GEOTECHNICAL INVESTIGATION & REPORT for RECONSTRUCTION

of

CUSHMAN LAKE DAM

August 2012

Prepared For: Collings Lakes Community Association

Folsom Township, New Jersey

DSS File #31-98

LJCE Ref. No. 14991

COLLINGS LAKE CIVIC ASSOCIATION
P.O. Box 475
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Prepared By:
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One Pavilion Avenue
Riverside, New Jersey 08075

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NJ PE# GE-16247

INTRODUCTION

This report presents the findings, conclusions, and recommendations of a geotechnical engineering study for the evaluation and reconstruction of the existing dam embankment and secondary spillway for the Cushman Lake Dam, Folsom, Atlantic County, NJ.

The purpose of this work was to study the soil profile and soil properties encountered at the site, and to address the reconstruction of the dam and replacement of the secondary spillway.

SITE & PROJECT DESCRIPTION

The dam embankment separates Cushman Lake from the downstream swampy forested intermittent lake. The existing dam at Cushman is an earth embankment totaling approximately 700 ft. The embankment contains a principal spillway with five weir openings dropping into a concrete structure consisting of three rectangular-shaped discharge conduits. The breach occurred during a major storm event [Hurricane Irene] in August 2011. The top of embankment ranges from 15 feet – 20 feet in width and varies in elevation from 68.5 feet – 71+ feet. Cushman Lake was drained, and has remained so, as a result of the breach at the secondary spillway. The water level in Cushman Lake remains at the bottom of the breach.

The embankment side slopes are stable and were covered with vegetation and trees, which have now been removed. No water was observed seeping along the downstream slope of the embankment during inspections prior to the breach. Site and project information was obtained from available ***LJCE*** drawings and from our recent site reconnaissance.

SUBSURFACE INVESTIGATION

The investigation included the advancement of five Standard Penetration Test (SPT) borings, B-1 through B-5, along the top of embankment. The SPT borings were advanced to a depth of 25 feet along the crest of the dam using truck-mounted. Additionally, a Wildcat penetration sounding was taken in the breach area where the secondary spillway was washed out.

Soil samples in all SPT borings were recovered via a two-inch O.D. split-spoon sampler, driven by a 140-pound hammer, free falling 30 inches (ASTM D 1586). Soil samples were identified and logged in the "Burmister Soil Identification System" and the "Unified Soil Classification System."

The locations of the test borings are shown on the "Boring Location Plan" included with the test boring logs. The surface elevation contours shown on the drawing were obtained by the Survey Department of ***LJCE.***

LABORATORY TESTING

All recovered soil samples were taken to the ***LJCE*** soils laboratory in Riverside, NJ, for examination and testing. The drillers' field classifications were confirmed or modified as necessary by our soil laboratory engineers. In addition to detailed visual classifications, gradation analysis and moisture content measurements were performed to determine soil engineering properties and to assist in soil identification.

SOIL & SUBSURFACE CONDITIONS

Soils Encountered

The dam embankment consists of very loose to medium dense soils, of local origin, described as brown and yellow brown and medium to coarse to fine SAND, trace SILT, trace fine GRAVEL, with occasional organic material as found in Boring #3. The thickness of the organic appeared to be less than 2 feet. Generally borings encountered loose material from two to four feet below the top of embankment to a depth ranging from 10 to 14 feet. Beneath this zone, soil ranged from medium dense to very dense. It should be mentioned that in the absence of foreign material from within the soil matrix, it is generally difficult to differentiate the boundaries between natural, backfilled or regraded natural soils, even when classified by experienced engineers. Accordingly, the depth and thickness of the embankment fill material placed on top of the natural alluvial deposits could vary from those shown on the boring logs and is not clearly evident from the logged data. The natural alluvial soils immediately below the embankment consist of gray or brown medium to fine or coarse to fine SAND, trace SILT, trace GRAVEL, generally having a compact to very dense relative density. The detailed stratigraphy is shown on the boring logs.

