Report of Geotechnical Engineering Investigation

LAKE EUSTIS DRIVE AND LAKESHORE DRIVE

STORMWATER IMPROVEMENTS

Lake County, Florida

GEC Project No. 2833G

Geotechnical and Environmental Consultants, Inc.
At the very foundation of our community

May 5, 2008

DRMP
941 Lake Baldwin Lane
Orlando, Florida 32814

Attention: Mr. John Minton, P.E.

Subject: Report of Geotechnical Engineering Investigation
LAKE EUSTIS DRIVE AND LAKESHORE DRIVE STORMWATER IMPROVEMENTS
Lake County, Florida
GEC Project No. 2833G

Dear Mr. Minton:

Geotechnical and Environmental Consultants, Inc. (GEC) is pleased to provide this Geotechnical Report for the above-referenced project. This study was performed in general accordance with GEC Proposal No. 5029G dated December 12, 2007. The purposes of this investigation were to evaluate soil, groundwater and pavement conditions at 4 separate improvement area locations along Lake Eustis Drive and Lakeshore Drive to provide geotechnical recommendations to assist with planning and design of stormwater improvements. This report describes our exploration procedures, exhibits the data obtained and presents our conclusions and recommendations regarding the geotechnical engineering aspects of this project.

GEC appreciates the opportunity to work with DRMP on this project. Should there be any questions regarding the contents of this report, or if we may be of further assistance, please do not hesitate to contact us.

Very truly yours,

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS, INC.

5/9/08

Eric W. Nagowski, E.I.
Engineer Intern

5/9/08

Christopher P. Meyer, P.E.
Senior Project Engineer
Florida License No. 49328

EWN/CPM/crp

1230 East Hillcrest Street, Orlando, FL 32803-4713
407/898-1818 Fax 407/898-1837 E-mail: gec@g-e-c.com
www.g-e-c.com

OFFICES IN ORLANDO AND KISSIMMEE

Table of Contents

1.0 SITE AND PROJECT DESCRIPTION 1

2.0 NRCS SOIL SURVEY REVIEW 2

3.0 SUBSURFACE EXPLORATION 2
- 3.1 Machine Auger Borings 3
- 3.2 Field Permeability Tests 3
- 3.3 Groundwater Measurement 4

4.0 LABORATORY TESTING 4
- 4.1 Corrosion Series Testing 5
- 4.2 Limerock Bearing Ratio Testing 5

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS 5
- 5.1 Auger Boring Results 6
- 5.2 Groundwater Levels 6
- 5.3 Permeability Testing 7

6.0 PAVEMENT CORING RESULTS 7

7.0 GEOTECHNICAL ANALYSES AND RECOMMENDATIONS 8
- 7.1 Stormwater Management 8
- 7.2 Unsuitable Soils 9
- 7.3 Pipe Bedding, Backfill and Compaction 9

8.0 CONSTRUCTION ISSUES 10
- 8.1 Temporary Dewatering 11
- 8.2 Temporary Excavations 11

9.0 USE OF THIS REPORT 12

APPENDIX

FIGURES:

Figure 1: USGS Quadrangle and SCS Soil Survey Maps
Figure 2: Site Maps with Boring Locations
Figure 3: Auger Boring Results

TABLES:

Table 8: Laboratory Test Results
Table 9: Corrosion Series Test Results
Table 10: Pavement Core Results

Appendix A: Pavement Core Photographs
Appendix B: Field Permeability Calculations
Appendix C: LBR Test Results

1.0 SITE AND PROJECT DESCRIPTION

The project includes proposed stormwater improvements along a 3.2-mile section of the subject roadway in Lake County, Florida. The project begins at US441 near Tavares and ends at CR 419 near Eustis. The project consists of four separate proposed improvement areas located at the following Sections, Townships and Range of Lake County, Florida:

Table 1
Improvement Area Locations

Improvement Area	Section	Township	Range
1	21	19 S	26 E
3/4	15	19 S	26 E
6	10	19 S	26 E
7	11	19 S	26 E

- Improvement Area 1 is located along Lake Eustis Drive approximately 500 feet northeast of U.S. 441 and north of Lake Juanita. We understand the improvements may consist of approximately 1,500 feet of new storm sewers.

- Improvement Area 3/4 is located on Lakeshore Drive. This area begins approximately 300 feet southwest of Hermosa Drive and ends approximately 350 feet northeast of Clay Boulevard. We understand the improvements may consist of adding about 200 l.f. of lake shore erosion protection and up to approximately 1,200 of new storm sewer.

- Improvement Area 6 is located on Lakeshore Drive at the Intersection of Woodward Road. The alignment extends approximately 260 feet north and south of Woodward Road for a total length of 520 feet. The project area also includes 560 feet of Woodward Road. Improvements may consist of replacing storm sewer and outfall(s).

- Improvement Area 7 is located on Lakeshore Drive between the Lake Eustis Marina Canal and the CSX Railroad track, south of Morin Street. The total length of this alignment is 1,050 feet. We understand the improvements may consist of new storm sewers.

We also understand that the proposed stormwater improvements to these 4 areas may consist of roadside swales or exfiltration trenches.

The 4 improvements area locations are shown on excerpts of the U.S. Geological Survey Eustis, Florida Quadrangle map (**Figure 1**) in the **Appendix**. According to the quadrangle map, the existing ground surface elevations along the alignment range from approximately +65 to +75 feet NGVD.

2.0 NRCS SOIL SURVEY REVIEW

The 4 improvement areas are shown on the USDA Natural Resources Conservation Service (NRCS) Web Soil Survey Map (**Figure 1**) (http://soils.usda.gov/survey) in the **Appendix**. The following NRCS Soil Survey types are identified within the project limits.

Table 2
Lake County NRCS Soil Survey Review

Improvement Area	Unit No.	Soil Name	Depth to Seasonal High Groundwater (feet)
1, 6, 7	17	Arents	---
1, 6	20	Immokalee sand	0.5 - 1.5
1	41	Pomello sand, 0 to 5 percent slopes	2 - 3.5
1	43	St. Lucie sand, 0 to 5 percent slopes	>6.0
3/4	9	Candler sand, 5 to 12 percent slopes	>6.0
7	44	Swamp	Ponded

Much of the Improvement Areas 1, 6, and 7 are identified as Arents. Arents consist of material excavated from multiple areas and is typically used to fill low-lying areas such as swamps, marshes and shallow depressions.

Information contained in the NRCS Soil Survey is very general and may be outdated. It may not therefore be reflective of actual soil and groundwater conditions, particularly if recent development in the site vicinity has modified soil conditions or surface/subsurface drainage.

3.0 SUBSURFACE EXPLORATION

The subsurface exploration for this study consisted of performing the following:

Improvement Area 1

- 3 auger borings to 7 to 8 feet
- 2 pavement cores
- 2 field permeability tests
- obtained 1 bulk sample for LBR testing

Area 3/4

- 4 auger borings to 8 feet
- 2 pavement cores
- 2 field permeability tests
- obtained 1 bulk sample for LBR testing

Area 6

- 3 auger borings to 8 feet
- 2 pavement cores
- 1 field permeability test

Area 7

- 3 auger borings to 8 to 15 feet
- 2 pavement cores
- 2 field permeability tests
- obtained 1 bulk sample for LBR testing

The approximate boring and core locations are shown on Figure 2 in the **Appendix**. Boring and core locations were not surveyed, but established by taping distances from existing features shown on the plans provided by DRMP. Therefore, the boring and core locations should be considered approximate. Although the boring and core locations are therefore given only approximately, the methods used to locate the borings and cores are, in GEC's opinion, sufficient to meet the intent of our study. If greater accuracy is desired, a registered Professional land Surveyor should be retained to survey the boring and core locations.

3.1 Machine Auger Borings

Machine auger borings were drilled by hydraulically turning a 4-inch wide continuous flight auger into the ground in 5-foot increments until the desired boring termination depth was achieved. The auger flights were retrieved in 5-foot increments and examined by our field technician prior to collection of representative soil samples. The samples were sent to GEC's laboratory for further examination and limited laboratory testing.

3.2 Field Permeability Tests

Constant and falling head permeability tests were performed in the field at this site. The field permeability tests were performed by driving a 3-inch diameter casing into the ground to the desired test depth and washing the soil out of the casing with water. The casing was backfilled with quartz gravel to 24 inches above the bottom of the casing and was then raised a distance of 18 inches.

When a constant head permeability test was conducted, water was added to the casing to achieve a stable water level. Once the water level stabilized, the flow required to maintain the stable water level over time was measured.

When a falling head permeability test was conducted, water was added to the casing to achieve a stable water level. Once the water level stabilized, the water source was taken away and the drop in water level in the casing with respect to time was recorded.

These relationships were used to calculate the permeability of the soil. Field permeability tests and calculations were performed in general conformance with NAVFAC DM-7.1-108.

3.3 Groundwater Measurement

A GEC engineering technician measured the depth to the groundwater in the boreholes at the time of drilling and again after approximately 24 hours. Once the groundwater measurements were recorded, the boreholes were backfilled with soil cuttings to prevailing ground surface.

4.0 LABORATORY TESTING

Selected soil samples retrieved from the borings were tested in accordance with Florida Standard Testing Methods (FM). Florida Standard Testing Methods are adaptations of recognized standard methods, e.g., ASTM and AASHTO, which have been modified to accommodate Florida's geological conditions. The laboratory testing program for this project is summarized below:

Table 3
Summary of Laboratory Testing Program

Type of Test	Number of Tests
Percent Fines (FM 1-T 088)	9
Natural Moisture Content (FM 1-T 265)	1
Grain Size Analysis (FM 1-T 88)	3
Corrosion Series (FM 5-550, 5-551, 5-552 and 5-553)	3
Limerock Bearing Ratio (FM5-515)	3
Organic Content (FM 1-T267)	1

The results of our testing are shown adjacent to the soil boring profiles on **Figure 3** of the **Appendix**. The results of the laboratory testing are also summarized on the **Laboratory Test Results (Table 8)** in the **Appendix**. Corrosion series test results and LBR test results are also presented in the **Appendix**.

4.1 Corrosion Series Testing

Three corrosion series tests were performed on soil samples obtained from the borings performed. The individual results of the corrosion series tests and the corresponding environmental classifications are shown on **Table 9** in the **Appendix**.

4.2 Limerock Bearing Ratio Testing

Three Limerock Bearing Ratio (LBR) tests were performed on representative soils encountered at the improvement areas. The LBR tests were performed on samples of fine sand (SP) and fine sand with silt (SP-SM). These soil types were the predominant soils encountered from 0 to 5 ft of depth. The results of our LBR analyses are attached and a summary is presented below:

Table 4
LBR Analysis Summary

LBR Location	Max LBR Value
Area 1	36
Area 3/4	31
Area 7	56

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS

The results of our borings are presented on the **Boring Results sheets** in the **Appendix**. The soils encountered in the borings were classified using the Unified Soil Classification System (USCS) system (SP, SP-SM, etc.). All soils were described using the ASTM soil descriptions (e.g., sand with silt). We based our classifications on visual examination and the laboratory test results shown in the **Appendix**.

The boring logs indicate subsurface conditions only at the specific boring locations at the time of our field exploration. Subsurface conditions, including groundwater levels, at other locations of the project site may differ from conditions we encountered at the boring locations. Moreover, conditions at the boring locations can change over time. Groundwater levels fluctuate seasonally, and soil conditions can be altered by earthmoving operations.

