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Dare County, North Carolina



Dare County

Construction and Demolition Debris Landfill

Permit Modification

June 2008

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Report

Dare County, North Carolina

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*Construction and Demolition Debris Landfill
Permit Modification*

June 2008



Report

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Appendix A

Landfill Stability and Settlement Analysis

Section 1

Closure Plan

The North Carolina Solid Waste Regulation Section Rule 15A NCAC 13B .0543(a) requires construction and demolition landfill (C&DLF) owners/operators to prepare a closure plan that describes the steps necessary to close a C&DLF at any point during its active life. This closure plan establishes: design criteria for the closure cap system and the gas collection system, a closure sequence and construction schedule, construction cost estimates, and other important information relating to closure.

1.1 Construction of Cap System

1.1.1 Final Cover System

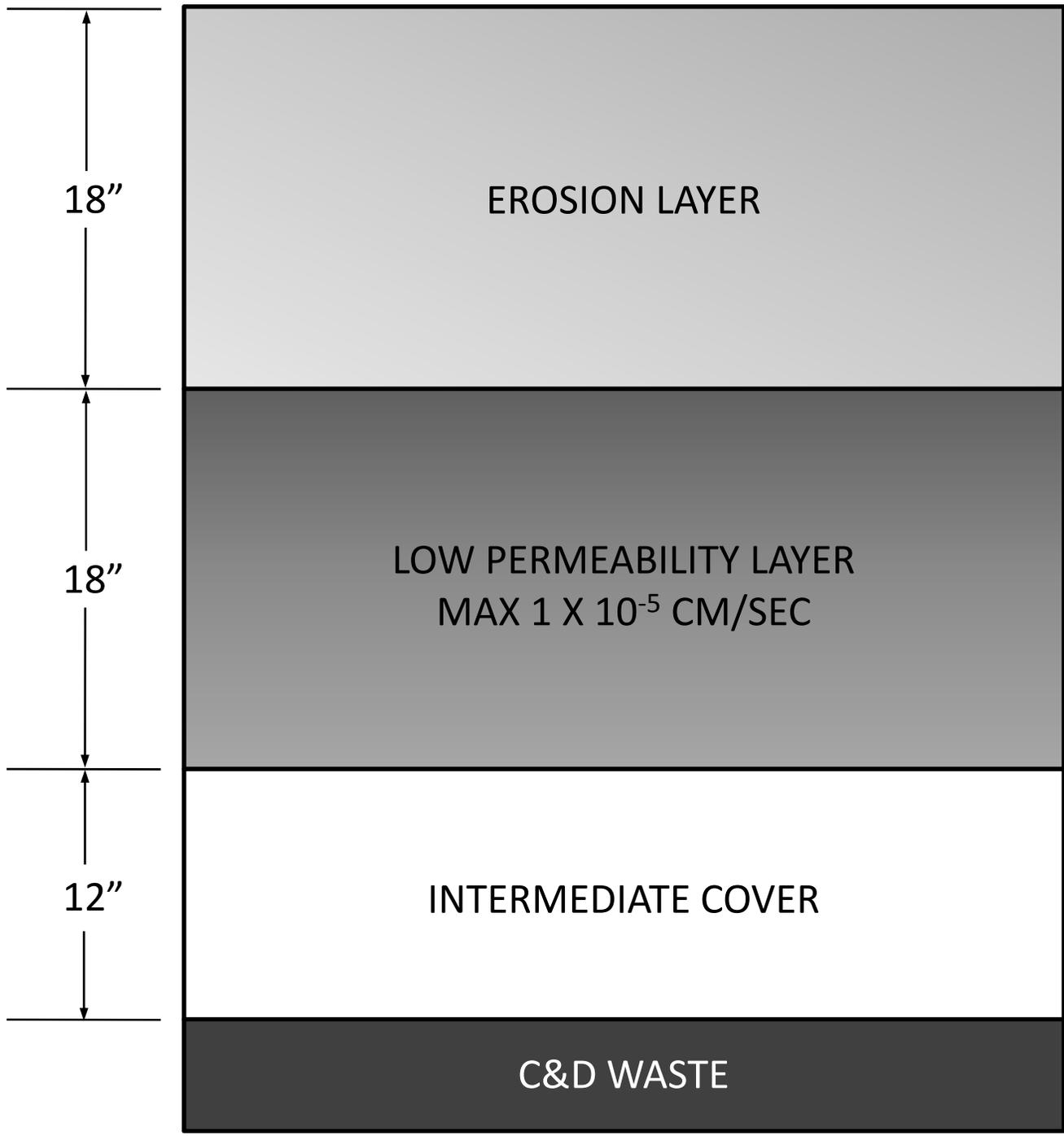
The final cover system has been designed to minimize the amount of storm water infiltration into the landfill and to resist erosive forces. The final cover system consists of the following layers (listed from top to bottom), which meet the requirements of Rule 0.543(c)(1):

- An 18-inch erosion layer consisting of earthen material that is capable of sustaining native plant growth; and
- An 18-inch low permeability barrier of earthen material with a permeability no greater than 1.0×10^{-5} cm per second.

Material for the low permeability layer will originate from the on-site borrow area. As the borrow area is mined for intermediate and daily cover, material that is most suitable for the cap will be stockpiled. It is currently anticipated that bentonite will be added to the stockpiled soil at a rate of 2 percent to achieve the required permeability.

The post-settlement grades of the top surface slopes will not be less than 5 percent (to prevent ponding). Figure No. 1-1 provides a section detail of the proposed final cover system.

Closure side slopes will be 3:1; however, post-settlement slopes are expected to be less than 3:1. Rule 0.543(c)(3)(C) allows for alternative side slopes (those greater than 25%) to be approved by the North Carolina Department of Environment and Natural Resources Solid Waste Section (NCDENR SWS) if the design is certified (by a licensed professional engineer in the State of North Carolina) to be stable, encourage runoff, and be safe to construct, operate and maintain. A slope stability analysis was prepared as part of the Cell 3 Permit Application dated May 2005. The slope stability analysis demonstrates these requirements (see Appendix A). Although post-settlement slope stability analysis assumed a 2-foot earthen cap, as opposed to what is described above, the additional 12 inches of cap material has been determined to be inconsequential with regard to slope stability.



CDM

DATE 6-18-2008

FINAL COVER SYSTEM

FIGURE NO.

1-1

1.1.2 Gas Collection System

The placement of a low-permeability final cover system will prevent the release of landfill gas generated during the post-closure period. To minimize pressures exerted on the barrier, passively vented gas wells will be used. The exact location of the vertical gas wells will be determined at the time of closure. Generally, one vertical well per acre is anticipated to be installed. A bentonite seal and synthetic boot will be installed around the vertical gas well to prevent storm water infiltration. The depth of the vertical gas wells will extend from final grade to less than 10 feet into waste. Figure No. 1-2 provides a section detail of the proposed vertical gas well design.

1.2 Estimate of Largest Closure

The approved C&DLF site plan includes five individual disposal cells separated by drainage laterals. Each cell represents one phase of C&DLF development. Currently, Cells No. 1 and 2 are inactive and at finished grades, while Cell No. 3 is in operation. Cells 4 and 5 are proposed to be developed as Phases IV and V, but are not yet permitted. Cells 1 through 3 cover 33.9 acres. This represents the largest closure area, as currently permitted.

1.3 Estimate of Maximum Inventory of Waste On-Site

The maximum amount of waste that is expected to be disposed at the C&DLF, based on the approved permit, was calculated using the Earthworks Module of Softdesk. The total gross airspace available between the proposed top of final cover and the base grades is approximately 945,000 cubic yards (CY). The final cover material required to construct the 3-foot thick cover system for the C&D Landfill (33.9 acres total surface area) is 164,076 CY. It is anticipated that a 4:1 waste to cover ratio will be achieved; therefore, $(945,000 \text{ CY} - 164,076 \text{ CY}) \times 20\% \text{ cover} = \underline{156,185 \text{ CY}}$ daily and intermediate cover will be required. Deducting the volume of the final cover system (164,076 CY) and daily/intermediate cover materials (156,185 CY) from the total gross airspace, the maximum available net airspace in Cells 1 through 3 for waste to be disposed is projected to be 624,739 CY.

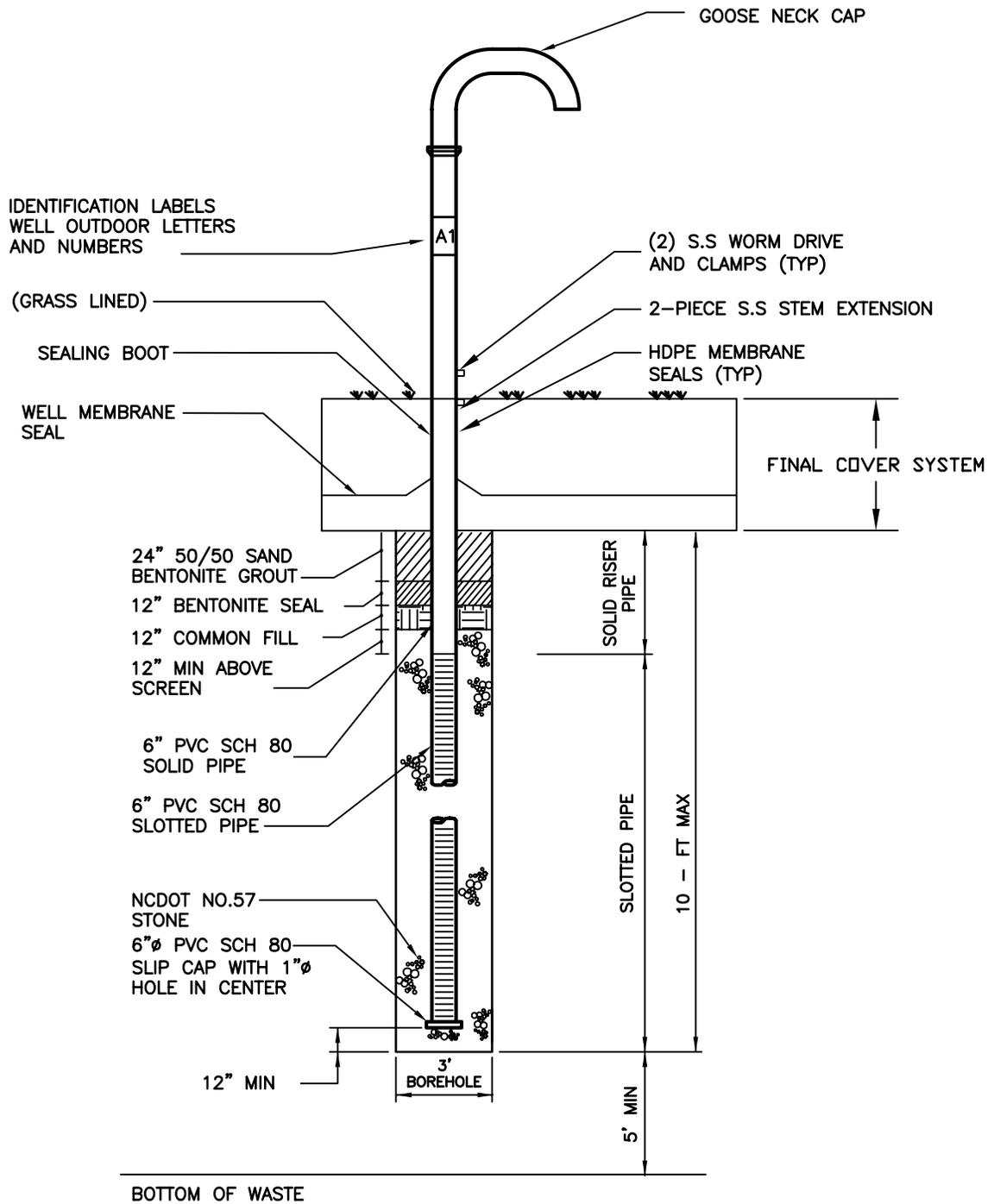
1.4 Landfill Closure Sequence

The landfill closure sequence is summarized in the table on Page 1-5 and described in the following sections.

1.4.1 Determination of Closure Area

The County will determine the location and acreage of areas to be closed. Closure procedures will not be instituted until an adequate area (approximately 10 acres or more) of the landfill is within 15 feet of final grade. An estimate of landfill area that is within 15 feet of final grade should be determined periodically by the surveyor for the site during the active life of the facility.

When an area has reached final grades, the County must initiate the closure process no later than 30 days after the final receipt of waste. However, if the area has not



DATE 5-21-2008

VERTICAL GAS
WELL

FIGURE
NO.

1-2



Camp Dresser & McKee

CLOSURE SEQUENCE	
<i>Activity</i>	<i>Process Date</i>
Determination of Closure Area and Initiate Closure Process	No later than 30 days after the final receipt of waste
Notification of Intent to Close	Once an area has been determined to be closed
Develop Closure Schedule for Closure Activities	
Prepare Construction Contract Documents	
Develop Final Closure Schedule	Once the SWS has commented on the closure schedule
Select a General Contractor	After receiving sealed bids
Closure Construction	Closure activities must be completed within 180 days of beginning closure activities or as otherwise approved
Certification of Closure Construction	At completion of construction
Record Notation to Deed	After final closure of property

reached final grades and there is reasonable likelihood that additional waste will be received in the near future, then closure activities must begin no later than one year after the most recent receipt of wastes.

1.4.2 Notification of Intent to Close

Once the County has determined that an area will be closed, a Notice of Intent to Close must be placed in the operating record and the SWS must be notified of the action per Rule .0543(c)(4). The final cover design, area to be closed, and scheduling of closure activities presented in this Permit Modification Application shall be reviewed and updated as necessary.

1.4.3 Develop Closure Schedule

The County will prepare a schedule for bidding and construction of the closure activities. Closure activities must be completed within 180 days of beginning closure activities unless the County gains approval from the SWS by demonstrating that the construction period, by necessity, will require an extended schedule and that measures to protect human health and the environment have been implemented in the interim.

