Stingy Run Dam
Initial Safety Factor Assessment
General James Gavin Power Plant
Cheshire, Ohio
S&ME Project No. 7217-15-006A

Prepared for:
American Electric Power
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December 28, 2015

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1.0 Introduction

1.1 Background

In April of 2015, the US EPA formally published national regulations for disposal of coal combustion residuals (CCR) from electric facilities. As part of the rule, the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that aspects of the CCR impoundments are in accordance with the rules. Based on our understanding of the Request for Fee Estimate received from AEP on April 29, 2015, AEP specifically requested P.E. certification to fulfill the requirements of 40 CFR § 257.73(e), *Periodic Safety Factor Assessments*. In the employment of BBC&M Engineering, Inc., the undersigned engineers conducted a site investigation at the Stingy Run Dam in 2010. Considering this work, S&ME was selected to perform the Safety Factor Assessment for this facility. S&ME understands that certification and/or documentation for other structural integrity criteria will be performed by AEP or other consultants.

1.2 Location and Historic Overview

The Gavin Power Plant is located along the Ohio River, approximately 10 miles north of Gallipolis. The fly ash reservoir dam, known as the Stingy Run Dam or Stingy Creek Dam, is located approximately 2 miles northwest of the plant. The fly ash impoundment was put into service in 1974 and the dam was raised 40 feet in 1988, but sluicing of ash was discontinued in 1994 prior to fully utilizing the capacity of the reservoir. Since discontinuing fly ash disposal, the normal pool level was maintained near Elevation 698 feet, approximately 28 feet lower than the design pool elevation of the raised dam. In 2014, stop logs in the outlet structure were removed down to approximate Elevation 675 and the pool has been furthered lowered to near Elevation 665 through means of pumping to facilitate expansion of the adjacent residual waste landfill. AEP is actively planning to close the fly ash reservoir and has begun preliminary site preparation work within the now exposed reservoir floor.

Figure 1-1 – Location Map – Aerial Photo Depicting Higher Pool

The original earth fill dam consisted of an approximately 105 foot high arched dam constructed as a conventional zoned earth embankment with a clay core and upstream and downstream compacted shale fill zones. The clay core was extended through overburden foundations layers of clay, sand, and weathered shale and keyed into intact bedrock. As part of a planned phased construction approach with the initial construction, the dam raising for Phase II was completed in 1988. The clay core was extended and tapered up the upstream slope and supported by an internal bottom ash zone and downstream compacted shale fill.

1.3 Previous Investigations

In 2009, the undersigned engineers, when in the employment of BBC&M Engineering, Inc., performed a subsurface investigation and geotechnical assessment of the Stingy Run Dam to examine slope stability failure modes for the critical cross-section not addressed in the original design reports. This assessment, dated April of 2010, concluded that the embankment exhibited adequate factors of safety against slope failure under maximum surcharge pool and rapid drawdown loading conditions relative to typical US Army Corps of Engineers requirements. Site maps, logs of soils borings and laboratory testing results from the 2010 assessment are included in Appendices I and II.

2.0 Scope of Work

In accordance with AEP's request, the following work items were performed by S&ME:

1. S&ME completed a cursory review of previously conducted assessment work performed by the undersigned engineers, as well as the original design reports made available by AEP.

2. S&ME visited the site along with personnel from AEP. The site visit was not a formal inspection, but rather served to verify that no significant modifications or changed conditions have taken place since the previous assessment.

3. Upon completing Tasks 1 and 2, S&ME determined that there was sufficient information to certify the structural integrity of the surface impoundment in accordance with the requirements of 40 CFR § 257.73(e). A separate letter has been prepared to this effect.

3.0 Information Review and Site Visit

To support the safety factor assessment, S&ME conducted a cursory review of previous design reports and construction drawings relating to the Stingy Run Dam and conducted a site visit at the facility. AEP provided S&ME with the following documents:

- Proposed Dam Raising for Phase II Stingy Run Fly Ash Retention Pond - Preliminary Design Report, March, 1986
- Proposed Dam Raising for Phase II Stingy Run Fly Ash Retention Pond - Final Design Report, December, 1986
- Design Drawings – Dam Raising for Phase II Stingy Run Fly Ash Retention Pond, As-Built Status, 1989

On July 28, 2015, the undersigned S&ME personnel met with Mr. Shah Baig (AEP Civil Engineering) and Mr. Doug Workman (Gavin Plant Landfill and Dams Manager) at the Gavin Plant and conducted a site visit at the Stingy Run Dam. The participants discussed the past performance of the dam and recent changes to the crest, inboard slope, and pool level associated with the nearby landfill expansion. During our site visit, S&ME observed that portions of the embankment crest had been lowered approximately 4 feet and the upper inboard slope protection in some areas had been removed. The pool level was also lowered below the current stop log elevation through means of pumping, such that only a few feet of water was present in the reservoir adjacent to the dam. Based on our site visit, no significant geometry changes

appeared to have been made to the downstream slope since the 2010 assessment. While the site visit was not a formal inspection, visual observations of the Stingy Run Dam did not reveal any dam safety concerns, and the downstream slope appears to be in a similar condition as in 2010 when our previous investigation was performed.

4.0 Safety Factor Assessment

As part of the safety factor assessment, S&ME completed Parts 1 and 2 of Section 257.73(e) of the Final Rules for the Disposal of Coal Combustion Residuals from Electric Utilities published on April 17, 2015 in the Federal Register. In accordance with the Rule, the analysis was performed for the critical cross-sections(s) that are anticipated to be most susceptible of all cross-sections to structural failure based on appropriate engineering considerations. The Rule specified the following loading conditions for analysis:

i. Static Factor of Safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
ii. Calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.50
iii. The calculated seismic factor of safety must equal or exceed 1.00
iv. For dikes constructed of soils susceptible to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

4.1 Limit Equilibrium Analyses

Our 2010 Supplemental Investigation discussed in detail the field exploration, laboratory testing, parameter selection, and limit equilibrium slope stability analyses that were performed to develop safety factors for the Stingy Run Dam. In summary, the investigation consisted of obtaining subsurface data at two previous boring locations near the downstream toe to evaluate the potential for the dam foundation soils to liquefy during a seismic event, and performing slope stability analyses for the sudden drawdown and surcharge pool load cases which were not addressed in the original dam raising design reports. Subsurface data was also obtained from the crest of the dam to obtain undisturbed samples of the uppermost clay core material.

Static analyses were performed for the surcharge pool and sudden drawdown load cases to determine the factor of safety against rotational and block failures using soil strength parameters established during the original dam raising investigation. The Simplified Bishop Method was used for circular failure surfaces for comparison with the original stability runs. Spencer's method, however, was used for the block failures as the Simplified Bishop Method is limited to analyses with circular failure surfaces per US Army Corps of Engineers (2003) recommendations.

As part of the current assessment, S&ME used the previously developed slope stability models and evaluated the stability of the dam for the long-term maximum storage pool and maximum surcharge loading cases with a pool Elevation of 675 corresponding to the permanently lowered stop log elevation. The maximum surcharge pool loading case was also evaluated for an additional pool level surcharge of 27.3 inches corresponding to the probable maximum precipitation (PMP) value for the site. Both the upstream and downstream slopes were evaluated during the current limit equilibrium analysis. At the

time of this report, S&ME understands that the embankment crest has been lowered 4 feet across its entire width. As such, the crest modification has been reflected in the new limit equilibrium analysis. S&ME reviewed the pseudo-static stability analysis performed in support of the Phase II dam raising as detailed in the 1986 Final Design Report. The results of the analysis demonstrate an acceptable factor of safety.

Strength parameters were assigned to each layer using the same values used in the original design, with the exception of the Upstream Fly Ash layer, which was originally assumed as a 'no strength' layer. For this layer, the 2010 Supplemental Investigation based the strength and unit weight values on typical values for sluiced ash, including AEP shear strength testing and AECOM's Root Cause Analysis of the TVA Kingston Ash Slide, where fly ash was impounded in a similar manner as Stingy Run. Table 1 lists the design strength parameters used for 'End of Construction' (Total) and 'Steady State' (Effective) conditions for each material. Supporting data for the development of these strength values can be found in the original preliminary and final design reports for the dam raising.

Table 4-1 – Shear Strength Parameters

Material Description	γ_T *(pcf)*	γ_{sat} *(pcf)*	*Total*		*Effective*	
			ϕ	c (psf)	ϕ'	c' (psf)
New U/S Clay Core ('88)	126	129	0	1200	16	700
New D/S Random Fill ('88)	126	129	0	1500	16	800
Bottom Ash Zone	105	115	39	0	39	0
Existing Clay Core ('74)	130	133	0	1720	23	0
Existing D/S Random Fill ('74)	130	133	0	3680	27	0
U/S Random Fill ('74)	127	130	0	2000	21	0
U/S Fly Ash	100	100	700	0	30	0
Upper Clay	127	127	0	1440	21	860
Upper Sand	127	130	30	0	30	0
Intermediate Clay	126	126	0	2160	22	0
Lower Sand	127	130	30	0	30	0
Lower Clay/Shale	130	131	0	3000	22	0
Intact Rock	130	131	0	5000	5000	0

U/S - Upstream; D/S - Downstream

4.2 Liquefaction Potential of Embankment Soils

S&ME evaluated the potential of the embankment soils to liquefy during a seismic event. The Stingy Run dam was designed and constructed in a manner consistent with a conventional water storage dam and is composed entirely of engineered materials. The clay core was constructed directly into bedrock both below the dam and at the abutments. S&ME reviewed the construction methods for placement of the various embankment materials. Of the various layers, all are either entirely or mostly cohesive with the exception of the compacted bottom ash drainage layer located on the downstream side of the core. The

compacted bottom was placed as a structural fill layer in addition to serving as a drainage and filter layer. Based on the controlled manner in which the bottom ash zone was placed, this material is not subject to liquefaction during the design seismic event.