The depths and thicknesses of the subsurface strata indicated on the boring logs were interpolated between samples obtained at different depths in the borings.

The depths and thicknesses of the subsurface strata indicated on the boring logs were interpolated between samples obtained at different depths in the borings. The actual transition between soil layers may be different than indicated. *These stratification lines were used for our analytical purposes and actual earthwork quantities measured during construction should be expected to vary from quantities calculated based on the information in this report.*

5.1 Auger Boring Results

In general, the borings performed at all four improvement areas encountered fine sand (SP) and fine sand with silt (SP-SM) from the existing grade to depths between 7 and 8 feet. Notable exceptions to the above-generalized soil profile were observed at the following locations:

- Boring HA-6 in Improvement Area 3/4 encountered silty fine sand (SM) from the existing grade to a depth of approximately 5 feet.
- Boring HA-9 in Improvement Area 6 encountered mucky fine sand (PT) from approximately 4 to 5 feet below the existing grade.
- Boring HA-11 of Improvement Area 7 encountered silty fine sand (SM) from the existing grade to approximately 7 feet followed by mucky fine sand (PT) to a depth of 14 feet.

Please refer to **Figure 3** of the **Appendix** for detailed soil profiles at individual boring locations.

5.2 Groundwater Levels

Groundwater levels encountered in the borings performed are presented in the table below:

Table 5
Groundwater Levels

Improvement Area	Encountered Groundwater Levels (ft)	Estimated Seasonal High Level (ft)
1	2 to 2.3	0.5
3/4	6.3 to GNE @ 8'	4.8 - 6.0
6	4.0 to 5.3	2 - 3.3
7	2.3 to 3.0	0.5 - 1.5

Groundwater levels at these improvement areas will be heavily dependent on the water levels in the nearby lakes and drainage features. Groundwater levels can vary seasonally and with changes in subsurface conditions between boring locations. Alterations in surface and/or subsurface drainage brought about by site development can also affect groundwater levels. *Therefore, groundwater depths measured at different times or at different locations along the project alignment can be expected to vary from those measured by GEC during this investigation.*

For the purposes of this report, estimated seasonal high groundwater levels are defined as groundwater levels that are anticipated at the end of the wet season of a "normal rainfall" year under current site conditions. We define a "normal rainfall" year as a year in which rainfall quantity and distribution were at or near historical rainfall averages.

5.3 Permeability Testing

A total of 4 falling head and 3 constant head field permeability tests were performed. The location and results of the permeability tests are presented in the following table.

Table 6
Permeability Test Results

Improvement Area	Boring Number	Test Type*	Test Depth (feet)	Soil Classification	Permeability Rate (ft/day)
1	HA-1	F	2-4	SP	44
1	HA-3	F	2-4	SP	25
3/4	HA-4	C	2-4	SP-SM	4
3/4	HA-6	F	2-4	SM	19
6	HA-10	C	2-4	SP	2
7	HA-11	C	2-4	SM	0.1
7	HA-13	F	2-4	SP-SM	0.7

* "C" indicates constant head and "F" indicates falling head

Our permeability calculations are included in the **Appendix**.

6.0 PAVEMENT CORING RESULTS

A total of 8 cores were obtained from the 4 improvement areas. The following table indicates the location of each core performed.

Table 7
Pavement Coring Locations

Core No.	Improvement Area	Roadway	Travel Lane
C-1	1	Lake Eustis Drive	NB
C-2	1	Lake Eustis Drive	SB
C-3	3/4	Lakeshore Drive	SB
C-4	3/4	Lakeshore Drive	NB
C-5	6	Lakeshore Drive	NB
C-6	6	Woodward Road	WB
C-7	7	Lakeshore Drive	NB
C-8	7	Lakeshore Drive	SB

In general, the cores performed encountered the following generalized pavement section:

- Improvement Area 1 - 12.75 to 13 inches of asphalt followed by 2 inches of large aggregate base.

- Improvement Area 3/4 - 4.3 to 8.5 inches of asphalt followed by 1 to 2.5 inches of large aggregate base.

- Improvement Area 6 - 2 to 4.75 inches of asphalt. Core C-5 had approximately 1 inch of large aggregate base beneath the asphalt. Core C-6 performed on Woodward Road encountered an unknown depth of very hard, uncorable concrete beneath the 2 inches of asphalt. Observed crack depths were 2 inches at the Woodward Road core location (C-6).

- Improvement Area 7 - 2.75 to 5.3 inches of asphalt followed by 1 inch of large aggregate base (C-8) and 7 inches of limerock base ©-7). Crack depths ranged from 2 to 2.75 inches.

Please refer to **Table 10** in the **Appendix** for detailed core information at individual core locations.

7.0 GEOTECHNICAL ANALYSES AND RECOMMENDATIONS

The analyses and recommendations contained in this report are based in part on the data obtained from a limited number of soil samples, cores and groundwater measurements obtained from widely-spaced borings/cores. The investigation methods used indicate subsurface conditions only at the specific boring locations, only at the time they were performed, and only to the depths penetrated. Borings/cores cannot be relied upon to accurately reflect the variations that usually exist between boring/core locations and these variations may not become evident until construction. If variations from the conditions described in this report do become evident during construction, or if project characteristics described in this report change, GEC should be retained so that we can reevaluate this report's conclusions and recommendations in light of such changes.

Borings/cores cannot be relied upon to accurately reflect the variations that usually exist between boring/core locations and these variations may not become evident until construction.

7.1 Stormwater Management

It is GEC's understanding Improvement Areas 1, 3/4, 6 and 7 will undergo stormwater improvements by either the construction of storm sewers, roadside swales or exfiltration trenches. Based on the results of the borings performed, soil and groundwater conditions indicate Areas 1, 6 and 7 have relatively shallow groundwater tables and will be best suited for stormwater treatment by swales, while exfiltration trenches may be a feasible option in Area

3/4 due to deeper groundwater tables. All 4 areas appear suitable for the installation of storm sewers with the exception of any areas with unsuitable soils as discussed below. Once the preferred stormwater management system has been selected, GEC requests the opportunity to review the plans to determine if there are any geotechnical concerns.

Our permeability results indicate that most of the shallow sandy soils in Improvement Areas 1, 3/4 and 6 are relatively free draining. However, the measured permeabilities at our two borings in Improvement Area 7 were relatively slow (0.1 and 0.7 ft/day) due to the greater amount of silty sands and shallower groundwater tables encountered.

7.2 Unsuitable Soils

Special consideration should be given to the organic soils encountered in borings HA-9 of Area 6 and HA-11 of Area 7. If fill is to be placed or buried stormwater structures (pipes, exfiltration trenches, etc) are planned, settlement of the organic soils and/or potentially reduced performance of the stormwater system should be anticipated. Typically, organic soils are removed in areas where new fill, pavements or drainage structures are planned. These organic soils, if they exist beneath the existing roadway, could be causing settlement and pavement distress.

Since this was a limited scope of study of the proposed improvement areas, additional field investigation may be necessary to delineate the extent of these organic soils depending on what improvements are proposed. Once plans are available, GEC should review the plans for this section to determine if any geotechnical concerns exist.

7.3 Pipe Bedding, Backfill and Compaction

The majority of the soils encountered in the auger borings are generally suitable for use as pipe bedding material and pipe excavation backfill.

The soils encountered in the auger borings are generally suitable for use as pipe bedding material and pipe excavation backfill. Ideally backfill soils should consist of non-plastic sands with less than about 12% fines content. The fill should not contain any significant amount of organic substances (less than 3% by weight) or other deleterious materials. The contractor should adhere to the following recommendations for bedding fill placement and compaction.

- Remove any soft, loose or organic soils from below the pipe invert elevation, for the full width of the trench, and to the depth required to reach suitable foundation material.
- Compact pipe bedding material to a minimum of 95% of the soil's Modified Proctor maximum dry density to a minimum depth of 6 inches below the bottom of pipe.

- Excavate and shape bedding soils to accommodate pipe "bells" to completely support each pipe section and help to eliminate point loading conditions.

- Place fill in level lifts no thicker than 12 inches.

- Compact each backfill lift to a minimum of 95% of the soil's modified Proctor maximum dry density as determined by AASHTO T-180 for each lift of fill placed.

- Compaction tests should be performed for each run of pipe between manholes or at least one test per 300 lineal feet.

- Allow an Engineering Technician, working under the direction of a registered Geotechnical Engineer, to perform in-place density tests to verify that the recommended degree of compaction has been achieved.

- Install sheeting and bracing or properly designed trench shields, if required, to support the sides of excavations during utility installation.

- All excavations including utility trenches, should comply with the recommendations included in the **Utility Excavations** section of this report.

- Where utility lines will traverse roadways and/or other permanent structures, such as sidewalks, the backfill should be compacted to 98% of the soil's Modified Proctor maximum dry density for a depth of 2 feet below ground surface.

8.0 CONSTRUCTION ISSUES

The following sections of this report include comments on issues related to the geotechnical aspects of the proposed construction. *These recommendations are not intended to dictate construction methods or sequences.* Instead, they are furnished as an aid to design professionals and to identify important construction issues related to foundation and earthwork plans and specifications. These recommendations may also be useful to personnel who observe construction activity.

Prospective contractors for this project should evaluate potential construction problems on the basis of their review of the contract documents, their own knowledge and experience in the local area, and on the basis of similar projects in other localities, taking into account their own proposed methods and procedures.

8.1 Temporary Dewatering

Depending on groundwater levels at the time of construction and final design grades, temporary dewatering may be required to facilitate stable excavations. The contractor should be required to provide a dewatering system which maintains groundwater levels at least 2 feet below compaction surfaces, including the bottom of excavations. A system of ditches and sumps may be sufficient in some instances to achieve adequate dewatering, but the contractor should be prepared to install wellpoint dewatering systems as necessary to maintain groundwater levels 2 feet beneath the bottom of excavations.

...the contractor must provide positive site drainage during the site preparation and fill placement.

Additionally, the contractor must provide positive site drainage during the site preparation and fill placement. Surface runoff should not be allowed to accumulate. Temporary rim ditches may be required to facilitate site preparation.

8.2 Temporary Excavations

The contractor should also be responsible for the means, methods, techniques, sequences, and operations of the construction.

The owner and the contractor should be familiar with local, state and federal safety regulations, including current Occupational Safety and Health Association (OSHA) excavation and trench safety standards. Construction site safety is the responsibility of the contractor. The contractor should also be responsible for the means, methods, techniques, sequences, and operations of the construction.

The contractor should be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should not exceed those specified in local, state, or federal safety regulations; e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926. *OSHA regulations are strictly enforced and, if not followed, the owner, contractor, earthwork subcontractor or utility subcontractor could be liable for substantial penalties.*

The soil encountered in the borings performed by GEC at this site is primarily sand with varying amounts of silt. We anticipate that OSHA will classify these materials as Type C. OSHA recommends a maximum temporary slope inclination of 1.5 horizontal to 1 vertical for this soil type. Soils encountered in the construction excavations may vary significantly across the site. Our soil classifications are based on the materials encountered in widely-spaced borings. The contractor should verify that similar conditions exist throughout the proposed excavation area. If different subsurface conditions are encountered at the time of construction, GEC should be contacted immediately to evaluate the conditions encountered.

