2-409.7

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**Department of Energy**

**Ohio Field Office**
**Fernald Area Office**
P. O. Box 538705
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APR 14 1997

DOE-0735-97

Mr. James A. Saric, Remedial Project Director
U.S. Environmental Protection Agency
Region V-SRF-5J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Mr. Tom Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

**TRANSMITTAL OF RESPONSES TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND OHIO ENVIRONMENTAL PROTECTION AGENCY COMMENTS ON DRAFT TEST PAD PROGRAM FINAL REPORT FOR THE ON-SITE DISPOSAL FACILITY**

Enclosed are the responses to comments from the U.S. Environmental Protection Agency (U.S. EPA) and Ohio Environmental Protection Agency (OEPA) on the *Draft Test Pad Program Final Report* for the On-Site Disposal Facility (OSDF). The responses reflect discussions held between the OEPA, Department of Energy (DOE), and Fluor Daniel Fernald, Inc. (FDF) on March 19, 1997. The document will be issued as Revision 0 following the U.S. EPA and OEPA concurrence with the responses to the comments.

If there are any questions regarding this transmittal, please contact Rod Warner at (513) 648-3156.

Sincerely,

Johnny W. Reising
Fernald Remedial Action
Project Manager

FEMP:Warner

Enclosure: As Stated



1

cc w/enc:

N. Hallein, EM-42/CLOV
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R. Beaumier, TPSS/DERR, OEPA-Columbus
T. Schneider, OEPA-Dayton (3 copies total of enc.)
F. Bell, ATSDR
D. S. Ward, GeoTrans
R. Vandegrift, ODOH
R. Geiger, PRC
T. Hagen, FDF/65-2
J. Harmon, FDF/90
AR Coordinator/78

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U. Kumthekar, FDF/64
C. Little, FDF/2
T. Walsh, FDF/65-2
EDC, FDF/52-7

**U.S. EPA Comments on the**
**"Draft Test Pad Program Final Report, Revision B"**

1. Commenting Organization: U.S. EPA Commentor: Saric
Section #: Page #: Line #: Code:
Original Comment #:

Comment: During test pad construction, only heavy caterpillar equipment was used to compact soil. Generally a sheep's-foot roller is used to achieve more uniform compaction of the clay materials by breaking down clods into finer particles. U.S. DOE must explain why a sheep's-footed roller was not used.

Response: The equipment used for compaction was the Caterpillar 815 with two tamping foot rollers. This was briefly discussed in Section 5.1. However, for clarity, identification of the Caterpillar 815 will be added to Section 6.6, Placement and Compaction of Lifts.

Action: The fifth bullet from the beginning of Section 6.6 has been revised as follows:

- the lift was compacted using the specified number of passes of the Caterpillar 815 in each lane; the specified number of passes for a given lane was selected considering the target compaction conditions for that lane.

---

2. Commenting Organization: U.S. EPA Commentor: Saric
Section #: Page #: Line #: Code:
Original Comment #:

Comment: Data logs indicate that several rain events occurred during the sealed, double-ring infiltrometer tests. Data logs also indicate that water was occasionally pumped out of the outer ring. U.S. DOE must indicate any impacts such rain events may have had on the test results.

Response: There were two occasions when water was pumped out of the outer ring of the sealed double-ring infiltrometer. The first occasion was before the cover was fully installed and involved pumping approximately ½ inch of water from the outer ring. The second occasion was shortly after the cover was installed and involved pumping ¼-½ inch of water from the outer ring. In both cases, the water was pumped out in less than 24 hours from the time it entered the outer ring. No other pumping was needed throughout the rest of the testing. Due to the small amount of water that was pumped and the short length of time it was present, there was no impact on the test results from the sealed double-ring infiltrometer.

Action: No action.

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## Ohio EPA Comments on the "Draft Test Pad Program Final Report, Revision B"

1. Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Page #: Line #: Code: General
Original Comment #:

Comment: The performance of the test pad was consistent with the performance standards for recompacted clay liners as specified in the Ohio Administrative Code (OAC). However, the in situ materials in the borrow area fail to meet two different material specifications as listed in OAC 3745-27-08. These two specifications are:

- 3745-27-08 (C)(1)(c)(I) 100% of soil having a maximum dimension not greater than two inches
- 3745-27-08 (C)(1)(c)(iv) not less than 25% of the particles having a maximum dimension not greater than 0.002 mm.

In Section 9.2 of the TPPFR, an alternative performance standard of not less than 15% of the particles having a maximum dimension not greater than 0.002 mm is reiterated. This alternate specification was first suggested by DOE in a letter dated January 26, 1996, and Ohio EPA has concurred with this concept. However, one of the samples from the lower brown till horizon could not meet the revised criterion, either. See Table 9-1. What procedures will be followed by the Construction Subcontractor to avoid using clays that fail to meet the new specification?

In the case of the first bullet, the TPPFR suggests keeping the OAC specification unchanged and requiring the Construction Subcontractor to propose a method to remove outsized particles (Section 9.3). The Ohio EPA approves of this approach, but notes that visual inspection will not achieve satisfactory results.

Response: Soils with less than 15% clay particles (.002 mm) were not used for construction of the test pads and will not be used for construction of the clay liners. The soil in zones of sandy material was segregated from test pad soils during construction of the test pad. Clay soils in the lower brown till horizon were blended during excavation. This yielded a composite soil that had an acceptable clay content. Soils borrowed from the OSDF excavation will be stockpiled and tested prior to use in the liner. Unsuitable clay liner material will be segregated and not used in the clay liner. The soils from the clay liner excavation are primarily upper brown till horizon soil which has a higher clay content than lower brown till horizon soils.

The construction of the test pad was used to demonstrate the acceptability of in situ clays and the construction technique necessary to meet OAC requirements. The native material was excavated and placed on the test pad for processing prior to compaction. The technique used to process the soil was pulverizing the soil with a soil processor to insure full lift thickness moisture conditioning. During this process, all visible rocks were removed by hand picking. Once the proper soil moisture was achieved, a Caterpillar 815

compactor was used to compact the soil. The number of passes used varied in order to assess the compaction results. After the specified number of passes, all visible rocks were removed prior to placing another of clay.

DOE proposed using SDRIs to measure the permeability of the test pad. This test covered more area than the Boutwell Test. By using the SDRI, a larger representative area is evaluated. The test results indicated that the required permeability was achieved, using a performance-based construction method. As such, DOE believes it has met the requirements and proposes to use the methods outlined in the report.

Action: None.

---

2. Commenting Organization: Ohio EPA Commentor: DERR
Section #: 3 Page #: Figure 3.2 Line #: Code: c
Original Comment #:

Comment: Should the vertical axis legend be "Percent Smaller Than 0.002 mm"?

Response: The vertical axis of Figure 3-2 is correct as "Percent Smaller Than 0.005 mm." The data reported in Section 3.0 is from previous geotechnical studies which used 0.005 mm as the definition of clay, instead of 0.002 mm as specified in the ARARs. All data collected during the test pad program used 0.002 as the definition of clay. In reviewing Section 3.0, discrepancies between the text, tables, and figures were found with regards to this issue. These discrepancies will be corrected.

Action: The first bullet on page 3-6 has been revised to read, "percent of particles smaller than 0.005 mm (percent clay)."

The sentence at the bottom of page 3-6 has been revised to read, "The analysis of the data in Table 3-2 reveals that the percentage of particles smaller than 0.005 mm, the percentage of particles passing the No. 200 sieve...."

The Particle Size header on Table 3-2 has been revised to read, "Percentage Smaller than 0.005 mm."

The third bullet on page 3-11 has been revised to read, "Figure 3-2 shows the percentage of particles smaller than 0.005 mm as a function of northing coordinate."

The first line of data on Table 3-3 has been revised to read, "Percentage Smaller Than 0.005 mm."

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3. Commenting Organization: Ohio EPA Commentor: DERR
Section #: 3.5 Page #: 3-12 Line #: Code: c
Original Comment #:

Comment: This paragraph should be modified to state that soil samples from a few of the borings had less than a 50 percent fraction passing the 200 mesh sieve (see Table 3-2 and Figure 3-3). While this apparently did not affect the final performance of the test pads, the specification should clearly state whether soils not meeting the 200 mesh sieve requirement are acceptable. The same issue needs to be addressed in the summary of Conformance Test Requirements of Section 9.6. The 200 mesh sieve requirement is an ARAR of OAC 3745-27-08 (C)(1)(c).

Response: Soils not meeting the requirement for greater than 50% passing the 200 sieve will not be used for construction of clay liners. Some small amounts of these soils not meeting the requirement may be blended with the soils with a high percentage of fines during the excavation, stockpiling, and construction process. Clay stockpiles will be sampled according to the Construction Quality Assurance Plan requirements. Only soils having greater than 50% fines will be used as liner material. This issue will be addressed in Section 3.5 and clarified in Section 9.6.

Action: The following bullet has been added to Section 3.5:

- soil samples from a few of the borings had less than a 50 percent fraction passing the 200 mesh sieve; soils not meeting this requirement will not be used for construction of clay liners.

The first bullet on page 3-12 has been revised as follows:

- with the exception of percentage of clay-size particles (i.e., particles with a maximum dimension not greater than 0.002 mm), both horizons of the brown till meet the remaining material property criteria of the OU2 ARARs.

The following bullet has been added to Section 9.6:

- Although soil samples from a few borings did not meet the requirement for greater than 50 percent passing the 200 sieve, all soils will meet this requirement during construction of the liner.

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4. Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 9 Page #: Figure 9-1 Line #: Code: c
Original Comment #:

Comment: Figure 9-1 appears to be mislabeled. It should say "Upper Horizon Brown Till Acceptable Permeability Zone (APZ)".

Response: Agreed. The text will be revised.

Action: The caption on Figure 9-1 now reads, "Upper Horizon Brown Till APZ."

5. Commenting Organization: Ohio EPA Commentor: DERR
Section #: Page #: Line #: Code:
Original Comment #:

Comment: Volume II, Appendix A is missing from my copy.

Response: This Appendix was inadvertently omitted from some of the copies.

Action: Appendix A is attached to this response package and will be included in the final report.

---

6. Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 9.5 Page #: Line #: last sentence Code:
Original Comment #:

Comment: The last sentence on this page which continues to the next page is incomplete.

Response: The text in section 9.5 will be modified.

Action: The sentence now reads, "Because of the deep indentations left by the compactor pad-foot at moisture contents at or above 3 percentage points wet of the standard Proctor optimum moisture content, the maximum allowable moisture content is 3 percentage points wet of optimum."

---

# APPENDIX A

# PRE-CONSTRUCTION LABORATORY TEST RESULTS

GEOSYNTEC CONSULTANTS

Geomechanics & Environmental Laboratory
2658 Holcomb Bridge Road • Suite 110
Alpharetta, Georgia 30201 • USA
Tel. (770) 645-6575 • Fax (770) 645-6570

13 November 1996

Mr. Kenneth W. Cargill, P.E.
GeoSyntec Consultants
1100 Lake Hearn Drive, Suite 200
Atlanta, Georgia 30342

Subject: Final Report - Laboratory Test Results
Test Pad Pre-construction Testing
FERMCO-OSDF

Dear Mr. Cargill:

GeoSyntec Consultants (GeoSyntec) Geomechanics and Environmental Laboratory in Alpharetta, Georgia is pleased to present the attached final test results (Tables 1 and 2, and Figures 1 through 12) for the above referenced project. A blank shown on any of the tables or the figures indicates that the test was not performed, the parameter is not applicable, or that the test resulted in insufficient data to report the designated parameter. Attachment A presents the general information pertinent to the testing program and the policy of GeoSyntec regarding the limitations of and the use of the test results.

