APPENDIX E.3
CLAY STOCKPILE AND TEST PAD REPORT

WASTE MANAGEMENT, INC.

Prepared for

Chemical Waste Management, Inc.
35251 Old Skyline Road
Kettleman City, CA 92139

CLAY STOCKPILE AND TEST PAD REPORT

KETTLEMAN HILLS FACILITY
KINGS COUNTY, CALIFORNIA

Prepared by

Geosyntec consultants

engineers | scientists | innovators

3990 Old Town Avenue, Suite B101
San Diego, California 92110

Project Number SC0472

December 2008

Geosyntec consultants

TABLE OF CONTENTS

Page

1. INTRODUCTION 1
   1.1 Terms of Reference 1
   1.2 Project Description 1
   1.3 Purpose and Scope of Work 2
2. PREVIOUS ONSITE CLAY EVALUATIONS 3
3. CLAY STOCKPILE 4
   3.1 General 4
   3.2 Stockpile Activities – CQA Monitoring 4
   3.3 Clay Stockpile Pre-Construction Activities – CQA Testing 4
4. CLAY TEST PAD CONSTRUCTION 6
   4.1 Overview 6
   4.2 Clay Liner Test Pad Construction 6
      4.2.1 General 6
      4.2.2 Test Pad Construction 6
         4.2.2.1 Site Preparation 6
         4.2.2.2 Stockpile Material Processing 6
         4.2.2.3 In-situ Material Processing, Placement and Compaction 7
      4.2.3 Test Pad Construction – CQA Testing 7
5. SDRI TESTING 9
   5.1 Overview 9
   5.2 Site Preparation and Equipment Installation 9
   5.3 Data Collection 10
      5.3.1 Outer Ring Water Depth (D_f) 10
      5.3.2 Water Temperature (T) 10
      5.3.3 Depth to Inner Ring (H_s) 11
      5.3.4 Inner Ring Infiltration (M_i-M_f) 11
      5.3.5 Soil Moisture Content (MC) 12
   5.4 Theory 12
   5.5 Results 13
      5.5.1 Infiltration Rate 13
      5.5.2 Wetting Front 14

TABLE OF CONTENTS (continued)

Page

5.5.3 Soil Suction 14
5.5.4 Hydraulic Conductivity 15
5.5.5 Laboratory Data and Comparison to Field Data 15

6. SUMMARY AND CONCLUSIONS 17

REFERENCES 18

TABLE OF CONTENTS (continued)

TABLES

Table 1 Clay Stockpile Testing Frequencies
Table 2 Clay Test Pad Testing Frequencies
Table 3 SDRI Measurements
Table 4 Comparison of Current and Previous Laboratory Test Results of Pecten Claystone

FIGURES

Figure 1 Site Plan
Figure 2 SDRI Test Setup
Figure 3 SDRI Infiltration Rate and Recorded Swell
Figure 4 Moisture Content versus Depth below SDRI Inner Ring

APPENDICES

A. Project Documents
- A-1 Project Specifications – Section 02220
- A-2 CQA Plan - Addendum 1

B. Construction Documentation
- B-1 Photo Log
- B-2 Compaction Equipment Specification Sheet

C. Clay Stockpile and Test Pad Results
- C-1 Laboratory Test Summary Table and Results
- C-2 Test Pad Compaction Test Results

D. SDRI Test Results

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CLAY STOCKPILE AND TEST PAD REPORT
KETTLEMAN HILLS FACILITY
KINGS COUNTY, CALIFORNIA

I certify that this document and attachments presented in this report are accurate and complete. This report was prepared by the staff of Geosyntec Consultants under my supervision to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who are directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete.

Jane Soule

Jane Soule
California Professional Civil Engineer No. 59815

10/20/09
Date

REGISTERED PROFESSIONAL ENGINEER
JANE W. SOULE
C 59815
exp 12/31/09
CIVIL
STATE OF CALIFORNIA

1. INTRODUCTION

1.1 Terms of Reference

This report presents the results of the clay stockpile and test pad evaluation for Chemical Waste Management, Inc. (CWMI) at the Kettleman Hills Facility in Kings County, California. This report was prepared by Ms. Jane Soule, G.E., and has been reviewed by Mr. Michael J. Minch, G.E., of Geosyntec Consultants, Inc. (Geosyntec), in accordance with the peer review policies of the firm.

1.2 Project Description

The Kettleman Hills Facility is approximately 1,600 acres with approximately 474 acres within the active operation area. The site is located in Kings County, California and is owned and operated by CWMI. Three waste management units are currently permitted and operated at the site, Landfill B-17 (Class II/III), Landfill B-19 (II/III) and Landfill B-18 (Class I/II). The planned expansion of Landfill B-18 will require construction of compacted clay liner (CCL) meeting the requirements of Subtitle C of Title 40 of the Code of Federal Requirements (CFR) §264.301 and California Code of Regulations (CCR), Title 23 §2541. These regulations specify that the CCL meet the following requirements:

- an in-situ (field) hydraulic conductivity no greater than $1x10^{-7}$ centimeters per second (cm/s);
- at least 30 percent of the material, by weight, shall pass a No. 200 U.S. Standard Sieve (0.075 mm); and
- be fine grained soil with a significant clay content without organic matter, in the "SC" (clayey sand), "CL" (clay, sandy or silty clay) or "CH" (clay, sandy clay) classes of the Unified Soil Classification System (USCS).

An onsite clay source was identified on the eastern boundaries of the Landfill B-17 project area (see Figure 1). The potential clay source is part of the Pecten claystone which has been used as a CCL for previous hazardous landfill liner construction projects at the site and has been demonstrated to meet the regulatory requirements. Previous clay investigations and testing programs on the Pecten claystone are summarized in the following reports:

- Environmental Construction Services (ECS), 1991, "Clay Source Report, Landfill B-18, Phases IA and IB, Kettleman Hills Facility, Kettleman City, California, Prepared for Chemical Waste Management, Inc., 25 November 1991.

- Environmental Solutions, Inc. (ESI), 1992, "Test Fill and Infiltrometer Test Results, Landfill B-18 Phases I and II and Final Closure," Prepared for Chemical Waste Management, Inc., 23 January 1992.

- Golder Construction Services (GSC), 1993, "Landfill B-18, Phases IIA and IIB Construction Reports Volume 1 – Clay Liner Source Report," Prepared for Chemical Waste Management, Inc., May 1993.

.These previous investigations are summarized in Section 2 of this report.

During the recent construction of Landfill B-17 Phase A1, approximately 24,000 cubic yards (cy) of soil from the Pecten claystone located northeast of Landfill B-17 Phase A1 was excavated and stockpiled for future use in construction of a CCL for the proposed Landfill B-18 expansion. Material from the stockpile was used to construct a test pad for field hydraulic conductivity testing. The requirements of the test pad construction are summarized in the project specifications Section 02220 (Geosyntec, 2007, see Appendix A-1). Construction quality assurance (CQA) testing requirements for the clay stockpile and test pad are summarized in the CQA Plan, Addendum 1 (Geosyntec, 2008, see Appendix A-2). Appendix B contains photographic documentation detailing activities during test pad construction and testing.

1.3 Purpose and Scope of Work

The purpose of this report is to document the method and equipment used during construction of the test pad as a minimum basis for future construction, that the test pad was constructed in accordance with the project specifications, and to evaluate whether the soil from the identified clay source meets the regulatory requirements for a CCL. Geosyntec's scope of work included the following tasks:

- Visual observation and laboratory testing of the clay excavation and stockpiling;
- Observing and documenting construction of the test pad;
- Performing in-place density and moisture content testing of the clay test pad;
- Laboratory testing of the clay test pad; and
- Providing, installing, and monitoring a sealed double-ring infiltrometer (SDRI) test on the clay test pad.

Geosyntec's services also included preparation of this CQA report summarizing the results of field observations and laboratory data.

2. PREVIOUS ONSITE CLAY EVALUATIONS

Previous clay source evaluations have been performed at the Kettleman Hills Facility for CCLs in Landfill B-18. Geosyntec has reviewed available reports on these activities. A summary of these reports is provided below.

Material was excavated onsite from the Pecten claystone for use in the Phase I and II clay liner for Landfill B-18. Field and laboratory testing from a SDRI test, site source evaluation and liner construction was reviewed (ESI, 1992; ECS, 1991; and GSC, 1993). These reports indicate that the clay material used in construction of the Phase I and II compacted clay liners had the following properties:

- Unified Soil Classification System description as a fat clay (CH) with an average of more than 80 percent or greater passing the No. 200 sieve (ranging from 48-94 percent);
- High swell potential (ESI reported an average swell of 16.5 percent under a low confining pressure);
- Average Liquid Limit (LL) of approximately 76 (ranging from 35 to 90) and an average Plasticity Index (PI) of approximately 55 (ranging from 18 to 68);
- Laboratory hydraulic conductivity ranging from approximately 2×10^{-10} centimeters/second (cm/s) to 2×10^{-7} cm/s with an average on the order of 8×10^{-9} cm/s.

These reports indicate that the Pecten claystone material, when compacted to greater than 90 percent of the maximum dry density per ASTM D1557 at a moisture content between +2% and +5% of the optimum moisture content, has a laboratory and field hydraulic conductivity less than 1×10^{-7} cm/s.

3. CLAY STOCKPILE

3.1 General

Clay material was excavated and stockpiled during July and August 2008 by Wood Brothers, Inc., (WBI). The clay material was excavated from the Pecten claystone located northeast of the Landfill B-17 area (see Figure 1). An engineering geologist from Geosyntec identified the limits of the claystone in the field with WBI prior to excavation. WBI stockpiled the low-permeability soil north of Landfill B-17 Phase A1 as approved by CWMI. Geosyntec monitored the excavation and performed conformance tests on the low-permeability soil as described in the following sections.

3.2 Stockpile Activities – CQA Monitoring

Geosyntec monitored that the borrow and stockpile areas were cleared and grubbed prior to excavation. Geosyntec personnel documented the activities during the clay soil excavation and stockpiling, and observed that material placed in the clay stockpile did not contain significant quantities of sandy soils or other unsuitable material.

3.3 Clay Stockpile Pre-Construction Activities – CQA Testing

The project specifications (Appendix A-1) require that the material to be placed in the clay stockpile meet the following specifications:

- Free of debris, rocks, gravel greater than 1 inch in any direction and other deleterious material;
- At least 30 percent of the material, by weight, shall pass the No. 200 sieve;
- Be classified as CL, SC, or CH in accordance with ASTM D2487; and
- Have a compacted field hydraulic conductivity of less than or equal to 1×10^{-7} cm/sec[1].

As the soil was excavated, Geosyntec collected representative samples and shipped them to Excel Geotechnical Testing (Excel) for laboratory testing in accordance with the CQA Plan. The following CQA tests were performed, at a minimum frequency of 1

[1] Field hydraulic conductivity of soils was evaluated using the SDRI (see Section 5).

per 5,000 cubic yards (cy), to evaluate compliance of the clay stockpile with the requirements specified for the clay source material:

- Moisture-Density Relationship (ASTM D 1557);
- Sieve Analysis (ASTM D 422);
- Atterberg Limits (ASTM D 4318);
- Classification (ASTM D 2487); and
- Hydraulic Conductivity (ASTM D 5084), remolded sample.

The required testing frequencies are presented in Table 2.

The moisture-density relationship (modified Proctor) testing results (ASTM D 1557), documented in Appendix C-1, indicate that the low-permeability soil had a maximum dry unit weight ranging from approximately 106 to 120 pcf with an optimum moisture content varying from approximately 13 to 18 percent.

Atterberg limits (ASTM D 4318) testing performed on the clay stockpile is documented in Appendix C-1. Results of this testing indicate a Liquid Limit (LL) varying from 61 to 110 percent and a Plasticity Index (PI) ranging from 38 to 69 percent. The sieve analysis (ASTM D 422) test results indicate that the low-permeability soil had a fines content ranging from 74 to 94 percent. These tests cited above indicate that the soil is classified as fat clay (CH) according to ASTM D 2487 soil classifications.

As required by the technical specification, Geosyntec obtained bulk samples of the clay stockpile at the specified frequency for hydraulic conductivity testing (ASTM D 5084). The samples were compacted to a minimum of 92 percent relative compaction with moisture contents ranging from 2 to 5 percent wet of the optimum moisture content. Hydraulic conductivity test results ranged from 2×10^{-8} to 9×10^{-8} cm/s. The hydraulic conductivity test results are presented in Appendix C-1.

4. CLAY TEST PAD CONSTRUCTION

4.1 Overview

CQA testing was performed during the construction of the clay test pad by using methods and frequencies specified in the Project Documents, as presented in Table 2. Laboratory and field test results performed on the clay stockpile and test pad are included in Appendix C. Appendix B contains photographic documentation detailing activities during test pad construction and testing.

4.2 Clay Liner Test Pad Construction

4.2.1 General

The construction of the clay test pad began on 28 July 2008 and was completed on 7 August 2008. The test pad was constructed approximately 50 feet wide by 50 feet long and consisted of six 6-in lifts. Observations and testing conducted on the clay liner test pad by Geosyntec are described in the following sections. SDRI testing is described in Section 5.

4.2.2 Test Pad Construction

Geosyntec CQA personnel continuously monitored activities performed prior to and during construction of the clay test pad. CQA monitoring activities performed during clay test pad construction included monitoring of processed material placement, measurement of lift thickness, documentation of the number of passes performed by compaction equipment, and a visual assessment of incoming soil. The following sections describe construction test pad.

4.2.2.1 Site Preparation

Prior to construction of the test pad, the area was cleared and grubbed. The subgrade was then proof-rolled to eliminate soft zones, irregularities, and abrupt changes in grade. The subgrade was graded to slope a grade of approximately 2 to 3 percent to provide positive drainage.

4.2.2.2 Stockpile Material Processing

WBI moisture conditioned the clay in the stockpile prior to placement in lifts for the test pad. Moisture conditioning typically included applying water to the surface with a water truck. Due to cementation in the formational soil, significant quantities of oversize particles were present in the stockpile. Further, due to the high plasticity of the clay material, significant clods were present upon wetting. The material was processed in the stockpile to reduce particle/clod size by mixing using a tractor with a rotary disc

and a bushog[2]. In addition, one to three laborers were present to manually remove oversize particles.

4.2.2.3 In-situ Material Processing, Placement and Compaction

Soil was transported to the test pad area from the adjacent stockpile area with paddlewheel scrapers. The test pad was constructed in six lifts, each with a compacted lift height of no greater than 6 inches. Loose lift thickness was on the order of 8 inches. Moisture was added periodically with a water truck to maintain the clay's moisture content.

Each lift was compacted with approximately 16 passes using a Rex 3-35 pad foot compactor (specification sheet for compactor is provided in Appendix B-2). After placement and compaction of each lift, a series of field density test were conducted to measure the soil density and compaction (See Section 4.2.3). In order to improve the bonding between layers, the surface of each lift was scarified and wetted with the disc and bushog prior to placement of a new lift.

The surface of the test fill was graded level with a motor grader, and rolled with two passes of a single drum smooth roller. The test pad was covered in an additional lift of clay and visqueen to minimize desiccation until installation of the SDRI was initiated. The visqueen and additional lift were removed prior to construction of the SDRI.

4.2.3 Test Pad Construction – CQA Testing

Compaction and moisture content specifications for the clay test pad are as follows:

> "The clay shall be compacted to at least 92 percent relative compaction. The moisture content shall be uniform and shall be 2% to 5% wet of optimum moisture content."

CQA testing was conducted on the clay test pad to control the amount of moisture in the fill, monitor the effectiveness of the compaction procedures, and to evaluate the properties of the low-permeability soil. Geosyntec performed the following tests during and after the construction of the clay test pad:

- Nuclear Density and Water Content (ASTM D 6938);
- Moisture-Density Relationship (ASTM D 1557);

[2] A bushog is typically used in agricultural applications to clear weeds between rows.

- Sieve Analysis (ASTM D 422);
- Thin-wall, Drive Tube Density (ASTM D 2937);
- Atterberg Limits (AST D4318);
- Hydraulic Conductivity (ASTM D 5084); and
- SDRI (ASTM D 5093) (described in Section 4.4.3.4).

The required frequencies and the number of tests taken during construction of the clay test pad are listed in Table 2.

In-place field density/moisture was monitored by the nuclear gauge (ASTM D 6938) and the drive cylinder test (ASTM D 2937). Areas with failing moisture content or compaction tests were reworked or replaced. Holes from nuclear gauge or drive cylinder testing were filled with powdered bentonite.

Results obtained from the nuclear density gauge indicated that the low-permeability soil was compacted with an average moisture content of 21 percent and an average relative compaction of 94 percent. Drive cylinder test and in-place density/moisture test results are included in Appendices C-1 and C-2, respectively.

Saturated hydraulic conductivity was measured by laboratory flexible wall permeability testing (ASTM D 5084). Samples were obtained by using thin wall tubing and sent to Excel for testing. Saturated hydraulic conductivity measured in the laboratory ranged from 3×10^{-9} to 1×10^{-8} cm/s. The hydraulic conductivity test results performed on the clay test pad are summarized in Table C-3 of Appendix C-1.

5. SDRI TESTING

5.1 Overview

A SDRI test (ASTM D-5093) was performed to evaluate the field hydraulic conductivity of the clay test pad and to provide a correlation between field and laboratory hydraulic conductivity.

The SDRI test provides a direct measurement of the vertical, one-dimensional, infiltration rate of water through soil at very low confining stresses. The SDRI apparatus includes a 2-ft square inner ring and a 6-ft square outer ring. This large size allows for the testing of both micro (i.e., inter-granular) and macro (i.e., through discontinuities) effects on the infiltration rate of liquid flow through a soil layer. The infiltration rate (**q**) is defined as the quantity of liquid entering a porous material per unit area per unit time. The hydraulic conductivity (**k**), which is not a direct measurement from this test, is defined as the flux of liquid per unit hydraulic gradient. Derivation of equations relating infiltration rate to hydraulic conductivity is provided in Section 5.4.

5.2 Site Preparation and Equipment Installation

The SDRI was installed by Geosyntec personnel on 12 August 2008. The SDRI test apparatus consists of an open-air, square shaped, metal outer ring and a covered, square shaped, fiberglass inner ring. The outer ring measures 6 ft on a side, and 3 ft high. The inner ring measures 2 ft on each side and 10-inches high at its peak. The outer ring was embedded in a bentonite chip filled trench to an average depth of 18 in. The inner ring was embedded in a bentonite grout filled trench to an average depth of about 3 in. Both the inner and the outer rings were then filled with water. The outer ring was filled with water to a depth of approximately 12 to 13 in., completely submerging the inner ring. A flexible bag was attached to the inner ring with flexible Tygon tubing and barbed nylon hose fittings. The infiltration rate was measured for the 4 ft^2 section of the test pad soil directly underlying the inner ring. During the test, the outer ring served only as a water reservoir for inducing a uniform hydraulic head and a flow boundary to produce one-dimensional vertical flow beneath the inner ring. Floating panels of insulation were placed in the water reservoir to reduce evaporation. This insulation also minimized changes in water temperature. The SDRI set up is shown schematically in Figure 2.

Water-filled flexible bags were attached to the inlet port of the inner ring. The flexible bags were submerged underwater in the outer ring reservoir. This allowed the hydraulic head on the inner ring to equalize with that of the outer ring without flow between the two rings. Flow into the inner ring was measured over discrete time intervals by measuring the change in mass of the bags. The SDRI was installed 12 August 2008 and

data was collected between 13 August and 13 October 2008, when the test was terminated and the equipment was removed.

5.3 Data Collection

Geosyntec personnel collected the SDRI data during the majority of the testing period however, CWMI personnel collected data while Geosyntec was not on-site and supplied the data to Geosyntec. The data recorded included the following:

- Outer Ring Water Depth (D_f) - measured using a stationary scale as the depth of standing water in the outer ring,
- Water Temperature (T) - measured with a thermometer as the water temperature in the outer ring,
- Depth to the Inner Ring (H_s) – measured depth from a point on the top of the inner ring to a stationary string hung across the outer ring. This measurement evaluates swelling of the clay in test area.
- Inner Ring Infiltration (M_i-M_f) - measured as the difference between initial and final weight of the water in the flexible bags for a given period of time, and
- Soil Moisture Content (MC) - measured after completion of the test for the soil column beneath the inner ring; the profile of MC vs. depth was used to estimate the depth of the wetting front.

5.3.1 Outer Ring Water Depth (D_f)

The water depth in the outer ring (D_f) was recorded using a ruler fixed to the outer ring. The ring was filled up to 12.1 to 13.8 in. above the test fill pad surface. The depth of water was used to estimate the total hydraulic head to induce flow. Table 3 presents the measured outer ring water depths.

5.3.2 Water Temperature (T)

The temperature of the water (T) was measured with a thermometer placed in the outer ring reservoir. Temperature was measured to estimate the effects of thermal expansion and contraction of the water on the infiltration rate. Water within the inner ring could expand and contract slightly with changes in temperature. As the water cools, it contracts and more water is pulled out of the flexible bags and into the space within the

inner ring; as the water warms, it expands and is pushed out of the ring into the bag. The density of water is non-linearly related to its temperature. Table 3 also presents the measured water temperatures.

Based on the field measurements, the temperature changes are considered negligible between initial and final readings. Therefore, the space within the inner ring above the test section remained relatively constant between these readings.

5.3.3 Depth to Inner Ring (H_s)

The depth to the inner ring (H_s) was recorded using a ruler measuring the distance between a point on the top of the inner ring to a stationary string fastened across the outer ring. This value corresponds to the height of swell of the clay in the test area. Total swell was estimated to be greater than 3.5 inches. Table 3 presents the measured outer ring water depths.

5.3.4 Inner Ring Infiltration (M_i-M_f)

Flexible bags were used to measure the volume of water infiltrating through the test section underlying the inner ring. The inner ring infiltration data were collected by the following procedure for each time interval:

- flexible bags were filled with water and their valves were closed. The exterior of the bags were then dried and weighed to the nearest tenth of a gram (M_i);
- each bag was submerged in the outer ring with the valves still closed;
- each time interval for infiltration monitoring was started by attaching the flexible bags to the inner ring inlet tube connected to the lower flow port and the valves opened; the date and time was recorded;
- each time interval for infiltration was ended by closing the valve on the flexible bag, disconnecting the bag from the inner ring inlet tubing, and recording the date and time;
- the use of multiple bags allowed for the beginning of one interval to be concurrent with the end of the previous interval as a full bag was swapped out for partially emptied bag;
- the flexible tubing was secured so that it remained submerged; and

- the flexible bags were removed from the outer ring reservoir, dried, and weighed to the nearest tenth of a gram (M_f);

The volume of water infiltrating the test section during a particular time interval was computed by subtracting the final bag mass from the initial bag mass (i.e., M_f-M_i). Table 3 presents the measured masses of the bags.

5.3.5 Soil Moisture Content (MC)

At the end of the test, the soil moisture profile was evaluated by taking soil samples from below the inner ring. The water from within the inner and outer rings was first evacuated and the inner ring removed to allow sampling of the test section soil.

Soil samples were obtained by cutting 6-in by 6-in block samples with 0.1 foot and 0.2 foot thicknesses down to a maximum depth of 2 feet (24 inches) below the surface. Each 0.1 ft or 0.2 ft. interval was placed in a sealed plastic bag to preserve the in-situ moisture content. The soil moisture content was tested in the laboratory in accordance with ASTM D 2216. Results of the moisture content tests are discussed in Section 5.5.2 and are presented in Appendix D.

5.4 Theory

The seepage of water into the test area is driven by the hydraulic gradient caused by the ponded water and high capillary suction of the partially saturated clay (as opposed to fully saturated conditions associated with laboratory tests).

The saturated hydraulic conductivity can be computed using a form of Darcy's Law which includes terms for the total hydraulic gradient. The governing equation that describes the infiltration of water through the compacted clay is developed below, based on the terms and sign convention in Figure 2.

$$q = -ki = -k\frac{\Delta h}{\Delta L} \qquad (1)$$

Where,
q = infiltration rate per unit area and time (L/T)
k = saturated hydraulic conductivity (L/T)
$\frac{\Delta h}{\Delta L}$ = total hydraulic gradient (L/L), or i
$\Delta h = h_1 - h_2$
$\Delta L = z_1 - z_2$
h = Total Head
$h = z + \varphi$
z = elevation head

φ = pressure head due to hydraulic head or soil suction/tension

$$q = -k\left[\frac{(z_1+\varphi_1)-(z_2+\varphi_2)}{(z_1-z_2)}\right] \quad (2)$$

For any given wetting front, $L_f = z_1 - z_2$. Substituting this into Equation (2), the infiltration rate at any wetting front is calculated as:

$$q = -k\left[\frac{\varphi_1}{L_f} - \frac{\varphi_2}{L_f} + 1\right] \quad (3)$$

As shown in Figure 2, at Point 1, the pressure head is equal to the depth of water in the outer ring, D_f, with soil suction/tension equal to zero (i.e., the soil is saturated). At Point 1, the pressure head is $D_f = \varphi_1$. Also, since the clay fill is unsaturated below the wetting front, the in situ pressure head at Point 2 will be equal to the soil suction and negative in sign convention, and can be designated simply at φ, i.e., $\varphi = -\varphi_2$. Substituting into Equation (3):

$$q = -k\left[\frac{D_f}{L_f} + \frac{\varphi}{L_f} + 1\right] \quad (4)$$

Equation (4) is time dependent. That is, the infiltration flow rate per unit area (q) and the depth of the wetting front ($\mathbf{L_f}$) are interrelated and vary with time. As the wetting front advances, Equation 4 can be rearranged to calculate hydraulic conductivity as the infiltration rate appears to stabilize from daily readings:

$$k = -\frac{q}{\frac{D_f}{L_f} + \frac{\varphi}{L_f} + 1} \quad (5)$$

Equation 5 was used to calculate the hydraulic conductivity of the compacted clay liner. Results of the test are presented below in Section 5.5.

5.5 Results

5.5.1 Infiltration Rate

The infiltration rate per unit area (**q**) is calculated as the total water lost during a measured time increment. The calculated infiltration rate (**q**) is presented in Table 3. The infiltration rate at the end of the test was measured at 8 x 10^{-7} cm/s and was observed to generally decrease over time (see Figure 3).

5.5.2 Wetting Front

The conventional method to estimate the depth to the wetting front (D_f) at the end of the test requires obtaining moisture content samples along a vertical column of soil below the inner ring. The moisture profile with depth is then compared against the saturation line and the original moisture content to estimate the depth of the wetting front.

Geosyntec collected moisture samples at 0.1 to 0.2 feet increments along two moisture columns. Figure 4 presents a plot of this moisture content versus depth. As shown in Figure 4, the moisture content decreases with depth as would be expected when significant swelling of the clay occurs[3]. Based on the results of the moisture content testing and visual observation of the soil upon excavation[4], the wetting front (L_f) is estimated to be approximately 1.4 feet (17 inches). At a depth of approximately 1.9 feet (23 inches), the moisture content of the soil beneath the inner ring is equivalent to the as-compacted conditions. The soil between depths of 1.4 feet and 1.9 feet represent an area where increased moisture content, but not saturated, due to soil suction.