9.0 USE OF THIS REPORT

GEC has prepared this report for the exclusive use of our client, DRMP, and for specific application to our client's project. GEC will not be held responsible for any third party's interpretation or use of this report's subsurface data or engineering analysis without our written authorization.

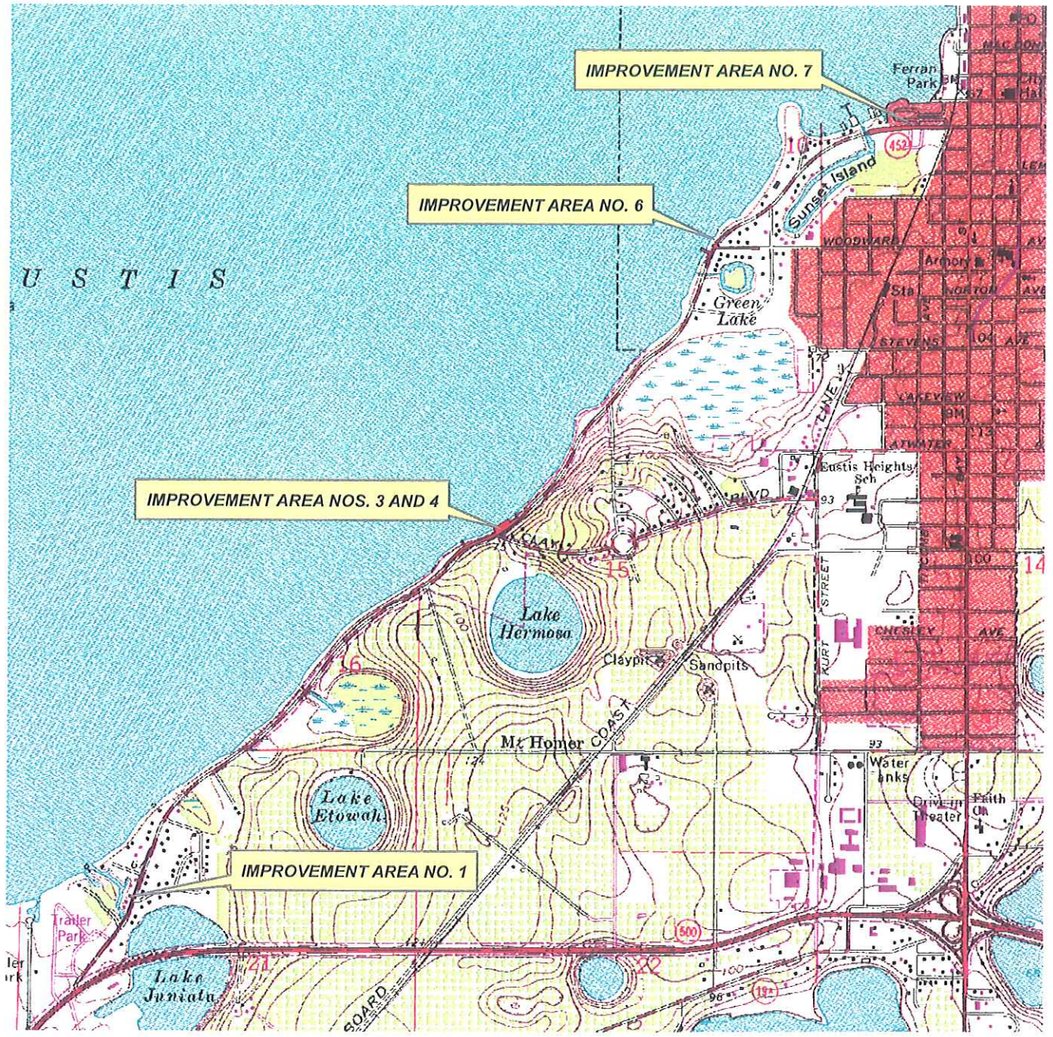
The sole purpose of the borings performed by GEC at this site was to obtain indications of subsurface conditions as part of a geotechnical exploration program. GEC has performed no evaluations along the alignment to identify potential presence of contaminated soil or groundwater, nor have we subjected any soil samples to analysis for contaminants.

GEC has strived to provide the services described in this report in a manner consistent with that level of care and skill ordinarily exercised by members of our profession currently practicing in Central Florida. No other representation is made or implied in this document.

The conclusions or recommendations of this report should be disregarded if the nature, design, or location of the facilities is changed. If such changes are contemplated, GEC should be retained to review the new plans to assess the applicability of this report in light of proposed changes.

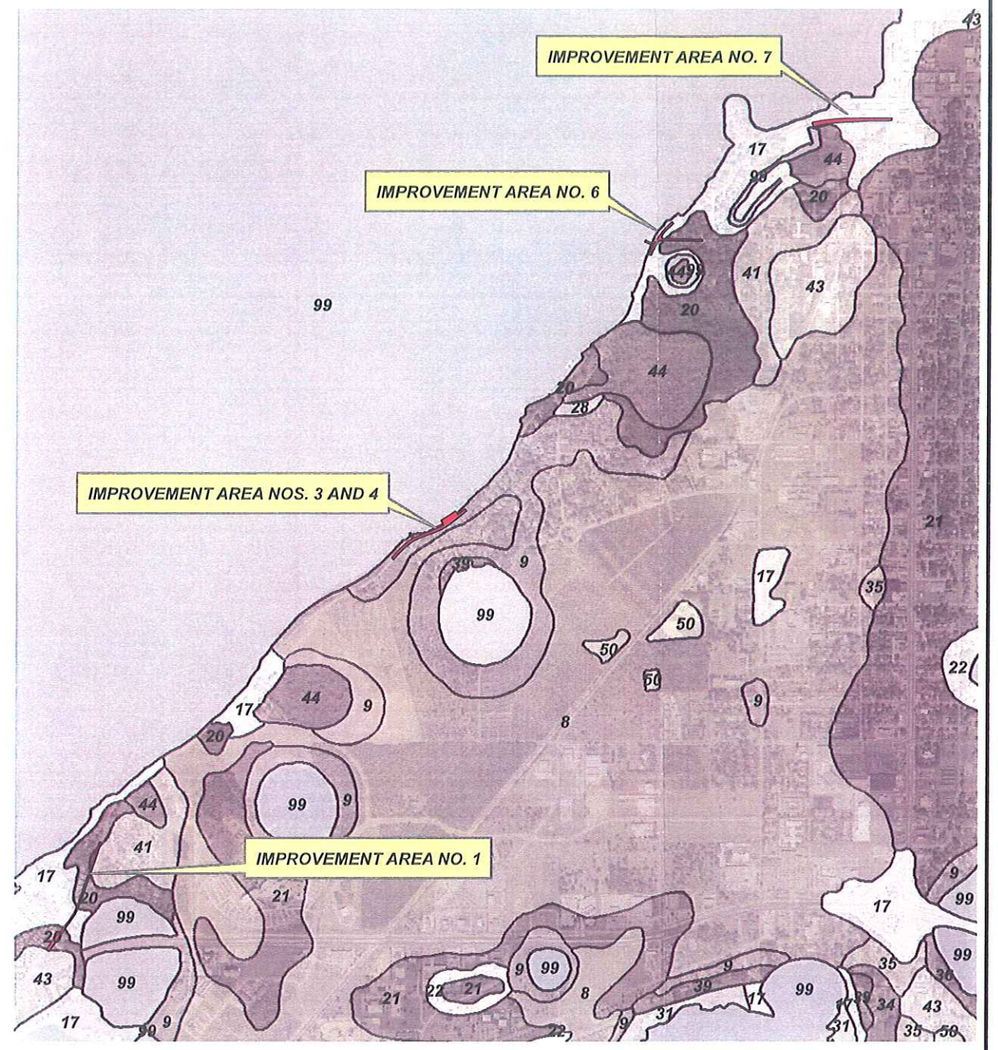
APPENDIX

USGS QUADRANGLE AND NRCS SOIL SURVEY MAPS



Prepared from:
USGS EUSTIS, FL. QUADRANGLE MAP

Sections: 10, 11, 15, 21
Township: 19 South
Range: 26 East



Prepared from:
NRCS Soil Survey of Lake County, FL.

Lake County Map Unit Legend:
For Improvement Area No. 1:
17 - Arents
20 - Immokalee sand
41 - Pomello sand, 0 to 5 percent slopes
43 - St. Lucie sand, 0 to 5 percent slopes

For Improvement Area Nos. 3 and 4:
9 - Candler sand, 5 to 12 percent slopes

For Improvement Area No. 6:
17 - Arents
20 - Immokalee sand

For Improvement Area No. 7:
17 - Arents
44 - Swamp

Geotechnical and Environmental Consultants, Inc.
1230 E. HILLCREST ST.
ORLANDO, FLORIDA 32803
(407) 898-1818
FAX (407) 898-1897
COA NO. 00005882

LAKE EUSTIS/ LAKESHORE DRIVE STORMWATER IMPROVEMENTS

PROJECT NO.: 2833G
DATE: 5-1-08
SENIOR PROFESSIONAL: CPM
P.E. No. 49328
PROJECT PROFESSIONAL: EWN
DRAWN: SKR
REVISION:
REVISION:

N

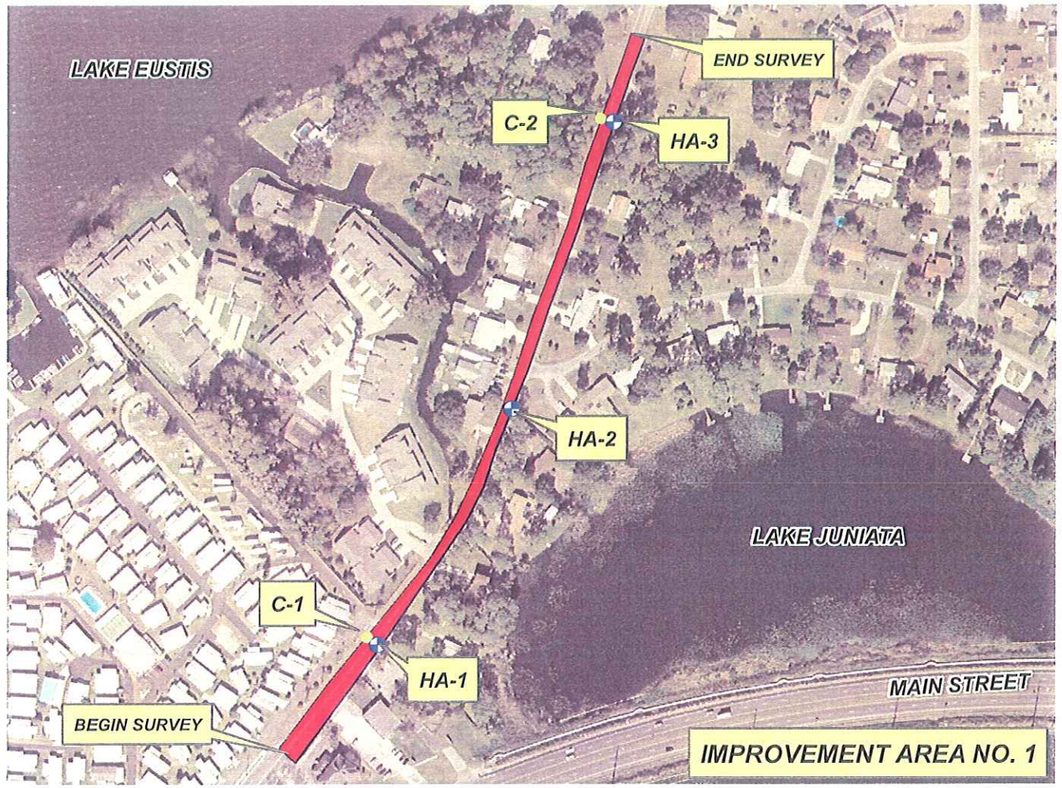
0 1,000 2,000
SCALE feet

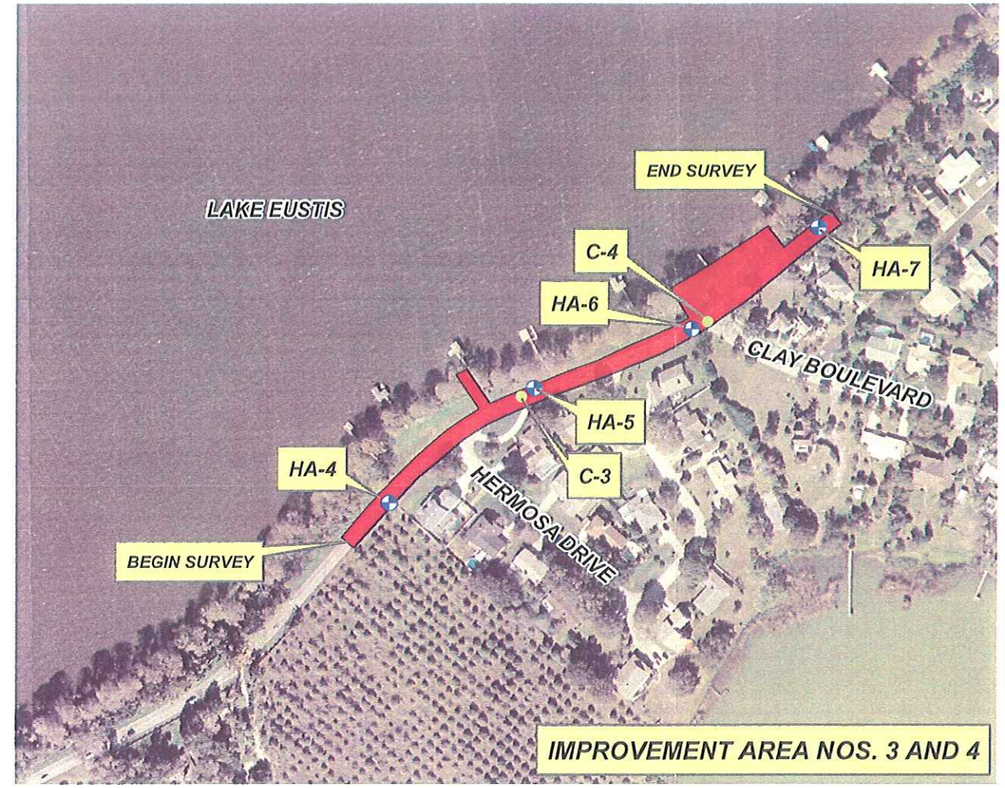
USGS QUADRANGLE AND NRCS SOIL SURVEY MAPS

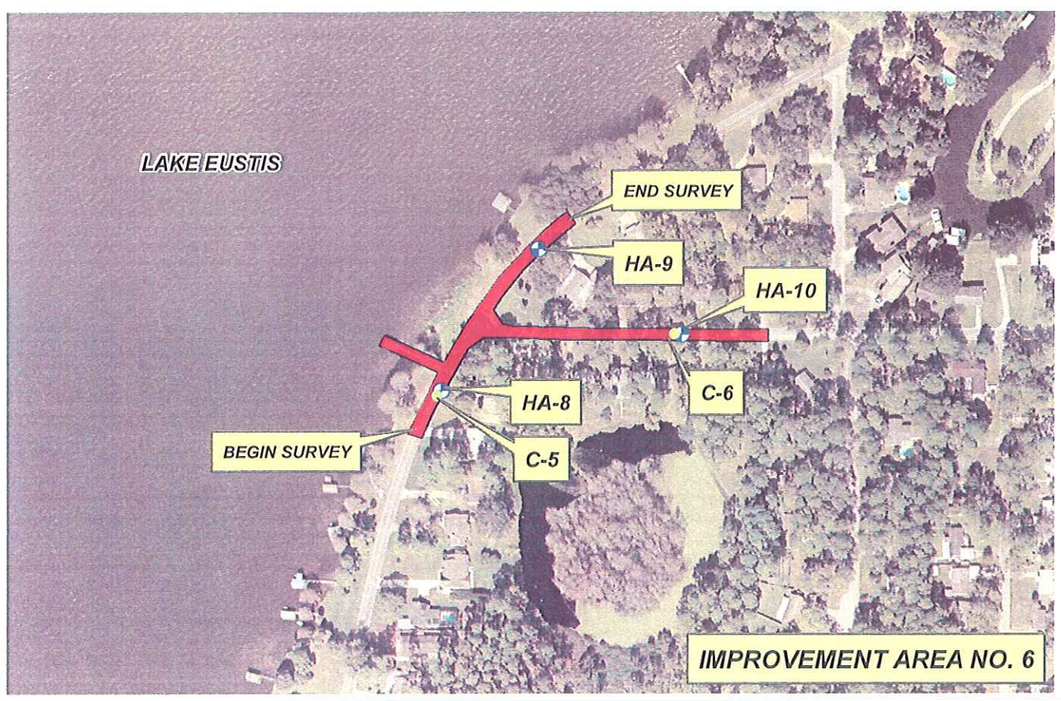
FIGURE 1

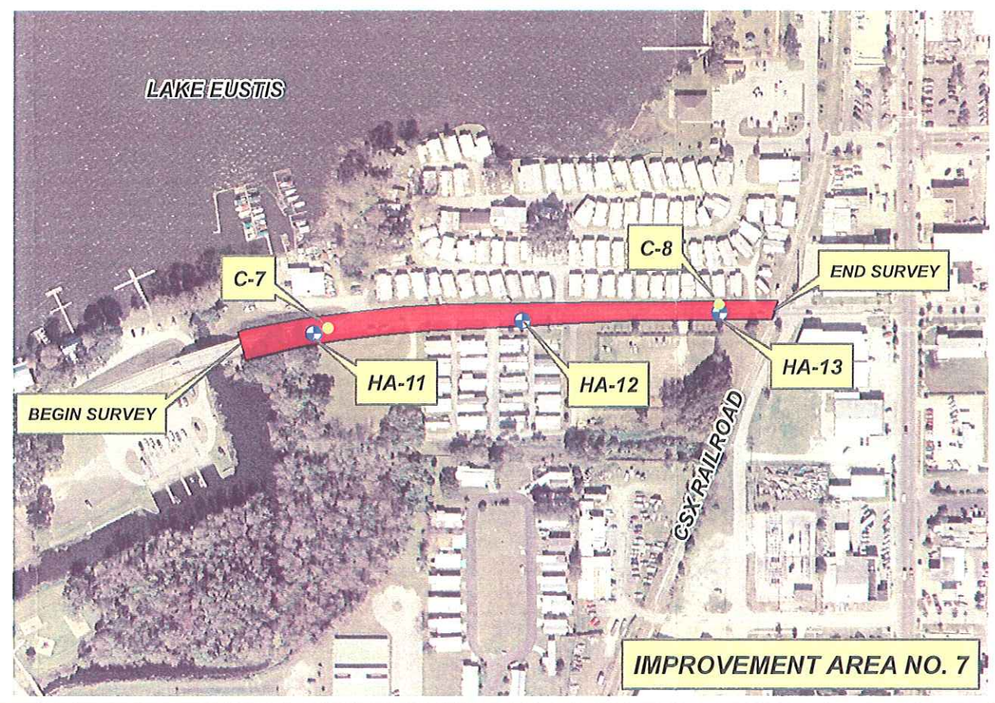
D7\12833G\2833gmaps

SITE MAPS WITH BORING LOCATIONS









Geotechnical and Environmental Consultants, Inc.
1230 E. HILLCREST ST.
ORLANDO, FLORIDA 32803
(407) 898-1818
FAX (407) 898-1897
COA NO. 00005882

LAKE EUSTIS/ LAKESHORE DRIVE STORMWATER IMPROVEMENTS

PROJECT NO.:	2833G
DATE:	5-1-08
SENIOR PROFESSIONAL:	CPM P.E. No. 49328
PROJECT PROFESSIONAL:	EWN
DRAWN:	SKR
REVISION:	
REVISION:	