Groundwater

Groundwater was encountered at depths ranging from 4 to 8 ft below existing top of embankment at the time of drilling depending upon location along the embankment. In general, groundwater elevations can be expected to vary with variations in the lake level and with seasonal and climatic conditions. At the time of drilling both upper and lower lakes were emptied.

DISCUSSION

General

The geotechnical investigation indicated that the dam embankment is mainly loose to very loose granular soils underlain by natural native granular soils in variable states of relative density, typically compact, down to the termination of the borings.

The existing earth dam embankment crest width is variable, averaging about 15 ft or wider at the top, with a top elevation of about 68.5 to 71+. The embankment slopes are generally variable 2:1 at the steepest to greater than 3:1. The upstream and downstream slopes were covered by vegetation which has been removed before borings were taken.

Dam improvements will include a renovated primary spillway and a completely reconstructed secondary spillway where the breach occurred. The new spillway renovation must accommodate the current constraints imposed by NJDEP, Dam Safety Section (DSS). The reconstructed spillway embankment should be protected from scour and erosion and may need protection from wave fetch along the upstream embankment slope, depending upon hydraulic calculations.

Seepage and slope stability have been estimated based upon proposed slopes and tests to determine soil characteristic for the proposed reconstructed dam embankment to ensure the embankment has a sufficient factor of safety under critical flood conditions with various water surface elevations within the upper lake. We are recommending that the entire embankment be proof-rolled as described hereinafter. We recommend at least two piezometers be installed in the embankment to monitor the phreatic surface of hydrostatic load in the vicinity of the spillway when the lake is full. This could be incorporated at the time of reconstruction. The water level readings in the piezometers will provide valuable information to confirm if the actual phreatic surface conforms to the estimated phreatic surface, and that the dam will perform as designed.

The embankment soils are loose and must be densified and in some areas widened to improve the stability. While earthquake requirements are not in place for low head dams in this region, it is our opinion that, after densification and compaction of new fill materials, the embankment would be stable against liquefaction.

Earthwork Recommendations

Clear and strip from the embankment crest and slopes of the construction area, all existing vegetation and topsoil, including any trees and entire root systems to root diameters down to at least one to two inches as directed by the Design Engineer. Soft or very loose soils containing significant organic materials should be undercut to satisfactory underlying soils, as determined by the Design Engineer. Remove miscellaneous concrete, tires and other materials along the upstream embankment. Should it be desirable to leave any non-soil material in place, the decision would require approval of the Design Engineer. Dewatering will likely be required to accomplish any undercutting under dry conditions.

During a dry and favorable weather period and under the technical supervision of a Design Engineer, proofroll and compact the resulting grades with a medium to heavy duty smooth drum vibratory roller. The existing embankment, after stripping, should be rigorously compacted with at least 8 passes of the vibratory roller. The purpose is to densify, as much as possible, the very loose embankment soils to improve the soil strength and stability. It may be necessary to start the compaction without vibratory rolling to gradually densify the very loose soils.

In all areas where new fill is to be placed (primarily the breach area), remove any unsuitable soils down to a firm soil subgrade. Where the existing embankment is to be modified, the embankment shall be benched horizontally so that new fill can be added and satisfactorily compacted. The Design Engineer must approve the excavation limits and replacement with suitable compacted fill materials.

Undercut any zones of instability disclosed by the over excavation and the proofrolling and replace the undercut material with structural fill, as defined by the Design Engineer. The previously stripped site soil may be used as structural fill, but only if it does not contain organic materials and it is at the proper moisture content and has been approved for use by the Design Engineer.

Grade the site to proposed elevations with controlled select fill, as defined by the design plans. At the location of the western-most portion of the embankment, the asphalt paved spillway should be removed to eliminate a smooth surface conducive to "piping". The area should be proof rolled as described previously prior to raising the embankment to finish grade. All excavations should be in compliance with "Excavating and Trenching Operations" manual (latest edition), issued by the US Department of Labor, OSHA 2226.