4.3 Summary of Results

A summary of the computed safety factors for the critical cross-section is provided in Table 5-1. Also included in the table are the minimum values defined in 40 CFR § 257.73(e)(1) subparts (i) through (iv). Graphical output corresponding to the analysis cases performed by S&ME are presented in Appendix III. In each analysis case, the downstream slope yielded a lower factor of safety than the upstream slope.

Table 4-2 – Safety Factor Summary

Analysis Case	Minimum Safety Factor	Computed Safety Factor
Long-term, maximum storage pool	1.50	1.50
Maximum surcharge pool	1.40	1.50
Pseudo-static seismic loading	1.00	1.22
Embankment Liquefaction	1.20	Non-liquefiable

5.0 Professional Engineer's Certification

Based on our previous investigation and current assessment of the Stingy Run Dam, S&ME certifies that this assessment meets the requirements of paragraphs (e)(1) and (e)(2) of Part 257.73 for the critical cross-section of the embankment.

We appreciate having been given the opportunity to be of service on this project. If you have any questions, please do not hesitate to contact this office.

Sincerely,

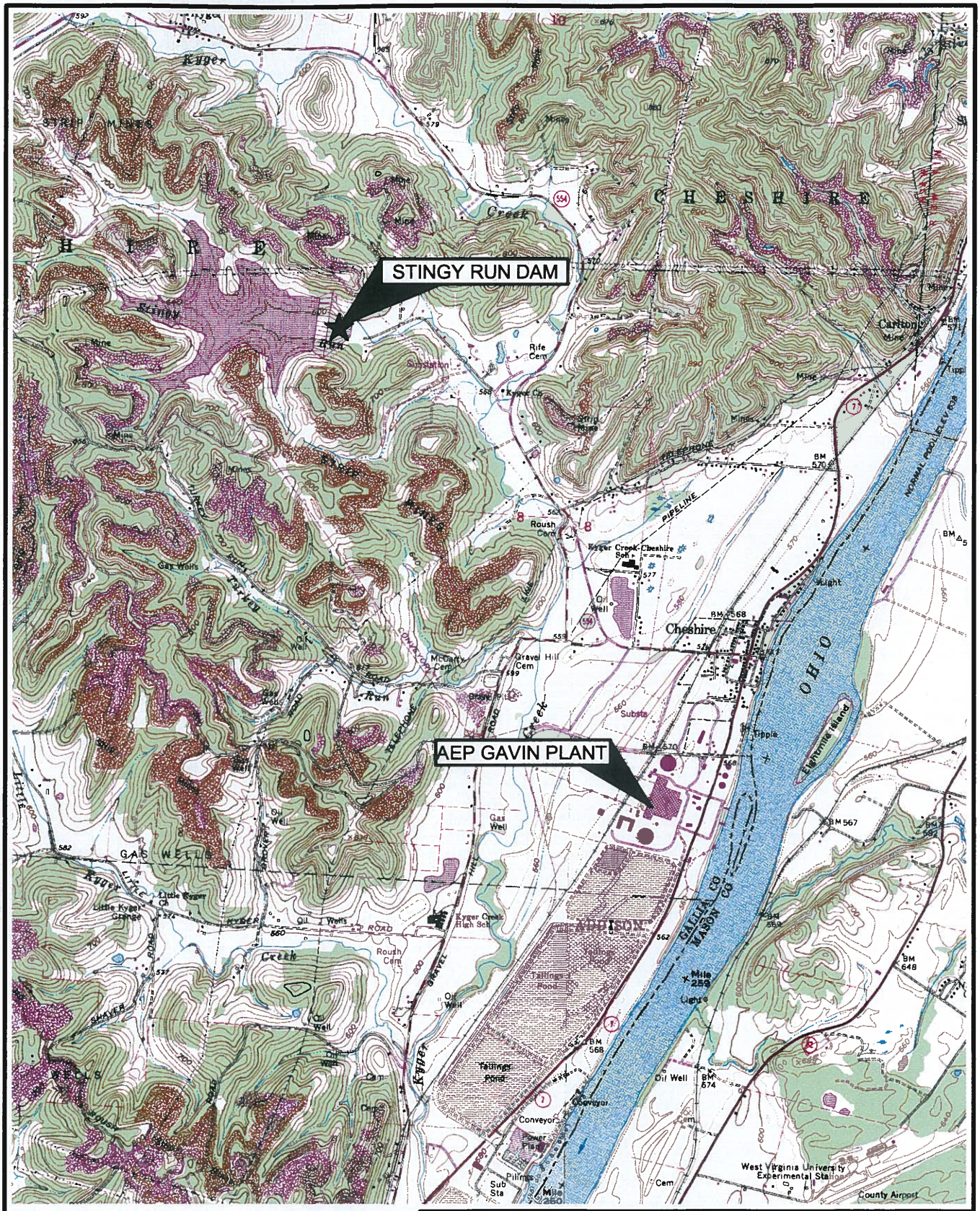
S&ME, Inc.

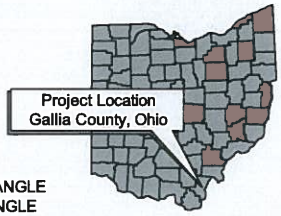
Michael T. Romanello, P.E.
Project Engineer
Registration No. 74384

Michael G. Rowland, P.E.
Senior Engineer
Registration No. 65559

Appendices

Appendix I – 2010 Site Investigation Figures





USGS Mapping:
CHESHIRE QUADRANGLE
ADDISON QUADRANGLE

VICINITY MAP

AEP Gavin Plant Supplemental Investigation
Stingy Run Fly Ash Reservoir Dam
Cheshire, Ohio

Project: 011-11497-014	Drawn By: MTR	
Drawing Date: 6-04-2009	Approved By: MGR	
Last Updated: 2-3-2010	Scale: 1" = 3000'	1:1

BBC&M
SOLUTIONS TO BUILD ON
Columbus (614) 793-2226
Cleveland (216) 901-1000
Cincinnati (513) 771-8471
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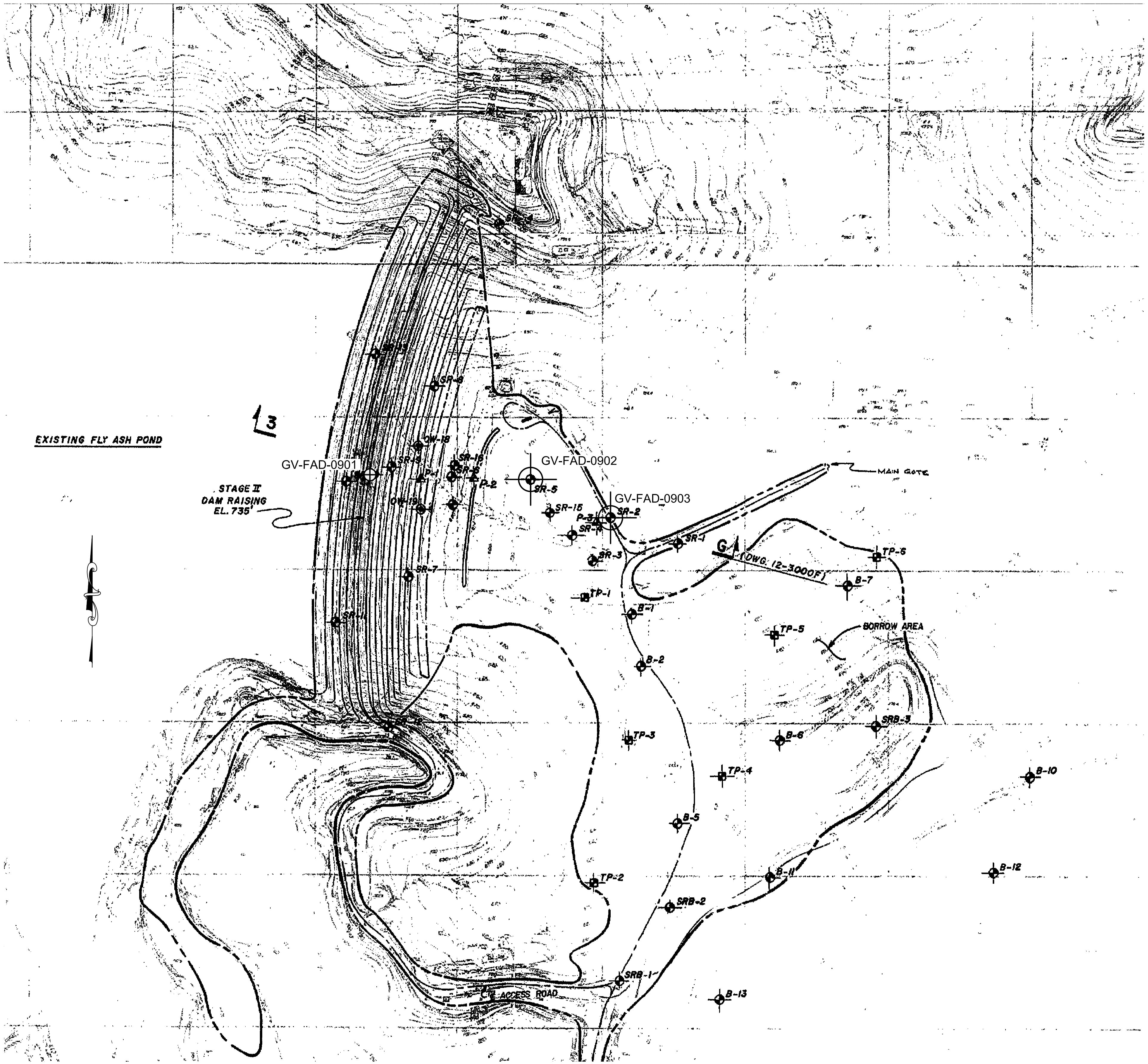
PLATE 1