The Geomechanics and Environmental Laboratory appreciates the opportunity to provide testing services for this project. Should you have any questions regarding the attached test results or if you require additional information, please do not hesitate to contact either of the undersigned.

Sincerely,

Barry E. Sigmon, P.G.
Assistant Program Manager
Geotechnical Testing

Nader S. Rad, Ph.D., P.E.
Laboratory Director

Attachment
Copy To: David Phillips

GE3900-5.2/F964G024.CDB

# TABLE 1

## SUMMARY OF INDEX PROPERTIES TEST RESULTS
## TEST PAD PRE-CONSTRUCTION TESTING

## FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT COMPANY
## FERMCO - OSDF

| Site Sample ID | Lab Sample No. | As-Received Moisture Content ASTM D 1140 (%) | Grain Size | | | Atterberg Limits ASTM D 4318 | | | Soil Classification ASTM D 2487 | Compaction ASTM D 698 | | | Compaction ASTM D 1557 | | | Specific Gravity ASTM D 854 (-) | Hydraulic Conductivity ASTM D 5084 Table No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Percent Passing #200 Sieve ASTM D 1140 (%) | ASTM D 422 | | | | | | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | | |
| | | | | Sieve Figure No. | Hydrom. Figure No. | LL (%) | PL (%) | PI (-) | | | | | | | | | |
| 411980 | 96B71 | 25.5 | | | | | | | | | | | | | | | |
| 411981 | 96B72 | 26.8 | | | | | | | | | | | | | | | |
| 411982 | 96B73 | 22.1 | | | | | | | | | | | | | | | |
| 411983 | 96B74 | 19.2 | 73.5 | 1 | 1 | 43 | 19 | 24 | CL - Lean Clay with Sand | 111.6 | 17.2 | 2 | | | | | |
| 411984 | 96B75 | 18.8 | 74.8 | 3 | 3 | 43 | 20 | 23 | CL - Lean Clay with Sand | 111.8 | 16.7 | 4 | | | | | |
| 411985 | 96B76 | 14.5 | | | | | | | | | | | | | | | |
| 411986 | 96B77 | 15.9 | | | | | | | | | | | | | | | |
| 411987 | 96B78 | 15.8 | | | | | | | | | | | | | | | |

# TABLE 1 (Continued)

## SUMMARY OF INDEX PROPERTIES TEST RESULTS
## TEST PAD PRE-CONSTRUCTION TESTING

## FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT COMPANY
## FERMCO - OSDF

| Site Sample ID | Lab Sample No. | As-Received Moisture Content ASTM D 2216 (%) | Grain Size | | | Atterberg Limits ASTM D 4318 | | | Soil Classification ASTM D 2487 | Compaction ASTM D 698 | | | Compaction ASTM D 1557 | | | Specific Gravity ASTM D 854 (-) | Hydraulic Conductivity ASTM D 5084 Table No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Percent Passing #200 Sieve ASTM D 1140 (%) | ASTM D 422 Sieve Figure No. | ASTM D 422 Hydrom. Figure No. | LL (%) | PL (%) | PI (-) | | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | | |
| 411988 | 96B79 | 14.1 | | | | | | | | | | | | | | | |
| 411989 | 96B80 | 13.9 | 67.1 | 5 | 5 | 25 | 16 | 9 | CL - Sandy Lean Clay | 124.3 | 12.3 | 6 | | | | | |
| 411990 | 96B81 | 13.2 | 55.2 | 7 | 7 | 24 | 15 | 9 | CL - Sandy Lean Clay with Gravel | 124.8 | 11.8 | 8 | | | | | |
| 411991 | 96B82 | 13.3 | | | | | | | | | | | | | | | |
| 411992 | 96B83 | 10.6 | | | | | | | | | | | | | | | |
| 411993 | 96B84 | 12.4 | | | | | | | | | | | | | | | |
| 411983 & 411984 | 96B100[1] | | | | | | | | | 113.0 | 16.3 | 9 | 124.9 | 11.9 | 10 | 2.72 | 2 |
| 411989 & 411990 | 96B101[2] | | | | | | | | | 126.0 | 11.7 | 11 | 135.0 | 8.3 | 12 | 2.71 | 2 |

Notes:

1. Laboratory samples 96B74 and 96B75 were combined.
2. Laboratory samples 96B80 and 96B81 were combined.

# TABLE 2

## SUMMARY OF PERMEABILITY TEST RESULTS
## TEST PAD PRE-CONSTRUCTION TESTING

## FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT COMPANY
## FERMCO - OSDF

| Site Sample ID | Lab Sample No.[1] | Grain Size | | | Atterberg Limits ASTM D 4318 | | | Soil Classification ASTM D 2487 | Compaction ASTM D 698 | | | Compaction ASTM D 1557 | | | Hydraulic Conductivity ASTM D 5084 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent Passing #200 Sieve ASTM D 1140 (%) | ASTM D 422 | | | | | | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Test Specimen Initial Conditions | | Consolidation Pressure (psi) | Hydraulic Conductivity (cm/s) |
| | | | Sieve Figure No. | Hydrom. Figure No. | LL (%) | PL (%) | PI (-) | | | | | | | | Dry Unit Weight (pcf) | Moisture Content (%) | | |
| 411983 & 411984 Combined | 96B100.01 | | | | | | | | | | | | | | 106.3 | 16.7 | 2 | 5.2E-5 |
| | | | | | | | | | | | | | | | | | 5 | 2.8E-5 |
| | | | | | | | | | | | | | | | | | 10 | 2.0E-6 |
| | 96B100.02 | | | | | | | | | | | | | | 110.9 | 17.0 | 2 | 6.4E-7 |
| | | | | | | | | | | | | | | | | | 5 | 1.8E-7 |
| | | | | | | | | | | | | | | | | | 10 | 2.5E-8 |
| | 96B100.03 | | | | | | | | | | | | | | 108.3 | 18.4 | 2 | 8.4E-8 |
| | | | | | | | | | | | | | | | | | 5 | 2.7E-8 |
| | | | | | | | | | | | | | | | | | 10 | 2.3E-8 |
| | 96B100.04 | | | | | | | | | | | | | | 110.2 | 18.6 | 2 | 4.8E-8 |
| | | | | | | | | | | | | | | | | | 5 | 1.1E-8 |
| | | | | | | | | | | | | | | | | | 10 | 6.7E-9 |

Note:

1. Laboratory samples 96B74 and 96B75 were combined.

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## TABLE 2 (Continued)

## SUMMARY OF PERMEABILITY TEST RESULTS
## TEST PAD PRE-CONSTRUCTION TESTING

## FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT COMPANY
## FERMCO - OSDF

| Site Sample ID | Lab Sample No.[1] | Grain Size | | | Atterberg Limits ASTM D 4318 | | | Soil Classification ASTM D 2487 | Compaction ASTM D 698 | | | Compaction ASTM D 1557 | | | Hydraulic Conductivity ASTM D 5084 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent Passing #200 Sieve ASTM D 1140 (%) | ASTM D 422 | | | | | | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Test Specimen Initial Conditions | | Consolidation Pressure (psi) | Hydraulic Conductivity (cm/s) |
| | | | Sieve Figure No. | Hydrom. Figure No. | LL (%) | PL (%) | PI (-) | | | | | | | | Dry Unit Weight (pcf) | Moisture Content (%) | | |
| 411983 & 411984 Combined | 96B100.05 | | | | | | | | | | | | | | 106.3 | 20.7 | 2 | 1.1E-8 |
| | | | | | | | | | | | | | | | | | 5 | 6.8E-9 |
| | | | | | | | | | | | | | | | | | 10 | 5.2E-9 |
| | 96B100.06 | | | | | | | | | | | | | | 107.1 | 18.5 | 2 | 1.2E-6 |
| | | | | | | | | | | | | | | | | | 5 | 6.5E-7 |
| | | | | | | | | | | | | | | | | | 10 | 1.0E-7 |
| | 96B100.07 | | | | | | | | | | | | | | 108.3 | 17.3 | 2 | 6.7E-6 |
| | | | | | | | | | | | | | | | | | 5 | 2.4E-6 |
| | | | | | | | | | | | | | | | | | 10 | 9.0E-7 |

Note:

1. Laboratory samples 96B74 and 96B75 were combined.

## TABLE 2 (Continued)

## SUMMARY OF PERMEABILITY TEST RESULTS
## TEST PAD PRE-CONSTRUCTION TESTING

## FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT COMPANY
## FERMCO - OSDF

| Site Sample ID | Lab Sample No.[1] | Grain Size | | | Atterberg Limits ASTM D 4318 | | | Soil Classification ASTM D 2487 | Compaction ASTM D 698 | | | Compaction ASTM D 1557 | | | Hydraulic Conductivity ASTM D 5084 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent Passing #200 Sieve ASTM D 1140 (%) | ASTM D 422 | | | | | | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Test Specimen Initial Conditions | | Consolidation Pressure (psi) | Hydraulic Conductivity (cm/s) |
| | | | Sieve Figure No. | Hydrom. Figure No. | LL (%) | PL (%) | PI (-) | | | | | | | | Dry Unit Weight (pcf) | Moisture Content (%) | | |
| 411983 & 411984 Combined | 96B100.08 | | | | | | | | | | | | | | 119.3 | 12.4 | 2 | 1.4E-7 |
| | | | | | | | | | | | | | | | | | 5 | 1.2E-7 |
| | | | | | | | | | | | | | | | | | 10 | 4.8E-8 |
| | 96B100.09 | | | | | | | | | | | | | | 112.8 | 17.2 | 2 | 2.1E-8 |
| | | | | | | | | | | | | | | | | | 5 | 1.3E-8 |
| | | | | | | | | | | | | | | | | | 10 | 9.2E-9 |
| | 96B100.10 | | | | | | | | | | | | | | 106.4 | 19.2 | 2 | 5.5E-8 |
| | | | | | | | | | | | | | | | | | 5 | 2.8E-8 |
| | | | | | | | | | | | | | | | | | 10 | 2.1E-8 |

Note:

1. Laboratory samples 96B74 and 96B75 were combined.

## TABLE 2 (Continued)

## SUMMARY OF PERMEABILITY TEST RESULTS
## TEST PAD PRE-CONSTRUCTION TESTING

## FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT COMPANY
## FERMCO - OSDF

| Site Sample ID | Lab Sample No.[1] | Grain Size | | | Atterberg Limits ASTM D 4318 | | | Soil Classification ASTM D 2487 | Compaction ASTM D 698 | | | Compaction ASTM D 1557 | | | Hydraulic Conductivity ASTM D 5084 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent Passing #200 Sieve ASTM D 1140 (%) | ASTM D 422 | | | | | | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Test Specimen Initial Conditions | | Consolidation Pressure (psi) | Hydraulic Conductivity (cm/s) |
| | | | Sieve Figure No. | Hydrom. Figure No. | LL (%) | PL (%) | PI (-) | | | | | | | | Dry Unit Weight (pcf) | Moisture Content (%) | | |
| 411989 & 411990 Combined | 96B101.01 | | | | | | | | | | | | | | 118.7 | 11.9 | 2 | 1.5E-5 |
| | | | | | | | | | | | | | | | | | 5 | 1.3E-5 |
| | | | | | | | | | | | | | | | | | 10 | 8.9E-6 |
| | 96B101.02 | | | | | | | | | | | | | | 124.7 | 11.7 | 2 | 5.3E-6 |
| | | | | | | | | | | | | | | | | | 5 | 5.4E-6 |
| | | | | | | | | | | | | | | | | | 10 | 1.7E-6 |
| | 96B101.03 | | | | | | | | | | | | | | 121.5 | 13.6 | 2 | 3.0E-8 |
| | | | | | | | | | | | | | | | | | 5 | 2.3E-8 |
| | | | | | | | | | | | | | | | | | 10 | 1.7E-8 |
| | 96B101.04 | | | | | | | | | | | | | | 123.4 | 14.0 | 2 | 2.8E-8 |
| | | | | | | | | | | | | | | | | | 5 | 1.6E-8 |
| | | | | | | | | | | | | | | | | | 10 | 1.1E-8 |