Select Fill

Controlled fill should consist of inorganic, readily compactable, predominantly well-graded granular soils with between 10% and 20% fines (material passing the No. 200 sieve). It is recommended that fragments having a maximum dimension greater than three inches be excluded from the fill. The moisture content of the fill materials should be controlled to within 2% of the optimum by wetting, aeration or blending to facilitate compaction.

All fill should be controlled fill. Controlled fill should be placed in loose horizontal lifts with a maximum thickness of nine inches with horizontal benching. It is recommended that controlled fill within the construction area be compacted to at least 92% and 95% of the maximum dry density as determined by the Modified Proctor Test (ASTM D 1557) in the dam embankment. Each lift of new fill should be cut into the existing slope at least 2 ft and benched, to avoid developing a shear plane between the existing and new fill. In addition, it is recommended that all fills be stable without significant movement under construction traffic, as judged by the Design Engineer. Quality control testing of proposed fill materials and fill densities in-place must be conducted throughout the entire earthwork operation.

Seepage

While there has been no evidence of seepage through the embankment or around the existing structure, seepage through the dam embankment and through the spillway section has been considered in the design analyses. Design decisions have been based upon observations of the dam when functioning at normal lake levels in addition to results of limited laboratory testing of on-site soils.

Recommended Design Parameters for Existing Sandy Soil Without Densification

φ, friction angle	28°
Unit Weight, dry	102 pcf
e, void ratio	0.66
k, permeability	1.0×10^{-3} cm/sec
c, cohesion	0 psf

Imported and existing sandy (silty) soil with densification should have the following properties. (These are preliminary values and must be confirmed for final design by testing, etc.)

φ, friction angle	32° to 34°
Unit Weight, dry	108 to 110 pcf
e, void ratio	0.45 to 0.55
k, permeability	0.5 to 10^{-4} cm/sec
c, cohesion	0 psf

Foundations

Since no new foundations are proposed within the embankment, no discussion or recommendations are included in this report.

Construction Dewatering

Groundwater levels encountered during construction may vary somewhat from those levels shown on the boring logs due to seasonal variations or climatic conditions and the lake levels. However, the contractor should assume dewatering of excavations will be necessary for embankment and spillway construction. A dewatering plan should be submitted for approval prior to construction.

The dewatering specifications should be of the performance type requiring that the contractor provides an adequate dewatering system capable of maintaining the water table at a minimum of 2 ft below the prevailing excavation bottom during excavation and reconstruction, as well as during backfilling operations.

Dewatering should continue until adequate structural dead weight is available to resist uplift pressures. The required dewatering operation could be continuous on an around-the-clock basis, as necessary. Therefore, we recommend that a standby system be provided to assure the continuity of the dewatering operation.

The necessity of cofferdamming is anticipated during spillway construction. The contractor should be responsible for the method, means, and design of the cofferdam by a professional engineer. Plans must be submitted for approval by the owner's Design Engineer.

LIMITATIONS

The conclusions and recommendations contained in this report are based upon the subsurface data obtained during this investigation and on details stated in this report. It is understood that the number of borings made are consistent with good engineering practice but actual conditions encountered may differ significantly from those projected in this report. Should conditions arise which differ from those described in this report, ***LJCE*** should be notified immediately and provided with all information regarding subsurface conditions.

Our recommendations are based upon the assumption that the Design Engineer is in responsible control of the project during construction and will be retained for the observation of stripping operations, proofrolling, preparation of embankment subgrades, controlled fill placement, and all critical earthwork operations. ***LJCE*** should be engaged to do the on-site quality control observation to ensure the work is carried out in the owner's best interests.

This report is intended for use with regard to the specific project discussed herein, and any changes in the design of the structures or location, however slight, should be brought to our attention so that we may determine how they may affect our conclusions. We are responsible for the conclusions and opinions contained in this report and on the data relating only to the specific project and location discussed herein.