5.5.3 Soil Suction

Soil suction was not directly measured as part of this field work. However, lysimeters installed as part of the SDRI constructed for development of Phase I/II of Landfill B-18 (ESI, 1992) measured a soil suction of 280 inches of pressure with tensiometers in unsaturated soil below the SDRI inner ring.

Geosyntec developed a soil-moisture characteristic curve for the soil at the wetting front, relating the volumetric water content of the soil to the suction head, using the van Genuchten function (van Genuchten, 1980). The van Genuchten curve-fitting parameters used in the function were back-calculated from the water retention parameters recommended in the Hydraulic Evaluation of Landfill Performance (HELP) model documentation (Schroeder et al. 1994) for moderately compacted clays of high plasticity. Based on the moisture content measured in the laboratory for the soil just below the wetting front, the soil-moisture characteristic curve results in an unsaturated soil suction of approximately 33 feet (396 inches). This value is on the same order of magnitude with the suction pressures measured in the field during previous

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[3] Moisture content at saturation is a function of the dry density of the soil (i.e., the volume of void space). As soil swells and becomes less dense, the volume of void increases, thereby increasing the moisture content at saturation.

[4] Free water was observed in the voids of the soil matrix to a depth of approximately 1.4 feet. From approximately 1.4 feet to 1.9 feet, the material was softened and visually wetter. At a depth of approximately 1.9 feet and below, the soil was hard visually similar to areas outside the SDRI area.

investigations. For use in these calculations, Geosyntec has assumed a soil suction of 280 inches (23 feet) consistent with that previously monitored at the site.

5.5.4 Hydraulic Conductivity

Using Equation 5, the hydraulic conductivity is calculated using the data from the last testing interval, as follows:

$$k = -\frac{q}{\frac{D_f}{L_f} + \frac{\varphi}{L_f} + 1} = \frac{7.6x\ 10^{-7}\ cm/s}{\frac{12.5}{17} + \frac{280}{17} + 1} = 4.2x10^{-8} cm/s$$

The results of this test indicate that the field hydraulic conductivity of the Pecten claystone, when compacted to the specifications presented in Appendix A, meet the hydraulic conductivity requirements of a compacted clay liner as outlined in Section 1.2.

5.5.5 Laboratory Data and Comparison to Field Data

As discussed in Section 4.2.3, Geosyntec tested the hydraulic conductivity of 10 samples collected using 3-inch diameter thin-wall Shelby tubes from the test pad area. These samples were tested at a minimum confining pressure of 2 psi. The average hydraulic conductivity of the laboratory testing on the test pad samples is approximately 5.1×10^{-9} cm/s (see Appendix C).

The field test results are approximately one order of magnitude higher than laboratory results. These differences are expected and may be attributed to the unrestrained swelling of the clay which occurs during field testing when compared to laboratory results which have small consolidation pressures preventing some of the swelling. The low hydraulic conductivity measured in the laboratory is a function of the consolidation pressure used in the test to prevent swelling.

By comparing laboratory and field hydraulic conductivity testing, the following correlation factor (CF_k) is calculated:

$$CF_k = \frac{k_{field}}{k_{lab}} = \frac{4.2x10^{-8} cm/s}{5.1x10^{-9} cm/s} = 8.2$$

Therefore, during future construction a correlation factor of 8.2 should be applied against laboratory test results to estimate field hydraulic conductivity of the CCL.

6. SUMMARY AND CONCLUSIONS

Excavation and stockpiling of clay from the Pecten Claystone, as well as test pad construction, was performed in general accordance with the requirements presented in Appendix A. The excavated clay was classified as a fat clay (CH) with more than 30 percent of the material, by weight, passing the No. 200 sieve. This material, when tested in the both the laboratory and field, has a hydraulic conductivity no greater than $1x10^{-7}$ cm/s. Therefore, this material meets the requirements of a CCL as defined by 40 CFR §264.301 and CCR Title 23 §2541. Further, this material is similar to the material previously used as CCL for Landfill B-18 at the Kettleman Hills Facility (see Table 4).

During future construction a correlation factor of 8.2 should be applied against laboratory test results to estimate field hydraulic conductivity of the CCL.

REFERENCES

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Schroeder, P.R., Lloyd, C.M., and Zappi, P.A., 1994, "The hydrologic evaluation of landfill performance (HELP) model, user's guide for version 3," U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., Report No. EPA/600/R-94/168a.

Van Genuchten, M. T., 1980, ''A closed form equation for predicting the hydraulic conductivity of unsaturated soils,'' Soil Science Society of America Journal, 44, 892–898.

TABLE 1
CLAY STOCKPILE TESTING FREQUENCIES

Test	ASTM Standard	Required Frequency	Number of Tests	Actual Frequency[1]
Moisture-Density Relationship	ASTM D 1557	1 per 5,000 CY	7	1 per 3,371 CY
Sieve Analysis	ASTM D 422	1 per 5,000 CY	7	1 per 3,371 CY
Atterberg Limits	ASTM D 4318	1 per 5,000 CY	7	1 per 3,371 CY
Hydraulic Conductivity	ASTM D 5094	1 per 5,000 CY	7	1 per 3,371 CY

Notes
1. Based on approximately 23,600 cy of clay material stockpiled.

TABLE 2
CLAY TEST PAD TESTING FREQUENCIES

Test	ASTM Standard	Required Number of Tests	Number of Tests
Bulk Samples:			
Moisture-Density Relationship	ASTM D 1557	3	3
In-Situ Density/Moisture:			
Nuclear Density	ASTM 6938	5 per lift	40 (min 5 per lift)
Shelby Tube Samples:			
Sieve Analysis	ASTM D 422	6	6
Density	ASTM D 2937	6	10
Atterberg Limits	ASTM D 4318	6	10
Hydraulic Conductivity	ASTM D 5094	6	10

TABLE 3
SDRI MEASUREMENTS

Geosyntec consultants

Date	Time	Water Level, Df (in)	Water Temp. (°F)	Rain?	Inner Ring Height, Hs (in)	Initial (full) Bag Mass (grams)		Final (empty) Bag Mass (grams)		Elapsed Time (hours)	Flow Q (cm^3/s)	Infiltration Rate q (cm/s)
8/13/2008	8:00	12.75	76	N		1485.1	0					
8/14/2008	8:04	12.75	80	N		1618.7	0	175.6	0	24.07		
8/14/2008	12:54	12.75	82	N		2023.3	1865.1	179	0	28.90		
8/15/2008	8:34	12.75	84	N	9.8	0	1885.1	?	1703.1	48.57		
8/16/2008	7:40	12.63	84	N	9.6	2167.8	2049.5	203.9	189.3	71.67		
8/17/2008	8:50	12.50	86	N	9.4	1914.6	1834.5	256.2	854.7	96.83	0.0343	9.2E-06
8/18/2008	8:27	12.44	84	N	9.2	2272.4	1944.1	462.8	548.9	120.45	0.0322	8.7E-06
8/19/2008	7:55	12.38	83	N	9.0	2110.8	1740.5	638.7	958.9	143.92	0.0310	8.3E-06
8/20/2008	8:07	12.25	81	N	8.8	1848.3	1852.2	1600.7	318.2	168.12	0.0222	6.0E-06
8/21/2008	8:10	12.25	82	N	8.6	2099.7	2137.4	621.8	1581	192.17	0.0173	4.7E-06
8/22/2008	8:03	12.38	82	N	8.5	2031	2056.7	2012.4	940.7	216.05	0.0149	4.0E-06
8/23/2008	8:18	12.25	82	N	8.4	2014.8	2074	1169.2	1666.4	240.30	0.0143	3.9E-06
8/25/2008	8:32	12.13	84	N	8.3	1984.6	1998.5	393.9	1554.6	288.53	0.01233	3.3E-06
8/26/2008	7:02	13.25	84	N	8.2	1956.3	1978	1126.4	1784.4	311.03	0.01324	3.6E-06
8/27/2008	8:09	13.13	84	N	8.1	2035	2032.4	1070.2	1802.9	336.15	0.01174	3.2E-06
8/29/2008	8:12	13	86	N	7.9	2027.3		2079.2	1204.6	384.20	0.00453	*See Note
8/30/2008	8:49	12.9375	88	N	7.8	2018.6		968.3		408.82	0.01195	3.2E-06
8/31/2008	8:37	12.9375	86	N	7.7	2057.4	1804.4	1076.2		432.62	0.01100	3.0E-06
9/2/2008	8:57	12.75	80	N	7.6	2088.4		907.9	748.1	480.95	0.013	3.4E-06
9/3/2008	9:11	12.628	80	N	7.5	2078.2		1027.9		505.18	0.012	3.3E-06
9/4/2008	8:15	12.5	81	N	7.5	2119.4		1191.4		528.25	0.011	2.9E-06
9/5/2008	9:05	13.8	82	N	7.4	2220.5	2297.6	1131.3		553.08	0.011	3.0E-06
9/8/2008	8:30	13.7	85	N	7.2	2098.5		2013.2	909	624.50	0.00621	1.7E-06
9/9/2008	8:30	13.5	84	N	7.2	2227.8				648.50		
9/10/2008	8:35	13.5	82	N	7.1	2226.6		1625.7		672.58	0.00694	1.9E-06
9/11/2008	8:25	13.1	80	N	7.1	4262.8	2329.8	1761.4		696.42	0.005	1.5E-06
9/15/2008	10:10	13.313	82	N	7	2246.4		3730.2	1466	794.17	0.004	1.1E-06

TABLE 3
SDRI MEASUREMENTS

Geosyntec consultants

Date	Time	Water Level, Df (in)	Water Temp. (°F)	Rain?	Inner Ring Height, Hs (in)	Initial (full) Bag Mass (grams)		Final (empty) Bag Mass (grams)		Elapsed Time (hours)	Flow Q (cm^3/s)	Infiltration Rate q (cm/s)
9/16/2008	8:20	13.25	82	N	6.9	2142.4		1788.2		816.33	0.006	1.5E-06
9/17/2008	8:35	13.125	82	N	6.9	2175.8		1718.9		840.58	0.005	1.3E-06
9/18/2008	8:06	13	79	N	6.9	2045.3		1760.4		864.10	0.005	1.3E-06
9/19/2008	8:37	13	78	N	6.9	1946.9		1663.9		888.62	0.004	1.2E-06
9/22/2008	8:31	12.75	76	N	6.8	1970		1087.7		960.52	0.003	8.9E-07
9/23/2008	8:28	12.6875	75	N	6.8	1984.6		1666.9		984.47	0.004	9.5E-07
9/24/2008	8:33	12.625	76	N	6.8	1722.2		1596.5		1008.55	0.004	1.2E-06
9/25/2008	8:10	12.375	78	N	6.7	1590.1		1498.8		1032.17	0.003	7.1E-07
9/26/2008	8:20	12.25	78	N	6.6	1498.1	1756.2	1281.2		1056.33	0.004	9.6E-07
9/29/2008	9:00	13.375	82	N	6.6	2293.3		1157.2	1410.2	1129.00	0.003	7.1E-07
9/30/2008	9:30	12.25	80	N	6.6	2284.8		1951.2		1153.50	0.004	1.0E-06
10/1/2008	9:10	12.25	82	N	6.6	2305.4		2269.8		1177.17	0.000	4.7E-08
10/2/2008	8:45	13.25	80	N	6.6	2212.1		1968.3		1200.75	0.004	1.1E-06
10/3/2008	9:30	13.25	77	N	6.5	2166.4	2237.1	1759		1225.50	0.005	1.4E-06
10/6/2008	9:50	13	72	N	6.5	2303.2		2161.3	1587.9	1297.83	0.003	6.8E-07
10/7/2008	8:25	13	72	N	6.4	2219.1		2161		1320.42	0.002	4.7E-07
10/8/2008	11:00	12.875	74	N	6.4	2164.5		1958.5		1347.00	0.003	7.3E-07
10/9/2008	10:30	12.75	72	N	6.4	2159.3		1731		1370.50	0.005	1.4E-06
10/10/2008	9:30	12.50	68	N	6.4	2297.5	2184.9	1810.1		1393.50	0.004	1.1E-06
10/13/2008	9:01	12.5	61	N	6.3			1915.6	1837.6	1465.02	0.003	7.6E-07

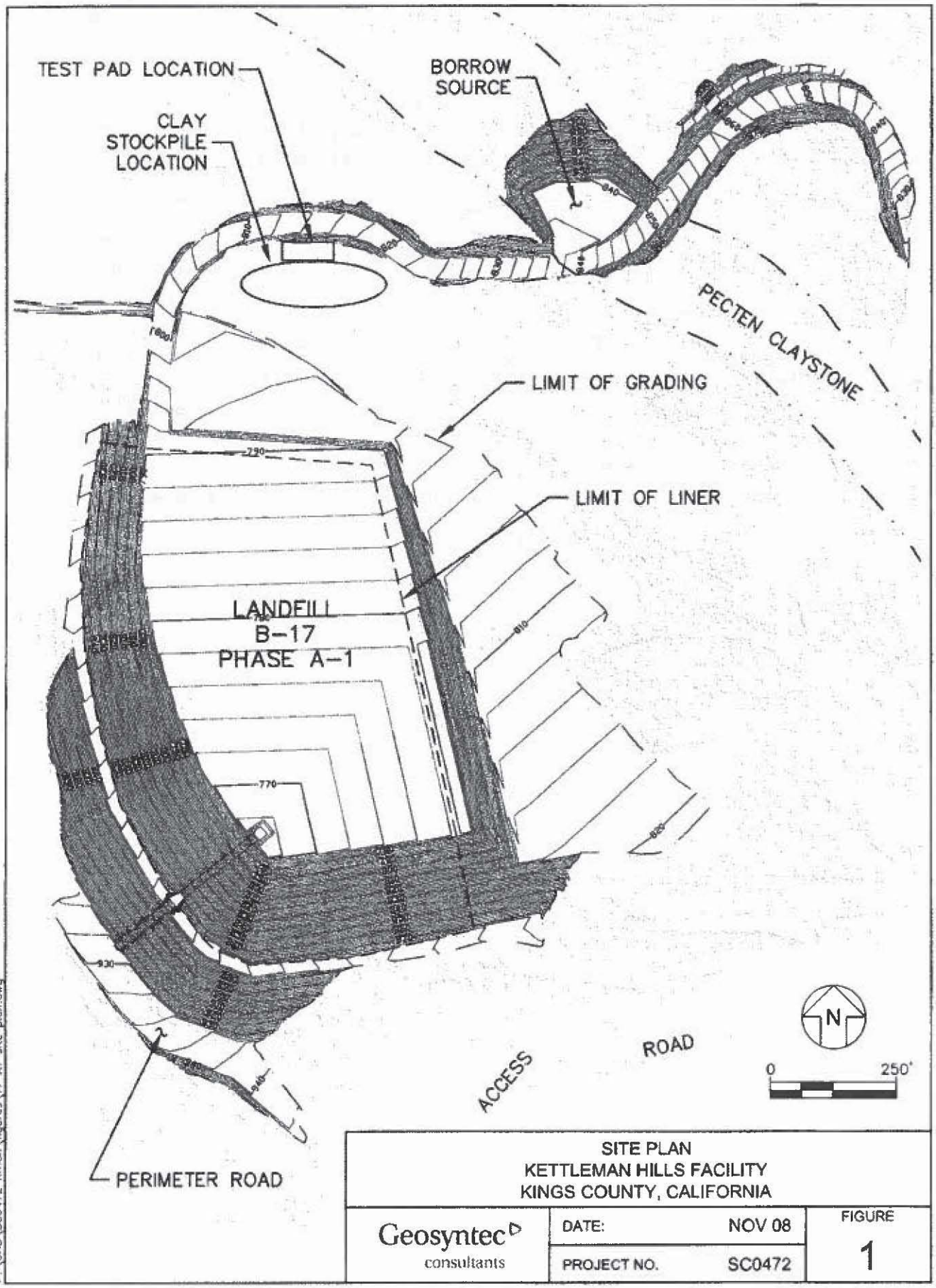
* Field data from 8/28/08 unclear. No bag weights recorded. Data not used.

=Empty bag, data not used

TABLE 4
COMPARISON OF CURRENT AND PREVIOUS LABORATORY TEST RESULTS OF PECTEN CLAYSTONE

	Soil Classification	Percent Passing No. 200 Sieve[1] (%)	LL/PI (%)[2]	Laboratory Hydraulic Conductivity[1] (cm/s)
Current Investigation	CH	89 (74 – 94)	93/64	3×10^{-8} (9×10^{-8} to 3×10^{-9})
Previous Landfill B-18 CCL Testing[3]	CH	>80 (48 - 94)	76/55	8×10^{-9} (2×10^{-7} to 2×10^{-10})

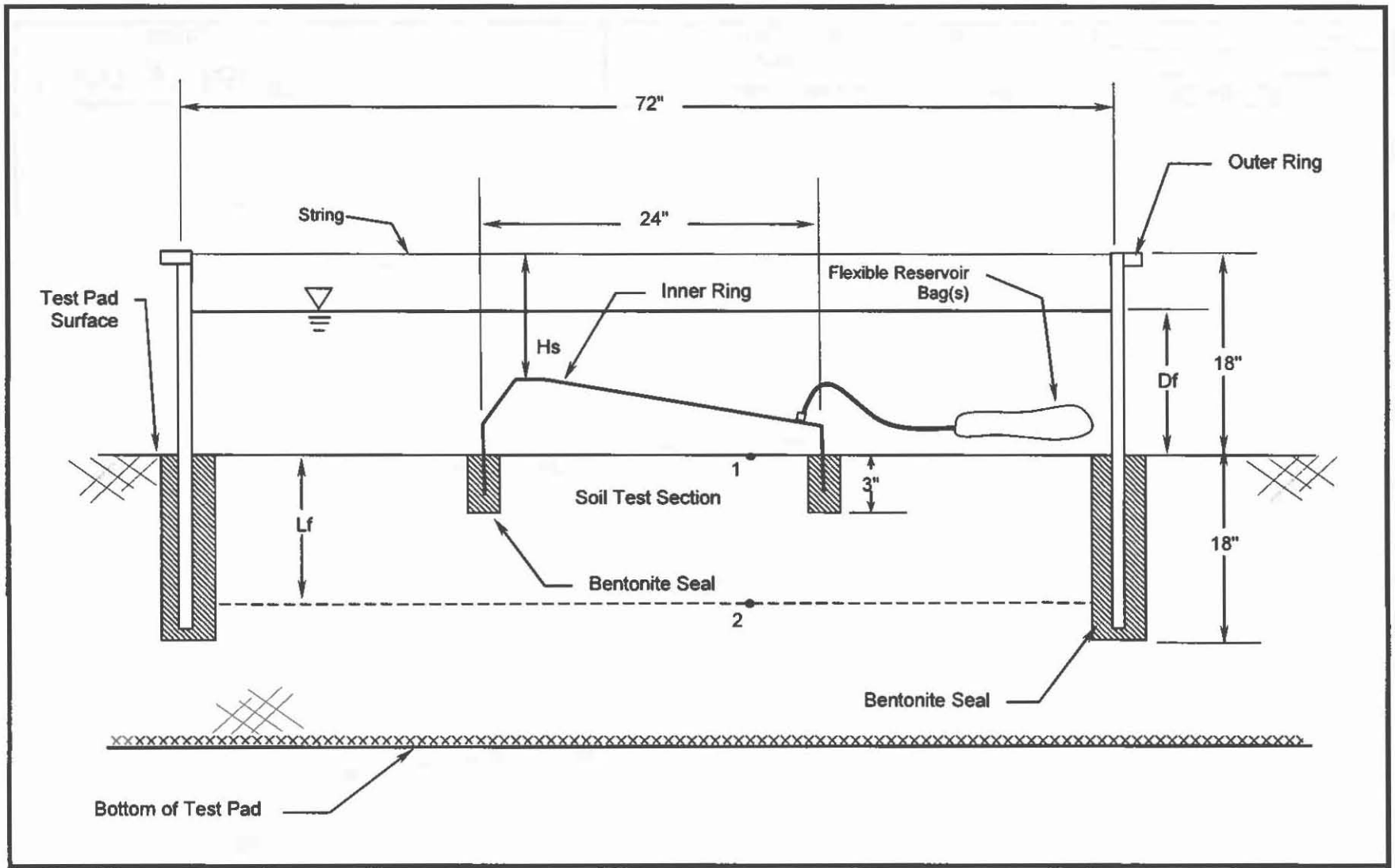
Notes:
1. First value reported is approximate average test results. Values in parentheses are ranges of data results.
2. Values reported are approximate averages.
3. Based on ECS (1991), ESI (1992), and GSC (1993).



SITE PLAN
KETTLEMAN HILLS FACILITY
KINGS COUNTY, CALIFORNIA

Geosyntec consultants	DATE:	NOV 08	FIGURE
	PROJECT NO.	SC0472	1

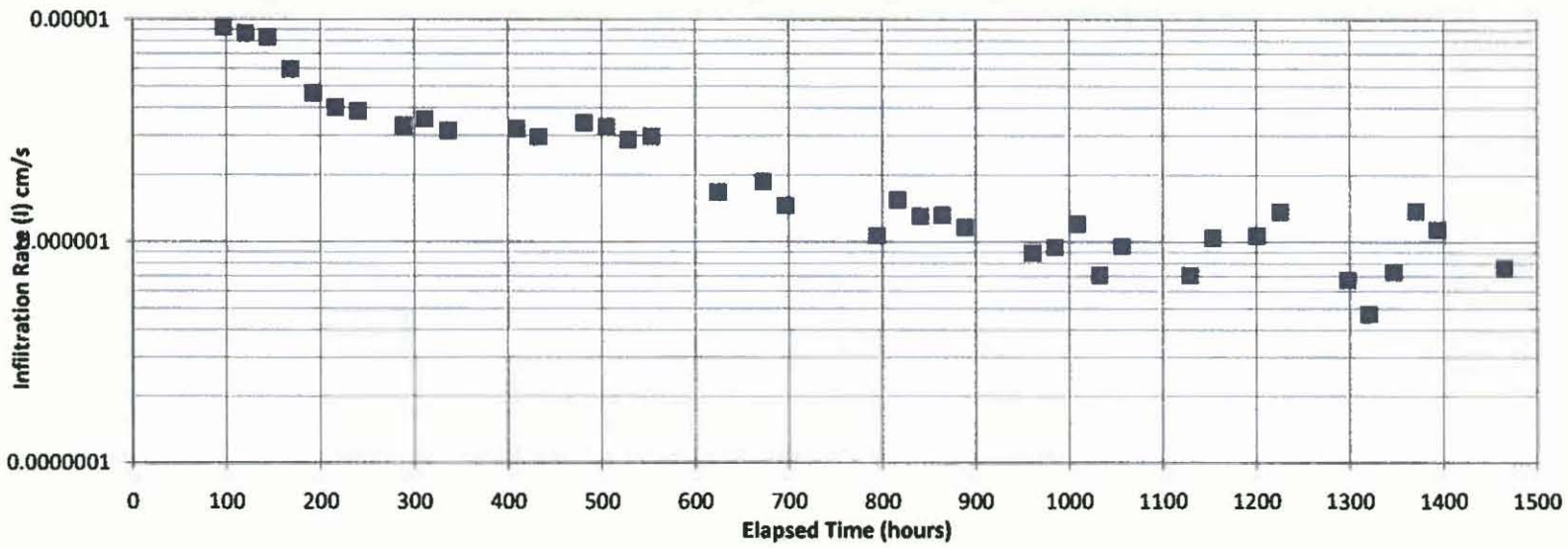
P:\CAD\SC0472 Kmon\figures\17 A1 site plan.dwg

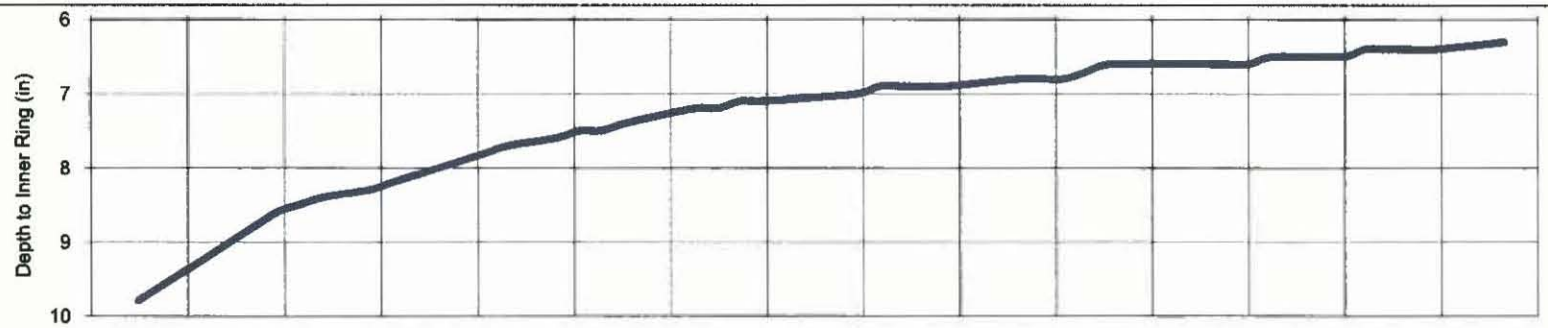


Geosyntec consultants

SDRI Test Setup
Kettleman Hills Facility
Kings County, California

FIGURE NO.	**2**
PROJECT NO.	SC0472
DATE:	17-Dec-08

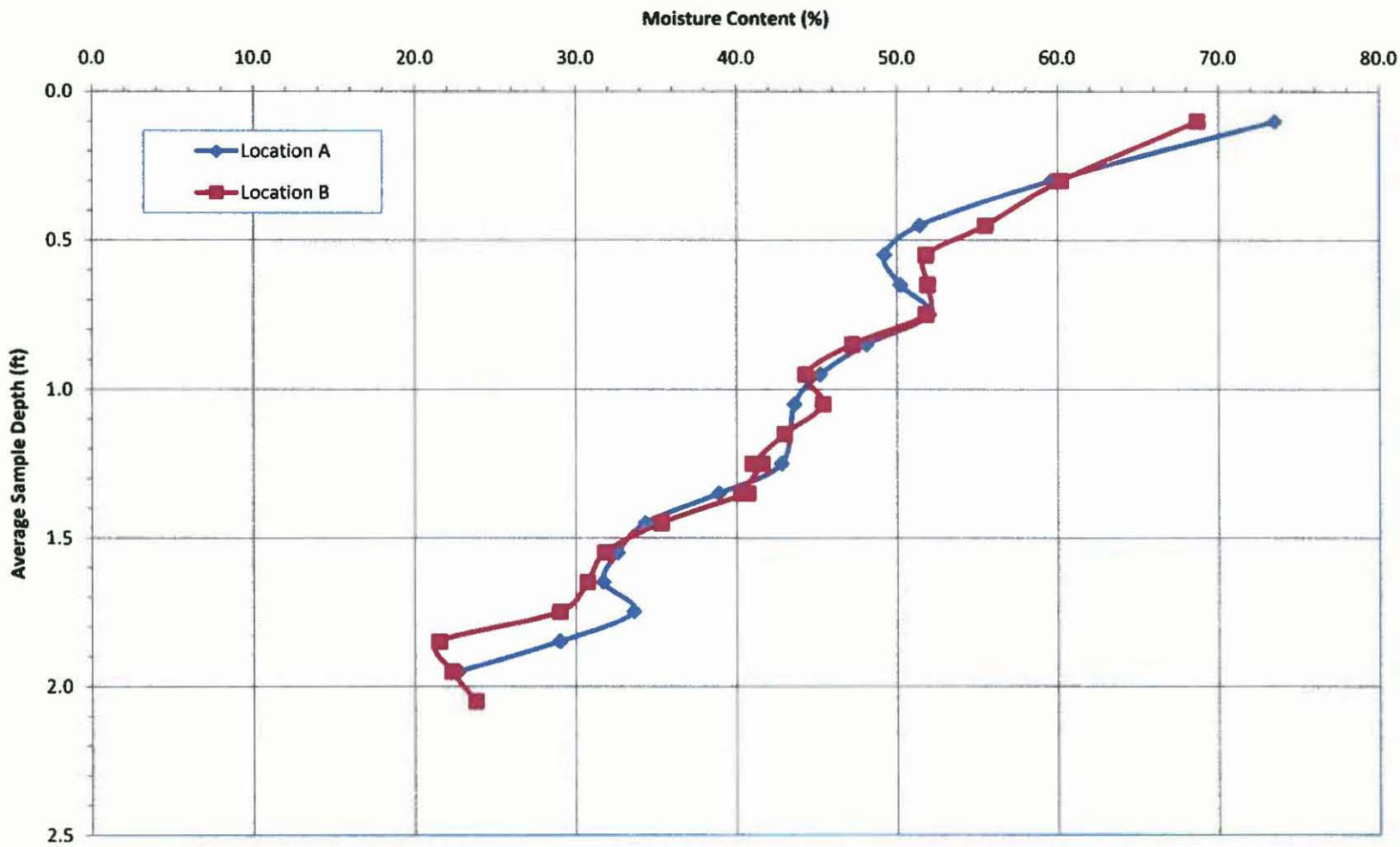




Geosyntec consultants

Infiltration Rate and Recorded Swell
Kettleman Hills Facility
Kings County, California

FIGURE NO. 3
PROJECT NO. SC0472
DATE: 25-Nov-08



Geosyntec consultants

Moisture Content versus Depth below SDRI Inner Ring
Kettleman Hills Facility
Kings County, California

FIGURE NO.	4
PROJECT NO.	SC0472
DATE	25-Nov-08

APPENDIX A
PROJECT DOCUMENTS

APPENDIX A-1
Project Specifications – Section 02220

SECTION 02220

COMPACTED CLAY LINER

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Furnishing all labor, materials, tools, supervision, transportation, and installation equipment necessary for the construction of the Compacted Clay Liner (CCL) test pad, as specified herein, as shown on the Construction Drawings and in accordance with the Construction Quality Assurance (CQA) Plan.