1.4.4 Prepare Construction Contract Documents

For the purpose of bidding, construction documents will be prepared for the area to be closed. The bidding documents will allow contractors to estimate the quantity of materials needed to properly implement the closure plan, as well as estimating the construction costs.

1.4.5 Develop Final Closure Schedule

Once the SWS has reviewed and commented on the closure schedule, the County will prepare a final schedule for bidding and construction of the closure activities.

1.4.6 Selecting a General Contractor

After receiving sealed bids, a contractor will be awarded the job of constructing the final cover according to the approved closure plan. The contractor will be required to complete all closure activities within 180 days of beginning such activities, or as otherwise approved by the SWS.

1.4.7 Securing Borrow Material for Landfill Cover

The material to be used for construction of the closure cap system will be obtained primarily from on-site sources. Off-site sources, as needed, will be selected based on proximity to the site, ability to provide material according to project specifications, and price.

1.4.8 Certification of Closure Construction

Following completion of the closure construction, a certification verifying that the closure construction was performed in accordance with the closure plan and signed by a registered professional engineer licensed in the State of North Carolina will be made part of the operating record. The County will notify the SWS that the certification has been placed in the operating record.

1.4.9 Record Notation to Deed

After final closure of the property, a notation will be placed on the deed to the property stating that the property was used as a landfill facility, and its use is restricted under the closure plan approved by the SWS.

1.5 Financial Assurance

A detailed cost estimate based on current costs has been prepared for closure of the largest active area of the landfill facility at any time during the life of the facility and is provided in Table 1-1. A copy of the cost estimate has been placed in the operating record. The cost estimate will be annually adjusted to account for inflation and any changes in conditions at the facility or in the design. If conditions call for a reduction in the amount to be financially assured, approval of the SWS must be obtained prior to officially reducing the amount.

Per Rule .0546(c)(1)(B), the County will annually adjust the closure cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument. It is expected that Dare County will use the local financial government test, and therefore will be required to update the closure cost estimate for inflation within 30 days after the close of the fiscal year and before submission of updated information to the SWS.

Table 1-1
Closure Cost Estimate
Dare County C&DLF
Dare County, North Carolina
June 2008

	Quantity	Unit	Cost	Total
Final Cover System				
Grade Intermediate Cover/Strip Existing Vegetation	33.9	ac	\$1,500.00	\$50,850
Cap System Components:				
a. 18" Erosion Layer	82,038	cy	\$13.30	\$1,091,105
b. 18" Low-Permeability Layer, augmented with 2% bentonite	82,038	cy	\$20.00	\$1,640,760
Seeding, Fertilizing & Mulching	33.9	ac	\$1,850.00	\$62,715
Temporary Erosion Control	33.9	ac	\$3,000.00	\$101,700
Permanent Erosion Control				
Diversion Berms/Downdrains	33.9	ac	\$33,300.00	\$1,128,870
Landfill Gas Management				
Vertical Gas Vents (34 @ Avg. Depth of 10')	340	vf	\$108.50	\$36,890
Surveys	33.9	ac	\$333.33	\$11,300
Final Landscaping				
Seeding, Fertilizing & Mulching	33.9	ac	\$1,850.00	\$62,715
Indemnification	1	ls	\$5,000.00	\$5,000
Subtotal				\$4,191,905
Bonds and Mobilization/Demobilization (5% of Subtotal)				\$209,595
Engineering Services, CQA/CQC (12% of Subtotal)				\$503,029
Contingency (15% of Subtotal)				\$628,786
TOTAL				\$5,533,315
COST PER ACRE				\$163,225

Section 2

Post-Closure Plan

The North Carolina Solid Waste Regulation Section Rule 15A NCAC 13B .0543(a) requires owners/operators of C&DLFs to prepare a post-closure plan. The purpose of the plan is to provide the necessary information for preserving the integrity of the landfill facility in its post-closure life. This post-closure plan specifically addresses maintenance activities for the closure cap, landfill gas monitoring system, groundwater monitoring wells, and erosion and sedimentation control system to be installed at the C&DLF. This plan also addresses certification and financial assurance requirements.

Post-closure care will begin immediately following final closure of the landfill. Post-closure care may be decreased from the minimum time period of 30 years specified in the regulations if the County can demonstrate that the reduced period will pose no threat to human health or the environment. However, the SWS reserves the right to increase the post-closure care period if it is deemed necessary to protect human health and the environment.

2.1 Maintenance and Monitoring Activities

Post-closure maintenance and monitoring activities for the C&DLF are described in the following sections.

2.1.1 Final Cover System

Inspection of the final cover system will take place quarterly and encompass the entire landfill. Items of concern to be noted by the inspector include but are not limited to: signs of erosion (ruts, sediment deposits, etc.), patches of stressed or dead vegetation, animal burrows, recessed areas or ponding, upheaving, leachate seepage stains and/or flowing leachate, cracks in the cap, damaged gas vents and tree saplings (especially species with tap roots). Following each inspection, a summary report of the condition of the cover and the items of concern should be recorded in the post-closure log book of the facility. Areas that require further attention should be photographed and delineated on a map of the facility. These items should also be entered in the log book. Since post-closure inspection personnel will most likely change during the post-closure period, the post-closure log book should be kept in a standardized format that allows for new inspection personnel to easily review the results of past post-closure inspections of the site.

Action should be taken immediately to address any items of concern identified during the inspection. Obvious repair items should be performed under the supervision of the post-closure maintenance manager. If an item of concern requires further study to determine a course of action, the engineering firm responsible for closure design should be contacted for consultation.

As part of general maintenance, the vegetative cover should be mowed at least twice a year to suppress weed and brush growth. If vegetative cover is not adequate in any particular area, soil amendments should be applied as necessary and the area re-seeded in order to re-establish vegetation. Insecticides may be used to eliminate insect populations that are detrimental to the vegetation. Animal burrows and eroded or depressed areas should be filled in with compacted soil and reseeded.

2.1.2 Groundwater Monitoring Wells

Inspection of the groundwater monitoring wells will take place semi-annually during sampling events. The inspection will consist of verifying the condition of the monitoring wells to ensure that they are providing representative samples of the ground water being collected. The inspector should note the following:

- 1) The total depth of the well should be recorded every time a water sample is collected or a water level reading is taken to check if sediment has accumulated at the bottom. If sediment build-up has occurred, the sediment should be removed by pumping or bailing.
- 2) If turbid samples are collected from a well, redevelopment of the well will be necessary.
- 3) The above-ground protective casing should be inspected for damage. The protective casing should be of good structural integrity and free of any cracks or corrosion. The lockable cover and lock should also be checked at this time.
- 4) The surface seals should be inspected for settling and cracking. If the seal is damaged in any way, the seal should be replaced.
- 5) The well casing and cap should be inspected. The casing and cap should be of good structural integrity and free of any cracks or corrosion. Any debris should be removed from around the cap to prevent it from entering the well.

The condition of the groundwater monitoring system should be recorded in the post-closure log book following each sampling event. Monitoring of the groundwater wells shall be conducted as described in the groundwater monitoring plan.

2.1.3 Landfill Gas Monitoring System

Inspection of the landfill gas monitoring system should take place at least quarterly. The inspection should consist of verifying the condition and operation of the passive gas vents and gas monitoring wells. The full depth of all vents and monitoring wells should be checked for blockage that may be caused by settlement or cracks in the casing. At least once a year, all vents and wells should be tested with an air pump to ensure they are free-flowing. The summary of each inspection of the landfill gas monitoring system should be recorded in the post-closure log book along with photographs of any items of concern.

Testing of the gas monitoring wells shall be conducted quarterly, or as otherwise approved by the SWS.

If any vents or wells are not properly working, they should be flushed and pressure cleaned. If all attempts to repair a vent or well are unsuccessful, a replacement will be installed.

2.2 Erosion and Sedimentation Control System

Inspection of the erosion and sedimentation control system should occur semi-annually and after major storm events. During each inspection, the elements of the system including drainage ditches, drainage pipes, sedimentation pond, and inlet/outlet structures should be checked for obstructions and damage. The drainage ditches should be inspected for obstructions, erosion of side slopes, loss of vegetative cover, shifting of riprap, excessive buildup of sediment, or any other item that may prevent the proper functioning of the ditch. Drainage piping should be checked for blockages and the inlets/outlets should be inspected for undercutting and rutting. The sediment level in the sedimentation ponds should be measured to determine if removal is required. The condition of the riser/barrel should be checked to ensure that adequate gravel surrounds the riser and that the barrel is not filled with sediment. The berms of each pond should be inspected for stability. Following each inspection, a summary report should be entered in the post-closure log book along with photographs of any items of concern.

Maintenance and/or repairs should be performed immediately as prescribed by the inspectors review.

2.3 Certification of Post-Closure

Following completion of the post-closure care period, a certification verifying that post-closure care was performed in accordance with the post-closure plan and signed by a registered professional engineer licensed in the State of North Carolina will be made part of the operating record. The County will notify the SWS that the certification has been placed in the operating record.

2.4 Name of Individual Responsible for Post-Closure Maintenance of the Site

Mr. Edward Mann of Dare County is currently responsible for operations and maintenance of the site. Mr. Mann can be reached at the following address:

Mr. Edward Mann
Public Works Director, Dare County
P.O. Box 100
Manteo, North Carolina 27954

Mr. Mann most likely will not be employed with Dare County throughout the entire 30 year post-closure period. A new individual will be appointed at the time Mr. Mann's employment with the County ends.

2.5 Planned Use of Landfill after Closure

There are no current planned uses for the landfill site after closure. The property will remain County property, maintained by the County, with public access prohibited.

2.6 Financial Assurance

Dare County will submit a financial assurance package to SWS in accordance with the criteria set forth under Rule .0546. A detailed cost estimate for post-closure care has been prepared and is provided herein (Table 2-1) and a copy has been placed in the operating record. The cost estimate is based on 30 years of post-closure care.

Per Rule .0546(c)(3)(B), the County will annually adjust the post-closure cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument. Dare County anticipates using the local financial government test, and therefore will be required to update the post-closure cost estimate for inflation within 30 days after the close of the fiscal year and before submission of updated information to the SWS.

Table 2-1
Post-Closure Cost Estimate
Dare County C&DLF
Dare County, North Carolina
June 2008

	Quantity	Unit	Cost	Total
Administration	30	yr	\$5,000	\$150,000
Engineering	30	yr	\$10,000	\$300,000
Monitoring				
15 Groundwater Monitoring Well and QA/QC Samples Analyzed Semi-Annually for 30 years	60	events	\$2,475	\$148,500
3 Surface Water Sample Analyzed Semi-Annually for 30 years	60	events	\$325	\$19,500
Maintenance				
Fencing, Gates, Signs, etc.	30	yr	\$1,000	\$30,000
Access Roads	30	yr	\$3,000	\$90,000
Mowing	30	yr	\$12,000	\$360,000
Stormwater Structures	30	yr	\$9,000	\$270,000
Final Cover System Inspection & Repair	30	yr	\$25,000	\$750,000
Groundwater Monitoring Wells	30	yr	\$8,000	\$240,000
Subtotal				\$2,358,000
Contingency (15%)				\$353,700

TOTAL \$2,711,700

ANNUAL COST \$90,390

C&D Landfill Permit Modification Appendix A

Landfill Stability and Settlement Analysis (March 3, 2005)
(not included in electronic version)



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

June 26, 2008

Mr. Ed Mussler
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
401 Oberlin Road, Suite 150
Raleigh, North Carolina 27605

Subject: Dare County, North Carolina
C&D Landfill Permit Modification
Permit No. 28-03

Dear Ed:

On behalf of Dare County (County), Camp Dresser & McKee (CDM) is pleased to submit two (2) copies of the Construction and Demolition (C&D) Landfill Permit Modification for your review. Also included is a PDF on compact disc. The Permit Modification includes closure and post-closure plans prepared in accordance with Rules 15A NCAC 13B.0547(2)(a) and .0543. Also included, as required by Rule .0547(2)(b), are closure and post-closure care cost estimates. Based on conversations with Ms. Amy Kadrie (NCDENR SWS), the County is required to incorporate these cost estimates into their annual financial assurance documentation submitted after their fiscal year is closed and prior to November 1.

Please do not hesitate to contact me at (919) 325-3502 if you have any questions or if there is anything I can do to facilitate the review and approval of this permit modification.