Project No. 14991
Date: 8-1-2012

Log of Test Boring

Lippincott & Jacobs Consulting Engineers
One Pavilion Avenue, Riverside, NJ 08075

Plate No. 1 of 6
Boring No. B-1
Sheet 1 of 1

Project Cushman Lake Dam **Client** Collings Lake Civic Association **Surface Elev.** 69.0

Location Folsom, NJ

Drill Method: Hollow Stem Auger ID 3.25" **Casing ID** _____

Grouted ☐ **Date** _____

Groundwater Data
Depth 7'
Date 8-1-12
Time End of Boring

Depth (ft.)	Sample Type	Sample Number	Blow Count (Blows per 6 inches)	Lithology	Classification of Materials (Based upon samples recovered and observation of materials returned between samples)	Stratum	Moisture Content, %	Other Tests
0					Asphalt 3"			
		S-1	2-2-2		Brown Medium to Fine SAND, Trace to Little Silt, Trace of Gravel			
		S-2	2-2-2-2		Brown Fine SAND, Trace of Silt			
5		S-3	2-2-3-3					
		S-4	2-1-2-2					
		S-5	1-1-1-1					
10		S-6	2-2-2-8					
		S-7	6-7-8-8					
15								
		S-8	10-10-11-14		Brown Fine SAND, Trace of Silt, Occasional Gravel			
20								
		S-9	9-8-10-11		Brown Medium to Fine SAND, Trace of Silt, Trace of Gravel			
25					End of Boring at 25'			
30								
35								

Inspector _____ **Driller** E. Blemmings **Helper** M. Schick **Equipment** CME-55

Project No. 14991
Date: 8-1-2012

Log of Test Boring

Lippincott & Jacobs Consulting Engineers
One Pavilion Avenue, Riverside, NJ 08075

Plate No. 2 of 6
Boring No. B-2
Sheet 1 of 1

Project Cushman Lake Dam **Client** Collings Lake Civic Association **Surface Elev.** 72.8

Location Folsom, NJ

Drill Method: Hollow Stem Auger ID 3.25" **Casing ID** _____ **Depth** 12'

Grouted ☐ **Date** _____ **Date** 8-1-12

Time End of Boring

Groundwater Data

Depth (ft.)	Sample Type	Sample Number	Blow Count (Blows per 6 inches)	Lithology	Classification of Materials (Based upon samples recovered and observation of materials returned between samples)	Stratum	Moisture Content, %	Other Tests
0		S-1	30-6-6-4		Fill: Brown Medium to Fine SAND, Trace to Little Concrete Fragments, Trace of Silt			
		S-2	2-2-1-1		Brown Medium to Fine SAND, Trace to Little Silt, Trace of Gravel			
5		S-3	2-2-2-2		Yellowish brown coarse-fine SAND, little Silt		4.5	
		S-4	1-1-1-1					
		S-5	2-3-4-2		Brown Medium to Fine SAND, Trace to Little Silt, Trace to Little Ironstone Fragments			
10		S-6	2-2-2-2		Brown Medium to Fine SAND, Trace to Little Silt, Trace of Gravel			
▼		S-7	2-2-2-2					
15								
		S-8	3-4-7-8		Yellowish brown coarse to Fine SAND, Trace of Silt, Trace of Gravel		14.2	
20								
		S-9	5-4-7-8		Brown Medium to Fine SAND, Trace of Silt, Trace of Gravel			
25					End of Boring at 25'			
30								
35								

Inspector _____ **Driller** E. Blemmings **Helper** M. Schick **Equipment** CME-55

Project No. 14991
Date: 8-1-2012

Log of Test Boring

Lippincott & Jacobs Consulting Engineers
One Pavilion Avenue, Riverside, NJ 08075