B. Earthwork Contractor shall construct the CCL test pad to the elevations, lines, grades, and dimensions as shown on the Plans and described in the Specifications, unless otherwise directed by the Engineer.

C. Earthwork Contractor shall use clay from the source(s) selected by the owner.

D. The clay borrow source may contain some debris and oversize particles. The Earthwork Contractor shall remove large and easily recognizable debris. This debris must be removed prior to clay placement. Debris removal is considered part of the cost of clay placement.

1.2 RELATED SECTIONS

A. Section 02200 - Earthwork

1.3 REFERENCES

A. ASTM D422 - Standard Test Method for Particle Size Analysis of Soils

B. ASTM D854 - Standard Test Methods for Specific Gravity of Soils

C. ASTM D1140 - Standard Test Methods for Amount of Material in Soils Finer than the No. 200 Sieve.

D. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

E. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort

F. ASTM D1587 - Standard Practice for Thin-Walled Tube Geotechnical Sampling of Soils

G. ASTM D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.

H. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).

I. ASTM D2487 - Standard Test Method for Classification of Soils for Engineering Purposes.

J. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

K. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

L. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

M. ASTM D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

N. ASTM D5093 - Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed Inner Ring

O. Landfill B-17 Phase A1, Kettleman Hills Facility, Construction Quality Assurance Plan (CQA Plan).

1.4 QUALITY ASSURANCE

A. Construction Quality Assurance (CQA) monitoring shall be the responsibility of the Owner or Owner's Representative in accordance with the approved CQA Plan.

B. Quality control testing associated with filling and compaction operations shall be performed by the Owner or Owner's Representative in compliance with the CQA Plan and this Specification. The Contractor shall assist the Owner or Owner's Representative in obtaining clay samples at the frequencies provided in the CQA Plan.

C. Contractor shall provide labor, materials (granular bentonite), and equipment (chain trencher) necessary for the installation of the QA Monitor supplied Sealed Double Ring Infiltrometer equipment in accordance with ASTM D5093.

D. Earthwork Contractor shall give advance notice of at least 24 hours to the Owner or Owner's Representative when ready for compaction testing and inspection.

PART 2 – PRODUCTS

2.1 CLAY

A. Clay at the borrow source may not meet the contract specification for moisture content. Drying and/or wetting of this material may be required prior to placement.

B. Clay shall be free of debris, rocks, gravel greater than 1 inch in any direction, and other deleterious material.

C. At least 30 percent of the material, by weight, shall pass the No. 200 sieve.

D. Acceptable soils are those meeting the requirements of ASTM D 2487 for CL, SC, or CH with a compacted field permeability of less than or equal to $1x10^{-7}$ cm/sec.

2.3 EQUIPMENT

A. Provide equipment to excavate and transport clay from borrow source to test pad area.

B. Compaction equipment shall be of suitable mechanical type and adequate to obtain the densities specified, and shall provide satisfactory breakdown of materials to form a dense fill. Flooding or jetting methods of compaction shall not be used.

C. Locations inaccessible to heavy equipment shall be compacted by means of manually controlled pneumatic or vibrating tampers or by approved equivalent methods to achieve specified densities.

D. Compaction equipment shall be operated in strict accordance with the manufacturer's instructions and recommendations. Equipment shall be maintained in such condition that it shall deliver the manufacturer's rated compactive effort. If inadequate relative compaction is obtained, the Earthwork Contractor shall provide larger and/or different types of additional equipment at no additional cost. Hand-operated equipment shall be capable of achieving the specified densities.

E. Operate compaction equipment in strict accordance with the manufacturer's instructions and recommendations. If inadequate densities are obtained, provide larger and/or different types of additional equipment at no cost to the Owner.

F. Provide water application equipment free of leaks and equipped with a distributor bar or other accepted device to ensure uniform application.

G. Provide processing equipment suitable for providing a material that has a uniform moisture content.

H. On-site water source shall be made available for the EARTHWORK CONTRACTOR for the work included in this Section. The water source is located approximately 1.25 miles north of the project area and shall be identified in the pre-bid meeting at the site.

PART 3 – EXECUTION

3.1 GENERAL

The Earthwork Contractor shall:

A. Verify that the survey control system is installed and properly protected from construction operations prior to all earthwork, including clay placement.

B. Fill and compact all holes and other depressions prior to placement of clay.

C. Maintain surface of clay at minimum 2 percent grades for drainage.

D. Material incorporated into clay, determined by the Owner or Owner's Representative to be in violation of Specification requirements, shall be removed by the Earthwork Contractor at the Earthwork Contractor's expense.

3.2 TEST PAD CONSTRUCTION

A. Fill and compact all holes and other depressions prior to placement of clay.

B. Test pad area shall be cleared and grubbed.

C. Construct a test pad on the prepared subgrade. Surface of the test pad subgrade shall be proof-rolled to eliminate soft zones, irregularities, and abrupt changes in grade. Slope the finished subgrade surface at a grade of approximately 2 to 3 percent. No standing water or excessive moisture is allowed to accumulate on the surface of the subgrade.

D. The test pad shall be 50 feet long, 50 feet wide, and 3.5 feet deep. Some of the techniques to be monitored include: moisture conditioning, clod removal, scarification between lifts, number of equipment passes, lift thicknesses, and compactive effort.

E. The Earthwork Contractor will be responsible for verification that material that does not meet the Specifications is removed from the clay prior to placement.

F. Material incorporated into clay, determined by the Owner or Owner's Representative to be in violation of Specification requirements, shall be removed by the Earthwork Contractor at the Earthwork Contractor's expense.

G. Contractor shall breakdown claystone materials as necessary to meet maximum particle size requirements.

H. The clay material shall be compacted to at least 92 percent relative compaction. The moisture content shall be uniform and shall be 2% to 5% wet of the optimum moisture content.

I. Clay material shall be compacted in lifts with a compacted thickness of no greater than 6 inches.

J. Maintain surface of clay at minimum 2 percent grades for drainage.

K. Earthwork Contractor shall take adequate measurements to prevent moisture loss from the CCL.

L. Placement of successive clay layers shall not begin until the Owner or Owner's Representative has accepted the previous layer. Any damage to the previous layer or deterioration subsequent to acceptance shall be repaired by the Earthwork Contractor to the satisfaction of the Owner or Owner's Representative at the expense of the Earthwork Contractor.

M. Earthwork Contractor shall scarify the top of each lift and correct moisture content prior to placement of overlying lift.

N. Clay shall not be placed and compacted if the ambient air temperature drops below 32°F.

O. Earthwork Contractor shall seal the last and uppermost layer of CCL, after achieving the compaction requirements, with two passes of a single drum smooth roller.

P. Where test results indicate that the lift thickness, maximum particle size, in-place density/moisture content and or permeability of any portion of the clay does not meet the specified requirements, that particular portion shall be re-tested by the Owner or Owner's Representative and/or re-worked or replaced by the Earthwork Contractor at his expense until the required condition has been attained and the resulting product meets or exceeds the Specification requirements. No additional fill shall be placed over an area until the existing fill has been tested horizontally and vertically and determined by the Owner or Owner's Representative to meet the Compacted Clay Liner Specifications of this document.

Q. Assist the QA Monitor in obtaining cylinder push samples of the test fill per ASTM D1587 for laboratory permeability testing. These samples will be used to correlate field to laboratory permeability results.

R. Provide equipment and personnel to assist the QA Monitor in installing the Double Ring Infiltrometer per ASTM D 5093. The Infiltrometer has a 6-foot square outer ring and a 2-foot square inner ring. It is assumed that the assistance will require two laborers for one working day. Equipment needed includes:

a. grout mixer
b. 20 50-lb bags of bentonite grout (Volclay or similar)
c. wheelbarrow and shovels for placing grout in trenches
d. 1200 gallons of potable water for test

S. Keep personnel and equipment away from test area while test in running (estimated to be six weeks).

3.3 FIELD QUALITY CONTROL

A. The minimum frequency and details of quality assurance testing are provided in the CQA Plan. The Earthwork Contractor shall be aware of all field quality assurance requirements and activities, and shall incorporate these into his schedule.

B. All test holes, pits or other perforations resulting from testing of soils shall be filled with soil compacted to the satisfaction of the Owner or Owner's Representative.

C. If a defective area is discovered in the earthwork, the Owner or Owner's Representative will determine the extent and nature of the defect by performing additional tests, observations, a review of records, or other means that the Owner or Owner's Representative deems appropriate.

D. After the Owner or Owner's Representative determines the extent and nature of a defect, the Earthwork Contractor shall correct the deficiency at his expense to the satisfaction of the Owner or Owner's Representative.

E. Additional testing will be performed to verify that the defect has been corrected before the Earthwork Contractor performs any additional work in the area of the deficiency.

F. The Owner or Owner's Representative will determine in-place density and moisture content by any one or combination of the following methods: ASTM D1556, D2922, D2216, D3017, or other methods selected by the Owner or Owner's Representative. The Earthwork Contractor shall cooperate with this testing work by leveling small test areas designated by the Owner or Owner's

Representative. Backfilling of test areas shall be at Earthwork Contractor's sole expense. The frequency and location of testing shall be determined solely by the Owner or Owner's Representative. The Owner or Owner's Representative may test any lift of fill at any time, location, or elevation.

****END OF SECTION 02220****

APPENDIX A-1
CQA Plan – Addendum 1

LANDFILL B-17 PHASE A1
KETTLEMAN HILLS FACILITY
CONSTRUCTION QUALITY ASSURANCE PLAN

ADDENDUM NO. 1

1.1 Clay Liner Excavation

- Monitor that limits of borrow area are staked before work.
- Monitor that borrow area is cleared and grubbed prior to excavation.
- Visually observe excavated material for consistency with specifications.
- Monitor that upper 2 vertical feet of excavated material and material not meeting clay material specifications is stockpiled in general fill stockpile.
- Sample excavated material at a frequency of one sample per 5,000 cy of material excavated and perform the following laboratory tests:
  - Moisture-Density Relationship (ASTM D1557)
  - Sieve Analysis (ASTM D422)
  - Atterberg Limits (ASTM D4318)
  - Hydraulic Conductivity (ASTM D5094), remolded sample, compacted at a minimum of 90% relative compaction and at +2% optimum moisture content per ASTM D1557, at confining stress of 2 psi.

1.2 Clay Liner Test Pad

A compacted clay test pad will be constructed to evaluate the excavated material's performance as a compacted clay liner with a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec.

- Monitor that limits of borrow area are staked before work.
- Determine correlation between number of passes with compaction equipment and relative density.
- Document equipment used to construct test pad.
- Monitor that clay material meets the particle size requirements in the project specifications (1-inch maximum).
- Monitor that material is placed in lifts with a compacted thickness no greater than 6 inches.
- Monitor that moisture content is uniform and meets the project specifications.

- Document number of passes for each lift.
- Perform nuclear density tests (ASTM D2922 and D3017) at a frequency of five tests per lift being placed.
- Collect a minimum of three bulk samples to be tested for Moisture-Density Relationship (ASTM D1557)
- Collect a minimum of six in-situ samples using thin-wall samplers (Shelby Tubes) from the completed compacted clay to be tested for the following:
  - Sieve Analysis (ASTM D422)
  - Density (ASTM D2937)
  - Atterberg Limits (ASTM D4318)
  - Hydraulic Conductivity (ASTM D5094)

APPENDIX B
CONSTRUCTION DOCUMENTATION

APPENDIX B-1
Photo Log

Photo No.:	1	**Date:**	07-31-08
Photographer:	David Williams		
Subject:	Preparing to perform FDT on clay test pad		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	2	**Date:**	07-31-08
Photographer:	David Williams		
Subject:	Documenting FDT on clay test pad		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	3	**Date:**	08-07-08
Photographer:	Jane Soule		
Subject:	Compaction of clay test pad with REX 3-35		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	4	**Date:**	08-07-08
Photographer:	Jane Soule		
Subject:	Preparing to take Shelby tube samples on final clay test pad lift		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	5	**Date:**	08-12-08
Photographer:	David Williams		
Subject:	Removal of visqueen layer used to maintain moisture of clay test pad prior to SDRI installation		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	6	**Date:**	08-12-08
Photographer:	David Williams		
Subject:	SDRI Installation, cutting trench for inner ring		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	7	**Date:**	08-12-08
Photographer:	David Williams		
Subject:	SDRI Installation, inner ring in place		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	8	**Date:**	08-12-08
Photographer:	David Williams		
Subject:	SDRI Installation, filling outer ring with water		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	9	**Date:**	08-12-08
Photographer:	David Williams		
Subject:	SDRI installation complete		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	10	**Date:**	08-27-08
Photographer:	Jane Soule		
Subject:	SDRI during monitoring with insulating cover.		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	11	**Date:**	10-13-08
Photographer:	Jane Soule		
Subject:	SDRI Setup, showing measurement of depth of water & thermometer, string used to evaluate swell (depth to top of inner ring).		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	12	**Date:**	10-13-08
Photographer:	Jane Soule		
Subject:	Edge of outer ring, showing extensive swell of clay (beyond that of bentonite installed along seam), after draining of water.		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	13	**Date:**	10-13-08
Photographer:	Jane Soule		
Subject:	SDRI removal, stakes placed on ground surfaces to show extent of swell (approximately 5 – 6 inches)		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

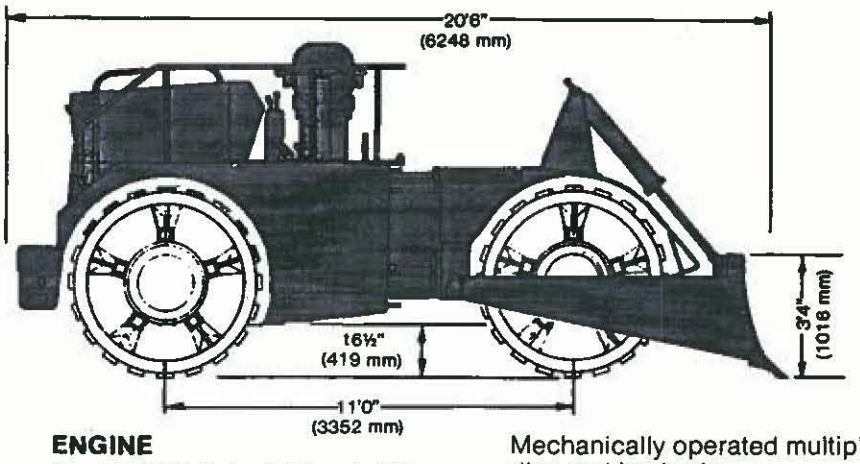
Photo No.:	14	**Date:**	10-13-08
Photographer:	Jane Soule		
Subject:	Excavation of trench around SDRI for removal		
Project:	Kettleman Hills Facility Landfill B-17, Phase A1	**City/State:**	Kings County, California

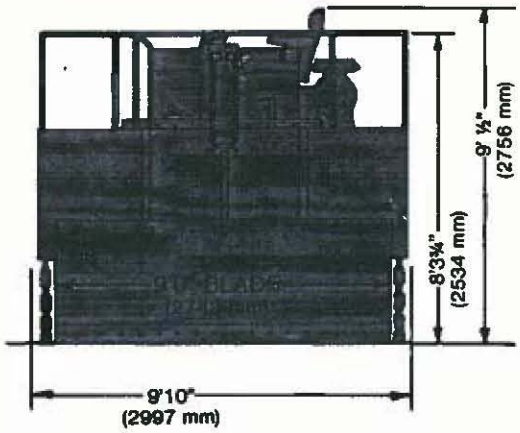
Photo No.:	15	**Date:**	10-13-08
Photographer:	Mike Minch		
Subject:	Sampling of soil for moisture content testing from inner ring area		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

Photo No.:	16	**Date:**	10-13-08
Photographer:	Jane Soule		
Subject:	Excavated trench within inner ring area, significant moisture evident to depth of 1.3 - 1.4 feet, increase in moisture from as-compacted condition evident to depth of 1.8 to 1.9 feet.		
Project:	Kettleman Hills Facility	**City/State:**	Kings County, California

APPENDIX B-2
Compaction Equipment Specification Sheet

REX MODEL 3-35 PACTOR SPECIFICATIONS





ENGINE
Model 6V53 Detroit Diesel, 185 H.P. @ 2500 RPM, variable speed governor, 22" (559 mm) blower type fan, two stage dry type replaceable element air cleaner with service indicator, fuel and oil filters.

TRANSMISSION AND TORQUE CONVERTER
Clark C-28000 series 3-speed forward and reverse power shift matched to a Clark C-270 series converter. Speeds: 1st-3.75; 2nd-7.25; 3rd-10.5.

DRIVE
3-Wheel configuration for effective full width compaction and stability, all wheels drive. No Spin front differential; Mechanical driveline with heavy duty universals.

AXLES AND WHEELS
Clark 33810 series heavy duty axles front and wear. Wheels: Open ring segmented pad type, 3" x 5" (76.2 mm x 127 mm) pads with raker bars.

STEERING
Articulated front steer actuated by two hydraulic rams. Inside turning radius; 11'3" (3429 mm); Outside turning radius; 22'6" (6858 mm).

BRAKES
Hydraulically operated, multiple disc service brakes running in oil. Mechanically operated multiple disc parking brake.

SHOCK PROTECTION AND SHIELDING
Rear axle is shock absorber mounted. All wheels equipped with rubber cushions mounted between outer ring and inner ring to reduce shock and eliminate metal-to-metal contact. Fenders, guards, and railings designed for maximum operator protection. Engine compartment protected by heavy gauge hood which opens fully with spring assist.

BLADE
9' Wide. Large full width blade. Hydraulically operated with up, down, and float positions. Blade raise above grade: 34" (864 mm); Blade down below grade: 4" (102 mm).

ELECTRICAL
12 Volt system, 62 amp alternator, voltage regulator, starter, emergency and service shutoff.

HYDRAULICS
A fully filtered system with service indicator, gear type pump, and spool valves.

LIGHTS
Two front, two rear.

GAUGES
Ammeter, engine oil pressure, transmission temperature and pressure, water temperature, hour meter, fuel, air cleaner service indicator, and tachometer.

OPERATOR CONTROLS & POSITIONING
Side facing, four way adjustable seating for full visibility front and rear. Travel direction and range and blade positioning hand controls. Braking and travel speed pedal controls. All located for operator comfort.

Operating weight less ROPS . . . 36,000# (16330 KG)
Operating weight with ROPS . . . 37,500# (17010 KG)

COMPACTIVE EFFORT
343 PSI (24.11 KG/cm²)

CAPACITIES
Fuel 125 gal. (473 liters), hydraulic system 55 gal. (208 liters), cooling system 13 gal. (49 liters), transmission and torque converter 8.5 gal. (32 liters), engine crankcase 4 gal. (15 liters), wheel ends 16 pts. (7.5 liters) ea., differential 34 pts. (16 liters) ea.

OPTIONS
1. Enclosed cab with built in ROPS, windshield wipers, front and rear tinted glass, dome light, lockable doors
2. Open ROPS
3. Heater and defroster fan
4. Air conditioning
5. Cold weather starting kit

NOTE: We reserve the right to amend these specifications at any time without notice.
The only warranty applicable is our standard written warranty. We make no other warranty, expressed or implied.

REXWORKS
P.O. Box 2037
Milwaukee, Wisconsin 53201
TELEX 26-9576
International Offices: Milwaukee, Bogota, Miami, Athens, Singapore, Paris
Distributors in all principal cities of the world

NIXON EGLI EQUIPMENT CO.
12050 CLARK STREET
SANTA FE SPRINGS, CA. 90670
(213) 944-3061

APPENDIX C
CLAY STOCKPILE AND TEST PAD RESULTS

APPENDIX C-1
Laboratory Test Summary Table and Results

TABLE C-1
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS
CLAY SOURCE TESTING - PECTEN CLAYSTONE
KETTLEMAN HILLS FACILITY, KINGS COUNTY, CALIFORNIA

Site Sample No.	Date Sampled	Source	Atterberg Limits			Soil Classification (ASTM D 2487)	Fines Content		Laboratory		Permeability (ASTM D5084)		
			LL	PL	PI		% < # 200 Sieve	Natural Moisture Content	Maximum Dry Density	Optimum Moisture	Dry Unit Weight	Moisture Content	Hydraulic Conductivity
			%	%				%	lb/ft^3	%	lb/ft^3	%	cm/s
CL-1	07/16/08	Clay stockpile	95	33	62	CH	87.4	15.3	111.0	17.3	99.1	19.1	9.3E-08
CL-2	07/24/08	Clay stockpile	61	23	38	CH	73.8	8.1	119.7	12.5	107.6	14.7	6.3E-08
CL-3	07/24/08	Clay stockpile	110	41	69	CH	93.5	22.6	106.0	18.0	96.9	20.1	4.0E-08
CL-4	07/27/08	Clay stockpile	88	27	61	CH	90.7	12.4	111.9	15.4	103.0	17.2	4.9E-08
CL-5	07/27/08	Clay test pad							113.6	16.0			
CL-6	07/31/08	Clay test pad	92	21	71						105.6	18.4	5.3E-09
CL-7	07/31/08	Clay test pad	90	23	67						100.0	20.6	3.6E-09
CL-8	07/31/08	Clay test pad	88	27	61						103.1	20.9	1.0E-08
CL-9	07/31/08	Clay test pad	88	29	59						104.6	21.2	3.1E-09
CL-10	08/03/08	Clay test pad							113.1	17.9			
CL-11	08/03/08	Clay stockpile	94	30	64	CH	89.8	16.2	112.8	16.6	103.5	18.3	2.3E-08
CL-12	08/04/08	Test Pad / FDT 5						20.4					
CL-13	08/04/08	Test Pad / FDT 8						18.9					
CL-14	08/04/08	Test Pad / FDT 14						20.6					
CL-15	08/07/08	Clay test pad							110.0	17.4			
CL-16	08/07/08	Clay test pad	98	31	67	CH	89.5	19.2			103.3	19.2	9.0E-09
CL-17	08/07/08	Clay test pad	99	30	69	CH	87.8	18.4			109.4	17.7	2.6E-09
CL-18	08/07/08	Clay test pad	95	27	68	CH	90.3	18.7			105.1	19.5	5.8E-09
CL-19	08/07/08	Clay test pad	98	32	66	CH	91.2	17.7			109.0	18.3	4.4E-09
CL-20	08/07/08	Clay test pad	95	28	67	CH	93.6	20			109.3	18.0	4.7E-09
CL-21	08/07/08	Clay test pad	103	29	74	CH	91.4	18.5			108.4	18.7	2.7E-09
CL-22	08/08/08	Clay stockpile	98	32	66	CH	87.2	15.7	107.4	18.1	98.7	20.3	5.8E-08
CL-23	08/11/08	Clay stockpile	89	27	62	CH	85.8	9.9	112.1	15.2	103.0	17.4	6.4E-08
Average:			93	29	64		89	17	112	16	104	19	2.6E-08
Max:			110	41	74		94	23	120	18	109	21	9.3E-08
Min:			61	21	38		74	8	106	13	97	15	2.6E-09

FDT = Field Density Test
L = Lift Number

TABLE C-2
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS - STOCKPILE SAMPLES
CLAY SOURCE TESTING - PECTEN CLAYSTONE
KETTLEMAN HILLS FACILITY, KINGS COUNTY, CALIFORNIA

