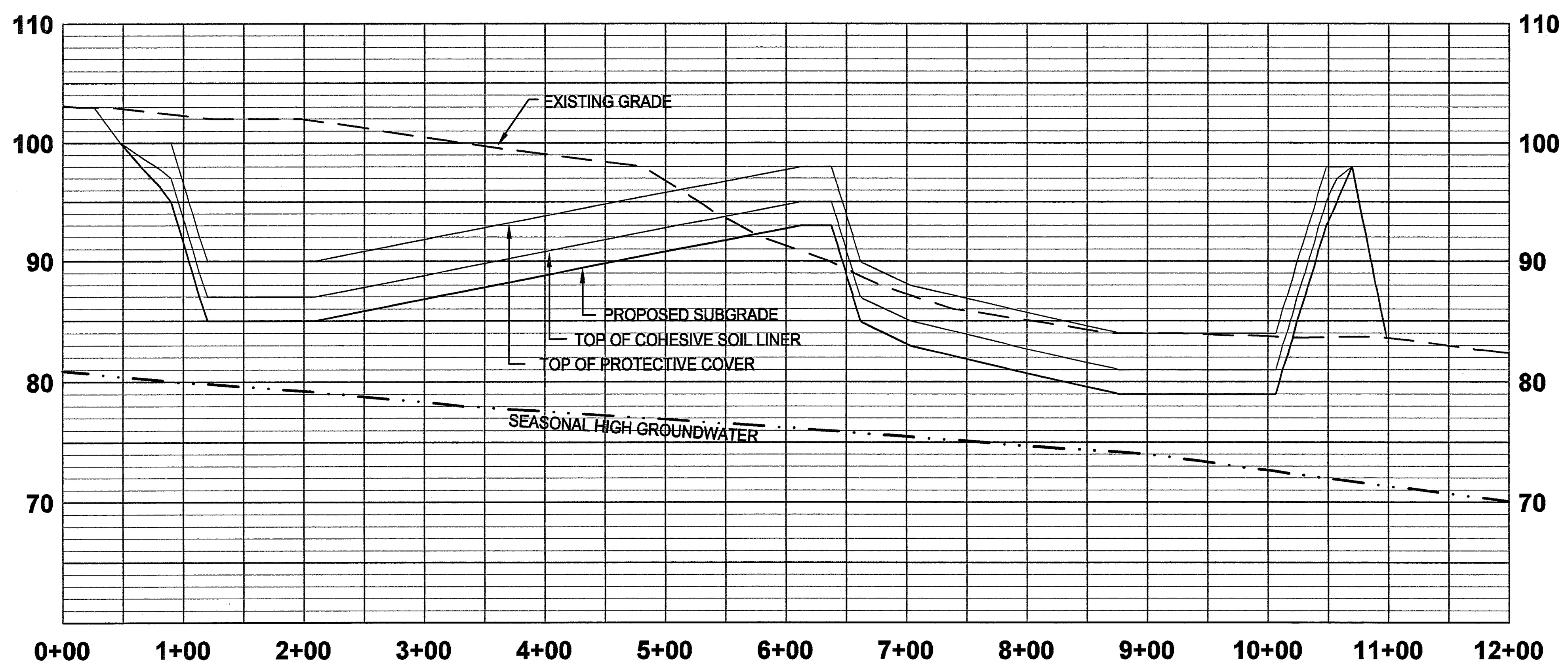
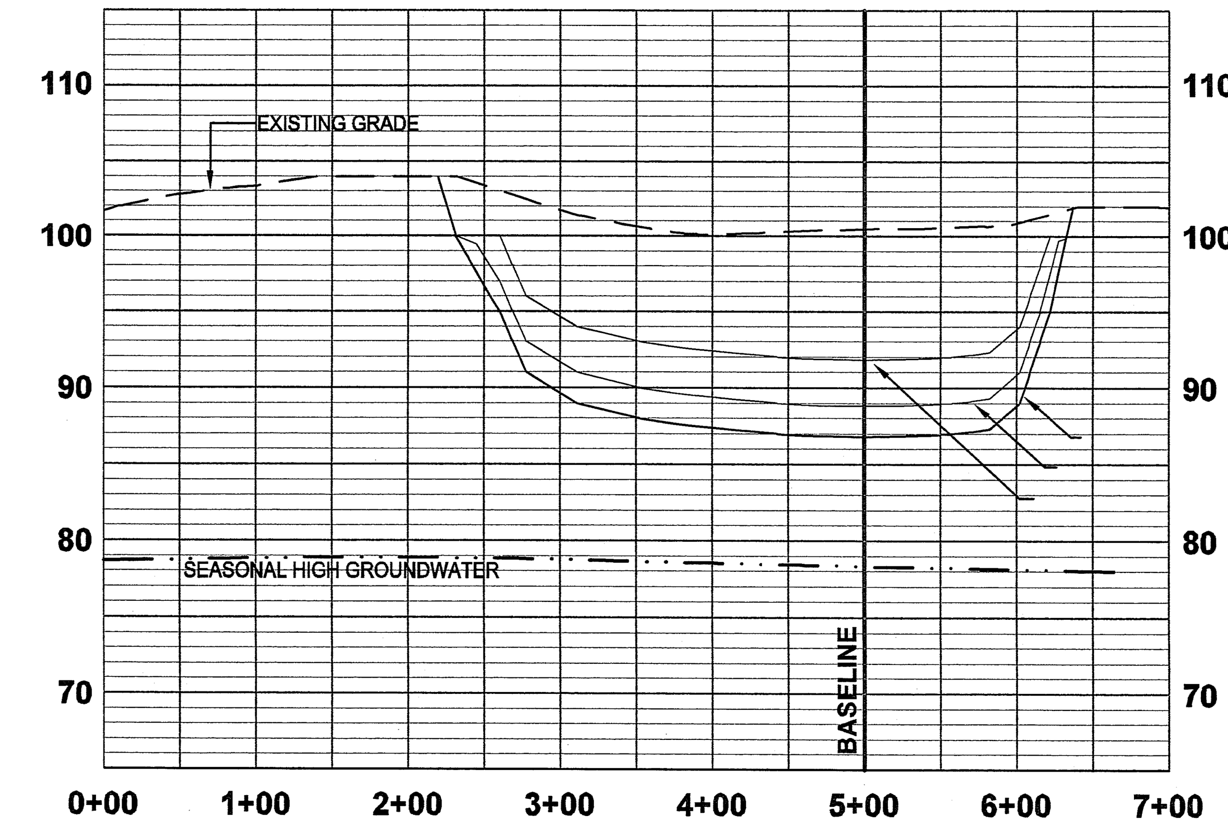


BASELINE PROFILE

SCALE: HOR.: 1" = 100'
VERT.: 1" = 10'

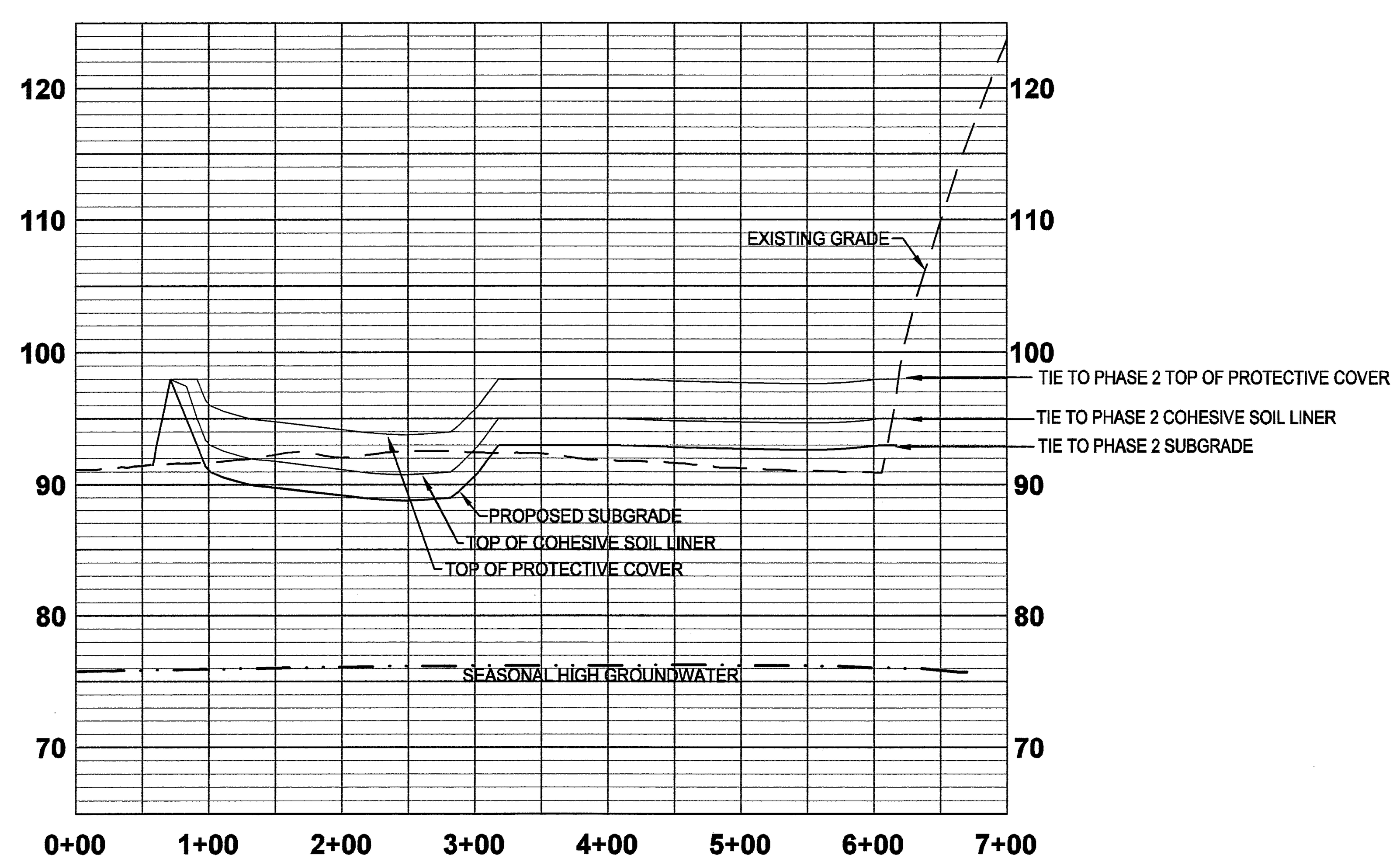


STATION 3+00

SCALE: HOR.: 1" = 100'
VERT.: 1" = 10'

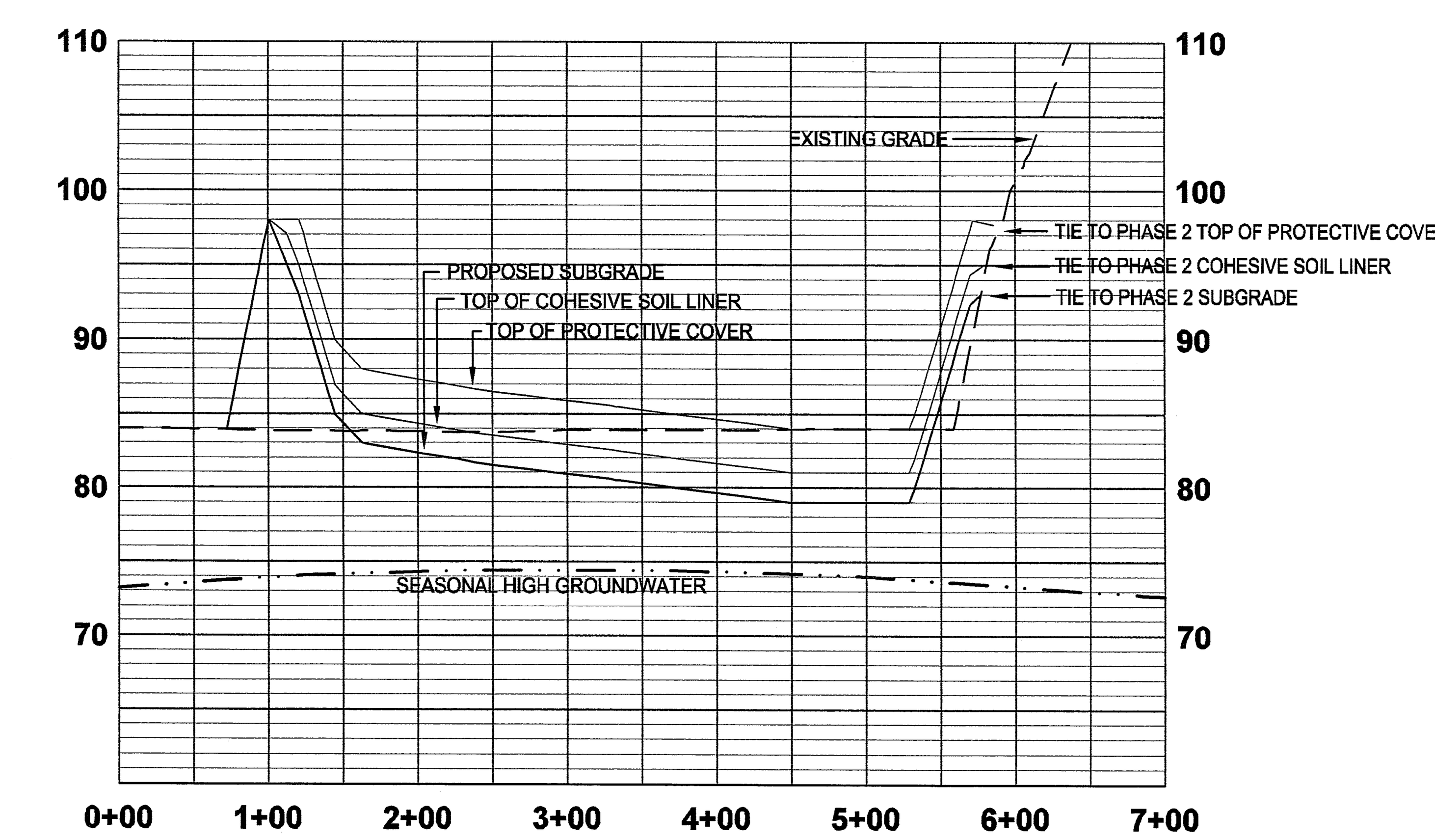
NOTE

THESE CROSS SECTIONS ARE INTENDED TO SHOW THE CROSS SECTIONS AT SPECIFIC POINTS AS DEFINED BY THE BASELINE GRID ON SHEET 3 OF 15. THEY ARE NOT INTENDED TO BE THE SOLE MEANS FOR CALCULATING THE EARTHWORK FOR THIS PROJECT.



STATION 6+00

SCALE: HOR.: 1" = 100'
VERT.: 1" = 10'



STATION 9+00

SCALE: HOR.: 1" = 100'
VERT.: 1" = 10'

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

ENGINEERING PLAN – PHASE 2
BASELINE PROFILE AND CROSS SECTIONS

DATE	BY	REV.	DESCRIPTION

SCALE: 1" = 100'
DATE: 10/5/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G08095
DRAWING NO. E13
SHEET NO. 15 OF 15

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6262 JIMMY D. WOODIE
11/25/2009

SECTION 3.0

MATERIALS AND CONSTRUCTION PRACTICES

All tests indicated in this section are described in Section 4.0 Construction Quality Assurance Plan. Tests mentioned in this section are the same tests indicated in Section 4.0.

3.1 Construction Sequence

1. Clear all areas necessary for construction of Riser Basins.
2. Construct Riser Basins.
3. Permanently seed all disturbed areas.
4. Prepare Subbase.
5. Construct Base Liner System.
6. Construct Penetrations.
7. Construct Protective cover over the Base Liner System.
8. Excavate the Leachate Trenches.
9. Construct Leachate Collection System.
10. Construct the pumps and force main from Leachate Collection System to the Lagoon.
11. Permanently seed any disturbed areas

3.2 Subbase

The fill subgrade will be placed in 8" loose lifts and compacted to at least 95% of maximum dry density and near optimum moisture contents; as determined by Standard Proctor Compaction Test (ASTM D698)' in 6" compacted lifts. Each compacted lift will be tested at one test per six inch (6") lift for each 200 linear feet or fraction thereof of compacted berm (s) less than 50 feet in base width and one test per six (6) inch lift for each 10,000 square feet or fraction thereof of compacted mass fill. If an area fails, it shall be recompacted, reworked or replaced and retested.

Before beginning construction of the base liner system, the Engineer shall visually inspect the exposed surface to evaluate the suitability of the subgrade and document that the surface is properly prepared and that the elevations are consistent with the Division approved engineering plans. The elevations will be verified from survey data based on a 50 foot grid across the subbase.

At a minimum, the subgrade shall be proof-rolled at cut sections utilizing a fully loaded tandem dump truck or equivalent. If movement of the subbase is observed under the tires, the section of movement will be removed and replaced with suitable fill material. This newly placed fill material will then be tested for proper density and moisture.

3.3 Base Liner System

3.3.1 Materials and Construction Practices for Cohesive Soil Liner

All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

The soil for the cohesive soil liner shall consist of the red, orange, clayey silt on-site soils passing the No. 200 Sieve and a permeability of 1.0×10^{-7} cm/sec or less for the base liner system is achieved. Off-site cohesive soils may be used if approved by the Engineer and provides a permeability of 1.0×10^{-7} cm/sec or lower for the base liner system. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil liner. The window is developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

A test strip of compacted cohesive soil liner shall be prepared to create a permeability “window” prior to general installation of the cohesive soil liner. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil liner. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least four compacted 6 inch lifts of cohesive soil liner. The test strip may be used as an integral part of the overall cohesive soil liner if it meets the required specification for the liner.

After the test strip passes, soil liner will be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift. A sheepsfoot roller or approved alternative may be used to compact the soil liner provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil liner shall be screened, disked, or prepared using any other, approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. The soil liner must be a minimum of 2.0 feet thick. No additional construction shall proceed on the soil liner at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved. If the soil for the cohesive soil liner is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory.

The thickness and grade of the soil liner will be verified by the Engineer before placement of the geomembrane liner. The thickness and grade will be verified by surveying the clay at 50’ grid points where the elevations of the subbase will be checked with the top of soil liner to verify 2.0 feet of soil liner. The grade will then be verified with the surveyed information. The survey will be performed by NC licensed surveyors.

Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil liner shall have no sudden sharp or abrupt changes in grade. The Contractor shall protect the cohesive soil liner from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil liner until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions will be replaced or reworked by the contractor to remove these defects.

The anchor trench shall be excavated by the Contractor to lengths and widths shown on the design drawings prior to geomembrane placement. Anchor trenches excavated in clay soils susceptible to desiccation cracks should be excavated only the distance required for that days liner placement to minimize the potential of desiccation cracking of the clay soils. Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

The backfill for the anchor trench shall be compacted to 95% maximum proctor density, There is no grain size requirement, and on-site material shall be used. The frequency of testing shall be for every six(6) inch lift and 500 feet of trench. There is no grain size requirement, and on-site material shall be used.

Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil liner and the surface shall remain the responsibility of the contractor.

3.3.2. Materials and Construction Practices for Flexible Membrane Liner

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

60 mil High Density Polyethylene (HDPE) – Geosynthetic Research Institute (GRI) GM 13 – is to be placed in direct contact with moist cohesive soil liner. The Landfill itself is single lined and will only have a Textured Geomembrane. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner.

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project. Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture. The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds. The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface. No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions which could result in damage to the geomembrane. Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas. The geomembrane will be deployed in a manner to minimize wrinkles. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed. In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The flexible membrane liner will be welded together by fusion and extrusion fillet welding methods. Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge. Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets.

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams may substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day. Fusion Welding is done by first overlapping panels of geomembrane approximately four (4) inches, next clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding. Next, adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths". A movable protective layer may be used, at the discretion of the Flexible Geomembrane Liner System, Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

Extrusion Welding is done by overlapping panels of geomembrane a minimum of three (3) inches and temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane. Next grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area. Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind. Purge the extruder prior to beginning the seam to remove all heat degraded extrudate from the barrel. Keep welding rod clean and off the ground.

At a minimum, test seams shall be made upon each start of work for each seaming crew, upon every four hours of continuous seaming, every time seaming equipment is changed or if significant changes in geomembrane temperature and weather conditions are observed. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams. The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width. Visually inspect the seam for squeeze out, footprint, pressure and general appearance. Two random samples one (1) inch wide shall be cut from the test seam. The specimens shall then be tested in peel using a field tensiometer and shall not fail in the seam. If a specimen fails the entire procedure shall be repeated. If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved. After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting and test results. Passing test results records shall be maintained.

Seaming shall extend to the outside edge of panels to be placed in the anchor trench. While welding a seam, monitor and maintain the proper overlap. Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind. While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly. Align wrinkles at the seam overlap to allow welding through the wrinkle. Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions. All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane. All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind two (2) inches minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

Air pressure testing will be conducted. The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time. An air pump with rubber hose and sharp hollow needle (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi will be used to test the seam. Seal both ends of the seam to be tested. Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld. Inflate the test channel to a pressure between 27 to 30 psi, close valve, and observe initial pressure after approximately 2 minutes. For the 60 mil HDPE liner the seam has to have a minimum initial pressure of 27 psi and a maximum initial pressure of 30 psi. Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize. Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds 3 psi or if the pressure does not stabilize, locate faulty area and repair. At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected. Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

In the event of a Non-Complying Air Pressure Test, check the seam end seals and retest seams. If non-compliance with specified maximum pressure differential re-occurs, repair the seam. When two (2) passing samples are located, the seam between these two (2) locations will be considered non-complying. Capping or removal are the only two (2) acceptable methods of repairing failed seams. Non-destruct test the entire length of the repaired seam.

Vacuum testing will be conducted when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

Vacuum box assembly consists of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, a vacuum gauge, vacuum pump assembly equipped with a pressure controller and pipe connection, a rubber pressure/vacuum hose with fittings and connections, a bucket and means to apply a soapy solution.

The procedure for Vacuum Testing is to trim excess overlap from seam, if any. Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi. Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested. Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner. Close the bleed valve and open the vacuum valve. Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box. Ensure that a leak tight seal is created. For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process. The procedure for Non-Complying Testis to mark all areas where soap bubbles appear and repair the marked areas. Retest repaired areas.

The procedure for Destructive Testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane. All destructive tests will be done according to ASTM D4437. The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications. A one (1) inch sample shall be cut from each end of the test seam for field testing. The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer for peel ASTM D4437. Tensile strength is essentially a measurement of the greatest tension stress a substance can bear without tearing. If the liner tears before any part of the seam does the test is successful. If any field sample fails to pass, it will be assumed the sample fails destructive testing. Destructive samples will be taken every 500 ft. of seam.

In the event of Destructive Test Failure, cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing. All destructive seam samples sent to the Flexible Membrane Liner System's laboratory shall be numbered. If the laboratory samples pass then repair the seam between the two (2) passing samples locations. All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken. Capping or removal of the failed seam are the only two (2) acceptable methods for repairing failed seams.

The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation. All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely matter to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil liner such as a temporary cover. If cohesive soil liner is damaged, it must be reworked. Procedures available for repair are (1)Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded, (2) Grinding and welding - used to repair sections of extruded seams, (3) Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws, (4) Capping - used to repair lengths of failed seams, (5) Removal of a bad seam and replacement with a strip of new material seamed into place.

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as built drawing.

3.4 Alternate Liner System

3.4.1 Materials and Construction Practices for Cohesive Soil Liner

All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

The soil for the cohesive soil liner shall consist of the red, orange, clayey silt on-site soils, if the mica content is less than 0.5 percent by weight passing the No. 200 Sieve and a permeability of 1.0×10^{-5} cm/sec or less, is achieved. Off-site cohesive soils may be used if approved by the Engineer and provides a permeability of 1.0×10^{-5} cm/sec or lower. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil liner. The window is developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

A test strip of compacted cohesive soil liner shall be prepared to create a permeability “window” prior to general installation of the cohesive soil liner. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil liner. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least three compacted 6 inch lifts of cohesive soil liner. The test strip may be used as an integral part of the overall cohesive soil liner if it meets the required specification for the liner.

After the test strip passes, soil liner will be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift. A sheepsfoot roller or approved alternative may be used to compact the soil liner provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil liner shall be screened, disked, or prepared using any other, approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. The soil liner must be a minimum of 1.5 feet thick. No additional construction shall proceed on the soil liner at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved. If the soil for the cohesive soil liner is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory.

The thickness and grade of the soil liner will be verified by the Engineer before placement of the geomembrane liner. The thickness and grade will be verified by surveying the clay at 50’ grid points where the elevations of the subbase will be checked with the top of soil liner to verify 1.5 feet of soil liner. The grade will then be verified with the surveyed information. The survey will be performed by NC licensed surveyors.

Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil liner shall have no sudden sharp or abrupt changes in grade. The Contractor shall protect the cohesive soil liner from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil liner until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions will be replaced or reworked by the contractor to remove these defects.

The anchor trench shall be excavated by the Contractor to lengths and widths shown on the design drawings prior to geomembrane placement. Anchor trenches excavated in clay soils susceptible to desiccation cracks should be excavated only the distance required for that days liner placement to minimize the potential of desiccation cracking of the clay soils. Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

The backfill for the anchor trench shall be compacted to 95% maximum proctor density, There is no grain size requirement, and on-site material shall be used. The frequency of testing shall be for every six(6) inch lift and 500 feet of trench. There is no grain size requirement, and on-site material shall be used.

Upon request, the Geosynthetic Clay Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil liner and the surface shall remain the responsibility of the contractor.

3.4.2. Materials and Construction Practices for Geosynthetic Clay Liner(GCL)

The Contractor shall furnish all labor, materials, supervision and equipment to complete the installation of the GCL, including, but not limited to, liner layout, seaming, patching, and all necessary and incidental items required to complete the Work, in accordance with the Contract Drawings and these Specifications.

Sufficient liner material shall be furnished to cover all lined areas shown on the Drawings, including overlaps at field seams and anchor trenches.

The GCL Manufacturer must have produced at least 10 million square feet (1 million square meters) of GCL, with at least 8 million square feet (800,000 square meters) installed. The manufacturer shall submit certification that GCL manufactured for the Project has been produced in accordance with these Specifications along with results from a quality control program. This information must be submitted for review prior to material delivery. The Engineer reserves the right to halt installation until proper certification is submitted and determined acceptable for use.

The Contractor shall submit to the Engineer, six (6) full sets of panel layout construction drawings. Drawings shall be submitted to the Engineer at least two (2) weeks prior to installation.

The manufacturer of the GCL used in this work shall approve all shop drawings and a proposed liner layout to cover the lined area shown on the Drawings.

Details shall be included to show the termination of the liner at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring. A specific anchor trench detail shall be provided.

The Contractor shall submit to the Engineer a physical sample of the liner to be used. The sample shall be labeled with the manufacturer's name, product identification, lot number and roll number.

Upon shipment, the Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification. The Contractor shall also submit to the Engineer inventory tickets, roll numbers or batch identifications, packing papers, and invoices for the liner used.

As installation proceeds, the Contractor shall submit certificates of subgrade acceptance to the Engineer, signed by the Contractor and the GCL Installer for each area that is covered by the GCL.

The Contractor shall provide personnel resumes demonstrating compliance with the following requirements.

1. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million square feet (100,000 square meters) in size.
2. A minimum of one field superintendent per shift shall be designated by the Contractor and approved by the Engineer. Each field superintendent shall have a minimum of three years and five million square feet of field experience in installing GCL's. Any change or replacement of superintendent during the Project must be approved by the Engineer.

3. Liner placement technicians shall have a minimum of one year and one million square feet of GCL placement experience.

The GCLs shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles and shall comply with all of the criteria listed in this Section. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Contractor also must obtain prior approval of the alternative GCL by the Engineer.

Reinforced GCL must be used on all areas of the site. An acceptable GCL product is Bentomat® ST as manufactured by CETCO or an engineer-approved equal. All areas of the project requiring reinforced GCL will be furnished with Bentomat® ST or an engineer-approved equal. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7m) in length and 15 feet (4.6m) in width for Bentomat. Short rolls [(those manufactured to a length greater than 70 feet (21m) but less than a full-length roll)] may be supplied at a rate of no greater than 3 per truckload or 3 rolls for every 36,000 square feet (3,500 square meters) of GCL, whichever is less. A 6-inch (150mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

The GCL manufacturer/Contractor shall provide the Engineer with manufacturing QA/QC certifications for each shipment of GCL, prior to the deployment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager, and shall include:

A. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the parameters swell index and fluid loss shown in CETCO's Technical Data Sheet TR404bm.

B. Manufacturer's test data for finished GCL products(s) of bentonite mass/area, GCL tensile strength, and GCL peel strength demonstrating compliance with the index parameters shown in CETCO's Technical Data Sheet TR404bm.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

D. Manufacturer's test data for finished GCL product(s) including GCL index flux, permeability, and hydrated internal shear strength data demonstrating compliance with the performance parameters shown in CETCO's Technical Data Sheet TR404bm.

Prior to shipment, the GCL manufacturer shall label each roll, identifying: product identification information (Manufacturer's name and address, brand name, product code), lot number, roll number, roll length, width, and weight.

The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit. All rolls shall be labeled and bagged in packaging that is resistant to photo degradation by ultraviolet (UV) light.

The granular bentonite or bentonite sealing compound used for seaming, penetration sealing, and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer.

CETCO GCL's are delivered in rolls weighing from 2,500 - 2,700 lbs (1,140-1,225 kg). It is necessary to support this weight using an appropriate core pipe. For any installation, the core pipe must not deflect more than 3 inches (75 mm) as measured from end to midpoint when a full

GCL roll is lifted. Lifting chains or straps rated for at least twice the load of the GCL should be used in combination with a spreader bar made from an I-beam. The spreader bar ensures that the lifting chains or straps do not chafe against the ends of the GCL roll, which must be able to rotate freely during installation.
A front end-loader, backhoe, dozer, or other equipment can be furnished with the spreader bar and core bar. Alternatively, a forklift with a “stinger” attachment may be used for on-site handling and, in certain cases, installation. **A forklift without a stinger attachment shall not be used to lift or handle the GCL rolls**.

When installing over certain geosynthetic materials, a 4-wheel all-terrain vehicle (ATV) can be used to deploy the GCL from behind. An ATV can be driven directly on the GCL provided that no sudden stops, starts, or turns are made.

Additional equipment needed for installation of CETCO’s GCL's include:

- Utility knife and spare blades (for cutting the GCL).
- Granular bentonite or bentonite mastic (for overlapped seams of GCLs with needle punched non-woven geotextiles and for sealing around structures and details).
- Waterproof tarpaulins (for temporary cover on installed material as well as or stockpiled rolls).
- Optional chalk line marker to simplify bentonite placement at seams (when installing a GCL with needle punched non-woven geotextile components).
- Optional flat-bladed vise grips (for positioning the GCL panel by hand).

The manufacturer assumes responsibility for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling, and storage of the GCL are the responsibility of the Contractor, Installer, or other designated party. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage. The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry, and well-drained. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks or by use of the dunnage shipped between rolls. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four). Rolls shall never be stacked on end. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation. The integrity and legibility of the labels shall be preserved during storage.

Any surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of vegetation, any debris, sticks, sharp rocks, void spaces, ice, abrupt elevation changes, standing water, cracks larger than one-quarter inch (6mm) in width, and any other foreign matter that could contact the GCL. Subgrade surfaces consisting of granular soils or gravel may not be acceptable due to their large void fraction and puncture potential. Subgrade soils should possess a particle size distribution such that at least 80 percent of the soil is finer than a No. 60 sieve (0.250 mm). Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch

(12mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor. On a continuing basis, the Contractor/GCL Installer shall submit certifications of subgrade acceptance to the Engineer, and the project Construction Observer shall verify acceptance of the subgrade before GCL placement.