Note:

1. Laboratory samples 96B80 and 96B81 were combined.

# TABLE 2 (Continued)

## SUMMARY OF PERMEABILITY TEST RESULTS
## TEST PAD PRE-CONSTRUCTION TESTING

## FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT COMPANY
## FERMCO - OSDF

| Site Sample ID | Lab Sample No.[1] | Grain Size | | | Atterberg Limits ASTM D 4318 | | | Soil Classification ASTM D 2487 | Compaction ASTM D 698 | | | Compaction ASTM D 1557 | | | Hydraulic Conductivity ASTM D 5084 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent Passing #200 Sieve ASTM D 1140 (%) | ASTM D 422 | | | | | | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Test Specimen Initial Conditions | | Consolidation Pressure (psi) | Hydraulic Conductivity (cm/s) |
| | | | Sieve Figure No. | Hydrom. Figure No. | LL (%) | PL (%) | PI (-) | | | | | | | | Dry Unit Weight (pcf) | Moisture Content (%) | | |
| 411989 & 411990 Combined | 96B101.05 | | | | | | | | | | | | | | 118.4 | 15.7 | 2 | 2.8E-8 |
| | | | | | | | | | | | | | | | | | 5 | 2.3E-8 |
| | | | | | | | | | | | | | | | | | 10 | 2.0E-8 |
| | 96B101.06 | | | | | | | | | | | | | | 118.3 | 13.7 | 2 | 5.6E-8 |
| | | | | | | | | | | | | | | | | | 5 | 3.8E-8 |
| | | | | | | | | | | | | | | | | | 10 | 2.3E-8 |
| | 96B101.07 | | | | | | | | | | | | | | 128.3 | 9.8 | 2 | 6.8E-7 |
| | | | | | | | | | | | | | | | | | 5 | 3.1E-7 |
| | | | | | | | | | | | | | | | | | 10 | 1.5E-7 |

Note:

1. Laboratory samples 96B80 and 96B81 were combined.

## TABLE 2 (Continued)

## SUMMARY OF PERMEABILITY TEST RESULTS
## TEST PAD PRE-CONSTRUCTION TESTING

## FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT COMPANY
## FERMCO - OSDF

| Site Sample ID | Lab Sample No.[1] | Grain Size | | | Atterberg Limits ASTM D 4318 | | | Soil Classification ASTM D 2487 | Compaction ASTM D 698 | | | Compaction ASTM D 1557 | | | Hydraulic Conductivity ASTM D 5084 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent Passing #200 Sieve ASTM D 1140 (%) | ASTM D 422 | | | | | | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Max. Dry Unit Weight (pcf) | Optimum Moisture Content (%) | Fig. No. | Test Specimen Initial Conditions | | Consolidation Pressure (psi) | Hydraulic Conductivity (cm/s) |
| | | | Sieve Figure No. | Hydrom. Figure No. | LL (%) | PL (%) | PI (-) | | | | | | | | Dry Unit Weight (pcf) | Moisture Content (%) | | |
| 411989 & 411990 Combined | 96B101.08 | | | | | | | | | | | | | | 125.1 | 11.9 | 2 | 1.2E-7 |
| | | | | | | | | | | | | | | | | | 5 | 3.6E-8 |
| | | | | | | | | | | | | | | | | | 10 | 2.3E-8 |
| | 96B101.09 | | | | | | | | | | | | | | 126.8 | 12.3 | 2 | 9.1E-8 |
| | | | | | | | | | | | | | | | | | 5 | 2.8E-8 |
| | | | | | | | | | | | | | | | | | 10 | 1.9E-8 |
| | 96B101.10 | | | | | | | | | | | | | | 120.1 | 13.1 | 2 | 9.0E-8 |
| | | | | | | | | | | | | | | | | | 5 | 3.6E-8 |
| | | | | | | | | | | | | | | | | | 10 | 2.4E-8 |

Note:

1. Laboratory samples 96B80 and 96B81 were combined.

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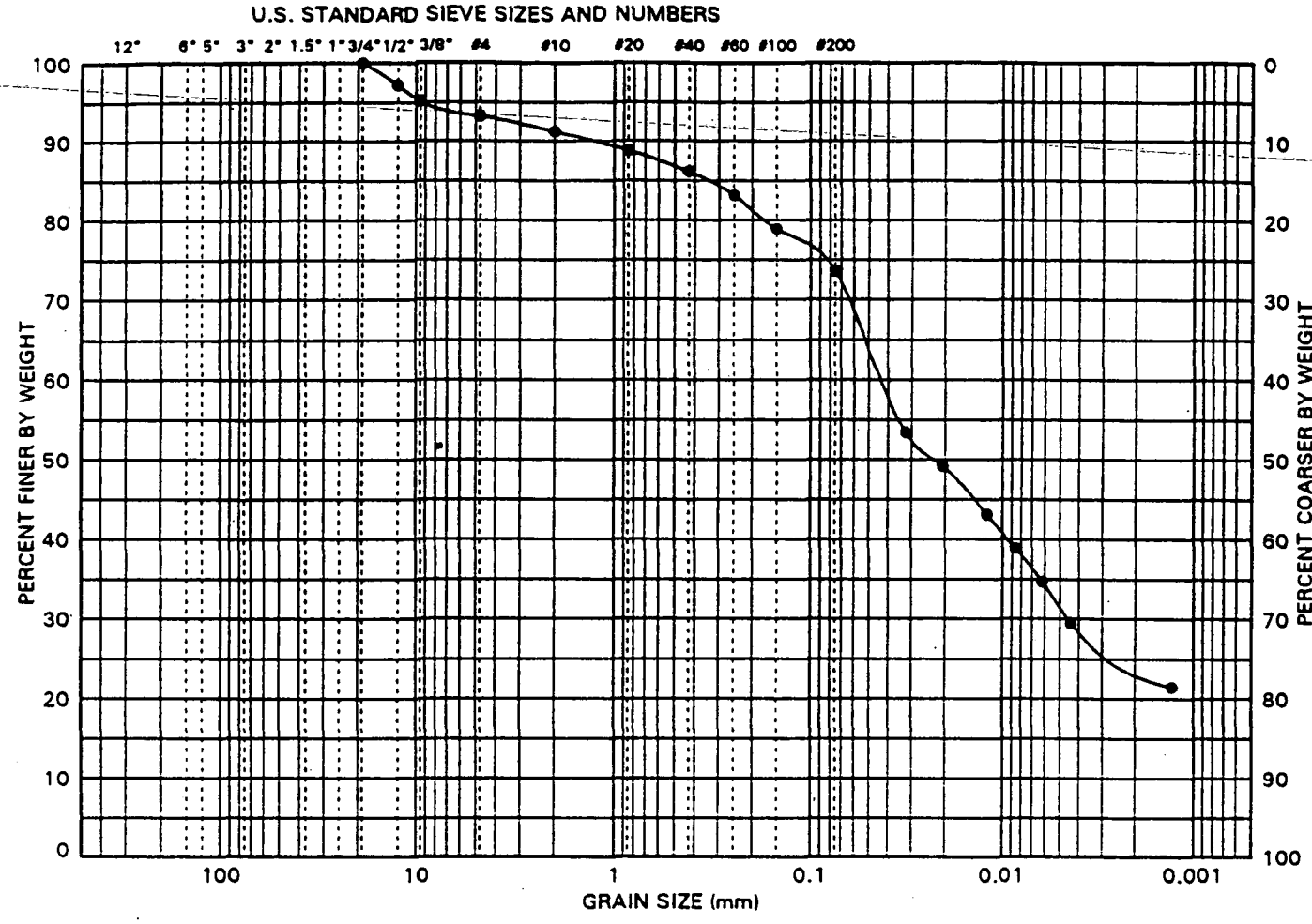
Atlanta, Georgia

FIGURE 1
PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4PS2 11/13/96

## PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318




| BOULDERS | COBBLES | GRAVEL | | SAND | | | FINES | |
|---|---|---|---|---|---|---|---|---|
| | | COARSE | FINE | COARSE | MEDIUM | FINE | SILT | CLAY |

| | | | | | |
|---|---|---|---|---|---|
| SITE SAMPLE ID | 411983 | LIQUID LIMIT (%) | 43 | SOIL FRACTIONS: GRAVEL (%) | 6.8 |
| LAB. SAMPLE NO. | 96B74 | PLASTIC LIMIT (%) | 19 | SAND (%) | 19.7 |
| SAMPLE DEPTH (ft) | | PLASTICITY INDEX | 24 | FINES (%) | 73.5 |
| SOIL CLASSIFICATION: CL - Lean Clay with Sand | | | | SILT (%) | 49.2 |
| | | | | CLAY(%) | 24.3 |
| | | | | COEFF. UNIFORMITY (Cu) | |
| | | | | COEFF. CURVATURE (Cc) | |

| PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS | | | | | | | | | | | | | | PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3" | 2" | 1.5" | 1" | 3/4" | 1/2" | 3/8" | #4 | #10 | #20 | #40 | #60 | #100 | #200 | | | | | |
| PERCENT PASSING SIEVE SIZES (mm) | | | | | | | | | | | | | | | | | | |
| 75 | 50 | 37.5 | 25 | 19 | 12.5 | 9.5 | 4.75 | 2.00 | 0.850 | 0.425 | 0.250 | 0.150 | 0.075 | 0.050 | 0.020 | 0.005 | 0.002 | 0.001 |
| 100 | 100 | 100 | 100 | 100 | 97 | 95 | 93 | 91 | 89 | 86 | 83 | 79 | 74 | 64 | 49 | 31 | 24 | |

NOTES:

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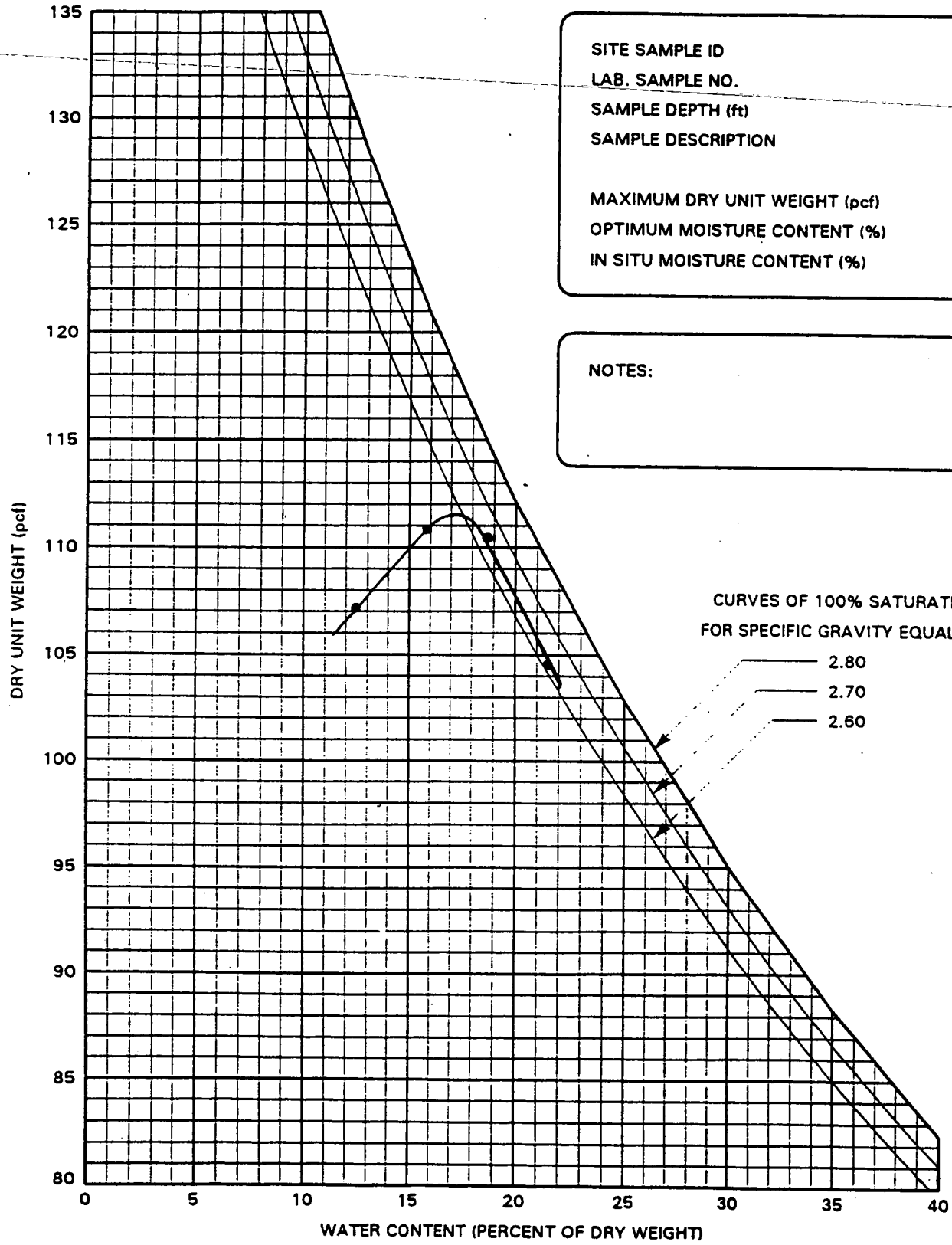
FIGURE 2
PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4MD1 11/13/96

## MOISTURE-DENSITY RELATIONSHIP, COMPACTION TESTING

ASTM D-698-B




| | |
|---|---|
| SITE SAMPLE ID | 411983 |
| LAB. SAMPLE NO. | 96874 |
| SAMPLE DEPTH (ft) | |
| SAMPLE DESCRIPTION | |
| MAXIMUM DRY UNIT WEIGHT (pcf) | 111.6 |
| OPTIMUM MOISTURE CONTENT (%) | 17.2 |
| IN SITU MOISTURE CONTENT (%) | |

NOTES:

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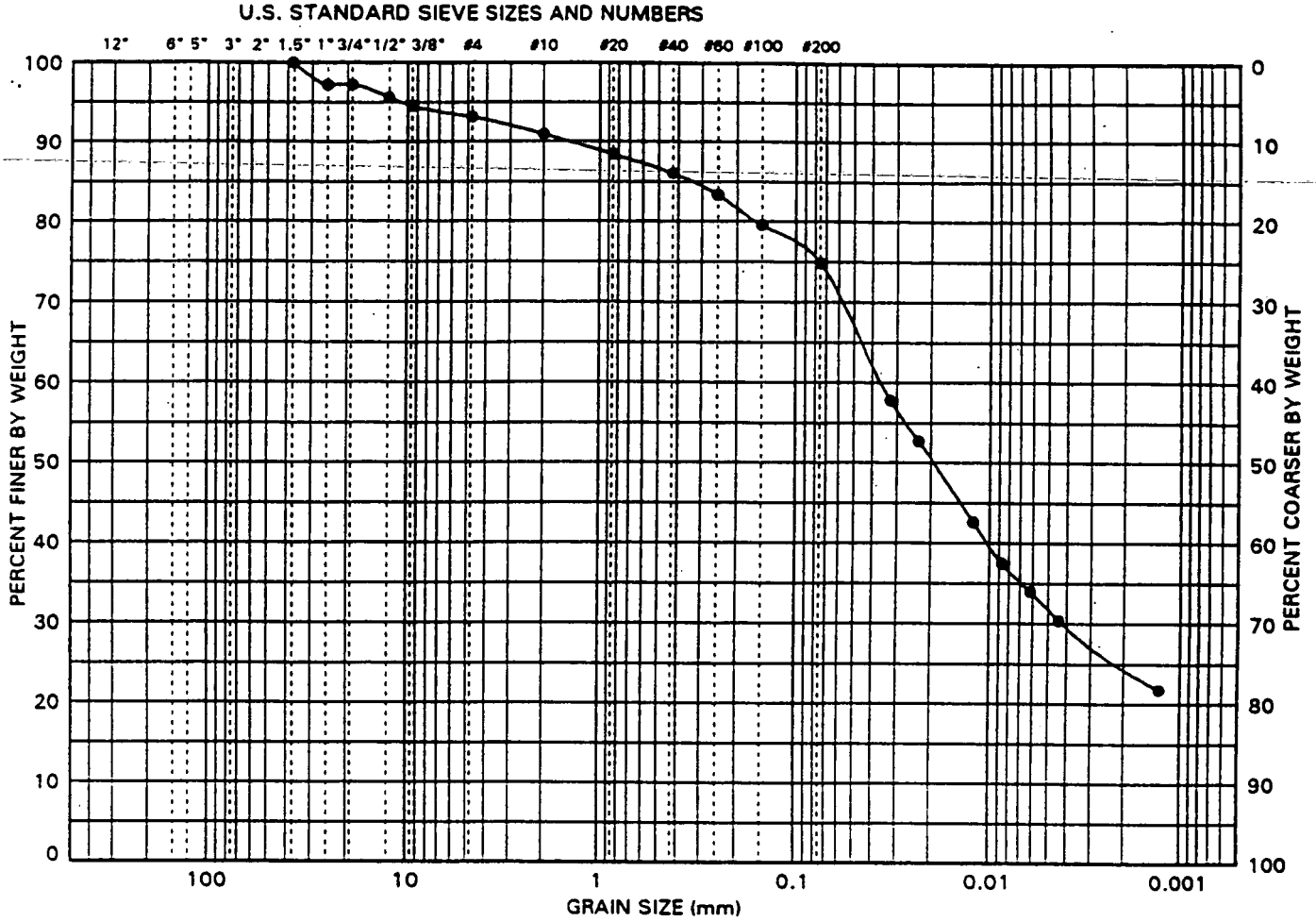
Atlanta, Georgia

FIGURE 3
PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4PS2 11/13/96

## PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318




| | | | |
|---|---|---|---|
| SITE SAMPLE ID | 411984 | LIQUID LIMIT (%) | 43 |
| LAB. SAMPLE NO. | 96B75 | PLASTIC LIMIT (%) | 20 |
| SAMPLE DEPTH (ft) | | PLASTICITY INDEX | 23 |

SOIL CLASSIFICATION:
CL - Lean Clay with Sand

| SOIL FRACTIONS | |
|---|---|
| GRAVEL (%) | 6.9 |
| SAND (%) | 18.3 |
| FINES (%) | 74.8 |
| SILT (%) | 50.0 |
| CLAY(%) | 24.8 |
| COEFF. UNIFORMITY (Cu) | |
| COEFF. CURVATURE (Cc) | |

PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS

| 3" | 2" | 1.5" | 1" | 3/4" | 1/2" | 3/8" | #4 | #10 | #20 | #40 | #60 | #100 | #200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PERCENT PASSING SIEVE SIZES (mm) | | | | | | | | | | | | | |
| 75 | 50 | 37.5 | 25 | 19 | 12.5 | 9.5 | 4.75 | 2.00 | 0.850 | 0.425 | 0.250 | 0.150 | 0.075 |
| 100 | 100 | 100 | 97 | 97 | 96 | 95 | 93 | 91 | 88 | 86 | 83 | 80 | 75 |

PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm)

| 0.050 | 0.020 | 0.005 | 0.002 | 0.001 |
|---|---|---|---|---|
| 67 | 50 | 32 | 25 | |

NOTES:

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Atlanta, Georgia

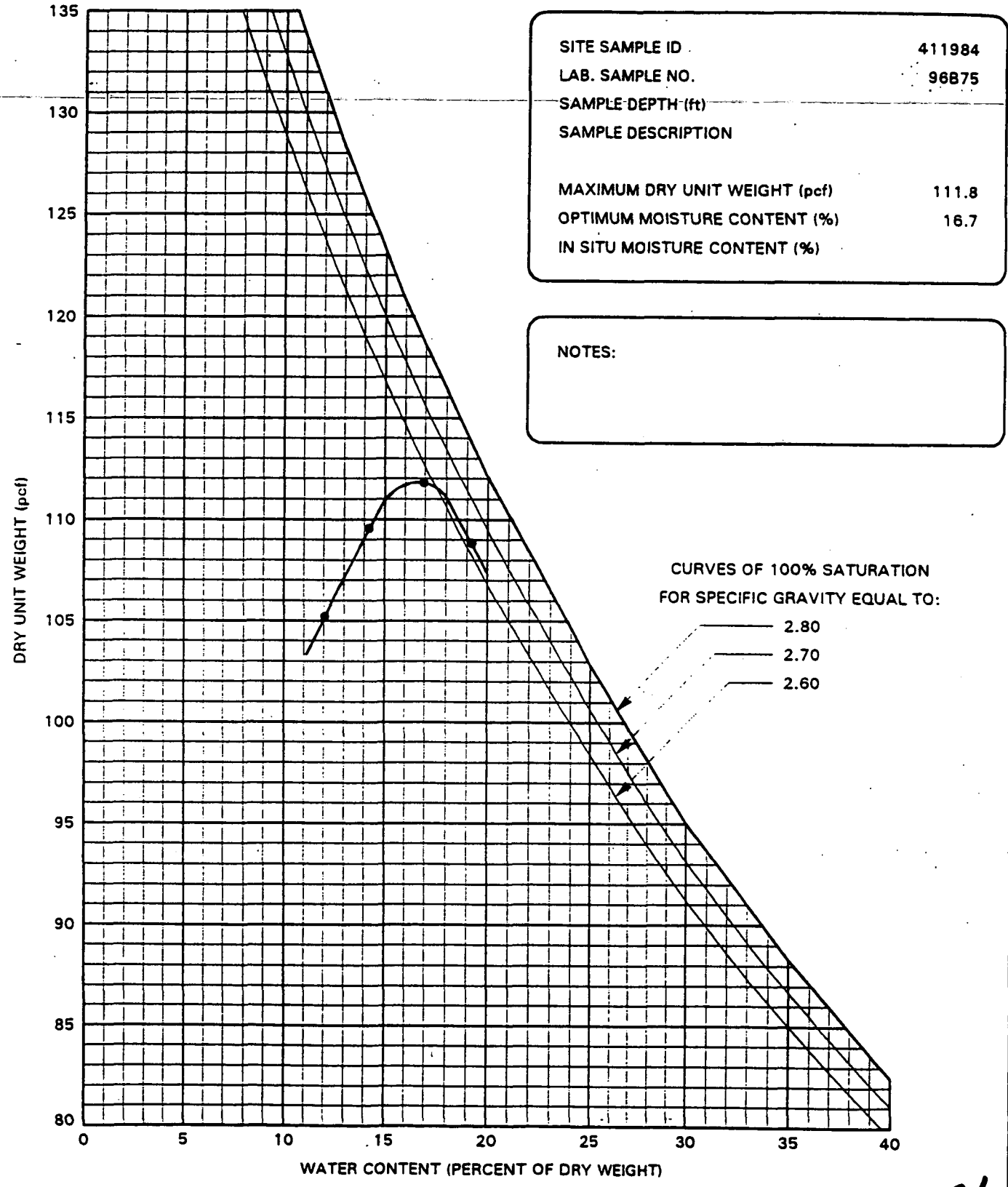
FIGURE 4

PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4MD1 11/13/96

## MOISTURE-DENSITY RELATIONSHIP, COMPACTION TESTING

ASTM D-698-B




| | |
|---|---|
| SITE SAMPLE ID | 411984 |
| LAB. SAMPLE NO. | 96875 |
| SAMPLE DEPTH (ft) | |
| SAMPLE DESCRIPTION | |
| MAXIMUM DRY UNIT WEIGHT (pcf) | 111.8 |
| OPTIMUM MOISTURE CONTENT (%) | 16.7 |
| IN SITU MOISTURE CONTENT (%) | |