Site Sample No.	Date Sampled	Source	Atterberg Limits			Soil Classification (ASTM D 2487)	Fines Content		Laboratory		Permeability (ASTM D5084)		
			LL	PL	PI		% < # 200 Sieve	Natural Moisture Content	Maximum Dry Density	Optimum Moisture	Dry Unit Weight	Moisture Content	Hydraulic Conductivity
			%	%				%	lb/ft^3	%	lb/ft^3	%	cm/s
CL-1	07/16/08	Clay stockpile	95	33	62	CH	87.4	15.3	111.0	17.3	99.1	19.1	9.3E-08
CL-2	07/24/08	Clay stockpile	61	23	38	CH	73.8	8.1	119.7	12.5	107.6	14.7	6.3E-08
CL-3	07/24/08	Clay stockpile	110	41	69	CH	93.5	22.6	106.0	18.0	96.9	20.1	4.0E-08
CL-4	07/27/08	Clay stockpile	88	27	61	CH	90.7	12.4	111.9	15.4	103.0	17.2	4.9E-08
CL-11	08/03/08	Clay stockpile	94	30	64	CH	89.8	16.2	112.8	16.6	103.5	18.3	2.3E-08
CL-22	08/08/08	Clay stockpile	98	32	66	CH	87.2	15.7	107.4	18.1	98.7	20.3	5.8E-08
CL-23	08/11/08	Clay stockpile	89	27	62	CH	85.8	9.9	112.1	15.2	103.0	17.4	6.4E-08
		Average:	91	30	60		87	14	112	16	102	18	5.6E-08
		Max:	110	41	69		94	23	120	18	108	20	9.3E-08
		Min:	61	23	38		74	8	106	13	97	15	2.3E-08

TABLE C-3
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS - TEST PAD SAMPLES
CLAY SOURCE TESTING - PECTEN CLAYSTONE
KETTLEMAN HILLS FACILITY, KINGS COUNTY, CALIFORNIA

Site Sample No.	Date Sampled	Source	Atterberg Limits			Soil Classification (ASTM D 2487)	Fines Content		Laboratory		Permeability (ASTM D5084)		
			LL	PL	PI		% < # 200 Sieve	Natural Moisture Content	Maximum Dry Density	Optimum Moisture	Dry Unit Weight	Moisture Content	Hydraulic Conductivity
			%	%				%	lb/ft^3	%	lb/ft^3	%	cm/s
CL-5	07/27/08	Clay test pad							113.6	16.0			
CL-6	07/31/08	Clay test pad	92	21	71						105.6	18.4	5.3E-09
CL-7	07/31/08	Clay test pad	90	23	67						100.0	20.6	3.6E-09
CL-8	07/31/08	Clay test pad	88	27	61						103.1	20.9	1.0E-08
CL-9	07/31/08	Clay test pad	88	29	59						104.6	21.2	3.1E-09
CL-10	08/03/08	Clay test pad							113.1	17.9			
CL-12	08/04/08	Test Pad / FDT 5						20.4					
CL-13	08/04/08	Test Pad / FDT 8						18.9					
CL-14	08/04/08	Test Pad / FDT 14						20.6					
CL-15	08/07/08	Clay test pad							110.0	17.4			
CL-16	08/07/08	Clay test pad	98	31	67	CH	89.5	19.2			103.3	19.2	9.0E-09
CL-17	08/07/08	Clay test pad	99	30	69	CH	87.8	18.4			109.4	17.7	2.6E-09
CL-18	08/07/08	Clay test pad	95	27	68	CH	90.3	18.7			105.1	19.5	5.8E-09
CL-19	08/07/08	Clay test pad	98	32	66	CH	91.2	17.7			109.0	18.3	4.4E-09
CL-20	08/07/08	Clay test pad	95	28	67	CH	93.6	20			109.3	18.0	4.7E-09
CL-21	08/07/08	Clay test pad	103	29	74	CH	91.4	18.5			108.4	18.7	2.7E-09
		Average:	95	28	67		91	19	112	17	106	19	5.1E-09
		Max:	103	32	74		94	21	114	18	109	21	1.0E-08
		Min:	88	21	59		88	18	110	16	100	18	2.6E-09

GEOMETRIC MEAN 5.35×10^{-9}

FDT = Field Density Test
L = Lift Number

Geosyntec consultants

WASTE MANAGEMENT

SOIL SAMPLE LOG

PROJECT: Kettleman Hills Landfill

LOCATION: Kettleman City, CA. PROJECT NO.: SC0472 TASK NO.: 03/1

DESCRIPTION: Cell B17, Phase A1 Clay test pad YEAR: 2008

	SITE SAMPLE NO.	LAB SAMPLE NO.	VISUAL DESCRIPTION	SOURCE (LOCATION/DEPTH)	MATERIAL TYPE	DATE SAMPLED (day/mo)	TEST METHODS ASTM	QA ID
7	CL-1		Brownish grey clay	Clay stockpile	Clay liner soil	16/7	D422, 4318, 1557, 5084	JD
8	CL-2					24/7		JD
9	CL-3					24/7		JD
11	CL-4					27/7		JD
12	CL 5			Clay test pad/L-2		27/7	D1557	DW
22	CL 6			Clay test pad/lift 3		31/7	D 5084	DW
23	CL 7							JD
24	CL 8							JD
25	CL 9							JD
26	CL 10			Clay test pad / L-4		3/8	D1557	DW
27	CL 11		Brownish grey clay	Clay stock pile		3/8	D422, 1557, 4318, 5084	DW
28	CL 12			Test pad/L-4/FDT 5		4/8	D2216	DW
29	CL 13			Test pad/L-4/FDT 8				DW
30	CL 14			Test pad/L-5/FDT 14				DW
31	CL 15			Clay test pad / L-6		7/8	D1557	DW
32	CL 16			Clay test pad / L-7		7/8	D5084	JD
33	CL 17							
34	CL 18							
35	CL 19							
36	CL 20							
37	CL 21							

NOTES:

CHECKED BY:

Geosyntec consultants

WASTE MANAGEMENT

SOIL SAMPLE LOG

PROJECT: Kettleman Hills Landfill

LOCATION: Kettleman City, CA. PROJECT NO.: SC0472 TASK NO.: 03/1

DESCRIPTION: Cell B17, Phase A1 Clay test pad YEAR: 2008

SITE SAMPLE NO.	LAB SAMPLE NO.	VISUAL DESCRIPTION	SOURCE (LOCATION/DEPTH)	MATERIAL TYPE	DATE SAMPLED (day/mo)	TEST METHODS	QA ID
38 CL-22		Brown/grey clay	Clay stockpile	Clay liner soil	8/8	D1557, 422, 4318, 5084	D
41 CL-23		↓	Clay stockpile	↓	11/8	1557, 422, 4318, 5084	D

(23)

NOTES:

CHECKED BY:

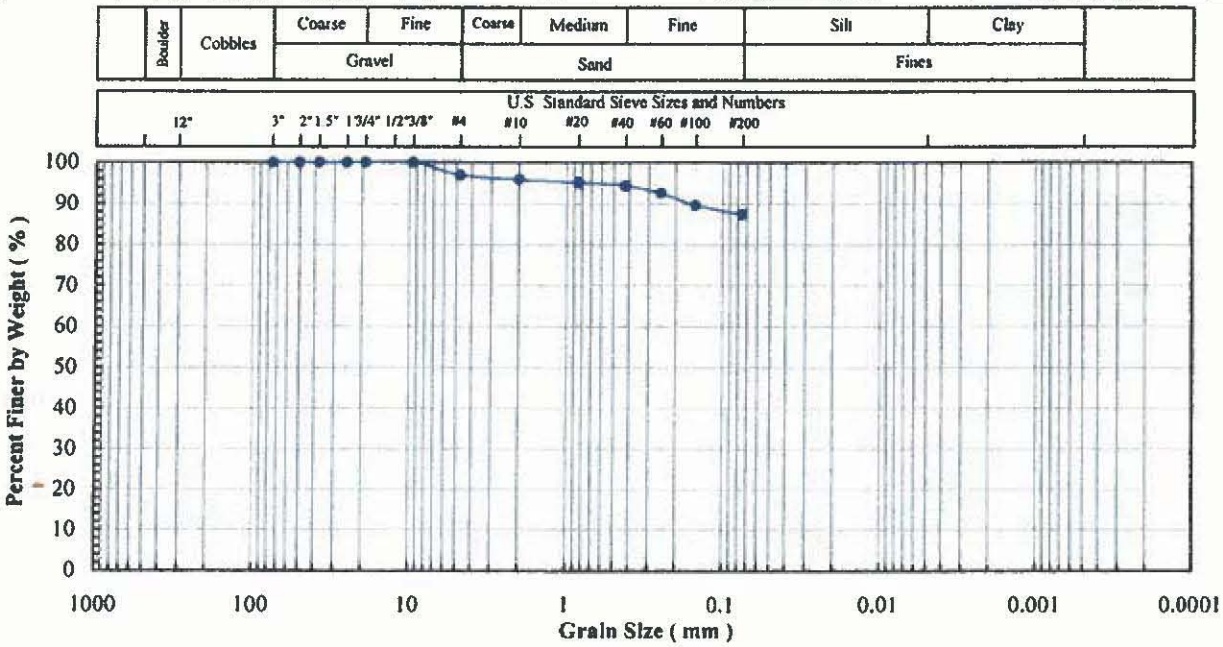
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-01
Lab Sample No:	G115

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



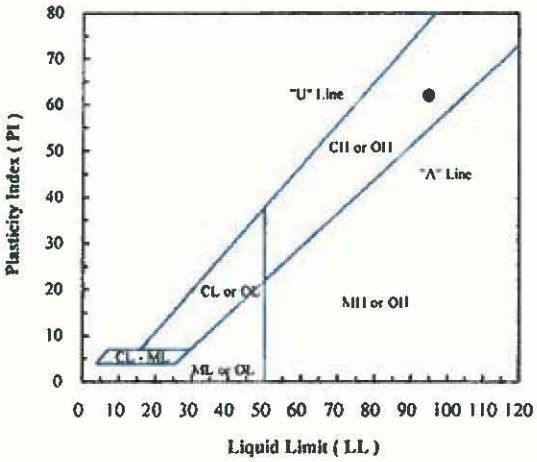
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	97.0
#10	2.00	95.9
#20	0.850	95.2
#40	0.425	94.4
#60	0.250	92.6
#100	0.150	89.6
#200	0.075	87.4

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	3.0
Sand (%):	9.6
Fines (%):	87.4
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	

Specific Gravity (-):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-01	G115	15.3	87.4	95	33	62	CH - Fat clay

Note(s):

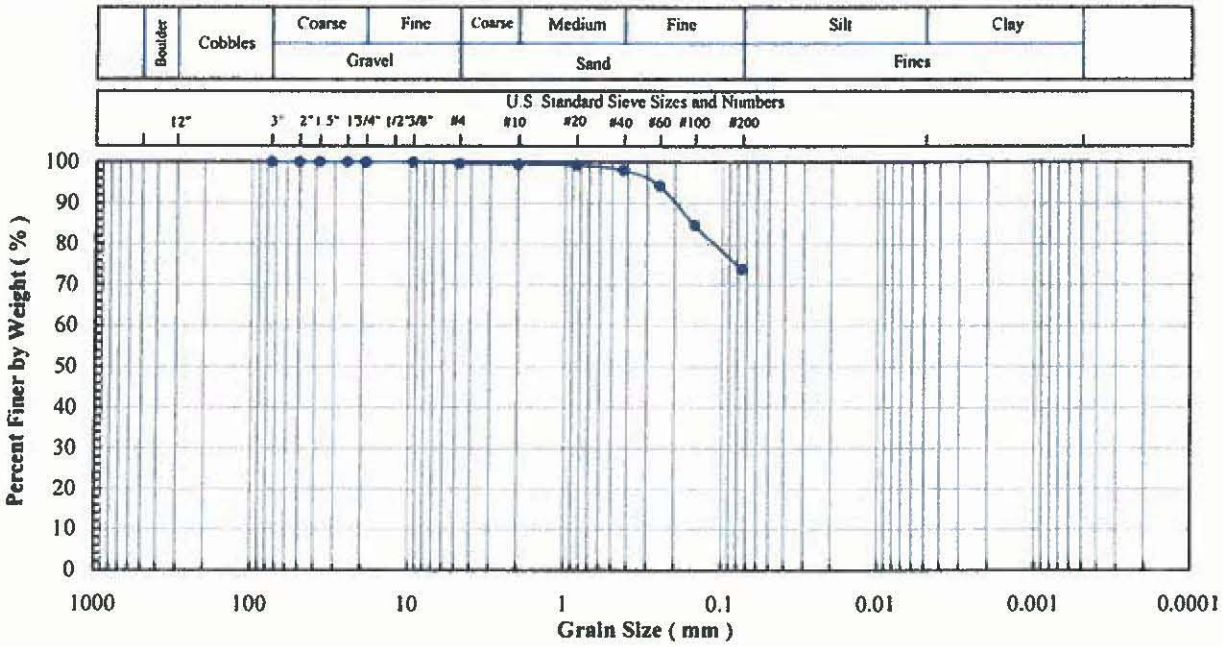
Excel Geotechnical Testing, Inc.
"Excellence In Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-02
Lab Sample No:	G124

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



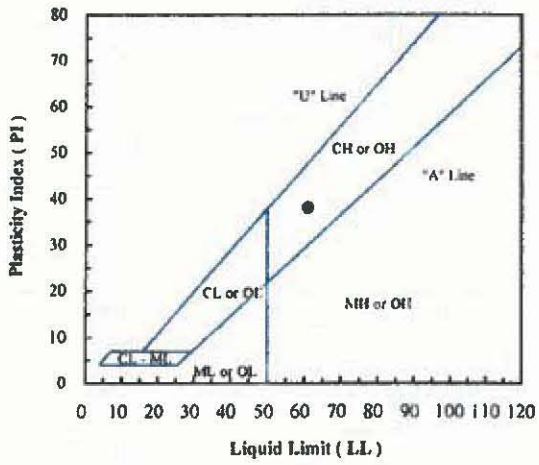
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	99.6
#10	2.00	99.4
#20	0.850	99.2
#40	0.425	98.0
#60	0.250	94.3
#100	0.150	84.6
#200	0.075	73.8

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.4
Sand (%):	25.8
Fines (%):	73.8
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Alterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-02	G124	8.1	73.8	61	23	38	CH - Fat clay with sand

Note(s):

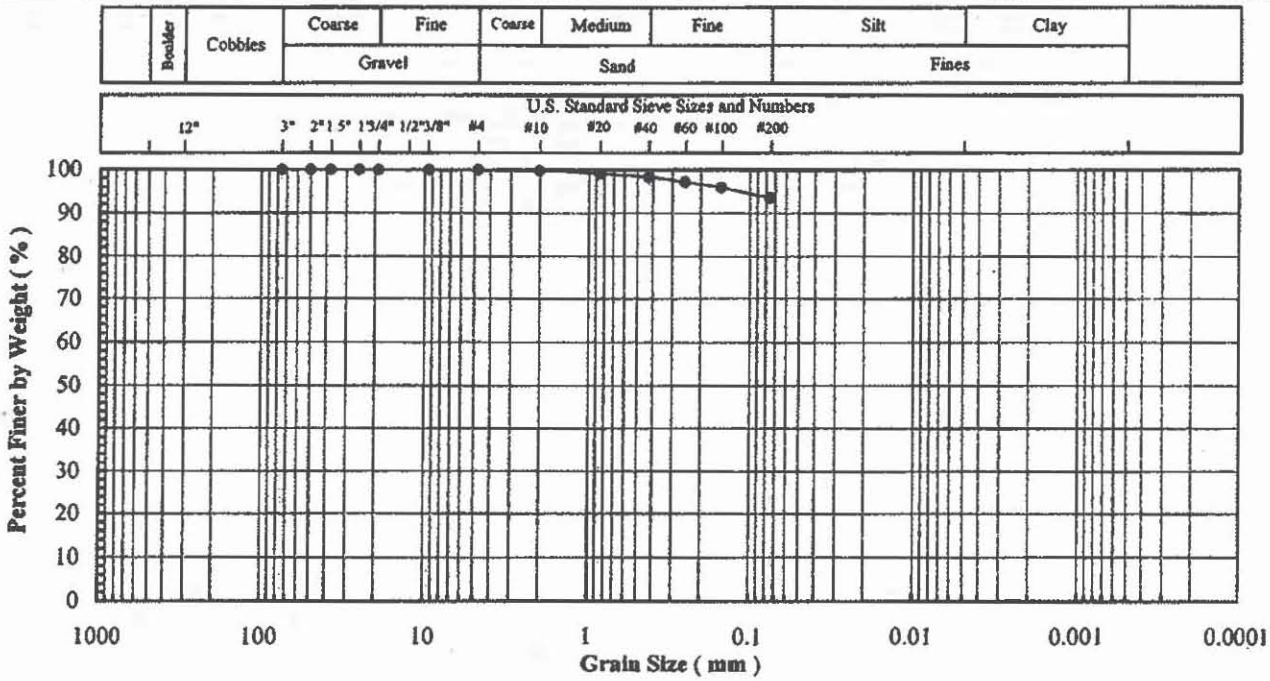
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-03
Lab Sample No:	G147

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



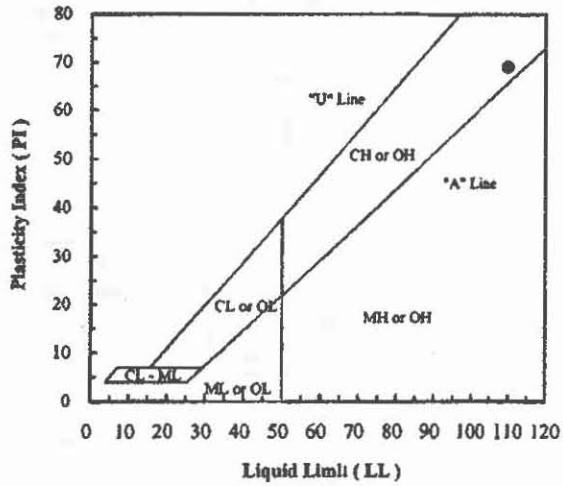
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.8
#20	0.850	99.1
#40	0.425	98.3
#60	0.250	97.2
#100	0.150	95.9
#200	0.075	93.5

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	6.5
Fines (%):	93.5
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	

Specific Gravity (-):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-03	G147	22.6	93.5	110	41	69	CH - Fat clay

Note(s):

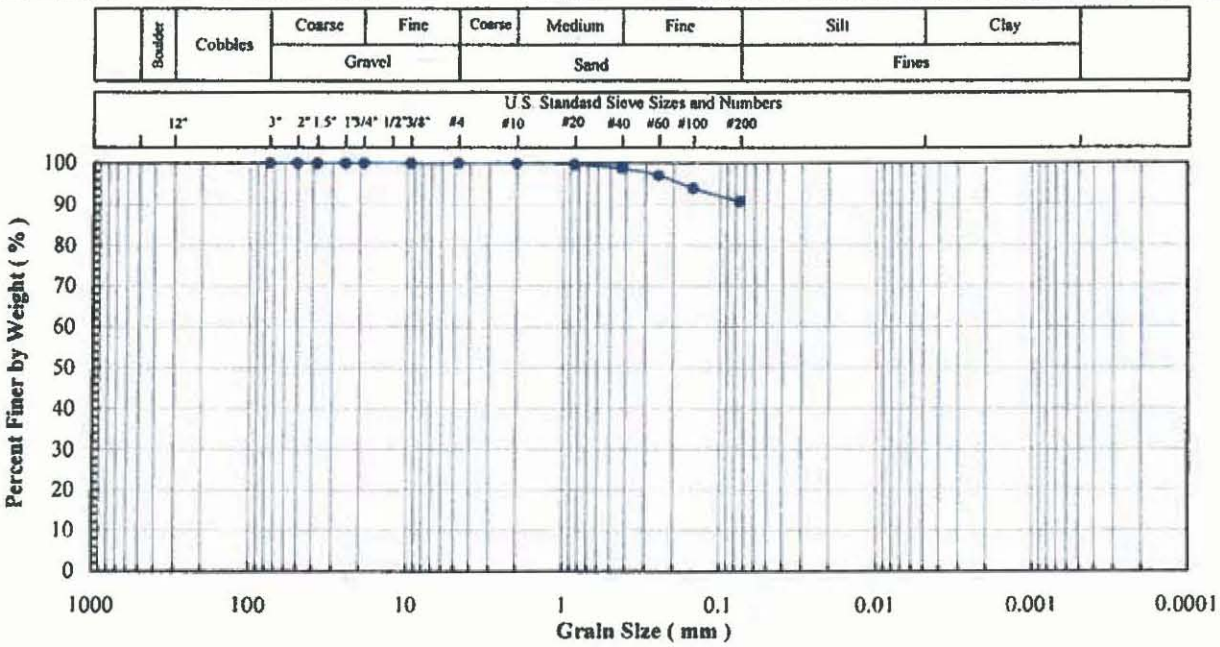
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-04
Lab Sample No:	G166

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



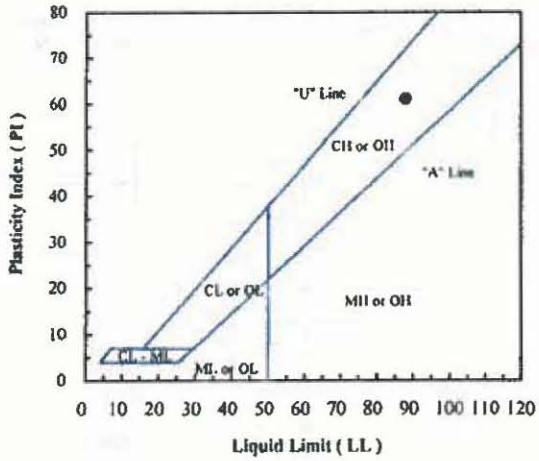
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.9
#20	0.850	99.7
#40	0.425	98.8
#60	0.250	97.1
#100	0.150	94.0
#200	0.075	90.7

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	9.3
Fines (%):	90.7
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-04	G166	12.4	90.7	88	27	61	CH - Fat clay

Note(s):

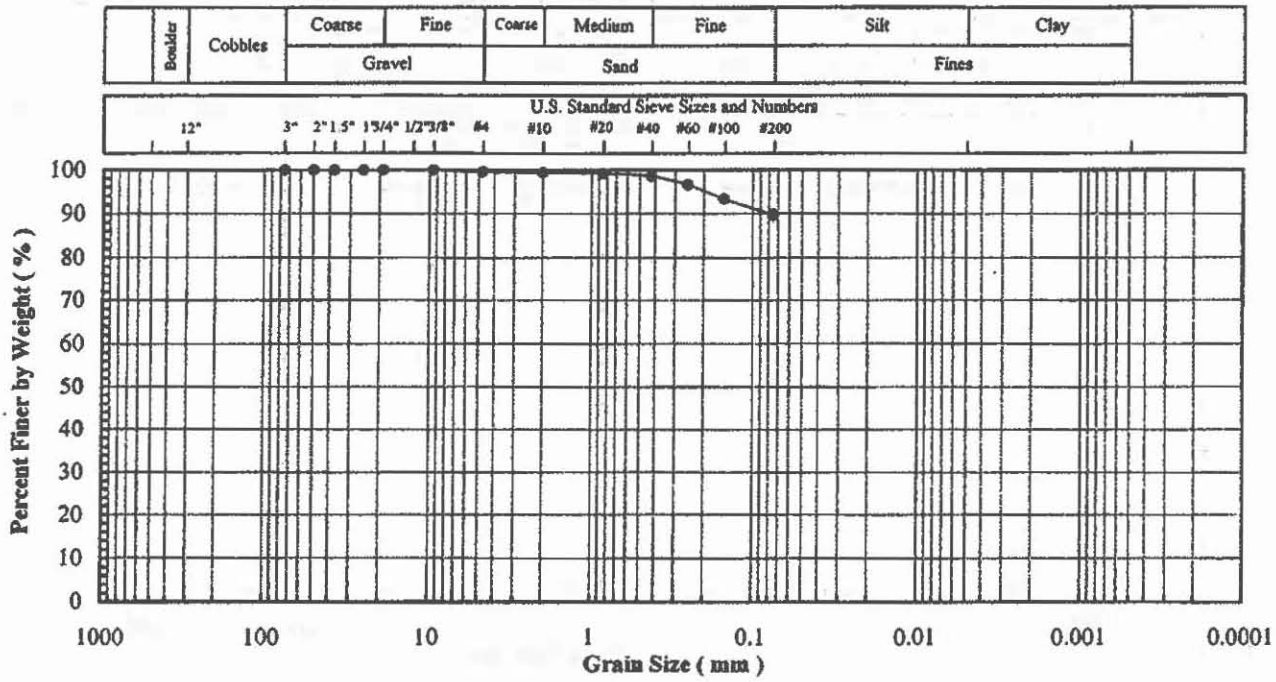
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-11
Lab Sample No:	H043

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Reg. Classification, Atterberg Limits



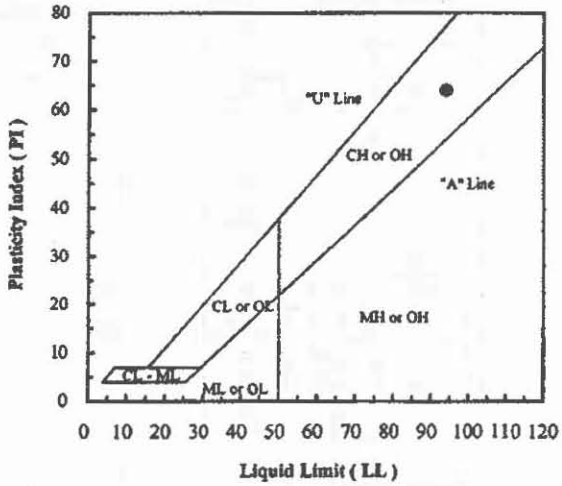
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	99.6
#10	2.00	99.4
#20	0.850	99.2
#40	0.425	98.6
#60	0.250	96.6
#100	0.150	93.4
#200	0.075	89.8

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.4
Sand (%):	9.8
Fines (%):	89.8
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	

Specific Gravity (-):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-11	H043	16.2	89.8	94	30	64	CH - Fat clay

Note(s):

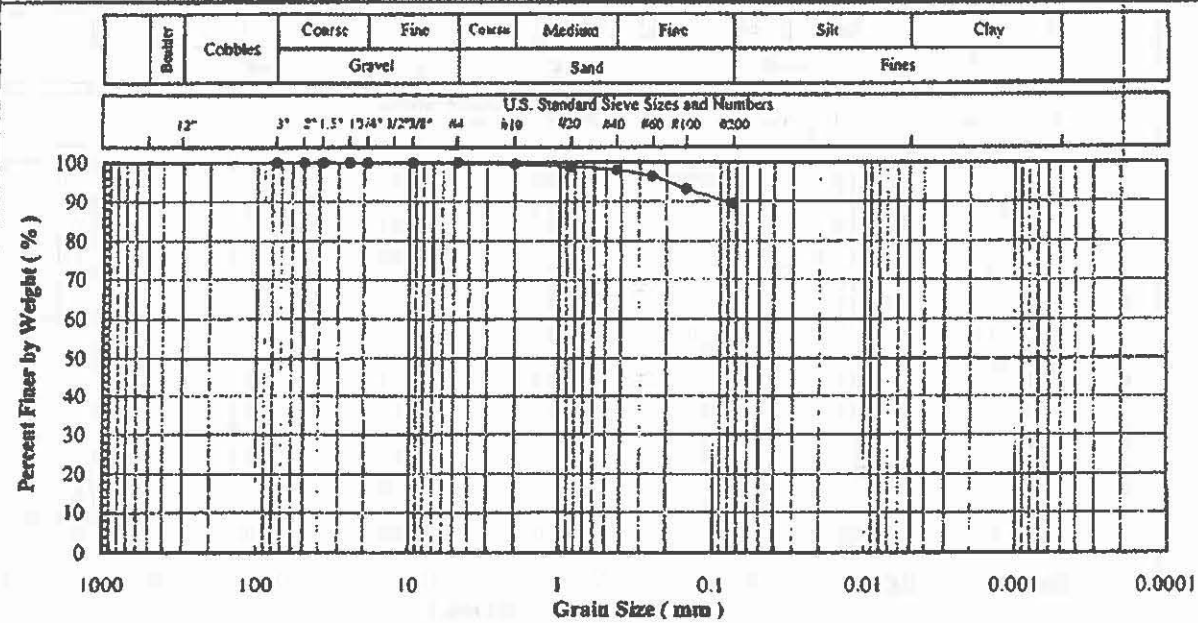
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 660 1666 Fax: (770) 660 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-16
Lab Sample No:	H051