It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated in accordance with the project plans and specifications. The excavated trench shall be verified by the Construction Observer prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

Placement of the GCL shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the CQA Engineer.

The contractor shall not install any GCL on this project, at any time, in the absence of the Construction Observer. During start-up of the GCL installation, an agent or representative of the Manufacturer shall provide on-site assistance and instruction to the Contractor and CQA Engineer regarding the appropriate installation techniques. The Construction Observer/Engineer shall inspect each panel, after placement and prior to seaming, for damage and/or defects. All defects and deficiencies shall be properly documented by the GCL Installer and Construction Observer. Defective or damaged panels shall be replaced or repaired, as approved by the Construction Observer/Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the Engineer. The Construction Observer shall observe and verify all repaired defects. Reinforced GCL shall be placed on all areas of the site. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) may be important if the GCL has two different geotextiles. Unless otherwise specified, however, the GCL shall be placed with the white side (non-woven) geotextile facing down. The GCL shall be properly weighted to avoid uplift due to wind. Equipment which could damage the GCL shall not be allowed to travel directly on it. Acceptable installation, therefore, may be accomplished such that the GCL is unrolled in front of the backwards-moving equipment. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues. 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. The GCL shall be kept free of debris, unnecessary tools and materials. In general, the GCL area shall remain neat in appearance. All damage shall be recorded and located in the record drawings. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement. The GCL shall be placed so that seams are parallel to the direction of the slope. End-of-roll seams should be located at least 3 feet (1m) from the toe and crest of slopes steeper than 4H:1V. GCL rolls shall **not** be released on the slope and allowed to unroll freely by gravity. All GCL panels shall be placed free of tension or stress and lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels. Similarly, the geomembrane placed over GCL shall lie flat and in contact with the underlying GCL with no wrinkles or fold. The GCL shall not be installed in standing/ponded water, during rainy weather/precipitation, excessive moisture, and during extremely/excessive high wind. Only as much GCL shall be deployed as can be covered at the end of the working day with the geomembrane. In no case shall the GCL be exposed to the elements at the end of the day. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it will be necessary to remove and replace the hydrated material. The Engineer, Construction Observer, and GCL supplier should be consulted for specific guidance if premature hydration occurs. 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 GCL panel, but prior to covering with the geomembrane panel, a thin film plastic sheeting may be used to cover and to temporarily protect the GCL from moisture, if approved by the Engineer.

Panels shall be placed from the highest elevation to the lowest within the area to be lined, to facilitate drainage in the event of precipitation. 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.

As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope. The front edge of the trench should be rounded so as to eliminate any sharp corners. The GCL should cover the entire trench floor but does not extend up the rear trench wall. The amount of trench open at any time shall be limited to one day of GCL installation capacity. The anchor trench shall be adequately drained to prevent water ponding and softening the adjacent soils. Loose soil shall be removed from the floor of the trench. The soil backfill should be placed in the trench to provide resistance against pullout. The size and shape of the trench, as well as the appropriate backfill procedures, should be in accordance with the project drawings and specifications.

The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required for Bentomat® ST.

The minimum dimension of the longitudinal overlap should be 6 inches (150 mm). End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure 24 inches (600 mm). In the opinion of the CQA Engineer/Inspector, 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 (rain lap) from the adjoining GCL panel. 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. 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. All seams constructed on sloped surface shall be vertical seams. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. Bentonite-enhanced seams are constructed between the overlapping adjacent panels described above. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6 inch (150 mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap. The bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot (0.4 kg/m).

Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid irregular tearing of the geotextile components of the GCL during the cutting process. The GCL shall be sealed around penetrations and structures embedded in the subgrade. Granular bentonite or a bentonite mastic shall be used liberally (approximately 2 lbs/in ft or 3 kg/m) to seal the GCL to these structures. When the GCL is placed over an earthen subgrade, a "notch" (approximately 3 inches wide and 8 inches deep) shall be cut against the edge of the subgrade area around the penetration. 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. A secondary collar of GCL should be placed around the penetration. It is helpful to first trace an outline of the penetration on the GCL and then cut a "star" pattern in the collar to enhance the collar's fit to the penetration. Vertical penetrations are prepared by notching into the subgrade. The penetration is completed with two separate pieces of GCL. A secondary collar is option in this case. When the GCL is terminated at a structure or wall that is embedded into the subgrade, the subgrade should be notched as described in Items B and D above. The notch is filled with granular bentonite, and the GCL should be placed over the notch and up against the structure. The connection to the structure can be accomplished by placement of soil or stone backfill in this area.

If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Dry bentonite or bentonite mastic should be applied around the damaged area at the rate of one-half pound per lineal foot prior to placement of the patch. Any epoxy-based adhesives shall be used to keep the patch in position during backfill operations.

Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles [such as 4-wheel all-terrain vehicles (ATV)] may be used to facilitate the installation of any geosynthetic material placed over the GCL, provided the ATV makes no sudden stops, starts, or turns. The GCL supplier or CQA engineer should be contacted with specific recommendations on the appropriate procedures in this situation. When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position. 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 or other ballast. Soil cover shall be placed over the GCL/geomembrane using low ground pressure construction equipment that minimizes stresses on the GCL/geomembrane, according to the existing project specification requirements for protective cover soil installation over geomembrane liner.

3.4.3. <u>Materials and Construction Practices for Flexible Membrane Liner</u>

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

60 mil High Density Polyethylene (HDPE) – Geosynthetic Research Institute (GRI) GM 13 – is to be placed in direct contact with moist cohesive soil liner. The Landfill itself is single lined and will only have a Textured Geomembrane. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner.

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project. Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture. The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds. The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface. No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions which could result in damage to the geomembrane. Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas. The geomembrane will be deployed in a manner to minimize wrinkles. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed. In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The flexible membrane liner will be welded together by fusion and extrusion fillet welding methods. Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge. Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets.

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams may substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day. Fusion Welding is done by first overlapping panels of geomembrane approximately four (4) inches, next clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding. Next, adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths". A movable protective layer may be used, at the discretion of the Flexible Geomembrane Liner System, Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

Extrusion Welding is done by overlapping panels of geomembrane a minimum of three (3) inches and temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane. Next grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼” outside of the extrusion weld area. Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind. Purge the extruder prior to beginning the seam to remove all heat degraded extrudate from the barrel. Keep welding rod clean and off the ground.

At a minimum, test seams shall be made upon each start of work for each seaming crew, upon every four hours of continuous seaming, every time seaming equipment is changed or if significant changes in geomembrane temperature and weather conditions are observed. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams. The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width. Visually inspect the seam for squeeze out, footprint, pressure and general appearance. Two random samples one (1) inch wide shall be cut from the test seam. The specimens shall then be tested in peel using a field tensiometer and shall not fail in the seam. If a specimen fails the entire procedure shall be repeated. If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved. After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting and test results. Passing test results records shall be maintained.

Seaming shall extend to the outside edge of panels to be placed in the anchor trench. While welding a seam, monitor and maintain the proper overlap. Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind. While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly. Align wrinkles at the seam overlap to allow welding through the wrinkle. Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions. All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane. All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind two (2) inches minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

Air pressure testing will be conducted. The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time. An air pump with rubber hose and sharp hollow needle (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi will be used to test the seam. Seal both ends of the seam to be tested. Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld. Inflate the test channel to a pressure between 27 to 30 psi, close valve, and observe initial pressure after approximately 2 minutes. For the 60 mil HDPE liner the seam has to have a minimum initial pressure of 27 psi and a maximum initial pressure of 30 psi. Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize. Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds 3 psi or if the pressure does not stabilize, locate faulty area and repair. At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected. Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

In the event of a Non-Complying Air Pressure Test, check the seam end seals and retest seams. If non-compliance with specified maximum pressure differential re-occurs, repair the seam. When two (2) passing samples are located, the seam between these two (2) locations will be considered non-complying. Capping or removal are the only two (2) acceptable methods of repairing failed seams. Non-destruct test the entire length of the repaired seam.

Vacuum testing will be conducted when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

Vacuum box assembly consists of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, a vacuum gauge, vacuum pump assembly equipped with a pressure controller and pipe connection, a rubber pressure/vacuum hose with fittings and connections, a bucket and means to apply a soapy solution.

The procedure for Vacuum Testing is to trim excess overlap from seam, if any. Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi. Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested. Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner. Close the bleed valve and open the vacuum valve. Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box. Ensure that a leak tight seal is created. For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process. The procedure for Non-Complying Testis to mark all areas where soap bubbles appear and repair the marked areas. Retest repaired areas.

The procedure for Destructive Testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane. All destructive tests will be done according to ASTM D4437. The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications. A one (1) inch sample shall be cut from each end of the test seam for field testing. The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer for peel ASTM D4437. Tensile strength is essentially a measurement of the greatest tension stress a substance can bear without tearing. If the liner tears before any part of the seam does the test is successful. If any field sample fails to pass, it will be assumed the sample fails destructive testing. Destructive samples will be taken every 500 ft. of seam.

In the event of Destructive Test Failure, cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing. All destructive seam samples sent to the Flexible Membrane Liner System's laboratory shall be numbered. If the laboratory samples pass then repair the seam between the two (2) passing samples locations. All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken. Capping or removal of the failed seam are the only two (2) acceptable methods for repairing failed seams.

The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation. All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely matter to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil liner such as a temporary cover. If cohesive soil liner is damaged, it must be reworked. Procedures available for repair are (1)Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded, (2) Grinding and welding - used to repair sections of extruded seams, (3) Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws, (4) Capping - used to repair lengths of failed seams, (5) Removal of a bad seam and replacement with a strip of new material seamed into place.

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

3.5 HDPE Double Bonded Drainage Net

3.5.1 Materials and Construction Practices

The geonets will be handled in such a manner as to ensure the geonets are not damaged in any way. On slopes, the geonets will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet will be positioned by hand after being unrolled to minimize wrinkles. Geonets can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geonets will not be welded to the geomembrane. Geonets will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geonet that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geonet will be overlapped by at least four inches and securely tied. Tying can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one foot intervals. In the corners of the side slopes where overlaps between perpendicular geonet strips are required, an extra layer of geonet will be unrolled along the slope, on top of the previously installed geonets, from the top to bottom of the slope.

Any holes or tears in the geonet will be repaired by placing a patch extending two feet beyond edges of the hole or tear. The patch will be secured to the original geonet by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geonet will be joined.

3.6 Protective Cover

3.6.1. Materials and Construction Practices

The soil for the select site backfill shall consist of suitable site soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension, which has been screened. No permeability, grain size, or other tests are required for this material. This material is not being used as a drainage media, leachate collection lines are installed every one hundred feet and designed to collect water flowing on top of the protective cover.

Leachate that may permeate thru the protective cover will flow into the composite geonet. The velocity of the leachate thru the protective cover will not adequate to carry sediment. However, the geotextiles that are bonded to the drainage net are intended to filter out sediment so that it will clog the geonet. The Apparent Opening Size (AOS) of the geotextile is large enough to let water pass but small enough to filter out soil particles greater than the number 100 sieve or 0.15 mm.

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The protective cover shall be composed of select backfill and backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

A minimum of 12 inches of cover between low ground pressure equipment such as the Caterpillar D6H LGP, or approved equal, and the liner is required at all times. Roadways for entering and for transporting material over slopes and floor shall have a minimum depth of four feet. Avoid undue stress on the liner at all times. Cover material must be pushed up side slopes, never down to help minimize wrinkles. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Material must be placed to minimize wrinkles, wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner. If damage does occur, report it to the Project Manager immediately so that repairs can be performed without needless delay. Cover shall be placed and maintained in a uniform thickness, free of ruts and irregularities. Do not work wet cover material that cannot support equipment. Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

3.7 Liner Tie-In

3.7.1. Materials and Construction Practices

The edge of the existing HDPE liner shall be exposed. The HDPE liner will be rolled back to expose the cohesive soil. The existing cohesive soil will be keyed into to each subsequent lift of the next phase's cohesive soil. If geosynthetic clay liner (GCL) is used, the GCL shall cover the keyed in area of both the existing and new cohesive soil liners and be in direct contact with the existing and new HDPE liners.

The new HDPE liner shall be overlapped over the existing HDPE liner and an extrusion or fusion weld completed along the entire length of the overlapped liners at the tie in and then non-destructively tested. Once the extrusion weld has been completed, a three foot cap will be placed over entire tie in seam and the seams non-destructively tested.

3.8 Leachate Collection System

3.8.1. Materials and Construction Practices

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications, or shall be the product of the listed manufacturers, or similar and equal; thereto, as approved by the Engineer.

The Leachate Collection System consists of No. 5 stone, 4.5 oz. Non-woven Geotextile fabric, and SDR 17 HDPE pipe will be used in the construction of the Leachate Collection System.

A 2' wide by 3' deep trench will be dug out of the protective cover as indicated on the operation drawings located in section 5 of this document. Excavation for the leachate collection shall be done only after the three foot of protective cover has been installed over the flexible membrane liner. Mechanical equipment can be used for the first two and one-half feet of excavation. The remaining one-half foot or whatever protective cover remains above the flexible membrane liner shall be excavated by hand so as to not damage the liner. If damage occurs to the liner the Engineer or Owner shall be notified immediately and the repair shall take place shortly thereafter.

The 4.5oz non-woven geotextile fabric will be placed in the trench such that it can completely surround the trench. No. 5 stone will be placed at a depth of 2” in the whole length of the trench. Next the butt fused perforated SDR 17 6” or 8” HDPE pipe will be placed on top of the 2” thick stone and then covered with the No. 5 stone. After the placement of the stone the 4.5oz geotextile will be closed over top of the trench. All the leachate collection pipe, as shown on the operation drawings, is connected in a way such that all leachate runs to the low spot in the landfill where it will be gravity fed into the sewer line.

Butt Fusion for HDPE pipe. Clean pipe ends inside and outside with a clean cloth to remove dirt, water, grease and other foreign materials. Square (face) the pipe ends using facing tool of the fusion machine. Check line-up of pipe ends in fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. This is commonly referred to as "adjusting high-low". It is advisable at this point to make sure the clamps are tight so that the pipe does not slip during the fusion process. Insert clean heater plate between aligned ends, and bring ends firmly in contact with plate, but do not apply pressure while achieving melt pattern. Carefully move the pipe ends away from the heater plate and remove the plate. (If the softened material sticks to the heater plate, discontinue the joint. Clean heater plate, re-square pipe ends and start over.)

Note: One pipe end usually moves away from the heater plate first. It is good practice to "bump" the plate away from the other side and then lift it out. Never drag or slide it over the melted pipe end.
Bring melted ends together rapidly. Do not slam. Apply enough pressure to form a double roll back to the body of the pipe brad around the entire circumference of the pipe about 1/8" to 3/16" wide. Pressure is necessary to cause the heated material to flow together. Allow the joint to cool and solidify properly. This occurs when the brad feels hard and your finger can remain comfortably on the brad. Remove the pipe from the clamps and inspect the joint appearance.

Knife Gate Valves will be placed in several places to control storm water and leachate as indicated in the operation drawings.

3.9 Sewer Line

3.9.1. Materials and Construction Practices

The sewer line consists of a SDR 17 HDPE dual containment pipe, 8” carrier by 12” containment, Polyethylene manholes are placed along the sewer line. The sewer line runs to the Leachate Lagoon where it is aerated as needed, recirculated or pumped to its appropriate location.

All Gravity Flow Pipeline shall be installed using a laser for control of vertical and horizontal alignment. The Contractor shall follow accepted practices in the utilization of the laser. A certified laser operator shall be present on the job at all times. Care shall be exercised to assure that the alignment control range of the instrument is not exceeded; but in no case, shall the range exceed 500 feet. Care shall be taken to prevent vibration of or direct sunlight on the instrument. Where present, a blower shall be provided to purge glue vapors from the pipe. An air velocity meter shall be provided so that the velocity of air in the pipe will not be great enough to cause the light beam to be distorted. The Contractor shall coordinate the work to minimize the number of take downs and set ups at each point. Periodic checks of the laser shall be made to assure that alignment is maintained.

Each pipe shall be laid on an even, firm bed, so that no uneven strain will come to any part of the pipe. Before each piece of pipe is lowered into the trench, it shall be thoroughly inspected to insure its being clean. Each piece of pipe shall be lowered separately. No piece of pipe or fitting which is known to be defective, shall be laid or placed in the lines. If any defective pipe or fitting shall be discovered after the pipe is laid it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe.

Butt Fusion for HDPE pipe. Clean pipe ends inside and outside with a clean cloth to remove dirt, water, grease and other foreign materials. Square (face) the pipe ends using facing tool of the fusion machine. Check line-up of pipe ends in fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. This is commonly referred to as "adjusting high-low". It is advisable at this point to make sure the clamps are tight so that the pipe does not slip during the fusion process. Insert clean heater plate between aligned ends, and bring ends firmly in contact with plate, but do not apply pressure while achieving melt pattern. Carefully move the pipe ends away from the heater plate and remove the plate. (If the softened material sticks to the heater plate, discontinue the joint. Clean heater plate, re-square pipe ends and start over.)

Note: One pipe end usually moves away from the heater plate first. It is good practice to "bump" the plate away from the other side and then lift it out. Never drag or slide it over the melted pipe end.

Bring melted ends together rapidly. Do not slam. Apply enough pressure to form a double roll back to the body of the pipe brad around the entire circumference of the pipe about 1/8" to 3/16" wide. Pressure is necessary to cause the heated material to flow together. Allow the joint to cool and solidify properly. This occurs when the brad feels hard and your finger can remain comfortably on the brad. Remove the pipe from the clamps and inspect the joint appearance.

HDPE Dual Containment Force main - ASTM D3350. All HDPE pipe shall be tested at its rated working pressure. In no case shall there be any visible leakage, nor shall there be leakage between any section of pipe.

3.10 Closure Cohesive Soil Cap

3.10.1. Materials and Construction Practices

All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

The soil for the cohesive soil cap shall consist of on-site soils if a permeability of 1.0 x 10^{-5} cm/sec or less is achieved. Off-site cohesive soils may be used if approved by the Engineer and provides a permeability of 1.0 x 10^{-5} cm/sec or lower Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

A permeability “window” shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil cap. The window shall be plotted on a semi-log plot with moisture content versus density. Laboratory testing to develop the window shall include a series of remolded samples compacted to various dry densities and moisture contents utilizing the same compactive effort (ASTM D 698 or D 1557). The remolded samples shall be tested for permeability to determine whether or not the particular soil type will provide the maximum permeability (1.0 x 10^{-5} cm/sec) at various dry densities and moisture contents. The window is then developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

A test strip of compacted cohesive soil cap shall be prepared to verify the permeability “window” prior to general installation of the cohesive soil cap. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil cap. At a minimum, the verification will consist of three moisture density tests, one Atterberg limits test, one grain size distribution test (ASTM D2487, D4318, and D422), and one Shelby Tube sample for each lift constructed in the test pad. Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 x10^{-5}cm/sec. Tests shall be performed in accordance with the ASTM D5084. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least three compacted 6 inch lifts of cohesive soil cap. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil cap. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeability of 1.0 x 10^{-5} cm/sec of the cohesive soil cap. The test strip may be used as an integral part of the overall cohesive soil cap if it meets the required specification for the cap. All results shall be given to the Construction Observer (CO).

After the test strip passes, soil will be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift. A sheepsfoot roller or approved alternative may be used to compact the soil cap provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil cap shall be screened, disked, or prepared using any other, approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. The clay cap must be a minimum of 1.5 feet thick. No additional construction shall proceed on the soil cap at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved. If the soil for the cohesive soil cap is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory.

The thickness and grade of the clay cap will be verified by the Engineer before placement of the geomembrane liner. The thickness and grade will be verified by surveying the cap at 50' grid points where the elevations of the subbase will be checked with the top of soil cap to verify 1.5 feet of cap. The grade will then be verified with the surveyed information. The survey will be performed by NC licensed surveyors.

Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil cap shall have no sudden sharp or abrupt changes in grade. The Contractor shall protect the cohesive soil cap from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil cap until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions will be replaced or reworked by the contractor to remove these defects.

The anchor trench shall be excavated by the Contractor to lengths and widths shown on the design drawings prior to geomembrane placement. Anchor trenches excavated in clay soils susceptible to desiccation cracks should be excavated only the distance required for that days liner placement to minimize the potential of desiccation cracking of the clay soils. Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil cap and the surface shall remain the responsibility of the contractor.

3.11 Closure Flexible Membrane Liner

3.11.1 Materials and Construction Practices

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

40 mil Linear Low Density Polyethylene (LLDPE) – Geosynthetic Research Institute (GRI) GM 17 – is to be placed in direct contact with moist cohesive soil cap. The extrusion cap and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner.

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project. Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture. The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds. The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface. No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions which could result in damage to the geomembrane. Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas. The geomembrane will be deployed in a manner to minimize wrinkles. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed. In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The flexible membrane liner will be welded together by fusion and extrusion fillet welding methods. Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge. Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets.

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams may substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day. Fusion Welding is done by first overlapping panels of geomembrane approximately four (4) inches, next clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding. Next, adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths". A movable protective layer may be used, at the discretion of the Flexible Geomembrane Liner System, Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

Extrusion Welding is done by overlapping panels of geomembrane a minimum of three (3) inches and temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane. Next grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area. Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind. Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel. Keep welding rod clean and off the ground.

Test seams shall be performed at the beginning of each seaming period and at approximately every 4-working hour intervals for each seaming apparatus used that day. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams. The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width. Visually inspect the seam for squeeze out, footprint, pressure and general appearance. Two random samples one (1) inch wide shall be cut from the test seam. The specimens shall then be tested in peel using a field tensiometer and shall not fail in the seam. If a specimen fails the entire procedure shall be repeated. If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved. After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting and test results. Passing test results records shall be maintained.

Seaming shall extend to the outside edge of panels to be placed in the anchor trench. While welding a seam, monitor and maintain the proper overlap. Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind. While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly. Align wrinkles at the seam overlap to allow welding through the wrinkle. Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions. All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane. All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind two (2) inches minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

Air pressure testing will be conducted. The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time. An air pump with rubber hose and sharp hollow needle (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi will be used to test the seam. Seal both ends of the seam to be tested. Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld. Inflate the test channel to a pressure between 25 to 30 psi, close valve, and observe initial pressure after approximately 2 minutes. For the 40 mil LLDPE liner the seam has to have a minimum initial pressure of 25 psi and a maximum initial pressure of 30 psi. Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize. Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds 4 psi or if the pressure does not stabilize, locate faulty area and repair. At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected. Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

In the event of a Non-Complying Air Pressure Test, check the seam end seals and retest seams. If non-compliance with specified maximum pressure differential re-occurs, repair the seam. When two (2) passing samples are located, the seam between these two (2) locations will be considered non-complying. Capping or removal of the non-complying seam are the only two (2) acceptable methods for repairing failed seams. Non-destruct test the entire length of the repaired seam.

Vacuum testing will be conducted when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

Vacuum box assembly consists of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, a vacuum gauge, vacuum pump assembly equipped with a pressure controller and pipe connection, a rubber pressure/vacuum hose with fittings and connections, a bucket and means to apply a soapy solution.

The procedure for Vacuum Testing is to trim excess overlap from seam, if any. Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi gauge. Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested. Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner. Close the bleed valve and open the vacuum valve. Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box. Ensure that a leak tight seal is created. For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process. The procedure for Non-Complying Test is to mark all areas where soap bubbles appear and repair the marked areas. Retest repaired areas.

The procedure for Destructive Testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane. All destructive tests will be done according to ASTM D4437. The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications. A one (1) inch sample shall be cut from each end of the test seam for field testing. The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer for peel ASTM D4437. Tensile strength is essentially a measurement of the greatest tension stress a substance can bear without tearing. If the liner tears before any part of the seam does, the test is successful. If any field sample fails to pass, it will be assumed the sample fails destructive testing. Destructive samples will be taken every 500 ft. of seam.

In the event of Destructive Test Failure, cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing. All destructive seam samples sent to the Flexible Membrane Liner System's laboratory shall be numbered. If the laboratory samples pass then repair the seam between the two (2) passing samples locations. All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken. Capping or removal of the failed seam is the only two (2) acceptable methods for repairing failed seams.

The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation. All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely matter to protect the moist cohesive soil cap and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil cap such as a temporary cover. If cohesive soil cap is damaged, it must be reworked. Procedures available for repair are (1) Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded, (2) Grinding and welding - used to repair sections of extruded seams, (3) Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws, (4) Capping - used to repair lengths of failed seams, (5) Removal of a bad seam and replacement with a strip of new material seamed into place.

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

3.12 <u>Closure HDPE Double Bonded Drainage Net</u>

3.12.1 <u>Materials and Construction Practices</u>

The geonets will be handled in such a manner as to ensure the geonets are not damaged in any way. On slopes, the geonets will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet will be positioned by hand after being unrolled to minimize wrinkles. Geonets can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geonets will not be welded to the geomembrane. Geonets will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geonet that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geonet will be overlapped by at least four inches and securely tied. Tying can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one foot intervals. In the corners of the side slopes where overlaps between perpendicular geonet strips are required, an extra layer of geonet will be unrolled along the slope, on top of the previously installed geonets, from the top to bottom of the slope.

Any holes or tears in the geonet will be repaired by placing a patch extending two feet beyond edges of the hole or tear. The patch will be secured to the original geonet by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geonet will be joined.

3.13 Closure Protective Cover

3.13.1 Materials and Construction Practices

The soil for the select site backfill shall consist of suitable site soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension, which has been screened. No permeability, grain size, or other tests are required for this material.

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The protective cover shall be composed of 24” of select backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

A minimum of 12 inches of cover between low ground pressure equipment such as the Caterpillar D6H LGP, or approved equal, and the liner is required at all times. Roadways for entering and for transporting material over slopes and floor shall have a minimum depth of four feet. Avoid undue stress on the liner at all times. Cover material must be pushed up side slopes, never down to help minimize wrinkles. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Material must be placed to minimize wrinkles, wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner. If damage does occur, report it to the Project Manager immediately so that repairs can be performed without needless delay. Cover shall be placed and maintained in a uniform thickness, free of ruts and irregularities. Do not work wet cover material that cannot support equipment. Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

3.14 Closure Methane Venting System

3.14.1 Materials and Construction Practices

The Methane Gas Venting System will consist of No. 5 stone, 8 oz. Geotextile fabric, and 8" PVC pipe will be used in the construction of the Gas venting system.

A 2’ wide by 1’ deep trench will be dug out of the intermediate cover as indicated on the operation drawings located in section 5 of this document. An 8 oz. geotextile fabric will be placed inside the trench such that it can completely surround the trench. No. 5 stone will be placed solely in the whole length of the trench except for the first 10’ in all directions of the 10” PVC solid walled vent pipe, where 8” PVC pipe shall be placed and covered with the No. 5 stone. After the placement of the stone the 8oz geotextile will be closed over top of the trench.

SECTION 4.0

CONSTRUCTION QUALITY ASSURANCE PLAN

4.1 Introduction

The Division of Waste Management requires that the Engineer certifies the constructed landfill is built according to approved plans and specifications. The Engineer that will accomplish this task is the one who did the planning and has written the specifications.

Before construction can begin a pre-construction meeting will be held and the responsibilities and duties of each party will be discussed.

The parties involved in the construction of the landfill are the Owner, Contractor and Engineer. The Contractor is contractually responsible to the Owner. The Engineer is the Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of the Engineer as the Owner's representative are set forth in the Contract Document and will not be changed without written consent of the Owner and Engineer.

The Contactor will purchase and supply all materials that are part of the landfill construction. They will employ subcontractors who will install and non-destructively test all flexible membrane liners. They will also employ a North Carolina licensed geotechnical engineer and land surveyor. The geotechnical engineer will test, report and certify the results for all structural and cohesive soils that are incorporated in the landfill. The surveyor will report and certify elevations of the as-built sub-grade, top of clay and protective cover.

The Contractor is responsible for following and meeting the requirements set forth in the contract documents. The Contractors will provide to the Owner of the landfill and the Engineer a completed landfill constructed by Division of Waste Management approved plans and specifications. The Contractor will give the Engineer a schedule for completion of the landfill including dates for expected construction of the clay test pad, base liner system installation, installation of protective cover, installation of leachate collection system, construction of final cover system, gas venting system and estimated time for project completion. The contractor is responsible for providing a foreman to remain on site at all times during construction, provide qualified personnel to conduct quality control, scheduling and coordinating the subcontractors, provide progress reports and as-built drawings, and coordinating construction activities with the Engineer. The foreman is responsible for supervising and coordinating with his crew, subcontractors, quality control personnel, attending all meetings and notifying the Engineer's Construction Observer when any discrepancies occur. The Contractor will meet with the Construction Observer on a daily basis to discuss the days construction activities. The results of all tests and any change in schedule shall be given to the Construction Observer as soon they are known by the contractor. The Contractor must be registered in the state of North Carolina.

As the owner's representative, the Engineer will employ the onsite construction observer. The Engineer will also employ all third party laboratories for conformance testing of the geosynthetics, destructive flexible membrane liner tests and random cohesive soil permeability tests.

The Engineer is responsible for providing the engineering design, drawings and specifications, contract documents and CQA needed for construction of the landfill. The Engineer is responsible for conduction of the pre-construction meeting, which will lay out the foundation for the project. The Engineer will approve any design changes and certify to the Division of Waste Management that the landfill was constructed according to the requirements of Rule .1621 Construction Quality Assurance Plan and .1624 Construction requirements for MSWLF Facilities, and Division approved plans and specifications. This will be accomplished by on site observation, independent laboratory soil testing to test site specific soil properties including permeability and independent material testing laboratories for destructive testing of the flexible membrane liner. The Engineer will be providing Quality Assurance by spot testing alongside the contractor, who will be providing the Quality Control. The Engineer will certify that the construction was completed in accordance with the CQA manual. The Engineer must be a professional engineer registered in North Carolina

The Construction Observer (CO) is the Engineer's representative on-site. It is the CO's responsibility to know and interpret the plans and specifications of the project. On a daily basis the CO will coordinate with the Foreman to help ensure a quality product for the Owner. The CO will keep a daily log on the activities of the Contractor, keep notes on all meetings, and handle all quality assurance activities indicated in this document.

The CO will keep a log of all material delivered on site and ensure the materials meets or exceeds the specifications indicated in this report. If the need arises additional meetings will be scheduled as seen fit by the CO.

4.2 Inspection Activities and Sampling Strategies

4.2.1. Base Liner System Subbase

The fill subgrade will be placed in 8" loose lifts and compacted to at least 95% of maximum dry density and near optimum moisture contents; as determined by Standard Proctor Compaction Test (ASTM D698) in 6" compacted lifts. No aggregate particles greater than 6" in any direction will be allowed in the subgrade or berm/embankment. Each compacted lift will be tested at one test per six inch (6") lift for each 200 lineal feet or fraction thereof of compacted berm(s) less than 50 feet in base width and one test per six (6) inch lift for each 10,000 square feet or fraction thereof of compacted mass fill. If an area fails, it shall be recompacted, reworked or replaced and retested.

Before beginning construction of the base liner system, the Engineer shall visually inspect the exposed surface to evaluate the suitability of the subgrade and document that the surface is properly prepared and that the elevations are consistent with the Division approved engineering plans. The elevations will be verified from survey data based on a 50 foot grid across the subbase.

At a minimum, the subgrade shall be proof-rolled at cut sections utilizing a fully loaded tandem dump truck or equivalent. If movement of the subbase is observed under the tires, the section of movement will be removed and replaced with suitable fill material. This newly placed fill material will then be tested for proper density and moisture.