Very truly yours,

W. Michael Brinchek, P.E.
Camp Dresser & McKee

attachments: as noted

cc: Ed ward Mann, Dare County
K. Yang/J. Boyer, CDM

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C&D Landfill Permit Modification

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Appendix A

Landfill Stability and Settlement Analysis

1

Section
One

Section 1

Closure Plan

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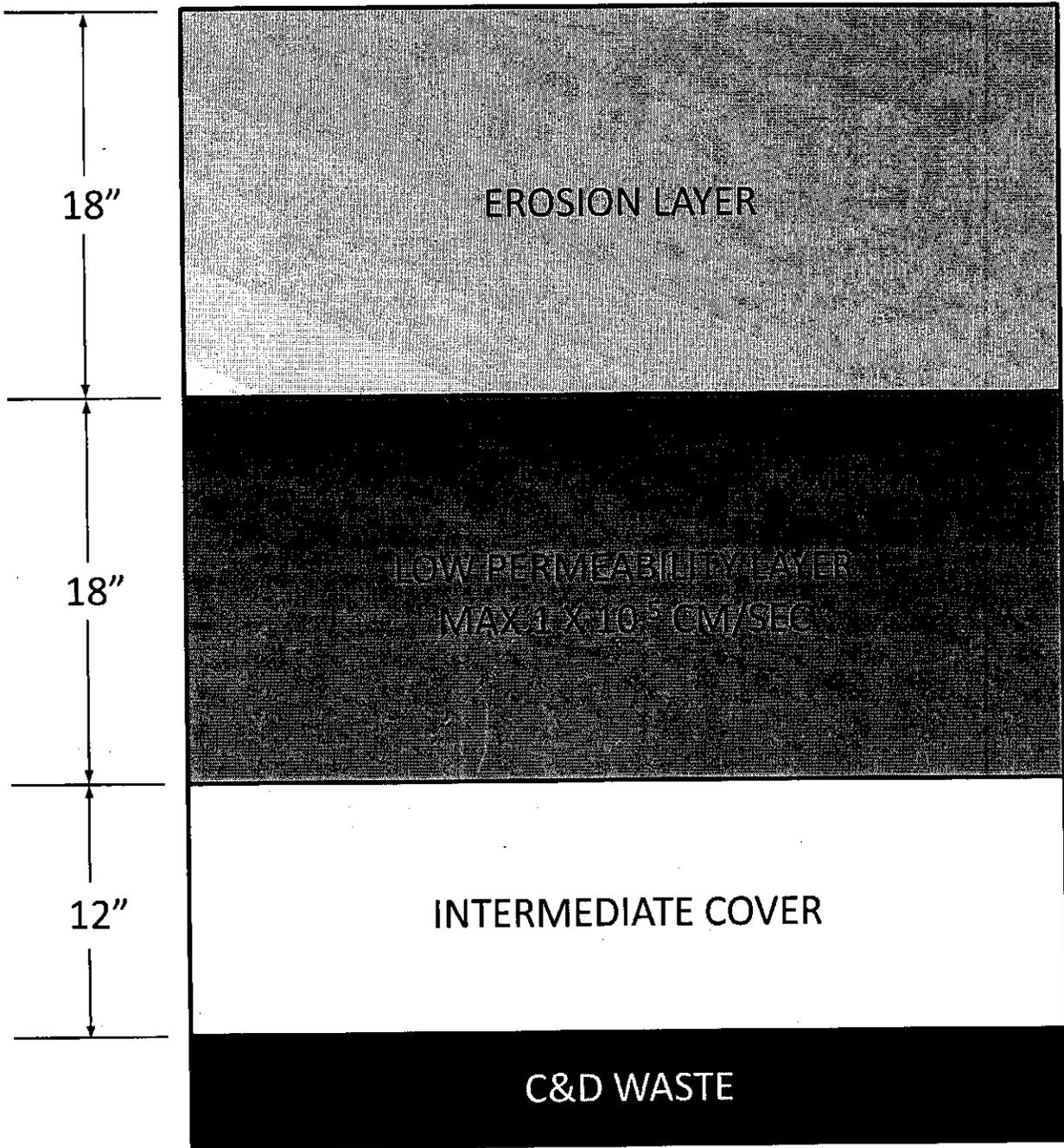
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DATE 6-18-2008

FINAL COVER
SYSTEM

FIGURE
NO.

1-1



Camp Dresser & McKee

1.1.2 Gas Collection System

The placement of a low-permeability final cover system will prevent the release of landfill gas generated during the post-closure period. To minimize pressures exerted on the barrier, passively vented gas wells will be used. The exact location of the vertical gas wells will be determined at the time of closure. Generally, one vertical well per acre is anticipated to be installed. A bentonite seal and synthetic boot will be installed around the vertical gas well to prevent storm water infiltration. The depth of the vertical gas wells will extend from final grade to less than 10 feet into waste. Figure No. 1-2 provides a section detail of the proposed vertical gas well design.

1.2 Estimate of Largest Closure

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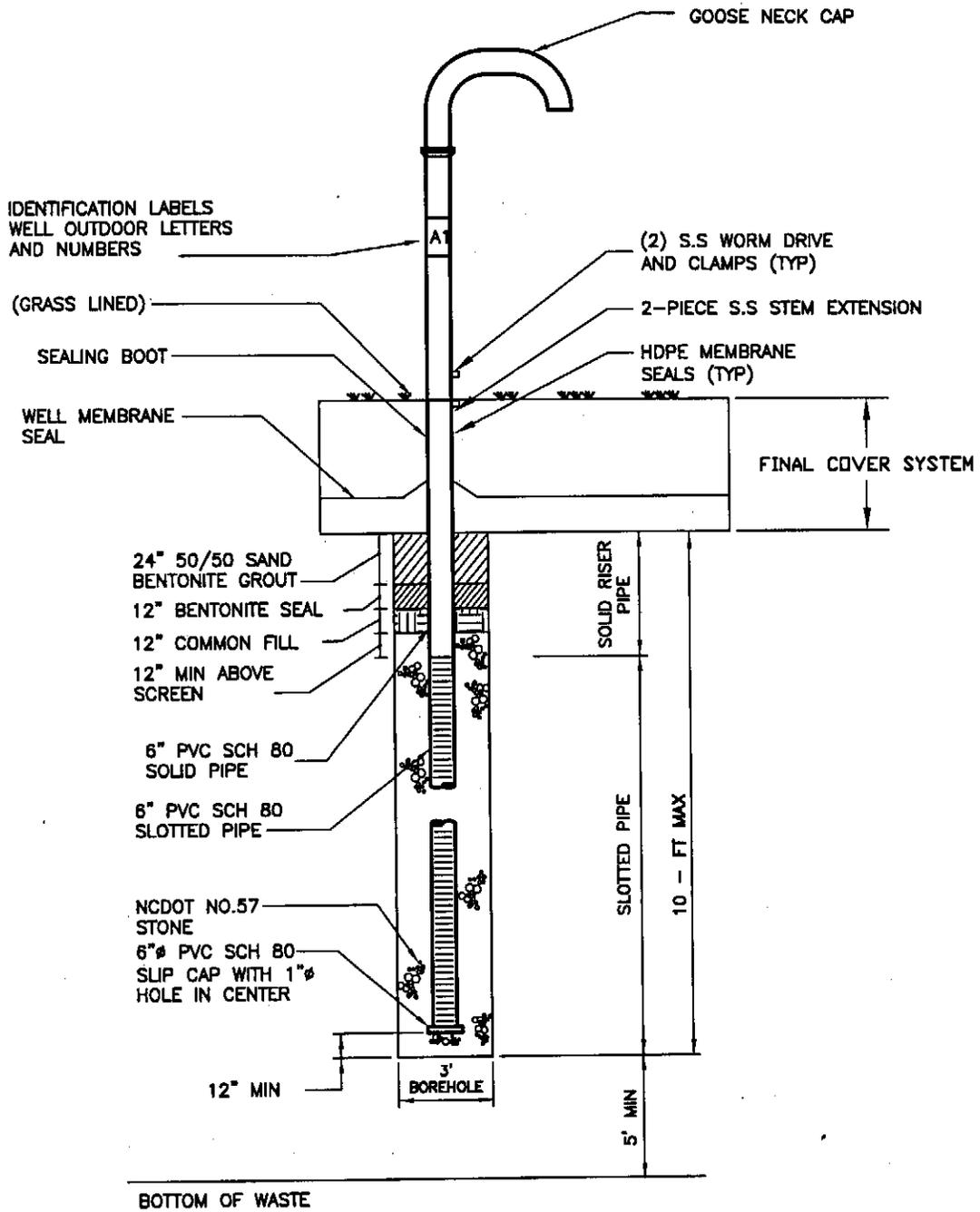
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When an area has reached final grades, the County must initiate the closure process no later than 30 days after the final receipt of waste. However, if the area has not



DATE 5-21-2008

VERTICAL GAS
WELL

FIGURE
NO.

1-2



Camp Dresser & McKee

CLOSURE SEQUENCE	
<i>Activity</i>	<i>Process Date</i>
Determination of Closure Area and Initiate Closure Process	No later than 30 days after the final receipt of waste
Notification of Intent to Close	Once an area has been determined to be closed
Develop Closure Schedule for Closure Activities	
Prepare Construction Contract Documents	
Develop Final Closure Schedule	Once the SWS has commented on the closure schedule
Select a General Contractor	After receiving sealed bids
Closure Construction	Closure activities must be completed within 180 days of beginning closure activities or as otherwise approved
Certification of Closure Construction	At completion of construction
Record Notation to Deed	After final closure of property

reached final grades and there is reasonable likelihood that additional waste will be received in the near future, then closure activities must begin no later than one year after the most recent receipt of wastes.

1.4.2 Notification of Intent to Close

Once the County has determined that an area will be closed, a Notice of Intent to Close must be placed in the operating record and the SWS must be notified of the action per Rule .0543(c)(4). The final cover design, area to be closed, and scheduling of closure activities presented in this Permit Modification Application shall be reviewed and updated as necessary.

1.4.3 Develop Closure Schedule

The County will prepare a schedule for bidding and construction of the closure activities. Closure activities must be completed within 180 days of beginning closure activities unless the County gains approval from the SWS by demonstrating that the construction period, by necessity, will require an extended schedule and that measures to protect human health and the environment have been implemented in the interim.

1.4.4 Prepare Construction Contract Documents

For the purpose of bidding, construction documents will be prepared for the area to be closed. The bidding documents will allow contractors to estimate the quantity of materials needed to properly implement the closure plan, as well as estimating the construction costs.

1.4.5 Develop Final Closure Schedule

Once the SWS has reviewed and commented on the closure schedule, the County will prepare a final schedule for bidding and construction of the closure activities.

1.4.6 Selecting a General Contractor

After receiving sealed bids, a contractor will be awarded the job of constructing the final cover according to the approved closure plan. The contractor will be required to complete all closure activities within 180 days of beginning such activities, or as otherwise approved by the SWS.

1.4.7 Securing Borrow Material for Landfill Cover

The material to be used for construction of the closure cap system will be obtained primarily from on-site sources. Off-site sources, as needed, will be selected based on proximity to the site, ability to provide material according to project specifications, and price.

1.4.8 Certification of Closure Construction

Following completion of the closure construction, a certification verifying that the closure construction was performed in accordance with the closure plan and signed by a registered professional engineer licensed in the State of North Carolina will be made part of the operating record. The County will notify the SWS that the certification has been placed in the operating record.

1.4.9 Record Notation to Deed

After final closure of the property, a notation will be placed on the deed to the property stating that the property was used as a landfill facility, and its use is restricted under the closure plan approved by the SWS.

1.5 Financial Assurance

A detailed cost estimate based on current costs has been prepared for closure of the largest active area of the landfill facility at any time during the life of the facility and is provided in Table 1-1. A copy of the cost estimate has been placed in the operating record. The cost estimate will be annually adjusted to account for inflation and any changes in conditions at the facility or in the design. If conditions call for a reduction in the amount to be financially assured, approval of the SWS must be obtained prior to officially reducing the amount.

Per Rule .0546(c)(1)(B), the County will annually adjust the closure cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument. It is expected that Dare County will use the local financial government test, and therefore will be required to update the closure cost estimate for inflation within 30 days after the close of the fiscal year and before submission of updated information to the SWS.

Table 1-1
Closure Cost Estimate
Dare County C&DLF
Dare County, North Carolina
June 2008

	Quantity	Unit	Cost	Total
Final Cover System				
Grade Intermediate Cover/Strip Existing Vegetation	33.9	ac	\$1,500.00	\$50,850
Cap System Components:				
a. 18" Erosion Layer	82,038	cy	\$13.30	\$1,091,105
b. 18" Low-Permeability Layer, augmented with 2% bentonite	82,038	cy	\$20.00	\$1,640,760
Seeding, Fertilizing & Mulching	33.9	ac	\$1,850.00	\$62,715
Temporary Erosion Control	33.9	ac	\$3,000.00	\$101,700
Permanent Erosion Control				
Diversion Berms/Downdrains	33.9	ac	\$33,300.00	\$1,128,870
Landfill Gas Management				
Vertical Gas Vents (34 @ Avg. Depth of 10')	340	vf	\$108.50	\$36,890
Surveys	33.9	ac	\$333.33	\$11,300
Final Landscaping				
Seeding, Fertilizing & Mulching	33.9	ac	\$1,850.00	\$62,715
Indemnification	1	ls	\$5,000.00	\$5,000
Subtotal				\$4,191,905
Bonds and Mobilization/Demobilization (5% of Subtotal)				\$209,595
Engineering Services, CQA/CQC (12% of Subtotal)				\$503,029
Contingency (15% of Subtotal)				\$628,786
TOTAL				\$5,533,315
COST PER ACRE				\$163,225

2

Section
Two

Section 2

Post-Closure Plan

The North Carolina Solid Waste Regulation Section Rule 15A NCAC 13B .0543(a) requires owners/operators of C&DLFs to prepare a post-closure plan. The purpose of the plan is to provide the necessary information for preserving the integrity of the landfill facility in its post-closure life. This post-closure plan specifically addresses maintenance activities for the closure cap, landfill gas monitoring system, groundwater monitoring wells, and erosion and sedimentation control system to be installed at the C&DLF. This plan also addresses certification and financial assurance requirements.

Post-closure care will begin immediately following final closure of the landfill. Post-closure care may be decreased from the minimum time period of 30 years specified in the regulations if the County can demonstrate that the reduced period will pose no threat to human health or the environment. However, the SWS reserves the right to increase the post-closure care period if it is deemed necessary to protect human health and the environment.

2.1 Maintenance and Monitoring Activities

Post-closure maintenance and monitoring activities for the C&DLF are described in the following sections.

2.1.1 Final Cover System

Inspection of the final cover system will take place quarterly and encompass the entire landfill. Items of concern to be noted by the inspector include but are not limited to: signs of erosion (ruts, sediment deposits, etc.), patches of stressed or dead vegetation, animal burrows, recessed areas or ponding, upheaving, leachate seepage stains and/or flowing leachate, cracks in the cap, damaged gas vents and tree saplings (especially species with tap roots). Following each inspection, a summary report of the condition of the cover and the items of concern should be recorded in the post-closure log book of the facility. Areas that require further attention should be photographed and delineated on a map of the facility. These items should also be entered in the log book. Since post-closure inspection personnel will most likely change during the post-closure period, the post-closure log book should be kept in a standardized format that allows for new inspection personnel to easily review the results of past post-closure inspections of the site.

Action should be taken immediately to address any items of concern identified during the inspection. Obvious repair items should be performed under the supervision of the post-closure maintenance manager. If an item of concern requires further study to determine a course of action, the engineering firm responsible for closure design should be contacted for consultation.