Plate No. 3 of 6
Boring No. B-3
Sheet 1 of 1

Project Cushman Lake Dam **Client** Collings Lake Civic Association **Surface Elev.** 71.0

Location Folsom, NJ

Drill Method: Hollow Stem Auger ID 3.25" **Casing ID** _____ **Depth** 8'

Grouted ☐ **Date** _____ **Date** 8-1-12

Time End of Boring

Groundwater Data

Depth (ft.)	Sample Type	Sample Number	Blow Count (Blows per 6 inches)	Lithology	Classification of Materials (Based upon samples recovered and observation of materials returned between samples)	Stratum	Moisture Content, %	Other Tests
0		S-1	5-11-4-3		Brown Medium to Fine SAND, Trace of Gravel, Trace of Silt			
		S-2	3-3-3-2		Yellowish brown coarse-fine SAND, little Silt, trace fine Gravel		4.4	
5		S-3	2-2-2-2					
		S-4	2-2-2-3		Yellowish brown coarse to Fine SAND, Little Silt, Trace of Gravel		10.3	
		S-5	1-1-1-1		Gray Medium to Fine SAND, Trace of Silt			
10		S-6	2-2-2-2		Dark Gray Organic CLAYEY SILT, Trace of Fine Sand, Trace of Decomposed Vegetation			
		S-7	2-4-5-5		Gray Medium to Fine SAND, Trace of Silt			
15								
		S-8	9-10-13-25		Brown Medium to Fine SAND, Trace of Silt, Trace of Gravel			
20								
		S-9	8-9-12-13					
25					End of Boring at 25'			
30								
35								

Inspector _____ **Driller** E. Blemmings **Helper** M. Schick **Equipment** CME-55

Project No. 14991
Date: 8-1-2012

Log of Test Boring

Lippincott & Jacobs Consulting Engineers
One Pavilion Avenue, Riverside, NJ 08075

Plate No. 4 of 6
Boring No. B-4
Sheet 1 of 1

Project Cushman Lake Dam **Client** Collings Lake Civic Association **Surface Elev.** 71.5

Location Folsom, NJ

Drill Method: Hollow Stem Auger ID 3.25" **Casing ID** _____

Grouted ☐ **Date** _____

Groundwater Data
Depth 9'
Date 8-1-12
Time End of Boring

Depth (ft.)	Sample Type	Sample Number	Blow Count (Blows per 6 inches)	Lithology	Classification of Materials (Based upon samples recovered and observation of materials returned between samples)	Stratum	Moisture Content, %	Other Tests
0		S-1	3-3-7-18		Brown Medium to Fine SAND, Trace of Silt			
		S-2	11-13-18-10		Brown Medium to Fine SAND, Trace of Silt, Trace of Gravel			
5		S-3	11-4-3-3		Brown or Gray Fine SAND, Trace of Silt			
		S-4	2-2-2-2					
	▼	S-5	3-3-4-3		Brown Medium to Fine SAND, Trace of Silt			
10		S-6	3-3-3-7					
		S-7	6-8-15-16		Brown Medium to Fine SAND, Trace of Silt, Trace of Gravel			
15								
		S-8	6-6-7-11		Gray Medium to Fine SAND, Trace of Silt, Some Gravel			
20								
		S-9	8-10-11-9		Brown Medium to Fine SAND, Trace of Silt, Some Gravel			
25					End of Boring at 25'			
30								
35								

Inspector _____ **Driller** E. Blemmings **Helper** M. Schick **Equipment** CME-55

Project No. 14991
Date: 8-1-2012

Log of Test Boring

Lippincott & Jacobs Consulting Engineers
One Pavilion Avenue, Riverside, NJ 08075

Plate No. 5 of 6
Boring No. B-5
Sheet 1 of 1

Project Cushman Lake Dam Client Collings Lake Civic Association Surface Elev. 67.0
Location Folsom, NJ
Drill Method: Hollow Stem Auger ID 3.25" Casing ID _____ Depth 6'
Grouted ☐ Date _____ Date 8-1-12
Time End of Boring