ASTM C 136, D 421, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



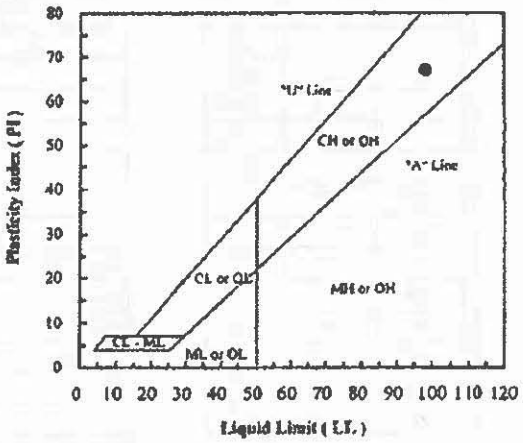
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.6
#20	0.850	98.9
#40	0.425	98.1
#60	0.250	96.4
#100	0.150	93.3
#200	0.075	89.5

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	10.5
Fines (%):	89.5
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	

Specific Gravity (-):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-16	H051	19.2	89.5	98	31	67	CH - Fat clay

Note(s):

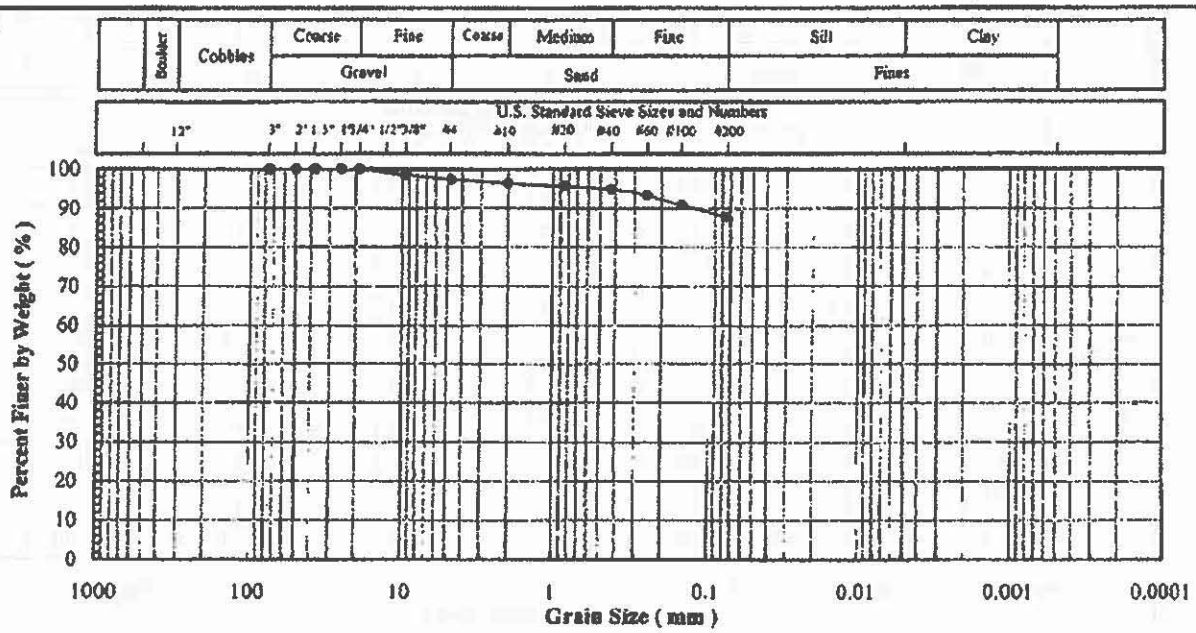
Excel Geotechnical Testing, inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kenleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-17
Lab Sample No:	H053

ASTM C136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Reg. Classification, Atterberg Limits



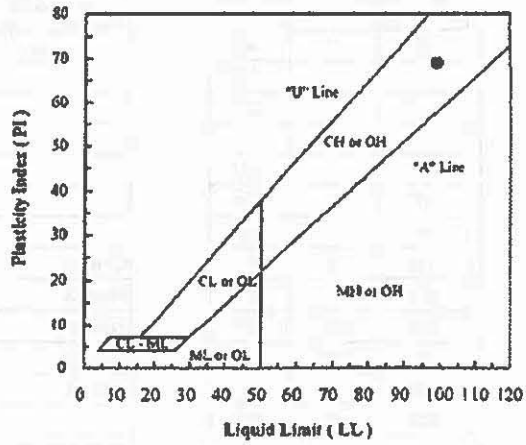
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	98.6
#4	4.75	97.4
#10	2.00	96.5
#20	0.850	95.6
#40	0.425	94.9
#60	0.250	93.4
#100	0.150	90.9
#200	0.075	87.8

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	2.6
Sand (%):	9.6
Fines (%):	87.8
Silt (%):	
Clay (%):	

Specific Gravity (-):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-17	H053	18.4	87.8	99	30	69	CH - Fat clay

Note(s):

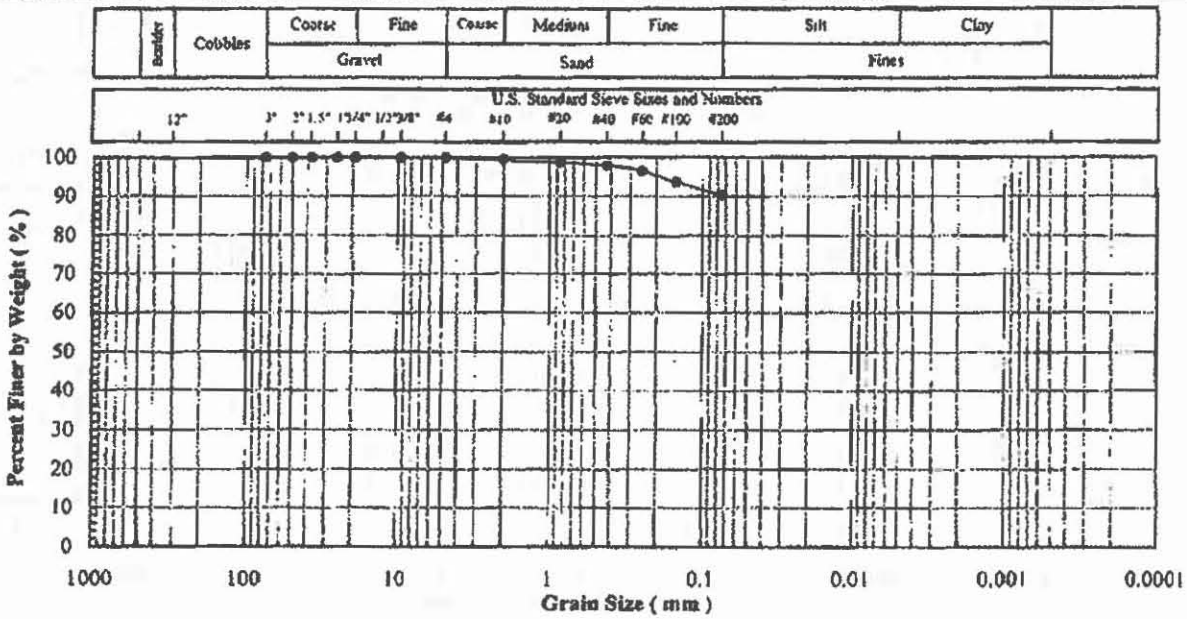
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-18
Lab Sample No:	H055

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



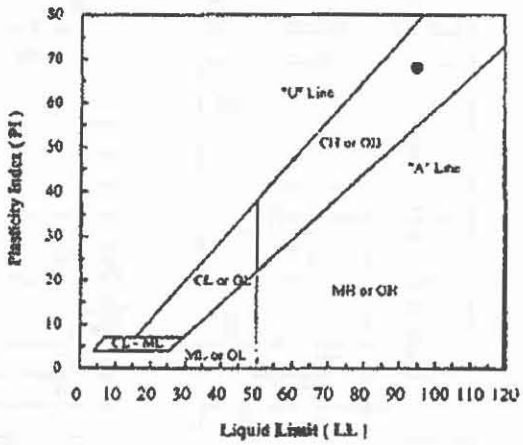
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.4
#20	0.850	98.7
#40	0.425	97.9
#60	0.250	96.4
#100	0.150	93.6
#200	0.075	90.3

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	9.7
Fines (%):	90.3
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	

Specific Gravity (-):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-18	H055	18.7	90.3	95	27	68	CH - Fat clay

Note(s)

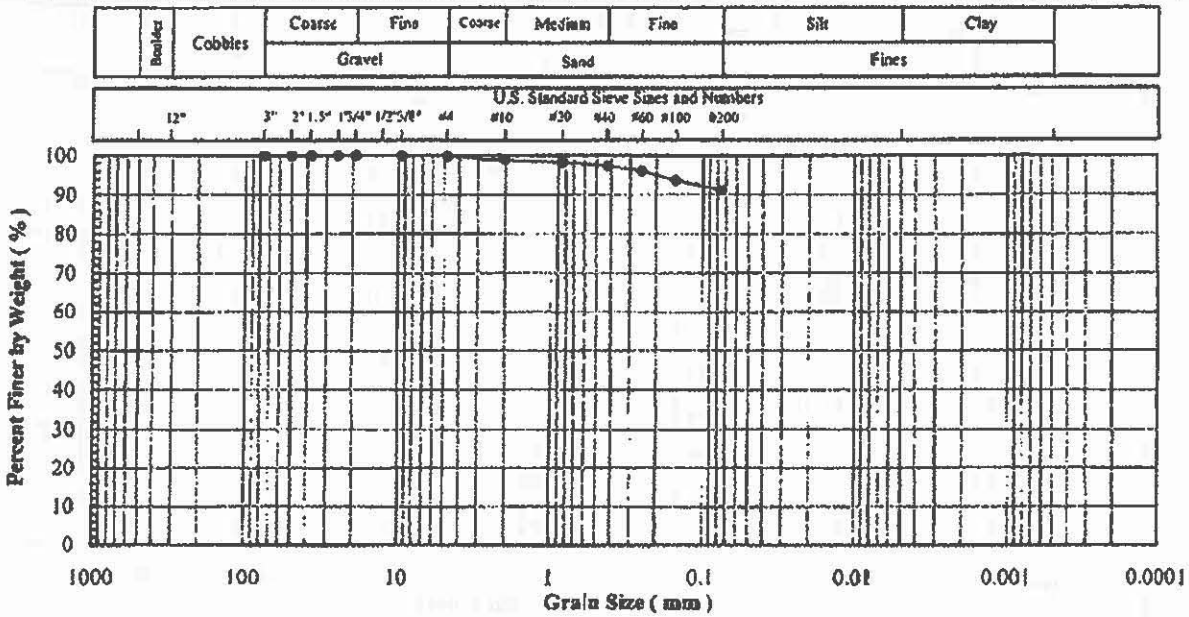
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-19
Lab Sample No:	H057

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



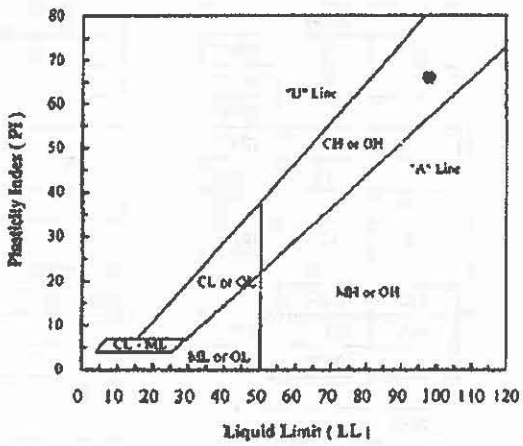
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	99.8
#10	2.00	98.9
#20	0.850	98.2
#40	0.425	97.3
#60	0.250	96.0
#100	0.150	93.7
#200	0.075	91.2

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.2
Sand (%):	8.6
Fines (%):	91.2
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	

Specific Gravity (-):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-19	H057	17.7	91.2	98	32	66	CH - Fat clay

Note(s):

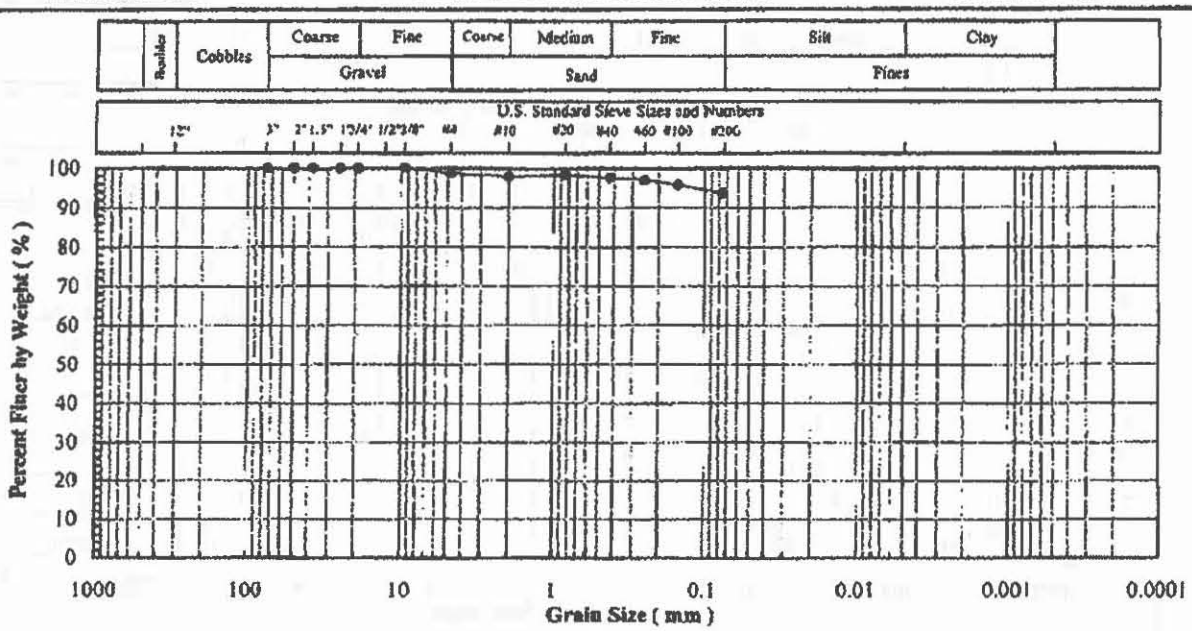
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 6786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-20
Lab Sample No:	H058

ASTM C 136, D 422, D 854, D 1140, D1216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



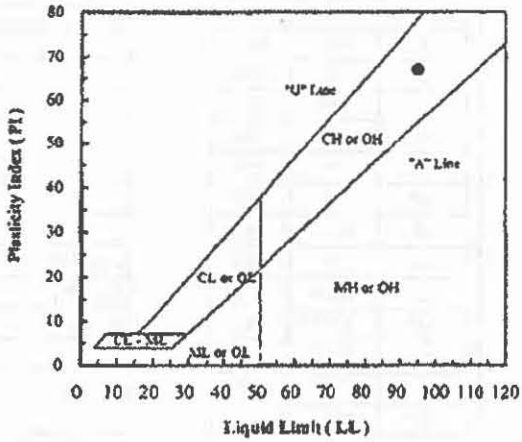
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	98.7
#10	2.00	97.9
#20	0.850	98.3
#40	0.425	97.6
#60	0.250	97.0
#100	0.150	95.8
#200	0.075	93.6

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	1.3
Sand (%):	5.1
Fines (%):	93.6
Silt (%):	
Clay (%):	

Specific Gravity (-):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-20	H058	20.0	93.6	95	28	67	CH - Fat clay

Note(s):

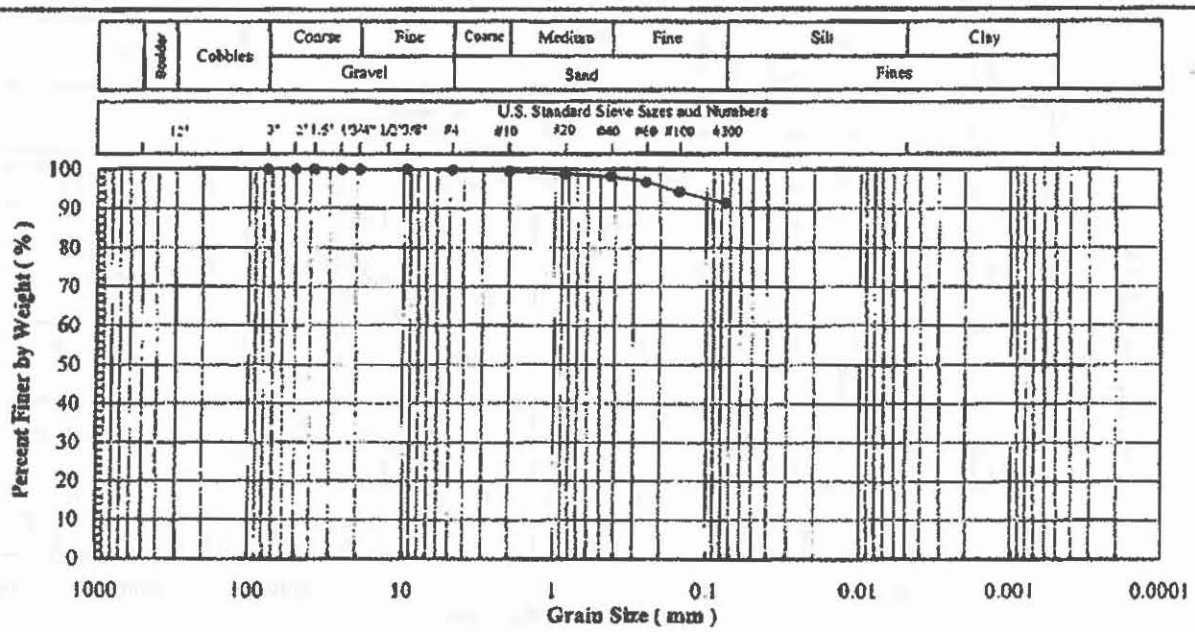
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID.	CL-21
Lab Sample No:	H061

ASTM C 136, D 422, D 854, D 5140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



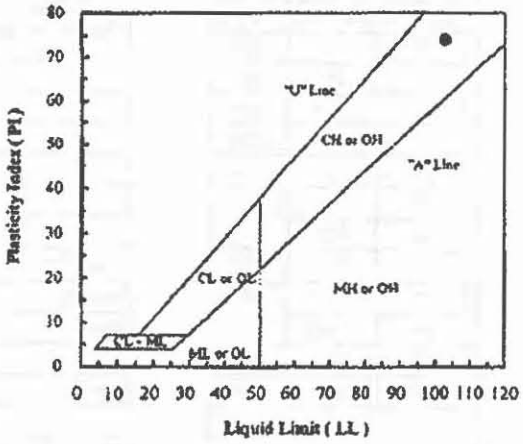
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	99.8
#10	2.00	99.4
#20	0.850	98.8
#40	0.425	98.1
#60	0.250	96.7
#100	0.150	94.2
#200	0.075	91.4

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.2
Sand (%):	8.4
Fines (%):	91.4
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-21	H061	18.5	91.4	103	29	74	CH - Fat clay

Note(s):

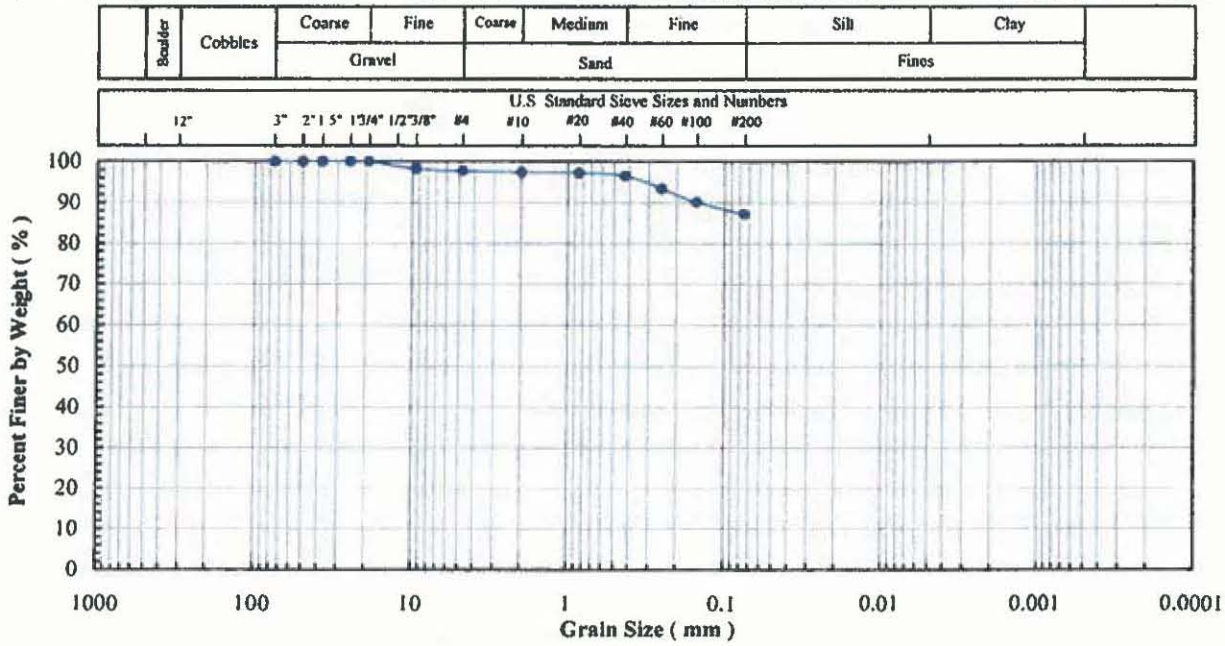
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-22
Lab Sample No:	H078

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



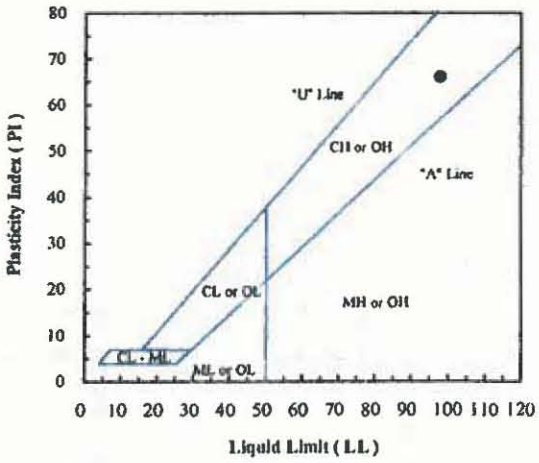
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	98.3
#4	4.75	97.8
#10	2.00	97.4
#20	0.850	97.3
#40	0.425	96.5
#60	0.250	93.5
#100	0.150	90.1
#200	0.075	87.2

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	2.2
Sand (%):	10.6
Fines (%):	87.2
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-22	H078	15.7	87.2	98	32	66	CH - Fat clay

Note(s):

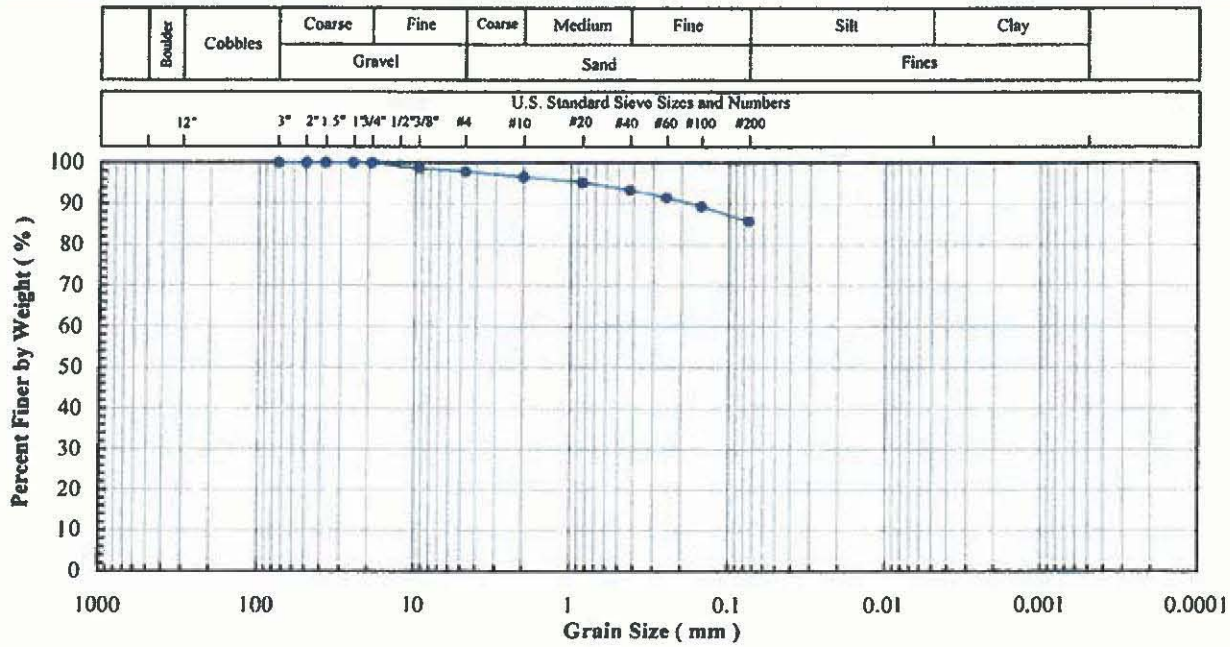
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Keitleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-23
Lab Sample No:	H080