As part of general maintenance, the vegetative cover should be mowed at least twice a year to suppress weed and brush growth. If vegetative cover is not adequate in any particular area, soil amendments should be applied as necessary and the area re-seeded in order to re-establish vegetation. Insecticides may be used to eliminate insect populations that are detrimental to the vegetation. Animal burrows and eroded or depressed areas should be filled in with compacted soil and reseeded.

2.1.2 Groundwater Monitoring Wells

Inspection of the groundwater monitoring wells will take place semi-annually during sampling events. The inspection will consist of verifying the condition of the monitoring wells to ensure that they are providing representative samples of the ground water being collected. The inspector should note the following:

- 1) The total depth of the well should be recorded every time a water sample is collected or a water level reading is taken to check if sediment has accumulated at the bottom. If sediment build-up has occurred, the sediment should be removed by pumping or bailing.
- 2) If turbid samples are collected from a well, redevelopment of the well will be necessary.
- 3) The above-ground protective casing should be inspected for damage. The protective casing should be of good structural integrity and free of any cracks or corrosion. The lockable cover and lock should also be checked at this time.
- 4) The surface seals should be inspected for settling and cracking. If the seal is damaged in any way, the seal should be replaced.
- 5) The well casing and cap should be inspected. The casing and cap should be of good structural integrity and free of any cracks or corrosion. Any debris should be removed from around the cap to prevent it from entering the well.

The condition of the groundwater monitoring system should be recorded in the post-closure log book following each sampling event. Monitoring of the groundwater wells shall be conducted as described in the groundwater monitoring plan.

2.1.3 Landfill Gas Monitoring System

Inspection of the landfill gas monitoring system should take place at least quarterly. The inspection should consist of verifying the condition and operation of the passive gas vents and gas monitoring wells. The full depth of all vents and monitoring wells should be checked for blockage that may be caused by settlement or cracks in the casing. At least once a year, all vents and wells should be tested with an air pump to ensure they are free-flowing. The summary of each inspection of the landfill gas monitoring system should be recorded in the post-closure log book along with photographs of any items of concern.

Testing of the gas monitoring wells shall be conducted quarterly, or as otherwise approved by the SWS.

If any vents or wells are not properly working, they should be flushed and pressure cleaned. If all attempts to repair a vent or well are unsuccessful, a replacement will be installed.

2.2 Erosion and Sedimentation Control System

Inspection of the erosion and sedimentation control system should occur semi-annually and after major storm events. During each inspection, the elements of the system including drainage ditches, drainage pipes, sedimentation pond, and inlet/outlet structures should be checked for obstructions and damage. The drainage ditches should be inspected for obstructions, erosion of side slopes, loss of vegetative cover, shifting of riprap, excessive buildup of sediment, or any other item that may prevent the proper functioning of the ditch. Drainage piping should be checked for blockages and the inlets/outlets should be inspected for undercutting and rutting. The sediment level in the sedimentation ponds should be measured to determine if removal is required. The condition of the riser/barrel should be checked to ensure that adequate gravel surrounds the riser and that the barrel is not filled with sediment. The berms of each pond should be inspected for stability. Following each inspection, a summary report should be entered in the post-closure log book along with photographs of any items of concern.

Maintenance and/or repairs should be performed immediately as prescribed by the inspectors review.

2.3 Certification of Post-Closure

Following completion of the post-closure care period, a certification verifying that post-closure care was performed in accordance with the post-closure plan and signed by a registered professional engineer licensed in the State of North Carolina will be made part of the operating record. The County will notify the SWS that the certification has been placed in the operating record.

2.4 Name of Individual Responsible for Post-Closure Maintenance of the Site

Mr. Edward Mann of Dare County is currently responsible for operations and maintenance of the site. Mr. Mann can be reached at the following address:

Mr. Edward Mann
Public Works Director, Dare County
P.O. Box 100
Manteo, North Carolina 27954

Mr. Mann most likely will not be employed with Dare County throughout the entire 30 year post-closure period. A new individual will be appointed at the time Mr. Mann's employment with the County ends.

2.5 Planned Use of Landfill after Closure

There are no current planned uses for the landfill site after closure. The property will remain County property, maintained by the County, with public access prohibited.

2.6 Financial Assurance

Dare County will submit a financial assurance package to SWS in accordance with the criteria set forth under Rule .0546. A detailed cost estimate for post-closure care has been prepared and is provided herein (Table 2-1) and a copy has been placed in the operating record. The cost estimate is based on 30 years of post-closure care.

Per Rule .0546(c)(3)(B), the County will annually adjust the post-closure cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument. Dare County anticipates using the local financial government test, and therefore will be required to update the post-closure cost estimate for inflation within 30 days after the close of the fiscal year and before submission of updated information to the SWS.

Table 2-1
Post-Closure Cost Estimate
Dare County C&DLF
Dare County, North Carolina
June 2008

	Quantity	Unit	Cost	Total
Administration	30	yr	\$5,000	\$150,000
Engineering	30	yr	\$10,000	\$300,000
Monitoring				
15 Groundwater Monitoring Well and QA/QC Samples Analyzed Semi-Annually for 30 years	60	events	\$2,475	\$148,500
3 Surface Water Sample Analyzed Semi-Annually for 30 years	60	events	\$325	\$19,500
Maintenance				
Fencing, Gates, Signs, etc.	30	yr	\$1,000	\$30,000
Access Roads	30	yr	\$3,000	\$90,000
Mowing	30	yr	\$12,000	\$360,000
Stormwater Structures	30	yr	\$9,000	\$270,000
Final Cover System Inspection & Repair	30	yr	\$25,000	\$750,000
Groundwater Monitoring Wells	30	yr	\$8,000	\$240,000
Subtotal				\$2,358,000
Contingency (15%)				\$353,700

TOTAL \$2,711,700

ANNUAL COST \$90,390

A

Appendix

A

C&D Landfill Permit Modification Appendix A

Landfill Stability and Settlement Analysis (March 3, 2005)



Memorandum

To: Tom Yanoschak

*From: Steve Whiteside
E. Devy Moalim*

Date: March 3, 2005

Subject: Dare County C & D Landfill Cell III

Purpose

The purpose of this memorandum is to provide the results CDM's of stability and settlement analyses for the proposed Cell 3 construction and demolition debris (C & D) landfills in Dare County, North Carolina. The proposed cell is located east of future cell 4 and will occupy area approximately 260 feet by 2,120 feet.

Project Information and Site Conditions

The Dare County landfill currently serves as a C & D disposal site. The total area of the site is approximately 836 acres. To date, two of the proposed five C & D landfill cells (Cell 1 and 2) have been constructed and occupy approximately 21 acres of the site. The proposed C & D landfill will have a maximum vertical slope height of 34.5 feet with side slopes graded at 3H:1V. The design cross-section for the Cell 3 final closure conditions is presented in Figure 1.

The existing disposal facility is located off of I-264 in Dare County, North Carolina. The site is bounded by I-264 to the north, Grouse Road to the east, Bear Road to the south, and Link Road to the west. Figure 2 presents a site location map.

Subsurface Conditions

The subsurface data utilized in the geotechnical analyses is based upon a previous report by Geohydro Engineers, Inc. (1993) and CDM's recent site investigation (2005). The previous report by others and CDM's Design Hydrogeologic report (March 2005) contain subsurface data and a discussion of regional geology and subsurface conditions. Information contained in these reports is not re-iterated herein. Appendix A and Appendix B contain applicable boring logs and laboratory test results from these reports.

Based on groundwater levels measured on November 25, 1993 by Geohydro Engineers, Inc. and January 13, 2005 by CDM, Inc., design groundwater is assumed to at EL 0 ft-MSL or at the existing ground surface elevation within the footprint of the landfill. This design groundwater level is assumed to be indicative of normal operating conditions.

Groundwater readings from previous reports are presented in **Appendix C**.

Slope Stability Analyses

Analyses for overall (global) stability were performed using the XSTABL computer program, version 5.203. This computer program calculates a factor of safety against failure of the overall landfill mass. Based upon the inputted slope geometry, soil and waste properties, and groundwater conditions the minimum acceptable factor of safety for stability of the landfill mass overall is 1.5.

The XSTABL computer program was used to perform a circular failure surface search through the C & D waste and foundation soils. The computed factor of safety for overall global stability is 1.7. The critical failure surface is a circular failure through the C & D waste extending to a depth of approximately 10 feet below the final cover of landfill side slope.

The XSTABL output files are presented in **Appendix D**.

Settlement Analyses

CDM performed settlement analyses for the proposed landfill geometry to estimate the magnitude of settlement of foundation soils due to the loads from C & D and cap materials.

Foundation settlements were computed using the Schmertmann Method for settlement of the design soil profile presented in Table 2 under maximum proposed loading conditions 34.5 feet C & D waste at point C shown in Figure 1.

The results of the analyses are presented in **Appendix E** and summarized below:

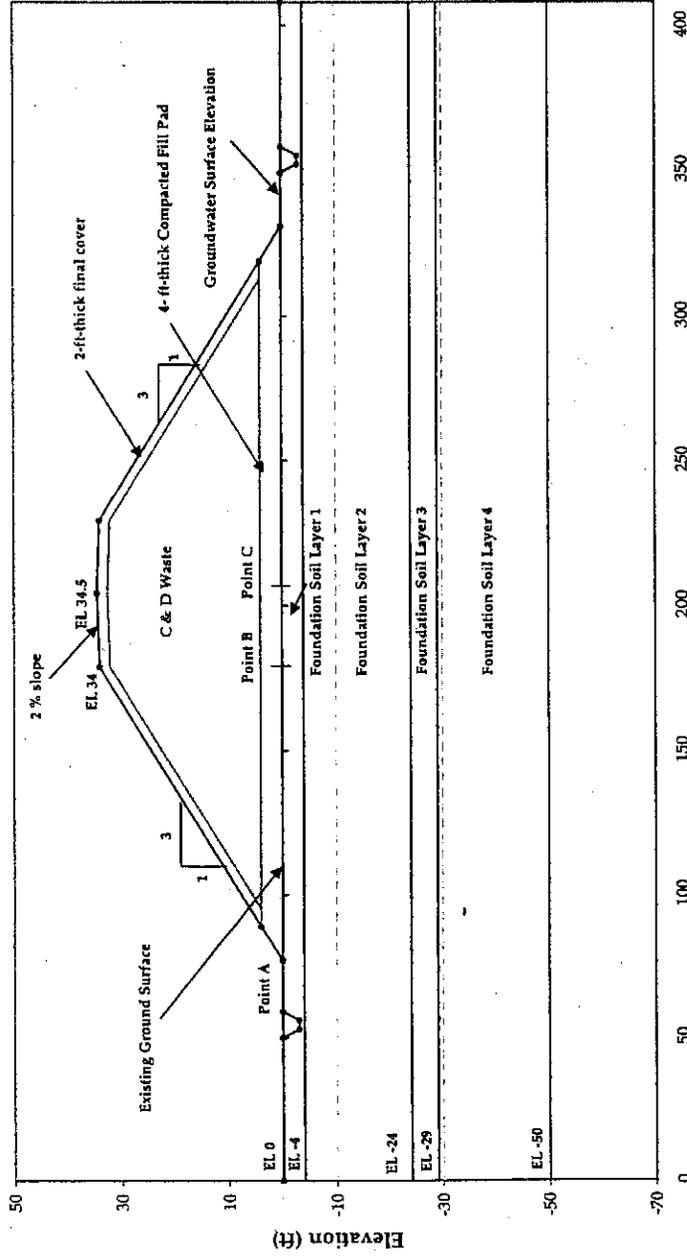
Point C – EL 34.5 (highest landfill elevation)

At t = 0 years settlement = 3.6 inches

t = 10 years settlement = 5.1 inches

t = 30 years settlement = 5.4 inches

Figure 1: Landfill Cell 3 Typical Cross Section



Summary of Soil Properties:

No.	Soil Type	Unit Dry Weight, γ (pcf)	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Basis for Parameter Selection
1	2-ft-thick Final Cover	120	-	35	Previous Report
2	C & D Waste	65	-	27.5	Literature Search
3	4-ft-thick Compacted Fill	120	-	35	Lab Test Results from Previous Report
4	Foundation Soil Layer 1 - SM	120	-	32	N SPT Values from Previous Report
5	Foundation Soil Layer 2 - SP/ SP - SM	120	-	30	N SPT Values from Previous Report
6	Foundation Soil Layer 3 - ML	120	-	28	N SPT Values from Previous Report
7	Foundation Soil Layer 4 - SP/ SP - SM	120	-	34	N SPT Values from Previous Report

Appendix A:
Boring Logs from Previous Report

Test Boring Record

Boring Number: <u>B-1A</u>	Date Drilled: <u>9-22-93</u>
Project Name: <u>Dare County Landfill</u>	Drilling Method: <u>hollow stem auger</u>
Project Number: <u>121-93-03160</u>	Initial water level: <u>4.6 feet</u>

Depth (feet)	Material Description	Elevation	Blows per foot	Water Level	Well Sketch
1.1	Topsoil (Approx. 14 inches)	0			<p>The well sketch shows a vertical well casing. At the top, there is a shaded area labeled 'Bentonite Seal'. Below this is a section with horizontal lines labeled 'Sand Filter'. The bottom section of the well is labeled 'Screened Interval'.</p>
4.0	Very firm gray fine to medium sand (SP)	(1)			
7.0	Firm gray slightly silty fine to medium sand (SP-SM)	(4)			
	BORING TERMINATED	(7)			

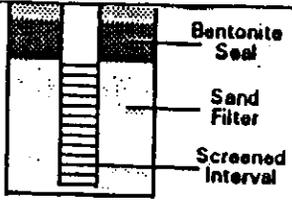
Test Boring Record

Boring Number: <u>B-2A</u>	Date Drilled: <u>9-23-93</u>
Project Name: <u>Dare County Landfill</u>	Drilling Method: <u>hollow stem auger</u>
Project Number: <u>121-93-03160</u>	Initial water level: <u>4.4 feet</u>

Depth (feet)	Material Description	Elevation	Blows per foot	Water Level	Well Sketch
2.0	Dark brown organic silt (OH)	0			
	Firm gray silty fine sand (SM)	(2)			
4.5	Loose gray slightly silty fine to medium sand (SP-SM)	(4)			
7.0	BORING TERMINATED	(7)			