Groundwater Data

Depth (ft.)	Sample Type	Sample Number	Blow Count (Blows per 6 inches)	Lithology	Classification of Materials (Based upon samples recovered and observation of materials returned between samples)	Stratum	Moisture Content, %	Other Tests
0								
		S-1	2-2-2-2		Gray Fine SAND, Trace of Silt, Occasional Roots			
		S-2	4-4-3-4		Brown or Gray Fine SAND, Trace of Silt			
5		S-3	3-2-2-3		Brown Medium to Fine SAND, Trace of Silt			
		S-4	4-5-9-10					
		S-5	7-8-10-14		Gray Medium to Fine SAND, Trace of Silt, Trace of Gravel			
10					End of Boring at 10'			
15								
20								
25								
30								
35								

Inspector _____ Driller E. Blemmings Helper M. Schick Equipment CME-55

Project No. 14991
Date: 8-1-2012

Log of Test Boring

Lippincott & Jacobs Consulting Engineers
One Pavilion Avenue, Riverside, NJ 08075

Plate No. 6 of 6
Boring No. WC-1
Sheet 1 of 1

Project Cushman Lake Dam **Client** Collings Lake Civic Association **Surface Elev.** 63.0

Location Folsom, NJ

Drill Method: Hollow Stem Auger ID _____ **Casing ID** 4"

Grouted ☐ **Date** _____

Groundwater Data
Depth None
Date 8-1-2012
Time End of Boring

Depth (ft.)	Sample Type	Sample Number	Blow Count (Blows per 6 inches)	Lithology	Classification of Materials (Based upon samples recovered and observation of materials returned between samples)	Stratum	Moisture Content, %	Other Tests
0	X	S-1	Hand Auger		Brown or Gray Medium to Fine SAND, Trace of Silt, Occasional Gravel			
	X	S-2	Hand Auger					
	X	S-3	Hand Auger					
	X	S-4	Hand Auger					
	X	S-5	Hand Auger					
5	X	S-6	Hand Auger					
	X	S-7	Hand Auger					
	X	S-8	Hand Auger					
	X	S-9	Hand Auger					
	X	S-10	Hand Auger					
10					End of Boring at 10'			
15								
20								
25								
30								
35								

Inspector _____ **Driller** E. Blemmings **Helper** M. Schick **Equipment** CME-55

WILDCAT DYNAMIC CONE LOG

Lippincott & Jacobs
One Pavilion Ave.
Riverside, NJ 08075

PROJECT NUMBER: 14991
DATE STARTED: 08-01-2012
DATE COMPLETED: 08-01-2012

HOLE #: WC-1
CREW: E. Blemings & M. Schick
PROJECT: Cushman Lake Dam
ADDRESS: Collings Lake Civic Association
LOCATION: Folsom, NJ

SURFACE ELEVATION: 63
WATER ON COMPLETION: None
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