4.2.2 Base Liner System Cohesive Soil Liner

All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Cohesive Soil Liner Borrow Material

Test Name	Test Method	Contractor/Engineer Frequency
Moisture/Density	ASTM D698/D1557	1 per 5000 c.y.
Remolded Permeability	ASTM D5084	1 per 5000 c.y.
Atterberg Limits	ASTM D4318	1 per 5000 c.y.
Visual Classification	ASTM D2487	1 per 5000 c.y.
Grain Size Distribution	ASTM D422	1 per 5000 c.y.

Cohesive Soil Liner Test Pad

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	3 per lift
Permeability	ASTM D5084	1 per lift
Remolded Permeability	ASTM D5084	1 per lift
Atterberg Limits	ASTM D4318	1 per lift
Visual Classification	ASTM D2487	1 per lift
Grain Size Distribution	ASTM D422	1 per lift

In-Place Cohesive Soil Liner

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	1 per lift per acre
Permeability	ASTM D5084	1 per lift per acre
Atterberg Limits	ASTM D4318	1 per lift per acre
Visual Classification	ASTM D2487	1 per lift per acre
Grain Size Distribution	ASTM D422	1 per lift per acre

(a) Suitable on-site and/or off-site soils may be used as cohesive soil liner if it can achieve an in-place permeability of 1.0 x 10^{-7} cm/sec or less for the base liner system or 1.0 x 10^{-5} cm/sec or less for the alternate base liner system and meets all testing requirements indicated in the material testing paragraph in this section. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

(b) A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil liner. The window shall be plotted on a semi-log plot with moisture content versus density. Laboratory testing to develop the window shall include a series of remolded samples compacted to various dry densities and moisture contents utilizing the same compactive effort (ASTM D 698 or D 1557). The remolded samples shall be tested for permeability to determine whether or not the particular soil type will provide the maximum permeability (1.0 x 10^{-7} cm/sec or 1.0 x 10^{-5} cm/sec) at various dry densities and moisture contents. The window is then developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

(c) Atterberg limits and grain size distribution shall also be conducted on the bulk samples used to prepare the permeability window ASTM D2487, D4318, D422. These tests can be used as indices on random samples collected from the borrow site during construction to verify the soil type is the same as was used to develop the "window". As a minimum, sufficient visual classifications and Atterberg limits shall be conducted in association with each permeability test to verify that the construction materials meet specifications.

(d) A test strip of compacted cohesive soil liner shall be prepared to verify the permeability "window" prior to general installation of the cohesive soil liner. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil liner. At a minimum, the verification will consist of three moisture density tests, one Atterberg limits test, one grain size distribution test (ASTM D698, ASTM D2487, D4318, and D422), and one Shelby Tube sample for each lift constructed in the test pad. Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil liner after placement and compaction. The permeability must be a maximum of 1.0 x10^{-7}cm/sec or 1.0 x10^{-5} cm/sec for alternate liner systems. Tests shall be performed in accordance with the ASTM D5084. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least four compacted 6 inch lifts of cohesive soil liner. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil liner. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeabilities of the cohesive soil liners. The test strip may be used as an integral part of the overall cohesive soil liner if it meets the required specification for the liner. All results shall be given to the Construction Observer.

(e) The soils shall be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift compacted preferably at a moisture content between 0 to 3% above optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698). A sheepsfoot roller or approved alternative may be used to compact the soil liner provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil liner shall be screened, disked, or prepared using any other approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. After each lift, the surface shall be scarified prior to the placement of the next lift to provide good bonding from one lift to the next.

(f) The cohesive soil liner shall be tested to evaluate the coefficient of permeability. The coefficient of permeability of the soil liner shall be equal to or less than 1.0×10^{-7} cm/sec (1.0×10^{-5} cm/sec for alternate base liner) after placement and compaction. The soil liner must be a minimum of 2.0 feet thick (1.5 feet thick for alternate base liner).

(g) Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil liner after placement and compaction. The permeability must be a maximum of 1.0×10^{-7} cm/sec (1.0×10^{-5} cm/sec for alternate base liner). Tests shall be performed in accordance with the ASTM D5084 with a hydraulic gradient of 20 and confining pressure of 10 psi.

(h) The soil liner shall be tested a minimum of one soil sample per lift per acre for laboratory permeability. All permeability testing will be on random samples judged by the Engineer to be representative of the most permeable soil conditions for the area being tested. The Engineer shall certify that the materials used in construction were tested according to the Division approved plans. If after placement of the soil liner it fails the required tests, the material will either be reworked or replaced and retested. The soil liner must remain moist at all times, if any section becomes dry, rework the dry area and moisten.

(i) A minimum of two (2) inches of soil shall be removed prior to securing each sample for permeability testing. The sampling tube shall be advanced vertically into the soil with as little soil disturbance as possible and should be pushed using a uniform pressure. The sampling tube (Shelby tube), when extracted, shall be free of dents, and the ends shall not be distorted. A backhoe or approved alternative should be used to advance the sampling tube (Shelby tube) as long as disturbance is minimized. Drive tube samples of the liner may be obtained for permeability testings. If the Engineer judges the sample to be too disturbed, another sample shall be taken. Once an acceptable sample has been secured and properly prepared, all sample excavations or other holes created by survey stakes, etc. shall be backfilled to grade with a 50% mixture of bentonite and similar soils in maximum 3-inch loose lifts and hand tamped with a blunt tool to achieve a tight seal equivalent to the original density.

(j) No additional construction shall proceed on the soil layers at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved.

(k) As a minimum, sufficient visual classifications (ASTM Test Designation D2487), gradation analyses (ASTM Test Designation D422) and Atterberg limits (ASTM Test Designation D4318) shall be conducted in association with each permeability test to verify that the construction materials meet specifications. The minimum number of tests will be 1 per lift per acre.

(l) If the soil for the cohesive soil liner is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory and mixed in the field using either a plug mill or a soil stabilizer. Where additives are required, the soil shall be placed in maximum 8-inch thick loose lifts and compacted preferably between 0 to +3% optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698) for the soil-additive mixture. All other compaction procedures for the soil apply.

(m) Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil liner shall have no sudden sharp or abrupt changes in grade such as tire ruts.

(n) The Contractor shall protect the cohesive soil liner from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil liner until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions shall be replaced or reworked by the contractor to remove these defects. Areas where the cohesive soil has been replaced, desiccation cracks and/or heaving is deeper than two (2) inches shall be retested.

(o) The thickness and grade of the soil liner will be verified by the surveyor before placement of the geomembrane liner. The soil liner will be surveyed at 50' grid points where the elevations of the subbase will be checked with the top of soil liner to verify 2.0 feet of soil liner (1.5 feet of soil liner for the alternate base liner). The grade will then be verified with the surveyed information. The survey will be performed by NC licensed surveyors.

(p) The anchor trench shall be excavated by the Contractor to lengths and widths shown on the design drawings prior to geomembrane placement. Anchor trenches excavated in cohesive soils susceptible to desiccation cracks should be excavated only the distance required for that days liner placement to minimize the potential of desiccation cracking of the cohesive soils. Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

(q) The tie in of the cohesive soil to the adjoining Phases will be stepped into the adjoining cohesive soil as the lifts of the constructed Phase are being compacted. The flexible membrane liner and drainage net will be folded back so that the adjoining cohesive liner is exposed so that the tie in can be completed.

(r) Surface Acceptance. Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil liner and the surface shall remain the responsibility of the contractor.

4.2.3 Alternate Base Liner System Specifications

(1) General

(1.1) General

This specification covers the technical requirements for the furnishing and installation of the Geosynthetic Clay Liner (GCL) described herein. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the contract drawings.

The Contractor shall furnish all labor, materials, supervision and equipment to complete the installation of the GCL, including, but not limited to, liner layout, seaming, patching, and all necessary and incidental items required to complete the Work, in accordance with the Contract Drawings and these Specifications.

Sufficient liner material shall be furnished to cover all lined areas shown on the Drawings, including overlaps at field seams and anchor trenches.

It is the intent of these Specifications to ensure a quality finished product. It shall be the responsibility of the Contractor to ensure that this requirement is met.

(1.2) Definitions

For the purposes of this specification guideline, the following terms are defined below:

Geosynthetic Clay Liner (GCL) - A manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetics. The GCL may be reinforced or unreinforced as required by site conditions. This site will require reinforced GCL over the entire area.

Geomembrane - An essentially impermeable geosynthetic composed of one or more geosynthetic sheets.

Geotextile - Any permeable textile used with foundation, soil, rock, earth, or any other geotechnical engineering related material as an integral part of a human-made project, structure, or system.

Minimum Average Roll Value - The minimum average value of a particular physical property of a material, for 95 percent of all the material in the lot.

Overlap - Where two adjacent GCL panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

(1.3) Submittals/Qualifications

A. The GCL Manufacturer must have produced at least 10 million square feet (1 million square meters) of GCL, with at least 8 million square feet (800,000 square meters) installed. The manufacturer shall submit certification that GCL manufactured for the Project has been produced in accordance with these Specifications along with results from a quality control program. This information must be submitted for review prior to material delivery. The Engineer reserves the right to halt installation until proper certification is submitted and determined acceptable for use.

B. The Contractor shall submit to the Engineer, six (6) full sets of panel layout construction drawings. Drawings shall be submitted to the Engineer at least two (2) weeks prior to installation.

C. The manufacturer of the GCL used in this work shall approve all shop drawings and a proposed liner layout to cover the lined area shown on the Drawings.

D. Details shall be included to show the termination of the liner at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring. A specific anchor trench detail shall be provided.

E. The Contractor shall submit to the Engineer a physical sample of the liner to be used. The sample shall be labeled with the manufacturer's name, product identification, lot number and roll number.

F. Upon shipment, the Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification. The Contractor shall also submit to the Engineer inventory tickets, roll numbers or batch identifications, packing papers, and invoices for the liner used.

G. As installation proceeds, the Contractor shall submit certificates of subgrade acceptance to the Engineer, signed by the Contractor and the GCL Installer for each area that is covered by the GCL.

H. The Contractor shall provide personnel resumes demonstrating compliance with the following requirements.

4. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million square feet (100,000 square meters) in size.

5. A minimum of one field superintendent per shift shall be designated by the Contractor and approved by the Engineer. Each field superintendent shall have a minimum of three years and five million square feet of field experience in installing GCL's. Any change or replacement of superintendent during the Project must be approved by the Engineer.

6. Liner placement technicians shall have a minimum of one year and one million square feet of GCL placement experience.

(1.4) <u>Construction Quality Assurance (CQA)</u>

A. The Engineer shall provide an construction observer (CO) for CQA of the GCL installation. The inspector shall be responsible for observing and documenting activities related to the CQA of the GCL. The contractor shall not install any GCL on this project, at any time, in the absence of the CQA construction observer.

B. Testing of the GCL, as necessary to support the CQA effort, shall be performed by a third party laboratory retained by the Engineer and independent from the GCL manufacturer and installer. The laboratory shall be accredited by the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP).

(2) <u>Products</u>

(2.1) <u>General</u>

A. The GCLs shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles and shall comply with all of the criteria listed in this Section. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Contractor also must obtain prior approval of the alternative GCL by the Engineer.

B. Reinforced GCL must be used on all areas of the site.

(2.2) <u>Materials</u>

A. An acceptable GCL product is Bentomat® ST as manufactured by CETCO or an engineer-approved equal.

B. All areas of the project requiring reinforced GCL will be furnished with Bentomat® ST or an engineer-approved equal.

C. The GCL(s) and their components shall have the properties shown in the attached CETCO's Technical Data Sheet (TR404bm).

D. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7m) in length and 15 feet (4.6m) in width for Bentomat. Short rolls [(those manufactured to a length greater than 70 feet (21m) but less than a full-length roll)] may be supplied at a rate of no greater than 3 per truckload or 3 rolls for every 36,000 square feet (3,500 square meters) of GCL, whichever is less.

E. A 6-inch (150mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

(2.3) <u>Product Quality Documentation</u>

The GCL manufacturer/Contractor shall provide the Engineer with manufacturing QA/QC certifications for each shipment of GCL, prior to the deployment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager, and shall include:

A. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the parameters swell index and fluid loss shown in CETCO's Technical Data Sheet TR404bm.

B. Manufacturer's test data for finished GCL products(s) of bentonite mass/area, GCL tensile strength, and GCL peel strength demonstrating compliance with the index parameters shown in CETCO's Technical Data Sheet TR404bm.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

D. Manufacturer's test data for finished GCL product(s) including GCL index flux, permeability, and hydrated internal shear strength data demonstrating compliance with the performance parameters shown in CETCO's Technical Data Sheet TR404bm.

BENTOMAT® ST CERTIFIED PROPERTIES

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY $ft^2(m^2)$	REQUIRED VALUES
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes	24 ml/2g min.
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes	18 ml max.
Bentonite Mass/Area[2]	ASTM D 5993	40,000 ft^2 (4,000 m^2)	0.75 lb/ft^2 (3.6 kg/m^2) min
GCL Tensile Strength[3]	ASTM D 6768	200,000 ft^2 (20,000 m^2)	30 lbs/in (53 N/cm) MARV
GCL Peel Strength[3]	ASTM D 6496	40,000 ft^2 (4,000 m^2)	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux[4]	ASTM D 5887	Weekly	1×10^{-8} m^3/m^2/sec max
GCL Hydraulic Conductivity[4]	ASTM D 5887	Weekly	5×10^{-9} cm/sec max
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321 ASTM D 6243	Periodic	500 psf (24 kPa) typ @ 200 psf

Bentomat ST is a reinforced GCL consisting of a layer of granular sodium bentonite between woven and nonwoven geotextiles, which are needlepunched together.

Notes

[1] Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.
[2] Bentonite mass/area reported at 0 percent moisture content.
[3] All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.
[4] Index flux and permeability testing with deaired distilled/deionized water at 80 psi (551kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5×10^{-9} cm/sec for typical GCL thickness. Actual flux values vary with field condition pressures. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.
[5] Peak values measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

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(2.4) Material Conformance Testing

The Engineer/Contractor shall perform the material conformance tests listed in Table 1.

Table 1: QA Testing Program for GCL Material Conformance

PROPERTY	TEST METHOD	UNITS	VALUE[1]	TEST FREQUENCY
Hydraulic Conductivity	ASTM D5084[2]	cm/s	$\leq 5.0 \times 10^{-9}$	100,000 ft^2
Bentonite Content	ASTM D3776[3]	psf	0.75 (@0% moisture)	100,000 ft^2
Thickness	ASTM D1777	inch	0.20	100,000 ft^2
Grab Tensile Strength	ASTM D4632	lbs	90	100,000 ft^2
Interface Friction Test	ASTM D5321[6]	degrees	≥ 26.0[4]	2
Interface Friction Test	ASTM D5321[6]	degrees	≥ 21.0[5]	2
Shear Strength	ASTM D5321	psf	500	2

[1] Minimum Average Roll Values (MARV).
[2] Conduct test at 5 psi effective stress.
[3] Alternatively, use ASTM D5993 for measuring the mass per unit area of GCL.
[4] GCL against the soil liner (peak value).
[5] GCL (woven geotextile) against the textured FML (peak value).
[6] Conduct test at 3 psi effective stress and hydrate the GCL.

Samples for material conformance testing shall be obtained upon delivery of the GCL. Samples shall be taken across the entire width of the roll. Samples shall be 1 foot to 3 feet long by the roll width. All material conformance testing shall be performed by a third party Geosynthetics Laboratory retained by the Engineer. All test results must be available at the Engineer's office prior to the deployment of any GCL roll at the site. The Engineer will examine all results from laboratory testing.

(2.5) Product Labeling

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand name, product code).
2. Lot number and roll number.
3. Roll length, width, and weight.

(2.6) <u>Packaging</u>

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photo degradation by ultraviolet (UV) light.

(2.7) <u>Accessory Bentonite</u>

A. The granular bentonite or bentonite sealing compound used for seaming, penetration sealing, and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer.

(2.8) <u>Equipment Requirements</u>

A. CETCO GCLs are delivered in rolls weighing from 2,500 - 2,700 lbs (1,140-1,225 kg). It is necessary to support this weight using an appropriate core pipe. For any installation, the core pipe must not deflect more than 3 inches (75 mm) as measured from end to midpoint when a full GCL roll is lifted.

B. Lifting chains or straps rated for at least twice the load of the GCL should be used in combination with a spreader bar made from an I-beam. The spreader bar ensures that the lifting chains or straps do not chafe against the ends of the GCL roll, which must be able to rotate freely during installation.

C. A front end-loader, backhoe, dozer, or other equipment can be furnished with the spreader bar and core bar. Alternatively, a forklift with a “stinger” attachment may be used for on-site handling and, in certain cases, installation. **A forklift without a stinger attachment shall not be used to lift or handle the GCL rolls**.

D. When installing over certain geosynthetic materials, a 4-wheel all-terrain vehicle (ATV) can be used to deploy the GCL from behind. An ATV can be driven directly on the GCL provided that no sudden stops, starts, or turns are made.

E. Additional equipment needed for installation of CETCO’s GCLs includes:

- Utility knife and spare blades (for cutting the GCL).
- Granular bentonite or bentonite mastic (for overlapped seams of GCLs with needle punched non-woven geotextiles and for sealing around structures and details).
- Waterproof tarpaulins (for temporary cover on installed material as well as or stockpiled rolls).
- Optional chalk line marker to simplify bentonite placement at seams (when installing a GCL with needle punched non-woven geotextile components).
- Optional flat-bladed vise grips (for positioning the GCL panel by hand).

(3) EXECUTION

(3.1) Shipping and Handling

A. The manufacturer assumes responsibility for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling, and storage of the GCL are the responsibility of the Contractor, Installer, or other designated party.

B. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

(3.2) Storage

A. Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry, and well-drained.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks or by use of the dunnage shipped between rolls. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four). Rolls shall never be stacked on end.

C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

D. The integrity and legibility of the labels shall be preserved during storage.

(3.3) Earthwork/Subgrade Preparation

A. Any surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of vegetation, any debris, sticks, sharp rocks, void spaces, ice, abrupt elevation changes, standing water, cracks larger than one-quarter inch (6mm) in width, and any other foreign matter that could contact the GCL.

B. Subgrade surfaces consisting of granular soils or gravel may not be acceptable due to their large void fraction and puncture potential. Subgrade soils should possess a particle size distribution such that at least 80 percent of the soil is finer than a No. 60 sieve (0.250 mm).

C. Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

D. On a continuing basis, the Contractor/GCL Installer shall submit certifications of subgrade acceptance to the Engineer, and the project Construction Observer shall verify acceptance of the subgrade before GCL placement.

E. It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

F. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated in accordance with the project plans and specifications. The excavated trench shall be verified by the Construction Observer prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

(3.4) GCL Placement

Placement of the GCL shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the Engineer.

A. The contractor shall not install any GCL on this project, at any time, in the absence of the CQA CO. During start-up of the GCL installation, an agent or representative of the Manufacturer shall provide on-site assistance and instruction to the Contractor and Engineer regarding the appropriate installation techniques.

B. The CQA CO shall inspect each panel, after placement and prior to seaming, for damage and/or defects. All defects and deficiencies shall be properly documented by the GCL Installer and CQA CO. Defective or damaged panels shall be replaced or repaired, as approved by the Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the Engineer. The CQA CO shall observe and verify all repaired defects.

C. Reinforced GCL shall be placed on all areas of the site.

D. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) may be important if the GCL has two different geotextiles. Unless otherwise specified, however, the GCL shall be placed with the white side (non-woven) geotextile facing down.

E. The GCL shall be properly weighted to avoid uplift due to wind.

F. Equipment which could damage the GCL shall not be allowed to travel directly on it. Acceptable installation, therefore, may be accomplished such that the GCL is unrolled in front of the backwards-moving equipment. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues. 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.

G. The GCL shall be kept free of debris, unnecessary tools and materials. In general, the GCL area shall remain neat in appearance. All damage shall be recorded and located in the record drawings.

H. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

I. The GCL shall be placed so that seams are parallel to the direction of the slope. End-of-roll seams should be located at least 3 feet (1m) from the toe and crest of slopes steeper than 4H:1V. GCL rolls shall **not** be released on the slope and allowed to unroll freely by gravity.

J. All GCL panels shall be placed free of tension or stress and lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels. Similarly, the geomembrane placed over GCL shall lie flat and in contact with the underlying GCL with no wrinkles or fold.

K. The GCL shall not be installed in standing/ponded water, during rainy weather/precipitation, excessive moisture, and during extremely/excessive high wind. Only as much GCL shall be deployed as can be covered at the end of the working day with the geomembrane. In no case shall the GCL be exposed to the elements at the end of the day. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it will be necessary to remove and replace the hydrated material. The Engineer, Construction Observer, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

L. 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 GCL panel, but prior to covering with the geomembrane panel, a thin film plastic sheeting may be used to cover and to temporarily protect the GCL from moisture, if approved by the Engineer.

M. Panels shall be placed from the highest elevation to the lowest within the area to be lined, to facilitate drainage in the event of precipitation.

N. 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.

(3.5) <u>Anchorage</u>

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope. The front edge of the trench should be rounded so as to eliminate any sharp corners. The GCL should cover the entire trench floor but does not extend up the rear trench wall.

B. The amount of trench open at any time shall be limited to one day of GCL installation capacity. The anchor trench shall be adequately drained to prevent water ponding and softening the adjacent soils. Loose soil shall be removed from the floor of the trench. The soil backfill should be placed in the trench to provide resistance against pullout. The size and shape of the trench, as well as the appropriate backfill procedures, should be in accordance with the project drawings and specifications.

(3.6) <u>Seaming</u>

A. The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required for Bentomat® ST.

B. The minimum dimension of the longitudinal overlap should be 6 inches (150 mm). End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure 24 inches (600 mm). In the opinion of the CQA Engineer/Inspector, 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.

C. 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.

D. 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.

E. All seams constructed on sloped surface shall be vertical seams.

F. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

G. Bentonite-enhanced seams are constructed between the overlapping adjacent panels described above. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6 inch (150 mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap. The bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot (0.4 kg/m).

(3.7) <u>Detail Work/Sealing Around Penetration and Structures</u>

A. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid irregular tearing of the geotextile components of the GCL during the cutting process. The GCL shall be sealed around penetrations and structures embedded in the subgrade. Granular bentonite or a bentonite mastic shall be used liberally (approximately 2 lbs/in ft or 3 kg/m) to seal the GCL to these structures.

B. When the GCL is placed over an earthen subgrade, a “notch” (approximately 3 inches wide and 8 inches deep) shall be cut against the edge of the subgrade area around the penetration. 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.

C. A secondary collar of GCL should be placed around the penetration. It is helpful to first trace an outline of the penetration on the GCL and then cut a “star” pattern in the collar to enhance the collar’s fit to the penetration.

D. Vertical penetrations are prepared by notching into the subgrade. The penetration is completed with two separate pieces of GCL. A secondary collar is option in this case.

E. When the GCL is terminated at a structure or wall that is embedded into the subgrade, the subgrade should be notched as described in Items B and D above. The notch is filled with granular bentonite, and the GCL should be placed over the notch and up against the structure. The connection to the structure can be accomplished by placement of soil or stone backfill in this area.

(3.8) Damage Repair

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Dry bentonite or bentonite mastic should be applied around the damaged area at the rate of one-half pound per lineal foot prior to placement of the patch. Any epoxy-based adhesives shall be used to keep the patch in position during backfill operations.

(3.9) Placement of Overlaying Materials

A. Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles [such as 4-wheel all-terrain vehicles (ATV)] may be used to facilitate the installation of any geosynthetic material placed over the GCL, provided the ATV makes no sudden stops, starts, or turns. The GCL supplier or engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

B. When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

C. 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 or other ballast.

D. Soil cover shall be placed over the GCL/geomembrane using low ground pressure construction equipment that minimizes stresses on the GCL/geomembrane, according to the existing project specification requirements for protective cover soil installation over geomembrane liner.

4.2.4. Base Liner System Flexible Membrane Liner Method of Deployment

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Flexible Membrane Liner Tests

Test Name	Description	Test Method	Frequency
Air Test	Air Test Seams		Every Seam
Vacuum Test	Every welded area		Where air test impossible
Destructive Tests	Seam Strength	ASTM D4437	Every 500' of seam

Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

60 mil High Density Polyethylene (HDPE) - Geosynthetic Research Institute (GRI) GM13 - Is to be placed in direct contact with moist cohesive soil liner or Geosynthetic Clay Liner (GCL). The Landfill itself is single lined and will only have a single Textured Geomembrane. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner and shall meet the following minimum properties:

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 1603 *(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)*	GM11 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 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(1) Preparation for Geomembrane Deployment

(a) Panel Layout

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project.

(b) Identification

Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture.

(c) Verification

Prior to site delivery, the manufacturer's quality certification for each roll will be delivered to the Engineer. The Engineer will inspect all certifications. If a certification does not meet minimum requirements outlined on GRI Test Method GM13 Table 2(a) for 60 mil, the individual roll will be rejected.

The Engineer will remove a sample from 1 out of 4 rolls delivered to the site and have a third party lab test for thickness, density, carbon black content, carbon black dispersion and tensile properties. The lab will have been accredited by the Geosynthetic Accreditation Institute (GAI).

(2) Field Panel Placement

(a) Location

The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

(b) Weather Conditions

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds.

(c) Method of Deployment shall follow the manufacturer's recommendations and sound, accepted engineering practices.

(1) The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface.

(2) No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions which could result in damage to the geomembrane.

(3) Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas.

(4) The geomembrane will be deployed in a manner to minimize wrinkles. The geomembrane will have no fold overs.

(5) Any damage to a panel of the geomembrane will be repaired. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed.

(3) Field Seaming

(a) Layout

In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

(b) Personnel

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

(c) Equipment

(1) Fusion Welding

Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge.

(2) Extrusion Fillet Welding

Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

(d) Weather Conditions

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams substantiate the decision made by the liner installer superintendent to seam on any given day.

(4) Seam Preparation

(a) Fusion Welding

(1) Overlap the panels of geomembrane approximately four (4) inches.

(2) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding.

(3) Adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

(4) A movable protective layer may be used, at the discretion of the Flexible Geomembrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

(b) Extrusion Welding

(1) Overlap the panels of geomembrane a minimum of three (3) inches.

(2) Temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane.

(3) Grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area.

(4) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.

(5) Purge the extruder prior to beginning the seam to remove all heat degraded extrudate from the barrel.

(6) Keep welding rod clean and off the ground.

(5) Test Seams

Test seams shall be performed at the beginning of each seaming period and at approximately every 4-working hour intervals for each seaming apparatus used that day. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams.

(a) Test Seam Length

The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width.

(b) Sample Procedure

(1) Visually inspect the seam for squeeze out, footprint, pressure and general appearance.

(2) Two random samples one (1) inch wide shall be cut from the test seam.

(3) The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer that has a constant separation of 2.0 in/min for peel and shear. The passing destructive test requirements for a 60-mil liner seam is: minimum peel adhesion of 91 ppi for hot wedge and 78 ppi for extrusion fillet seams, minimum shear strength of 120 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam. If a specimen fails, the entire procedure shall be repeated.

(4) If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved.

(5) After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained, listing seam identification number, welder's name, temperature control setting and test results.

(6) Passing test results records shall be maintained.

(6) <u>General Seaming Procedures</u>

(a) Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

(b) While welding a seam, monitor and maintain the proper overlap.

(c) Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind.

(d) While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly.

(e) Align wrinkles at the seam overlap to allow welding through the wrinkle.

(f) Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions.

(g) All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane.

(h) All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind ¼ of an inch minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

4.2.5 <u>Base Liner System Flexible Membrane Liner Tests</u>

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

(a) <u>Air Pressure Testing</u>

The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time.

(1) Equipment for Air Testing

An air pump (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi.

A rubber hose with fittings and connections.

A sharp hollow needle, or other approved pressure feed device with a pressure gauge capable of reading and sustaining a pressure between 25 to 30 psi.

(2) Procedure for Air Testing

Seal both ends of the seam to be tested.

Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld.

Inflate the test channel to a pressure between 25 to 30 psi, in accordance with the following schedule, close valve, and observe initial pressure after approximately 2 minutes.

INITIAL PRESSURE SCHEDULE *

Material (Mil)	**Min. Psi**	**Max. Psi**
40	25	30
60	27	30
80	30	30
100	30	30

***** Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize.

Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds the following or if the pressure does not stabilize, locate faulty area and repair.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL
AFTER 5 MINUTES - HDPE

Material (Mil)	**Pressure Diff.**
40	4 psi
60	3 psi
80	3 psi
100	3 psi

At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected.

Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

(3) In the event of a Non-Complying Air Pressure Test, the following procedure shall be followed:

Check seam end seals and retest seams.

If non-compliance with specified maximum pressure differential re-occurs, repair the seam. Capping or removal/reseam of the non-complying seam are the only two (2) acceptable methods of repairing failed seams.

Non-destruct test the entire length of the repaired seam.

(b) Vacuum Testing

This test is used when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

(1) Equipment for Vacuum Testing

Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

Vacuum pump assembly equipped with a pressure controller and pipe connection.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and means to apply a soapy solution.

A soapy solution.

(2) Procedure for Vacuum Testing

Trim excess overlap from seam, if any.

Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi gauge.

Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested.

Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.

Close the bleed valve and open the vacuum valve.

Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box.

Ensure that a leak tight seal is created.

For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process.

(3) Procedure for Non-Complying Test

Mark all areas where soap bubbles appear and repair the marked areas.

Retest repaired areas.

(c) Destructive Testing

(1) Concept

The purpose of destructive testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane.

(2) Procedure for Destructive Testing

All Destructive tests will be done according to GRI test method GM19. Destructive test samples shall be marked and cut out randomly at a minimum average frequency of one test location every 500 feet of seam length.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds at the discretion of the Flexible Membrane Liner Superintendent and Engineer.

Sample Size

The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications.

A one (1) inch sample shall be cut from each end of the test seam for field testing.

The two (2), one (1) inch wide samples shall be tested in the field with a tensiometer, that has a constant separation rate of 2.0 inch per minute for peel and shear. The passing destructive test requirements for a 60-mil liner seam is: minimum peel adhesion of 91 ppi for hot wedge and 78 ppi for extrusion fillet seams, minimum shear strength of 120 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam.

(3) Procedure in the event of Destructive Test Failure

Cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.

If the laboratory samples pass then repair the seam between the two (2) passing samples locations.

Capping or removal of the failed seam is the only two (2) acceptable methods for repairing failed seams.

All destructive seam samples sent to the Engineer's laboratory shall be numbered.

(d) Quality Assurance Laboratory Testing

(1) Destructive samples sent to the laboratory will be tested for shear/peel strength, elongation, and peel separation according to table 1(a) of GRI Test Method GM19. Five (5) specimens shall be tested for each test method with data recorded. Four (4) out of the five (5) specimens must pass and the fifth specimen must be 80% of the passing test values. The passing test values are as follows:

Hot Wedge Seams
Shear Strength-120 ppi
Shear elongation at break – 50%
Peel Strength- 91 ppi
Peel separation-25%
Extrusion Fillet Seams
Shear Strength-120 ppi
Shear Elongation at break-50%
Peel Strength- 78 ppi
Peel separation-25%

(2) Defects and Repairs

(a) The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation.

(b) All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

(c) Repair Procedures

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely manner to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil liner or geosynthetic clay liner (GCL) such as a temporary cover. If cohesive soil liner is damaged, it must be reworked. If the GCL is damage, it must be replaced with non-hydrated GCL. Procedures available for liner repair:

Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded.

Grinding and welding - used to repair sections of extruded seams.

Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws.

Capping - used to repair lengths of failed seams.

Removal of a bad seam and replacement with a strip of new material seamed into place.

(d) Verification of Repairs

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

(e) Liner Acceptance

The constructed liner will be accepted when all non-destruct and destruct tests have passed their respective tests and the results have been verified by the Engineer. Geocomposite can be installed over the liner once it has been accepted.