Test Boring Record

Boring Number: <u>B-3A</u>	Date Drilled: <u>9-23-93</u>
Project Name: <u>Dare County Landfill</u>	Drilling Method: <u>hollow stem auger</u>
Project Number: <u>121-93-03160</u>	Initial water level: <u>2.3 feet</u>

Depth (feet)	Material Description	Elevation	Blows per foot	Water Level	Well Sketch
0.8	Topsoil (Approx. 10 inches)	0			
4.0	Loose to Firm gray silty fine sand (SM)	(1)			
7.0	Firm gray slightly silty fine to medium sand (SP-SM)	(4)			
	BORING TERMINATED	(7)			

Test Boring Record

Boring Number: <u>B-4A</u>	Date Drilled: <u>9-21-93</u>
Project Name: <u>Dare County Landfill</u>	Drilling Method: <u>hollow stem auger</u>
Project Number: <u>121-93-03160</u>	Initial water level: <u>4.1 feet</u>

Depth (feet)	Material Description	Elevation	Blows per foot	Water Level	Well Sketch
3.0	Loose gray silty fine sand (SM)	1			<p>The well sketch shows a vertical well casing. At the top, there is a shaded area labeled 'Bentonite Seal'. Below this is a section with horizontal lines labeled 'Sand Filter'. The bottom section of the well is labeled 'Screened Interval'.</p>
	Firm gray fine to coarse sand (SP)	(4)			
7.0	BORING TERMINATED	(8)			

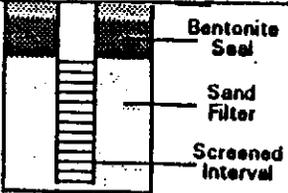
Test Boring Record

Boring Number: <u>B-5A</u>	Date Drilled: <u>9-22-93</u>
Project Name: <u>Dare County Landfill</u>	Drilling Method: <u>hollow stem auger</u>
Project Number: <u>121-93-03160</u>	Initial water level: <u>4.3 feet</u>

Depth (feet)	Material Description	Elevation	Blows per foot	Water Level	Well Sketch
2.0	Firm brown organic silt (OH)	1			<p>The well sketch shows a vertical well casing. At the top, there is a shaded area labeled 'Bentonite Seal'. Below the seal is a section with horizontal lines labeled 'Sand Filter'. Further down is a section with vertical lines labeled 'Screened Interval'. The well is shown as a vertical shaft with a central pipe.</p>
4.0	Very firm brown and gray silty fine sand (SM)	(1)			
	Firm gray slightly silty fine sand (SP-SM)	(3)			
7.0	BORING TERMINATED	(6)			

Test Boring Record

Boring Number: <u>B-6A</u> Project Name: <u>Dare County Landfill</u> Project Number: <u>121-93-03160</u>	Date Drilled: <u>9-22-93</u> Drilling Method: <u>hollow stem auger</u> Initial water level: <u>2.1 feet</u>
---	--

Depth (feet)	Material Description	Elevation	Blows per foot	Water Level	Well Sketch
1.7	Topsoil (Approx. 20 inches)	0			
4.0	Firm brown gray silty fine sand (SM)	(2)			
7.0	Very firm to firm gray fine to medium sand (SP)	(4)			
	BORING TERMINATED	(7)			

Symbols and Nomenclature

Symbols

- Undisturbed sample (UD) recovered
- ▨ Undisturbed sample (UD) not recovered
- Standard penetration resistance (ASTM D1586-67)
- 100/2" Number of blows (100) to drive the spoon a number of inches (2)
- AX, BX, Core barrel sizes which obtain cores 1 1/8, 1 5/8 and 2 1/8 inches in
NX diameter, respectively
- 65% Percentage of rock core recovered
- RQD Rock quality designation- % of core 4 or more inches long
- ≡ Water table at least 24 hours after drilling
- ≡ Water table one hour or less after drilling
- ▲ Loss of drilling water
- A Atterberg Limits Test performed
- C Consolidation Test performed
- GS Grain Size Test performed
- T Triaxial Shear Test performed
- P Proctor Compaction Test performed
- 18 Natural moisture content (percent)

Penetration Resistance Results

	Number of Blows, N	Approximate Relative Density
Sands	0-4	very loose
	5-10	loose
	11-20	firm
	21-30	very firm
	31-50	dense
	Over 50	very dense
	Number of Blows, N	Approximate Consistency
Silts and Clays	0-1	very soft
	2-4	soft
	5-8	firm
	9-15	stiff
	16-30	very stiff
	31-50	hard
	Over 50	very hard

Drilling Procedures

Soil sampling and standard penetration testing performed in accordance with ASTM D 1586. The standard penetration resistance is the number of blows of a 140 pound hammer falling 30 inches to drive a 2 inch O.D., 1.4 inch I.D. split spoon sampler one foot. Core drilling performed in accordance with ASTM designation D 2113. The undisturbed sampling procedure is described by ASTM specification D 1587.

Appendix B:

Lab Test Results from Previous Report

Dare County C&D Landfill

PROJECT NO.

DEPTH

COMPRESSION INDEX 0.12

121-93-03160

24.5'-25.0'

DRY UNIT WEIGHT (PCF) 83.1

BORING NO.

B-1

WATER CONTENT (%) 34.9

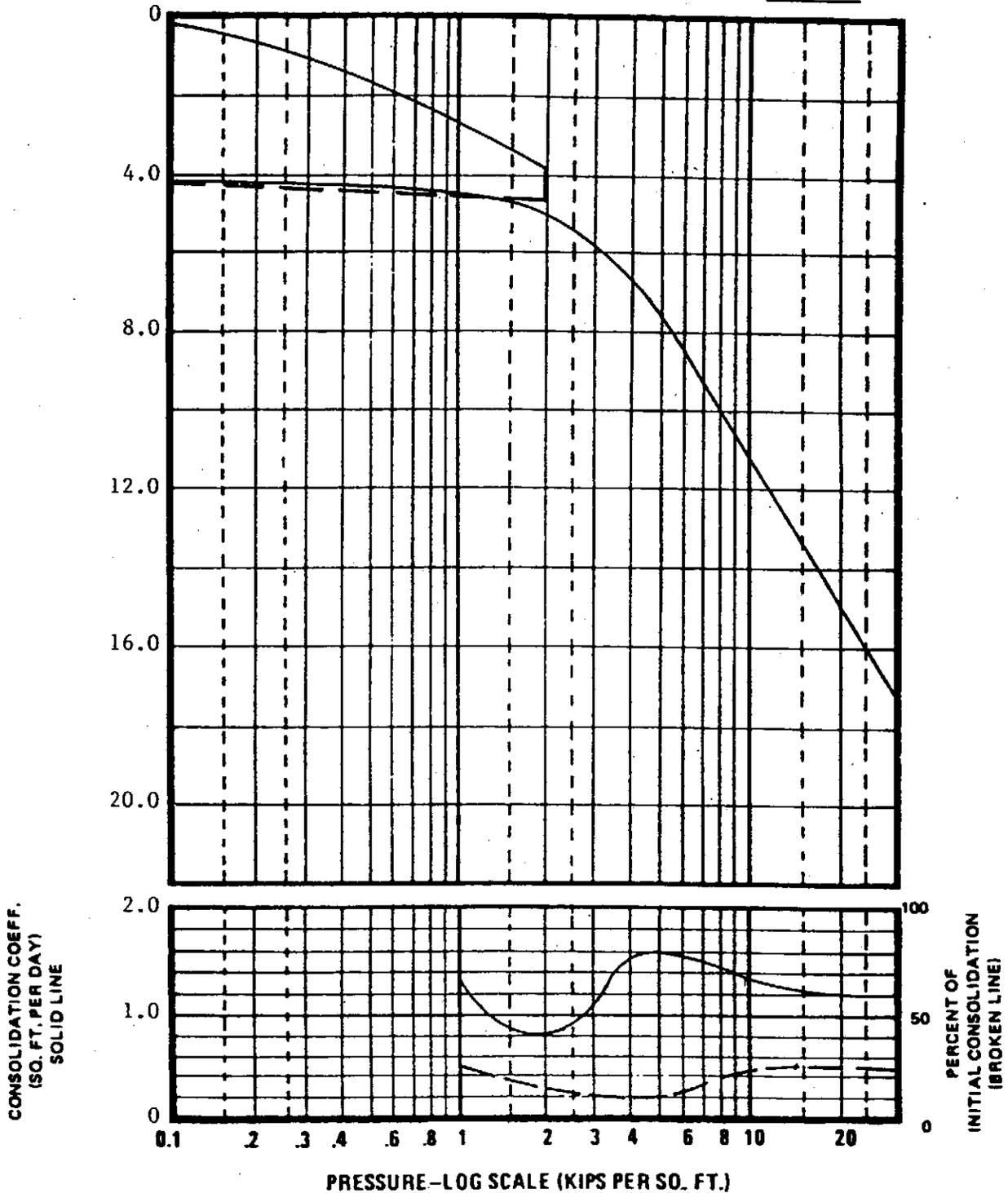
DESCRIPTION

SATURATION (%) 91.5

Gray silt (ML)