Images: ~Addison Ohio Quad Map.tif ~Cheshire Ohio Quad Map.tif ~gallia.tif
Xrefs:
File Last Updated: Feb 03, 2010
Plot Info: 3-5-2010 @ 8:19am By: MRomanello
BBC&M Filename: I:\DEPTS\CADD\Drawings\Projects\011-11497-014\011-11497-014 VMap.dwg Layout: V-Map (2)



LEGEND

GV-FAD-0901 — BORING NUMBER LOCATION BBCM 2009 SUPPLEMENTAL INVESTIGATION

SR-1 — BORING NUMBER LOCATION AEP 1985 INVESTIGATION

TP-1 — TEST PIT NUMBER LOCATION AEP 1985 INVESTIGATION

BBCM 2009 SUPPLEMENTAL INVESTIGATION

BORING	NORTHING	EASTING	ELEVATION
GV-FAD-0901	351,335.0	2,101,188.1	735.8
GV-FAD-0902	351,174.2	2,102,031.1	585.4
GV-FAD-0903	351,298.4	2,101,754.8	610.6

DRAWING REFERENCE: STINGY RUN FLY ASH DAM
STAGE II RAISING
BORING AND TEST PIT LOCATION PLAN
DRAWING NO. 12-3000B-1

PLAN OF BORINGS

Supplemental Geotechnical Investigation
Stingy Run Fly Ash Reservoir Dam
AEP Gavin Plant - Cheshire, Ohio

Project: 011-11497-014	Drawn By: MTR
Drawing Date: 10-07-2009	Approved By: MGR
Last Updated: 3-5-2010	Scale: 1" = 400' 1:1

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Cincinnati (513) 771-8471
Dayton (937) 424-1011

Images: ~Gavin Aerial.jpg ~Stingy Run Dr No. 12-3000B-1.tiff
Xrefs:
File Last Updated: Mar 05, 2010
Plot Info: 3-5-2010 @ 9:16am By: MRomanello
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EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS FOR SAMPLING AND DESCRIPTION OF SOIL

SAMPLING DATA

- Blocked-in "SAMPLES" column indicates sample was attempted and recovered within this depth interval.

- Sample was attempted within this interval but not recovered.

2/5/9 - The number of blows required for each 6-inch increment of penetration of a "Standard" 2-inch O.D. split-barrel sampler, driven a distance of 18 inches by a 140-pound hammer freely falling 30 inches. Addition of one of the following symbols indicates the use of a split-barrel other than the 2" O.D. sampler:

2S - 2½"O.D. split-barrel sampler

3S - 3" O.D. split-barrel sampler

P - Shelby tube sampler, 3" O.D., hydraulically pushed.

R - Refusal of sampler in very-hard or dense soil, or on a resistant surface.

50-2" - Number of blows (50) to drive a split-barrel sampler a certain number of inches (2), other than the normal 6-inch increment.

S/D - Split-barrel sampler (S) advanced by weight of drill rods (D),

S/H - Split-barrel sampler (S) advanced by combined weight of rods and drive hammer (H).

SOIL DESCRIPTIONS

All soils have been classified basically in accordance with the Unified Soil Classification System, but this system has been augmented by the use of special adjectives to designate the approximate percentages of minor components as follows:

Adjective	Percent by Weight
trace	1 to 10
little	11 to 20
some	21 to 35
"and"	36 to 50

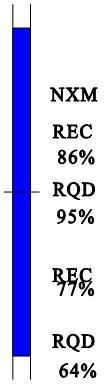
The following terms are used to describe density and consistency of soils:

Term (Granular Soils)	Blows per foot
Very-loose	Less than 5
Loose	5 to 10
Medium-dense	11 to 30
Dense	31 to 50
Very-dense	Over 50

Term (Cohesive Soils)	Qu (tsf)
Very-soft	Less than 0.25
Soft	0.25 to 0.5
Medium-stiff	0.5 to 1.0
Stiff	1.0 to 2.0
Very-stiff	2.0 to 4.0
Hard	Over 4.0

EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS FOR SAMPLING AND DESCRIPTION OF ROCK

SAMPLING DATA



When bedrock is encountered and rock core samples are attempted, the "SAMPLING EFFORT" column is used to record the type of core barrel used (NXM), the percentage of core recovered (REC) for each run of the sampler, and the Rock Quality Designation (RQD) value. Rock-core barrels can be of either single- or double-tube construction, and a special series of double-tube barrels, designated by the suffix M, is commonly used to obtain maximum core recovery in very-soft or fractured rock. Three basic groups of barrels are used most often in subsurface investigations for engineering purposes, and these groups and the diameters of the cores obtained are as follows:

AX, AW, AXM, AWM	-	1-1/8 inches
BX, BW, BXM, BWM	-	1-5/8 inches
NX, NW, NXM, NWM	-	2-1/8 inches

Rock Quality Designation (RQD) is expressed as a percentage and is obtained by summing the total length of all core pieces which are at least 4 inches long and then dividing this sum by the total length of core run. It has been found that there is a reasonably good relationship between the RQD value and the general quality of rock for engineering purposes. This relationship is shown as follows:

RQD - %	General Quality
0 - 25	Very-poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

ROCK HARDNESS

THE FOLLOWING TERMS ARE USED TO DESCRIBE ROCK HARDNESS:

Term	Meaning	Mohs' Hardness
Very-soft	Rock such as shale can be easily picked apart by the fingers. Sandstone is poorly cemented and very friable. The rock resembles hard clay or dense sand, but has rock structure.	Less than 1
Soft	Rock such as shale, siltstone or limestone can be scratched or powdered by fingernail pressure. Sandstone is mostly poorly cemented, and individual sand grains can be separated from the main rock mass by a fingernail.	1 to 1½
Medium-hard	Rock cannot be scratched by a fingernail, but can be powdered by a knife. Sandstone is mostly well cemented, but individual grains can be removed by scratching with a knife.	2½ to 5½
Hard	Rock is well cemented and cannot be powdered by a knife. Rock can be powdered by a steel file.	5½ to 6½
Very-hard	Rock cannot be scratched by a steel file and the core sample rings when struck with a hammer.	Greater than 6½

LOG OF BORING NO. FAD-0901
AEP GAVIN PLANT FLY ASH RESERVOIR DAM
CHESHIRE, OHIO

BBCM

LOCATION: **N 351,335; E 2,101,188** ELEVATION: **735.8** DATE: **10/27/09**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **21.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
735.3	0						TOPSOIL- 6 INCHES	
		1		3 / 3 / 3	9	73	FILL: Very-stiff to hard red-brown mottled with brown silty clay, little fine to coarse sand, trace fine gravel, damp.	H=3.5-4.5+
		2		4 / 6 / 5	16	60		H=3.75-4.5+
	5	3		P				H=4.5+
		4		2 / 3 / 5	11	100		H=3.25-4.25
		5		3 / 5 / 5	14	87		H=3.2-4.2
	10	6		2 / 3 / 6	13	100		H=3.5-4.5+ G
		7		P				H=3.5-4.0 LL=54 G
		8		2 / 4 / 6	14	67		H=2.75-3.5
	15	9		2 / 3 / 4	10	100		H=2.25-2.75
719.4								
718.9		10A		2 / 2 / 4	9	100	FILL: Hard gray-brown silty clay, little fine to coarse sand, some fine to coarse gravel, damp.	
		10B					FILL: Stiff red-brown mottled with brown silty clay, little fine to coarse sand, trace fine gravel, few seams of ash and cinders, damp.	H=2.25
		11A		2 / 2 / 5	10	100		H=1.25-2.5
716.7		11B					FILL: BOTTOM ASH: Medium-dense gray fine to coarse sand, trace fine gravel, trace silt, dry.	
	20	12		3 / 5 / 5	14	100		
714.8								
							- No Seepage encountered. - 6" interval was skipped before each shelby tube attempt to ensure a complete sample. - Boring was backfilled with cement-bentonite grout upon completion. - Boring location and elevation surveyed by AEP. - Survey reference: Ohio State Plane South NAD 27/NGVD 29.	
	25							

NATURAL CONSISTENCY INDEX
NATURAL MOISTURE CONTENT
PLASTIC LIMIT — LIQUID LIMIT
10 20 30 40

WATER LEVEL: ▽ ▼
WATER NOTE:
DATE:

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
(See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.85
Last Calibration Date : 02/17/09
Drill Rig Number : ATV 550X