4.2.6 Protective Cover for Landfill Construction

HPDE Geocomposite Drainage Netting manufactured by SKAPS Industries, or approved equal. Q/C testing information/certification for each property on geocomposite will be provided by the contractor/manufacture for the rolls delivered. The thickness, transmissivity and ply adhesion will be tested by the Engineer's third party laboratory for quality assurance. One roll from every 200,000 $ft.^2$ of material delivered to the site will be tested.

SKAPS TRANSNET HDPE GEOCOMPOSITE WITH 250 MIL GEONET

Last Updated on Wednesday, 08 September 2010 07:57

SKAPS TRANSNET™ GeoComposite consists of SKAPS GeoNet made from HDPE resin with non-woven polypropylene GeoTextile fabric heat bonded on both sides of GeoNet.

Property	Test Method	Unit	Required Value		Qualifier
				with 8 oz.	
Geonet					
Thickness	ASTM D 5199	mil		250 ±10	Range
Carbon Black	ASTM D 4218	%		2 to 3	Range
Tensile Strength	ASTM D 5035	lb/in		50	Minimum
Melt Flow	ASTM D 1238[3]	g/10 min		1	Maximum
Density	ASTM D 1505	g/cm^3		0.94	Minimum
Transmissivity[1]	ASTM D 4716	m^2/sec		$2.5x10^{-3}$	MARV[2]
Composite					
Ply Adhesion (Minimum)	ASTM D 7005	lb/in		0.5	MARV
Ply Adhesion (Average)	ASTM D 7005	lb/in		1	MARV
Transmissivity[1]	ASTM D 4716	m2/sec		$2x10^{-4}$	MARV
GeoTextile					
Fabric Weight	ASTM D 5261	oz/yd^2		8	MARV
Grab Strength	ASTM D 4632	lbs		225	MARV
Grab Elongation	ASTM D 4632	%		50	MARV
Tear Strength	ASTM D 4533	lbs		90	MARV
Puncture Resistance	ASTM D 4833	gpm/ft^2		130	MARV
CBR Puncture	ASTM D 6241	lbs		650	MARV
Water Flow Rate	ASTM D 4491	gpm/ft^2		100	MARV
Permittivity	ASTM D 4491	sec^{-1}		1.26	MARV
Permeability	ASTM D 4491	cm/sec		0.3	MARV
AOS	ASTM D 4751	US Sieve		80	MARV

Notes:

1. Transmissivity measured using water at 21 ± 2 °C (70 ± 4 °F) with a gradient of 0.1 and a confining pressure of 10000 psf between steel plates after 15 minutes. Values may vary between individual labs.

2. MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.

3. Condition 190/2.16

The geocomposite will be handled in such a manner as to ensure the geocomposite are not damaged in any way. On slopes, the geocomposite will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles. Geocomposite can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geocomposite will not be welded to the geomembrane. Geocomposite will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geocomposite that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geocomposite will be overlapped by at least four inches and securely tied. Tying can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one foot intervals. In the corners of the side slopes where overlaps between perpendicular geocomposite strips are required, an extra layer of geocomposite will be unrolled along the slope, on top of the previously installed geocomposite, from the top to bottom of the slope.

Any holes or tears in the geocomposite will be repaired by placing a patch, utilizing the same geocomposite material, extending two feet beyond edges of the hole or tear. The patch will be secured to the original geocomposite by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geocomposite will be joined.

The engineer will visually inspect the drainage layer before placement of the protective soil, if any defects are detected they will be repaired before placement of protective soil.

Protective Cover Soil

The soil for the protective cover consist of suitable soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension. The soil will be screened in the presence of the Engineer. The screening can be either on or off site. If screened soil is not used, the only acceptable alternate is a NCDOT approved sand. The borrow site for sand will be NCDOT approved for sand of any gradation. The NCDOT approval and gradation report shall be submitted to the Engineer. There are no permeability, grain size, or other test that will be required for this material. This material is not being used as a drainage media; leachate collection lines are installed and designed to collect water flowing on top of the protective cover.

Installation Protective Soil Cover

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The protective cover shall be composed of select backfill and backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

When installing the cover, the contractor shall adhere to the following guidelines:

(1) A minimum of 12 inches of cover between low ground pressure equipment such as the Caterpillar D6H LGP, or approved equal, and the liner is required at all times. Roadways for entering and for transporting material over slopes and floor shall have a minimum depth of four feet.

(2) Avoid undue stress on the liner at all times. Cover material must be pushed up side slopes, never down to help minimize wrinkles. Material must be placed to minimize wrinkles, wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Fold over of the liner will not be allowed. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner.

(3) If damage does occur, report it to the Construction Observer immediately so that repairs can be performed without needless delay. All repairs to any component of the liner system will be done and tested according to the required repairs and testing for that component.

(4) Cover shall be placed and maintained in a uniform thickness, free of ruts and irregularities.

(5) Do not work wet cover material that cannot support equipment.

(6) Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

(7) The thickness and grade of the protective soil will be verified by the surveyor. The soil liner will be surveyed at 50' grid points where the elevations of the top of cohesive soil will be checked with the top of protective cover to verify 3.0 feet protective cover. The grade will then be verified with the surveyed information. The survey will be performed by NC licensed surveyors.

Protective soil will be used to backfill all anchor trenches. The anchor trenches will be filled as the protective cover is being installed up the slopes on the geocomposite. The fill will consist of 8 inch loose lifts that will be compacted to 6 inch lifts. The lifts will be compacted to 95% of the Standard Proctor and tested for density on 2 foot intervals for every 500 ft. of anchor trench. The results of the tests will become part of the Contractor's Geotechnical Engineer's final report..

4.2.7 <u>Leachate Collection System</u>

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications, or shall be the product of the listed manufacturers, or similar and equal; thereto, as approved by the Engineer.

(1) <u>High Density Polyethylene Pipe</u>

The polyethylene pipe shall be high performance, ultra-high molecular weight, high density polyethylene pipe, conforming to ASTM D1248 (Type III, Class C, Category 5, Grade P34). Minimum cell classification values shall be 335434C as referenced in ASTM D3350. The pipe shall be SDR 17. The pipe shall contain 2 percent carbon black.

(2) Stone Surrounding Perforated Collection Piping

Stone for leachate collection system shall meet the requirements of NC DOT aggregate, standard size No. 5 and shall contain no fines greater than 2% by weight passing the #200 sieve and consist of rock dust produced through normal handling of the aggregate.. Stone must pass the sieve analysis test for No. 5 stone performed at the quarry. The quarry will provide their standard sieve analysis of the stone being delivered to the site and the Engineer will have a third party laboratory sieve analysis for approximately every 500 tons of stone delivered to the site.

The stone shall be non-carbonaceous mineral which must be chemical compatible with leachate with the maximum acceptable concentration of calcium carbonate per ASTM D4373 for the stone used in the leachate collection system.

(3) Geotextile Filter Fabric

Filter fabric surrounding the stone/collection piping shall be non-woven needle punched drainage fabric with the following minimum properties:

1)	Weight	4.5 oz/yd^2	ASTM D-5261
2)	Thickness	60 mils	ASTM D-1777
3)	Grab Strength	125 lbs.	ASTM D-4632
4)	Grab Elongation	60%	ASTM D-4632
5)	Trapezoidal Tear Strength	60 lbs.	ASTM D-4533
6)	Puncture Strength	65 lbs.	ASTM D-4833
7)	Mullen Burst Strength	185 psi	ASTM D-3786
8)	Permittivity	1.8 sec^{-1}	ASTM D-4491
9)	Apparent Opening Size (AOS)	0.212 mm (US sieve size 70)	ASTM D-4751

Filter fabric shall be manufactured by Polyfelt, Mirafi, or approved equal.

(4) Knife Gate Valves

Knife Gate Valves shall be bonnetless, wafer type made with a cast iron body, with several support ribs for a strong flanged connection. All sizes shall have a fabricated stainless steel liner. Standard flange holes will be drilled and tapped. Flange drilling dimensions will meet M.S.C. SP-81 and A.N.S.I. B16.5, Class 125/150 requirements. The raised face flange shall meet M.S.S. SP-81 face-to-face dimensions. Valves shall have all wetted parts of stainless steel. Stainless steel liner shall extend through the valve chest to the top of the packing gland. Both sides of the gate shall be finished ground. The stem shall be stainless steel and shall have double pitch threads. The yoke nut shall be acid-resisting bronze. The valve shall have a raised seat with a relieved area around the seat to prevent jamming. The valve gate shall be suitable for 125 psi pressure differential. Packing gland shall have three (3) layers of fiber packing with a 4th elastomer seal. Resilient seated knife gate valves shall have a round port with a replaceable resilient seat interlocked by a metal retaining ring. The metal ring shall act as a wiper blade to clean the gate before it passes over the seat. The resilient seat shall be captured and locked in place on three (3) sides only exposing one surface for sealing which prevents blowout. Knife gate valves shall be a series 304G as manufactured by Red Valve or equal.

(5) Polyethylene Manholes

Polyethylene manholes shall be produced using polyethylene compounds conforming to the requirement of Type III, Category "3", Class B, as defined and described in ASTM D-1248. Clean reworked material or reprocessed material may be used in the manufacture provided that the manhole components meet all the requirements of the product specification.

Polyethylene manholes shall be produced in the rotational molding process. The manhole will consist of an appropriate combination of base, elevation, and top section based on project requirements. Interior access to all manholes shall be designed so that a portable ladder or permanent step system can be supported by the installed manhole. Manholes may be supplied with factory molded steps. Man way reducers shall be concentric with respect to the larger portion of the manhole. The manhole shall be designed to accept and shall be furnished with concrete filled polyethylene manhole lids weighing not less than 190 pounds and must be compatible with a Dewey Brothers RCR-2001 standard cast iron frame. Manhole segment joints shall be designed to function as a full tongue and grove with the groove portion no less than 2.75 inches in depth, and shall include water tight gaskets and/or sealing compounds as recommended by the manufacturer.

Polyethylene manholes shall have a nominal cylinder internal diameter of 48 inches. The man way reducer nominal inside diameter shall be 27.75 inches. Wall thickness of all components shall be determined in accordance with ASTM D-2122 and shall be a minimum of .330 inches.

(6) Trenching for Leachate Piping

The Engineer shall provide on the Contract Drawings a horizontal layout for the proposed leachate collection system along with a minimum of two (2) bench marks. The Contractor shall be responsible for verifying the accuracy of any and all bench marks prior to use. No claim for extra work will be allowed for alleged inaccuracy for any bench mark. It shall be the Contractor's responsibility to protect the original line and bench marks set by the Engineer. Should this information become destroyed or damaged, the cost of the replacement will be borne by the Contractor.

Excavation for the leachate collection shall be done only after the three foot of protective cover has been installed over the flexible membrane liner. The width of the excavation shall be no wider than two feet. Surface water that may have been trapped in the trench shall be removed immediately.

Mechanical equipment can be used for the first two and one-half feet of excavation. The remaining one-half foot or whatever protective cover remains above the flexible membrane liner shall be excavated by hand so as to not damage the liner. If damage occurs to the liner the Engineer or Owner shall be notified immediately and the repair shall take place shortly thereafter. All repairs to any component of the liner system will be done and tested according to the required repairs and testing for that component.

(7) Leachate Trench Construction

Geotextile filter fabric shall be installed along the entire length of the trenching or as required by Project Specifications on top of the exposed flexible membrane liner/geocomposite net. This fabric is intended to protect the liner/net from the stone that surrounds the perforated collection piping.

In addition, the fabric shall be installed up the walls of the trench with enough excess at the top so that the stone can be completely covered with filter fabric.

The leachate collection pipe shall be placed in the bottom of the trench and the stone shall be placed around and over the pipe up to approximately six inches above the top of the protective cover.

The as-built location of the leachate collection trenches and sump shall be part of the CQA documentation.

(8) Videoing of Lines

All the lines that have cleanouts attached shall be videoed after installation to assure that the lines are clean and free of debris. The video shall include the entire length of the line that has been constructed. The video shall become part of the QC documentation.

4.2.8 Sewer Line

All HDPE pipe shall be laid in conformance with the ASTM standard for installing flexible thermoplastic pipe ASTM D2321. This specification shall be strictly conformed to unless otherwise noted by the Project Specifications or required by the Engineer on site because of local conditions.

All Dual Containment HDPE PIPE shall confirm to ASTM D3350.

(1) Construction Methods

All Gravity Flow Pipeline shall be installed using a laser for control of vertical and horizontal alignment. The Contractor shall follow accepted practices in the utilization of the laser. A certified laser operator shall be present on the job at all times. Care shall be exercised to assure that the alignment control range of the instrument is not exceeded; but in no case, shall the range exceed 500 feet. Care shall be taken to prevent vibration of or direct sunlight on the instrument. Where present, a blower shall be provided to purge glue vapors from the pipe. An air velocity meter shall be provided so that the velocity of air in the pipe will not be great enough to cause the light beam to be distorted. The Contractor shall coordinate the work to minimize the number of take downs and set ups at each point. Periodic checks of the laser shall be made to assure that alignment is maintained.

Each pipe shall be laid on an even, firm bed, so that no uneven strain will come to any part of the pipe. Before each piece of pipe is lowered into the trench, it shall be thoroughly inspected to insure its being clean. Each piece of pipe shall be lowered separately. No piece of pipe or fitting which is known to be defective shall be laid or placed in the lines. If any defective pipe or fitting shall be discovered after the pipe is laid it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe.

(2) Butt Fusion for HDPE pipe

Clean pipe ends inside and outside with a clean cloth to remove dirt, water, grease and other foreign materials.

Square (face) the pipe ends using facing tool of the fusion machine.

Check line-up of pipe ends in fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. This is commonly referred to as "adjusting high-low". It is advisable at this point to make sure the clamps are tight so that the pipe does not slip during the fusion process.

Insert clean heater plate between aligned ends, and bring ends firmly in contact with plate, but do not apply pressure while achieving melt pattern. Carefully move the pipe ends away from the heater plate and remove the plate. (If the softened material sticks to the heater plate, discontinue the joint. Clean heater plate, re-square pipe ends and start over.)

Note: One pipe end usually moves away from the heater plate first. It is good practice to "bump" the plate away from the other side and then lift it out. Never drag or slide it over the melted pipe end.

Bring melted ends together rapidly. Do not slam. Apply enough pressure to form a double roll back to the body of the pipe brad around the entire circumference of the pipe about 1/8" to 3/16" wide. Pressure is necessary to cause the heated material to flow together.

Allow the joint to cool and solidify properly. This occurs when the brad feels hard and your finger can remain comfortably on the brad. Remove the pipe from the clamps and inspect the joint appearance.

(3) Tests

HDPE Dual Containment Force main - ASTM F2164-02. All HDPE pipe shall be tested at 1.5 times the rated working pressure. The outer pipe shall be tested separately from the inner pipe. In no case shall there be any visible leakage, nor shall there be leakage between any section of pipe.

4.2.9 Closure Cap System

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

4.2.10 Conformance Testing for Interface Friction Angles of Capping Materials

Conformance testing for Interface Friction Angles, for every 200,000 square feet of capping materials is as follows:

Minimum Friction Angle for soil to textured LLDPE liner is 26 degrees and the test method is ASTM 5321.

Minimum Friction Angle for textured LLDPE liner to 250 mil double bonded geocomposite drainage net is 24 degrees and the test method is ASTM 5321.

Minimum Friction Angle for 250 mil double bonded geocomposite drainage net to soil is 26 degrees and the test method is ASTM 5321.

4.2.11 Closure Cohesive Soil Cap

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Cohesive Soil Cap Borrow Material

Test Name	Test Method	Contractor/Engineer Frequency
Moisture/Density	ASTM D698/D1557	1 per 5000 c.y.
Remolded Permeability	ASTM D5084	1 per 5000 c.y.
Atterberg Limits	ASTM D4318	1 per 5000 c.y.
Visual Classification	ASTM D2487	1 per 5000 c.y.
Grain Size Distribution	ASTM D422	1 per 5000 c.y.

Cohesive Soil Cap Test Pad

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	3 per lift
Permeability	ASTM D5084	1 per lift
Remolded Permeability	ASTM D5084	1 per lift
Atterberg Limits	ASTM D4318	1 per lift
Visual Classification	ASTM D2487	1 per lift
Grain Size Distribution	ASTM D422	1 per lift

In-Place Cohesive Soil Cap

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	1 per lift per acre
Permeability	ASTM D5084	1 per lift per acre
Atterberg Limits	ASTM D4318	1 per lift per acre
Visual Classification	ASTM D2487	1 per lift per acre
Grain Size Distribution	ASTM D422	1 per lift per acre

(a) Suitable on-site and/or off-site soils may be used as cohesive soil cap if it can achieve an in-place permeability of 1.0 x 10^{-5} cm/sec or less and meets all testing requirements indicated in the material testing paragraph in this section. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

(b) A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil cap. The window shall be plotted on a semi-log plot with moisture content versus density. Laboratory testing to develop the window shall include a series of remolded samples compacted to various dry densities and moisture contents utilizing the same compactive effort (ASTM D 698 or D 1557). The remolded samples shall be tested for permeability to determine whether or not the particular soil type will provide the maximum permeability (1.0 x 10^{-5} cm/sec) at various dry densities and moisture contents. The window is then developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

(c) Atterberg limits and grain size distribution shall also be conducted on the bulk samples used to prepare the permeability window ASTM D2487, D4318, D422. These tests can be used as indices on random samples collected from the borrow site during construction to verify the soil type is the same as was used to develop the "window". As a minimum, sufficient visual classifications and Atterberg limits shall be conducted in association with each permeability test to verify that the construction materials meet specifications.

(d) A test strip of compacted cohesive soil cap shall be prepared to verify the permeability "window" prior to general installation of the cohesive soil cap. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil cap. At a minimum, the verification will consist of three moisture density tests, one Atterberg limits test, one grain size distribution test (ASTM D2487, D4318, and D422), and one Shelby Tube sample for each lift constructed in the test pad. Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 x10^{-5}cm/sec. Tests shall be performed in accordance with the ASTM D5084. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least three compacted 6 inch lifts of cohesive soil cap. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil cap. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeability of 1.0 x 10^{-5} cm/sec of the cohesive soil cap. The test strip may be used as an integral part of the overall cohesive soil cap if it meets the required specification for the cap. All results shall be given to the Construction Observer.

(e) The soils shall be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift compacted preferably at a moisture content between 0 to 3% above optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698).

A sheepsfoot roller or approved alternative may be used to compact the soil cap provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil cap shall be screened, disked, or prepared using any other approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. After each lift, the surface shall be scarified prior to the placement of the next lift to provide good bonding from one lift to the next.

(f) The cohesive soil cap shall be tested to evaluate the coefficient of permeability. The coefficient of permeability of the soil cap shall be equal to or less than 1.0 x 10^{-5} cm/sec after placement and compaction. The soil cap must be a minimum of 1.5 feet thick.

(g) Laboratory falling head permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 x 10^{-5} cm/sec. Tests shall be performed in accordance with ASTM D5084. All laboratory permeability tests shall be performed at a confining pressure of 10 psi and at a hydraulic gradient of 20.

(h) The soil cap shall be tested a minimum of one soil sample per lift per acre for laboratory permeability. All permeability testing will be on random samples judged by the Engineer to be representative of the most permeable soil conditions for the area being tested. The Engineer shall certify that the materials used in construction were tested according to the Division approved plans. If after placement of the soil cap it fails the required tests, the material will either be reworked or replaced and retested. The soil cap must remain moist at all times, if any section becomes dry, rework the dry area and moisten.

(i) A minimum of two (2) inches of soil shall be removed prior to securing each sample for permeability testing. The sampling tube shall be advanced vertically into the soil with as little soil disturbance as possible and should be pushed using a uniform pressure. The sampling tube (Shelby tube), when extracted, shall be free of dents, and the ends shall not be distorted. A backhoe or approved alternative should be used to advance the sampling tube (Shelby tube) as long as disturbance is minimized. Drive tube samples of the cap may be obtained for permeability testings. If the Engineer judges the sample to be too disturbed, another sample shall be taken. Once an acceptable sample has been secured and properly prepared, all sample excavations or other holes created by survey stakes, etc. shall be backfilled to grade with a 50% mixture of bentonite and similar soils in maximum 3-inch loose lifts and hand tamped with a blunt tool to achieve a tight seal equivalent to the original density.

(j) No additional construction shall proceed on the soil layers at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved.

(k) As a minimum, sufficient visual classifications (ASTM Test Designation D2487) , analyses (ASTM Test Designation D422) and Atterberg limits (ASTM Test Designation D4318) shall be conducted in association with each permeability test to verify that the construction materials meet specifications. The minimum number of tests will be 1 per lift per acre.

(l) If the soil for the cohesive soil cap is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory and mixed in the field using either a pug mill or a soil stabilizer. Where additives are required, the soil shall be placed in maximum 8-inch thick loose lifts and compacted preferably between 0 to +3% optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698) for the soil-additive mixture. All other compaction procedures for the soil apply.

(m) Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil cap shall have no sudden sharp or abrupt changes in grade such as tire ruts.

(n) The Contractor shall protect the cohesive soil cap from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil cap until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions shall be replaced or reworked by the contractor to remove these defects. Areas where the cohesive soil has been replaced, desiccation cracks and/or heaving is deeper than two (2) inches shall be retested.

(o) The thickness and grade of the soil cap will be verified by the surveyor before placement of the geomembrane liner. The soil cap will be surveyed at 50' grid points where the elevations of the top of intermediate cover will be compared with the top of soil cap to verify 1.5 feet of soil cap. The grade will then be verified with the surveyed information. The survey will be performed by NC licensed surveyors.

(p) Surface Acceptance. Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil cap and the surface shall remain the responsibility of the contractor.

4.2.12 Closure Flexible Membrane Liner Method of Deployment

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Flexible Membrane Liner Tests

Test Name	**Description**	**Test Method**	**Frequency**
Air Test	Air Test Seams		Every Seam
Vacuum Test	Every welded area		Where air test impossible
Destructive Tests	Seam Strength	ASTM D4437	Every 500' of seam

Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The 40 mil Linear Low Density Polyethylene (LLDPE) textured flexible membrane liner is to be placed in direct contact with moist cohesive soil cap. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner and shall meet the following minimum properties:

English Units

Table 2(a) – Linear Low Density Polyethylene (LLDPE) Geomembrane (TEXTURED)

Properties	Test Method	Test Value 20 mils	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	Testing Frequency (minimum)
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%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	10	10	10	10	10	10	10	10	Every 2nd roll *(2)*
Density g/ml (max.)	D 1505/D 792	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939	200,000 lb
Tensile Properties *(3)* (min. ave.) • break strength – lb/in. • break elongation - %	D 6693 Type IV	30 250	45 250	60 250	75 250	90 250	120 250	150 250	180 250	20,000 lb
2% Modulus – lb/in. (max.)	D 5323	1200	1800	2400	3000	3600	4800	6000	7200	per formulation
Tear Resistance – lb (min. ave.)	D 1004	11	16	22	27	33	44	55	66	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	22	33	44	55	66	88	110	132	45,000 lb
Axi-Symmetric Break Resistance Strain - % (min.)	D 5617	30	30	30	30	30	30	30	30	per formulation
Carbon Black Content - %	D 1603 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	45,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)* (e) Standard OIT — or — (f) High Pressure OIT	D 3895 D 5885	100 400	100 400	100 400	100 400	100 400	100 400	100 400	100 400	200,000 lb
Oven Aging at 85°C *(7)* (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	35 60	35 60	35 60	35 60	35 60	35 60	35 60	35 60	per formulation
UV Resistance *(8)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 3895 D 5885	N. R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	per formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 9.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

(4) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(1) Preparation for Geomembrane Deployment

(a) Panel Layout

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project.

(b) Identification

Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture.

(c) Verification

The manufacturers certification will be reviewed by the Engineer. If the certification does not meet the requirements of GRI-GM17, the corresponding liner rolls will be rejected.

The Engineer will remove a sample from 1 out of 4 rolls delivered to the site and have a third party lab test for thickness, density, carbon black content, carbon black dispersion and tensile properties. The lab will have been accredited by the Geosynthetic Accreditation Institute (GAI).

(2) Field Panel Placement

(a) Location

The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

(b) Weather Conditions

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds.

(c) Method of Deployment shall follow the manufacturer's recommendations and sound, accepted engineering practices.

(1) The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface.

(2) No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions which could result in damage to the geomembrane.

(3) Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas.

(4) The geomembrane will be deployed in a manner to minimize wrinkles. The geomembrane will have no fold overs.

(5) Any damage to a panel of the geomembrane will be repaired. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed.

(3) Field Seaming

(a) Layout

In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

(b) Personnel

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

(c) Equipment

(1) Fusion Welding

Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge.

(2) Extrusion Fillet Welding

Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

(d) Weather Conditions

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day.

(4) Seam Preparation

(a) Fusion Welding

(1) Overlap the panels of geomembrane approximately four (4) inches.

(2) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding.

(3) Adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

(4) A movable protective layer may be used, at the discretion of the Flexible Geomembrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

(b) Extrusion Welding

(1) Overlap the panels of geomembrane a minimum of three (3) inches.

(2) Temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane.

(3) Grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area.

(4) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.

(5) Purge the extruder prior to beginning the seam to remove all heat degraded extrudate from the barrel.

(6) Keep welding rod clean and off the ground.

(5) <u>Test</u> <u>Seams</u>

Test seams shall be performed at the beginning of each seaming period and at approximately every 4-working hour intervals for each seaming apparatus used that day. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams.

(a) Test Seam Length

The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width.

(b) Sample Procedure

(1) Visually inspect the seam for squeeze out, footprint, pressure and general appearance.

(2) Two random samples one (1) inch wide shall be cut from the test seam.

(3) The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer that has a constant separation of 2.0 in/min for peel and shear. The passing destructive test requirements for a 40-mil liner seam is: minimum peel adhesion of 44 ppi for hot wedge and 50 ppi for extrusion fillet seams, minimum shear strength of 60 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam. If a specimen fails, the entire procedure shall be repeated.

(4) If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved.

(5) After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained, listing seam identification number, welder's name, temperature control setting and test results.

(6) Passing test results records shall be maintained.

(6) General Seaming Procedures

(a) Seaming shall extend to the outside edge of panels to be anchored.

(b) While welding a seam, monitor and maintain the proper overlap.

(c) Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind.

(d) While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly.

(e) Align wrinkles at the seam overlap to allow welding through the wrinkle.

(f) Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions.

(g) All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane.

(h) All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind ¼ of an inch minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

4.2.13 Closure Flexible Membrane Liner Tests

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

(a) Air Pressure Testing

The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time.

(1) Equipment for Air Testing

An air pump (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi.

A rubber hose with fittings and connections.

A sharp hollow needle, or other approved pressure feed device with a pressure gauge capable of reading and sustaining a pressure between 25 to 30 psi.

(2) Procedure for Air Testing

Seal both ends of the seam to be tested.

Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld.
Inflate the test channel to a pressure between 25 to 30 psi, in accordance with the following schedule, close valve, and observe initial pressure after approximately 2 minutes.

INITIAL PRESSURE SCHEDULE *

Material (Mil)	Min. Psi	Max. Psi
40	25	30
60	27	30
80	30	30
100	30	30

***** Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize.

Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds the following or if the pressure does not stabilize, locate faulty area and repair.

**MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL
AFTER 5 MINUTES - LLDPE**

Material (Mil)	Pressure Diff.
40	4 psi
60	3 psi
80	3 psi
100	3 psi

At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected.

Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

(3) In the event of a Non-Complying Air Pressure Test, the following procedure shall be followed:

Check seam end seals and retest seams.

If non-compliance with specified maximum pressure differential re-occurs, repair the seam. Capping or removal/reseam of the non-complying seam are the only two (2) acceptable methods for repairing failed seams. Non-destruct test the entire length of the repaired seam.

(b) Vacuum Testing

This test is used when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

(1) Equipment for Vacuum Testing

Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

Vacuum pump assembly equipped with a pressure controller and pipe connection.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and means to apply a soapy solution.

A soapy solution.

(2) Procedure for Vacuum Testing

Trim excess overlap from seam, if any.

Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi gauge.

Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested.

Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.

Close the bleed valve and open the vacuum valve.

Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box.

Ensure that a leak tight seal is created.

For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process.

(3) Procedure for Non-Complying Test

Mark all areas where soap bubbles appear and repair the marked areas.
Retest repaired areas.

(c) Destructive Testing

(1) Concept

The purpose of destructive testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane.

(2) Procedure for Destructive Testing

All Destructive tests will be done according to GRI test method GM19. Destructive test samples shall be marked and cut out randomly at a minimum average frequency of one test location every 500 feet of seam length.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds at the discretion of the Flexible Membrane Liner Superintendent and Engineer.

Sample Size

The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications.
A one (1) inch sample shall be cut from each end of the test seam for field testing.

The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer that has a constant separation of 2.0 in/min. for peel and shear. The passing destructive test requirements for a 40-mil LLDPE liner seam is: minimum peel strength of 50 ppi for hot wedge and 44 ppi for extrusion fillet seams, minimum shear strength of 60 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam.

(3) Procedure in the event of Destructive Test Failure

Cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.

If the laboratory samples pass then repair the seam between the two (2) passing samples locations.

Capping or removal/reseam of the non-complying seam are the only two (2) acceptable methods for repairing failed seams.

All destructive seam samples sent to the Engineer's laboratory shall be numbered.

(d) Quality Assurance Laboratory Testing

(1) Destructive samples sent to the laboratory will be tested for shear/peel strength, elongation, and peel separation according to table 1(a) of GRI Test Method GM19. Five (5) specimens shall be tested for each test method with data recorded. Four (4) out of the five (5) specimens must pass and the fifth specimen must be 80% of the passing test values. The passing test values are as follows:

Hot Wedge Seams
- Shear Strength-60 ppi
- Shear elongation at break – 50%
- Peel Strength- 50 ppi
- Peel separation-25%

Extrusion Fillet Seams
- Shear Strength-60 ppi
- Shear Elongation at break-50%
- Peel Strength- 44 ppi
- Peel separation-25%

(2) Defects and Repairs

(a) The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation.

(b) All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

(c) Repair Procedures

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely manner to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil cap such as a temporary cover. If cohesive soil cap is damaged, it must be reworked. Procedures available for liner repair:

Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded.

Grinding and welding - used to repair sections of extruded seams.

Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws.
Capping - used to repair lengths of failed seams.

Removal of a bad seam and replacement with a strip of new material seamed into place.

(d) Verification of Repairs

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

e) Liner Acceptance

The constructed liner will be accepted when all non-destruct and destruct tests have passed their respective tests and the results have been verified by the Engineer.

4.2.14 Closure Protective Cover

(1) HPDE Geocomposite Drainage Netting manufactured by SKAPS Industries, or approved equal. Q/C testing information/certification for each property on geocomposite will be provided by the contractor/manufacture for the rolls delivered. The thickness, transmissivity and ply adhesion will be tested by the Engineer's third party laboratory for quality assurance. One roll from every 200,000 ft.^{2} of material delivered to the site will be tested.

SKAPS TRANSNET HDPE GEOCOMPOSITE WITH 250 MIL GEONET

Last Updated on Wednesday, 08 September 2010 07:57

SKAPS TRANSNET™ GeoComposite consists of SKAPS GeoNet made from HDPE resin with non-woven polypropylene GeoTextile fabric heat bonded on both sides of GeoNet.