DEPTH	BLOWS PER 10 cm	RESISTANCE Kg/cm²	GRAPH OF CONE RESISTANCE 0 50 100 150	N'	TESTED CONSISTENCY SAND & SILT	TESTED CONSISTENCY CLAY
-	1	4.4	•	1	VERY LOOSE	VERY SOFT
-	1	4.4	•	1	VERY LOOSE	VERY SOFT
- 1 ft	12	53.3	••••••••••••••••	15	MEDIUM DENSE	STIFF
-	4	17.8	•••••	5	LOOSE	MEDIUM STIFF
-	2	8.9	••	2	VERY LOOSE	SOFT
- 2 ft	1	4.4	•	1	VERY LOOSE	VERY SOFT
-	6	26.6	•••••••	7	LOOSE	MEDIUM STIFF
-	15	66.6	••••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
- 3 ft	10	44.4	••••••••••••	12	MEDIUM DENSE	STIFF
- 1 m	7	31.1	•••••••••	8	LOOSE	MEDIUM STIFF
-	10	38.6	••••••••••••	11	MEDIUM DENSE	STIFF
- 4 ft	18	69.5	••••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
-	18	69.5	••••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
-	15	57.9	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
- 5 ft	20	77.2	••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
-	15	57.9	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
-	15	57.9	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
- 6 ft	16	61.8	•••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
-	26	100.4	••••••••••••••••••••••••••••••	-	MEDIUM DENSE	VERY STIFF
- 2 m	11	42.5	••••••••••••	12	MEDIUM DENSE	STIFF
- 7 ft	14	47.9	••••••••••••••	13	MEDIUM DENSE	STIFF
-	20	68.4	••••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
-	19	65.0	•••••••••••••••••••	18	MEDIUM DENSE	VERY STIFF
- 8 ft	20	68.4	••••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
-	17	58.1	•••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
-	18	61.6	••••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
- 9 ft	19	65.0	•••••••••••••••••••	18	MEDIUM DENSE	VERY STIFF
-	8	27.4	•••••••	7	LOOSE	MEDIUM STIFF
-	8	27.4	•••••••	7	LOOSE	MEDIUM STIFF
- 3 m 10 ft	7	23.9	••••••	6	LOOSE	MEDIUM STIFF
-						
-						
-						
- 11 ft						
-						
-						
- 12 ft						
-						
-						
- 4 m 13 ft						

SUMMARY OF LAI ATORY TEST DATA

SAMPLE IDENTIFICATION				USCS CLASSIFICATION	GRAIN SIZE DISTRIBUTION				PLASTICITY				SPECIFIC GRAVITY	MOISTURE CONTENT (%)	VOLUMETRIC ANALYSIS			pH	STRAIN (%)	SHEAR STRENGTH			CONSOLIDATION				
BORING NUMBER	SAMPLE NUMBER	DEPTH (FT.)	ELEVATION (FT.)		GRAVEL (%)	SAND (%)	SILT (%)	CLAY COLLOIDS (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX			DRY UNIT WEIGHT (PCF)	VOID RATIO	DEGREE OF SATURATION (%)			TYPE OF TEST	ANGLE OF INTERNAL FRICTION (DEGREES)	COHESION (TSF)	UNCONFINED COMPRESSIVE STRENGTH	OVERBURDEN STRESS (TSF)	PRECONSOLIDATION STRESS (TSF)	COMPRESSION INDEX	SWELLING INDEX
B-2																										
	S-3	4-6	68.8	SM	0.6	85.5								4.5												
	S-8	18-20	54.8	SP	1.9	95.8								14.2												
B-3																										
	S-2	2-4	69	SM	3.4	84.9								4.4												
	S-4	6-8	65	SM	3.2	82.3								10.3												