JOB: 011.11497.014

PLATE 5

2009 NEW DEFAULT BORING LOG-W/ N60 111497014.GPJ BBCM.GDT 3/16/10

LOG OF BORING NO. FAD-0902
AEP GAVIN PLANT FLY ASH RESERVOIR DAM
CHESHIRE, OHIO

BBCM

LOCATION: **N 351,174; E 2,102,031** ELEVATION: **585.4** DATE: **10/27/09 - 10/28/09**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **47.4'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
585.1	0						TOPSOIL - 3 INCHES	
		01		1 / 4 / 7	16	100	FILL: Stiff to very-stiff red-brown mottled with gray and brown silty clay, trace fine to coarse sand, trace fine gravel (shale fragments), few roots, damp.	H=1.25-1.75
582.0		2A		3 / 3 / 4	10	100		H=2.25
		2B					Medium-stiff to stiff brown mottled with gray silty clay, some fine to coarse sand, trace fine gravel, damp.	H=1.25-2.25
	5	03		2 / 3 / 3	9	60		H=0.75-1.25
		04		2 / 2 / 2	6	73		H=0.75-1.25
577.1		05		P				
575.6							Medium-dense brown fine to medium sand, trace coarse sand, little silt.	
	10	06		1 / 2 / 3	7	100	Medium-stiff to stiff brown mottled with dark-brown silty clay, some fine sand, trace coarse sand, trace fine gravel, moist.	H=0.75-1.5
573.9		07A		WH / WH	4	100		H=0.75-1.5
		07B					Medium-stiff to stiff gray-brown silty clay, interbedded with silt "and" fine sand, trace medium to coarse sand, moist.	G
573.0		07C		1 / 4 / 8	17	100	Very-stiff brown mottled with gray silty clay, trace fine sand, few lenses of silt, moist.	H=0.75-1.5
		08						H=0.25-1.75
		09A		5 / 6 / 6	17	100		H=3.25-3.75
570.3	15	09B						G H=2.75-3.75
568.9		10A		2 / 3 / 4	10	100	Loose to medium-dense brown fine to medium sand, trace coarse sand, trace fine gravel, little silt, little clay, wet.	
		10B					Stiff to very-stiff gray silty clay, trace fine to coarse sand, trace fine gravel, few seams of fine to medium sand, many lenses of silt, moist to wet.	G H=2.5-3.5
		11A		3 / 4 / 8	17	100		
		11B						H=2.5-3.5 G
		12A		WH / 3 / 5	11	100		
	20	12B						H=2.5-3.25
		13		2 / 4 / 8	17	100		H=2.75-3.75
		14		P				H=3.5
	25			1				

NATURAL CONSISTENCY INDEX
NATURAL MOISTURE CONTENT
PLASTIC LIMIT — LIQUID LIMIT
10 20 30 40

WATER LEVEL: ▽ 27.0 ▼
WATER NOTE: First Encounter
DATE: 10/27/09

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
(See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.85
Last Calibration Date : 02/17/09
Drill Rig Number : ATV 550X

2009 NEW DEFAULT BORING LOG-W/ N60 111497014.GPJ BBCM.GDT 3/16/10

LOG OF BORING NO. FAD-0902
AEP GAVIN PLANT FLY ASH RESERVOIR DAM
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LOCATION: **N 351,174; E 2,102,031** ELEVATION: **585.4** DATE: **10/27/09 - 10/28/09**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **47.4'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
	25	15		3/3/6	13	80	Stiff to very-stiff gray silty clay, trace fine to coarse sand, trace fine gravel, few seams of fine to medium sand, many lenses of silt, moist to wet.	H=2.25-3.5
		▽16		3/4/6	14	100		H=1.75-2.5
557.6		17A		3/5/7	17	100	Medium-dense brown fine to medium sand, trace coarse sand, trace fine gravel, little silt, wet.	H=0.75-2.75
		17B						G
556.0		18A		WH/1/4	7	100	Medium-stiff to stiff gray silty clay, trace fine to coarse sand, trace fine gravel, many lenses of fine to medium sand, interbedded sand seams, wet.	H=075-1.5
554.9	30	18B						
		19A		3/4/6	14	100	Medium-dense brown fine to medium sand, trace coarse sand, trace fine gravel, little silt, little clay, wet.	H=1.75-2.5
		19B						
		20A		WH/4/5	13	100		H=0.75-1.5
		20B						
		20C		2/4/7	16	47		G
		21						
	35	22A		4/4/7	16	100		G
		22B						
		23		2/7/9	23			
547.1		24A		3/5/5	14	100	Stiff to very-stiff gray silty clay, trace fine sand, few lenses of silt, few seams of fine to medium sand, wet.	H=1.75-2.25
		24B						
545.1	40	25A		2/4/7	16	100		H=1.5-2.25
		25B						G
544.0		26A		1/3/5	11	100	Medium-dense red-brown and gray fine to medium sand, trace coarse sand, little silt, little clay, wet.	H=1.25
		26B						
		26C					Stiff gray silty clay, trace fine sand, wet.	
		27A		1/3/5	11	100		
541.4		27B						G
		28A		4/6/31	52	100	Medium-dense red-brown, brown, and gray fine to medium sand, trace coarse sand, trace fine gravel, few seams of silty clay, wet.	
539.9	45	28B						
538.9		29		15/11/17	40	93	Brown and gray fine to coarse gravel (sandstone and siltstone fragments), little fine to coarse sand, trace silty clay, wet.	
538.4								
538.0		30		50-5"R		27	Very-stiff to hard gray mottled with red-brown silty clay, some fine to coarse sand, some fine to coarse gravel (shale fragments), wet.	H=3.8-4.5+
							Very-soft to soft gray shale interbedded with siltstone, fragmental structure, damp.	
	50						- Boring was backfilled with cement-bentonite	

NATURAL CONSISTENCY INDEX
NATURAL MOISTURE CONTENT
PLASTIC LIMIT — LIQUID LIMIT
10 20 30 40

WATER LEVEL: ▽ **27.0** ▼
WATER NOTE: **First Encounter**
DATE: **10/27/09**

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)
H - Penetrometer (tsf), W - Unit Dry Wt (pcf), D - Relative Dens (%)

Drill Rod Energy Ratio : 0.85
Last Calibration Date : 02/17/09
Drill Rig Number : ATV 550X

2009 NEW DEFAULT BORING LOG-W/ N60 111497014.GPJ BBCM.GDT 3/16/10

LOG OF BORING NO. FAD-0902
AEP GAVIN PLANT FLY ASH RESERVOIR DAM
CHESHIRE, OHIO

BBCM

LOCATION: **N 351,174; E 2,102,031** ELEVATION: **585.4** DATE: **10/27/09 - 10/28/09**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **47.4'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
	50						grout upon completion. - Seepage encountered at 11.0'. - Encountered water at 27'. - Boring location and elevation surveyed by AEP. - Survey reference: Ohio State Plane South NAD 27/NGVD 29.	10 20 30 40	
	55								
	60								
	65								
	70								
	75								

WATER LEVEL: ▽ **27.0** ▼

WATER NOTE: **First Encounter**

DATE: **10/27/09**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.85
Last Calibration Date : 02/17/09
Drill Rig Number : ATV 550X

JOB: 011.11497.014

PLATE 8

2009 NEW DEFAULT BORING LOG-W/ N60 111497014.GPJ BBCM.GDT 3/16/10

LOG OF BORING NO. FAD-0903
AEP GAVIN PLANT FLY ASH RESERVOIR DAM
CHESHIRE, OHIO

BBCM

LOCATION: **N 351,298; E 2,101,755** ELEVATION: **610.6** DATE: **10/26/09 - 10/27/09**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **67.3'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
610.5	0						TOPSOIL	10 20 30 40	
		01		4 / 3 / 5	11	80	FILL: Stiff to very-stiff red-brown, dark-brown and gray silty clay, some fine to coarse sand, trace fine gravel, damp.		H=1.5-3.75
606.5		2A		2 / 17 / 20	52	100			H=1.75-3.25
		2B					FILL: Dense brown fine gravel (sandstone fragments), some fine to coarse sand, trace silt, dry.		
605.2	5						FILL: Stiff to very-stiff brown, red-brown, and gray silty clay, some fine to coarse sand, trace fine to coarse gravel (sandstone fragments), few seams of silt, dry becoming moist.		
		03		3 / 3 / 4	10	100			H=2.25-3.5
		04		2 / 2 / 3	7	100			H=1.75-3.0
	10								
		05		3 / 3 / 4	10	100			H=3.0-3.5
596.7		6A		4 /					H=2.5-3.5
596.5		6B		5 / 6	16	100	FILL: Medium-dense brown and gray fine gravel, some fine to coarse sand, trace silt, moist.		H=3.5-4.25
		6C							
	15	6D					FILL: Stiff to very-stiff to hard brown mottled with gray silty clay, some fine to coarse sand, trace fine to coarse gravel, contains wood fragments, moist.		
594.3		7A		3 /	13	100			H=1.5-1.75
593.9		7B		4 / 5			FILL: Brown fine to coarse gravel, trace fine to coarse sand, moist.		H=3.25-3.75
593.2		7C					FILL: Very-stiff dark-brown mottled with gray silty clay, little fine to coarse sand, trace fine gravel, moist.		
		08		2 / 4 / 4	11	100			
	20						FILL: Medium-dense brown fine to medium sand, trace coarse sand, trace fine gravel, trace silt, moist.		
589.6									
		09		2 / 5 / 7	17	100	FILL: Very stiff to hard red-brown mottled with dark-gray silty clay, little fine to coarse sand, trace fine gravel, moist.		H=3.5-4.5
		10		2 / 8 / 12	28	100			H=3.5-4.5+
	25								