Aerial photograph source: Lake County Geographical Information System - 2005

LEGEND

- APPROXIMATE HAND AUGER BORING LOCATION
- APPROXIMATE CORE LOCATION

N

0 150 300
SCALE feet

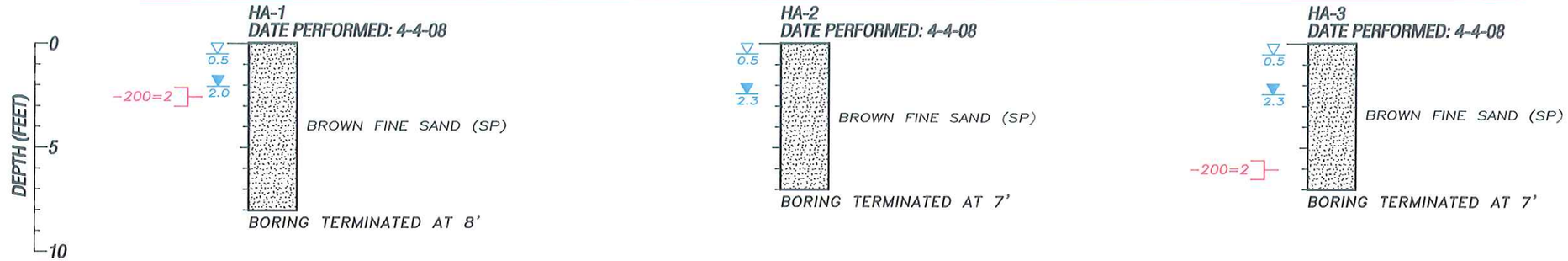
SITE MAP WITH BORING LOCATIONS

FIGURE 2

D71\2833G\2833gsitemap

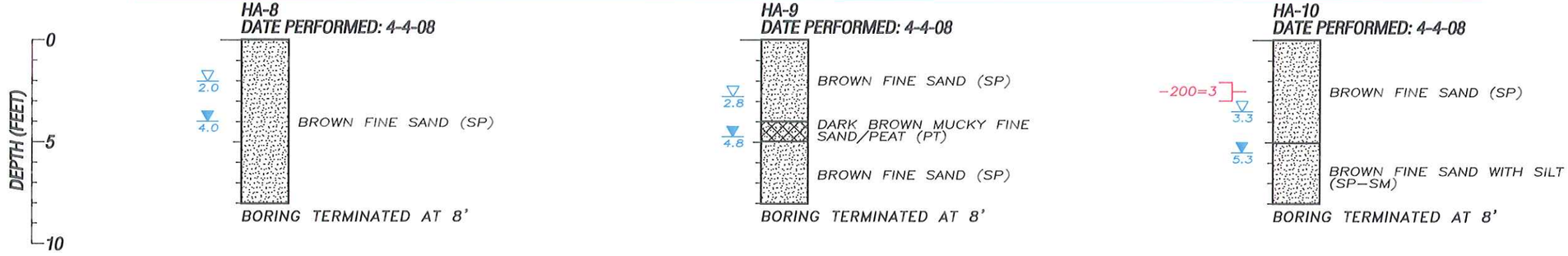
AUGER BORING RESULTS

IMPROVEMENT AREA NO. 1

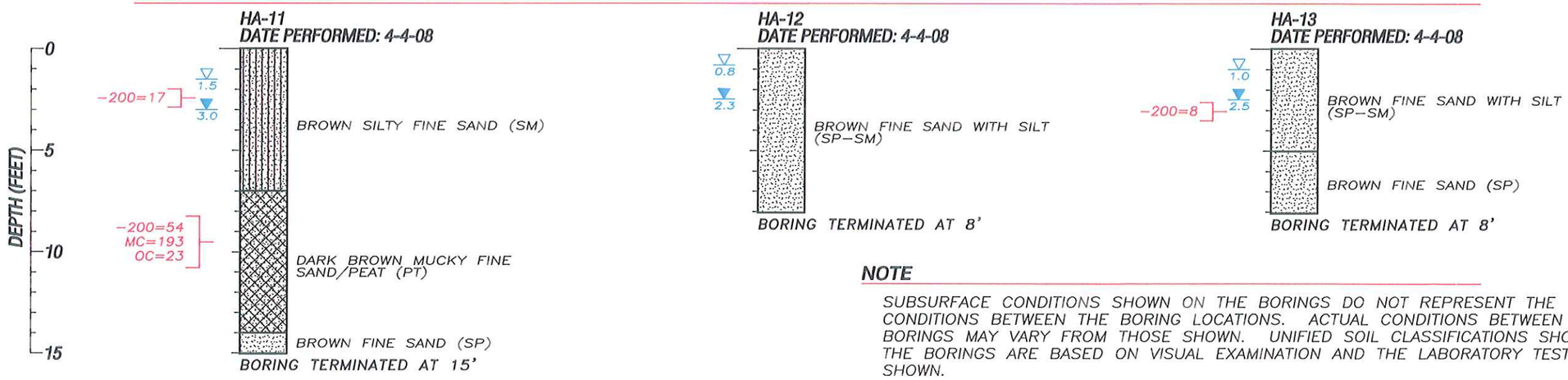


IMPROVEMENT AREA NOS. 3 AND 4

IMPROVEMENT AREA NO. 6



IMPROVEMENT AREA NO. 7



NOTE

SUBSURFACE CONDITIONS SHOWN ON THE BORINGS DO NOT REPRESENT THE CONDITIONS BETWEEN THE BORING LOCATIONS. ACTUAL CONDITIONS BETWEEN THE BORINGS MAY VARY FROM THOSE SHOWN. UNIFIED SOIL CLASSIFICATIONS SHOWN ON THE BORINGS ARE BASED ON VISUAL EXAMINATION AND THE LABORATORY TESTING SHOWN.

Geotechnical and Environmental Consultants, Inc.
1230 E. HILLCREST ST.
ORLANDO, FLORIDA 32803
(407) 898-1818
FAX (407) 898-1897
COA NO. 00005882

LAKE EUSTIS/ LAKESHORE DRIVE STORMWATER IMPROVEMENTS

PROJECT NO.:	2833G
DATE:	5-1-08
SENIOR PROFESSIONAL:	CPM P.E. No 49328
PROJECT PROFESSIONAL:	EWN
DRAWN:	SKR
REVISION:	
REVISION:	

LEGEND

- 0.5 — ESTIMATED SEASONAL HIGH GROUNDWATER DEPTH (FEET)
- 2.0 — ENCOUNTERED GROUNDWATER DEPTH (FEET)
- GNE — GROUNDWATER NOT ENCOUNTERED DURING DRILLING OF BORING
- -200= — PERCENT PASSING NO. 200 U.S. STANDARD SIEVE
- MC= — PERCENT NATURAL MOISTURE CONTENT
- OC= — PERCENT ORGANIC CONTENT
- SAND
- SAND AND SILT
- SAND AND MUCK/ PEAT

BORING RESULTS

FIGURE 3

LABORATORY TEST RESULTS

Table 8

Laboratory Soil Classification Test Results

Lake Eustis and Lakeshore Drive Stormwater Improvements

Lake County, Florida

GEC Project No. 2833G

Improvement Area	Boring No	Sample Depth (feet)	Percent Passing by Weight					Moisture Content (%)	Atterberg Limits		Organic Content (%)	Unified Class.
			#10 Sieve	#40 Sieve	#60 Sieve	#100 Sieve	#200 Sieve		Liquid Limit (%)	Plasticity Index (%)		
1	HA-1	0-5	---	---	---	---	2	---	---	---	---	SP
1	HA-3	5-7	---	---	---	---	2	---	---	---	---	SP
3/4	HA-4	0-5	---	---	---	---	7	---	---	---	---	SP-SM
3/4	HA-6	5-8	---	---	---	---	4	---	---	---	---	SP
6	HA-8	0-5	---	---	---	---	19	---	---	---	---	SM
6	HA-10	0-5	---	---	---	---	3	---	---	---	---	SP
7	HA-11	0-5	---	---	---	---	17	---	---	---	---	SM
7	HA-11	7-12	---	---	---	---	54	193	---	---	23	PT
7	HA-13	0-5	---	---	---	---	8	---	---	---	---	SP-SM
LBR SAMPLES												
1	LBR-1	1-3	100	62	23	6	3	---	---	---	---	SP
3/4	LBR-2	1-3	100	83	47	17	6	---	---	---	---	SP-SM
7	LBR-3	1-2	100	78	60	30	9	---	---	---	---	SP-SM

CORROSION SERIES TEST RESULTS

TABLE **9**

CORROSION SERIES TESTING RESULTS

Lake Eustis Drive and Lakeshore Dive

Stormwater Improvements

LAKE COUNTY, FLORIDA

GEC PROJECT NO. 2833G

Boring No.	Improvement Area	Depth (feet)	pH	Chlorides (ppm)	Sulfates (ppm)	Minimum Resistivity (ohm-cm)	Sub-structural Environmental Classification	
							Concrete	Steel
HA-2	1	0 to 7	6.6	60	<5	40,000	Slightly Aggressive	Moderately Aggressive
HA-9	6	0 to 5	6.1	90	36	24,000	Slightly Aggressive	Moderately Aggressive
HA-12	7	0 to 8	6.5	60	32	19,000	Slightly Aggressive	Moderately Aggressive

PAVEMENT CORE RESULTS

Table 10
Core Data Summary Table
Lakeshore Drive and Lake Eustis Drive Improvements
Lake County, Florida
GEC Project No. 2833G

Core No.	Improvement Area	Asphalt Thickness (in)	Concrete Thickness (in)	Overall CoreThickness (in)	Crack Depth (in)	Base Thickness (in)	Base type	Notes
C-1*	1	13	---	13	---	2	Asphalt/aggregate with sand	Delamination of asphalt at 6.5" from top of
	Lk Eustis							core
C-2	1	12.75	---	12.75	---	2	Large aggregate base with minimal liquid asphalt	
	Lk Eustis						binder and fines	
C-3	3/4	4 3/8	---	4 3/8	---	1	Large aggregate base with liquid asphalt	17" of stabilized subgrade beneath asphalt
	Lkshore Dr						binder and fines	
C-4	3/4	8.5	---	8.5	---	2.5	Large aggregate base with liquid asphalt	8" of stabilized subgrade beneath asphalt
	Lkshore Dr						binder and fines	
C-5	6	4.75	---	4.75	---	1	Large aggregate base with liquid asphalt	22" of stabilized subgrade beneath asphalt
	Lkshore Dr						binder and fines	
C-6**	6	2	Uknown	2 + X" Concrete	2	Unknown	Unknown	2" of asphalt over very hard un-corable
	Woodward							concrete
C-7	7	2.75	---	2.75	2.75	7	Limerock	Delamination at 1.5" from top of core
	Lkshore Dr							
C-8	7	5 3/8	---	5 3/8	2	1	Large aggregate base with liquid asphalt	
	Lkshore Dr						binder and fines	