Property	Test Method	Unit	Required Value		Qualifier
				with 8 oz.	
Geonet					
Thickness	ASTM D 5199	mil		250 ±10	Range
Carbon Black	ASTM D 4218	%		2 to 3	Range
Tensile Strength	ASTM D 5035	lb/in		50	Minimum
Melt Flow	ASTM D 1238[3]	g/10 min		1	Maximum
Density	ASTM D 1505	g/cm^3		0.94	Minimum
Transmissivity[1]	ASTM D 4716	m^2/sec		$2.5x10^{-3}$	MARV[2]
Composite					
Ply Adhesion (Minimum)	ASTM D 7005	lb/in		0.5	MARV
Ply Adhesion (Average)	ASTM D 7005	lb/in		1	MARV
Transmissivity[1]	ASTM D 4716	m2/sec		$2x10^{-4}$	MARV
GeoTextile					
Fabric Weight	ASTM D 5261	oz/yd^2		8	MARV
Grab Strength	ASTM D 4632	lbs		225	MARV
Grab Elongation	ASTM D 4632	%		50	MARV
Tear Strength	ASTM D 4533	lbs		90	MARV
Puncture Resistance	ASTM D 4833	gpm/ft^2		130	MARV
CBR Puncture	ASTM D 6241	lbs		650	MARV
Water Flow Rate	ASTM D 4491	gpm/ft^2		100	MARV
Permittivity	ASTM D 4491	sec^{-1}		1.26	MARV
Permeability	ASTM D 4491	cm/sec		0.3	MARV
AOS	ASTM D 4751	US Sieve		80	MARV

Notes:

1. Transmissivity measured using water at 21 ± 2 °C (70 ± 4 °F) with a gradient of 0.1 and a confining pressure of 10000 psf between steel plates after 15 minutes. Values may vary between individual labs.

2. MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.

3. Condition 190/2.16

The geocomposite will be handled in such a manner as to ensure the geocomposite are not damaged in any way. On slopes, the geocomposite will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles. Geocomposite can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geocomposite will not be welded to the geomembrane. Geocomposite will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geocomposite that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geocomposite will be overlapped by at least four inches and securely tied. Tying can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one foot intervals. In the corners of the side slopes where overlaps between perpendicular geocomposite strips are required, an extra layer of geocomposite will be unrolled along the slope, on top of the previously installed geocomposite, from the top to bottom of the slope.

Any holes or tears in the geocomposite will be repaired by placing a patch, utilizing the same geocomposite material, extending two feet beyond edges of the hole or tear. The patch will be secured to the original geocomposite by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geocomposite will be joined.

The engineer will visually inspect the drainage layer before placement of the erosive layer, if any defects are detected they will be repaired before placement of erosive layer.

(2) Erosive Layer

The soil for the erosive layers shall consist of suitable site soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension, which has been screened. No permeability, grain size, or other tests are required for this material.

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The erosive layer shall be composed of 24" of select backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

The depth of the erosive layer will be verified based on the 50 ft. grid and the difference in elevation from the top of the cohesive soil to the top of the erosive layer.

(a) A minimum of twelve inches (12") of cover between low ground pressure equipment and the liner is required at all times. Roadways for entering and for transporting material over slopes and capped/lined areas shall have a minimum depth of four feet (4').

(b) Avoid undue stress on the liner at all times. Cover material must be pushed up slopes, never down to help minimize wrinkles. Material must be placed to minimize wrinkles, wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Fold over of the liner will not be allowed. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner.

(c) If damage does occur, report it to the Project Manager immediately so that repairs can be performed without needless delay. All repairs to any component of the liner system will be done and tested according to the required repairs and testing for that component

(d) Do not work wet cover material that cannot support equipment.

(e) Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

(3) Vegetative Layer

Native vegetation will be used as approved by the Erosion Control Plan.

4.2.15 Closure Methane Venting System

NC.D.O.T. No.5 stone, Geotextile fabric, and 8" and 10" plastic pipes will be used in the construction of the gas venting system.

(1) Stone in Trenches and Surrounding Perforated Collection Piping

Stone for methane collection system shall meet the requirements of NC DOT aggregate, standard size No. 5 and shall contain no fines. Stone must pass the sieve analysis test for No. 5 stone performed at the quarry.

(2) Geotextile Fabric

Geotextile fabric surrounding the stone/piping shall be non-woven needle punched fabric with the following minimum properties:

1)	Weight	8.0 oz/yd^2	ASTM D-3776
2)	Grab Strength	205 lbs.	ASTM D-4632
3)	Grab Elongation	50%	ASTM D-4632
4)	Trapezoidal Tear Strength	85 lbs.	ASTM D-4533
5)	Puncture Strength	100 lbs.	ASTM D-4833
6)	Mullen Burst Strength	320 psi	ASTM D-3786
7)	Permittivity	1.4 sec^{-1}	ASTM D-4491

Geotextile fabric shall be manufactured by Polyfelt , TNS Advanced Technologies, or approved equal.

(3) Plastic Pipe

Plastic gravity sewer pipe and fittings used for methane vent shall be unplasticized polyvinyl chloride (PVC) and conform to the requirements of ASTM Designation D-3034 on ASTM F679, Type PSM, Class 12454-B, SDR-35 with elastomeric gasket joints. PVC pipe and fittings shall be as manufactured by J-M Pipe, Certainteed, H&W Industries or equal. The methane riser pipe shall be a 10 inch solid wall PVC pipe.

4.3 Documentation

At the completion of the contract, it is the Engineer's responsibility to provide to the Owner and eventually to the Division of Waste Management the following:

1. All parties involved in the landfill construction including name and contact information and responsibilities'.
2. As-built drawings of the subgrade, liner system, leachate collection, gas vents, etc. provided by NC Professional Land Surveyor.
3. Documentation of all subbase standard Proctor tests.
4. Documentation of all cohesive soil liner tests including test pads, permeability, standard Proctor and Atterberg limits.
5. Documentation of all destructive and non-destructive tests, methods and results and repairs.
6. Geomembrane panel layout with test locations and repairs illustrated.
7. Documentation of all hydrostatic testing of non-perforated leachate collection pipe.
8. Completed and signed meeting minutes including pre-construction, progress and any trouble shooting.
9. Summary of all construction activities from the Engineer.
10. Provide color photographs of major construction features.
11. Any other pertinent documentation.

The CQA report shall be sealed by the Engineer and a certification that construction was completed in accordance with the CQA plan, Conditions of the permit to construct, the requirements of rule .1624 Construction Requirements for MSWLF Facilities, and acceptable engineering practices.

Shop Drawings

Contractor is required to submit to the Engineer a descriptive detail and any shop and setting drawings. On composite liner system, such submission shall include the following:

(1) Flexible Membrane Liner Panel Layout Drawings,
(2) Flexible Membrane Liner Penetration Details,
(3) Flexible Membrane Liner Anchoring Detail,
(4) Flexible Membrane Liner Seaming Detail,
(5) Single Flexible Membrane Liner Anchoring to Structure Detail,
(6) Flexible Membrane Liner Extension Detail, and
(7) Certified experience records for manufacturer, fabricator and installer, listing installations of Flexible Membrane Liners.

SEAM TESTING

Project Name ________________________ Project Number ___________________ Superintendent ____________________

NSC FIELD SEAM NO.	SEAM DATE	SHOP DWGN SEAM NO.	WELDER AND SEAMER ID. NO.	TEST DATE	START _____ PRESS.	START TIME	END _____ PRESS.	END TIME	AIR TEST RESULTS	COMMENTS	REPAIR DATE	WELDER AND GUN ID. NO.	REPAIR VACUUM TEST DATE	SEAM (INITIAL) (DATE)

Page _______ of _______

DESTRUCTIVE TEST SAMPLES

Project Name ________________________ Project Number ________________________ Supervisor ________________

DATE	WELDER ID.	SEAMER	SEAM NO.	LOCATION	SAMPLE ID.

Page ______ of ______

TEST SEAM RECORDS

Project Name ________________________Project Number ________________________Supervisor _________________

TEST DATE	TIME	LBS./IN.	PASS/FAIL	MACHINE NUMBER	TEMP. SETTING	OPERATOR

Page _______ of _________

REPAIR REPORT

Project Name __________________________ Project Number ____________________ Supervisor ________________________

FIELD SEAM #	PANEL #	REPAIR DATE	WELDER AND SEAMER ID. #	LOCATION OF REPAIR	REPAIR VACUUM TEST DATE	REPAIR ACCEPTE D (INITIAL) (DATE)

Page ______ of _______

SECTION 5.0

OPERATION PLAN

5.1 Introduction

The County Landfill will only accept Municipal Solid Wastes (MSW) from the County. The County will construct a 9.23 acre Municipal Solid Waste Landfill (Phase 2) according to Subtitle D requirements. The facility will be constructed with 24 inches of cohesive soil (permeability of 1.0×10^{-7} cm/sec), or 18 inches of cohesive soil (permeability of 1.0×10^{-5} cm/sec) with reinforced geosynthetic clay liner (GCL), 60 mil High Density Polyethylene liner (HDPE), 36 inches of protective cover over the liner and a leachate collection system which flows to the existing leachate lagoon.

The perimeter of the lined area will be marked off by 2 inch PVC pipe at 100' intervals that will be placed in the anchor trenches. Solid waste will not be placed within four (4) feet of this boundary to assure that it is being placed directly above the liner system so that no leachate can flow outside of this area.

All storm water that comes in contact with solid waste will be handled as leachate. The leachate is collected in the sump area, where it is pumped by force main to the lagoon.

Storm water that has not come in contact with waste can be removed from the landfill by pumping thru a sump pump over the berm prior to waste being placed in the sump basin. A mobile pump can also be used to pump storm water over the berm.

Leachate will be pumped and treated at the Kinston Wastewater Treatment Plant. The leachate will have to be tested according to the pretreatment conditions outlined in the pre-treatment agreement.

Leachate will be treated at the Kinston Wastewater Treatment Plant. The leachate will have to be tested according to the pretreatment conditions outlined in the pre-treatment agreement. The leachate will be pumped to the Treatment Plant.

The leachate lagoon will be inspected on a monthly basis and a report generated and placed in the landfill records. The report will include the date the liner was inspected, the inspector, general observations since the last inspection, visible abrasions, possible stress cracks, or obvious punctures. Stress cracks can occur in wrinkles that are generated from heat expansion or contraction due to freezing. Also, the HDPE liner may deteriorate due to ultra violet light and this can appear as an abrasion where material can be scraped away with a hard object. If any damage or possible weak spots due to ultra violet exposure has been detected, a qualified HDPE installation company shall be notified immediately so that a repair patch can be installed. The leachate level shall not be allowed to exceed the depth of the damaged liner until it has been repaired and tested by the liner installation company. Once this has been accomplished all testing documentation shall be placed in the operating records.

The County will implement a program at the landfill for detecting and preventing the disposal of hazardous and liquid wastes. The program consists of random inspection of incoming loads at a minimum of 1% of the weekly traffic. Landfill personnel will be trained to recognize hazardous and liquid wastes. Records will be kept on the training and the inspections. (See Section 5.3-Appendix I).

The County will monitor for explosive gases at landfill structures and the perimeter of the landfill. There are fourteen(14) existing methane monitoring probes. The methane monitoring probes will be monitored quarterly. The concentration of methane gases generated by the landfill cannot exceed 25 percent of the lower explosive limit for methane in the structures, and it cannot exceed 100 percent of the lower explosive limit for methane of the landfill property boundary. (See Section 5.4-Appendix II) If methane gas is found to exceed the acceptable limits at either the property boundary or landfill structures, it is the County's responsibility to do the following:

1. Immediately take all necessary steps to ensure protection of human health, i.e. no smoking, temporarily abandon the structure and notify the Division of Waste Management.

2. Within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and

3. Within 60 days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Division of Waste Management that the plan has been implemented. The plan will describe the nature and extent of the problem and the proposed remedy.

Off and on site erosion will be controlled through erosion control structures and devices. Provisions for a vegetative ground cover sufficient to restrain erosion will be accomplished within <u>15 working days</u> or <u>90 calendar days</u> upon completion of any phase of landfill development.

The County will record and retain at the landfill an operating record of the following information:

(1) Inspection records, waste determination records, and training procedures;
(2) Amounts by weight of solid waste received at the landfill;
(3) Waste determination, Leachate sampling data, leachate levels, meteorological data ;
(4) Gas monitoring results and any remediation plans;
(5) Any demonstration, certification, findings, monitoring, testing or analytical data required for surface and groundwater monitoring;
(6) Any monitoring, testing or analytical data required for closure or post-closure;
(7) Any cost estimates and financial assurance documentation.

All information contained in the operating record will be furnished upon request to the Division of Waste Management or be made available at all reasonable times for inspection by the Division.

Ground and surface water will be sampled and analyzed according to Subtitle D Appendix I detection monitoring requirements. The monitoring frequency for all Appendix I detection monitoring constituents will be at least semiannual during the life of the facility (including closure) and the post-closure period. A minimum of four independent samples from each well (background and down gradient) will be collected and analyzed for the Appendix I constituents during the first semiannual sampling event. At least one sample from each well (background and down gradient) will be collected and analyzed during subsequent semiannual sampling events.

If the County determines that there is a statistically significant increase over background for one or more of the constituents listed in Appendix I at any monitoring well at the relevant point of compliance, the County will, within 14 days of the finding, report to the Division of Waste Management and place a notice in the operating record indicating which constituents have shown statistically significant changes from background levels. The County will establish an assessment monitoring program within 90 days. The County may demonstrate that a source other than the landfill caused the contamination or that the statistically significant increase resulted from an error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality. A report documenting these demonstrations will be certified by a Licensed Geologist or Professional Engineer and approved by the Division of Waste Management. A copy of this report will be placed in the operating record. If a successful demonstration is made, documented, and approved by the Division, the County may continue detection monitoring. If after 90 days, a successful demonstration is not made, the County will initiate an assessment monitoring program.

5.2 Operational Requirements

1. Waste Acceptance and Disposal Requirements

   a. The Municipal Solid Waste Landfill (MSWLF) will only accept those solid wastes which it is permitted to receive. The County will notify the Division within 24 hours of attempted disposal of any waste the landfill is not permitted to receive. Signs are placed at the entrance to the Landfill stating that Hazardous and Liquid wastes are not accepted and that random waste screening is performed.

   b. The following wastes are prohibited from disposal at the MSWLF:

      i. Hazardous waste as defined within 15A NCAC 13A, to also include hazardous waste from conditionally exempt small quantity generators.

      ii. Polychlorinated biphenyls (PCB) wastes as defined in 40 CFR 761.

      iii. Bulk or non-containerized liquid waste will not be placed in the landfill unless:

         (i) The waste is household waste other than septic waste and waste oil,
         (ii) The waste is leachate or gas condensate derived from the landfill.

      iv. White Goods, Yard Waste, Tires.

      v. Containers holding liquid wastes will not be placed in the landfill unless:

         (i) The container is a small container similar in size to that normally found in household waste;
         (ii) The container is designed to hold liquids for use other than storage; or
         (iii) The waste is household waste.

      vi. For the purpose of this paragraph:

         (i) Liquid waste means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), S. W. 846.

   c. Spoiled foods, animal carcasses, abattoir waste, hatchery waste, and other animal waste delivered to the disposal site will be covered immediately.

   d. The following are items that are banned in the future from the landfill:

      i. Beverage containers that are required to be recycled under G.S. 18B-1006.1 (Effective January 1, 2008).

      ii. Recyclable rigid plastic containers that are required to be labeled as provided BELOW that have a neck smaller than the body of the container and that accept a screw top, snap cap, or other closure. The prohibition on disposal of recyclable rigid plastic containers in landfills does not apply to rigid plastic containers that are intended for use in the sale or distribution or motor oil. (Effective October 1, 2009)

         (a) For polyethylene terephthalate, the letters “PETE” and the number 1.
         (b) For high density polyethylene, the letters “HDPE” and the number 2.
         (c) For vinyl, the letter “V” and the number 3.
         (d) For low density polyethylene, the letters “LDPE” and the number 4.

(e) For polypropylene, the letters “PP” and the number 6.
(f) For polystyrene, the letters “PS” and the number 7.
(g) For any other, the letters “OTHER” and the number 7.

iii. Motor vehicle oil filters (effective October 1, 2009).

iv. Wooden pallets, except that wooden pallets maybe disposed of in a landfill that is permitted to only accept construction and demolition debris (effective October 1, 2009).

v. Discarded computer equipment (effective April 1, 2011).

e. Asbestos waste will be accepted and managed in accordance with 40 CFR 61. The waste will be covered immediately with soil in a manner that will not cause airborne conditions and must be disposed of separate and apart from other solid wastes:

i. At the bottom of the working face or;
ii. In an area not contiguous with other disposal areas. Separate areas will be clearly designated so that asbestos is not exposed by future land disturbing activities.

f. Wastewater treatment sludges may be accepted either as a soil conditioner incorporated into or applied onto vegetative growth layer but in no case greater than six inches in depth. Or wastewater treatment sludges may be co-disposed in the lined area.

g. The County will continue a program at the Landfill for detecting and preventing the disposal of hazardous and liquid wastes. (Section 5.3-Appendix I) This program will include, at a minimum:

i. Random inspections of incoming loads or other comparable procedures;
ii. Records of any inspections;
iii. Training of facility personnel to recognize hazardous and liquid wastes.
iv. If hazardous wastes are identified by facility personnel, Emergency Management or personnel trained, shall be notified to identify the waste and address removal, storage and final deposition of the waste.

h. Waste placement will be within the areal limits of the base liner system and in a manner consistent with the effective permit.

2. Cover material requirements.

a. Except as in Part (b), The County must cover disposed solid waste with six inches of earthen material at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors blowing litter, and scavenging.

b. Alternative materials such as synthetic cover may be used as daily cover on the working face until it is necessary to cover with earthen material. The alternative material must be approved by the Division of Waste Management and applied according to manufacturers recommendations. At a minimum soil cover will be used once a week.

c. Areas which will not have additional wastes placed on them for 12 months or more, but where final termination of disposal operations has not occurred, will be covered with a minimum of one foot of intermediate cover.

3. Disease vector control

   a. The County will prevent or control on-site populations of disease vectors using techniques appropriate for protection of human health and the environment. At the end of every day, waste will be covered by 6” of soil cover. Any waste that requires immediate cover, will be covered immediately with soil.

   b. "Disease vectors" means any rodents, flies, mosquitoes, or other animals, including insects, capable of transmitting disease to humans.

4. Explosive gases control

   a. The County must ensure that:

      i. The concentration of methane gas generated by the landfill does not exceed 25 percent of the lower explosive limit for methane in landfill structures (excluding gas control or recovery system components); and
      ii. The concentration of methane gas does not exceed 100 percent of the lower explosive limit for methane at the landfill property boundary.

   b. The County will implement a routine methane monitoring program to ensure that the standards of 4 (a) are met. (Section 5.4-Appendix II)

      i. The type and frequency of monitoring must be determined based on the following factors:
         (i) Soil conditions;
         (ii) The hydrogeologic conditions surrounding the facility;
         (iii) The hydraulic conditions surrounding the facility;
         (iv) The location of facility structures and property boundaries.

      ii. The minimum frequency of monitoring will be quarterly.

   c. If methane gas levels exceeding the limits specified in 4 (a) are detected, the owner or operator will:

      i. Immediately take all necessary steps to ensure protection of human health, i.e. no smoking, temporarily abandon the structure and notify the Division of Waste Management.
      ii. Within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and
      iii. Within 60 days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Division of Waste Management that the plan has been implemented. The plan will describe the nature and extent of the problem and the proposed remedy.

   d. "Lower explosive limit" means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25° C and atmospheric pressure.

5. Air Criteria

   a. The County will ensure that the landfill does not violate any applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the US. EPA Administrator pursuant to Section 110 of the Clean Air Act, as amended.

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. Any such infrequent burning will be approved by the Division of Waste Management, Division of Air Quality and the local Fire Marshall.

c. Earth moving equipment will be provided to control accidental fires and leachate tank trucks used for water or leachate that would be recirculated can also be used. Arrangements have been made with the local fire department to provide actual fire protection. This Fire department has access at all times to the landfill to provide fire fighting services when needed. Landfill personnel can use soil to isolate the fire so it will not spread any further but actual fighting of the fire should be the responsibility of the trained fire department.

d. Fires that occur at the landfill will be reported to the Division of Waste Management within 24 hours and written notification will be submitted within 15 days.

6. Access and safety requirements

a. The landfill will be adequately secured by means of gates, chains, beams, fences and other security measures approved by the Division of Waste Management to prevent unauthorized entry.

b. An attendant will be on duty at the site at all times while it is open for public use to ensure compliance with operational requirements.

c. The access road to the site will be of all-weather construction and maintained in good condition.

d. Dust control measures will be implemented when necessary. If dust problems should arise, the County will use any reasonable means necessary to reduce it. At a minimum the County will spray water on necessary areas.

e. Signs providing information on tipping or disposal procedures, the hours during which the site is open for public use, the permit number and other pertinent information will be posted at the site entrance.

f. Signs will be posted stating that no hazardous or liquid waste can be received.

g. Traffic signs or markers will be provided as necessary to promote an orderly traffic pattern to and from the discharge area and to maintain efficient operating conditions.

h. The removal of solid waste from the landfill will be prohibited unless the County approves and the removal is not performed on the working face.

i. Barrels and drums will not be disposed of unless they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained therein, except fiber drums containing asbestos.

7. Erosion and Sedimentation Control Requirements

a. Adequate sediment control measures (structures or devices), will be utilized to prevent silt from leaving the landfill.

b. Adequate sediment control measures (structures or devices), will be utilized to prevent excessive on-site erosion.

c. Provisions for a vegetative ground cover sufficient to restrain erosion will be accomplished within **21 calendar days** upon completion of any phase of landfill development.

8. Drainage Control and Water Protection Requirements

   a. Surface water will be diverted from the operational area and will not be impounded over waste..

   b. Solid waste will not be disposed of in water.

   c. Leachate will be contained on site and properly treated prior to discharge.

   d. The landfill will not:

      (i) Cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements pursuant to Section 402.

      (ii) Cause the discharge of a nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirements 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.

9. Liquids Restriction

   a. Bulk or non-containerized liquid waste will not be placed in the landfill unless:

      (i) The waste is household waste other than septic waste and waste oil,

      (ii) The waste is leachate or gas condensate derived from the landfill.

   b. Containers holding liquid wastes will not be placed in the landfill unless:

      (i) The container is a small container similar in size to that normally found in household waste;

      (ii) The container is designed to hold liquids for use other than storage; or

      (iii) The waste is household waste.

   c. For the purpose of this paragraph:

      (i) Liquid waste means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), S. W. 846.

   d. Test for free liquids:

      Sludges or other wastes may be tested for free liquids after previous screening tests have shown that the waste is not hazardous and does not contain PCB's. The specified test to determine whether or not a material is considered to be a liquid is the Paint Filter Test method 9095. The procedure for conducting this test is as follows:

      (i) Obtain standard 400- micron paint filter;

      (ii) Place a properly-sized, clean, dry funnel in a ring stand or similar device;

      (iii) Fold the filter and line the funnel with it;

(iv) Place a 100 ml sample of waste into the funnel;

(v) Place a clean, dry container under the funnel; and,

(vi) Check in exactly 5 minutes to see if any liquid is in the container.

(vii) If any liquid passes through the filter in 5 minutes or less, the waste is considered to be a liquid. The filtrate can be water, oil or any combination of any non-hazardous liquids.

10. Record keeping Requirements

a. The County's MSWLF will record and retain at the facility, or an alternative location near the facility approved by the Division of Waste Management, in an operating record the following information as it becomes available.

(i) Inspection records, waste determination records, and training procedures;

(ii) Amounts by weight of solid waste received at the landfill to include source of generation.

(iii) Waste determination, Leachate sampling data, leachate levels, meteorological data ;

(iv) Gas monitoring results and any remediation plans;

(v) Any demonstration, certification, findings, monitoring, testing or analytical data required for surface and groundwater monitoring;

(vi) Any monitoring, testing or analytical data required for closure or post-closure; and,

(vii) Any cost estimates and financial assurance documentation.

b. All information contained in the operating record will be furnished upon request to the Division of Waste Management or be made available at all reasonable times for inspection by the Division.

c. The County will maintain a copy of the operation plan at the landfill.

11. Spreading and Compacting Requirements

a. The initial lift of solid waste will be placed over the drainage area of the sump. This lift will be covered with six (6) inches of daily cover and intermediate cover where necessary. This lift will absorb the rain water and allow some of it to evaporate prior to reaching the leachate collection system. When a heavy rain does occur, the impact on the leachate collection system will not be immediate. Prior to placement of solid waste over any leachate pipe, the geotextile fabric that is covering the stone will be folded back so that solid waste will be in direct contact with the stone. This method will not allow biological growth to develop on the geotextile which could eventually clog the system.

b. The initial lift of solid waste will be placed loosely at a depth of 4 feet. As this lift is being placed, a spotter should be placed in the landfill to assure that the compactor does not drive any long, sharp objects through the protective cover into the liner system. If an object were to penetrate the liner system, the protective cover must be removed and the penetration repaired. The subsequent lifts can be placed up to final grades. Heavy landfill equipment including articulating dump trucks, and compactor will only be allowed on areas that have a minimum of 4' of solid waste. Only low pressure equipment such as a D6 LGP Caterpillar will be allowed on the protective cover.

c. The landfill will restrict solid waste into the smallest area feasible, typically 60' x 75' area.

d. Solid waste will be compacted as densely as practical into cells. The compactor should run over an area of solid waste a minimum of 6 times.

e. Appropriate methods such as fencing and diking will be provided within the area to confine solid waste subject to be blown by the wind. At the conclusion of each day of operation, all windblown material resulting from the operation will be collected and returned to the area.

12. Leachate Management Plan

a. The County will record the flows weekly from the sump pumps to the lagoon and the volume pumped from the lagoon to the Waste Water Treatment Plant. Monthly visually inspect the lagoon liner for damage.

b. The County will maintain records for the amount of leachate pumped to the lagoon from the sumps and the amount pumped to the Waste Water Treatment Plant. Records of the visual inspections and any repairs made will also become part of the operating record.

c. The County will quality sample their leachate bi-annually for Appendix I constituents, pH, BOD, COD, TDS, phosphate, nitrate, and sulfate. The sample will be obtained from the inverts of the two(2) force mains coming into the lagoon from Phase 1 and 2, and sampled the same time as the monitoring wells. The results will be part of the operating record and submitted with the semiannual groundwater sampling events.

d. The leachate is being treated by Kinston Wastewater Treatment Plant.

e. Under extreme operational conditions, the County has the option of shutting down the flow of leachate to the lagoon by shutting off the pump. The leachate will be temporarily stored within the MSWLF units until such a time the flow of leachate can continue to the lagoon. If any rain or other event requires storage of leachate or storm water in the cell, the Division of Waste Management will be notified immediately followed by written communication.

f. Leachate will not recirculated.

g. The video camera accessible leachate lines shall be videoed at the completion of the construction to assure that no sediment or other material has accumulated in the lines or the pump riser during construction. Thereafter annually, the same lines will be videoed by the County to assure that no blockages have occurred. If a blockage is encountered, the line will be pressured washed until the blockage is removed and re-videoed. The sediment or other material that has been washed to the sump shall be vacuumed from the sump utilizing a vacuum truck. The lines will be videoed annually and cleaned if necessary until the waste in the landfill has reached the height of the surrounding exterior berms. Once the waste has reached the berm height, the videoing and necessary cleaning shall be done every three years.

Records of all videoing and pressurized washing shall become part of the operating record.

5.3 <u>Appendix I</u>

A. INTRODUCTION

The municipal solid waste stream is made up of wastes from all sectors of society. The waste is often categorized by its source or its characteristics. Terms used include commercial, industrial, residential, biomedical, hazardous, household, solid, liquid, demolition/construction, sludge, etc. Regardless of how one classifies wastes, the bottom line is that wastes are delivered to the landfill and a management decision must be made to either reject or accept them. This responsibility rests with the manager of the landfill. Wastes which are not authorized to be accepted at the landfill create a number of potential problems including: (1) liability due to future releases of contaminants; (2) bad publicity if media learns of unacceptable waste entering the landfill; (3) potential for worker injury; (4) exposure to civil or criminal penalties; (5) damage to landfill environmental control systems.

B. HAZARDOUS WASTE REGULATIONS AND MANAGEMENT

In the United States, hazardous waste is regulated under RCRA, Subtitle C. A waste is hazardous if it is listed as a hazardous waste by the Administrator of the Environmental Protection Agency (EPA) in the Code of Federal Regulations, Title 40, Part 261, or if it meets one or more of the hazardous waste criteria as defined by EPA. These criteria are:

- Ignitability
- Corrosivity
- Reactivity
- Toxicity

1. Ignitability

Ignitable waste is a waste that burns readily, causes a fire by friction under normal circumstances, or is an oxidizer. Any waste having a flash point of <140F falls in this category. Flash point is that temperature at which a liquid gives off vapors that will ignite when an open flame is applied. Under Department of Transportation (DOT) definitions, a flammable liquid has a flash point of >100 F. A combustible liquid has a flash point between 100 and 200 F. Therefore, a flammable liquid is always hazardous while a combustible liquid may or may not be hazardous depending upon its flash point.

2. Corrosivity

A corrosive waste is one having a very high or a very low pH. The pH of a liquid is a measure of how acidic or basic (alkaline) the material is. The pH scale ranges from 0 to 14. High numbers are basic and low numbers are acidic. A substance having a pH $\leq$2.0 or $\geq$12.5 is defined as hazardous under RCRA.

3. Reactivity

A waste is reactive if it is normally unstable: reacts violently with water; forms an explosive mixture with water; contains quantities of cyanide or sulfur that could be released to the air; or can easily be detonated or exploded. These wastes may fall into any one of several DOT categories.

4. Toxicity Characteristic Leaching Procedure (TCLP)

A waste is TCLP toxic if the concentration of any constituent in Table 1 exceeds the standard assigned to that substance. The TCLP is a methodology which attempts to simulate the conditions within a landfill. An acidic solution is passed through a sample of waste and the resultant "leachate" is analyzed for contaminants. The TCLP is designed to detect heavy metals, pesticides and a few other organic and inorganic compounds. The purpose of the test is to prevent groundwater contamination by highly toxic materials. TCLP tests the mobility of 40 different elements and compounds.

Except in certain specified circumstances, regulated quantities of hazardous waste must be disposed of at a permitted hazardous waste disposal facility. In accordance with 40 CFR Part 261.3, **any material contaminated by a hazardous waste is also deemed to be a hazardous waste and must be managed as such.** Hazardous waste from conditionally exempt small quantity generators are to be disposed of in a Hazardous waste disposal facility. RCRA permits are also required to store, transport, and treat hazardous waste.

C. POLYCHLORINATED BIPHENYL'S (PCBs)

1. Introduction

PCBs are nonflammable and conduct heat without conducting electricity. These compounds were most frequently used as an additive to oil or other liquids in situations where heat was involved. The PCBs enhance the heat conducting properties of the liquid and thereby increase the heat dissipation or cooling effect obtained. They have also been used in lubricants and paint. In the United States one of the most common applications was in electric transformers. The only effective method for destroying PCBs is high Temperature incineration which is relatively expensive due to a shortage of PCB incineration capacity.