WATER LEVEL: ▽ **34.0** ▼ **45.0**
WATER NOTE: **First Encounter** **At Completion**
DATE: **10/26/09** **10/27/09**

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)
H - Penetrometer (tsf), W - Unit Dry Wt (pcf), D - Relative Dens (%)

Drill Rod Energy Ratio : 0.85
Last Calibration Date : 02/17/09
Drill Rig Number : ATV 550X

2009 NEW DEFAULT BORING LOG-W/ N60 111497014.GPJ BBCM.GDT 3/16/10

LOG OF BORING NO. FAD-0903
AEP GAVIN PLANT FLY ASH RESERVOIR DAM
CHESHIRE, OHIO

BBCM

LOCATION: **N 351,298; E 2,101,755** ELEVATION: **610.6** DATE: **10/26/09 - 10/27/09**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **67.3'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
584.7	25							10 20 30 40	
		11A		4 / 5 / 5	14	100	FILL: Hard gray, brown, and dark-gray silty clay, some fine to coarse sand, trace fine to coarse gravel (shale and coal fragments), moist.		H=4.0-4.5+
583.5		11B							H=1.5
583.3							Stiff brown silty clay, trace fine to medium sand, few roots, moist.		
		12		2 / 3 / 4	10	100	Stiff to very-stiff gray mottled with brown clayey silt, trace fine to medium sand, slightly organic, moist.		H=1.75-2.5
580.3	30	13A		2 / 4 / 4	11	100	Very-stiff brown mottled with gray silty clay, little fine to medium sand, moist to wet.		H=1.5-2.5
		13B							
577.7				P					
		14				100	Very-loose gray and brown fine to medium sand, trace coarse sand, trace silt, little clay, wet.		H=0.5-1.5
576.2		15A		WR / WH / 2	3	100	Medium-stiff to stiff brown mottled with dark-brown and dark-gray silty clay, some fine to medium sand, trace coarse sand, trace fine gravel, wet.		G H=0.7-1.5
	35	15B							
		16		WH / 1 / 2	4	100			H=0.7 G
573.5		17		WH / 1 / 4	7	87	Stiff gray and gray mottled with brown silty clay, trace fine sand, wet, contains sand seam at 40.3'.		H=1.25-1.75
				P					
	40	18							H=3.25-3.5
569.6									
		19		2 / 8 / 12	28	47	Stiff to very-stiff gray mottled with orange-brown silty clay, trace fine to coarse sand, few seams of fine to medium sand, few lenses and seams of silt, moist.		H=1.25-2.5 G
		20		2 / 4 / 8	17	73			H=1.5-2.5
	45	21		5 / 7 / 8	21	100			H=2.25-2.75 G
				P					
		22							H=3.75
		23		2 / 5 / 7	17	100			H=1.75-2.75
				3 / 6 / 7					
560.8		24A			18	100			H=1.5-2.5
	50								

2009 NEW DEFAULT BORING LOG-W/ N60 111497014.GPJ BBCM.GDT 3/16/10

WATER LEVEL: ▽ **34.0** ▼ **45.0**
WATER NOTE: **First Encounter** **At Completion**
DATE: **10/26/09** **10/27/09**

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)
H - Penetrometer (tsf), W - Unit Dry Wt (pcf), D - Relative Dens (%)

Drill Rod Energy Ratio : 0.85
Last Calibration Date : 02/17/09
Drill Rig Number : ATV 550X

JOB: 011.11497.014 -CONTINUED- **PLATE 10**

LOG OF BORING NO. FAD-0903
AEP GAVIN PLANT FLY ASH RESERVOIR DAM
CHESHIRE, OHIO

LOCATION: **N 351,298; E 2,101,755** ELEVATION: **610.6** DATE: **10/26/09 - 10/27/09**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **67.3'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT; 10 20 30 40)	TEST RESULTS
	50	24B					Stiff to very-stiff brown mottled with gray silty clay, little fine to coarse sand, trace fine gravel (sandstone and shale fragments), moist.		H=1.5-2.75
		25		3/4/8	17	100			H=2.25-2.75
		26		4/6/12	26	100			H=1.75-2.75
		27		5/9/12	30	100			H=1.75-2.75 G
555.3	55	28		4/10/12	31	80	Very-stiff to hard red-brown mottled with gray silty clay, trace fine to coarse sand, trace fine gravel (similar to very-soft shale), moist.		H=3.75-4.5+
		29		6/12/17	41	100			H=4.0-4.5+
		30		7/10/15	35	100			H=4.0-4.5+
550.6	60	31		10/17/25	60	100	Very-stiff to hard red-brown mottled with gray silty clay, trace fine to coarse sand, trace fine gravel (similar to very-soft shale), moist.		H=4.5+ G
		32		5/10/18	40	100			H=4.5+
		33		9/25/24	69	100			H=4.5+
		34		5/12/10	31	100			H=4.5+
544.3	65	35A		5/12/		100			H=2.25-2.75
543.6		35B		50-5"R			Very-soft gray shale, fragmental structure, similar to hard clayey silt, calcareous, damp.		H=4.5+
543.3		36		50-3"R			Soft to medium-hard gray shale interbedded with limestone, damp.		H=4.5+
	70						- Boring was backfilled with cement-bentonite grout. - Encountered water at 34.0' - Boring location and elevation surveyed by AEP. - Survey reference: Ohio State Plane South NAD 27/NGVD 29.		
	75								

WATER LEVEL: ▽ **34.0** ▼ **45.0**
WATER NOTE: **First Encounter** **At Completion**
DATE: **10/26/09** **10/27/09**

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)
H - Penetrometer (tsf), W - Unit Dry Wt (pcf), D - Relative Dens (%)

Drill Rod Energy Ratio : 0.85
Last Calibration Date : 02/17/09
Drill Rig Number : ATV 550X

JOB: 011.11497.014 **PLATE 11**

2009 NEW DEFAULT BORING LOG-W/ N60 111497014.GPJ BBCM.GDT 3/16/10

Appendix II – 2010 Laboratory Testing Results

SUMMARY OF LABORATORY TEST RESULTS

BORING	G'int Id.	MC	LL	PL	PI	GRADATION			COMPACTION		TRIAXIAL				DIRECT SHEAR			UNCONFIN COMPRESS	CONSOLID.	SPECIFIC GRAVITY	UNIT DRY WEIGHT	REMOLDED	PERMEABILITY				RELATIVE DENSITY	LOI	ROCK CORE	SHELBY TUBE	CBR
							Hydrometer																cohesive	non/cohes	wall rigid	wall flexible					
						sieve	short	long	standard	modified	uncons. undrain	consolid undrain w/ pores	drained	drained	undrain	residual															
		%	%	%	%	* SEE INDIVIDUAL TEST CURVES															PCF						%	%			
FAD-0901	5.50																												*	
FAD-0901	7.00	20																												
FAD-0901	10.25	19	48	23	25	*		*																						
FAD-0901	11.75											*																		
FAD-0901	12.25											*																		
FAD-0901	12.75											*																		
FAD-0901	13.25	21	54	24	30	*		*																					*	
FAD-0901	16.70	10																												
FAD-0902	8.00																												*	
FAD-0902	11.80	24	25	15	10	*		*																						
FAD-0902	14.55	24	47	24	23	*		*																						
FAD-0902	16.25					*		*																						
FAD-0902	18.50	27	46	23	23	*		*																						
FAD-0902	23.50																												*	
FAD-0902	28.40					*		*																						
FAD-0902	29.95	21	35	19	16																									
FAD-0902	31.70	26	44	24	20																									
FAD-0902	34.25					*		*																						
FAD-0902	35.55	18				*		*																						
FAD-0902	38.90	25	44	24	20																									

SUM REG 11149701 4.GPJ BBCM.GDT 3/4/10

PLATE 1

BBCM
SOLUTIONS TO BUILD ON

TESTING SUMMARY - STANDARD

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 DATE 3/4/10

SUMMARY OF LABORATORY TEST RESULTS

BORING	G'int Id.	MC	LL	PL	PI	GRADATION			COMPACTION		TRIAXIAL			DIRECT SHEAR			UNCONFIN COMPRESS	CONSOLID.	SPECIFIC GRAVITY	UNIT DRY WEIGHT	REMOLDED	PERMEABILITY				RELATIVE DENSITY	LOI	ROCK CORE	SHELBY TUBE	CBR
						sieve	Hydrometer short	Hydrometer long	standard	modified	uncons. undrain	consolid undrain w/ pores	drained	drained	undrain	residual						cohesive	non/cohes rigid wall		flexible wall					
		%	%	%	%	* SEE INDIVIDUAL TEST CURVES														PCF						%	%			
FAD-0902	40.65					*		*																					
FAD-0902	43.45	18	28	17	11	*		*																					
FAD-0903	33.00																											*	
FAD-0903	34.20					*		*																					
FAD-0903	36.25	23	29	16	13	*		*																					
FAD-0903	40.00																											*	
FAD-0903	41.75	24	39	20	19	*		*																					
FAD-0903	44.75	27	49	21	28	*		*																					
FAD-0903	46.50																											*	
FAD-0903	54.25	19	41	20	21	*		*																					
FAD-0903	60.25	11	35	21	14	*		*																					