* 13" of Asphalt and plus 2" of base limits from US 441 to 330' NE of C-1

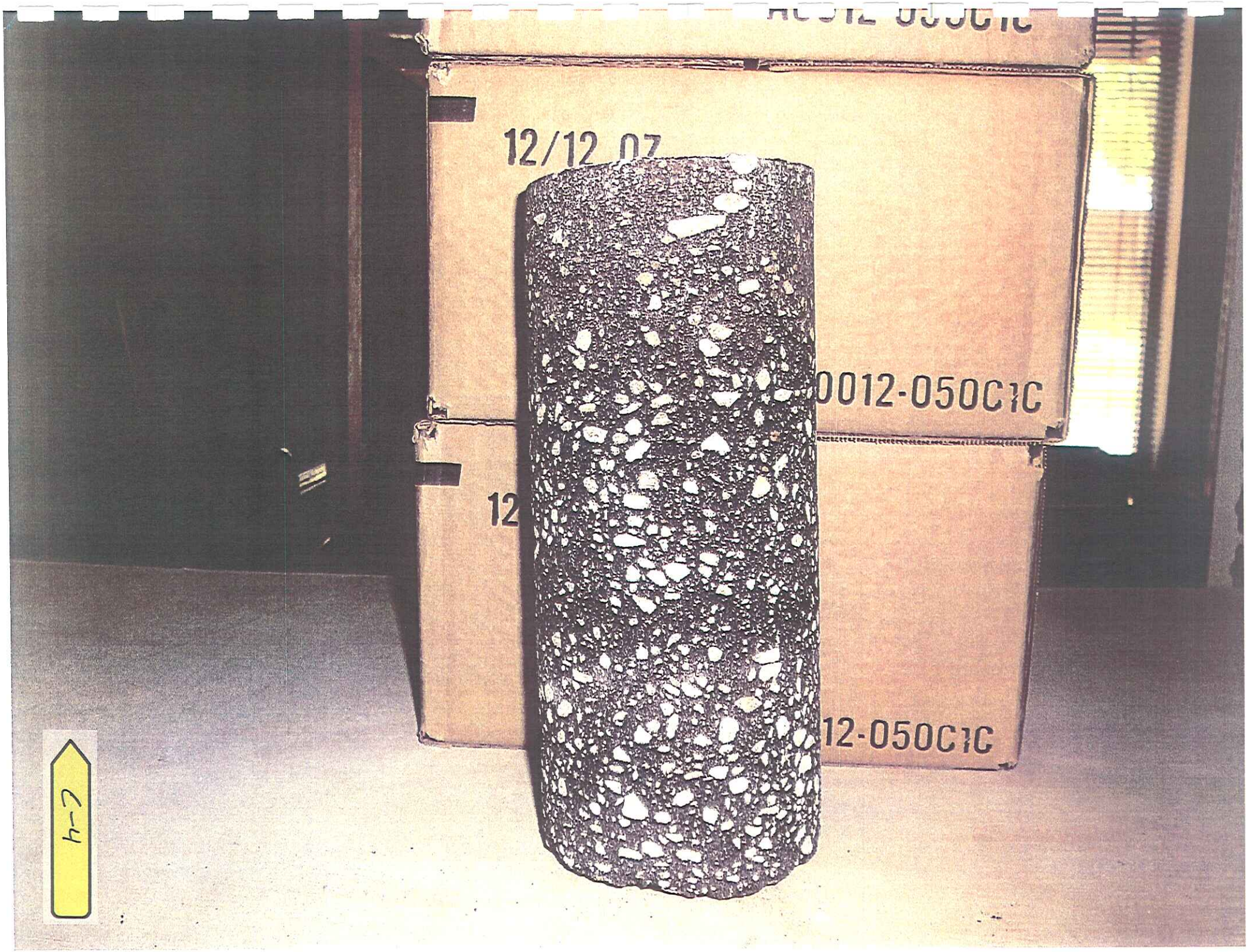
** Limits of concrete unknown

PAVEMENT CORE PHOTOGRAPHS

12/12
1C
12/
50C1C
12/
50C1C
C-1

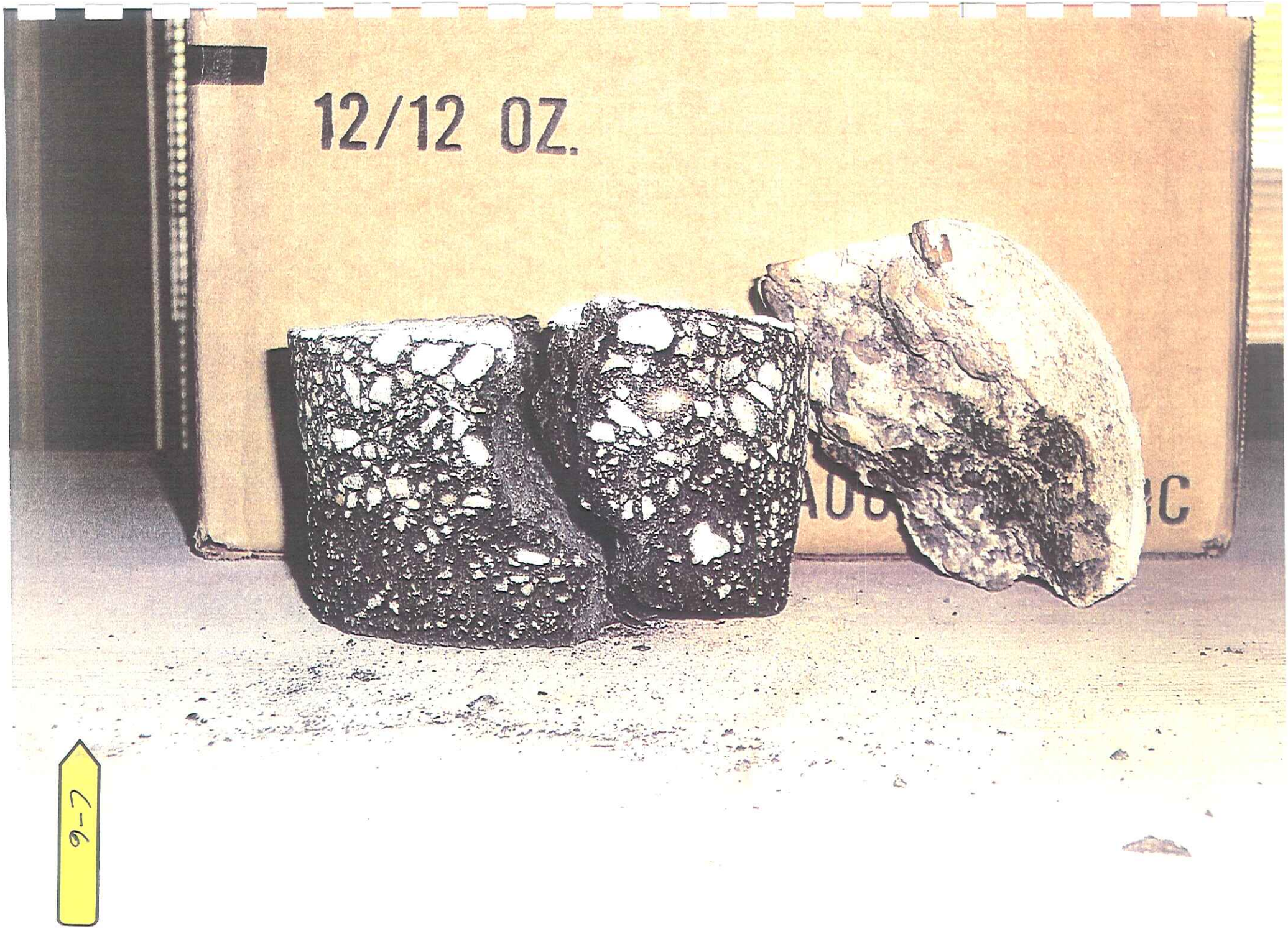
C-2

C-3



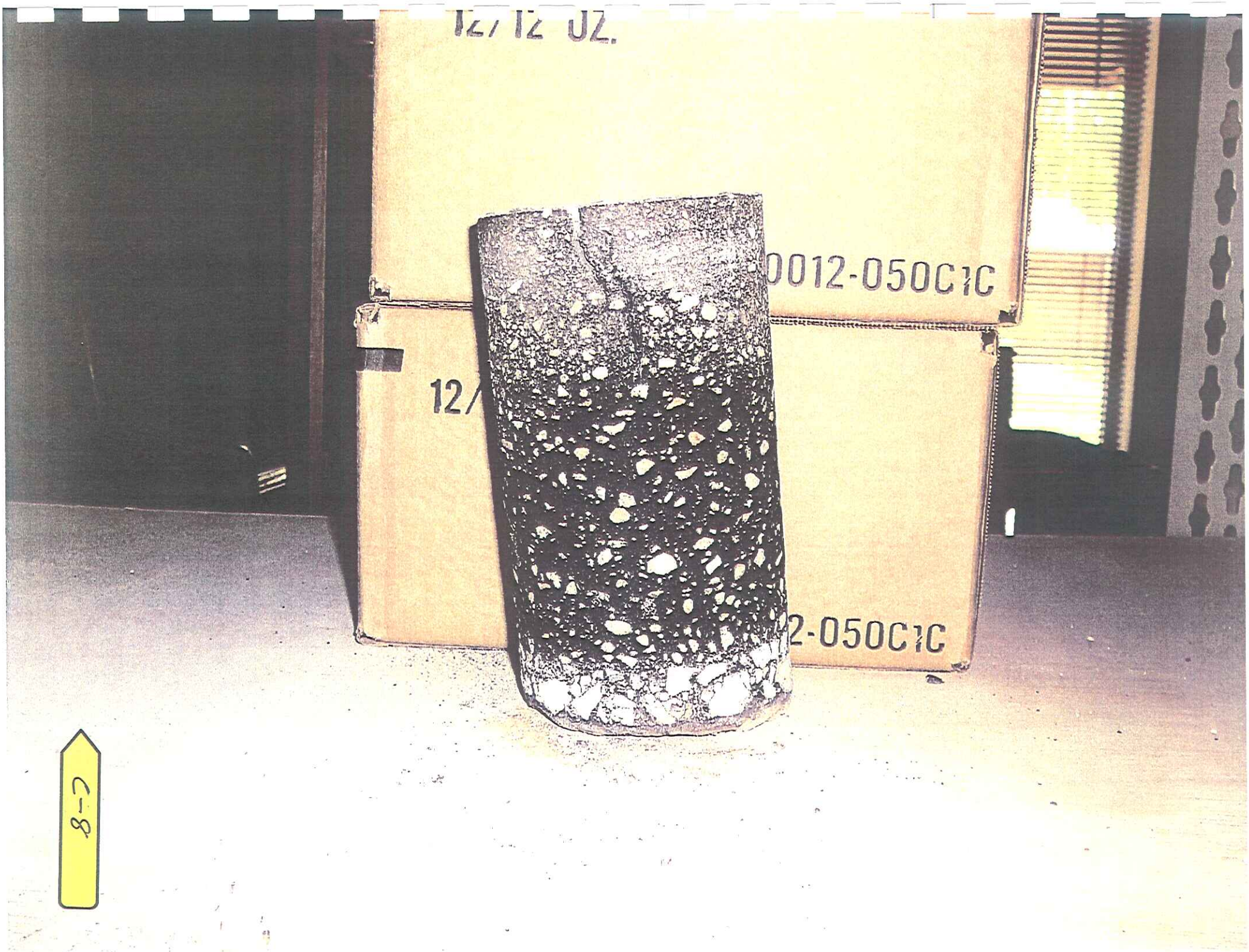
7-4

C-5



C-6

C-7


0012-050C1C
2-050C1C
C-8

FIELD PERMEABILITY CALCULATIONS

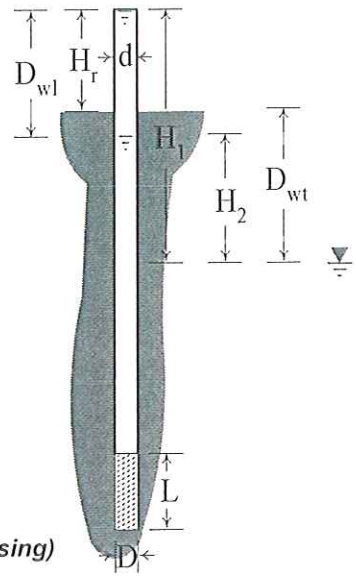
Geotechnical and Environmental Consultants, Inc.

At the very foundation of our community

Falling Head Field Permeability Test Calculations

Lake Eustis/Lakeshore Drive Improvements	Pond No:
	Test Location: HA-1
	Soil Type: SP-SM ~ 200 = 2
GEC Project No. 2833G	Test Depth: 2' - 4'

Input From Test



$d = D\ (in)$:	3.25	*Diameter of Gravel Pack & Casing*
$H_r\ (ft)$:	3	*Riser Height*
$D_{wt}\ (ft)$:	2	*Groundwater Depth*
$L\ (ft)$:	2	*Length of Gravel Pack*
$D_{wl}\ (ft)$:	1	*Water Level Drop (Drawdown)*
Δt:	0 min 6 sec	*Time for Water Level to Drop*

Calculations

$H_1 = H_r + D_{wt}$ — *Initial Piezometric Head (Starting Water Level at Top of Casing)*

$H_2 = H_1 - D_{wt}$ — *Final Piezometric Head*

$m = \sqrt{\frac{k_h}{k_v}}$ — *Transformation Ratio*

$m = \sqrt{2}$ — *Assuming $k_v = 0.5k_h$*

$$k_h = \frac{d^2 \cdot \ln\left(\frac{2 \cdot m \cdot L}{D}\right)}{8 \cdot L \cdot (\Delta t)} \cdot \ln\left(\frac{H_1}{H_2}\right)$$

From NAVFAC TM 5-818-5 PG. 35*

**(Formula Applicable When: $m \cdot \frac{L}{D} = 10.44 > 4$)*

k_h = 44.769 ft/day *OR* k_h = 0.0158 cm/sec

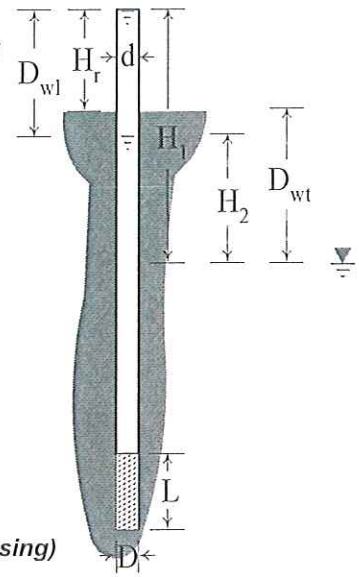
Geotechnical and Environmental Consultants, Inc.