LIQUID LIMIT 25

PLASTIC LIMIT 21



CONSOLIDATION TEST RESULTS

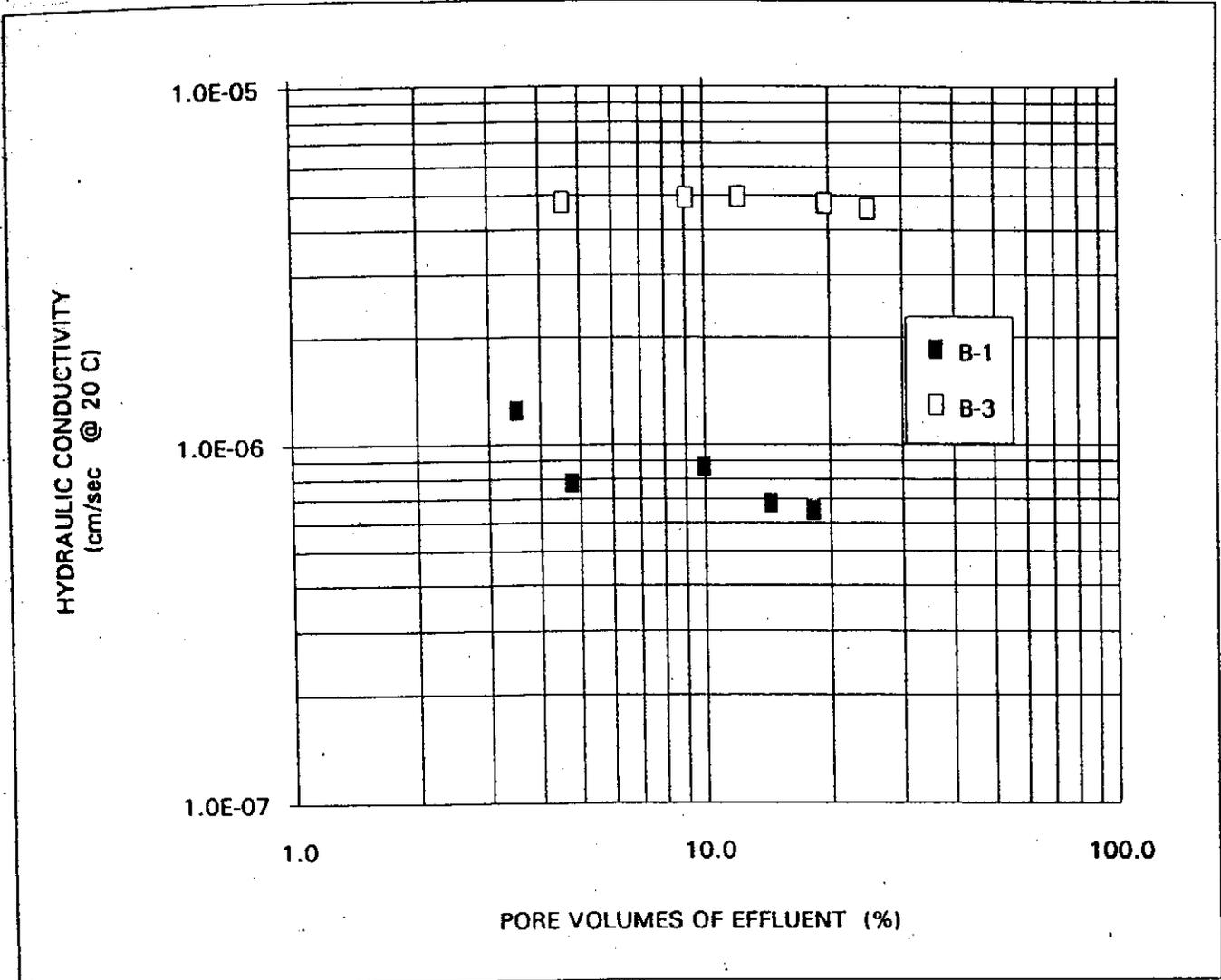
GECHYDRO

HYDRAULIC CONDUCTIVITY LABORATORY TEST RESULTS

GEOHYDRO

Project Name: Dare County Landfill
Project Number: 121-93-03160

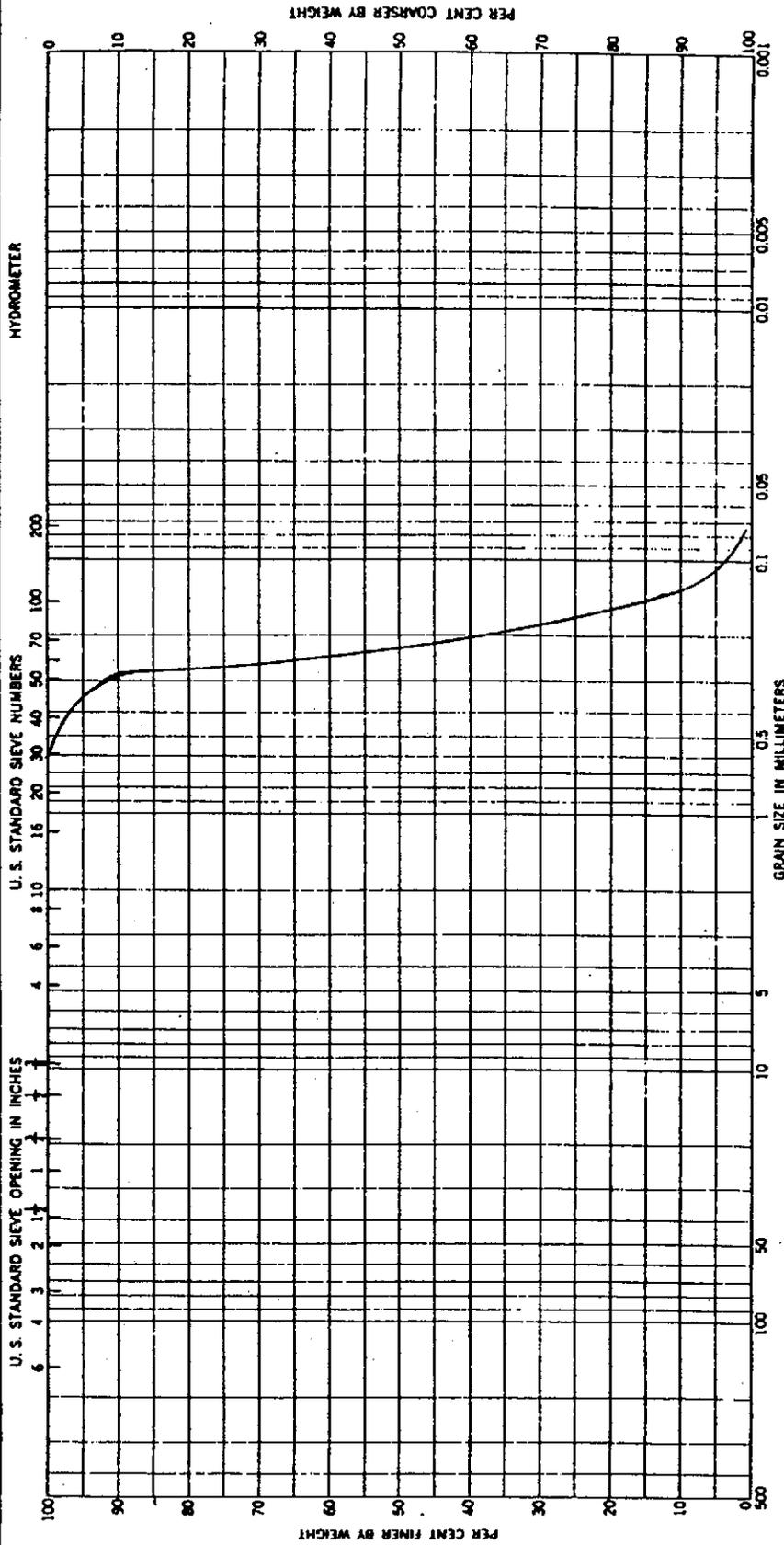
Date: November 1, 1993
Test Method: D-5084



Sample Identification	B-1	B-3
Sample depth (feet)	25.0 to 25.5	25.0 to 25.5
Sample Description	Gray silt (ML)	Gray silt (ML)
Sample Type	TWT	TWT
Diameter (cm)	7.23	7.15
Length (cm)	10.60	11.60
Initial Moisture Content (%)	35.4	30.3
Specific Gravity (assumed)	2.7	2.7
Dry Unit Weight (pcf)	86.7	90.4
Void Ratio	0.944	0.864
Porosity (%)	48.6	46.3
Maximum Consolidation Stress (psi)	5.0	5.0
Minimum Consolidation Stress (psi)	1.0	3.0
Hydraulic Conductivity (cm/sec @ 20 C)	7.4 E-07	4.8 E-06

Project Dare County Landfill Job No. 121-93-03160

Date 10-8-93



Boring No.	Sample No.	Elev or Depth	Classification	Nat w %			PI
				LL	PL	PI	
B-1	S-2	4'	Light gray fine to medium sand (SP)				

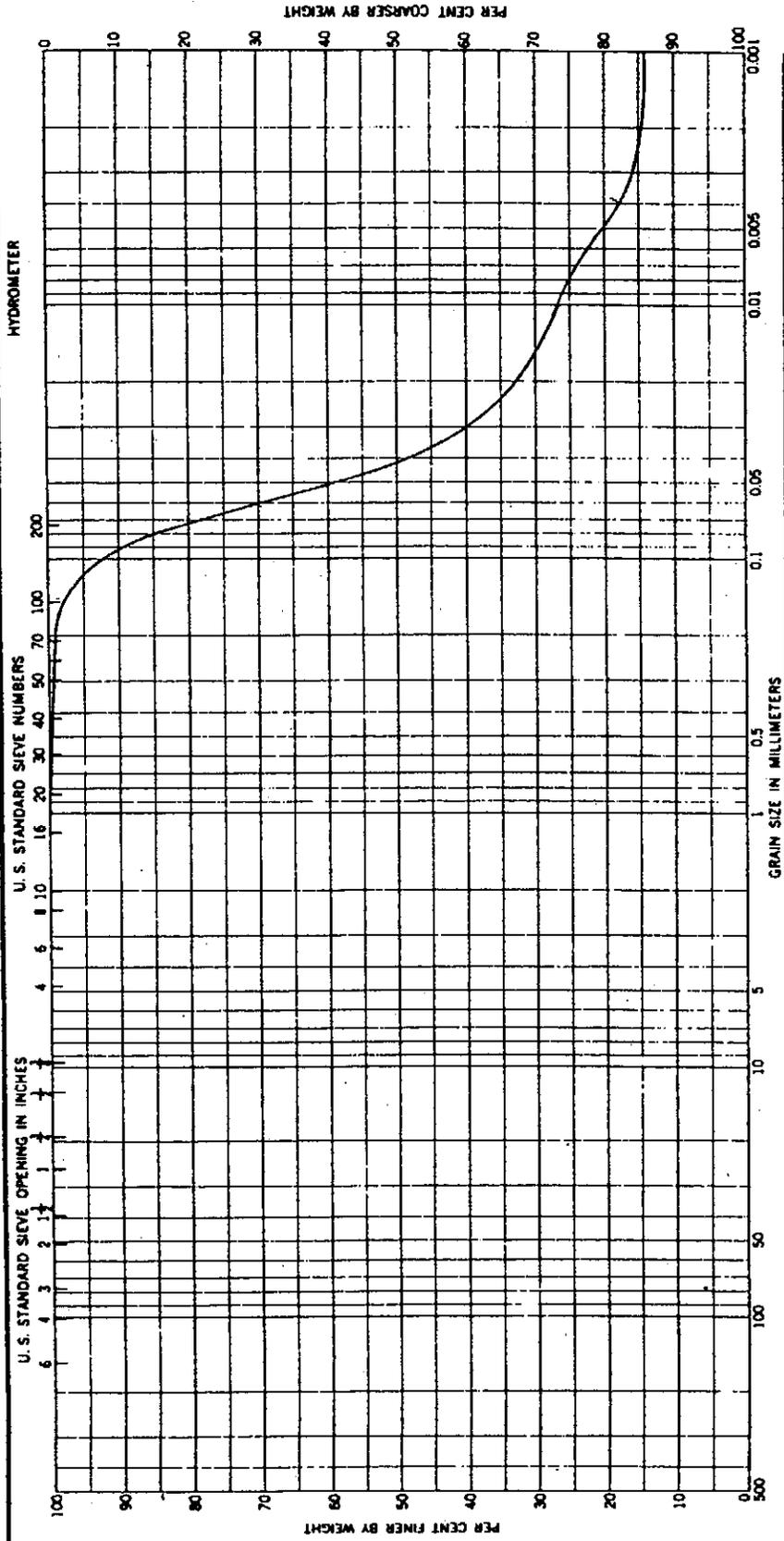
GEOHYDRO

GRADATION CURVES

Job No. 121-93-03160

Date 11/1/93

Project Dare County Landfill



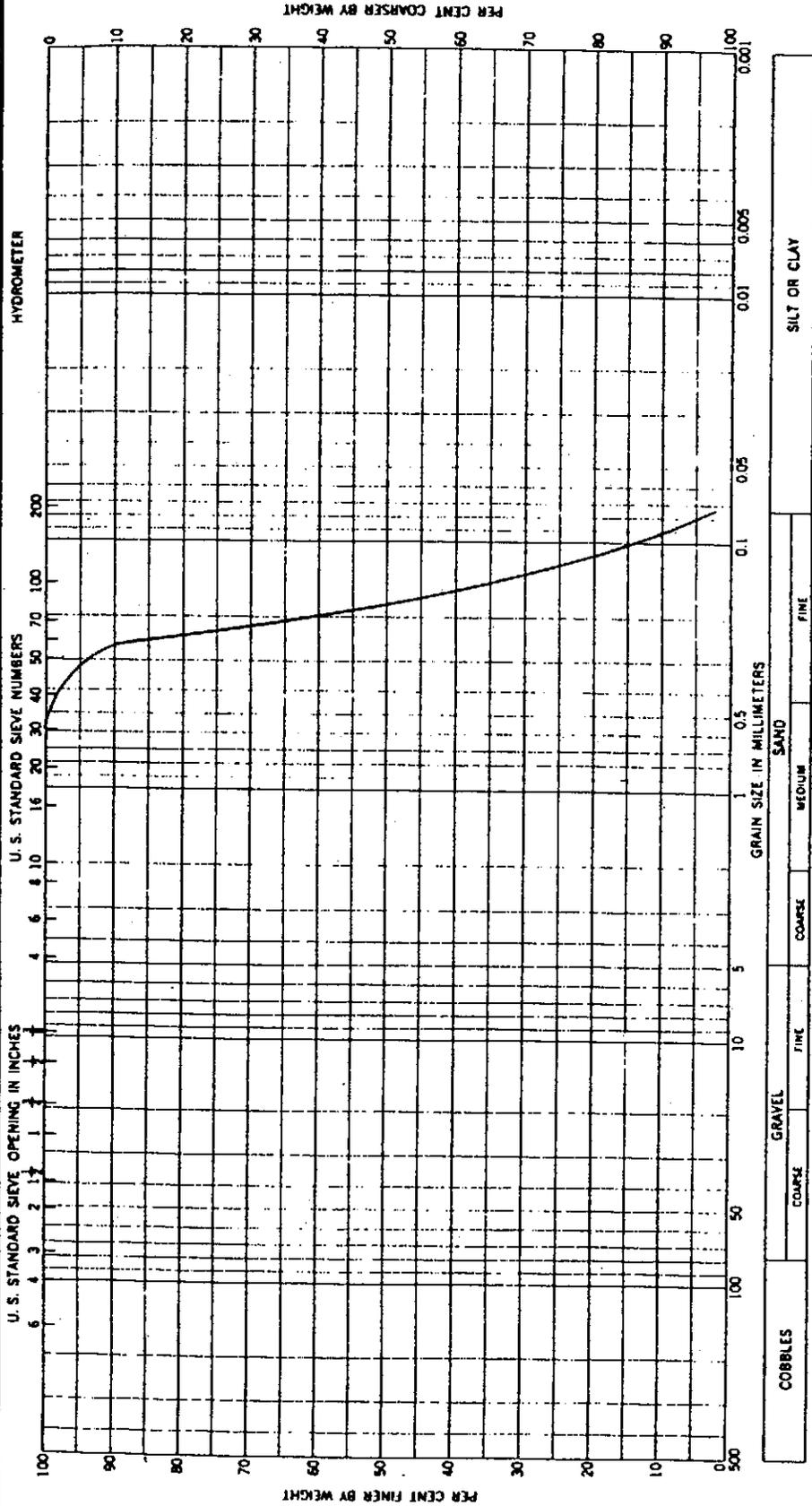
GEOHYDRO

Sample No.	Elev. or Depth	Classification	NaI w %	LL	PL	PI
B-3	25.0' - 25.5'	Gray silt (ML)	30.3	---	---	---

GRADATION CURVES

Project Dare County Landfill Job No. 121-93-03160

Date 10-8-93



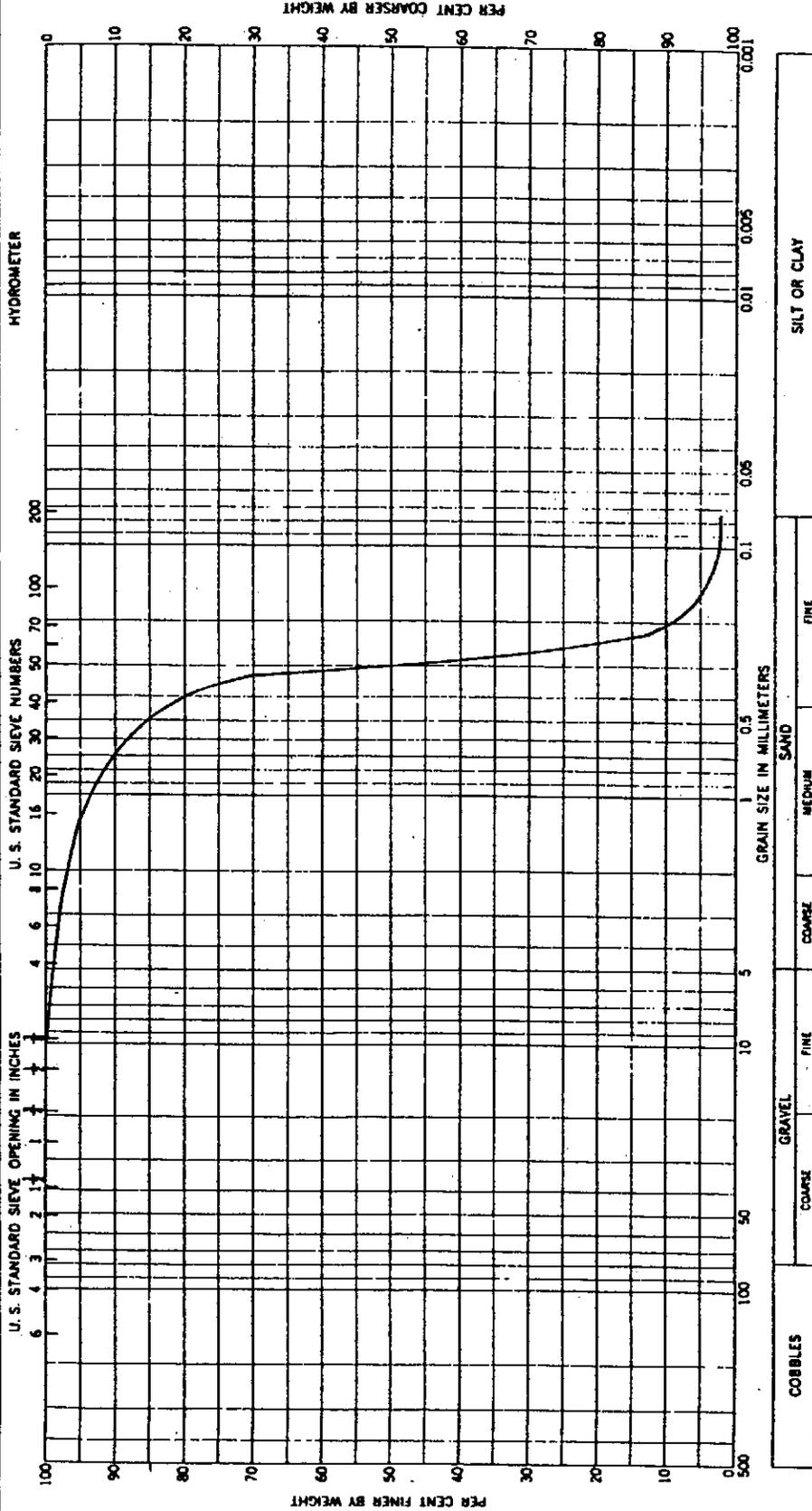
Boring No.	Sample No.	Elev or Depth	Classification			
	S-2	4'	Gray fine to medium sand (SP)			
			LL	PL	PI	