NOTES:

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Atlanta, Georgia

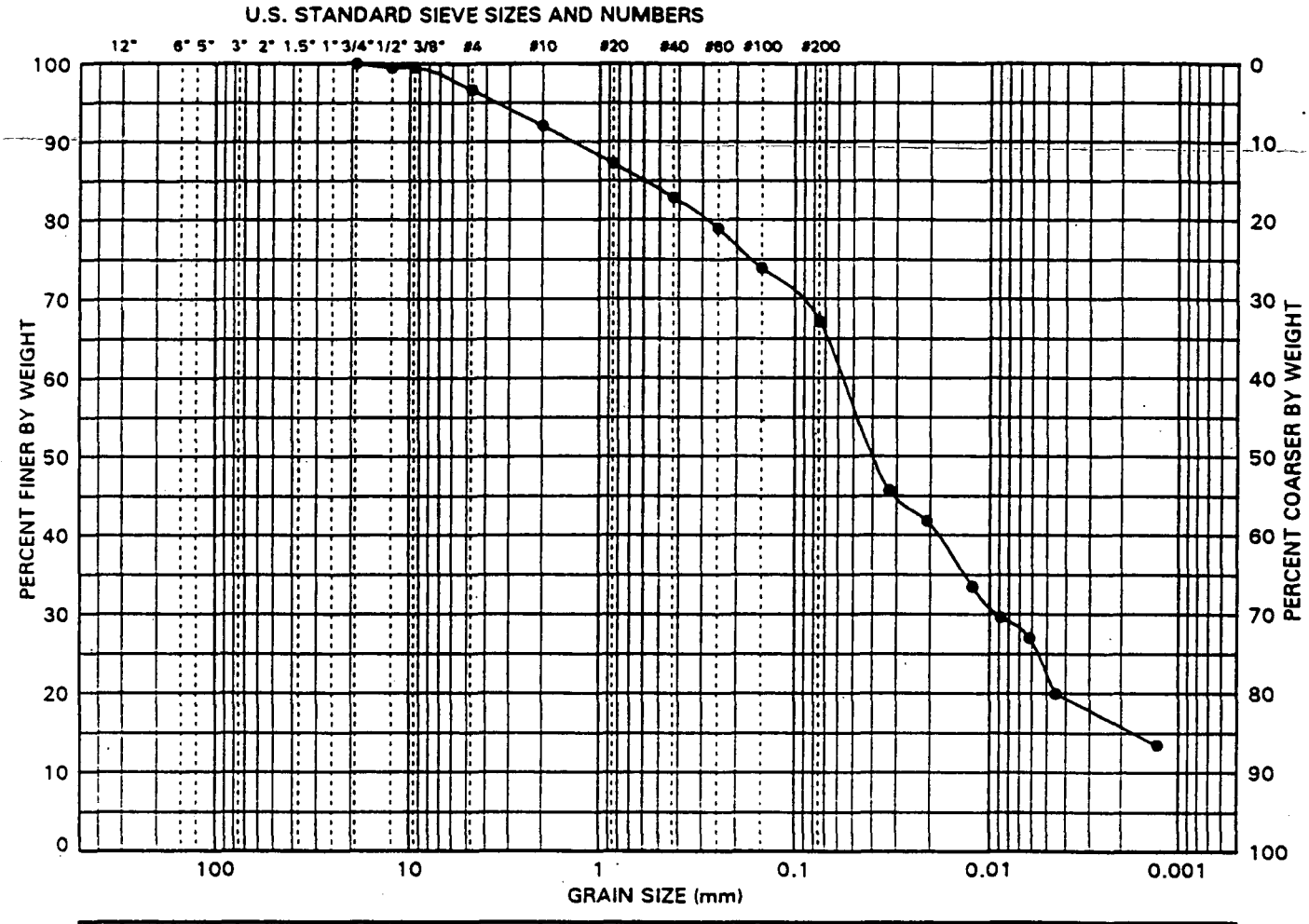
**FIGURE 5**

PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4PS2 11/13/96

## PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318




| | | | |
|---|---|---|---|
| SITE SAMPLE ID | 411989 | LIQUID LIMIT (%) | 25 |
| LAB. SAMPLE NO. | 96B80 | PLASTIC LIMIT (%) | 16 |
| SAMPLE DEPTH (ft) | | PLASTICITY INDEX | 9 |

SOIL CLASSIFICATION:
CL - Sandy Lean Clay

| SOIL FRACTIONS | |
|---|---|
| GRAVEL (%) | 3.4 |
| SAND (%) | 29.5 |
| FINES (%) | 67.1 |
| SILT (%) | 51.3 |
| CLAY(%) | 15.8 |
| COEFF. UNIFORMITY (Cu) | |
| COEFF. CURVATURE (Cc) | |

PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS

| 3" | 2" | 1.5" | 1" | 3/4" | 1/2" | 3/8" | #4 | #10 | #20 | #40 | #60 | #100 | #200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

PERCENT PASSING SIEVE SIZES (mm)

| 75 | 50 | 37.5 | 25 | 19 | 12.5 | 9.5 | 4.75 | 2.00 | 0.850 | 0.425 | 0.250 | 0.150 | 0.075 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 97 | 92 | 87 | 83 | 79 | 74 | 67 |

PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm)

| 0.050 | 0.020 | 0.005 | 0.002 | 0.001 |
|---|---|---|---|---|
| 57 | 41 | 22 | 16 | |

NOTES:

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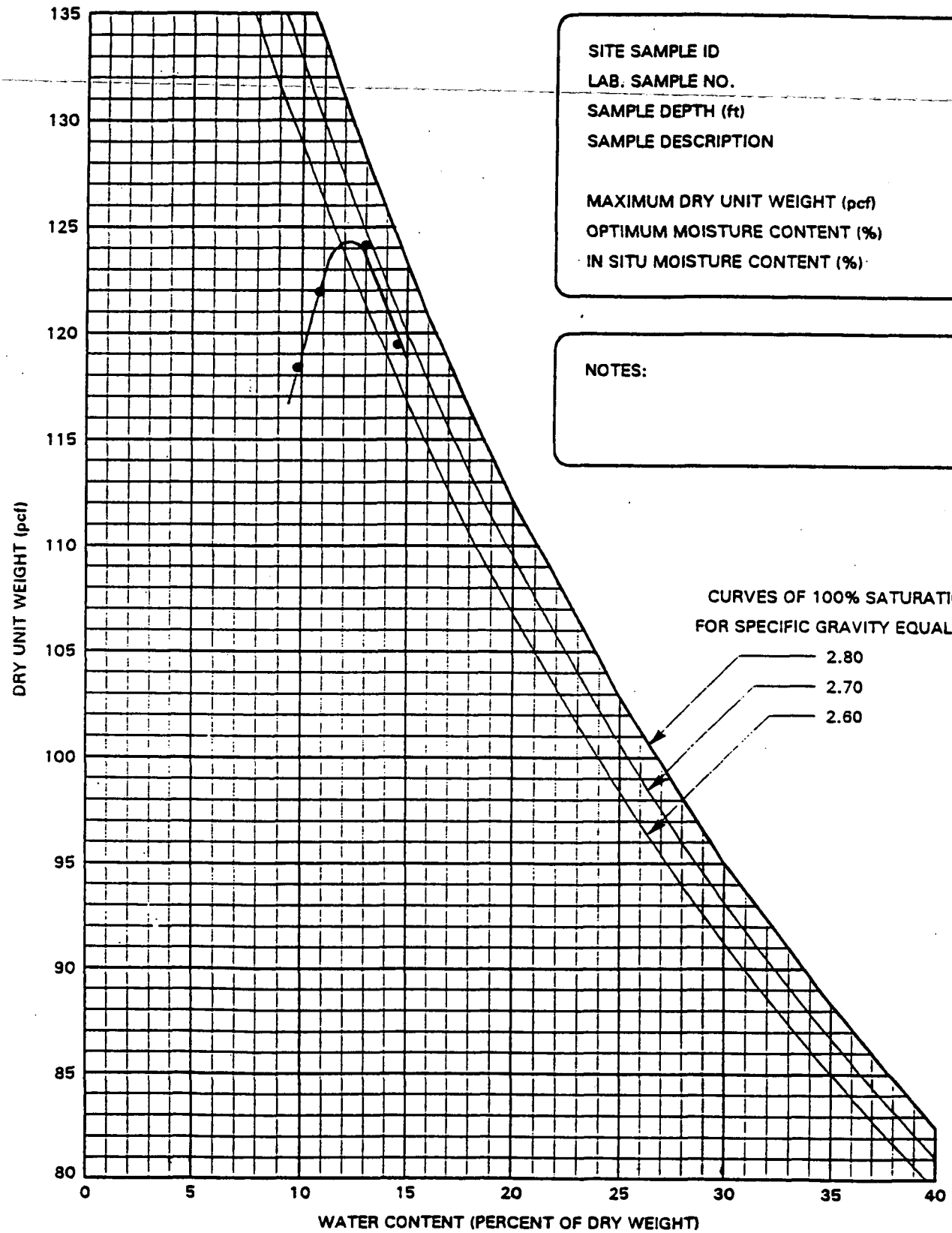
Atlanta, Georgia

FIGURE 6
PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4MD1 02/24/96

## MOISTURE-DENSITY RELATIONSHIP, COMPACTION TESTING

ASTM D-698-B




| | |
|---|---|
| SITE SAMPLE ID | 411989 |
| LAB. SAMPLE NO. | 96B80 |
| SAMPLE DEPTH (ft) | |
| SAMPLE DESCRIPTION | |
| MAXIMUM DRY UNIT WEIGHT (pcf) | 124.3 |
| OPTIMUM MOISTURE CONTENT (%) | 12.3 |
| IN SITU MOISTURE CONTENT (%) | |

NOTES:

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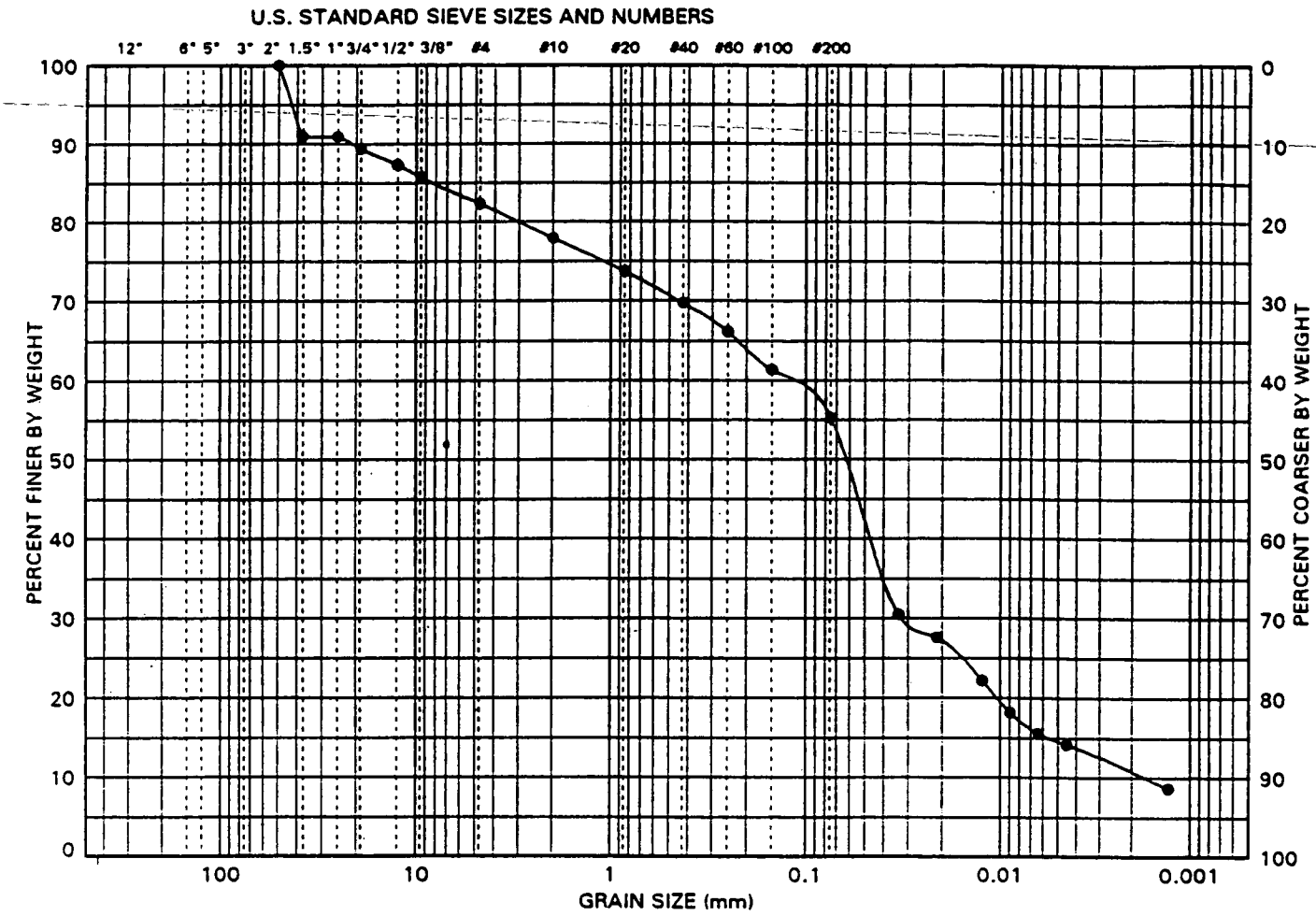
Atlanta, Georgia

FIGURE 7
PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4PS2 11/13/96

## PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318




| COBBLES | GRAVEL | | SAND | | | FINES | |
|---|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | SILT | CLAY |

| | | | |
|---|---|---|---|
| SITE SAMPLE ID | 411990 | LIQUID LIMIT (%) | 24 |
| LAB. SAMPLE NO. | 96881 | PLASTIC LIMIT (%) | 15 |
| SAMPLE DEPTH (ft) | | PLASTICITY INDEX | 9 |

SOIL CLASSIFICATION:
CL - Sandy Lean Clay with Gravel

| SOIL FRACTIONS | |
|---|---|
| GRAVEL (%) | 17.7 |
| SAND (%) | 27.1 |
| FINES (%) | 55.2 |
| SILT (%) | 44.6 |
| CLAY(%) | 10.6 |
| COEFF. UNIFORMITY (Cu) | |
| COEFF. CURVATURE (Cc) | |

| PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS | | | | | | | | | | | | | | PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3" | 2" | 1.5" | 1" | 3/4" | 1/2" | 3/8" | #4 | #10 | #20 | #40 | #60 | #100 | #200 | | | | | |
| PERCENT PASSING SIEVE SIZES (mm) | | | | | | | | | | | | | | | | | | |
| 75 | 50 | 37.5 | 25 | 19 | 12.5 | 9.5 | 4.75 | 2.00 | 0.850 | 0.425 | 0.250 | 0.150 | 0.075 | 0.050 | 0.020 | 0.005 | 0.002 | 0.001 |
| 100 | 100 | 91 | 91 | 89 | 87 | 86 | 82 | 78 | 74 | 70 | 66 | 61 | 55 | 43 | 27 | 15 | 11 | |

NOTES:

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Atlanta, Georgia

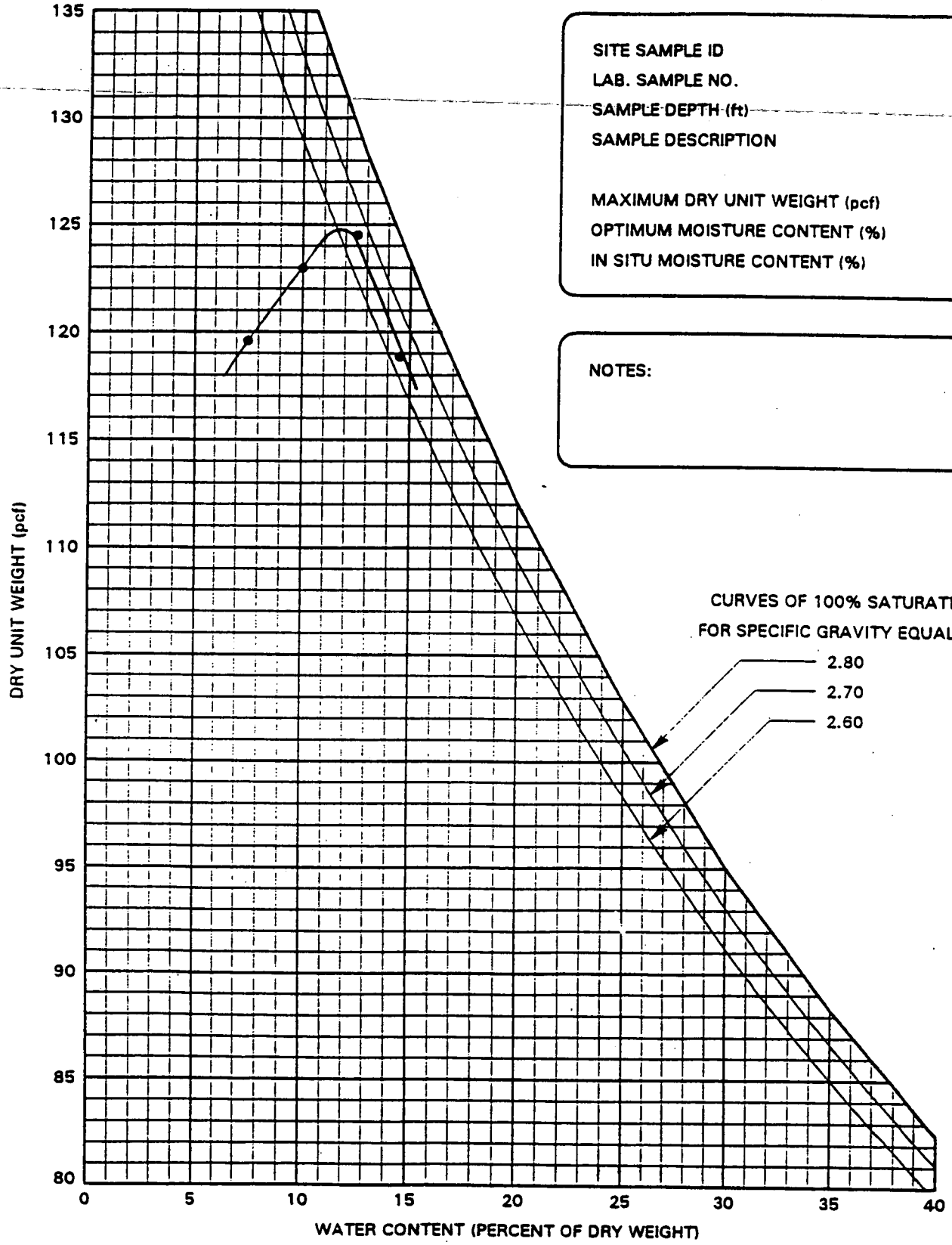
**FIGURE 8**

PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4MD1 03/01/96

## MOISTURE-DENSITY RELATIONSHIP, COMPACTION TESTING

ASTM D-698-8




| | |
|---|---|
| SITE SAMPLE ID | 411990 |
| LAB. SAMPLE NO. | 96B81 |
| SAMPLE DEPTH (ft) | |
| SAMPLE DESCRIPTION | |
| MAXIMUM DRY UNIT WEIGHT (pcf) | 124.8 |
| OPTIMUM MOISTURE CONTENT (%) | 11.8 |
| IN SITU MOISTURE CONTENT (%) | |

NOTES:

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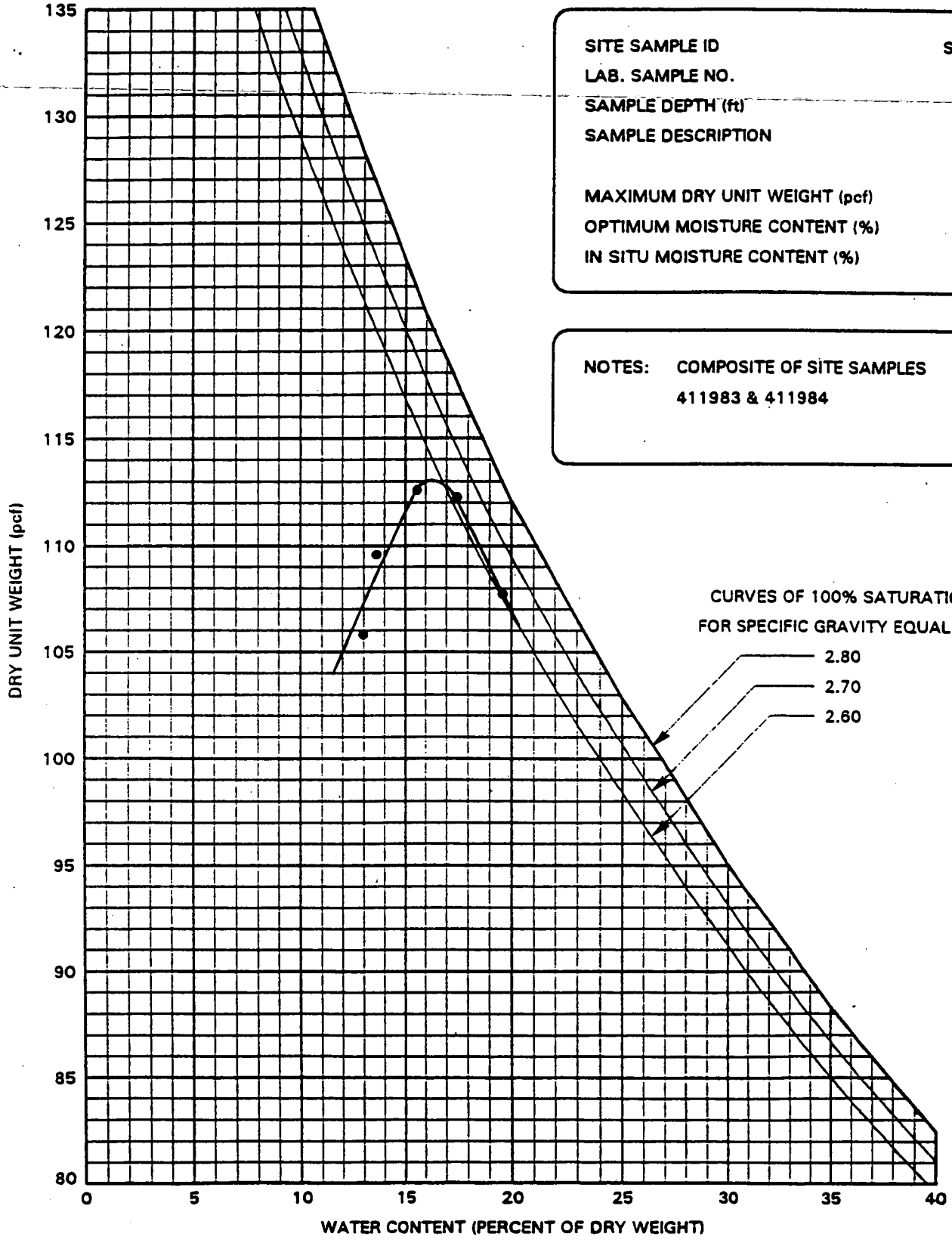
**FIGURE 9**

PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4MD1 04/08/96

## MOISTURE-DENSITY RELATIONSHIP, COMPACTION TESTING

ASTM D-698-8




| | |
|---|---|
| SITE SAMPLE ID | See Notes |
| LAB. SAMPLE NO. | 96B100 |
| SAMPLE DEPTH (ft) | |
| SAMPLE DESCRIPTION | |
| MAXIMUM DRY UNIT WEIGHT (pcf) | 113.0 |
| OPTIMUM MOISTURE CONTENT (%) | 16.3 |
| IN SITU MOISTURE CONTENT (%) | |

NOTES: COMPOSITE OF SITE SAMPLES
411983 & 411984

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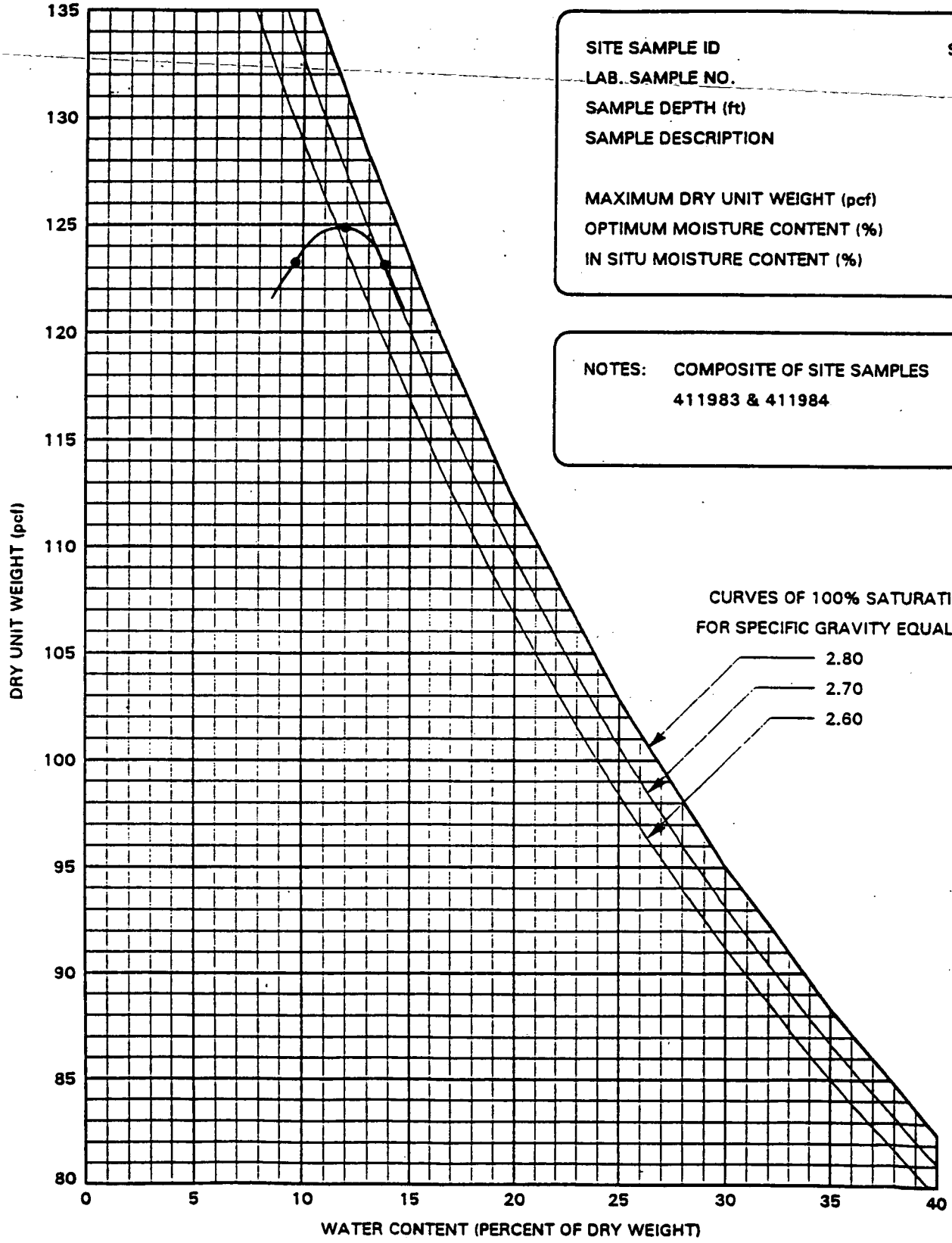
Atlanta, Georgia

FIGURE 10
PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4MD1 03/01/98

# MOISTURE-DENSITY RELATIONSHIP, COMPACTION TESTING

ASTM D-1557-B




| | |
|---|---|
| SITE SAMPLE ID | See Notes |
| LAB. SAMPLE NO. | 96B100 |
| SAMPLE DEPTH (ft) | |
| SAMPLE DESCRIPTION | |
| MAXIMUM DRY UNIT WEIGHT (pcf) | 124.9 |
| OPTIMUM MOISTURE CONTENT (%) | 11.9 |
| IN SITU MOISTURE CONTENT (%) | |

NOTES: COMPOSITE OF SITE SAMPLES
411983 & 411984

GEO SYNTEC CONSULTANTS
Geomechanics and Environmental Laboratory
Atlanta, Georgia

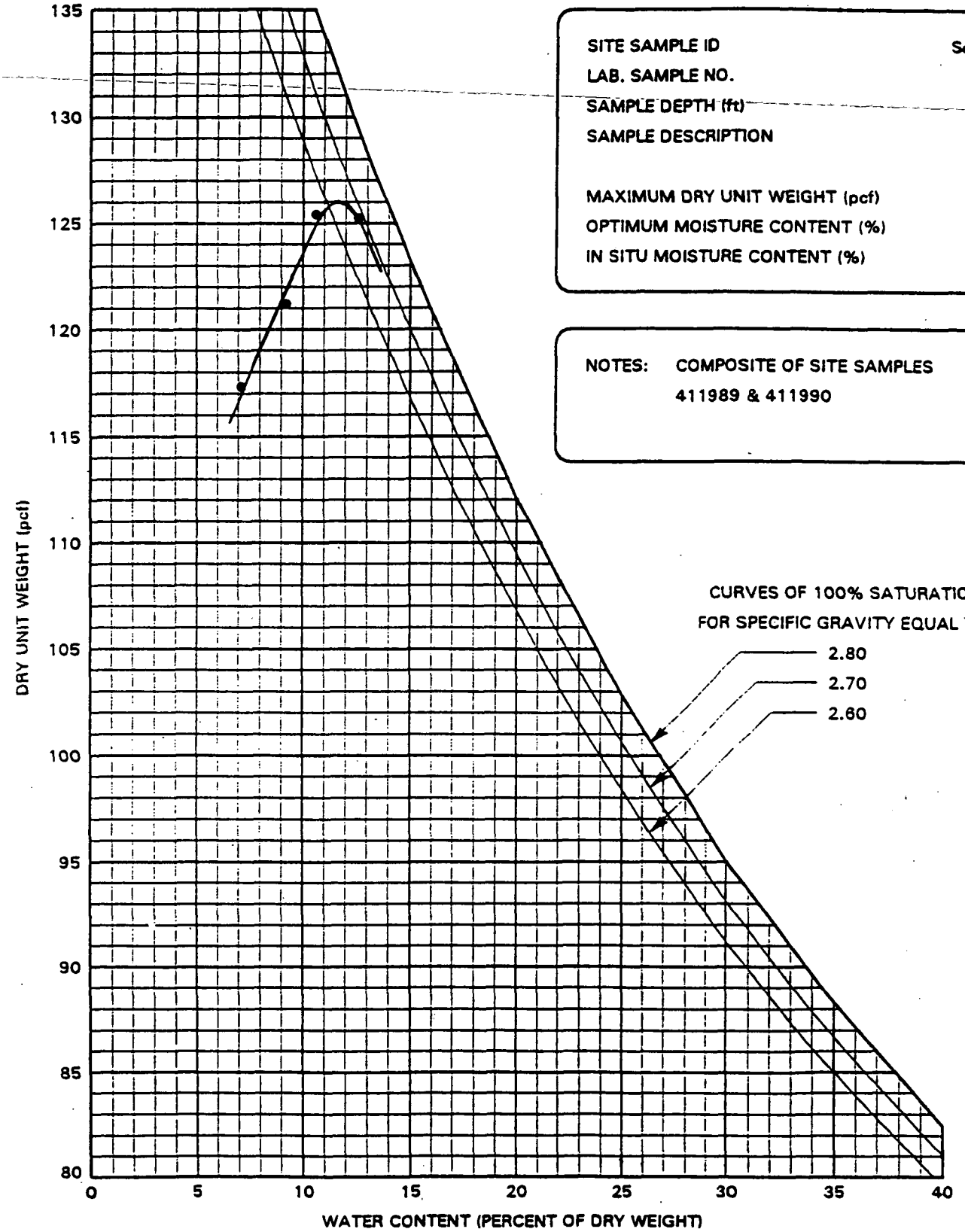
**FIGURE 11**

PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4MD1 04/08/98

## MOISTURE-DENSITY RELATIONSHIP, COMPACTION TESTING

ASTM D-698-8




| | |
|---|---|
| SITE SAMPLE ID | See Notes |
| LAB. SAMPLE NO. | 968101 |
| SAMPLE DEPTH (ft) | |
| SAMPLE DESCRIPTION | |
| MAXIMUM DRY UNIT WEIGHT (pcf) | 126.0 |
| OPTIMUM MOISTURE CONTENT (%) | 11.7 |
| IN SITU MOISTURE CONTENT (%) | |

NOTES: COMPOSITE OF SITE SAMPLES 411989 & 411990

GEO SYNTEC CONSULTANTS
Geomechanics and Environmental Laboratory
Atlanta, Georgia