At the very foundation of our community

Falling Head Field Permeability Test Calculations

Lake Eustis/Lakeshore Drive Improvements	Pond No:
	Test Location: HA-3
	Soil Type: SP ~~SM~~ -2 or 2
GEC Project No. 2833G	Test Depth: 2' - 4'

Input From Test



$d = D\ (in)$:	3.25	*Diameter of Gravel Pack & Casing*
$H_r\ (ft)$:	3	*Riser Height*
$D_{wt}\ (ft)$:	2.3	*Groundwater Depth*
$L\ (ft)$:	2	*Length of Gravel Pack*
$D_{wl}\ (ft)$:	1	*Water Level Drop (Drawdown)*
Δt:	0 min 10 sec	*Time for Water Level to Drop*

Calculations

$$H_1 = H_r + D_{wt}$$

Initial Piezometric Head (Starting Water Level at Top of Casing)

$$H_2 = H_1 - D_{wt}$$

Final Piezometric Head

$$m = \sqrt{\frac{k_h}{k_v}}$$

Transformation Ratio

$$m = \sqrt{2}$$

Assuming $k_v = 0.5k_h$

$$k_h = \frac{d^2 \cdot \ln\left(\frac{2 \cdot m \cdot L}{D}\right)}{8 \cdot L \cdot (\Delta t)} \cdot \ln\left(\frac{H_1}{H_2}\right)$$

From NAVFAC TM 5-818-5 PG. 35*

**(Formula Applicable When: $m \cdot \frac{L}{D} = 10.44 > 4$)*

k_h = 25.170 ft/day *OR* k_h = 0.0089 cm/sec

Geotechnical and Environmental Consultants, Inc.

At the very foundation of our community

Constant Head Field Permeability Test Calculations

Lake Eustis/Lakeshore Drive Improvements	Pond No:
	Test Location: HA-4
	Soil Type: SP-SM ✓ -2W=7
GEC Project No. 2833G	Test Depth: 2' - 4'

Input From Test

$q\left(\frac{gal}{\min}\right)$: 0.850 — *Flow in Gallons/Minute*

$q\left(\frac{ft^3}{day}\right)$: 163.625 — *Flow in Cubic Feet/Day*

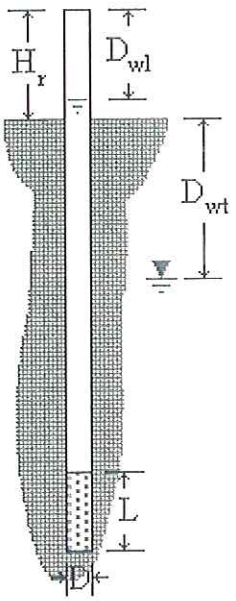
$D\ (in)$: 3.25 — *Diameter of Gravel Pack*

$L\ (ft)$: 2 — *Length of Gravel Pack*

$H_r\ (ft)$: 3 — *Riser Height*

$D_{wl}\ (ft)$: 0 — *Water Level in Casing*

$D_{wt}\ (ft)$: 8 — *Groundwater Depth*



Calculations

$$m = \sqrt{\frac{k_h}{k_v}}$$ *Transformation Ratio*

$$m = \sqrt{2}$$ *Assuming $k_v = 0.5k_h$*

$$H_c = D_{wt} + H_r - D_{wl}$$ *Constant Piezometric Head*

$$k_h = q \cdot \frac{\ln\left[m \cdot \frac{L}{D} + \sqrt{1 + \left(m \cdot \frac{L}{D}\right)^2}\right]}{2 \cdot \pi \cdot L \cdot H_c}$$ *From NAVFAC TM 5-818-5 PG. 35*

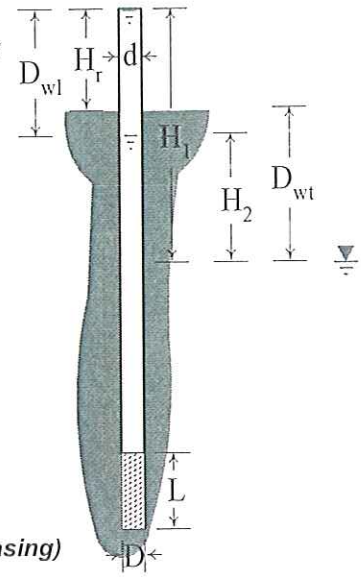
k_h = 3.600 ft/day *OR* k_h = 0.0013 cm/sec

Falling Head Field Permeability Test Calculations

Geotechnical and Environmental Consultants, Inc.
At the very foundation of our community

Lake Eustis/Lakeshore Drive Improvements	Pond No:
	Test Location: HA-6
	Soil Type: ~~SP~~/SM -2w=19
GEC Project No. 2833G	Test Depth: 2' - 4'

Input From Test



$d = D\ (in)$: 3.25		*Diameter of Gravel Pack & Casing*
$H_r\ (ft)$: 3		*Riser Height*
$D_{wt}\ (ft)$: 8		*Groundwater Depth*
$L\ (ft)$: 2		*Length of Gravel Pack*
$D_{wl}\ (ft)$: 1		*Water Level Drop (Drawdown)*
Δt: 0	*min*	*Time for Water Level to Drop*
6	*sec*	

Calculations

$H_1 = H_r + D_{wt}$ — *Initial Piezometric Head (Starting Water Level at Top of Casing)*

$H_2 = H_1 - D_{wt}$ — *Final Piezometric Head*

$m = \sqrt{\frac{k_h}{k_v}}$ — *Transformation Ratio*

$m = \sqrt{2}$ — *Assuming $k_v = 0.5k_h$*

$$k_h = \frac{d^2 \cdot \ln\left(\frac{2 \cdot m \cdot L}{D}\right)}{8 \cdot L \cdot (\Delta t)} \cdot \ln\left(\frac{H_1}{H_2}\right)$$

From NAVFAC TM 5-818-5 PG. 35*

**(Formula Applicable When: $m \cdot \frac{L}{D} = 10.44 > 4$)*

k_h = 19.122 ft/day *OR* k_h = 0.0067 cm/sec

Geotechnical and Environmental Consultants, Inc.

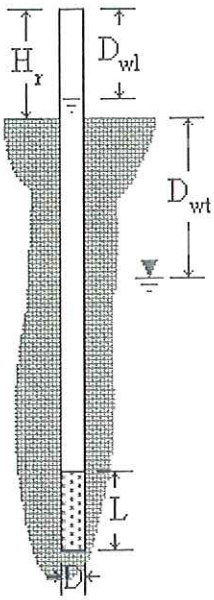
At the very foundation of our community

Constant Head Field Permeability Test Calculations

Lake Eustis/Lakeshore Drive Improvements	Pond No:
	Test Location: HA-10
	Soil Type: SP-~~SM~~ -Zone 3
GEC Project No. 2833G	Test Depth: 2' - 4'

Input From Test

$q\left(\frac{gal}{\min}\right)$:	0.350	*Flow in Gallons/Minute*
$q\left(\frac{ft^3}{day}\right)$:	67.375	*Flow in Cubic Feet/Day*
$D\ (in)$:	3.25	*Diameter of Gravel Pack*
$L\ (ft)$:	2	*Length of Gravel Pack*
$H_r\ (ft)$:	3	*Riser Height*
$D_{wl}\ (ft)$:	0	*Water Level in Casing*
$D_{wt}\ (ft)$:	5.3	*Groundwater Depth*



Calculations

$$m = \sqrt{\frac{k_h}{k_v}}$$ *Transformation Ratio*

$$m = \sqrt{2}$$ *Assuming $k_v = 0.5k_h$*

$$H_c = D_{wt} + H_r - D_{wl}$$ *Constant Piezometric Head*

$$k_h = q \cdot \frac{\ln\left[m \cdot \frac{L}{D} + \sqrt{1 + \left(m \cdot \frac{L}{D}\right)^2}\right]}{2 \cdot \pi \cdot L \cdot H_c}$$ *From NAVFAC TM 5-818-5 PG. 35*

k_h = 1.965 ft/day *OR* k_h = 0.0007 cm/sec

Geotechnical and Environmental Consultants, Inc.

At the very foundation of our community

Constant Head Field Permeability Test Calculations

Lake Eustis/Lakeshore Drive Improvements	Pond No:
	Test Location: HA-11
	Soil Type: ~~SP~~/SM -200#17
GEC Project No. 2833G	Test Depth: 2' - 4'

Input From Test

$q\left(\frac{gal}{\min}\right)$: 0.001 — *Flow in Gallons/Minute*

$q\left(\frac{ft^3}{day}\right)$: 0.1985156 — *Flow in Cubic Feet/Day*

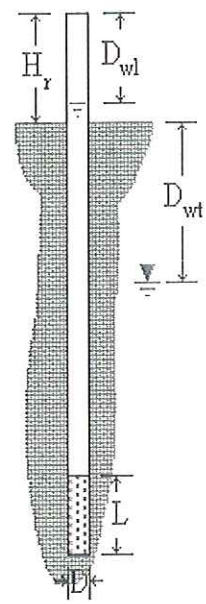
$D\ (in)$: 3.25 — *Diameter of Gravel Pack*

$L\ (ft)$: 2 — *Length of Gravel Pack*

$H_r\ (ft)$: 3 — *Riser Height*

$D_{wl}\ (ft)$: 0 — *Water Level in Casing*

$D_{wt}\ (ft)$: 5 — *Groundwater Depth*



Calculations

$$m = \sqrt{\frac{k_h}{k_v}}$$ — *Transformation Ratio*

$$m = \sqrt{2}$$ — *Assuming $k_v = 0.5k_h$*

$$H_c = D_{wt} + H_r - D_{wl}$$ — *Constant Piezometric Head*

$$k_h = q \cdot \frac{\ln\left[m \cdot \frac{L}{D} + \sqrt{1 + \left(m \cdot \frac{L}{D}\right)^2}\right]}{2 \cdot \pi \cdot L \cdot H_c}$$ — *From NAVFAC TM 5-818-5 PG. 35*

k_h = 0.006 ft/day *OR* k_h = 0.0000 cm/sec

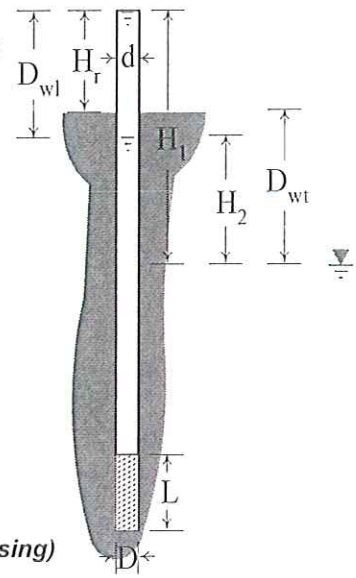
Geotechnical and Environmental Consultants, Inc.