GRADATION CURVES



Project Dare County Landfill Job No. 121-93-03160

Date 10-8-93

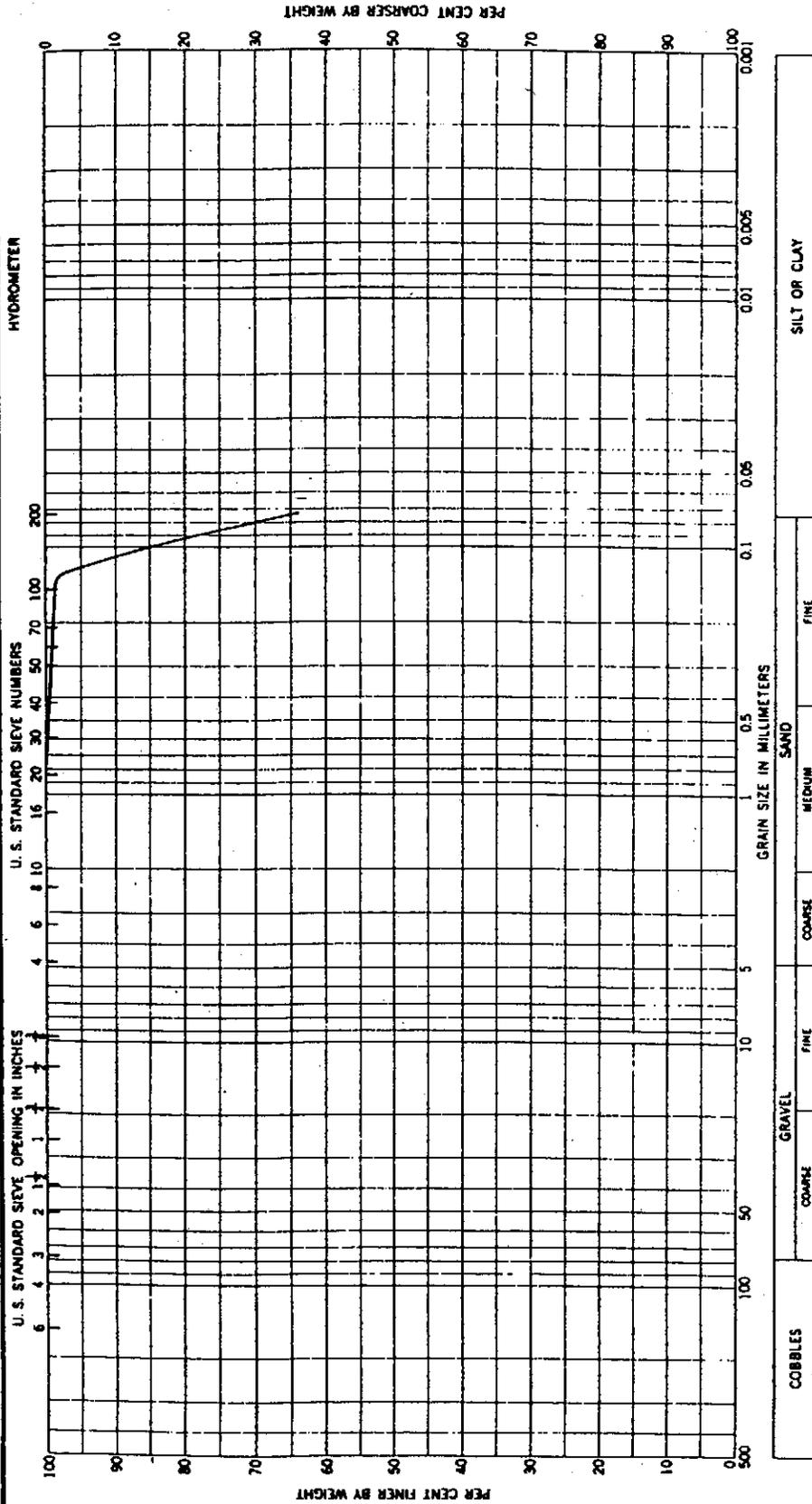


COBBLES		GRAVEL		SAND		SILT OR CLAY	
		COARSE	FINE	COARSE	MEDIUM	FINE	
Boring No.	Sample No.	Elev or Depth	Classification		Net %	LL	PL
B-4	S-12	4.5'	Gray fine to coarse sand (SP)				
GRADATION CURVES							

GEOHYDRO

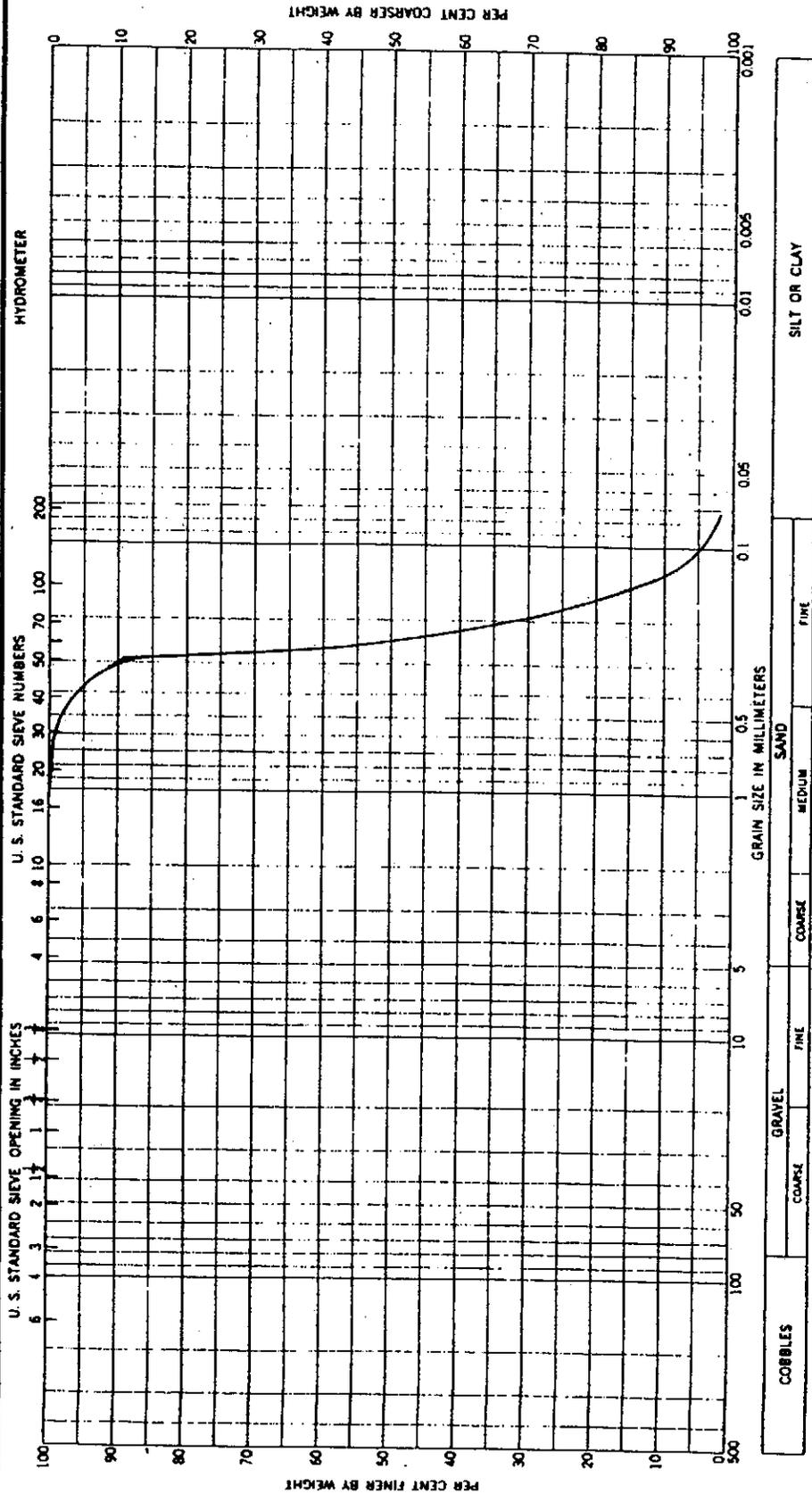
Project Dare County Landfill Job No. 121-93-03160

Date 11/1/93



Project Dare County Landfill Job No. 121-93-03160

Date 10-8-93



Boring No.	Sample No	Elev or Depth	Classification	SAND			SILT OR CLAY		
				Nat w %	LL	PL	PI		
B-6	S-4	8'	Gray fine to medium sand (SP)						

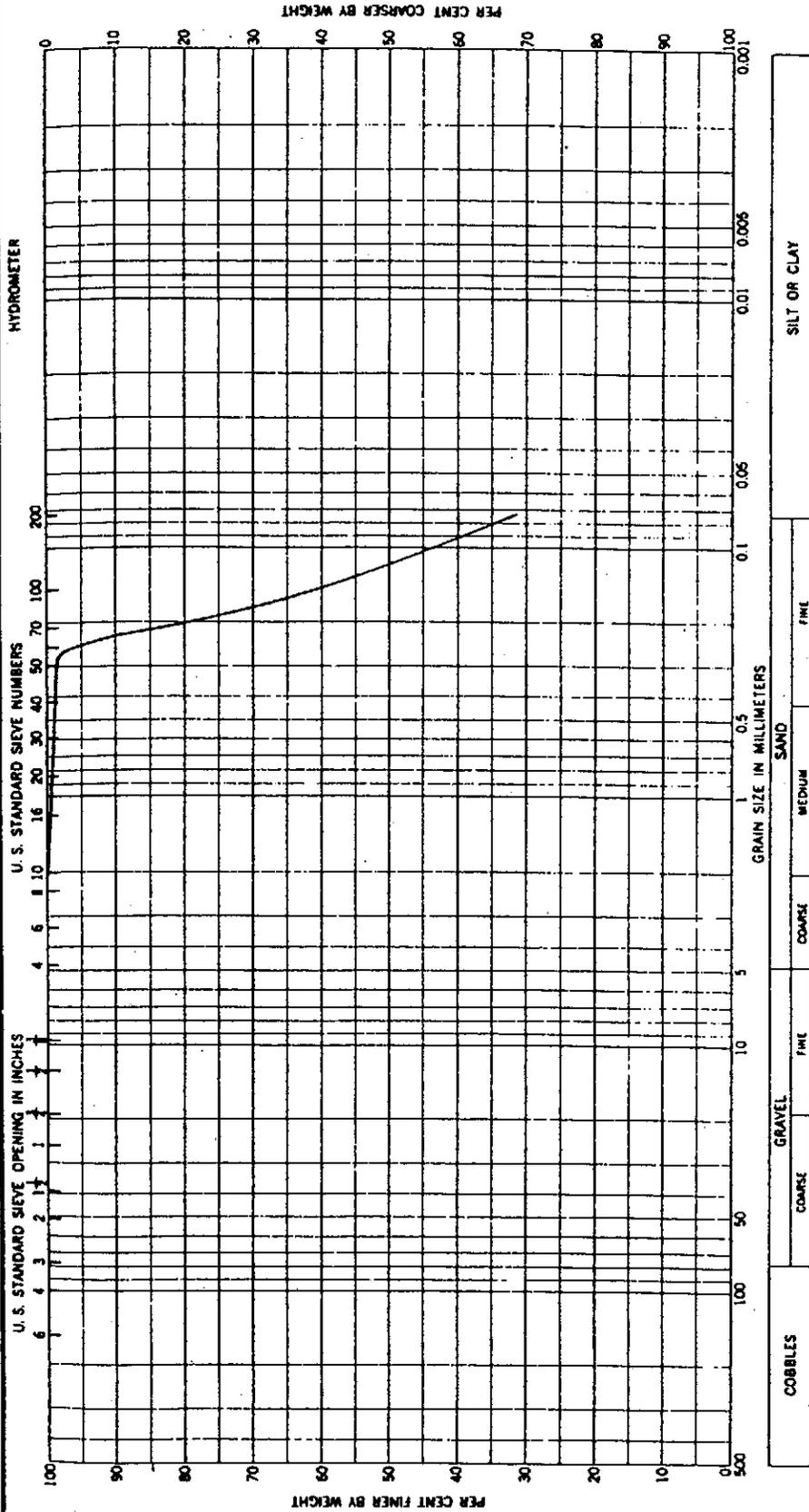
GEOHYDRO

GRADATION CURVES

Job No. 121-93-03160

Date 11/1/93

City of Davis County Landfill



COBBLES		GRAVEL			SAND			SILT OR CLAY		
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE			