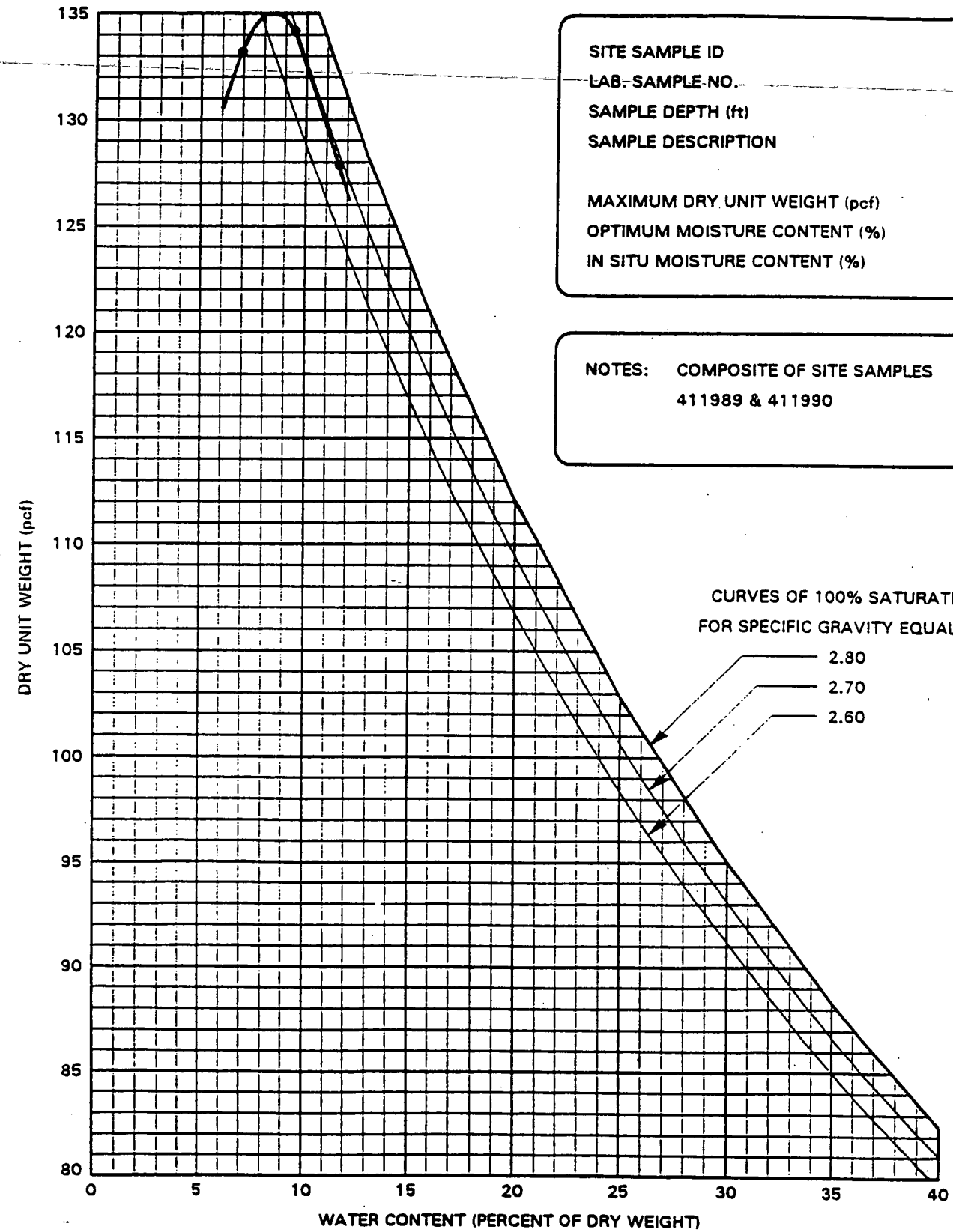
FIGURE 12

PROJECT: FERMCO-OSDF
PROJECT NO.: GE3900-5.2
DOCUMENT NO.: F964G024.CDB

GS FORM: 4MD1 03/01/96

## MOISTURE-DENSITY RELATIONSHIP, COMPACTION TESTING

ASTM D-1557-8




| | |
|---|---|
| SITE SAMPLE ID | See Notes |
| LAB. SAMPLE NO. | 968101 |
| SAMPLE DEPTH (ft) | |
| SAMPLE DESCRIPTION | |
| MAXIMUM DRY UNIT WEIGHT (pcf) | 135.0 |
| OPTIMUM MOISTURE CONTENT (%) | 8.3 |
| IN SITU MOISTURE CONTENT (%) | |

NOTES: COMPOSITE OF SITE SAMPLES
411989 & 411990

# ATTACHMENT A

Sample Identification, Handling, Storage and Disposal

Laboratory Test Standards

Application of Test Results

## SAMPLE IDENTIFICATION, HANDLING, STORAGE AND DISPOSAL

Test materials were sent to GeoSyntec Consultants (GeoSyntec) Geomechanics and Environmental Laboratory in Atlanta, Georgia by the client or its representative(s). Samples delivered to the laboratory were identified by client sample identification (ID) numbers which had been assigned by representative(s) of the client. Upon being received at the laboratory, each sample was assigned a laboratory sample number to facilitate tracking and documentation.

Based on the information provided to GeoSyntec by the client or its representative(s) and, when applicable, procedural guidelines recommended by an industrial hygiene consultant, the following Occupational Safety and Health Administration (OSHA) level of personal protection was adopted for handling and testing of the test materials:

[X] test materials were not contaminated, no special protection measures were taken;
[ ] level D
[ ] level C
[ ] level B

In accordance with the health and safety guidelines of GeoSyntec, contaminated materials are stored in a designated containment area in the laboratory. Non-contaminated materials are stored in a general storage area in the laboratory.

GeoSyntec Geomechanics and Environmental Laboratory will continue storing the test materials for a period of 30 days from the date of this report or a year from the time that the samples were received, which ever is shorter. Thereafter: (i) contaminated materials will be returned to the client or its designated representative(s); and (ii) the materials which are not contaminated will be discarded unless long-term storage arrangements are specifically made with GeoSyntec Geomechanics and Environmental Laboratory.

## LABORATORY TEST STANDARDS

At the request of the client, the laboratory testing program was performed utilizing the guidelines provided in the following test standards:

[X] **moisture content** - American Society for Testing and Materials (ASTM) D 2216 "*Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures*";

[ ] **moisture content** - ASTM D 4643 "*Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Method*";

[ ] **particle-size analysis** - ASTM C 136, "*Standard Method for Sieve Analysis of Fine and Coarse Aggregates*";

[X] **particle-size analysis** - ASTM D 422, "*Standard Method for Particle-Size Analysis of Soils*";

[X] **percent passing No. 200 sieve** - ASTM D 1140, "*Standard Test Method for Amount of Material in Soil Finer Than No. 200 (75 microns) sieve*";

[X] **Atterberg limits** - ASTM D 4318, "*Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*";

[X] **soil classification** - ASTM D 2487, "*Standard Test Method for Classification of Soils for Engineering Purposes*";

[ ] **soil pH** - ASTM D 4972, "*Standard Test Method for pH of Soils*";

[ ] **soil pH** - United States Environmental Protection Agency (USEPA) SW-846 Method 9045, Revision 1, 1987, Standard Test Method for Measurement of "*Soil pH*";

[X] **specific gravity** - ASTM D 854, "*Standard Test Method for Specific Gravity of Soils*";

[ ] **carbonate content** - ASTM D 3042, "*Standard Test Method for Insoluble Residue in Carbonate Aggregates*";

[ ] **carbonate content** - ASTM D 4373, "*Standard Test Method for Calcium Carbonate Content of Soils*";

[ ] **soundness** - ASTM C 88, "*Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate*";

[ ] **loss-on-ignition (LOI)** - ASTM D 2974, "*Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils*";

[X] **standard Proctor compaction** - ASTM D 698, "*Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop*";

[X] **modified Proctor compaction** - ASTM D 1557, "*Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop*";

[ ] **maximum relative density** - ASTM D 4253, "*Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table*";

[ ] **minimum relative density** - ASTM D 4254, "*Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density*";

[ ] **unit weight** - ASTM D 2937, "*Standard Test Method for Density of Soil In Place by the Drive-Cylinder Method*";

[ ] **unit weight, void ratio, porosity, and degree of saturation** - U. S. Army Corp of Engineers (USCOE); EM-1110-2-1906, "*Unit Weight, Void Ratio, Porosity, and Degree of Saturation, Appendix II*";

[ ] **mass per unit area** - ASTM D 3776, "*Standard Test Method for Mass Per Unit Area (weight) of Woven Fabric*";

[ ] **thickness measurement** - ASTM D 1777, "*Standard Test Method for Measuring Thickness of Textile Materials*";

[ ] **free swell** - United States Pharmacopeia National Formulary (USP-NF) XVII, "*Swell Index of Clay*";

[ ] **swell of clay in GCL's** - Geosynthetic Research Institute (GRI) GCL-1, "*Standard Test Method for Swell Measurement of the Clay Component of GCL's*";

[ ] **fluid loss** - American Petroleum Institute (API) RP 13B, "*Section 4, Bentonite*";

[ ] **marsh funnel** - API RP 13B, "*Section 4, Field Testing of Oil Mud Viscosity and Gel Strength*";

[ ] **pinhole dispersion** - ASTM D 4647, "*Standard Test Method for Identification and Classification of Dispersive Clay Soils by the Pinhole Test*";

[ ] **gradient ratio** - ASTM D 5101, "*Standard Test Method for Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio*";

[ ] **hydraulic conductivity ratio (HCR)** - ASTM D 5567, "*Standard Test Method for Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems*";

[ ] **hydraulic transmissivity** - ASTM D 4716, "*Standard Test Method for Constant Head Hydraulic Transmissivity (In-plane flow) of Geotextiles and Geotextile Related Products*";

[ ] **one-dimensional consolidation** - ASTM D 2435, "*Standard Test Method for One-Dimensional Consolidation Properties of Soil*";

[ ] **one-dimensional swell/collapse** - ASTM D 4546, "*Standard Test Method for One-Dimensional Swell or Settlement Potential of Cohesive Soils*";

[ ] **unconfined compressive strength (UCS)** - ASTM D 2166, *" Standard Test Method for Unconfined Compressive Strength of Cohesive Soil"*;

[ ] **triaxial compressive strength ($\overline{ICU}$)** - ASTM D 4767, *"Standard Test Method for Triaxial Compression Test on Cohesive Soils"*;

[ ] **triaxial compressive strength (UU)** - ASTM D 2850, *"Standard Test Method for Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression"*;

[ ] **rigid wall constant head hydraulic conductivity** - ASTM D 2434, *"Standard Test Method for Permeability of Granular Soils (Constant Head)"*;

[ ] **rigid wall constant head hydraulic conductivity** - USCOE: EM-1110-2-1906, *"Standard Test Method for Permeability Tests, Appendix VII"*;

[X] **flexible wall falling head hydraulic conductivity** - ASTM D 5084, *"Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"*;

[ ] **flexible wall falling head hydraulic conductivity** - USCOE: EM-1110-2-1906, *"Standard Test Method for Permeability Tests, Appendix VII"*;

[ ] **index flux of GCL** - proposed ASTM method rough draft # 1, 6/18/94, *"Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter"*;

[ ] **flexible wall falling head hydraulic conductivity** - GRI GCL-2, *"Standard Test Method for Permeability of Geosynthetic Clay Liners (GCLs)"*;

[ ] **permeability/compatibility** - USEPA Method 9100 SW-846, Revision 1, 1987, Standard Test Method for Measurement of *"Saturated Hydraulic Conductivity, Saturated Leachate Conductivity and Intrinsic Permeability"*;

[ ] **permeability** - API RP 27, *"Recommended Practice for Determining Permeability of Porous Media"*;

[ ] **capillary-moisture** - ASTM D 2325, *"Standard Test Method for Capillary-Moisture Relationships for Coarse- and Medium-Textured Soils by Porous-Plate Apparatus"*;

[ ] **capillary-moisture** - ASTM D 3152, *"Standard Test Method for Capillary-Moisture Relationships for Fine-Textured Soils by Pressure-Membrane Apparatus"*;

[ ] **paint filter liquids** - USEPA Method 9095, SW-846, Revision 1, 1987, *"Paint Filter Liquids Test"*; and

[ ] **bulk unit weight** - ASTM C 138, *"Standard Test Method for Weight per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete"*.

APPLICATION OF TEST RESULTS

The reported test results apply to the field materials inasmuch as the samples sent to the laboratory for testing are representative of these materials. This report applies only to the materials tested and does not necessarily indicate the quality or condition of apparently identical or similar materials. The testing was performed in accordance with the general engineering standards and conditions reported. The test results are related to the testing conditions used during the testing program. As a mutual protection to the client, the public, and GeoSyntec, this report is submitted and accepted for the exclusive use of the client and upon the condition that this report is not used, in whole or in part, in any advertising, promotional or publicity matter without prior written authorization from GeoSyntec.