TABLE 1

T.C.L.P. CONSTITUENTS & REGULATORY LEVELS (mg/L)			
CONSTITUENT	REG LEVEL	CONSTITUENT	REG LEVEL
Arsenic	5.0	Hexachlorobenzene	0.13
Barium	100	Hexachloro-1,3-butadiene	0.5
Benzene	0.5	Hexachloroethane	3.0
Cadmium	1.0	Lead	5.0
Carbon Tetrachloride	0.5	Lindane	0.4
Chlordane	0.03	Mercury	0.2
Chlorobenzene	100	Methoxychlor	10.0
Chloroform	6.0	Methyl ethyl ketone	200
Chromium	5.0	Nitrobenzene	2.0
m-Cresol	200	Pentachlorophenol	100
o-Cresol	200	Pyridine	5.0
p-Cresol	200	Selenium	1.0
Cresol	200	Silver	5.0
1,4-Dichlorobenzene	10.0	Tetrachloroethylene	0.7
1,2-Dichloroethane	0.7	Toxaphene	0.5
1,1-Dichloroethylene	0.5	Trichloroethylene	0.5
2,4-Dichlorophenoxyacetic acid	0.7	2,4,5-Trichlorophenol	400
2,4-Dinitrotoluene	0.13	2,4,6-Trichlorophenol	2.0
Endrin	0.02	2,4,5-TP (Silvex)	1.0
Heptachlor (and its hydroxide)	0.008	Vinyl Chloride	0.2

By law PCB's are no longer used as dielectrics in transformers and capacitors manufactured after 1979. There are many millions of pounds of PCBs still in use or in storage. One example is the ballasts used in fluorescent light fixtures. It has been estimated that there are between 0.5 million and 1.5 billion ballasts currently in use in this country. Due to the long life of these units, about half of these may be of pre-1979 manufacture and contain PCBs. Since each ballast contains about one ounce of nearly pure PCB fluid, there are about **20 to 30 million pounds** of PCBs in existing lighting fixtures. These items are <u>not</u> the subject to RCRA Subtitle D Waste Screening!

Commercial or industrial sources of PCB wastes that should be addressed by the program include:

- Mineral oil and dielectric fluids containing PCBs;
- Contaminated soil, dredged material, sewage sludge, rags, and other debris from a release of PCBs;
- Transformers and other electrical equipment containing dielectric fluids; and
- Hydraulic machines.

2. PCB Regulatory Requirements

As contrasted to hazardous wastes, the Toxic Substance Control Act regulates PCBs based on the concentration of PCBs in the waste rather than the source or characteristic of the waste. The regulations concerning PCB disposal are spelled out in 40 CFR Part 761. Subtitle D of RCRA merely requires that PCB waste not be disposed in a MSW landfill. PCB management requirements include:

Waste containing more than 500 ppm of PCBs must be incinerated. Waste containing from 50 to 500 ppm must be disposed of by incineration, approved burning, or in chemical waste landfill permitted to receive such wastes. The regulations are silent concerning wastes containing less than 50 ppm of PCBs; however, the regulations cannot be circumvented by diluting stronger wastes.

D. FUNDAMENTALS OF WASTE SCREENING

1. Know Your Generators and Haulers

Since the level of sophistication of your waste screening program will be a reflection of the likelihood of hazardous waste and PCB waste being in your incoming waste, **<u>knowledge of the commercial industrial base of your service area is critical.</u>** Some examples are the automotive industry, which generates solvents, paint wastes, lead acid batteries, grease and oil; the dry cleaning industry, which may generate filters containing dry cleaning solvents; metal platers which generate heavy metal wastes; and other industries which generate a variety of undesirable wastes; e.g. chemical and related products, petroleum refining, primary metals, electrical and electronic machinery, etc.

Landfill managers should also know the haulers and trucks serving the businesses in their community which are likely to carry unacceptable wastes.

Some local governments and solid waste management agencies have enacted legislation requiring haulers to provide a manifest showing the customers whose wastes make up that particular load. Such a manifest is an extremely useful tool when a load is found to contain prohibited wastes. It is unwise to accept wastes from unknown, unlicensed, or otherwise questionable haulers.

2. Inspections

An inspection is typically a visual observation of the incoming waste loads by an individual who is trained to identify regulated hazardous or PCB wastes that would not be acceptable for disposal at the MSWLF unit. The training of landfill personnel will be conducted by a local EMS official or a SWANA certification. An inspection is considered satisfactory if the inspector knows the nature of all materials received in the load and is able to discern whether the materials are potentially regulated hazardous wastes or PCB wastes.

Ideally, all loads should be screened; however, it is generally not practical to inspect in detail all incoming loads. Random inspections, therefore, can be used to provide a reasonable means to adequately control the receipt of inappropriate wastes. Random inspections are simply inspections made on less than every load. At a minimum the inspection frequency will not be less than one percent of the waste stream.

The frequency of random inspections may be based on the type and quantity of wastes received daily, and the accuracy and confidence desired in conclusions drawn from inspection observations. Because statistical parameters are not provided in the regulation, a reasoned, knowledge-based approach may be taken. A random inspection program may take many forms such as inspecting every incoming load one day out of every month or inspecting one or more loads from transporters of wastes of unidentifiable nature each day. If these inspections indicate that unauthorized wastes are being brought to the MSWLF site, the random inspection program should be modified to increase the frequency of inspections.

Inspection priority also can be given to haulers with unknown service areas, to loads brought to the facility in vehicles not typically used for disposal of municipal solid waste, and to loads transported by previous would-be offenders. For wastes of unidentifiable nature received from sources other than households (e.g., industrial or commercial establishments), the inspector should question the transporter about the source/composition of the materials.

An inspection flow chart to identify, accept, or refuse solid waste is provided as Figure 1.

Inspections of materials may be accomplished by discharging the vehicle load in an area designed to contain potentially hazardous wastes that may arrive at the facility. The waste should be carefully spread for observation using a front end loader or other piece of equipment. The Division of Waste Management recommends that waste should be hand raked to spread the load. Personnel should be trained to identify suspicious wastes. Some indications of suspicious wastes are:

- Hazardous placards or markings;
- Liquids;
- Powders or dusts;
- Sludges;
- Bright or unusual colors;
- Drums or commercial size containers; or
- Chemical odors.

The County will follow these procedures when suspicious wastes are discovered.

- Segregate the wastes;
- Question the driver;
- Review the manifest (if applicable);
- Contact possible source;
- Call the State Solid Waste Management Department;
- Use appropriate protective equipment;
- Contact laboratory support if required; and
- Notify the local Hazardous Material Response Team.

Containers with contents that are not easily identifiable, such as unmarked 55-gallon drums, should be opened only by properly trained personnel. Because these drums could contain hazardous waste, they should be refused whenever possible. Upon verifying that the solid waste is acceptable, it may then be transferred to the working face for disposal.

Testing typically would include the Toxicity Characteristic Leaching Procedure (TCLP) and other tests for characteristics of hazardous wastes including corrositivity, ignitability, and reactivity. Wastes that are suspected of being hazardous should be handled and stored as a hazardous waste until a determination is made.

If the wastes temporarily stored at the site are determined to be hazardous, Lenoir County is responsible for the management of the waste. If the wastes are to be transported from the facility, the waste must be: (1) stored at the MSWLF facility in accordance with requirements of a hazardous waste generator, (2) manifested, (3) transported by a licensed Treatment, Storage, or Disposal (TSD) facility for disposal.

E. RECORD KEEPING AND NOTIFICATION REQUIREMENTS

Records must be kept pursuant to an incident where regulated hazardous waste or prohibited waste is found at the landfill. It is also recommended that records be kept of all screening activities and incidents, whether or not, regulated or prohibited wastes are found. This will help prove that the landfill owner/operator has acted in a prudent and reasonable manner.

The best way to prove compliance with this requirement is to document each inspection including:

Date and time of waste detection
Hauler name (company and driver)
Waste(s) detected
Waste generator(s) if able to identify
Action(s) taken to manage or return material(s)
Efforts taken if extreme toxicity or hazard was discovered
Landfill employee in responsible charge

40 CFR Part 258 requires that records should be maintained at or near the landfill site during its active life and as long after as may be required by the appropriate state or local regulations.

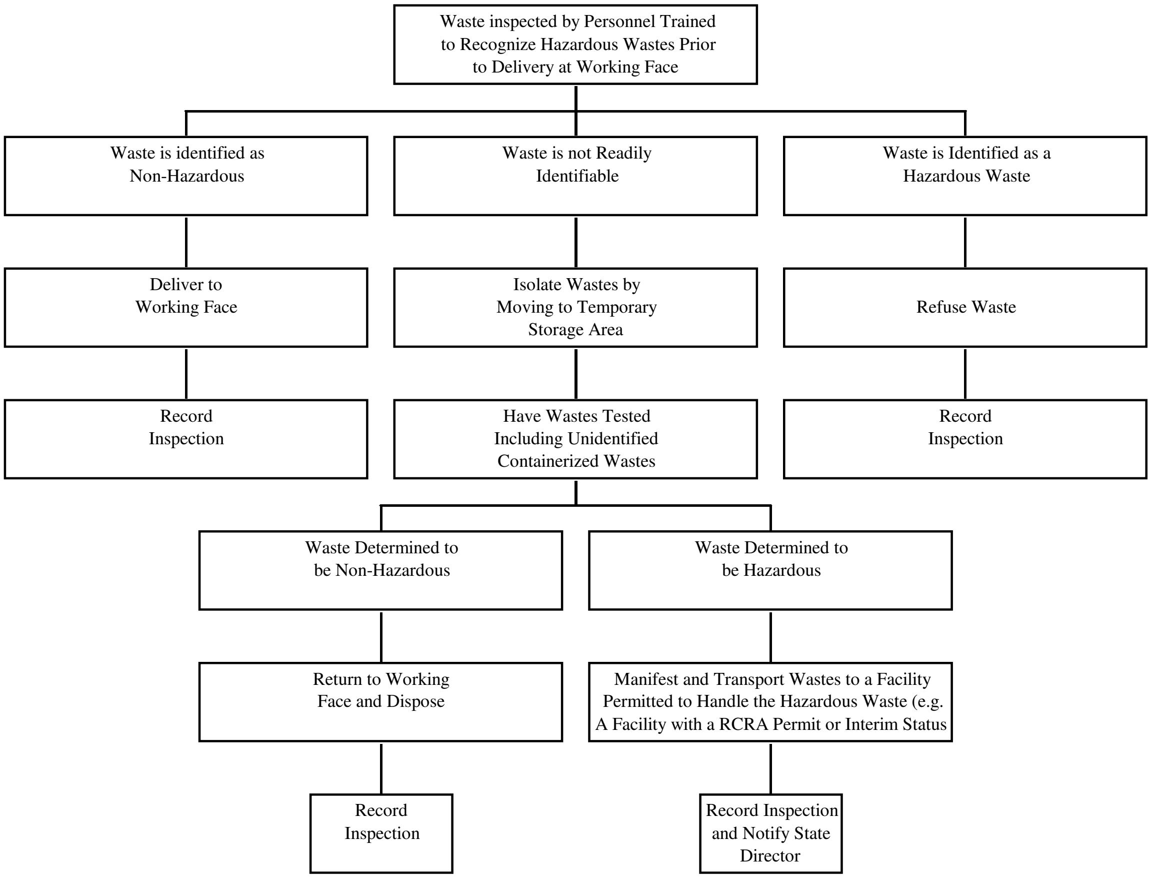

FIGURE 1
Hazardous Waste Inspection Decision Tree
Inspection Prior to Working Face

WASTE SCREENING CHECK LIST

CONTAINERS	YES	NO
FULL…………………………………………………………..	______	______
PARTIALLY FULL………………………………………..	______	______
EMPTY……………………………………………………..	______	______
CRUSHED………………………………………………….	______	______
PUNCTURED……………………………………………….	______	______
POWDERS/DUSTS		
IDENTIFIED……………………………………………….	______	______
UNKNOWN………………………………………………….	______	______
SATURATION……………………………………………	______	______
LABEL/HAZARDOUS…………………………………..	______	______
ODOR/FUMES		
STRONG…………………………………………………….	______	______
FAINT………………………………………………………..	______	______
HEAT………………………………………………………..	______	______
ITEMS FOUND		
BATTERIES……………………………………………….	______	______
OIL……………………………………………………………..	______	______
BIOMEDICAL……………………………………………	______	______
RADIOACTIVE…………………………………………..	______	______
ASHES/RESIDUE………………………………………..	______	______
SOD/SOIL………………………………………………….	______	______
LIQUID……………………………………………………	______	______
HAZARDOUS……………………………………………..	______	______
PCB'S……………………………………………………….	______	______

CHECK ALL THAT APPLY

DETAILED SCREENING REPORT

WASTE SOURCE____
ADDRESS____
____
____

PROBABLE [ ] SUSPECTED [ ] CONFIRMED [ ]

WASTE
HAULER____
ADDRESS____
____
____

DRIVER'S NAME____
DETAIL____
____
____

NOTIFIED:

WASTE SOURCE [ ] HAULING MANAGEMENT [ ] SITE MANAGEMENT [ ]

STATE [ ] FEDERAL [ ]

NAME____
WITNESS (IF ANY)____
DATE______________________TIME______________________ AM PM
____

ACTION REQUIRED

5.4 **Appendix II**

LENOIR COUNTY - EXPLOSIVE GAS CONTROL PLAN

Quarterly, the County Landfill will monitor the explosive gas at the landfill structures and at or near the landfill boundary. The permanent probes consist of a plastic stand pipe similar to a piezometer used for groundwater detection.

The location and spacing of the methane monitoring probes is somewhat arbitrary. The locations were determined by the relationship of solid waste with property lines and landfill structures. The spacing of the monitoring probes is between 200 and 400 feet. The migration of methane gas is induced by pressure gradients. The methane will move from areas of high pressure to those of low pressure following the path of least resistance. The methane will migrate vertically until it reaches the landfill cap, where it will begin to flow horizontally. This occurs until it finds a pathway out, either by the installed methane collection trenches or migration through the permeable *in situ* soils. Since methane is lighter than air, it wants to escape into the atmosphere. It has been our experience that whenever gas is migrating no matter what the spacing or depth of the monitoring probes, the gas will fill the void created by the monitoring point and an explosive meter will monitor the level. The various depths of the monitoring probes are to ensure a stable monitoring point. The only time a shallow monitoring point has not worked is in a very heavy, impermeable clay layer that acts as a seal to the migration of the gas. If a clay layer is encountered during the construction of the monitoring points, it will either be moved beyond the clay or excavated to a depth that is in the conductive zone below the clay.

The permanent probes surround Phase 2. The County's landfill is designed with a base liner system and cap system, there should be no migration of methane in the permeable *in situ* soils.

The gas can be detected by use of an instrument that reports the percent of lower explosive limit. The instrument being used is the Gas Tech GP 204.

Based on current conditions, there are fourteen(14) existing monitoring points. Quarterly, a County employee will visit each monitoring point either the temporary or permanent. The monitoring points consist of all methane probes and leachate collection system cleanouts. Using the detection instrument, he will determine if methane gas has filled the probes. If the probe is near the property line and methane gas is detected at or beyond the lower explosive limit (100% LEL), it must then be determined if the gas is migrating across the landfill boundary. If the probe is on the boundary or methane gas has migrated beyond the boundary , a remediation plan must be completed by Lenoir County.

Other points of monitoring will be the landfill structures. Each structure will be monitored for methane using the following methods:

1. All crawl spaces will be monitored;
2. All corners in the structure will be monitored;
3. Any holes, cracks and pipes through the foundation will be monitored

If methane gas is detected beyond 25% of its lower explosive limit in any structure, check the calibration of the monitor and resample. If the reading is still above 25%, evacuate the building and try to find the source of gas. If the source is found try to remove the source. If this fails a remediation plan is stated in the operational requirements.

5.5 <u>Operation Drawings</u>

5.5.1 Title Sheet
5.5.2 Index Sheet
5.5.3 Facility Operations
5.5.4 Initial Placement of Waste
5.5.5 Initial Fill Plan
5.5.6 2nd Year Fill Plan
5.5.7 3rd Year Fill Plan
5.5.8 4th Year Fill Plan
5.5.9 Final Fill with Intermediate Cover
5.5.10 Final Fill with Methane Venting and Monitoring System
5.5.11 Operation Details

LENOIR COUNTY
MUNICIPAL SOLID WASTE
LANDFILL FACILITY

OPERATION PLAN - PHASE 2

Permit Number: 5409-MSWLF
Site Location: 2949 Hodges Farm Road
La Grange, NC 28551

Applicant: Lenoir County
Applicant's Address: 130 South Queen Street
Kinston, NC 28502

BOARD OF COMMISSIONERS

George W. Graham, Jr. - Chairman
Claude Stroud - Vice-Chairman
Jackie Brown
Reuben Davis
Chris Humphrey
Thomas A. Pharo
Linda Rouse Sutton

COUNTY MANAGER

Michael W. Jarman

SOLID WASTE DIRECTOR

Tom Miller

Engineer
Municipal Engineering Services Company, P.A.
Garner, NC - Morehead City, NC - Boone, NC

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE
11/25/2009

by ______________________
Professional Engineer
(Garner Office)

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529
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P.O. BOX 349 BOONE, N.C. 28607
(828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557
(252) 726-9481

SCALE:	1:1
DATE:	10/22/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. T1	SHEET NO. 1 OF 11

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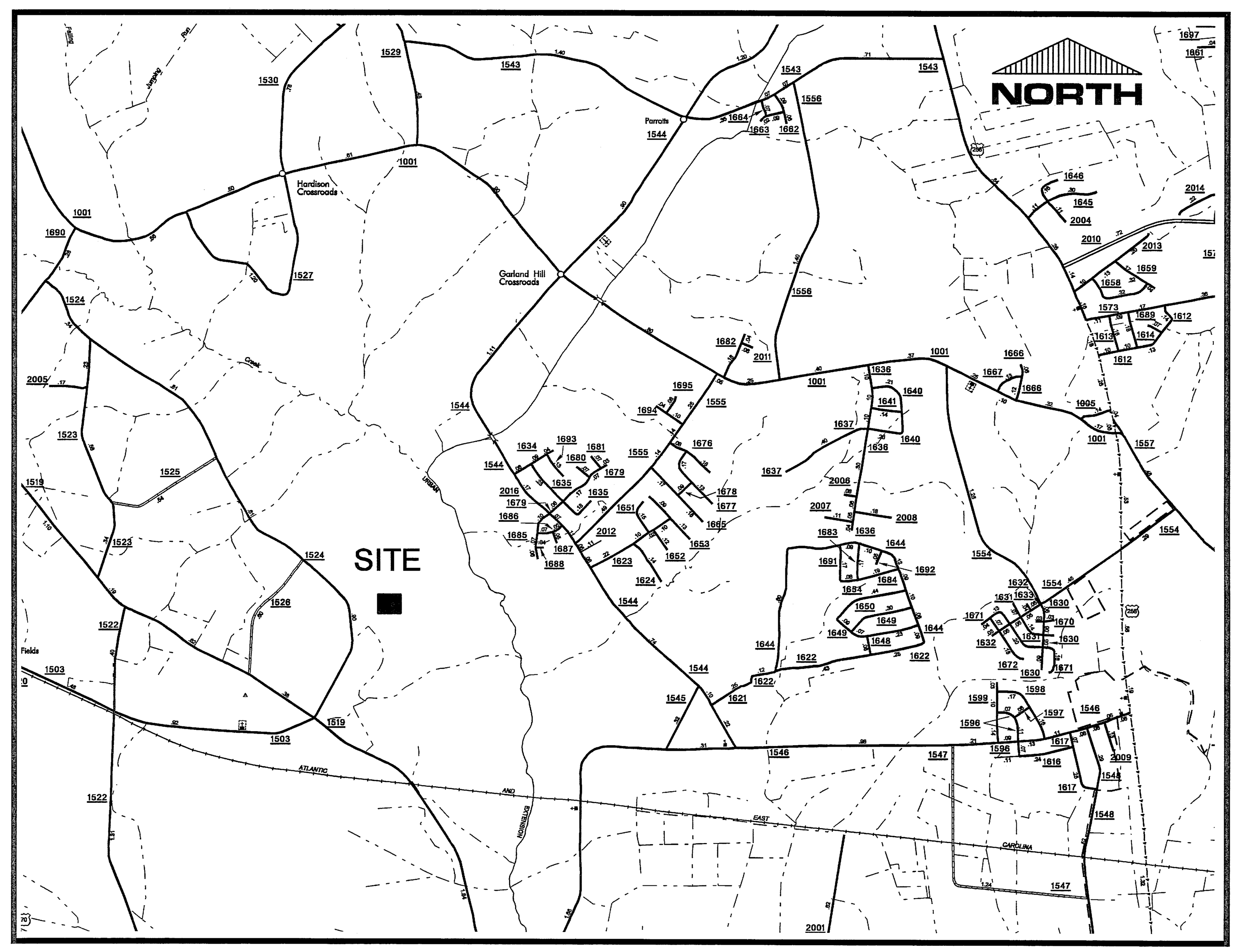
INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION
1	T1	TITLE SHEET
2	T2	INDEX AND VICINITY MAP
3	P1	FACILITY OPERATIONS
4	P2	INITIAL PLACEMENT OF WASTE
5	P3	INITIAL FILL PLAN
6	P4	2nd YEAR FILL PLAN
7	P5	3rd YEAR FILL PLAN
8	P6	4th YEAR FILL PLAN
9	P7	FINAL FILL WITH INTERMEDIATE COVER
10	P8	METHANE VENTING AND MONITORING PLAN
11	P9	OPERATION DETAILS



VICINITY MAP

LICENSE NUMBER: C-0281
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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

INDEX AND VICINITY MAP

SCALE:	1:1
DATE:	5/21/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. T2	SHEET NO. 2 OF 11

11/25/2009

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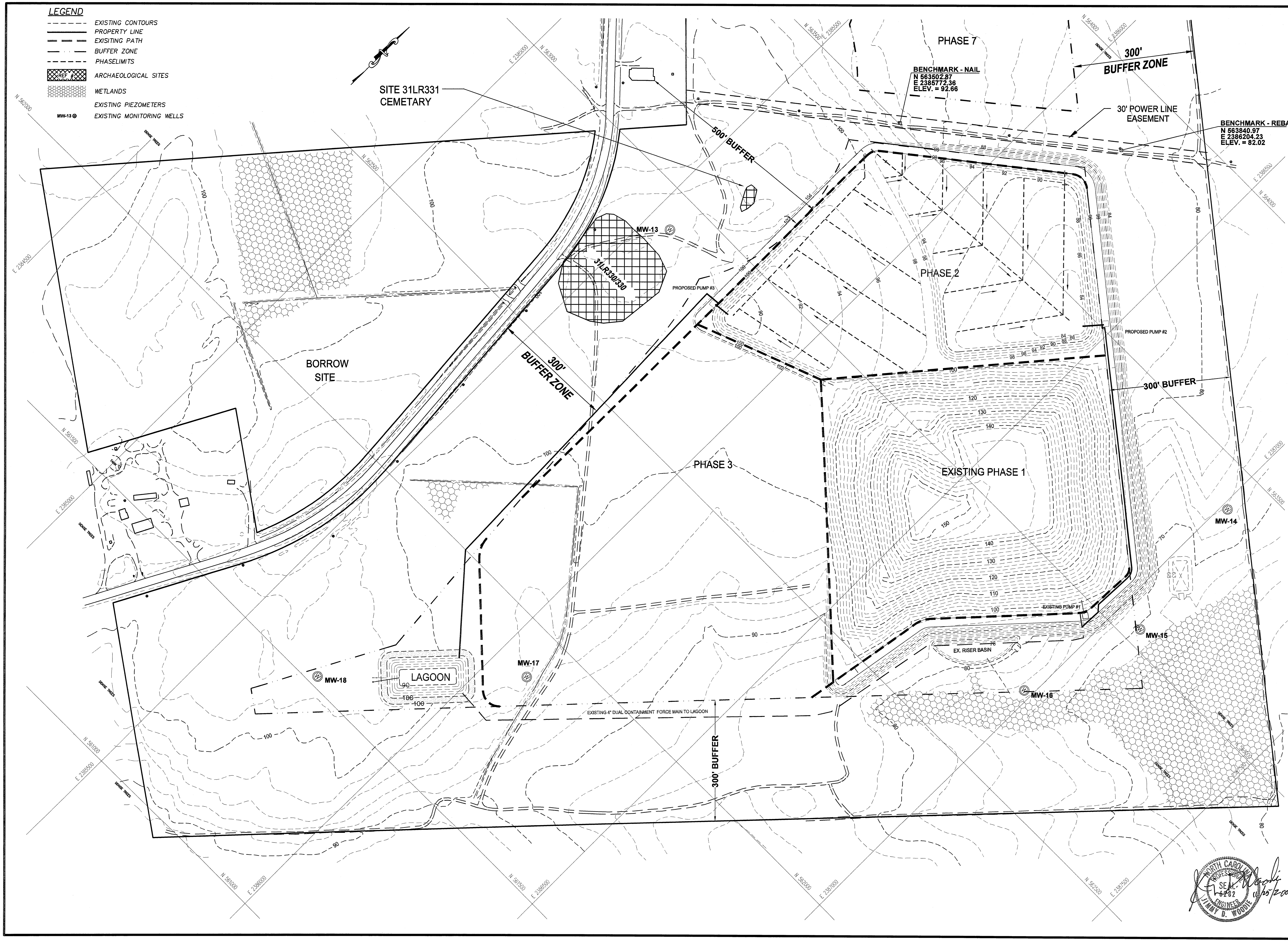

LICENSE NUMBER: C-0281

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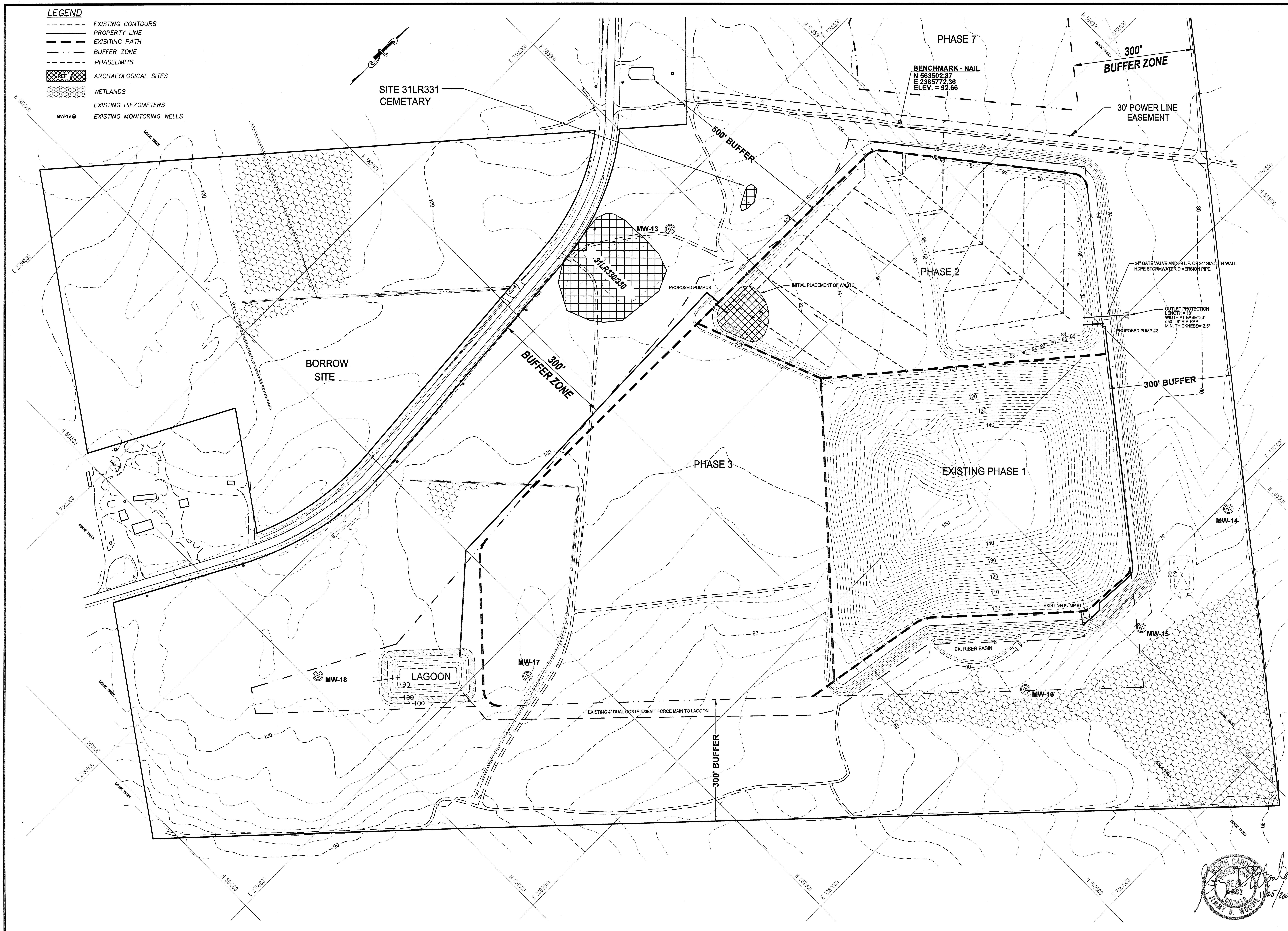
P.O. BOX 828 MOREHEAD CITY, N.C. 28557
(252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
			OPERATION PLAN – PHASE 2 FACILITY OPERATIONS

SCALE:	1" = 100'
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO.	SHEET NO.
P1	3 OF 11



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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
			OPERATION PLAN – PHASE 2 INITIAL PLACEMENT OF WASTE AND STORMWATER DIVERSION

SCALE:	1" = 100'
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO.	SHEET NO.
P2	4 OF 11

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL JIMMY D. WOODIE

11/25/09

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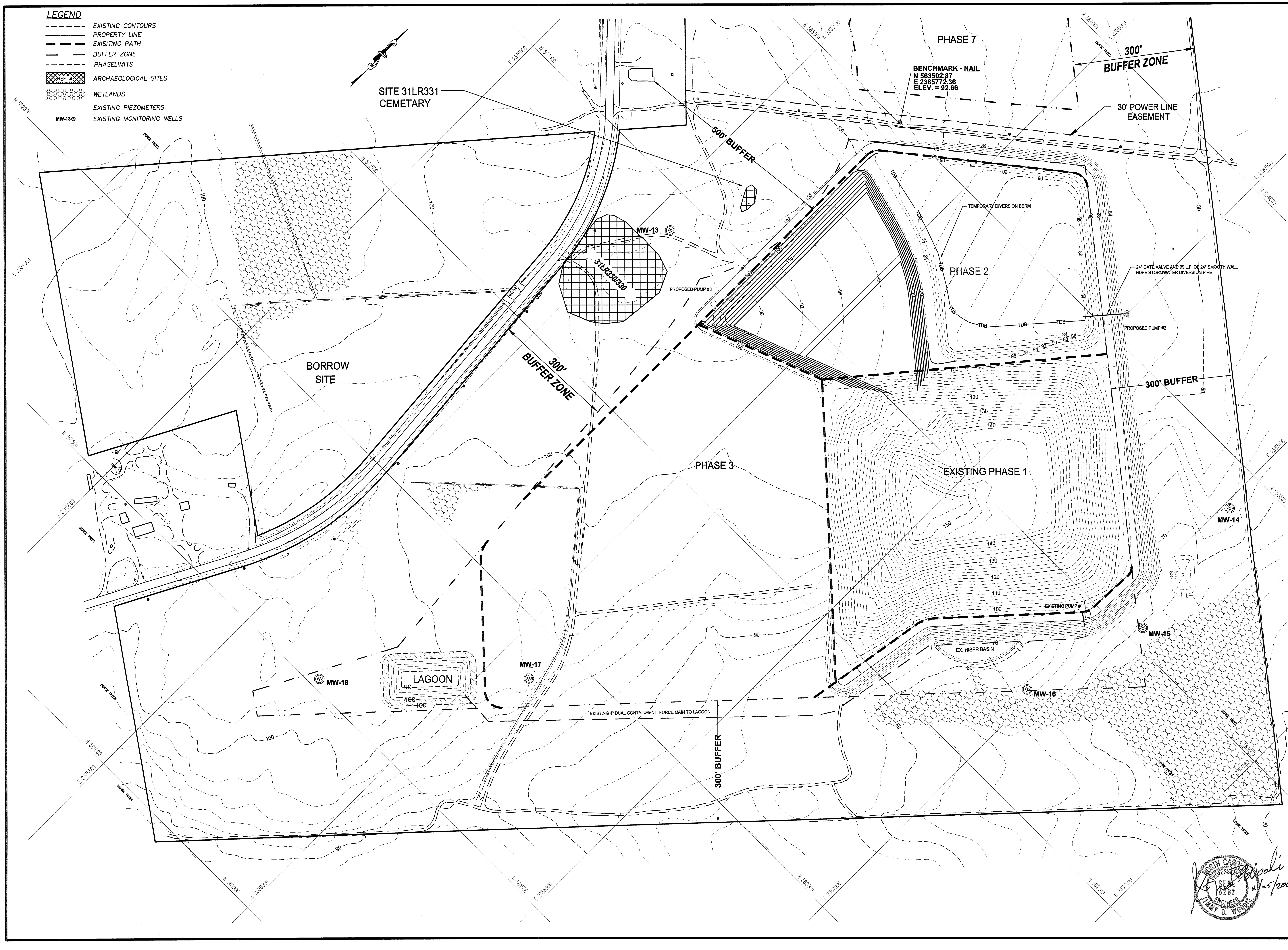