Boring No.	Sample No.	Elev or Depth	Classification	Net w %	LL	PL	PI
--	Bulk 2	--	Gray tan silty fine sand (SM)	--	--	--	--

GRADATION CURVES



GECHYDRO

LOCATION excavation area

DEPTH _____

DESCRIPTION

Gray tan silty fine sand (SM)

NATURAL MOISTURE CONTENT _____

OPTIMUM MOISTURE CONTENT 16.2 %

MAXIMUM DRY DENSITY (PCF) 110.0

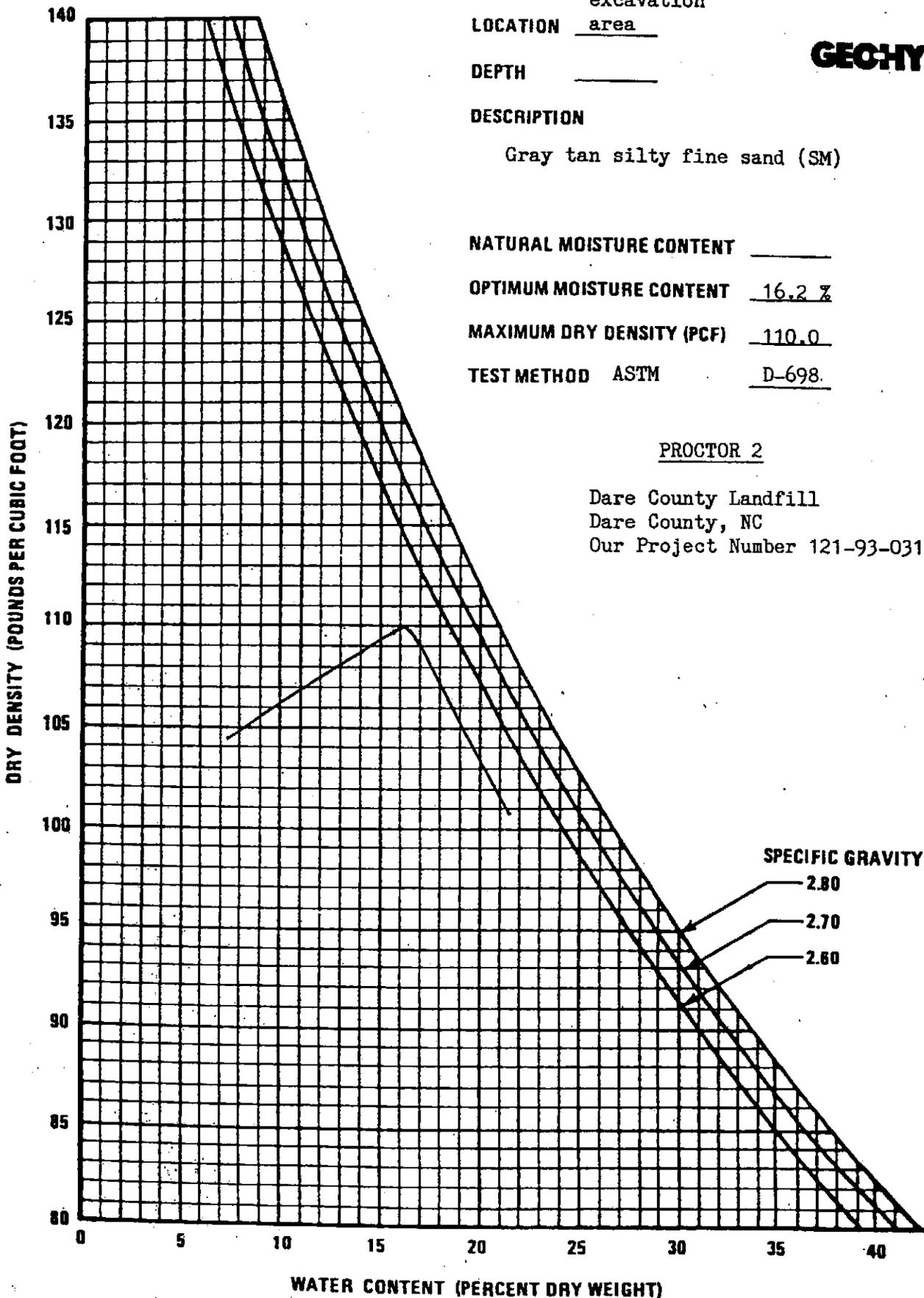
TEST METHOD ASTM D-698

PROCTOR 2

Dare County Landfill

Dare County, NC

Our Project Number 121-93-03160



PROCTOR TEST RESULTS

Appendix C:

Groundwater Reading from Previous Reports

TABLE 2

**In-Situ Hydraulic Conductivity Test Results
Dare County Construction and Demolition Landfill
Dare County, North Carolina
Our Project Number 121-93-03160**

Boring Number	Screen Depth (feet)	USCS Classification	In-Situ Hydraulic Conductivity (cm/sec)
B-1	10 to 20	SP	3.7×10^{-5}
B-2	40 to 50	SP-SM/SP	2.1×10^{-5}
B-3	40 to 50	SP	2.6×10^{-5}
B-4	40 to 50	SP-SM/SP	3.2×10^{-5}
B-5	10 to 20	SP/SP-SM	5.0×10^{-4}
B-6	25 to 30	ML	1.9×10^{-6}

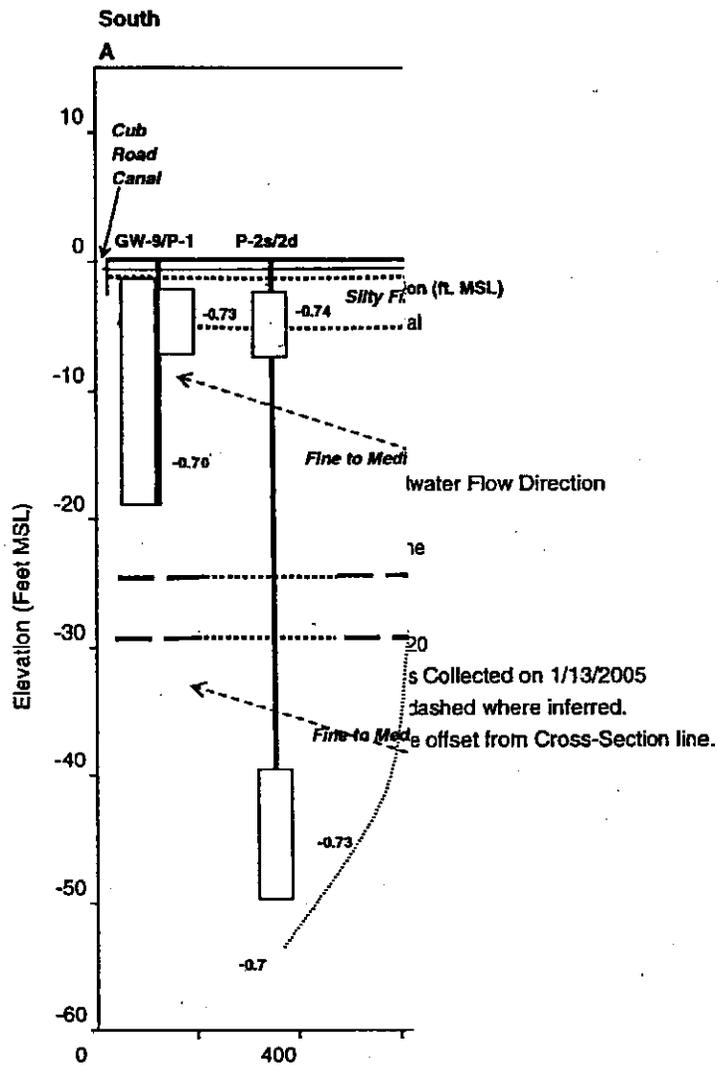


Figure 3-2
Water Flow Lines
Wastewater Treatment Facility - Cell 3
Hydrogeologic Investigation

Appendix D:

Slope Stability Analyses using XSTABL Program

```

*****
*                               *
*           X S T A B L         *
*                               *
*       Slope Stability Analysis *
*           using the           *
*       Method of Slices       *
*                               *
*       Copyright (C) 1992 - 99 *
*       Interactive Software Designs, Inc. *
*       Moscow, ID 83843, U.S.A. *
*                               *
*       All Rights Reserved     *
*                               *
*       Ver. 5.203              *
*                               *
*****
    
```

Problem Description : Dare Co. C & D Landfill Cell III

 SEGMENT BOUNDARY COORDINATES

15 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	100.0	50.0	100.0	4
2	50.0	100.0	53.0	97.0	4
3	53.0	97.0	56.0	97.0	4
4	56.0	97.0	59.0	100.0	4
5	59.0	100.0	89.0	104.0	3
6	89.0	104.0	179.0	134.0	1
7	179.0	134.0	204.0	134.5	1
8	204.0	134.5	229.0	134.0	1
9	229.0	134.0	319.0	104.0	1
10	319.0	104.0	331.0	100.0	3
11	331.0	100.0	349.0	100.0	4
12	349.0	100.0	352.0	97.0	4
13	352.0	97.0	355.0	97.0	4
14	355.0	97.0	358.0	100.0	4
15	358.0	100.0	408.0	100.0	4

11 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	89.0	104.0	95.2	104.0	3
2	95.2	104.0	179.0	132.0	2
3	179.0	132.0	204.0	132.5	2
4	204.0	132.5	229.0	132.0	2
5	229.0	132.0	312.8	104.0	2
6	312.8	104.0	319.0	104.0	3
7	95.2	104.0	312.8	104.0	3
8	77.0	100.0	331.0	100.0	4
9	.0	96.0	408.0	96.0	5
10	.0	76.0	408.0	76.0	6
11	.0	71.0	408.0	71.0	7

 ISOTROPIC Soil Parameters

Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

***** SIMPLIFIED BISHOP METHOD *****

The most critical circular failure surface
is specified by 26 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	90.67	104.56
2	94.66	104.77
3	98.65	105.06
4	102.63	105.44
5	106.61	105.90
6	110.57	106.45
7	114.52	107.08
8	118.45	107.79
9	122.38	108.58
10	126.28	109.46
11	130.16	110.41
12	134.02	111.45
13	137.87	112.57
14	141.68	113.77
15	145.47	115.05
16	149.23	116.41
17	152.97	117.84
18	156.67	119.36
19	160.34	120.95
20	163.97	122.62
21	167.57	124.36
22	171.14	126.18
23	174.66	128.08
24	178.14	130.04
25	181.58	132.08
26	184.86	134.12

**** Simplified BISHOP FOS = 1.679 ****

The following is a summary of the TEN most critical surfaces

Problem Description : Dare Co. C & D Landfill Cell III

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.679	82.56	295.24	190.86	90.67	184.86	4.158E+06
2.	1.716	75.88	273.22	167.69	98.00	157.89	1.230E+06
3.	1.773	123.82	163.10	48.92	120.00	156.07	2.556E+05
4.	1.832	-38.96	761.95	668.27	105.33	190.27	7.754E+06
5.	1.913	129.28	164.02	54.71	112.67	173.81	1.053E+06
6.	1.980	25.86	596.20	495.90	90.67	206.68	1.421E+07
7.	1.996	88.00	223.74	122.07	76.00	165.64	2.961E+06
8.	2.010	128.87	138.56	25.80	120.00	150.39	1.541E+05
9.	2.091	127.49	143.89	35.27	112.67	158.48	4.877E+05
10.	2.093	68.27	262.33	162.16	61.33	157.20	2.985E+06

*** END OF FILE ***

Appendix E:
Settlement Analyses

CLIENT: Dare Co.
PROJECT: Dare Co. C & D Landfill Cell III
DETAIL: Schmertmann Settlement
FILE NAME: Point C, Waste Unit Weight = 65 pcf, H = 34.5 ft

JOB NO: 17952-44296
DATE CHK:
CHECK BY:

COMP BY: EDM
DATE: 3/3/05
PAGE NO: 4 of 6

Plane Strain	
slope =	0.046
slope =	0.018

Axisymmetric Strain	
slope =	0.038
slope =	0.018

Increments	Depth (ft.)	Strain Influence
1	1.0	0.15
2	3.0	0.24
3	5.0	0.33
4	7.0	0.42
5	9.5	0.54
6	14.5	0.64
7	19.5	0.55
8	24.5	0.46
9	29.5	0.37
10	34.5	0.28
11	39.5	0.19
12	44.5	0.10
13	49.5	0.01

Plane	Axisymmetric
0.15	0.24
0.24	0.31
0.33	0.39
0.42	0.47
0.54	0.56
0.64	0.64
0.55	0.55
0.46	0.46
0.37	0.37
0.28	0.28
0.19	0.19
0.10	0.10
0.01	0.01

CLIENT: Dare Co. **JOB NO:** 17952-44296 **COMP BY:** EDM
PROJECT: Dare Co. C & D Landfill Cell III **DATE CHK:** DATE: 3/3/2005
DETAIL: Schmertmann Settlement **CHECK BY:** .PAGE NO: 6 of 6
FILENAME: Point C, Waste Unit Weight = 65 pcf, H = 34.5 ft

Soil Type:		q_c/N
Category	Description	
A	Silts, sandy silts, slightly cohesive silt-sand	2
B	Clean, fine to medium sands and slightly silty	3.5
C	Coarse sands and sands with little gravel	5
D	Sandy gravel and gravel	6

Where: q_c = Average dutch Cone Resistance
 N = SPT N value

Strain Condition:		
Strain	q_c/N	Description
Axisymmetric	2.5	L/B = 1
Plane	3.5	L/B > 10