BBCM SOLUTIONS TO BUILD ON

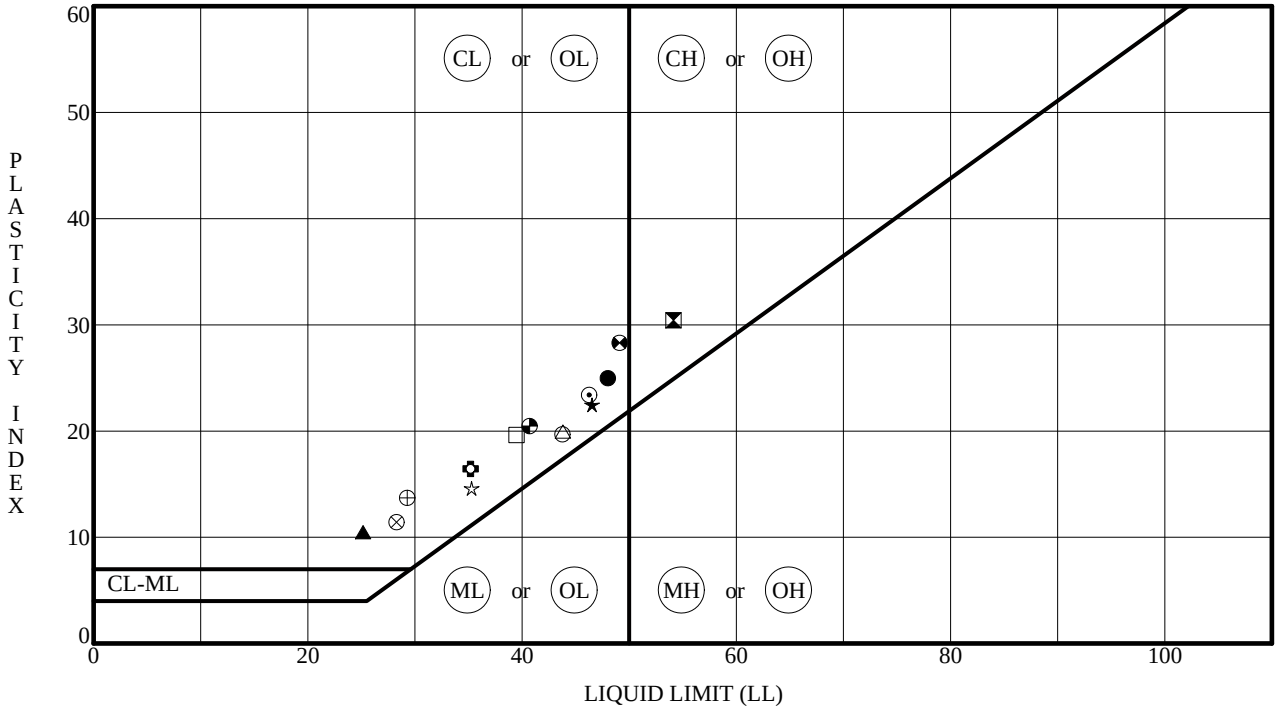
TESTING SUMMARY - STANDARD

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 DATE 3/4/10

SUM REG 11149701 4.GPJ BBCM.GDT 3/4/10

PLATE 2

ATTERBERG LIMITS' RESULTS



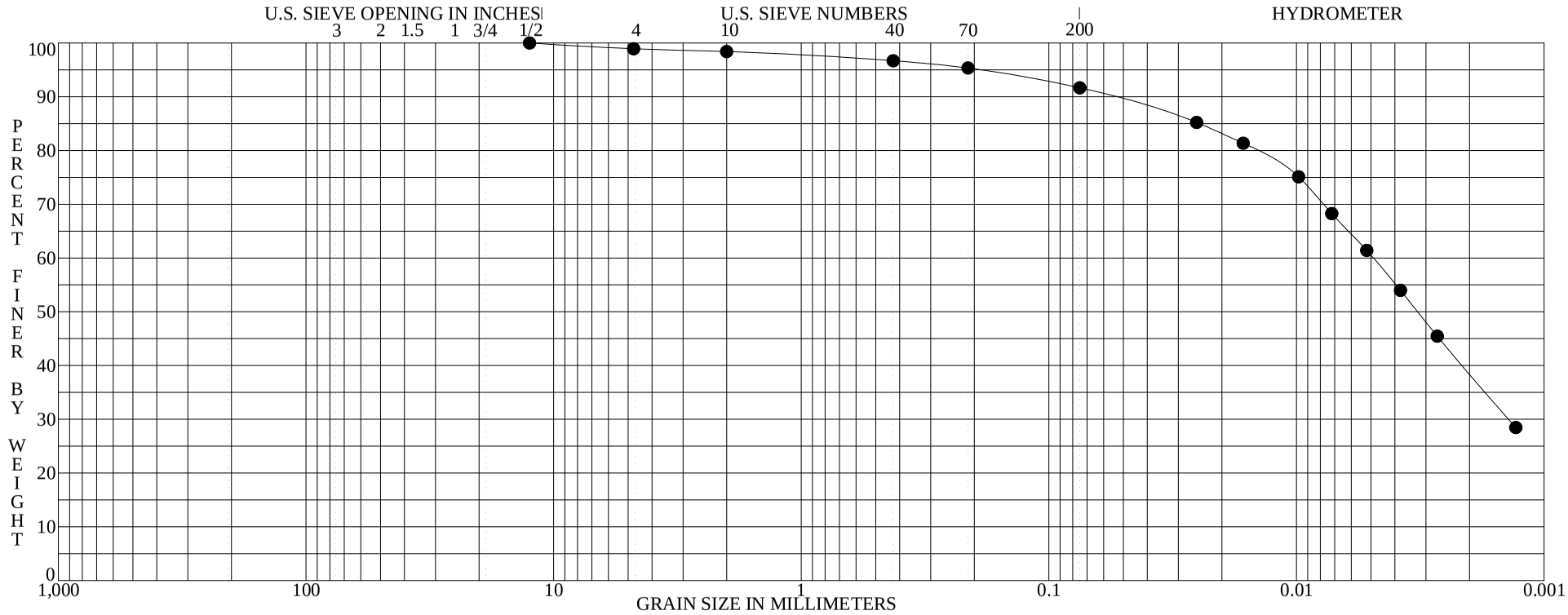
Specimen Id.	Pt. ID	MC	LL	PL	PI	.002mm	ASTM Classification
● FAD-0901	10.25	19	48	23	25	38.5	LEAN CLAY CL
⊠ FAD-0901	13.25	21	54	24	30	41.9	FAT CLAY CH
▲ FAD-0902	11.80	24	25	15	10	14.7	SANDY LEAN CLAY CL
★ FAD-0902	14.55	24	47	24	23	53.0	LEAN CLAY CL
⊙ FAD-0902	18.50	27	46	23	23	59.4	LEAN CLAY CL
✿ FAD-0902	29.95	21	35	19	16		
○ FAD-0902	31.70	26	44	24	20		
△ FAD-0902	38.90	25	44	24	20		
⊗ FAD-0902	43.45	18	28	17	11	15.0	CLAYEY SAND SC
⊕ FAD-0903	36.25	23	29	16	13	19.1	SANDY LEAN CLAY CL
□ FAD-0903	41.75	24	39	20	19	41.5	LEAN CLAY CL
⊗ FAD-0903	44.75	27	49	21	28	53.5	LEAN CLAY CL
◕ FAD-0903	54.25	19	41	20	21	36.0	LEAN CLAY CL
☆ FAD-0903	60.25	11	35	21	14	30.1	LEAN CLAY CL

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

ALPIEPA

PLATE

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0901 S-6 9.5' to 11.0'**	**LEAN CLAY CL**	**19**	**48**	**23**	**25**		

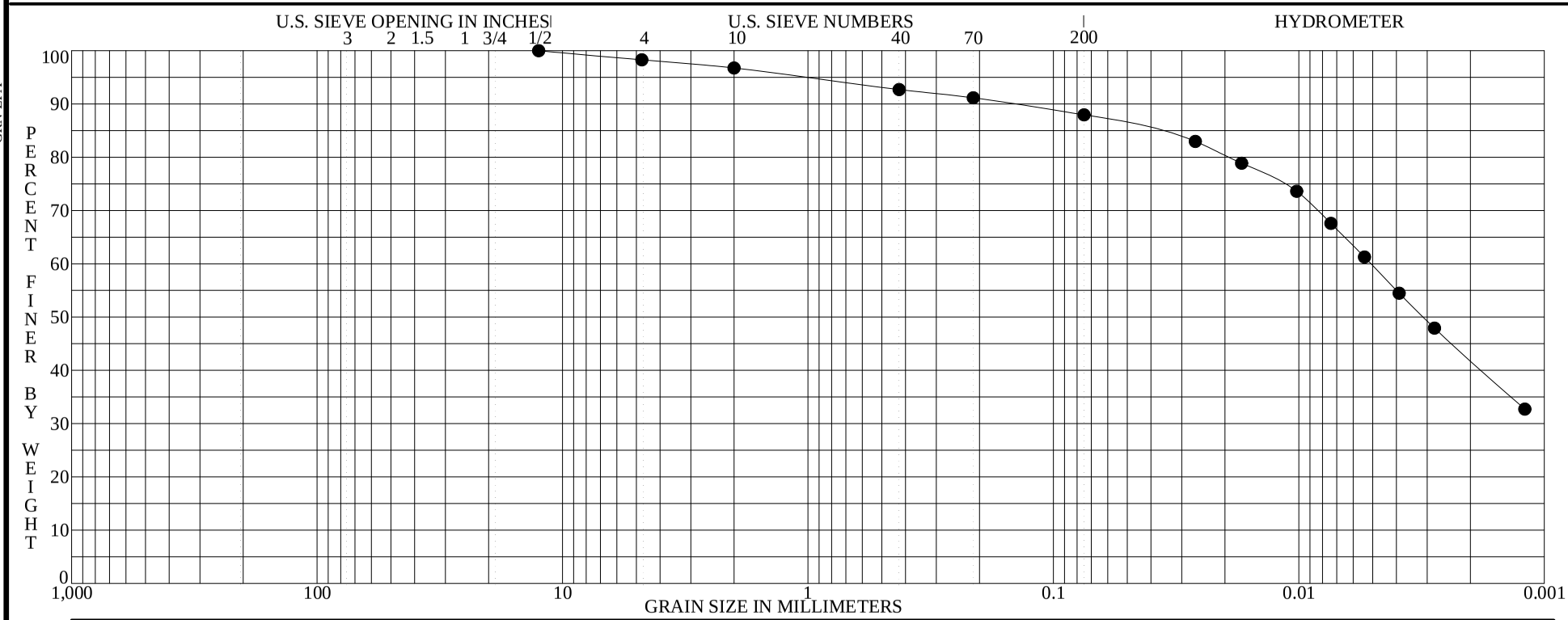
	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0901 S-6 9.5' to 11.0'**	**12.5000**	**0.1918**	**0.0049**	**0.0032**		**1.1**	**7.3**	**53.2**	**38.5**

ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 4



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
● **GV-FAD-0901 S-7 IV 11.5' to 13.5'**	**FAT CLAY CH**	**21**	**54**	**24**	**30**		

Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **GV-FAD-0901 S-7 IV 11.5' to 13.5'**	**12.5000**	**1.0208**	**0.0051**	**0.0031**		**1.7**	**10.3**	**46.1**	**41.9**

ASTM D422

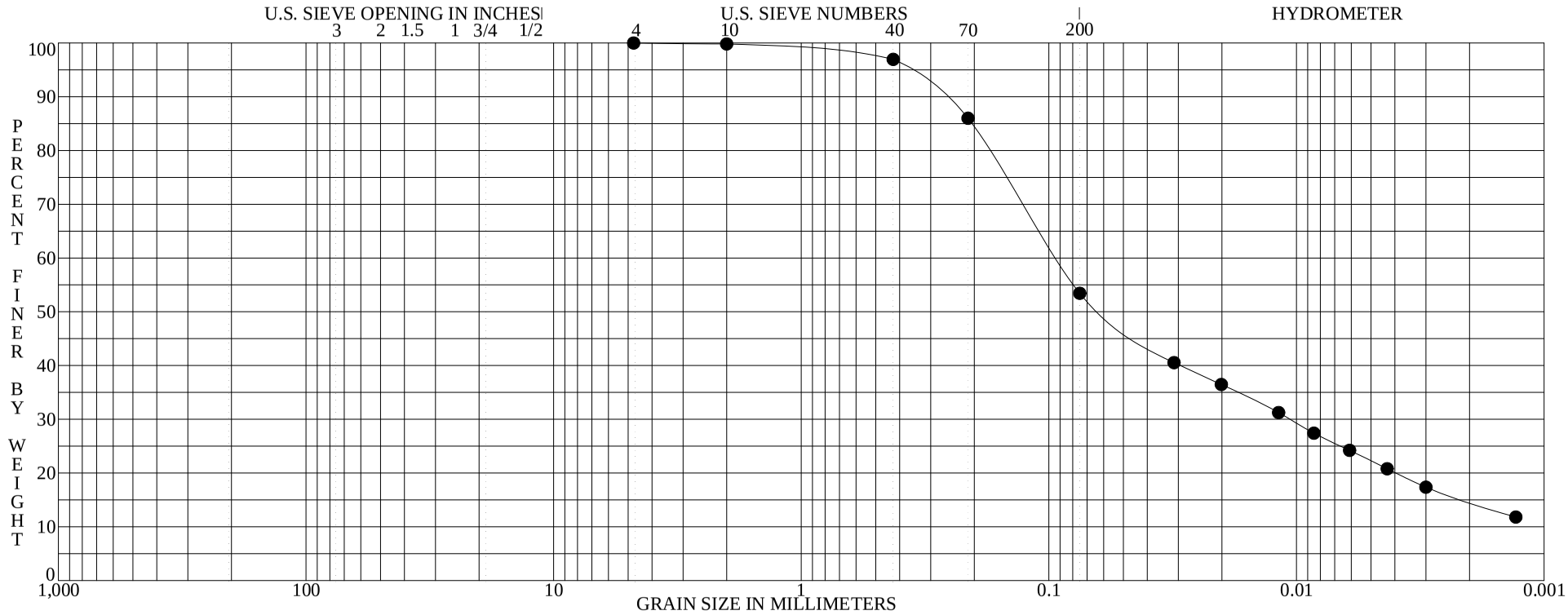
GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

GRN-EPA

PLATE 5

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0902 S-7B 11.5' to 12.1'**	**SANDY LEAN CLAY CL**	**24**	**25**	**15**	**10**		

	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0902 S-7B 11.5' to 12.1'**	**4.7500**	**0.3753**	**0.0925**	**0.0594**		**0.0**	**46.6**	**38.8**	**14.7**

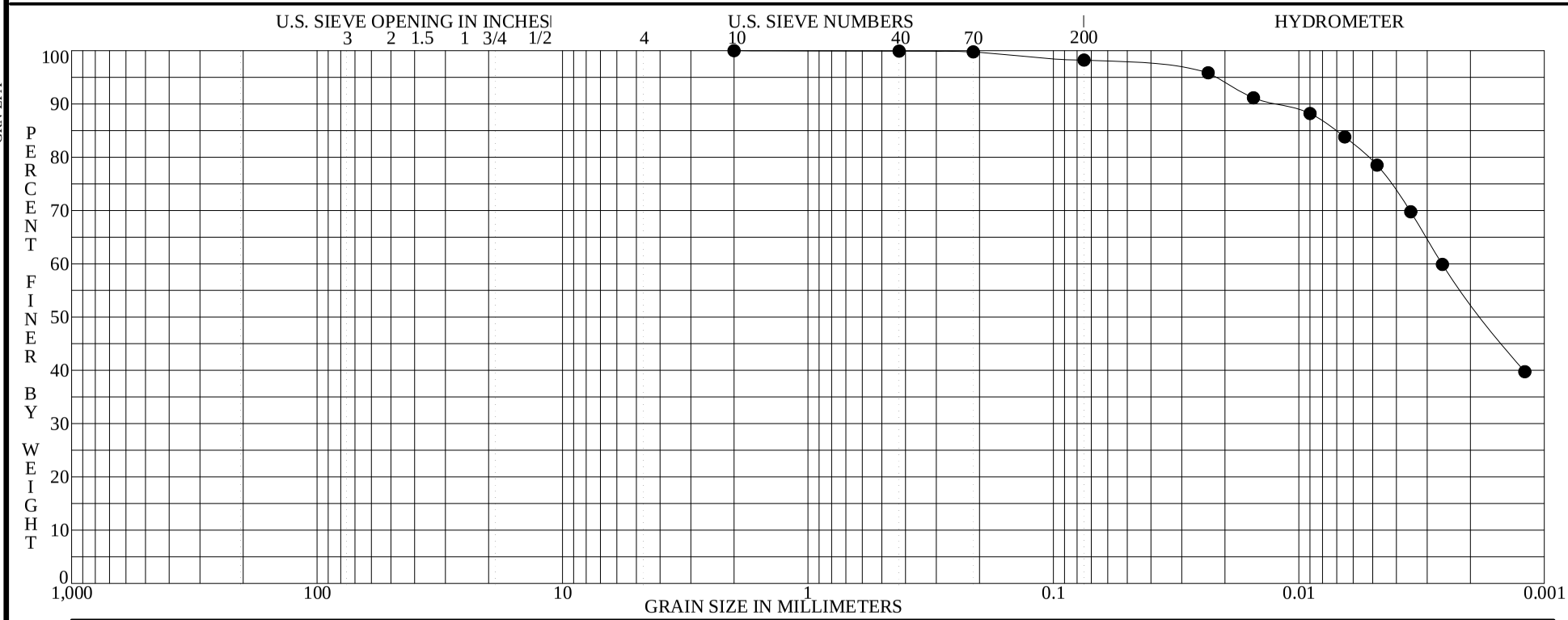
ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 6

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0902 S-9A 14.0' to 15.1'**	**LEAN CLAY CL**	**24**	**47**	**24**	**23**		

	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0902 S-9A 14.0' to 15.1'**	**2.0000**	**0.0217**	**0.0026**	**0.0018**		**0.0**	**1.8**	**45.2**	**53.0**