At the very foundation of our community

Falling Head Field Permeability Test Calculations

Lake Eustis/Lakeshore Drive Improvements	Pond No:
	Test Location: HA-13
	Soil Type: SP-SM ~20028
GEC Project No. 2833G	Test Depth: 2' - 4'

Input From Test



$d = D\ (in)$:	3.25	*Diameter of Gravel Pack & Casing*
$H_r\ (ft)$:	3	*Riser Height*
$D_{wt}\ (ft)$:	5.5	*Groundwater Depth*
$L\ (ft)$:	2	*Length of Gravel Pack*
$D_{wl}\ (ft)$:	1	*Water Level Drop (Drawdown)*
Δt:	3 min 31 sec	*Time for Water Level to Drop*

Calculations

$H_1 = H_r + D_{wt}$ — *Initial Piezometric Head (Starting Water Level at Top of Casing)*

$H_2 = H_1 - D_{wt}$ — *Final Piezometric Head*

$m = \sqrt{\frac{k_h}{k_v}}$ — *Transformation Ratio*

$m = \sqrt{2}$ — *Assuming k_v=0.5k_h*

$$k_h = \frac{d^2 \cdot \ln\left(\frac{2 \cdot m \cdot L}{D}\right)}{8 \cdot L \cdot (\Delta t)} \cdot \ln\left(\frac{H_1}{H_2}\right)$$

From NAVFAC TM 5-818-5 PG. 35*

**(Formula Applicable When: $m \cdot \frac{L}{D} = 10.44 > 4$)*

k_h = 0.714 ft/day *OR* k_h = 0.0003 cm/sec

LBR TEST RESULTS

LIMEROCK BEARING RATIO TEST REPORT

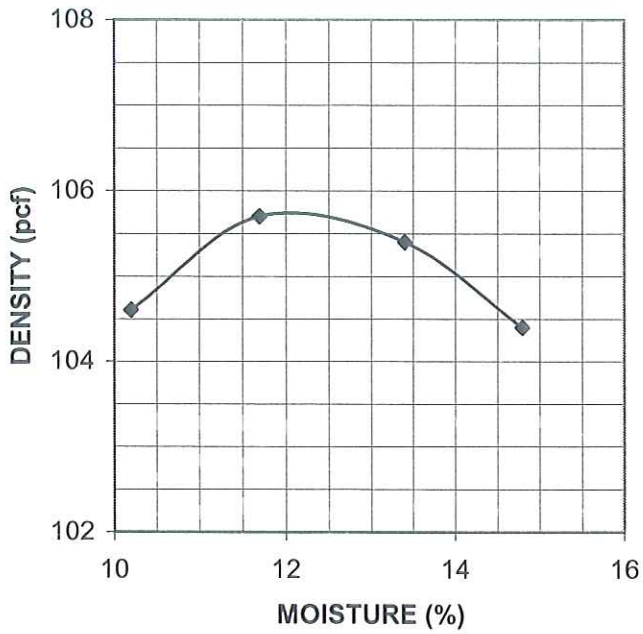


Figure 2: Moisture Content Versus Density

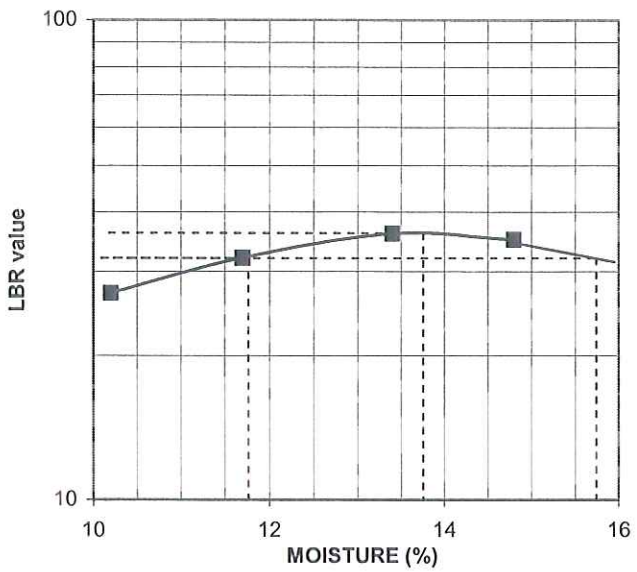


Figure 1: Moisture Content Versus LBR

Project Information

Project Name: LAKE EUSTIS DRIVE

GEC Project No: 2833G

Sample Information Area 1

Location: LBR-1 1'-3'

Date Tested: 4-14-08

Material Description: GREY FINE SAND (SP)

Modified Proctor Test Results

Optimum Moisture (%)= 12.0

Max. Dry Density (pcf)= 106

LBR Test Results (FM 5-515)

Maximum LBR at Optimum LBR Moisture= 36.0

LBR at -2% of Optimum LBR Moisture= 32.0

LBR at +2% of Optimum LBR Moisture= 32.0

Geotechnical and Environmental Consultants, Inc.

LIMEROCK BEARING RATIO TEST REPORT

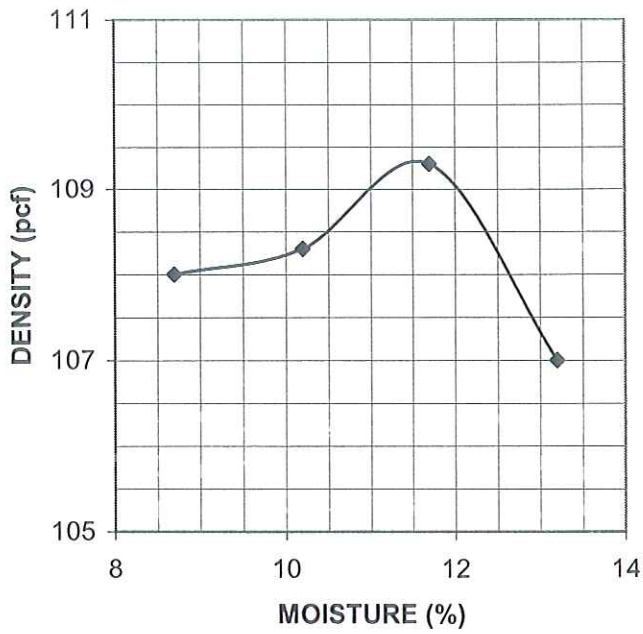


Figure 2: Moisture Content Versus Density

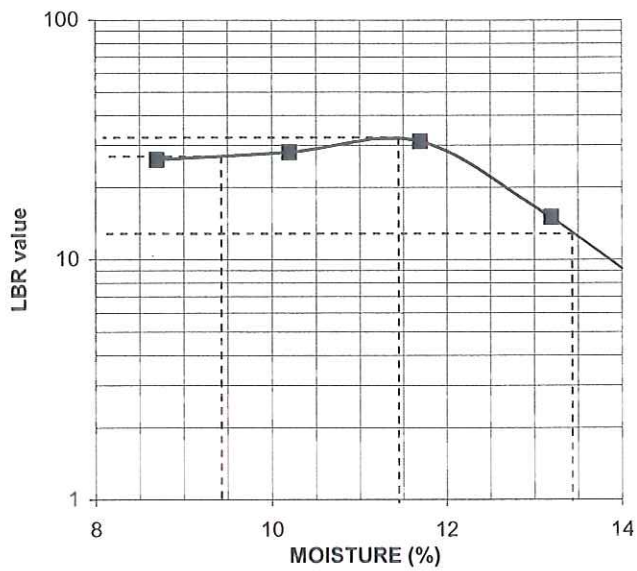


Figure 1: Moisture Content Versus LBR

Project Information

Project Name: LAKE EUSTIS DRIVE

GEC Project No: 2833G

Sample Information Area 3/4

Location: LBR-2 1'-3'

Date Tested: 4-14-08

Material Description: BROWN FINE SAND W/ SILT (SP-SM)

Modified Proctor Test Results

Optimum Moisture (%)= 12.0

Max. Dry Density (pcf)= 109

LBR Test Results (FM 5-515)

Maximum LBR at Optimum LBR Moisture= 31.0

LBR at -2% of Optimum LBR Moisture= 26.0

LBR at +2% of Optimum LBR Moisture= 13.0

Geotechnical and Environmental Consultants, Inc.

LIMEROCK BEARING RATIO TEST REPORT

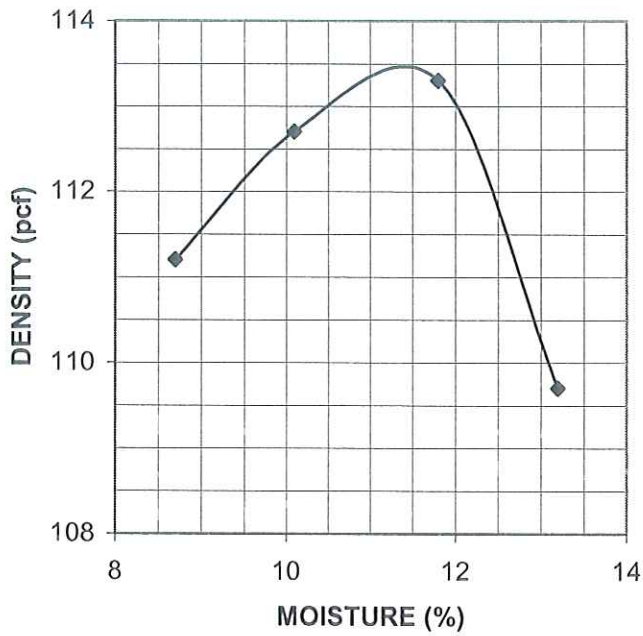


Figure 2: Moisture Content Versus Density

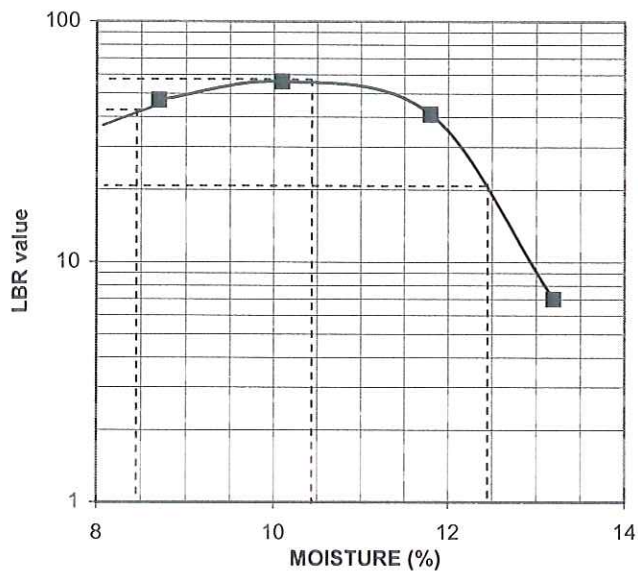


Figure 1: Moisture Content Versus LBR

Project Information

Project Name: LAKE EUSTIS DRIVE

GEC Project No: 2833G

Sample Information Area 7

Location: LBR-3 1'-2'

Date Tested: 4-14-08

Material Description: BROWN FINE SAND W/ SILT (SP-SM)

Modified Proctor Test Results

Optimum Moisture (%)= 11.0

Max. Dry Density (pcf)= 113

LBR Test Results (FM 5-515)

Maximum LBR at Optimum LBR Moisture= 56.0

LBR at -2% of Optimum LBR Moisture= 42.0

LBR at +2% of Optimum LBR Moisture= 21.0

Geotechnical and Environmental Consultants, Inc.