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
			OPERATION PLAN – PHASE 2 INITIAL FILL PLAN

SCALE:	1" = 100'
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. P3	SHEET NO. 5 OF 11

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 16282 JIMMY D. WOODIE
11-25-2009

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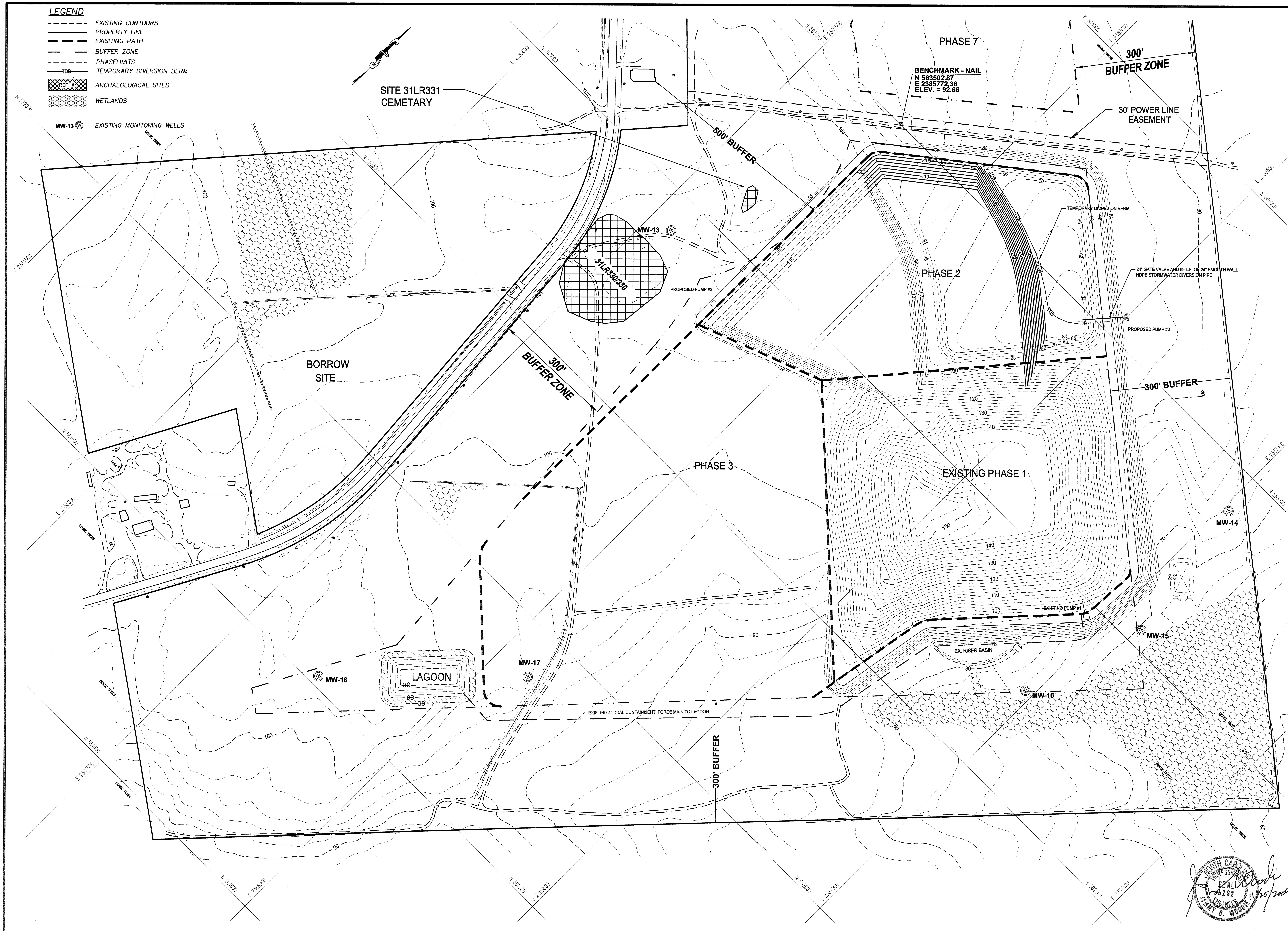

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

OPERATION PLAN – PHASE 2
2nd YEAR FILL PLAN

SCALE:	1" = 100'
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO.	P4
SHEET NO.	6 OF 11

NORTH CAROLINA PROFESSIONAL SEAL 26282 ENGINEER JIMMY D. WOODIE

11/25/2009

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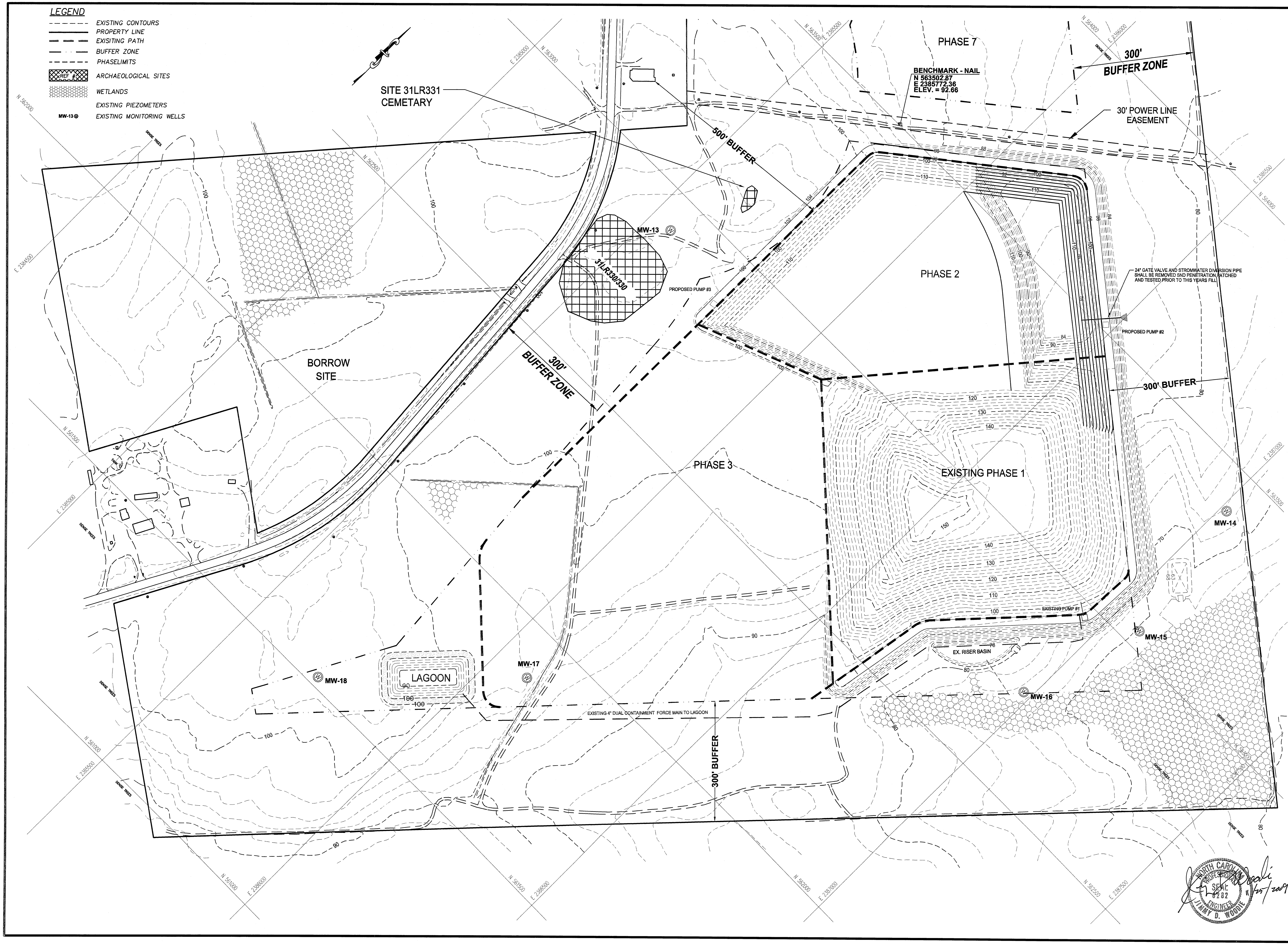

LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

OPERATION PLAN – PHASE 2
3rd YEAR FILL PLAN

SCALE: 1" = 100'
DATE: 10/20/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER: G08095
DRAWING NO.: P5
SHEET NO.: 7 OF 11

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 028282 JIMMY D. WOODIE 11/25/2009

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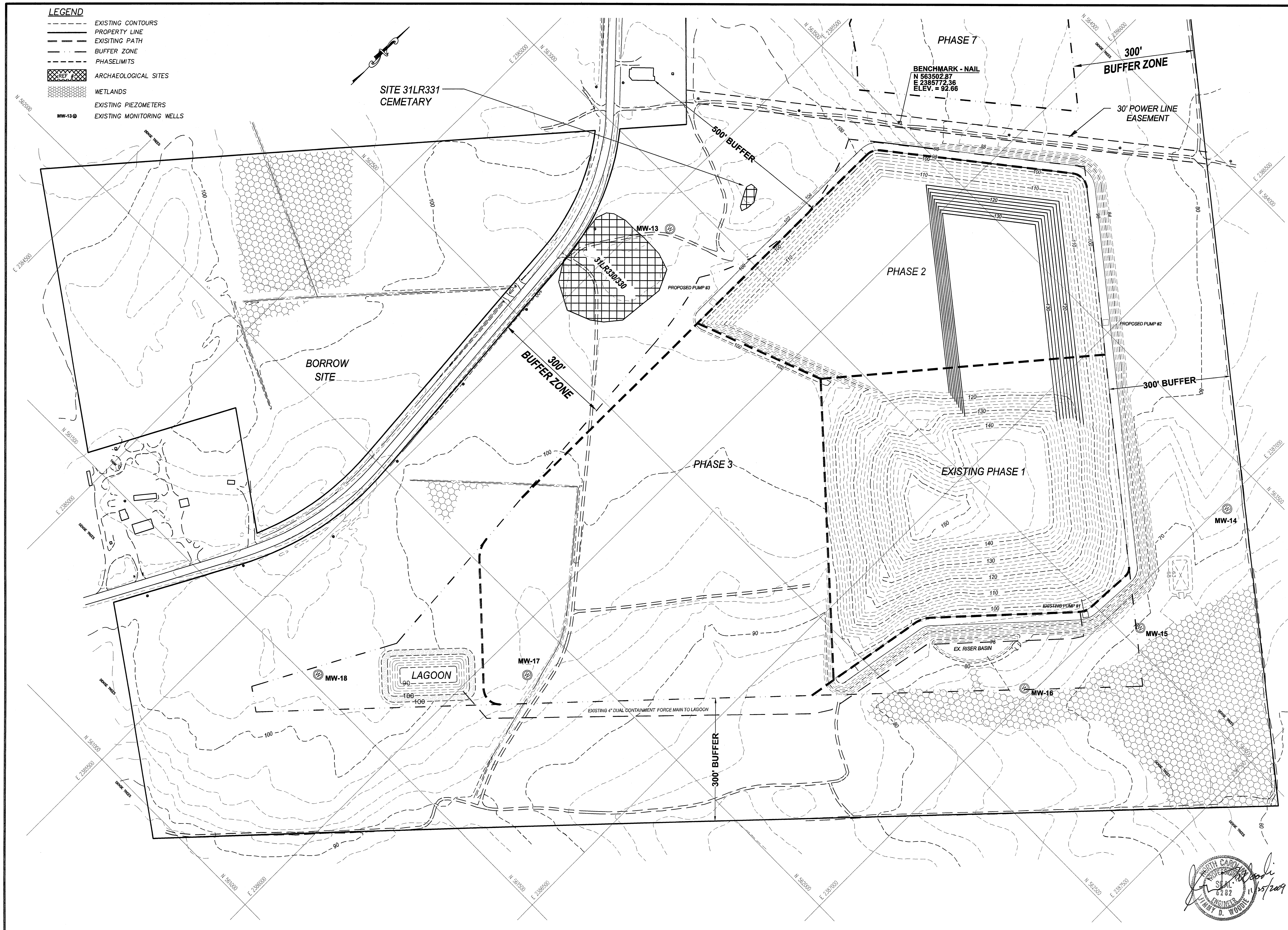

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

OPERATION PLAN – PHASE 2
4th YEAR FILL PLAN

SEAL 6282 — NORTH CAROLINA — ENGINEER — JIMMY D. WOODIE

11/25/2009

SCALE:	1" = 100'
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE

PROJECT NUMBER
G08095

DRAWING NO.	SHEET NO.
P6	8 OF 11

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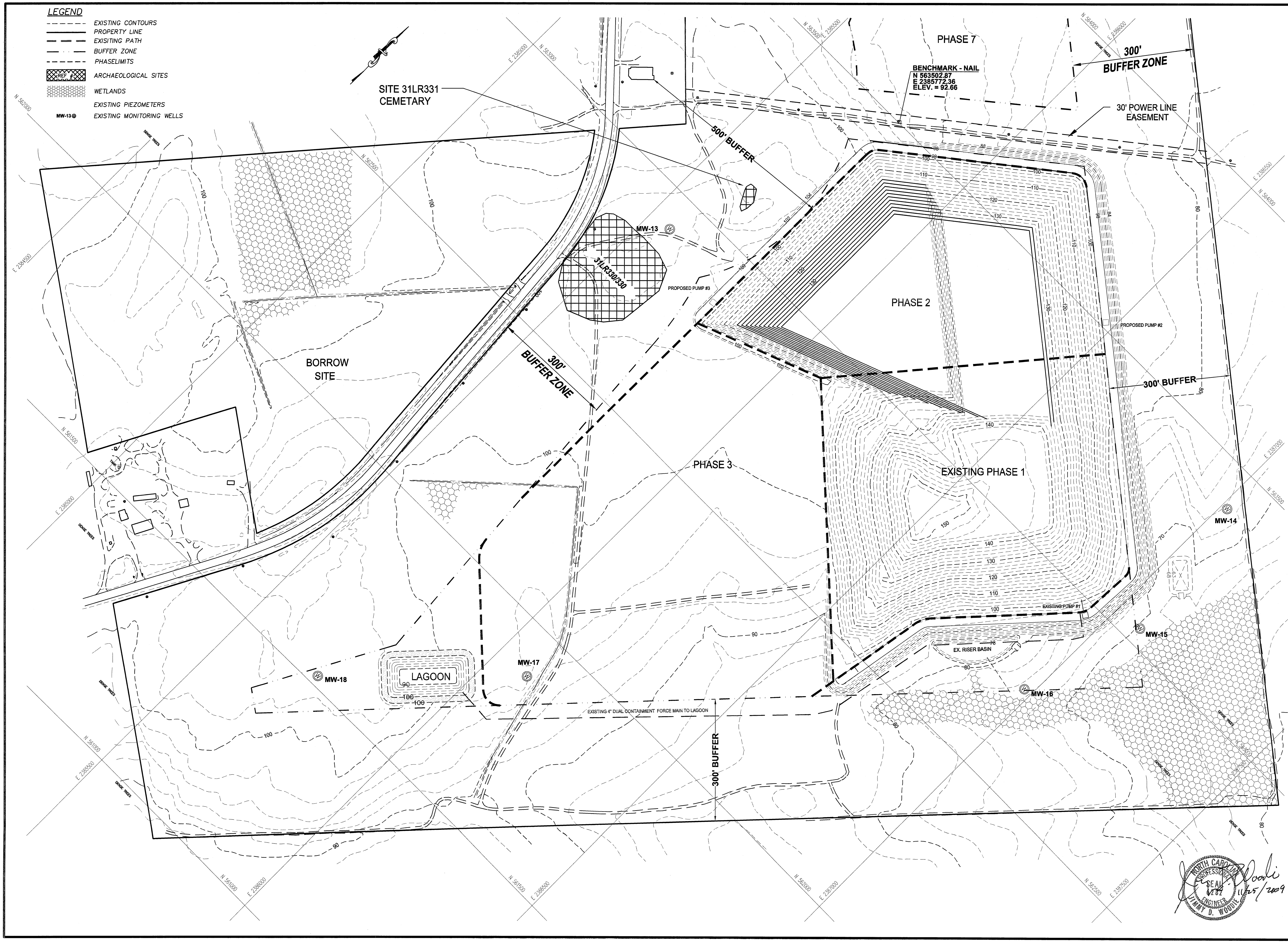

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

OPERATION PLAN – PHASE 2
FINAL FILL WITH INTERMEDIATE COVER

SCALE:	1" = 100'
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE

PROJECT NUMBER
G08095

DRAWING NO.	SHEET NO.
P4	9 OF 11

NORTH CAROLINA PROFESSIONAL SEAL ENGINEER JIMMY D. WOODIE

11/25/2009

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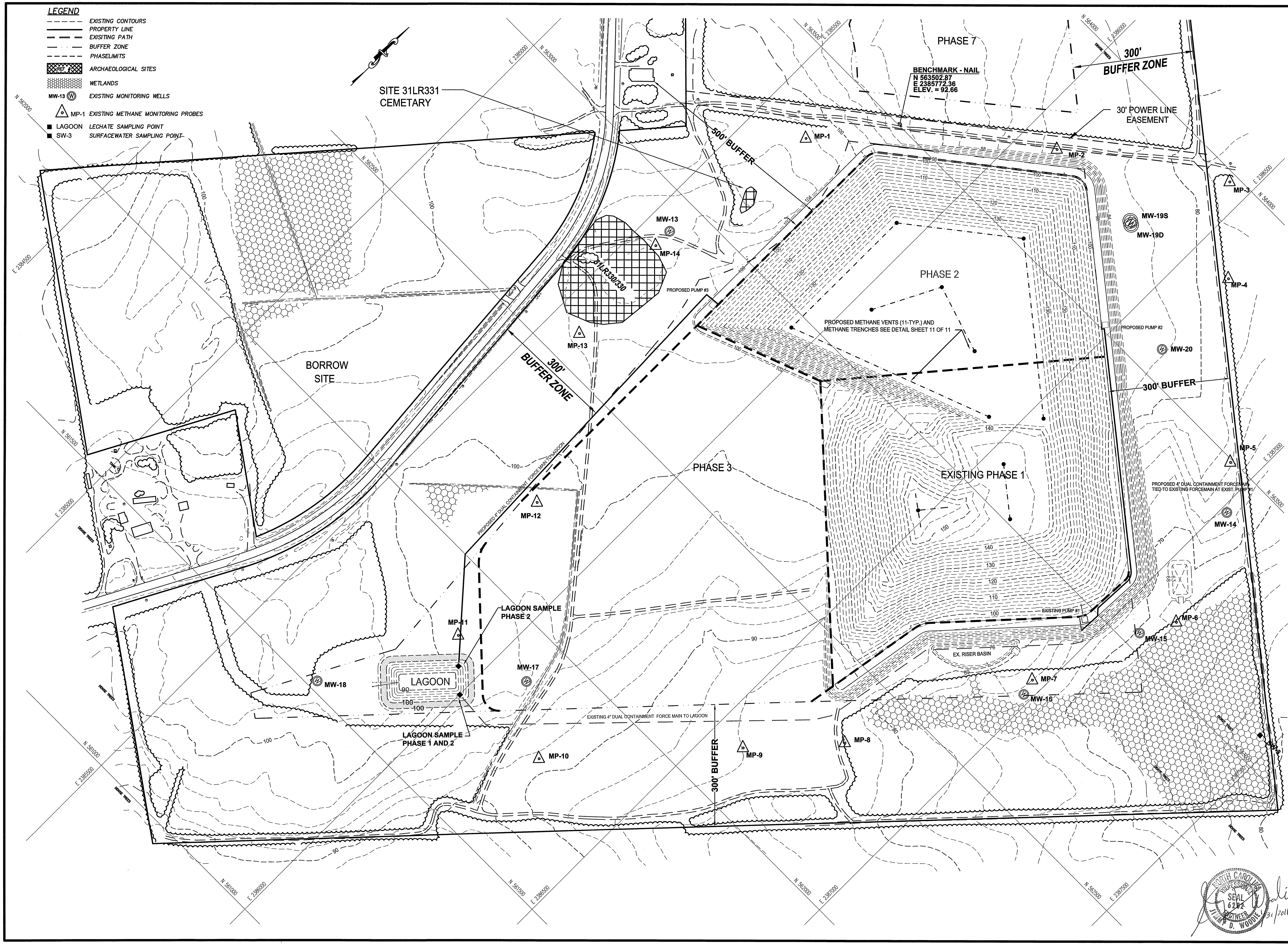

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY

LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
11/19/2010	LHC	2	REV'D PER NCDENR COMMENT LETTER DATED 11/17/2010
9/16/10	LCH	1	REV'D PER NCDENR COMMENT LETTER DATED 7/21/2010 AND 9/9/2010

OPERATION PLAN – PHASE 2
METHANE VENTING AND MONITORING PLAN

SCALE:	1" = 100'
DATE:	10/20/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G08095
DRAWING NO. P8	SHEET NO. 10 OF 11

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6202 JIMMY D. WOODIE

31/2011

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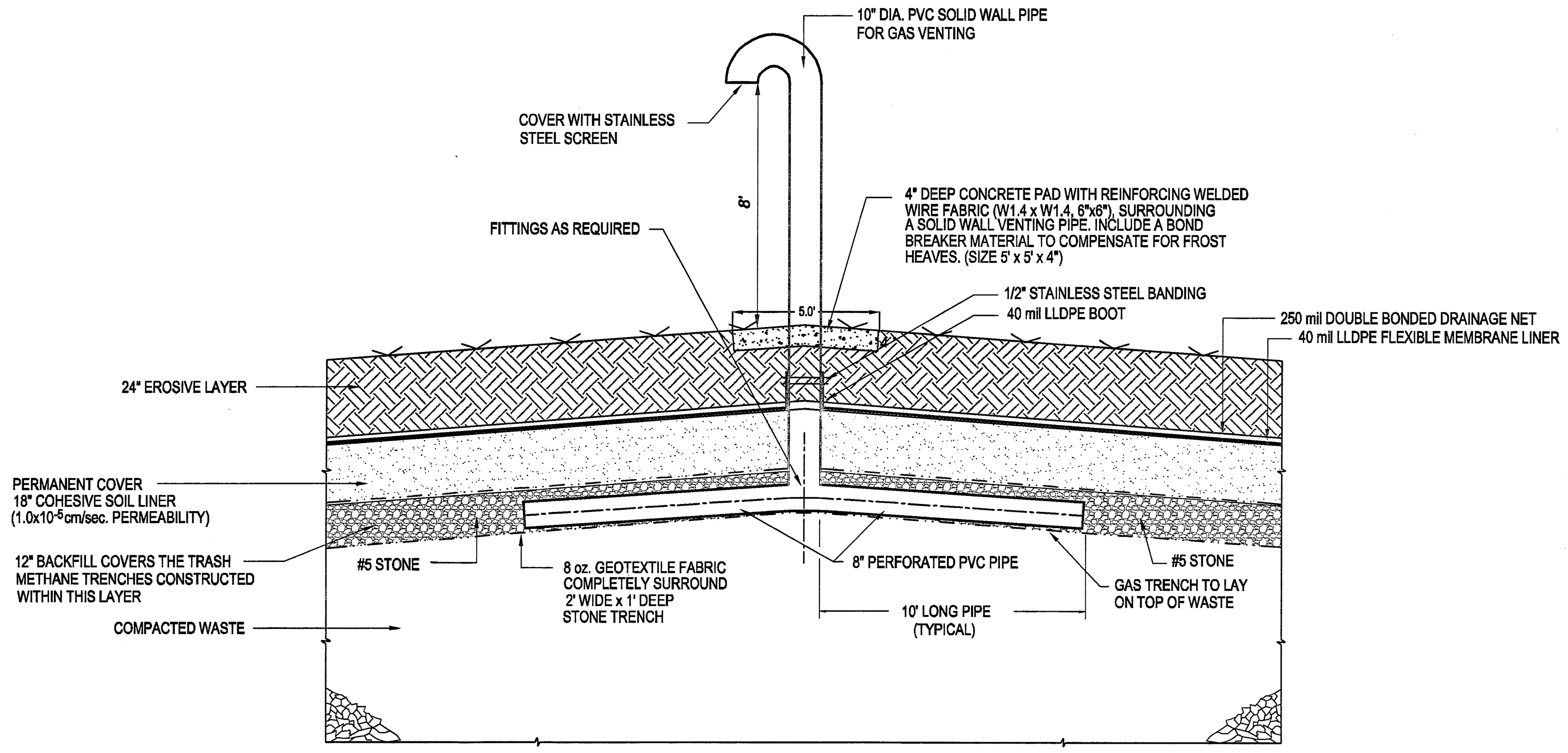
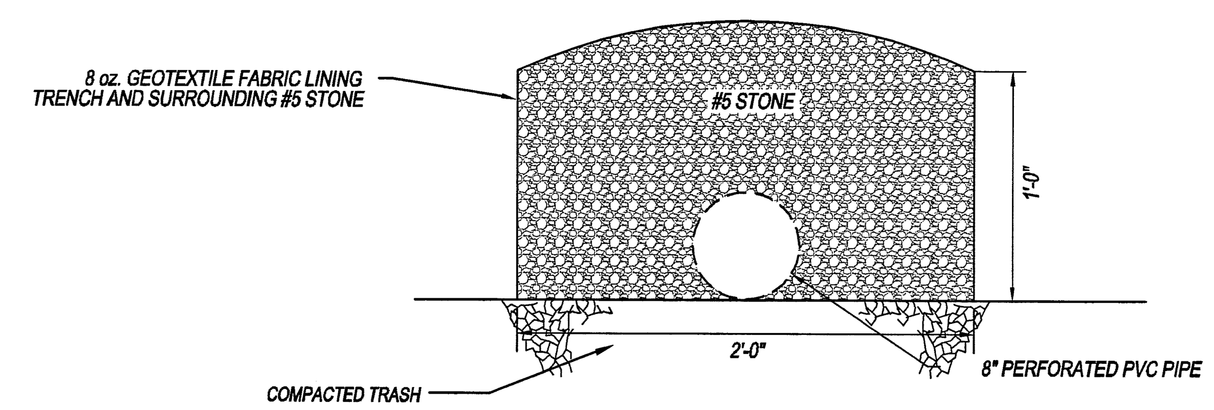


TYPICAL METHANE GAS COLLECTION TRENCH CLOSURE DETAIL
AND CAP COVER DETAIL (MSW)

N.T.S.



PERMANENT METHANE TRENCH DETAIL

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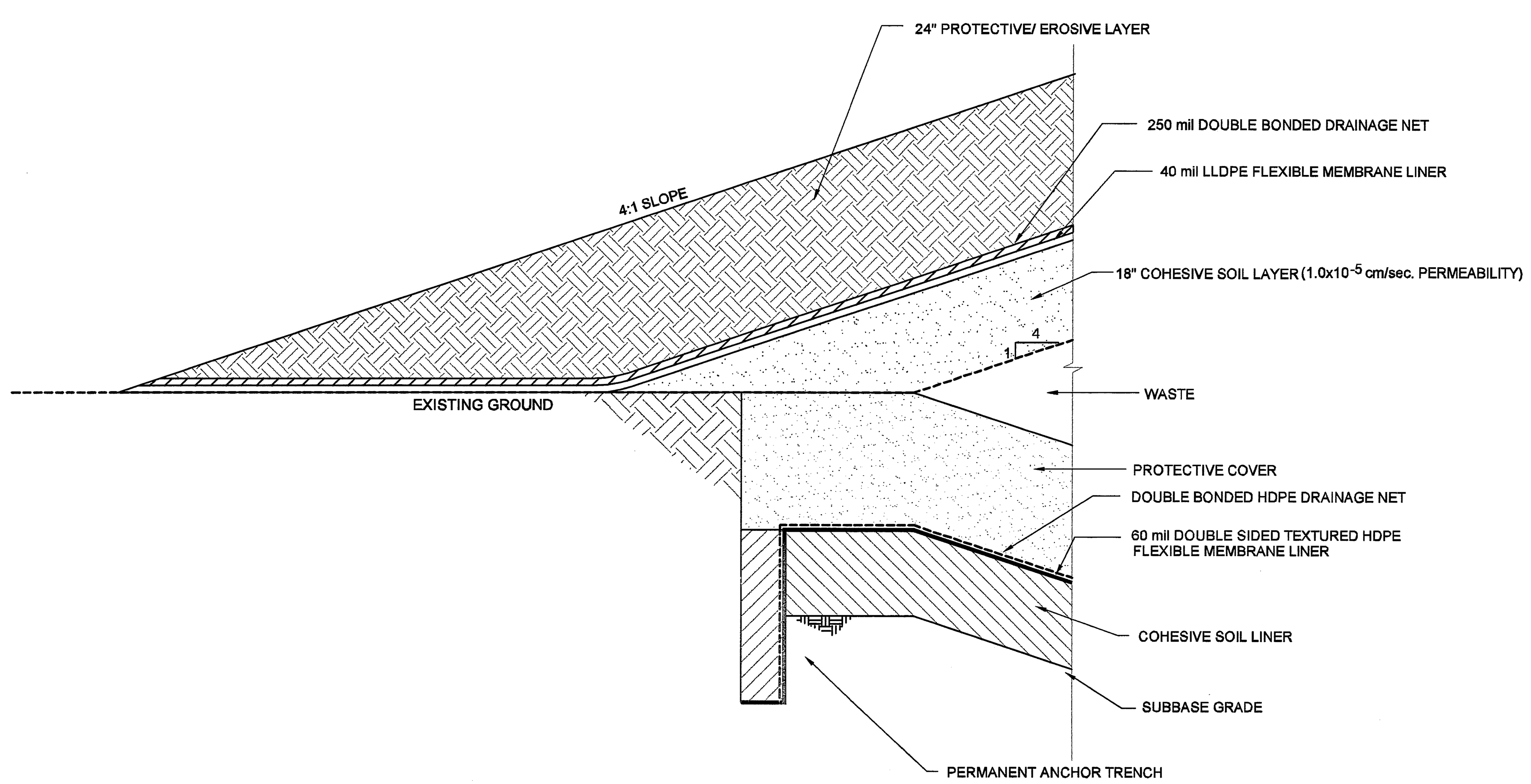
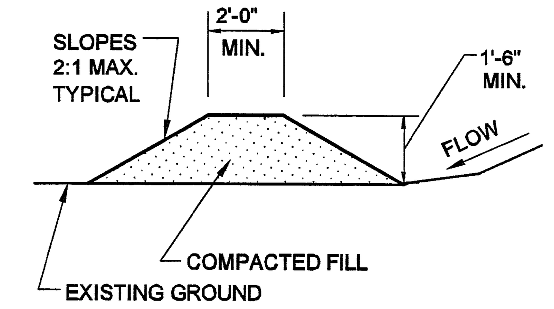


TYPICAL CAP CLOSURE DETAIL

N.T.S.