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



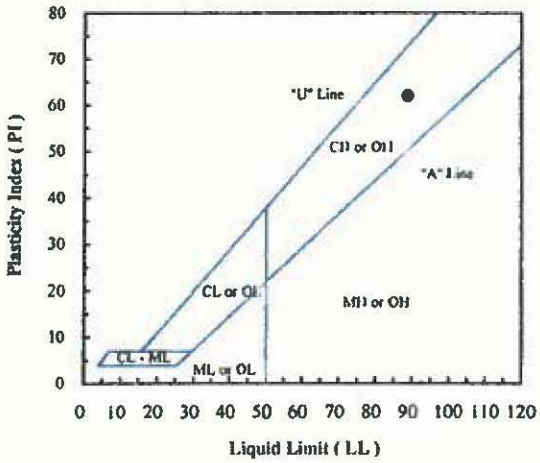
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	98.7
#4	4.75	97.9
#10	2.00	96.6
#20	0.850	95.3
#40	0.425	93.4
#60	0.250	91.6
#100	0.150	89.4
#200	0.075	85.8

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	2.1
Sand (%):	12.1
Fines (%):	85.8
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
CL-23	H080	9.9	85.8	89	27	62	CH - Fat clay

Note(s):

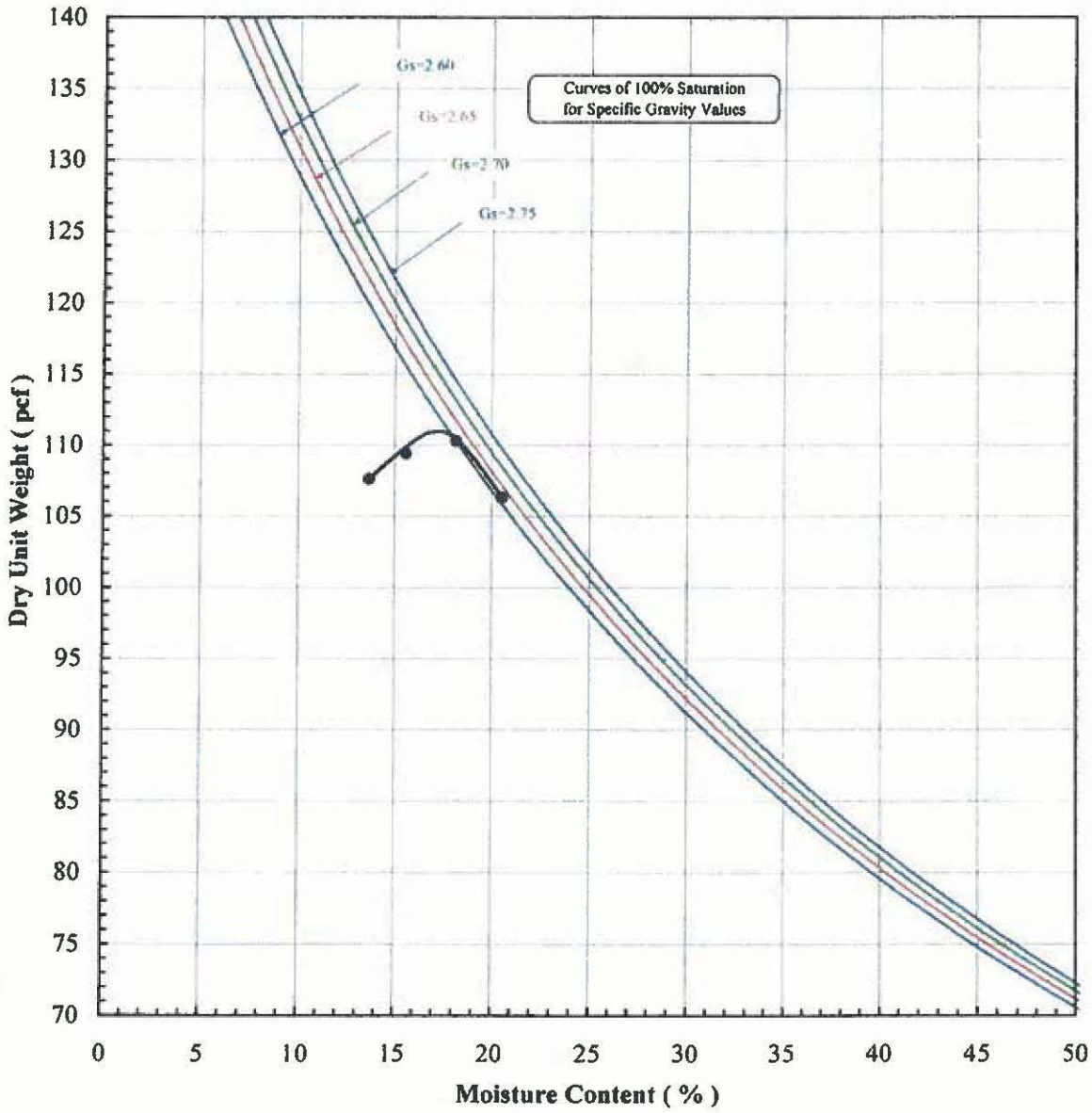
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-01
Lab Sample No:	G115

ASTM D 1557

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-01	G115	111.0	17.3	

Note(s)

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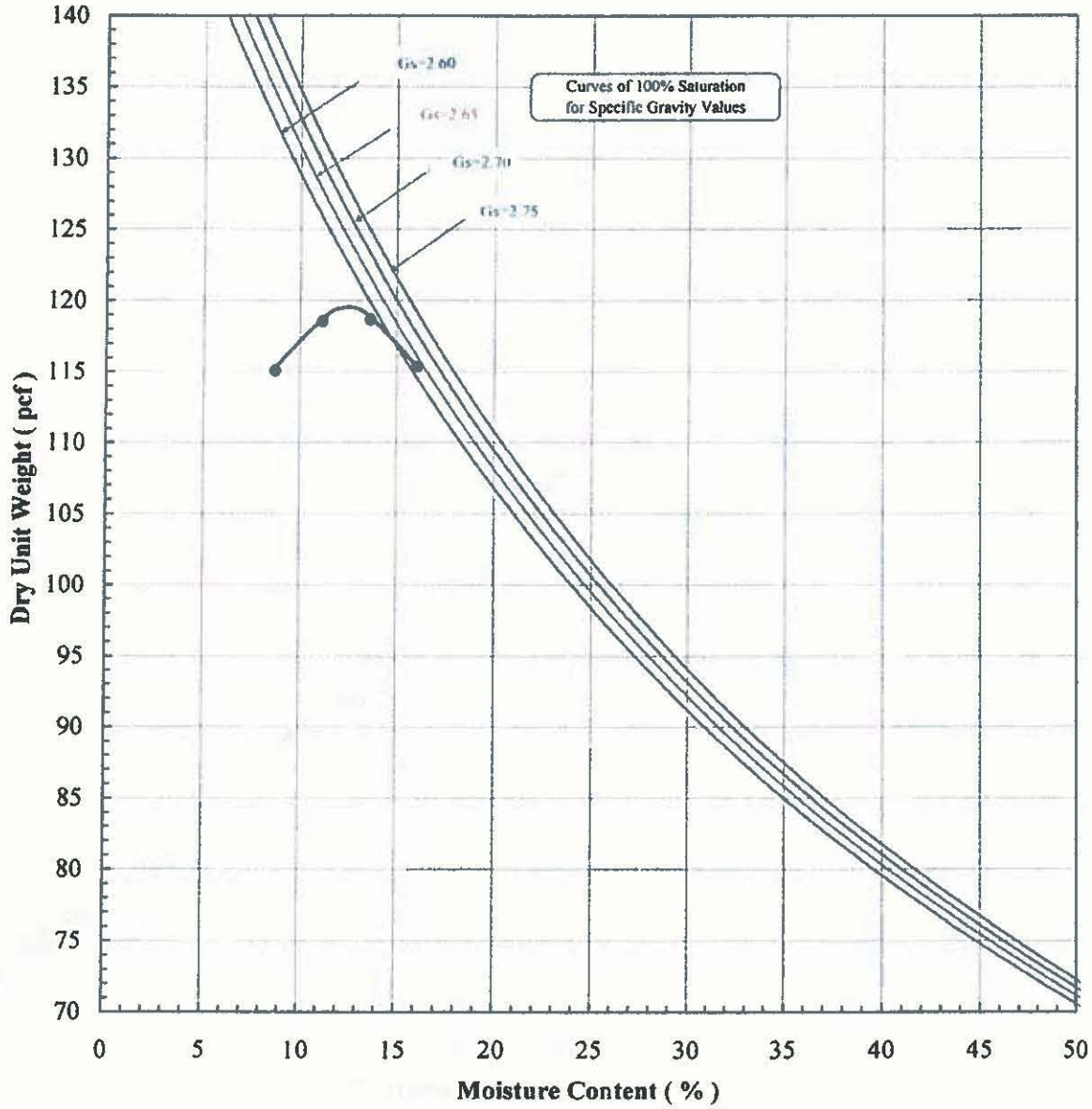
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-02
Lab Sample No:	G124

ASTM D 1557

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-02	G124	119.7	12.5	

Note(s):

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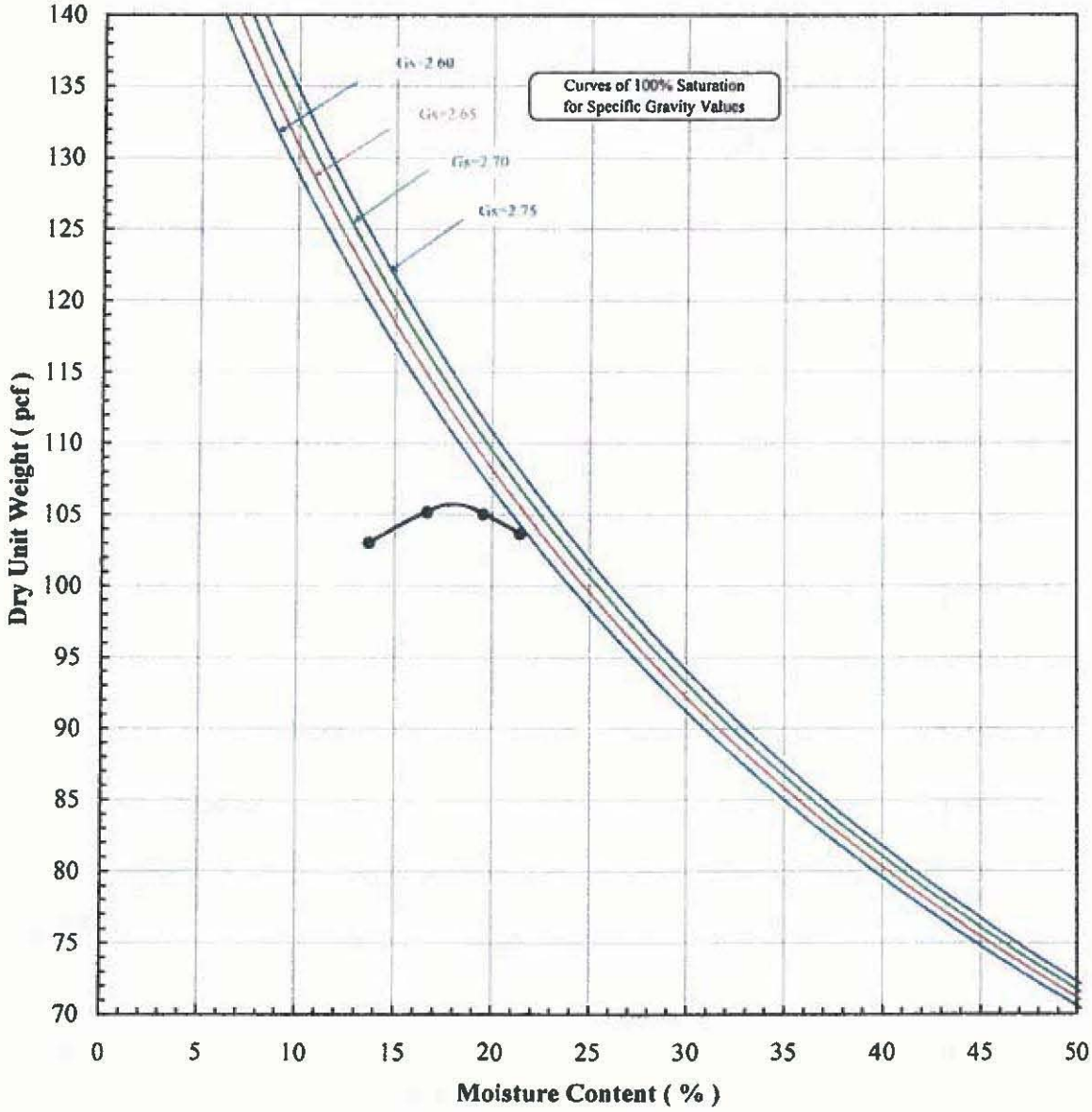
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID.	CL-03
Lab Sample No:	G147

ASTM D 1557

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-03	G147	106.0	18.0	

Note(s):

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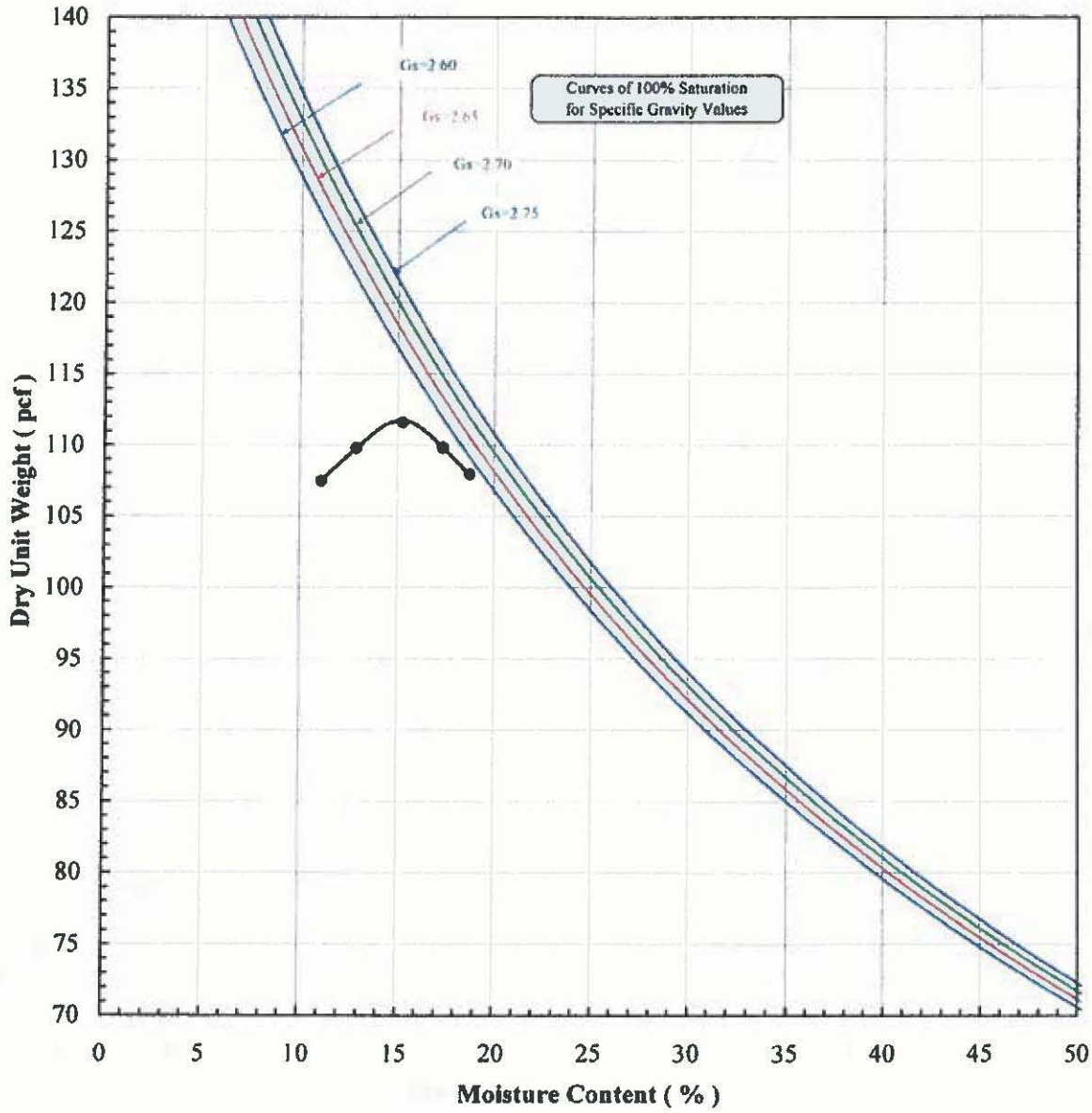
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-04
Lab Sample No:	G166

ASTM D 1557 **COMPACTION MOISTURE-DENSITY RELATIONSHIP** Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-04	G166	111.9	15.4	

Note(s):

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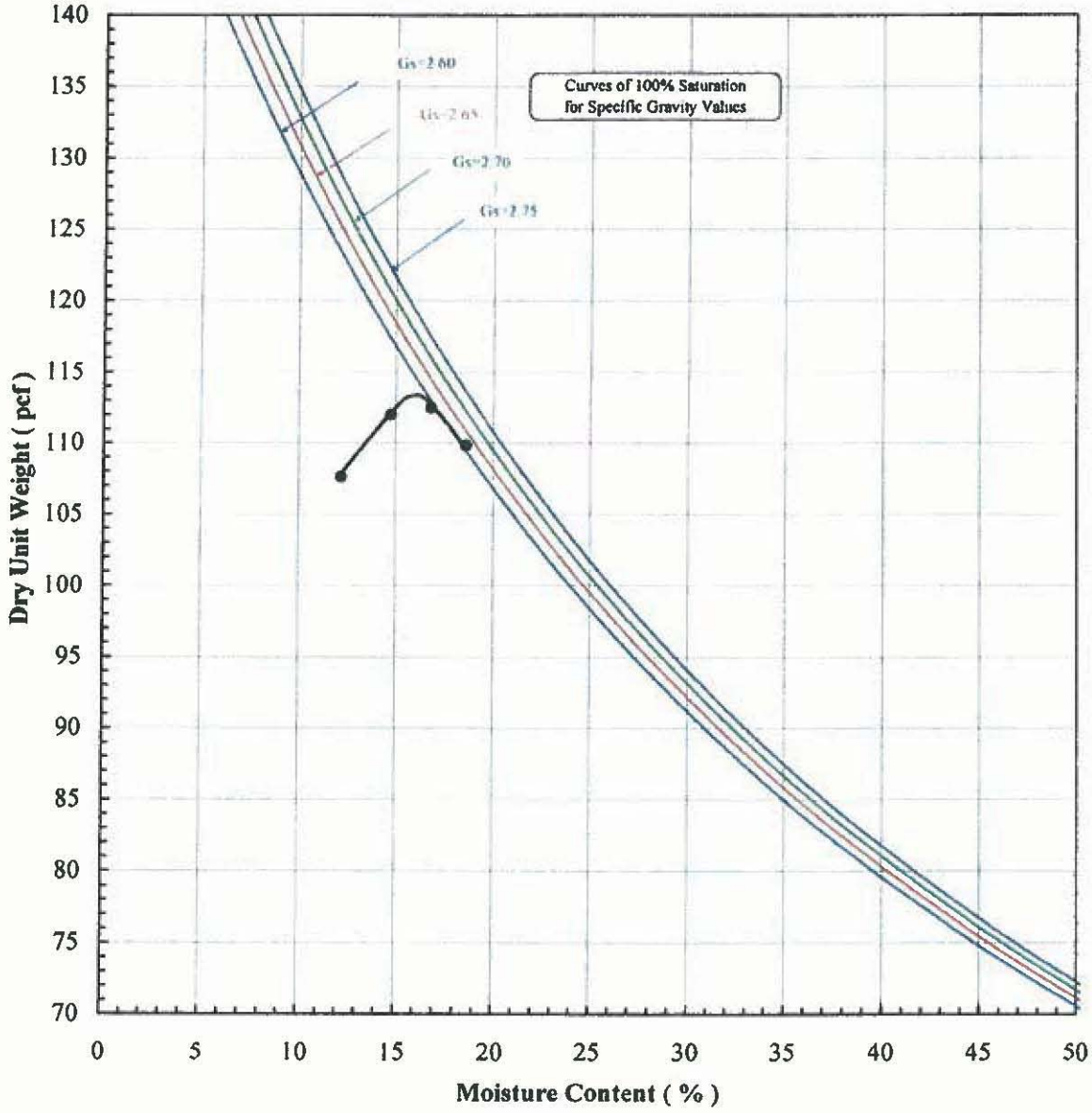
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-05
Lab Sample No:	G167

ASTM D 1557

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-05	G167	113.6	16.0	

Note(s):

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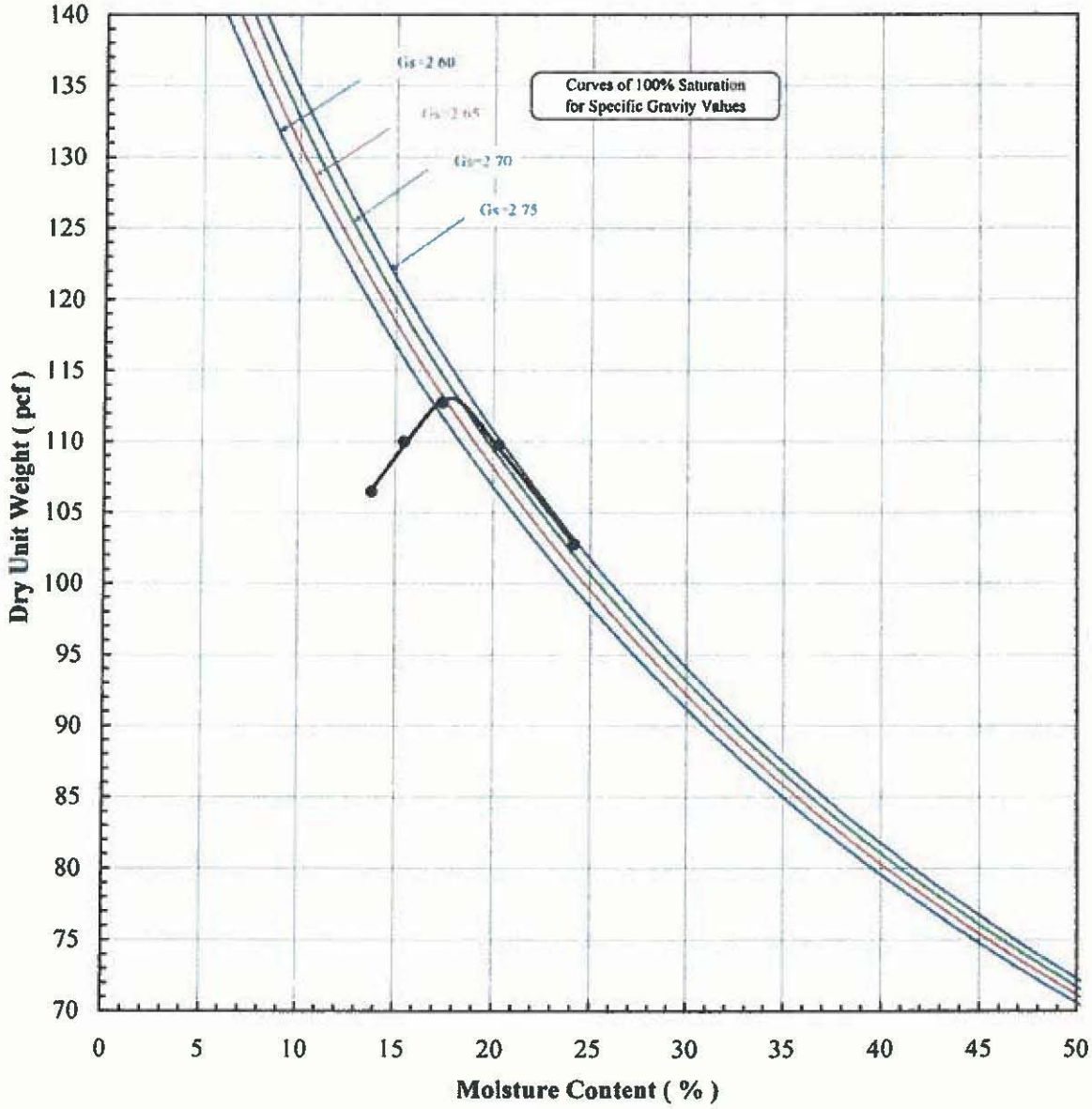
Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-10
Lab Sample No:	H042

ASTM D 1557

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-10	H042	113.1	17.9	

Note(s):

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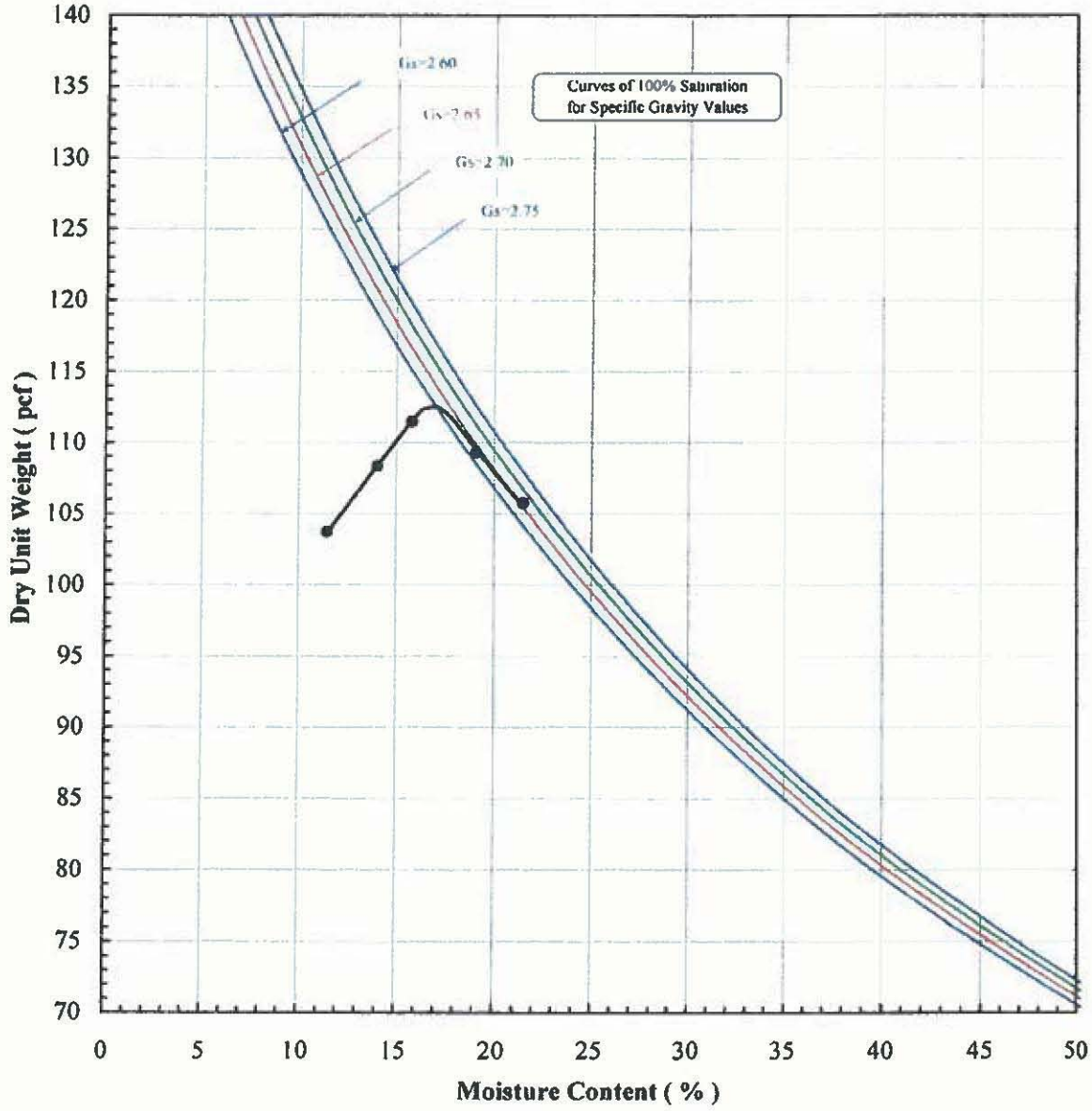
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-11
Lab Sample No:	H043