Lippincott & Jacobs Consulting Engineers

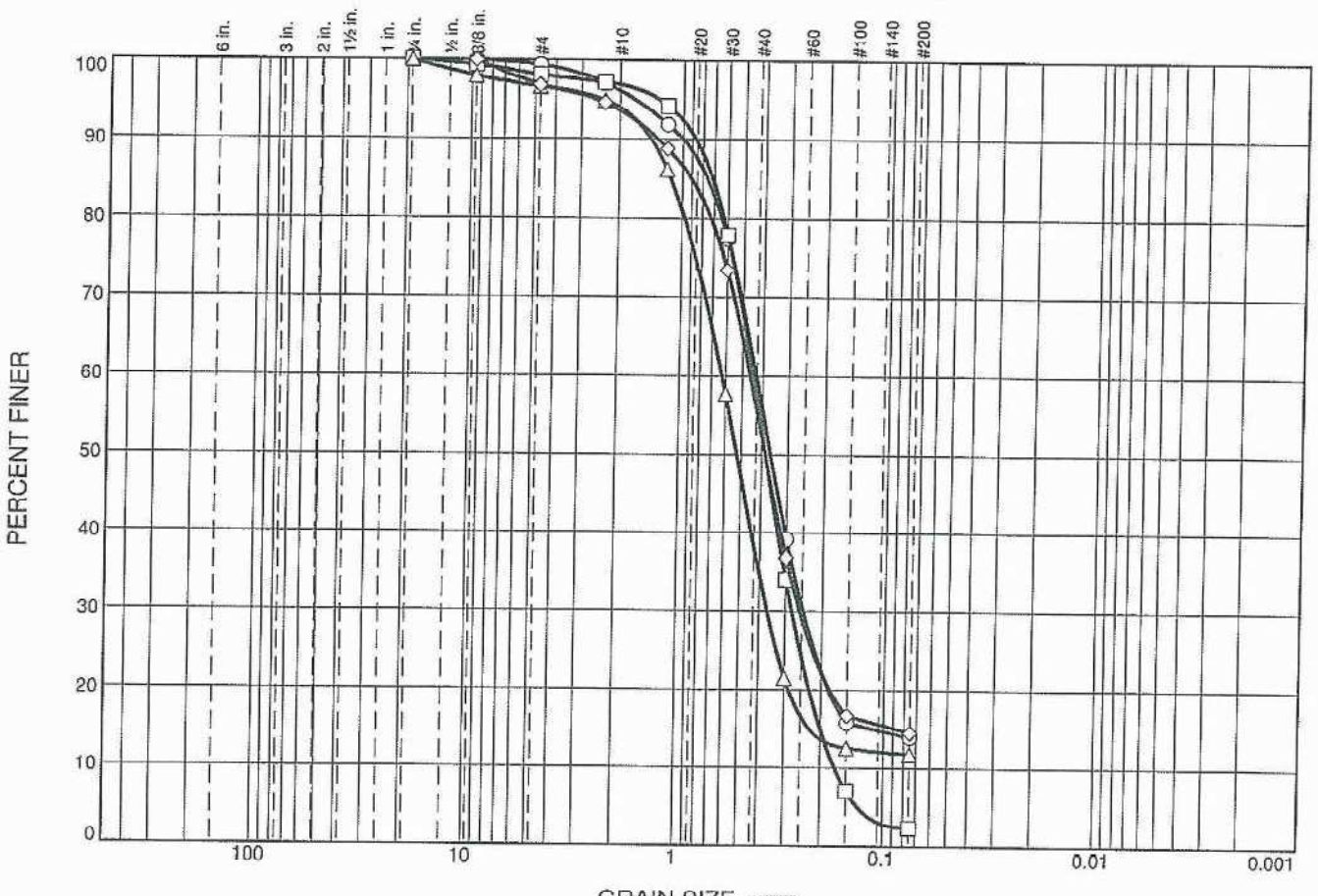
DRAWN: WJ DATE: 2/6/2013

CHECKED: MA DATE:

PROJECT NO. 14991

TABLE NO. 1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.6	3.3	36.8	45.4	13.9	
□	0.0	0.0	1.9	1.2	39.8	54.8	2.3	
△	0.0	0.0	3.4	2.6	56.1	26.2	11.7	
◇	0.0	0.0	3.2	3.1	37.9	41.3	14.5	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-2	S-3	4	Yellowish brown coarse-fine SAND, little Silt	SM
□	B-2	S-8	18	Brown Medium to Fine SAND, Trace of Silt, Trace of Gravel	SP
△	B-3	S-2	2	Yellowish brown coarse-fine SAND, little Silt, trace fine Gravel	SM
◇	B-3	S-4	6	Brown Medium to Fine SAND, Trace to Little Silt, Trace of Gravel	SM

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Client: Collings Lake Civic Association

Project: Cushman Lake Dam

Project No.: 14991

Figure 1

Tested By: Waheed Jafry **Checked By:** Murat Arkan