TEMPORARY STORMWATER DIVERSION BERM DETAIL

N.T.S.

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
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P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
9/15/10	LCH	1	PER NC SOLID WASTE SECTION LETTER DATED 7/21/10 AND 9/9/10

OPERATION PLAN-PHASE 2
OPERATION DETAILS

SCALE:	1:1
DATE:	10/22/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G08095
DRAWING NO. P9	SHEET NO. 11 OF 11

NORTH CAROLINA PROFESSIONAL SEAL ENGINEER JIMMY D. WOODIE
9/22/2010

SECTION 6.0

CLOSURE
PLAN

6.1 Introduction

The County will cap their landfill within 180 days after the final receipt of solid waste. The cap system will consist of 12 inches bridging material (temporary cover), 18 inches of cohesive soil liner with a permeability no greater than 1.0 x 10^{-5} cm/sec, 40 mil Linear Low Density Polyethylene (LLDPE), drainage layer, 24 inches of protective/erosive layer. The post-settlement surface slopes on the cap system will be a minimum of 5 percent and a maximum of 25 percent. The cap contains gas venting system consisting of a series of washed stone trenches below the soil liner that will be vented through 10" diameter PVC pipes that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

The largest area to be closed within the permitted life will be 20 acres.

The estimate of the maximum inventory of wastes on-site over the active life of Phases 1 and 2 will be 1,194,226 cubic yards.

Prior to beginning closure, the County shall notify the Division of Waste Management that a notice of the intent to close the unit has been placed in the operating record. The County shall begin closure activities no later than thirty (30) days after the date on which the landfill receives the final wastes or if the landfill has remaining capacity and there is a reasonable likelihood that the landfill will receive additional wastes, no later than one year after the most recent receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Division of Waste Management if the County demonstrates that the landfill has the capacity to receive additional waste and the County has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the closed landfill.

The County shall complete closure activities in accordance with the closure plan within 180 days following the final receipt of waste. Extensions of the closure period may be granted by the Division of Waste Management if the County demonstrates that closure will, of necessity, take longer than one hundred eighty (180) days and the County has taken and will continue to take all steps to prevent threats of human health and environment from the enclosed landfill.

Estimated schedule of closure will be approximately 24 years.

Following closure of the landfill, the County shall notify the Division that a certification, signed by the Engineer verifying that closure has been completed in accordance with the closure plan, and has been placed in the operating record. The County shall record a notation on the deed to the landfill property and notify the Division of Waste Management that the notation has been recorded and a copy has been placed in the operating record. The notation on the deed shall in perpetuity notify any potential purchaser of the property that the land has been used as a landfill and its use is restricted under the closure plan approved by the Division of Waste Management. The County may request permission from the Division to remove the notation from the deed if all waste are removed from the landfill.

6.2 Cap System

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

6.3 Cohesive Soil Cap

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Cohesive Soil Cap Borrow Material

Test Name	Test Method	Contractor/Engineer Frequency
Moisture/Density	ASTM D698/D1557	1 per 5000 c.y.
Remolded Permeability	ASTM D5084	1 per 5000 c.y.
Atterberg Limits	ASTM D4318	1 per 5000 c.y.
Visual Classification	ASTM D2487	1 per 5000 c.y.
Grain Size Distribution	ASTM D422	1 per 5000 c.y.

Cohesive Soil Cap Test Pad

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	3 per lift
Permeability	ASTM D5084	1 per lift
Remolded Permeability	ASTM D5084	1 per lift
Atterberg Limits	ASTM D4318	1 per lift
Visual Classification	ASTM D2487	1 per lift
Grain Size Distribution	ASTM D422	1 per lift

In-Place Cohesive Soil Cap

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	1 per lift per acre
Permeability	ASTM D5084	1 per lift per acre
Atterberg Limits	ASTM D4318	1 per lift per acre
Visual Classification	ASTM D2487	1 per lift per acre
Grain Size Distribution	ASTM D422	1 per lift per acre

(a) Suitable on-site and/or off-site soils may be used as cohesive soil cap if it can achieve an in-place permeability of 1.0 x 10^{-5} cm/sec or less and meets all testing requirements indicated in the material testing paragraph in this section. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

(b) A permeability “window” shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil cap. The window shall be plotted on a semi-log plot with moisture content versus density. Laboratory testing to develop the window shall include a series of remolded samples compacted to various dry densities and moisture contents utilizing the same compactive effort (ASTM D 698 or D 1557). The remolded samples shall be tested for permeability to determine whether or not the particular soil type will provide the maximum permeability (1.0 x 10^{-5} cm/sec) at various dry densities and moisture contents. The window is then developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

(c) Atterberg limits and grain size distribution shall also be conducted on the bulk samples used to prepare the permeability window ASTM D2487, D4318, D422. These tests can be used as indices on random samples collected from the borrow site during construction to verify the soil type is the same as was used to develop the “window”. As a minimum, sufficient visual classifications and Atterberg limits shall be conducted in association with each permeability test to verify that the construction materials meet specifications.

(d) A test strip of compacted cohesive soil cap shall be prepared to verify the permeability "window" prior to general installation of the cohesive soil cap. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil cap. At a minimum, the verification will consist of three moisture density tests, one Atterberg limits test, one grain size distribution test (ASTM D2487, D4318, and D422), and one Shelby Tube sample for each lift constructed in the test pad. Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 $x10^{-5}$cm/sec. Tests shall be performed in accordance with the ASTM D5084. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least three compacted 6 inch lifts of cohesive soil cap. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil cap. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeability of 1.0×10^{-5} cm/sec of the cohesive soil cap. The test strip may be used as an integral part of the overall cohesive soil cap if it meets the required specification for the cap. All results shall be given to the Construction Observer.

(e) The soils shall be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift compacted preferably at moisture content between 0 to 3% above optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698). A sheepsfoot roller or approved alternative may be used to compact the soil cap provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil cap shall be screened, disked, or prepared using any other approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. After each lift, the surface shall be scarified prior to the placement of the next lift to provide good bonding from one lift to the next.

(f) The cohesive soil cap shall be tested to evaluate the coefficient of permeability. The coefficient of permeability of the soil cap shall be equal to or less than 1.0×10^{-5} cm/sec after placement and compaction. The soil cap must be a minimum of 1.5 feet thick.

(g) Laboratory falling head permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0×10^{-5}cm/sec. Tests shall be performed in accordance with ASTM D5084. All laboratory permeability tests shall be performed at a confining pressure of 10 psi and at a hydraulic gradient of 20.

(h) The soil cap shall be tested a minimum of one soil sample per lift per acre for laboratory permeability. All permeability testing will be on random samples judged by the Engineer to be representative of the most permeable soil conditions for the area being tested. The Engineer shall certify that the materials used in construction were tested according to the Division approved plans. If after placement of the soil cap it fails the required tests, the material will either be reworked or replaced. The soil cap must remain moist at all times, if any section becomes dry, rework the dry area and moisten.

(i) A minimum of two (2) inches of soil shall be removed prior to securing each sample for permeability testing. The sampling tube shall be advanced vertically into the soil with as little soil disturbance as possible and should be pushed using a uniform pressure. The sampling tube (Shelby tube), when extracted, shall be free of dents, and the ends shall not be distorted. A backhoe or approved alternative should be used to advance the sampling tube (Shelby tube) as long as disturbance is minimized. Drive tube samples of the cap may be obtained for permeability testings. If the Engineer judges the sample to be too disturbed, another sample shall be taken. Once an acceptable sample has been secured and properly prepared, all sample excavations shall be backfilled to grade with a 50% mixture of bentonite and similar soils in maximum 3-inch loose lifts and hand tamped with a blunt tool to achieve a tight seal equivalent to the original density.

(j) No additional construction shall proceed on the soil layers at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved.

(k) As a minimum, sufficient visual classifications (ASTM Test Designation D2487) , analyses (ASTM Test Designation D422) and Atterberg limits (ASTM Test Designation D4318) shall be conducted in association with each permeability test to verify that the construction materials meet specifications. The minimum number of tests will be 1 per lift per acre.

(l) If the soil for the cohesive soil cap is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory. Where additives are required, the soil shall be placed in maximum 8-inch thick loose lifts and compacted preferably between 0 to +3% optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698) for the soil-additive mixture. All other compaction procedures for the soil apply.

(m) Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil cap shall have no sudden sharp or abrupt changes in grade.

(n) The Contractor shall protect the cohesive soil cap from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil cap until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions shall be replaced or reworked by the contractor to remove these defects.

(o) The thickness and grade of the soil cap will be verified by the surveyor before placement of the geomembrane liner. The soil cap will be surveyed at 50' grid points where the elevations of the top of intermediate cover will be compared to the top of soil cap to verify 1.5 feet of soil cap. The grade will then be verified with the surveyed information. The survey will be performed by NC licensed surveyors.

(p) Surface Acceptance. Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil cap and the surface shall remain the responsibility of the contractor.

6.4 <u>Flexible Membrane Liner Method of Deployment</u>

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Flexible Membrane Liner Tests

Test Name	Description	Test Method	Frequency
Air Test	Air Test Seams		Every Seam
Vacuum Test	Every welded area		Where air test impossible
Destructive Tests	Seam Strength	ASTM D4437	Every 500' of seam

Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

40 mil Linear Low Density Polyethylene (LLDPE) is to be placed in direct contact with moist cohesive soil cap. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner and shall meet the following minimum properties:

English Units

Table 2(a) – Linear Low Density Polyethylene (LLDPE) Geomembrane (TEXTURED)

Properties	Test Method	Test Value								Testing Frequency (minimum)
		20 mils	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%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	10	10	10	10	10	10	10	10	Every 2nd roll *(2)*
Density g/ml (max.)	D 1505/D 792	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939	200,000 lb
Tensile Properties *(3)* (min. ave.) • break strength – lb/in. • break elongation - %	D 6693 Type IV	30 250	45 250	60 250	75 250	90 250	120 250	150 250	180 250	20,000 lb
2% Modulus – lb/in. (max.)	D 5323	1200	1800	2400	3000	3600	4800	6000	7200	per formulation
Tear Resistance – lb (min. ave.)	D 1004	11	16	22	27	33	44	55	66	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	22	33	44	55	66	88	110	132	45,000 lb
Axi-Symmetric Break Resistance Strain - % (min.)	D 5617	30	30	30	30	30	30	30	30	per formulation
Carbon Black Content - %	D 1603 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	45,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)* (e) Standard OIT — or — (f) High Pressure OIT	D 3895 D 5885	100 400	100 400	100 400	100 400	100 400	100 400	100 400	100 400	200,000 lb
Oven Aging at 85°C *(7)* (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	35 60	35 60	35 60	35 60	35 60	35 60	35 60	35 60	per formulation
UV Resistance *(8)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 3895 D 5885	N. R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	per formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 9.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

(4) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(1) Preparation for Geomembrane Deployment

(a) Panel Layout

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project.

(b) Identification

Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture.

(c) Verification

The manufacturers certification will be reviewed by the Engineer. If the certification does not meet the requirements of GRI-GM17, the corresponding liner rolls will be rejected.

(2) Field Panel Placement

(a) Location

The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

(b) Weather Conditions

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds.

(c) Method of Deployment shall follow the manufacturer's recommendations and sound, accepted engineering practices.

(1) The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface.

(2) No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions which could result in damage to the geomembrane.

(3) Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas.

(4) The geomembrane will be deployed in a manner to minimize wrinkles. The geomembrane will have no fold overs.

(5) Any damage to a panel of the geomembrane will be repaired. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed.

(3) <u>Field Seaming</u>

(a) Layout

In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

(b) Personnel

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

(c) Equipment

(1) Fusion Welding

Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge.

(2) Extrusion Fillet Welding

Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

(d) Weather Conditions

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day.

(4) Seam Preparation

(a) Fusion Welding

(1) Overlap the panels of geomembrane approximately four (4) inches.

(2) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding.

(3) Adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

(4) A movable protective layer may be used, at the discretion of the Flexible Geomembrane Liner System, Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

(b) Extrusion Welding

(1) Overlap the panels of geomembrane a minimum of three (3) inches.

(2) Temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane.

(3) Grind seam overlap prior to welding within one (1) hour of welding operation In a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area.

(4) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.

(5) Purge the extruder prior to beginning the seam to remove all heat degraded extrudate from the barrel.

(6) Keep welding rod clean and off the ground.

(5) Test Seams

Test seams shall be performed at the beginning of each seaming period and at least once each four (4) hours for each seaming apparatus used that day. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams.

(a) Test Seam Length

The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width.

(b) Sample Procedure

(1) Visually inspect the seam for squeeze out, footprint, pressure and general appearance.

(2) Two random samples one (1) inch wide shall be cut from the test seam. The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer that has a constant separation of 2.0 in/min for peel and shear. The passing destructive test requirements for a 40-mil LLDPE liner seam is: minimum peel strength of 50 ppi for

hot wedge and 44 ppi for extrusion fillet seams, minimum shear strength of 60 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam.

If a specimen fails the entire procedure shall be repeated.

(3) If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved.

(4) After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting and test results.

(5) Passing test results records shall be maintained.

(6) General Seaming Procedures

(a) Seaming shall extend to the outside edge of panels to be anchored. While welding a seam, monitor and maintain the proper overlap.

(b) Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind.

(c) While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly.

(d) Align wrinkles at the seam overlap to allow welding through the wrinkle.

(e) Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions.

(f) All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane.

(g) All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind ¼ of an inch minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

6.5 Flexible Membrane Liner Tests

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

(a) Air Pressure Testing

The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time.

(1) Equipment for Air Testing

An air pump (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi.

A rubber hose with fittings and connections.

A sharp hollow needle, or other approved pressure feed device with a pressure gauge capable of reading and sustaining a pressure between 25 to 30 psi.

(2) Procedure for Air Testing

Seal both ends of the seam to be tested.

Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld.

Inflate the test channel to a pressure between 25 to 30 psi, in accordance with the following schedule, close valve, and observe initial pressure after approximately 2 minutes.

INITIAL PRESSURE SCHEDULE *

Material (Mil)	Min. Psi	Max. Psi
40	25	30
60	27	30
80	30	30
100	30	30

* Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize.

Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds the following or if the pressure does not stabilize, locate faulty area and repair.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL
AFTER 5 MINUTES - LLDPE

Material (Mil)	Pressure Diff.
40	4 psi
60	3 psi
80	3 psi
100	3 psi

At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected.

Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

(3) In the event of a Non-Complying Air Pressure Test, the following procedure shall be followed:

Check seam end seals and retest seams.

If non-compliance with specified maximum pressure differential re-occurs, repair the seam. Capping or removal/reseam of the non-complying seam are the only two (2) acceptable methods of repairing failed seams.

Non-destruct test the entire length of the repaired seam

(b) Vacuum Testing

This test is used when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

(1) Equipment for Vacuum Testing

Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

Vacuum pump assembly equipped with a pressure controller and pipe connection.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and means to apply a soapy solution.

A soapy solution.

(2) Procedure for Vacuum Testing

Trim excess overlap from seam, if any.

Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi gauge.

Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested.

Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.

Close the bleed valve and open the vacuum valve.

Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box.

Ensure that a leak tight seal is created.

For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process.

(3) Procedure for Non-Complying Test

Mark all areas where soap bubbles appear and repair the marked areas.

Retest repaired areas.

(c) Destructive Testing

(1) Concept

The purpose of destructive testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane.

(2) Procedure for Destructive Testing

All Destructive tests will be done according to GRI test method GM19. Destructive test samples shall be marked and cut out randomly at a minimum average frequency of one test location every 500 feet of seam length.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds at the discretion of the Flexible Membrane Liner Superintendent and Engineer.

Sample Size

The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications.

A one (1) inch sample shall be cut from each end of the test seam for field testing.

The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer for peel and shear. The passing destructive test requirements for a 40-mil LLDPE liner seam is: minimum peel strength of 50 ppi for hot wedge and 44 ppi for extrusion fillet seams, minimum shear strength of 60 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam.

(3) Procedure in the event of Destructive Test Failure

Cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.

If the laboratory samples pass then reconstruct the seam between the two (2) passing samples locations.

Heat tack the overlap along the length of the seam to be reconstructed and extrusion weld.

Vacuum test the extrusion weld.

If either of the samples fail, then additional samples are taken in accordance with the above procedure until two (2) passing samples are found to establish the zone in which the seam should be reconstructed.

All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken.

In cases of reconstructed seams exceeding 150 feet, a destructive sample must be taken and pass destructive testing from within the zone in which the seam has been reconstructed.

All destructive seam samples sent to the Engineer's laboratory shall be numbered.

(d) Quality Assurance Laboratory Testing

(1) Destructive samples sent to the laboratory will be tested for shear/peel strength, elongation, and peel separation according to table 1(a) of GRI Test Method GM19. Five (5) specimens shall be tested for each test method with data recorded. Four (4) out of the five (5) specimens must pass and the fifth specimen must be 80% of the passing test values. The passing test values are as follows:

Hot Wedge Seams
- Shear Strength-60 ppi
- Shear elongation at break – 50%
- Peel Strength- 50 ppi
- Peel separation-25%

Extrusion Fillet Seams
- Shear Strength-60 ppi
- Shear Elongation at break-50%
- Peel Strength- 44 ppi
- Peel separation-25%

(2) Defects and Repairs

(a) The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation.

(b) All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

(c) Repair Procedures

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely manner to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil cap such as a temporary cover. If cohesive soil cap is damaged, it must be reworked. Procedures available for liner repair:

Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded.

Reconstruction - used to repair seams bounded by passing destruct samples.

Grinding and welding - used to repair sections of extruded seams.

Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws.

Capping - used to repair lengths of failed extruded seams.

Removal of a bad seam and replacement with a strip of new material seamed into place.

(d) Verification of Repairs

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

e) Liner Acceptance

The constructed liner will be accepted when all non-destruct and destruct tests have passed their respective tests and the results have been verified by the Engineer.

6.6 Protective Cover

(1) HPDE Geocomposite Drainage Netting manufactured by SKAPS Industries, or approved equal. Q/C testing information/certification for each property on geocomposite will be provided by the contractor/manufacture for the rolls delivered. The thickness, transmissivity and ply adhesion will be tested by the Engineer's third party laboratory for quality assurance. One roll from every 200,000 $ft.^2$ of material delivered to the site will be tested.

SKAPS TRANSNET HDPE GEOCOMPOSITE WITH 250 MIL GEONET

Last Updated on Wednesday, 08 September 2010 07:57

SKAPS TRANSNET™ GeoComposite consists of SKAPS GeoNet made from HDPE resin with non-woven polypropylene GeoTextile fabric heat bonded on both sides of GeoNet.

Property	Test Method	Unit	Required Value		Qualifier
				with 8 oz.	
Geonet					
Thickness	ASTM D 5199	mil		250 ±10	Range
Carbon Black	ASTM D 4218	%		2 to 3	Range
Tensile Strength	ASTM D 5035	lb/in		50	Minimum
Melt Flow	ASTM D 1238[3]	g/10 min		1	Maximum
Density	ASTM D 1505	g/cm^3		0.94	Minimum
Transmissivity[1]	ASTM D 4716	m^2/sec		$2.5x10^{-3}$	MARV[2]
Composite					
Ply Adhesion (Minimum)	ASTM D 7005	lb/in		0.5	MARV
Ply Adhesion (Average)	ASTM D 7005	lb/in		1	MARV
Transmissivity[1]	ASTM D 4716	m2/sec		$2x10^{-4}$	MARV
GeoTextile					
Fabric Weight	ASTM D 5261	oz/yd^2		8	MARV
Grab Strength	ASTM D 4632	lbs		225	MARV
Grab Elongation	ASTM D 4632	%		50	MARV
Tear Strength	ASTM D 4533	lbs		90	MARV
Puncture Resistance	ASTM D 4833	gpm/ft^2		130	MARV
CBR Puncture	ASTM D 6241	lbs		650	MARV
Water Flow Rate	ASTM D 4491	gpm/ft^2		100	MARV
Permittivity	ASTM D 4491	sec^{-1}		1.26	MARV
Permeability	ASTM D 4491	cm/sec		0.3	MARV
AOS	ASTM D 4751	US Sieve		80	MARV

Notes:

1. Transmissivity measured using water at 21 ± 2 °C (70 ± 4 °F) with a gradient of 0.1 and a confining pressure of 10000 psf between steel plates after 15 minutes. Values may vary between individual labs.

2. MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.

3. Condition 190/2.16

The geocomposite will be handled in such a manner as to ensure the geocomposite are not damaged in any way. On slopes, the geocomposite will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles. Geocomposite can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geocomposite will not be welded to the geomembrane. Geocomposite will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geocomposite that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geocomposite will be overlapped by at least four inches and securely tied. Tying can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one foot intervals. In the corners of the side slopes where overlaps between perpendicular geocomposite strips are required, an extra layer of geocomposite will be unrolled along the slope, on top of the previously installed geocomposite, from the top to bottom of the slope.

Any holes or tears in the geocomposite will be repaired by placing a patch, utilizing the same geocomposite material, extending two feet beyond edges of the hole or tear. The patch will be secured to the original geocomposite by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geocomposite will be joined.

The engineer will visually inspect the drainage layer before placement of the erosive layer, if any defects are detected they will be repaired before placement of erosive layer.

(2) Erosive Layer

The soil for the erosive layers shall consist of suitable site soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension, which has been screened. No permeability, grain size, or other tests are required for this material.

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The erosive layer shall be composed of 24” of select backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

The depth of the erosive layer will be verified based on the 50 ft. grid and the difference in elevation from the top of the cohesive soil to the top of the erosive layer.

(a) A minimum of twelve inches (12") of cover between low ground pressure equipment and the liner is required at all times. Roadways for entering and for transporting material over slopes and capped/lined areas shall have a minimum depth of four feet (4').

(b) Avoid undue stress on the liner at all times. Cover material must be pushed up slopes, never down to help minimize wrinkles. Material must be placed to minimize wrinkles; wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Fold over of the liner will not be allowed. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner.

(c) If damage does occur, report it to the Project Manager immediately so that repairs can be performed without needless delay. All repairs to any component of the liner system will be done and tested according to the required repairs and testing for that component.

(d) Do not work wet cover material that cannot support equipment.

(e) Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

(3) Vegetative Layer

Native vegetation will be used as approved by the Erosion Control Plan.

6.7 Methane Venting System

Gas Venting System

NC.D.O.T. No 5 stone, Geotextile fabric, and 8" and 10” plastic pipes will be used in the construction of the Gas venting system.

(1) Stone in Trenches and Surrounding Perforated Collection Piping

Stone for methane collection system shall meet the requirements of NC DOT aggregate, standard size No. 5 and shall contain no fines. Stone must pass the sieve analysis test for No. 5 stone performed at the quarry.

(2) Geotextile Fabric

Geotextile fabric surrounding the stone/piping shall be non-woven needle punched fabric with the following minimum properties:

1)	Weight	8.0 oz/yd^2	ASTM D-3776
2)	Grab Strength	205 lbs.	ASTM D-4632
3)	Grab Elongation	50%	ASTM D-4632
4)	Trapezoidal Tear Strength	85 lbs.	ASTM D-4533
5)	Puncture Strength	100 lbs.	ASTM D-4833
6)	Mullen Burst Strength	320 psi	ASTM D-3786
7)	Permittivity	1.4 sec^{-1}	ASTM D-4491

Geotextile fabric shall be manufactured by Polyfelt , TNS Advanced Technologies, or approved equal.

(3) Plastic Pipe

Plastic gravity sewer pipe and fittings used for methane vent shall be unplasticized polyvinyl chloride (PVC) and conform to the requirements of ASTM Designation D-3034 on ASTM F679, Type PSM, Class 12454-B, SDR-35 with elastomeric gasket joints. PVC pipe and fittings shall be as manufactured by J-M Pipe, Certainteed, H&W Industries or equal. The methane riser pipe shall be a 10 inch solid wall PVC pipe.

6.8 Closure Costs

The largest area to be closed within the permitted life will be Phases 1 and 2 (20 Ac.). The estimated costs shown below are only for Phases 1 and 2. Post Closure will be 30 years after closure.

Closure Costs:
Closure will consist of the following which costs are estimated as being done by a third party.

1. 18" of $1x10^{-5}$ cm/sec. soil cover;
2. 40 Mil LLDPE Liner and Drainage net;
3. Erosion Control Devices;
4. 24" Erosive layer;
5. Seeding and Mulching;
6. Mobilization/Demobilization;
7. Labor Costs; and
8. Stone for methane gas collection.
9. Geotextile for methane gas collection.
10. Vent pipes for methane gas collection.
11. Engineering Costs and QA/QC of the Composite liner and certification of closure.

Estimate of Probable Costs:

1. 18" of $1x10^{-5}$ cm/sec. soil cover for 20 acres:

   Total yardage + 15% = 55,660 yd^3 @ a cost of $6.90/$yd^3$
   ∴ Cost = $384,054

2. 40 Mil LLDPE Liner and Drainage net for 20 acres

   Total Footage + 15% = 1,001,880 ft^2 @ a cost of $0.85/$ft^2$
   ∴ Cost = $851,598

3. Erosion Control devices

   Estimated costs @ $75,000
   ∴ Cost = $75,000

4. 24" Erosive soil layer for 38 acres.

   Total yardage + 15% = 74,213 yd^3 @ a cost of $4.05/$yd^3$
   ∴ Cost = $300,563

5. Seeding and Mulching for 20 acres.

   Estimated cost of $2,000/acre
   ∴ Cost = $40,000

6. Mobilization/Demobilization.

   Estimated cost of $175,000

7. Labor Costs.

   Estimated cost of $200,000

8. Stone for methane gas collection.

Total estimated linear feet = 1,952 ft.
Total estimated volume for a 2'x1' trench = 3,904 ft^3
with a density of 120 lbs/ft^3 total weight =235 tons @ a cost of $18.00/ton
$\therefore$ Cost = $4,230

9. Geotextile for methane gas collection.

Total estimated linear feet = 1,952 ft.
Total estimated perimeter for a 2'x1' trench = (1,952 ft $\times$ 6 ft)@ a cost of $0.20/ ft^2
$\therefore$ Cost = $2,343

10. Vent pipes for methane gas collection.

Estimated cost @ $600.00 each (11).
$\therefore$ Cost = $6,600

11. Engineering Costs and QA/QC of the Composite liner and certification of closure.

Estimated cost = $200,000
$\therefore$ Cost = $200,000

Total of Estimated Phase 1 and 2 Closure Costs:

	1.	$ 384,054
	2.	$ 851,598
	3.	$ 75,000
	4.	$ 300,563
	5.	$ 40,000
	6.	$ 175,000
	7.	$ 200,000
	8.	$ 4,230
	9.	$ 2,343
	10.	$ 6,600
	11.	$ 200,000
Total:		$ 2,239,388

SECTION 7.0

POST-CLOSURE PLAN

7.1 Introduction

CONTACTS:

Name:	Michael W. Jarman
Title:	County Manager
Phone No.:	(252) 559-6450
Address:	130 South Queen Street Kinston, NC 27502

DESCRIPTION OF USE:

The County has no future use planned for their landfill at this time.

DESCRIPTION OF MAINTENANCE ACTIVITIES:

The landfill will be monitored quarterly for evidence of settlement, subsidence, ponding in the cap system, leachate seepages, and any erosion. The quarterly inspection will also include observation and necessary repair of the security fence, entrance sign, access roads to the methane and groundwater monitoring points, the actual ground water monitoring wells and methane probes, accumulated silt in the sediment basins, leachate lagoon, pumps and edge of waste markers. Annually in the spring, the vegetative cover will be monitored to assure a good stand of vegetation, and where needed, it will be reseeded. Semi-annually the cap vegetation will be mowed and any saplings removed. These maintenance activities will take place over the entire post closure period of thirty years.

The pumps in the sumps will be monitored quarterly to assure that they are operating properly by manually operating each pump. The flow pumped from each sump for the quarter will be documented. The pumps at the lagoon will also be manually operated to assure that they are working properly and the flow to the Waste Water Treatment Plant documented for the quarter. If for any reason a pump is not operating, it will be repaired or replaced within two weeks of the inspection.

Any repairs to the cap system will be done according to the approved closure plan and documented according to the approved quality assurance plan. Damages that require repairs shall be reported to the NC Solid Waste Section within 3 days of inspection/observation.

The leachate collection system will be videoed every five years and power washed if necessary. The pump risers will be vacuum cleaned every five years. Leachate will be collected and treated until the generation of leachate has stopped due to capping.

All quarterly inspections/observations will be documented and become part of the landfill's operating record. All repairs/maintenance will be documented and also become part of the landfill's operating record. Data collected from all pumps will also become part of the operating record.

DESCRIPTION OF MONITORING ACTIVITIES:

The County will monitor and analyze ground and surface water semi-annually according to the approved monitoring plan for a period of thirty years. The County will also monitor methane gas at landfill structures and the boundary quarterly according to the approved methane monitoring plan for the thirty-year period. All reports and records required by the approved monitoring plans will become part of the landfill's operating record.

COMPLETION OF POST-CLOSURE CARE

Following completion of the post-closure care period for each MSWLF unit, the owner or operator will notify the Division of Waste Management that a certification, signed by a registered professional engineer, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record.

CLOSURE OF LEACHATE STORAGE FACILITIES

The County will close the leachate lagoon within 180 days after liquid collection has ceased. The plan for closure of the lagoon shall be approved by the NC Solid Waste Section prior to commencing closure activities.

All solid waste will be removed from the leachate lagoon, connecting sewer lines, and manholes. All solid waste removed will be properly handled and disposed of according to federal and State requirements. All connecting lines will be disconnected and securely capped or plugged.

All waste residues, contaminated system components (composite liner system), contaminated subsoils, structures and equipment contaminated with waste will be removed and appropriately disposed. If the groundwater surrounding the impoundment is contaminated, other corrective actions to remediate a contaminant plume may be required by the Department. If the groundwater surrounding the lagoon is found not to be contaminated, the liner system may remain in place if drained, cleaned to remove all traces of waste, and both liners punctured so that drainage is allowed. The lagoon is to be backfilled and regraded to the surrounding topography.

7.2 <u>Post Closure Costs</u>

The largest closed area to be monitored within the post closure life will be Phases 1 and 2 (20 Ac.).

Post Closure Costs:

Methane gas, ground water and surface water will be monitored for 30 years after closure. The cap will also have to be monitored for the 30 year period. All costs include reports, data analysis, and certifications.

1. Ground and Surface Water monitoring semiannually for 30 years for appendix I constituents and statistical analysis.
   Estimated cost/sample = $840.00/sample
   Total annual samples = 2(9 wells + 3 surface) = 24 samples/year
   Estimated cost = 30 years x 24 samples/year x $840.00/sample

   ∴ Cost = $604,800

2. Methane Gas monitoring quarterly for 30 years.
   Estimate $600.00/quarter = $2,400.00/year
   Estimated cost = 30 year x $2,400.00

   ∴ Cost = $72,000

3. Cap Monitoring and repairing any problems.
   Estimate $100,000 for the 30 years.

   ∴ Cost = $100,000

4. Closure of sedimentation and erosion control devices.
   Estimate $24,000.00 for closure

   ∴ Cost = $24,000

5. Leachate Management including pumping data.
   Estimate $400,000 for the 30 years.

   ∴ Cost = $400,000

6. Closure of leachate lagoon.
   Estimate $30,000 for Closure.

7. Maintenance of gas vents, monitoring wells, pumps, access roads, fencing, signage, EOW markers etc.
   Estimate $160,000

Total of Estimated Phase 1 and 2 Post Closure Costs:

	1. $ 604,800
	2. $ 72,000
	3. $ 100,000
	4. $ 24,000
	5. $ 400,000
	6. $ 30,000
	7. $ 160,000
Total:	$ 1,390,800

SECTION 8.0

FINANCIAL ASSURANCES

TO BE SUBMITTED AT A LATER DATE