ASTM D 1557 **COMPACTION MOISTURE-DENSITY RELATIONSHIP** Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-11	H043	112.8	16.6	

Note(s):

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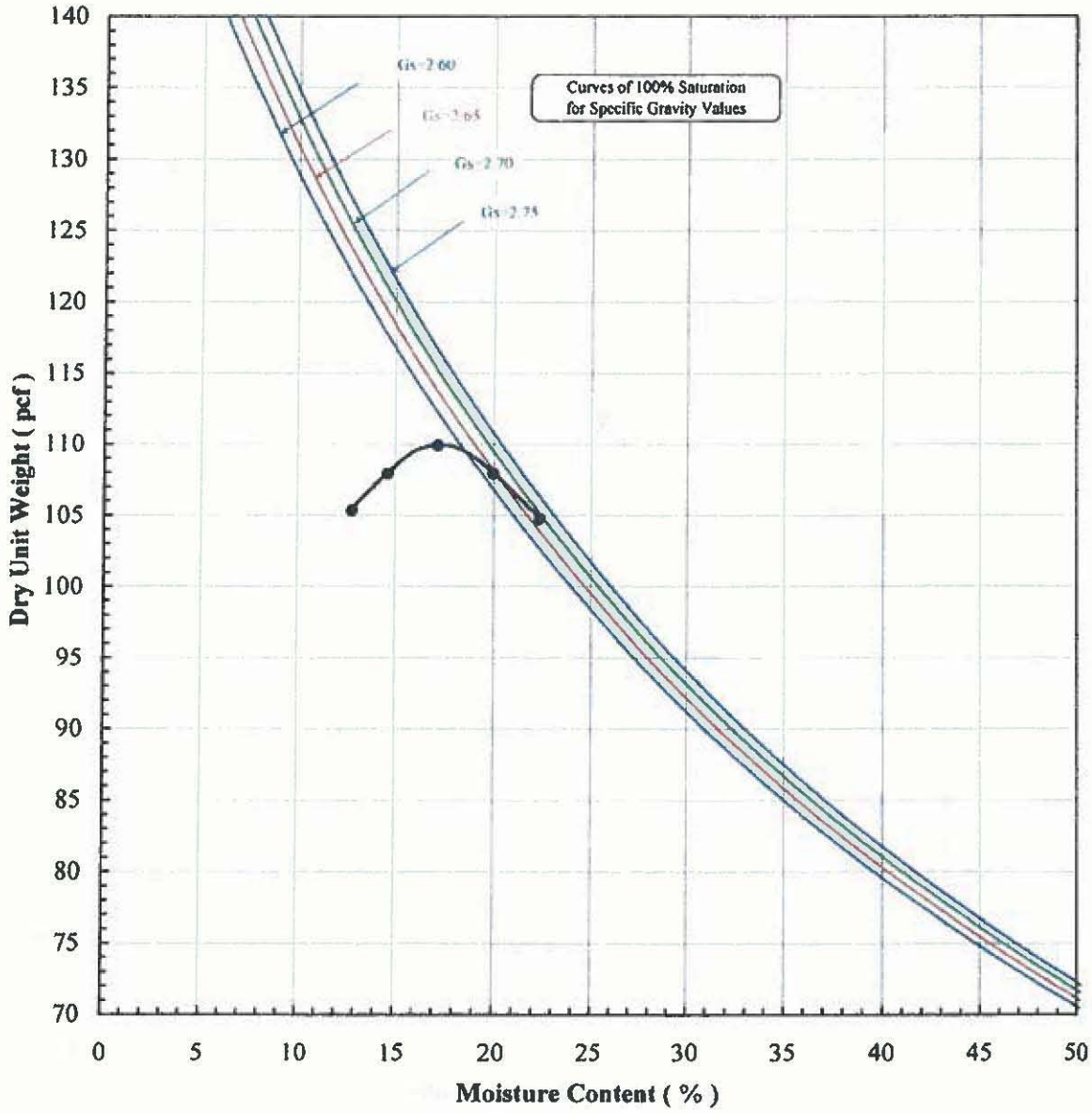
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-15
Lab Sample No:	H065

ASTM D 1557

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-15	H065	110.0	17.4	

Note(s):

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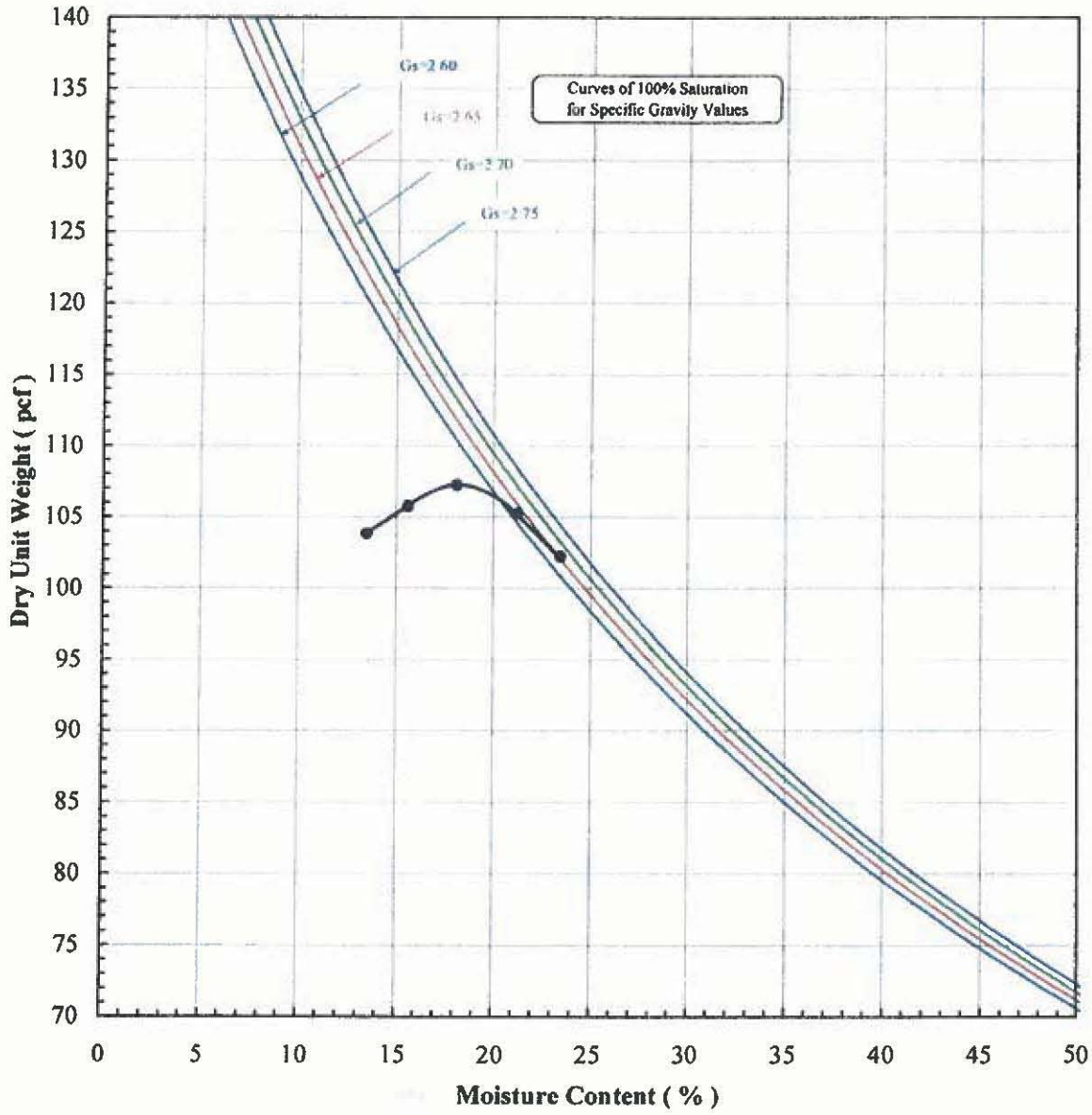
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-22
Lab Sample No:	H078

ASTM D 1557

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-22	H078	107.4	18.1	

Note(s):

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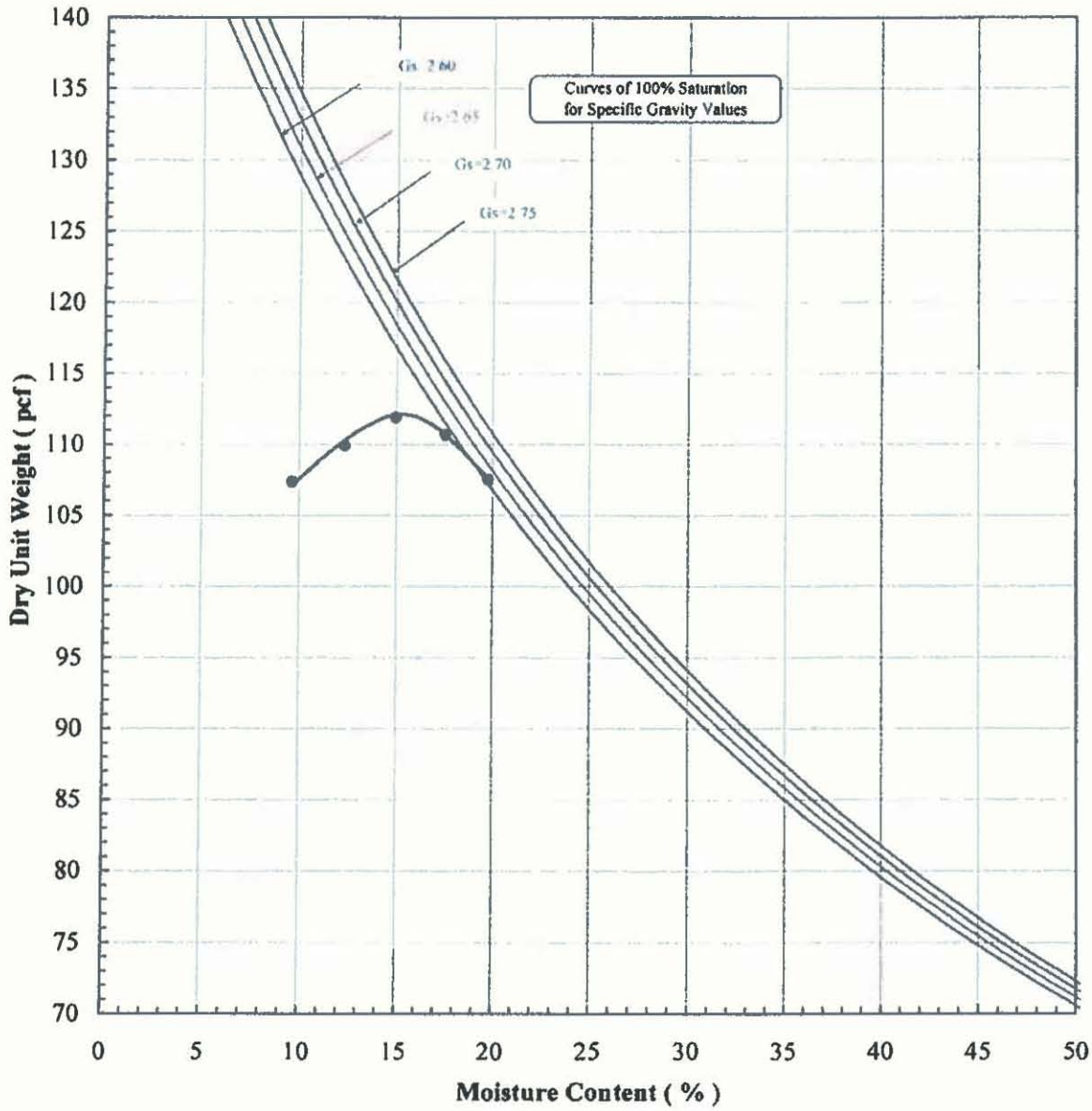
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Kettleman B-17 Landfill
Project No:	309
Client Sample ID:	CL-23
Lab Sample No:	H080

ASTM D 1557

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
CL-23	H080	112.1	15.2	

Note(s):

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-01
Lab Sample Number:	G115
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	7/27/2008

Remolded Specimen	Proctor [5] Compaction		Specimen Initial Conditions [6]		Test Conditions					Hydraulic Conductivity
	Max. DUW	Opt. MC	Dry Unit Weight	Moisture Content	Cell Press.	Back Press.	Consolid. Press.	Permeant Liquid [7]	Average Gradient	
(-)	(pcf)	(%)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
Notes 2, 3 & 4	110.0	17.3	99.1	19.1	72.0	70.0	2.0	DTW	12	9.3E-8

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. All particles larger than 3/8 inch, if any, were discarded when forming the remolded specimen.
3. Remolded specimen was formed by tamping the soil in one-centimeter-thick layers.
4. Remolded specimen approximately 2.87 inches in diameter and 2.36 inches in height.
5. Maximum Dry Unit Weight (DUW) and Optimum Moisture Content (MC) based on Modified Proctor Compaction Test (ASTM D 1557).
6. Based on the target values of 90% of the maximum dry unit weight and the optimum moisture content plus 2%.
7. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-02
Lab Sample Number:	G124
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	7/27/2008

Remolded Specimen	Proctor [5] Compaction		Specimen Initial Conditions [6]		Test Conditions					Hydraulic Conductivity
	Max. DUW	Opt. MC	Dry Unit Weight	Moisture Content	Cell Press.	Back Press.	Consolid. Press.	Permeant Liquid [7]	Average Gradient	
(-)	(pcf)	(%)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
Notes 2 , 3 & 4	119.7	12.5	107.6	14.7	72.0	70.0	2.0	DTW	14	6.3E-8

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. All particles larger than 3/8 inch, if any, were discarded when forming the remolded specimen.
3. Remolded specimen was formed by tamping the soil in one-centimeter-thick layers.
4. Remolded specimen approximately 2.87 inches in diameter and 2.36 inches in height.
5. Maximum Dry Unit Weight (DUW) and Optimum Moisture Content (MC) based on Modified Proctor Compaction Test (ASTM D 1557).
6. Based on the target values of 90% of the maximum dry unit weight and the optimum moisture content plus 2%.
7. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-03
Lab Sample Number:	G147
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/01/2008

Remolded Specimen	Proctor [5] Compaction		Specimen Initial Conditions [6]		Test Conditions					Hydraulic Conductivity
	Max. DUW	Opt. MC	Dry Unit Weight	Moisture Content	Cell Press.	Back Press.	Consolid. Press.	Permeant Liquid [7]	Average Gradient	
(-)	(pcf)	(%)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
Notes 2 , 3 & 4	106.0	18.0	96.9	20.1	72.0	70.0	2.0	DTW	14	4.0E-8

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. All particles larger than 3/8 inch, if any, were discarded when forming the remolded specimen.
3. Remolded specimen was formed by tamping the soil in one-centimeter-thick layers.
4. Remolded specimen approximately 2.87 inches in diameter and 2.36 inches in height.
5. Maximum Dry Unit Weight (DUW) and Optimum Moisture Content (MC) based on Modified Proctor Compaction Test (ASTM D 1557).
6. Based on the target values of 92% of the maximum dry unit weight and the optimum moisture content plus 2%.
7. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-04
Lab Sample Number:	G166
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/02/2008

Remolded Specimen	Proctor [5] Compaction		Specimen Initial Conditions [6]		Test Conditions					Hydraulic Conductivity
	Max. DUW	Opt. MC	Dry Unit Weight	Moisture Content	Cell Press.	Back Press.	Consolid. Press.	Permeant Liquid [7]	Average Gradient	
(-)	(pcf)	(%)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
Notes 2 , 3 & 4	111.9	15.4	103.0	17.2	72.0	70.0	2.0	DTW	16	4.9E-8

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. All particles larger than 3/8 inch, if any, were discarded when forming the remolded specimen.
3. Remolded specimen was formed by tamping the soil in one-centimeter-thick layers.
4. Remolded specimen approximately 2.87 inches in diameter and 2.36 inches in height.
5. Maximum Dry Unit Weight (DUW) and Optimum Moisture Content (MC) based on Modified Proctor Compaction Test (ASTM D 1557).
6. Based on the target values of 92% of the maximum dry unit weight and the optimum moisture content plus 2%.
7. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-06
Lab Sample Number:	H021
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/04/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.67	7.21	105.6	18.4	72.0	70.0	2.0	DTW	13	5.3E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318: 92 | 21 | 71

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-07
Lab Sample Number:	H023
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/04/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.68	7.26	100.0	20.6	72.0	70.0	2.0	DTW	15	3.6E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318: 90 | 23 | 67

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-08
Lab Sample Number:	H025
Material Type:	Soil
Specified Value (cm/sec):	1.0E-7
Date Test Started:	8/04/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.63	7.20	103.1	20.9	72.0	70.0	2.0	DTW	9	1.0E-8

Atterberg Test Results (LL, PL, PI) - ASTM D 4318: 88 | 27 | 61

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-09
Lab Sample Number:	H027
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/04/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.64	7.18	104.6	21.2	72.0	70.0	2.0	DTW	16	3.1E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318:

88	29	59

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-11
Lab Sample Number:	H043
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/16/2008

Remolded Specimen	Proctor [5] Compaction		Specimen Initial Conditions [6]		Test Conditions					Hydraulic Conductivity
	Max. DUW	Opt. MC	Dry Unit Weight	Moisture Content	Cell Press.	Back Press.	Consolid. Press.	Permeant Liquid [7]	Average Gradient	
(-)	(pcf)	(%)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
Notes 2 , 3 & 4	112.8	16.6	103.5	18.3	72.0	70.0	2.0	DTW	8	2.3E-8

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. All particles larger than 3/8 inch, if any, were discarded when forming the remolded specimen.
3. Remolded specimen was formed by tamping the soil in one-centimeter-thick layers.
4. Remolded specimen approximately 2.87 inches in diameter and 2.36 inches in height.
5. Maximum Dry Unit Weight (DUW) and Optimum Moisture Content (MC) based on Modified Proctor Compaction Test (ASTM D 1557).
6. Based on the target values of 92% of the maximum dry unit weight and the optimum moisture content plus 2%.
7. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-16
Lab Sample Number:	H050
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/09/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.70	7.10	103.3	19.2	72.0	70.0	2.0	DTW	13	9.0E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318: 98 | 31 | 67

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-17
Lab Sample Number:	H052
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/09/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.66	7.16	109.4	17.7	72.0	70.0	2.0	DTW	16	2.6E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318:

99	30	69

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-18
Lab Sample Number:	H054
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/09/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.69	7.07	105.1	19.5	72.0	70.0	2.0	DTW	14	5.8E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318: 95 | 27 | 68

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.

Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-19
Lab Sample Number:	H056
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/09/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.71	7.15	109.0	18.3	72.0	70.0	2.0	DTW	14	4.4E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318:

98	32	66

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-20
Lab Sample Number:	H059
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/09/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.63	7.19	109.3	18.0	72.0	70.0	2.0	DTW	14	4.7E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318: 95 | 28 | 67

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D 5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-21
Lab Sample Number:	H060
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/09/2008

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [2] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [3] (-)	Average Gradient (-)	Conductivity (cm/s)
1	ST	5.62	7.24	108.4	18.7	72.0	70.0	2.0	DTW	15	2.7E-9

Atterberg Test Results (LL, PL, PI) - ASTM D 4318:

103	29	74

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 6786

FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-22
Lab Sample Number:	H078
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/22/2008

Remolded Specimen	Proctor [5] Compaction		Specimen Initial Conditions [6]		Test Conditions					Hydraulic Conductivity
	Max. DUW	Opt. MC	Dry Unit Weight	Moisture Content	Cell Press.	Back Press.	Consolid. Press.	Permeant Liquid [7]	Average Gradient	
(-)	(pcf)	(%)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
Notes 2, 3 & 4	107.4	18.1	98.7	20.3	72.0	70.0	2.0	DTW	14	5.8E-8

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. All particles larger than 3/8 inch, if any, were discarded when forming the remolded specimen.
3. Remolded specimen was formed by tamping the soil in one-centimeter-thick layers.
4. Remolded specimen approximately 2.87 inches in diameter and 2.36 inches in height.
5. Maximum Dry Unit Weight (DUW) and Optimum Moisture Content (MC) based on Modified Proctor Compaction Test (ASTM D 1557).
6. Based on the target values of 92% of the maximum dry unit weight and the optimum moisture content plus 2%.
7. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D5084 *

Project Name:	Kettleman B-17 Landfill
Project Number:	309
Client Name:	Geosyntec Consultants
Site Sample ID:	CL-23
Lab Sample Number:	H080
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	8/22/2008

Remolded Specimen	Proctor [5] Compaction		Specimen Initial Conditions [6]		Test Conditions					Hydraulic Conductivity
	Max. DUW	Opt. MC	Dry Unit Weight	Moisture Content	Cell Press.	Back Press.	Consolid. Press.	Permeant Liquid [7]	Average Gradient	
(-)	(pcf)	(%)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
Notes 2, 3 & 4	112.1	15.2	103.0	17.4	72.0	70.0	2.0	DTW	13	6.4E-8

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. All particles larger than 3/8 inch, if any, were discarded when forming the remolded specimen.
3. Remolded specimen was formed by tamping the soil in one-centimeter-thick layers.
4. Remolded specimen approximately 2.87 inches in diameter and 2.36 inches in height.
5. Maximum Dry Unit Weight (DUW) and Optimum Moisture Content (MC) based on Modified Proctor Compaction Test (ASTM D 1557).
6. Based on the target values of 92% of the maximum dry unit weight and the optimum moisture content plus 2%.
7. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

APPENDIX C-2
Test Pad Compaction Test Results

Geosyntec consultants

SUMMARY OF FIELD DENSITY TEST

PROJECT: Kettleman Hills Facility - Clay Source Evaluation — PROJECT NO.: SC0472

LOCATION: Kings County, CA — TASK NO.: 1

CONTRACTOR: Wood Brothers, Inc. — DATE:

SPECIFICATION REQUIREMENTS

SOURCE: On-site clay

% COMPACTION: 92% — MOISTURE RANGE: 19.3% to 22.3% and

18.0% to 21.0% (Samples 61-76)

NUCLEAR GAUGE TYPE: Troxler 3440 A — NUCLEAR GAUGE SERIAL NO.: 20202

DATE OF TEST	TEST NO.	TEST LOCATION		LAB RESULTS			TYPE OF TEST		FIELD TEST RESULTS				PERCENT COMPACT	PASS/ FAIL	RETEST NO	QA ID
				SAMPLE NO.	MAX UNIT WT	O.M.C.	ASTM D-2922	ASTM D-1556	DEPTH/ ELEV	WET UNIT WT	DRY UNIT WT	F.M.C.				
(day/mo)					(pcf)	(%)			(ft)	(pcf)	(pcf)	(%)	(%)			
29/7	11	B-2	0-6"	CL-1	111.0	17.3			0.5	125.3	100.8	24.4	90.8	Fail	17	JD
29/7	12	B-4	0-6"	CL-1	111.0	17.3			0.5	125.2	102.1	22.7	92.0	Pass*	--	JD
29/7	13	C-3	0-6"	CL-1	111.0	17.3			0.5	125.0	103.8	21.4	93.5	Pass	--	JD
29/7	14	D-4	0-6"	CL-1	111.0	17.3			0.5	123.1	98.6	25.6	88.3	Fail	18	JD
29/7	15	E-2	0-6"	CL-1	111.0	17.3			0.5	125.5	102.7	22.2	92.5	Pass	--	JD
29/7	16	D-4	0-6"	CL-1	111.0	17.3			0.5	123.8	100.9	22.7	90.9	Fail	18	JD
29/7	17	B-2	0-6"	CL-1	111.0	17.3			0.5	123.1	100.1	22.9	90.2	Fail	19	JD
29/7	18	D-4	0-6"	CL-1	111.0	17.3			0.5	125.6	103.3	21.6	93.0	Pass	--	JD
29/7	19	B-2	0-6"	CL-1	111.0	17.3			0.5	123.3	99.9	23.4	90.0	Fail	20	JD
29/7	20	B-2	0-6"	CL-1	111.0	17.3			0.5	122.5	102.4	19.6	92.3	Pass	--	JD
30/7	21	D-5	6" - 12"	CL-1	111.0	17.3			0.5	121.7	101.5	19.9	91.4	Fail	27	JD
30/7	22	C-2	6" - 12"	CL-1	111.0	17.3			0.5	123.3	101.2	21.8	91.2	Fail	30	JD
30/7	23	B-2	6" - 12"	CL-1	111.0	17.3			0.5	123.2	101.6	21.2	91.5	Fail	28	JD
30/7	24	B-4	6" - 12"	CL-1	111.0	17.3			0.5	117.7	97.3	20.9	87.7	Fail	29	JD
30/7	25	D-4	6" - 12"	CL-1	111.0	17.3			0.5	114.4	97.8	23.2	88.1	Fail	26	JD
30/7	26	D-4	6" - 12"	CL-1	111.0	17.3			0.5	127.5	106.2	20.0	95.7	Pass	--	JD
30/7	27	E-5	6" - 12"	CL-1	111.0	17.3			0.5	124.0	102.8	20.6	92.6	Pass	--	JD
30/7	28	B-2	6" - 12"	CL-1	111.0	17.3			0.5	124.0	102.5	20.9	92.4	Pass	--	JD
30/7	29	B-4	6" - 12"	CL-1	111.0	17.3			0.5	129.7	103.1	20.9	92.9	Pass	--	JD
30/7	30	C-2	6" - 12"	CL-1	111.0	17.3			0.5	125.3	103.4	21.2	93.1	Pass	--	JD
30/7	31	D-5	12" - 18"	CL-1	111.0	17.3			0.5	124.6	102.9	20.5	92.7	Pass	--	JD
30/7	32	B-4	12" - 18"	CL-1	111.0	17.3			0.5	125.2	103.2	21.3	93.0	Pass	--	JD
30/7	33	D-2	12" - 18"	CL-1	111.0	17.3			0.5	125.2	103.8	20.6	93.5	Pass	--	JD
30/7	34	A-5	12" - 18"	CL-1	111.0	17.3			0.5	125.3	102.5	22.2	92.4	Pass	--	JD
30/7	35	B-2	12" - 18"	CL-1	111.0	17.3			0.5	127.0	107.5	18.1	96.9	Fail	NR	JD
30/7	36	C-3	18" - 24"	CL-1	111.0	17.3			0.5	123.8	101.0	22.6	91.0	Fail	37	JD
30/7	37	C-3	18" - 24"	CL-1	111.0	17.3			0.5	124.8	102.0	22.4	91.9	Fail	57	JD
30/7	38	D-3	18" - 24"	CL-1	111.0	17.3			0.5	125.6	102.6	21.8	92.4	Pass	--	JD
30/7	39	E-5	12" - 18"	CL-1	111.0	17.3			0.5	120.9	97.8	23.7	88.1	Fail	45	JD
30/7	40	E-3	12" - 18"	CL-1	111.0	17.3			0.5	123.8	101.0	22.6	91.0	Fail	42	JD
30/7	41	C-2	12" - 18"	CL-1	111.0	17.3			0.5	124.7	102.8	21.4	92.6	Pass	--	JD
30/7	42	E-3	12" - 18"	CL-1	111.0	17.3			0.5	125.3	102.2	22.9	92.1	Fail	46	JD
30/7	43	C-4	12" - 18"	CL-1	111.0	17.3			0.5	127.4	104.2	21.8	93.9	Pass	--	JD
30/7	44	B-4	12" - 18"	CL-1	111.0	17.3			0.5	126.4	103.6	22.0	93.4	Pass	--	JD
31/7	45	E-5	12" - 18"	CL-1	111.0	17.3			0.5	120.9	97.8	23.7	88.1	Fail	51	JD
31/7	46	E-3	12" - 18"	CL-1	111.0	17.3			0.5	123.8	101.0	22.6	91.0	Fail	48	JD
31/7	47	C-2	12" - 18"	CL-1	111.0	17.3			0.5	124.7	102.8	21.4	92.6	Pass	--	JD
31/7	48	E-3	12" - 18"	CL-1	111.0	17.3			0.5	125.3	102.2	22.9	92.1	Pass*	--	JD
31/7	49	C-4	12" - 18"	CL-1	111.0	17.3			0.5	127.4	104.2	21.8	93.9	Pass	--	JD
31/7	50	B-4	12" - 18"	CL-1	111.0	17.3			0.5	126.4	103.6	22.0	93.4	Pass	--	JD
01/8	51	E-5	12" - 18"	CL-1	111.0	17.3			0.5	120.9	97.8	23.7	88.1	Fail	--	JD
01/8	52	E-3	12" - 18"	CL-1	111.0	17.3			0.5	123.8	101.0	22.6	91.0	Fail	54	JD
01/8	53	C-2	12" - 18"	CL-1	111.0	17.3			0.5	124.7	102.8	21.4	92.6	Pass	--	JD
01/8	54	E-3	12" - 18"	CL-1	111.0	17.3			0.5	125.3	102.2	22.9	92.1	Pass*	--	JD
01/8	55	C-4	12" - 18"	CL-1	111.0	17.3			0.5	127.4	104.2	21.8	93.9	Pass	--	JD
01/8	56	B-4	12" - 18"	CL-1	111.0	17.3			0.5	126.4	103.6	22.0	93.4	Pass	--	JD
04/08	57	C-3	18" - 24"	CL-1	111.0	17.3			0.5	125.3	101.0	24.9	91.0	Fail	58	JD
04/08	58	C-3	18" - 24"	CL-1	111.0	17.3			0.5	126.2	102.0	23.7	91.9	Fail	63	JD
05/08	61	D-4	18" - 24"	CL-5	113.6	16.0			0.5	128.2	105.9	23.7	93.3	Fail	NR	JD
05/08	62	D-2	18" - 24"	CL-5	111.0	17.3			0.5	125.5	104.3	22.6	94.0	Pass**	--	JD
05/08	63	C-3	18" - 24"	CL-5	113.6	16.0			0.5	128.2	106.0	21.4	93.3	Pass	--	JD
05/08	64	B-4	18" - 24"	CL-5	113.6	16.0			0.5	127.5	105.9	22.9	93.2	Pass*	--	JD
05/08	65	B-2	18" - 24"	CL-5	113.6	16.0			0.5	127.0	105.3	21.8	92.7	Pass	--	JD
07/08	66	C-3	24" - 30"	CL-5	113.6	16.0			0.5	126.7	104.8	20.9	92.3	Pass	--	JD
07/08	67	B-4	24" - 30"	CL-5	113.6	16.0			0.5	124.5	104.9	19.6	92.4	Pass	--	JD
07/08	68	C-2	24" - 30"	CL-5	113.6	16.0			0.5	127.2	106.2	19.8	93.5	Pass	--	JD
07/08	69	A-1	24" - 30"	CL-5	113.6	16.0			0.5	125.0	105.4	18.6	92.8	Pass	--	JD
07/08	70	E-5	24" - 30"	CL-5	113.6	16.0			0.5	126.4	105.1	20.3	92.4	Pass	--	JD

DATE OF TEST (day/mo)	TEST NO.	TEST LOCATION		LAB RESULTS			TYPE OF TEST		FIELD TEST RESULTS				PERCENT COMPACT (%)	PASS/ FAIL	RETEST NO.	QA ID
				SAMPLE NO.	MAX UNIT WT (pcf)	O.M.C. (%)	ASTM D-2922	ASTM D-1556	DEPTH/ ELEV (ft)	WET UNIT WT (pcf)	DRY UNIT WT (pcf)	F.M.C. (%)				
07/08	71	D-4	30" - 36"	CL-5	113.6	16.0			0.5	130.4	109.9	18.6	96.8	Pass	--	JD
07/08	72	B-4	30" - 36"	CL-5	113.6	16.0			0.5	126.4	105.5	20.0	92.8	Pass	--	JD
07/08	73	C-3	30" - 36"	CL-5	113.6	16.0			0.5	126.8	104.1	21.4	91.6	Fail	NR	JD
07/08	74	D-2	30" - 36"	CL-5	113.6	16.0			0.5	127.9	107.3	19.2	94.4	Pass	--	JD
07/08	75	A-2	30" - 36"	CL-5	113.6	16.0			0.5	127.6	106.0	20.5	93.3	Pass	--	JD
07/08	76	D-4	30" - 36"	CL-5	113.6	16.0			0.5	127.5	106.8	19.4	94.1	Pass	--	JD

Tests 1-9: First lift was removed after significant failing tests.
Tests 59 and 60 were not recorded due to nuclear gauge malfunction.
Re-test of FDT 51 not recorded
Pass* Moisture content was outside of range, but FDT was passed by Engineer.
Pass ** Previous proctor used for this test.
NR No Retest

Figure C-1: Location of Passing Field Density Tests
Clay Testpad
Kettleman Hills Facility, Kings County, California

Lift 1 - 0 to 6"					
	1	2	3	4	5
A					
B		X		X	
C			X		
D				X	
E		X			

Lift 2 - 6 to 12"					
	1	2	3	4	5
A					
B		X		X	
C		X			
D				X	
E					X

Lift 3 - 12 to 18"					
	1	2	3	4	5
A					X
B			XXXX		
C		XXX		XXX	
D		X			X
E			XX		

Lift 4 - 18 to 24"					
	1	2	3	4	5
A					
B		X		X	
C			X		
D		X	X		
E					

Lift 5 - 24 to 30"					
	1	2	3	4	5
A	X				
B				X	
C		X	X		
D					
E					X

Lift 6 - 30 to 36"					
	1	2	3	4	5
A		X			
B				X	
C					
D		X		XX	
E					

Note: Each box represents approximately 10 ft x 10 ft in the field
X' represents a passing field density test

APPENDIX D
SDRI Test Results

Excel Geotechnical Testing, Inc.
"Excellence in Testing"

941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Test Results Summary

Project Name: Kettleman B-17 Landfill

Client Name: Geosyntec

Index Test Results

Sample Information				Test Information						Remarks
Site ID			Lab. No.	Moisture Content ASTM D 2216	Fines Content ASTM D 1140	Attreberg Limits ASTM D 4318			Soil Class. ASTM D 2487	
	Depth (ft)					LL	PL	PI		
(-)	Top	Bottom	(-)	(%)	(%)	(-)	(-)	(-)	(-)	
A	0.0	0.2	J079	73.5						
A	0.2	0.4	J080	59.6						
A	0.4	0.5	J081	51.4						
A	0.5	0.6	J082	49.2						
A	0.6	0.7	J083	50.2						
A	0.7	0.8	J084	52.0						
A	0.8	0.9	J085	48.1						
A	0.9	1.0	J086	45.2						
A	1.0	1.1	J087	43.6						
A	1.2	1.3	J089	42.8						
A	1.3	1.4	J090	38.9						
A	1.4	1.5	J091	34.3						
A	1.5	1.6	J092	32.6						
A	1.6	1.7	J093	31.7						
A	1.7	1.8	J094	33.6						
A	1.8	1.9	J095	29.0						
A	1.9	2.0	J096	22.7						

Excel Geotechnical Testing, Inc.
"Excellence In Testing"

941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Test Results Summary

Project Name: Kettleman B-17 Landfill

Client Name: Geosyntec

Index Test Results

Sample Information				Test Information						
Site ID			Lab. No.	Moisture Content ASTM D 2216	Fines Content ASTM D 1140	Attreberg Limits ASTM D 4318			Soil Class. ASTM D 2487	Remarks
	Depth (ft)					LL	PL	PI		
(-)	Top	Bottom	(-)	(%)	(%)	(-)	(-)	(-)	(-)	
B	0.0	0.2	J097	68.7						
B	0.2	0.4	J098	60.2						
B	0.4	0.5	J099	55.5						
B	0.5	0.6	J100	51.8						
B	0.6	0.7	J101	51.9						
B	0.7	0.8	J102	51.8						
B	0.8	0.9	J103	47.2						
B	0.9	1.0	J104	44.3						
B	1.0	1.1	J105	45.4						
B	1.1	1.2	J106	43.0						
B-1	1.2	1.3	J107	41.0						
B-2	1.2	1.3	J108	41.6						
B-1	1.3	1.4	J109	40.3						
B-2	1.3	1.4	J110	40.7						
B	1.4	1.5	J111	35.3						
B	1.5	1.6	J112	31.8						
B	1.6	1.7	J113	30.7						
B	1.7	1.8	J114	29.0						
B	1.8	1.9	J115	21.5						
B	1.9	2.0	J116	22.3						
B	2.0	2.1	J117	23.8						

APPENDIX E.4
PHASES I AND II CLAY LINER COMPACTION SPECIFICATIONS

Design Change Form

KETTLEMAN HILLS FACILITY
LANDFILL B-18

Number: 3

Date: May 29, 1991 Engineer: Kerry K. Parkinson

Location/Reference of Change: Construction Specifications and Quality Assurance Plan, Landfill Unit B-18, Phases I/II and Final Closure. Page 02924-6, Section B, Item d, which specifies the following:

d. Minimum Moisture Content: Within the range defined by the area formed by connecting the following points for the Modified Proctor Compaction curve.

- 3 to 5 percent above the optimum moisture content for a density equal to 90 percent of the maximum Modified Proctor density.
- 0 to 3 percent above the optimum moisture content for a density equal to 95 percent of the maximum Modified Proctor density.

Change: Change Section B, Item d, to the following:

d. Moisture Content: Within the range defined by the area formed by connecting the following points for the Modified Proctor Compaction curve.

- 2 to 5 percent above the optimum moisture content for a density equal to 90 percent of the maximum Modified Proctor density.
- 3 percent above the optimum moisture content at 97 percent of the maximum Modified Proctor density.
- 1 percent above the optimum moisture content at 98 percent of the maximum Modified Proctor density.

APPROVAL FROM DESIGNER

Date: 5/29/91 Engineer: Kerry K Parkinson

Time: P.M.

Type of Correspondence: Letter dated May 31, 1991 by ESI

ACKNOWLEDGEMENT FROM OWNER

Date: 6-5-91 Engineer: [illegible]

Environmental Construction Services

CC: CWM-KETTLEMAN

9037031\34387

ENVIRONMENTAL SOLUTIONS, INC.

May 31, 1991

Project No. 89-9771

Mr. Scott Brown
Engineering and Construction Manager
Chemical Waste Management, Inc.
35251 Old Skyline Road
Kettleman City, California 93239

Revised Compaction Relationships
Clay Liner Material from
B-18 Clay Processing Area
Landfill Unit B-18
Kettleman Hills Facility

Dear Mr. Brown:

Pursuant to your request we have reevaluated the compaction specification for the Phase I clay liner construction at Landfill Unit B-18. This evaluation is based on compaction data from the testfill construction and interface testing program collected over the last six months. Additionally, we have reviewed the field density test results from the initial 10,000 cubic yards of clay liner placement.

The original specification from the Construction Specifications and Quality Assurance Plan, Landfill Unit B-18, Phases I and II, and Final Closure (Page 02924-6, Section B, Item d) specifies the following:

- Minimum Moisture Content: Within the range defined by the area formed by connecting the following points for the Modified Proctor Compaction curve.
  - 3 to 5 percent above the optimum moisture content for a density equal to 90 percent of the maximum Modified Proctor density.
  - 0 to 3 percent above the optimum moisture content for a density equal to 95 percent of the maximum Modified Proctor density.

This criterion, which allows a lower water content for higher compactive efforts, is established to: (1) assure that both the required strength and permeability characteristics are realized; and (2) provide flexibility for the contractor and CQA engineer to work with a range of water contents without having a clay which is too wet or dry, or too close to saturation. This flexibility is desirable in hot dry areas where exact water content is difficult to control. This specification is represented by the area designated as "Original Specification" in Figure 1, attached.

To further facilitate construction control of water content and quality assurance/quality control activities during clay liner placement, the moisture-density relationship graph is being changed to that shown by the "Revised Specification" in Figure 1. The revised moisture-density window is defined by the area encompassed by connecting the following water content density points:

- 2 percent above the optimum moisture content for a density equal to 90 percent of the maximum Modified Proctor density.
- 5 percent above the optimum moisture content for a density equal to 90 percent of the maximum Modified Proctor density.
- 3 percent above the optimum moisture content at 97 percent of the maximum Modified Proctor density.
- 1 percent above the optimum moisture content at 98 percent of the maximum Modified Proctor density.

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The majority of material placed in the initial 10,000 cubic yards of clay liner is within the revised specification range. Test results indicate that a portion of the initial clay liner placement was at higher densities and moisture contents than the specification range. Due to the relatively low volume, minor deviation from the specification, and discontinuous placement of the material outside of this range, no planes of weakness or other detrimental features have been developed. Consequently, the clay liner placed to date is acceptable.

Please call us if you need further information regarding this material.

Very truly yours,

Kerry K Parkinson

Kerry K. Parkinson, P.E.
Civil Engineer

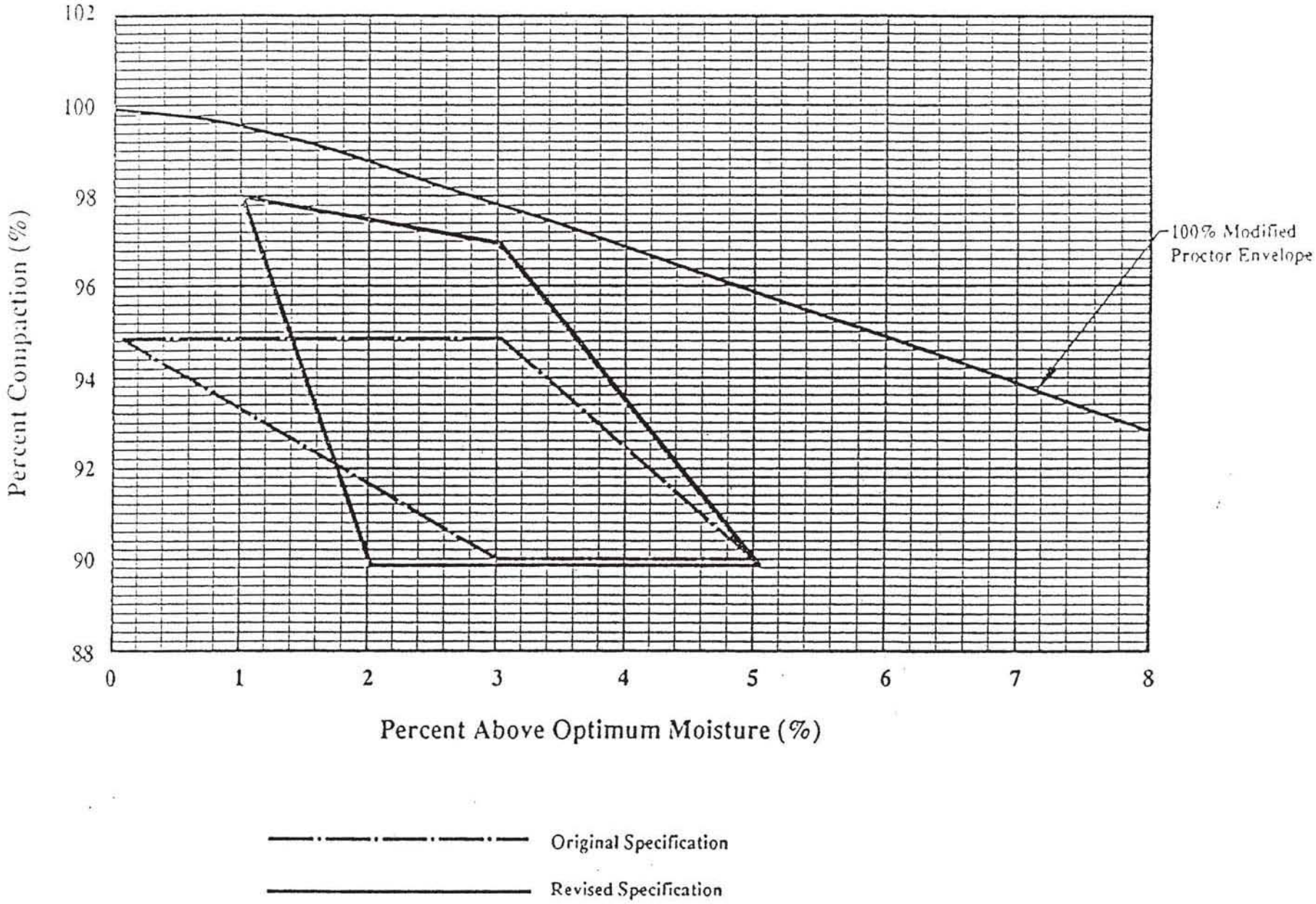
KKP:RDE:dk
Attachments

cc: Bob Henry
Richard Ellison
Miro Knezevic

FIGURE 1

LANDFILL UNIT B-18 PHASE I

WATER CONTENT - DENSITY RELATIONSHIPS



Design Change Form

KETTLEMAN HILLS FACILITY
LANDFILL B-18

Number: 3 Modified

Date: June 28, 1991 Originating Engineer: Kerry K. Parkinson

Location/Reference of Change: Construction Specifications and Quality Assurance Plan, Landfill Unit B-18, Phases I/II and Final Closure. Page 02924-6, Section B, Item d, which specifies the following:

d. Minimum Moisture Content: Within the range defined by the area formed by connecting the following points for the Modified Proctor Compaction curve.

- 3 to 5 percent above the optimum moisture content for a density equal to 90 percent of the maximum Modified Proctor density.
- 0 to 3 percent above the optimum moisture content for a density equal to 95 percent of the maximum Modified Proctor density.

Change: Change Section B, Item d, to the following:

d. Moisture Content: Within the range defined by the area formed by connecting the following points for the Modified Proctor Compaction curve.

- 2 percent above the optimum moisture content for a density equal to 90 percent of the maximum Modified Proctor density.
- 5 percent above the optimum moisture content for a density equal to 90 percent of the maximum Modified Proctor density.
- 3 percent above the optimum moisture content at 97 percent of the maximum Modified Proctor density.
- 1 percent above the optimum moisture content at 98 percent of the maximum Modified Proctor density.

The following tolerance criteria has been established for clay compaction at the B-18 Landfill:

- Twenty percent of the tests per equipment spread per day may be outside the specified moisture-density window by the following amount:
  - Moisture Content ±0.5%
  - Percent Compaction -0.5%
- So long as the average of all acceptable tests for that equipment spread per day falls within the moisture-density window.

APPROVAL FROM DESIGNER

Date: 6/28/91 Engineer: Kerry K Parkinson

Time: P.M.

Type of Correspondence:

ACKNOWLEDGEMENT FROM OWNER

Date: 7/7/91 Engineer: [illegible]

Environmental Construction Services

CC: CWM-KETTLEMAN

9037031\34387

ENVIRONMENTAL SOLUTIONS, INC.

June 28, 1991

Project No. 89-9771

Mr. Scott Brown
Engineering and Construction Manager
Chemical Waste Management, Inc.
35251 Old Skyline Road
Kettleman City, California 93239

Moisture-Density Tolerance Criteria
Clay Liner Material
Landfill Unit B-18
Kettleman Hills Facility

Dear Mr. Brown:

The purpose of this letter is to document the compaction test tolerance criteria established during our site visit on June 18, 1991. The tolerance criteria was developed based on our discussions with the CQA engineer and your staff, and review of the clay compaction results being realized. Those discussions and data indicated that a small percentage of tests were being considered as failures, even though they were just outside of the moisture-density window provided in our May 31, 1991, letter.

Your staff and the CQA Engineer requested that consideration be given to enlarging the window, if possible, without affecting necessary engineering properties of the material. We concluded that the window should not be changed without additional laboratory testing and analyses. However, it was also concluded that it would be acceptable for a small percentage of tests to lie just outside of the window, so long as average conditions were well within the basic criteria. This arrangement assures that the contractor continues to prepare and place the clay in a manner which provides the desired results, but also eliminates schedule delays and operational disruptions when the criteria is only occasionally missed by a small amount.

Accordingly, the following tolerance criteria, illustrated in the enclosed revision to Figure 1, has been established for clay compaction at the B-18 Landfill:

- Twenty percent of the tests per equipment spread per day may be outside the specified moisture-density window by the following amount:
  - Moisture Content ± 0.5%
  - Percent Compaction - 0.5%
- So long as the average of all acceptable tests for that equipment spread per day falls within the moisture-density window.

Please call us if you require additional information regarding this matter.

Very truly yours,

Kerry K. Parkinson

Kerry K. Parkinson, P.E.
Civil Engineer

KKP:hd
Enclosure

cc: Bob Henry
Richard Ellison
Miro Knezevic

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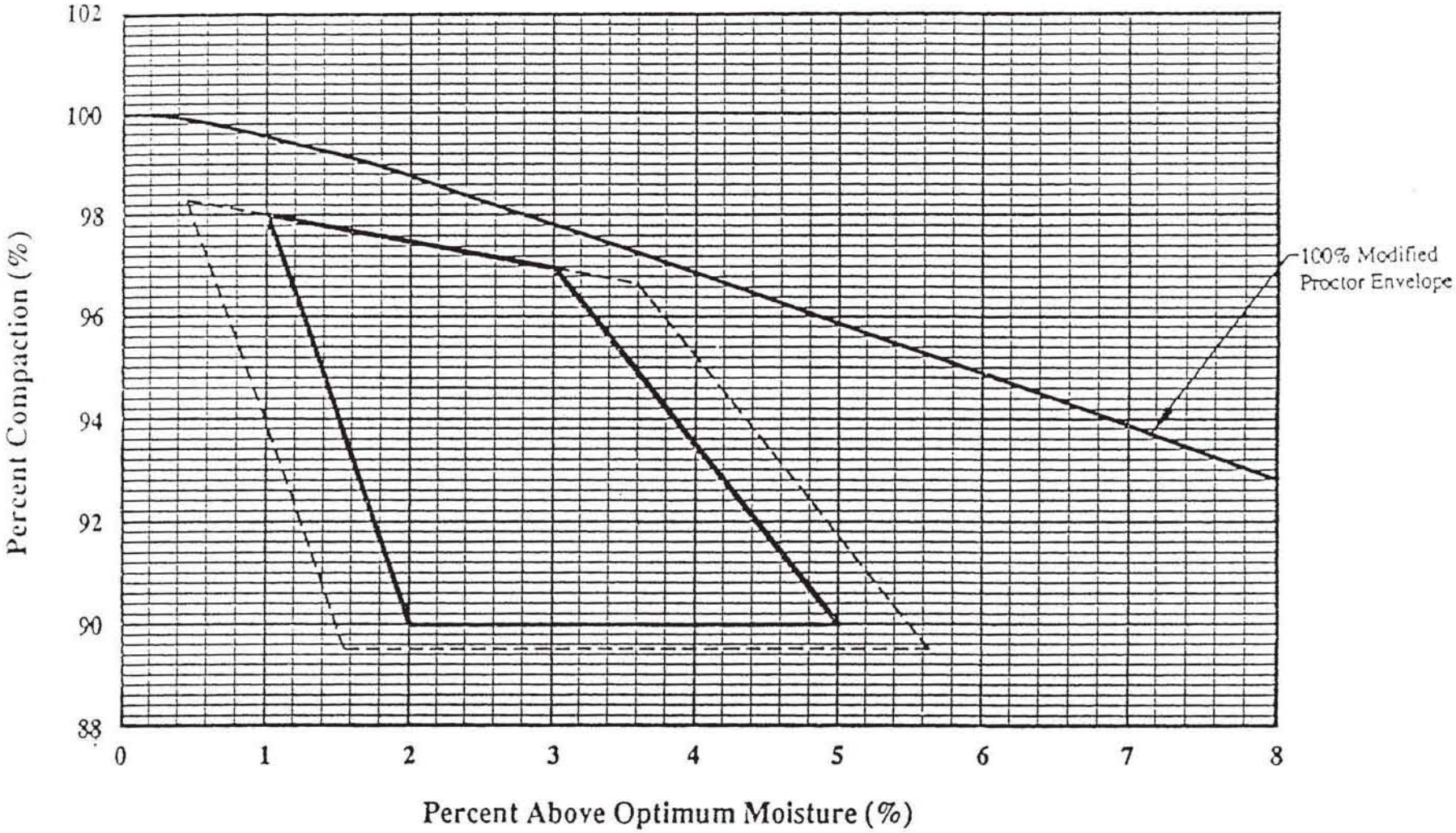
FIGURE 1

LANDFILL UNIT B-18 PHASE I

WATER CONTENT - DENSITY RELATIONSHIPS
(REVISED JUNE 28, 1991)



Specified Moisture-Density Window

Tolerance Limit (±0.5 percent above optimum moisture, -0.5 percent compaction)

ENVIRONMENTAL SOLUTIONS