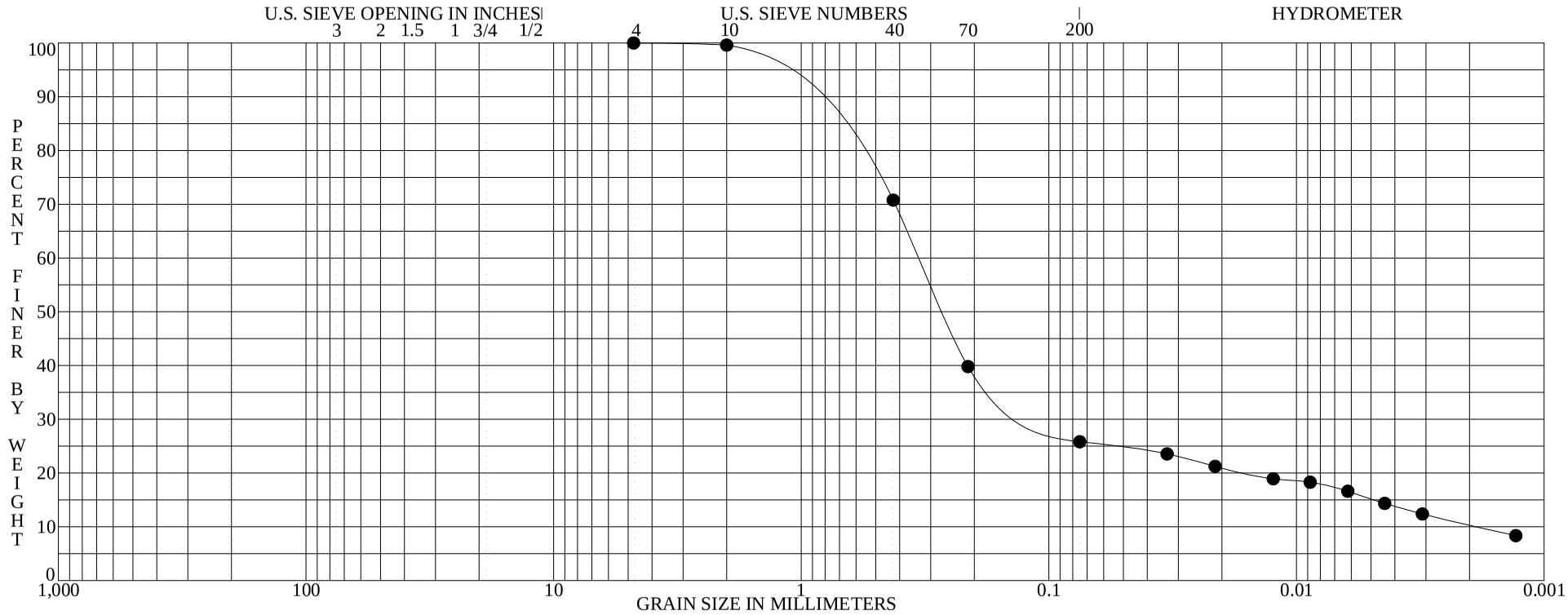
ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 7

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
● **GV-FAD-0902 S-10A 16.0' to 16.5'**							

Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **GV-FAD-0902 S-10A 16.0' to 16.5'**	**4.7500**	**1.5611**	**0.3337**	**0.2665**	**0.0019**	**0.0**	**74.2**	**15.5**	**10.3**

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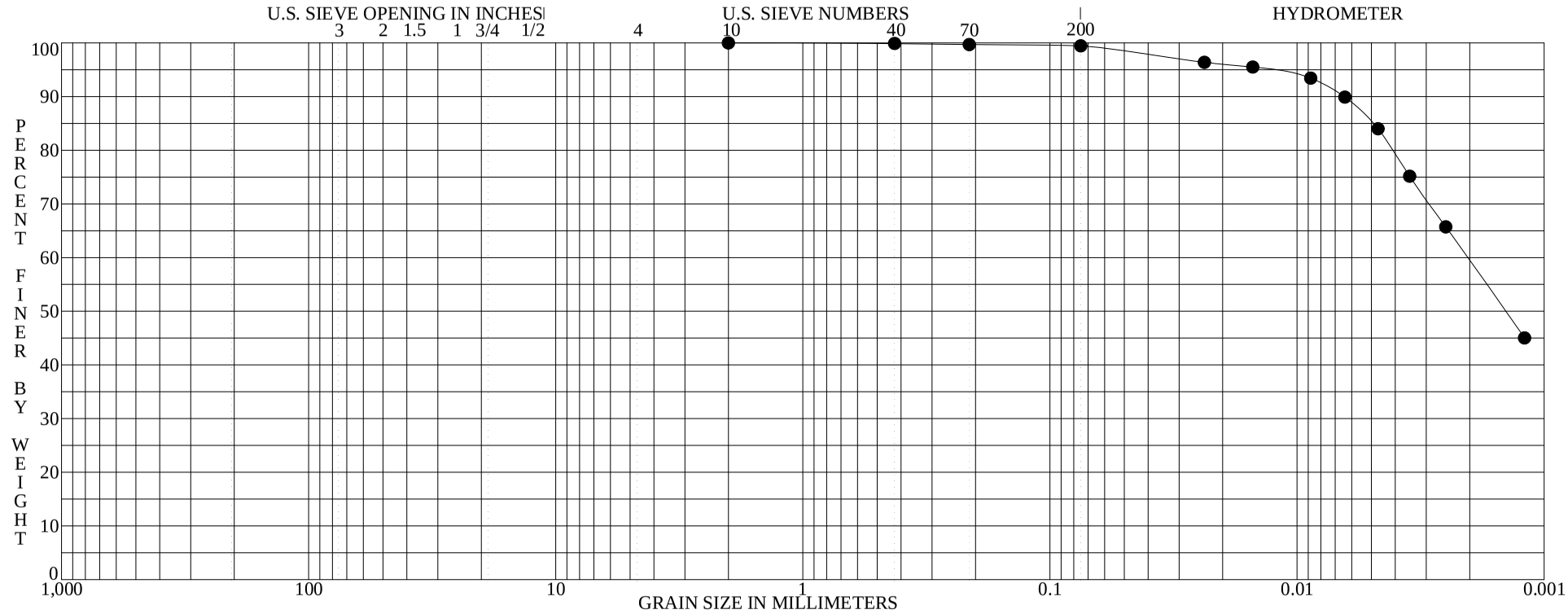
GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 8

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
● **GV-FAD-0902 S-11B 18.0' to 19.0'**	**LEAN CLAY CL**	**27**	**46**	**23**	**23**		

Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **GV-FAD-0902 S-11B 18.0' to 19.0'**	**2.0000**	**0.0132**	**0.0020**	**0.0014**		**0.0**	**0.5**	**40.0**	**59.4**

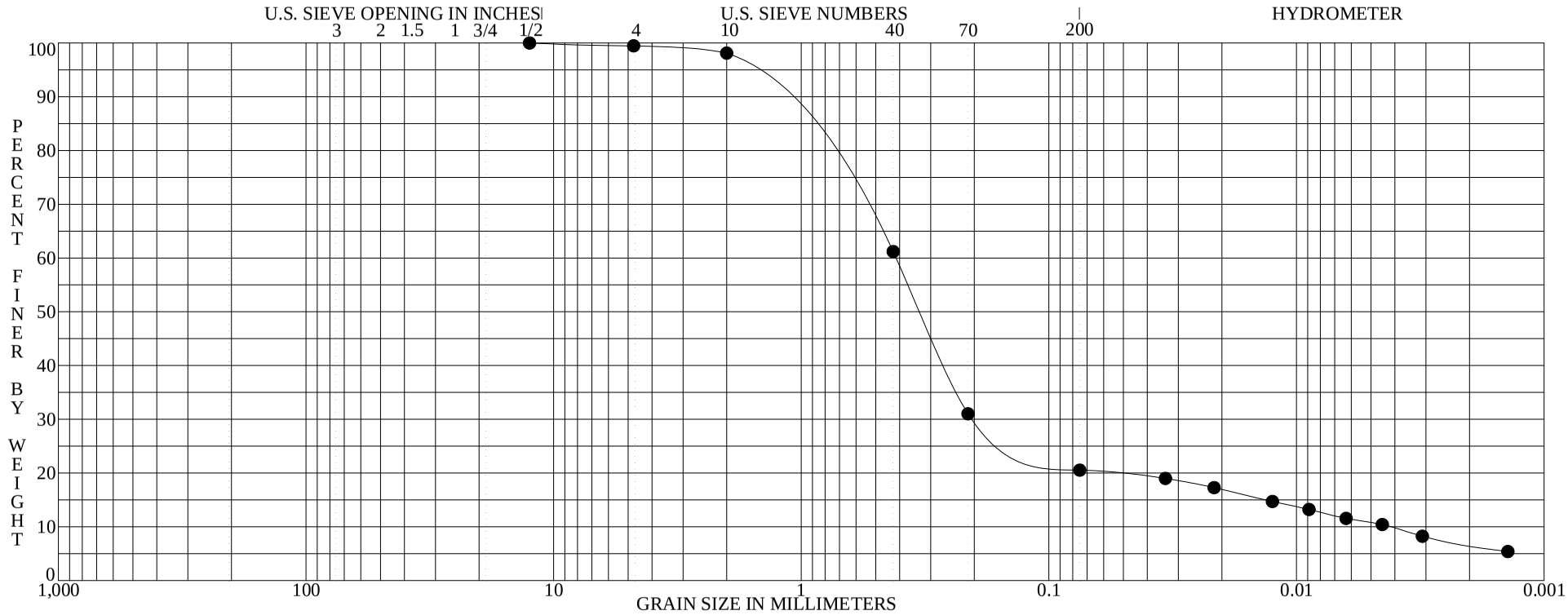
ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 9

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
● **GV-FAD-0902 S-17B 27.8' to 29.0'**							

Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **GV-FAD-0902 S-17B 27.8' to 29.0'**	**12.5000**	**1.7542**	**0.4134**	**0.3283**	**0.0042**	**0.5**	**78.9**	**13.9**	**6.7**

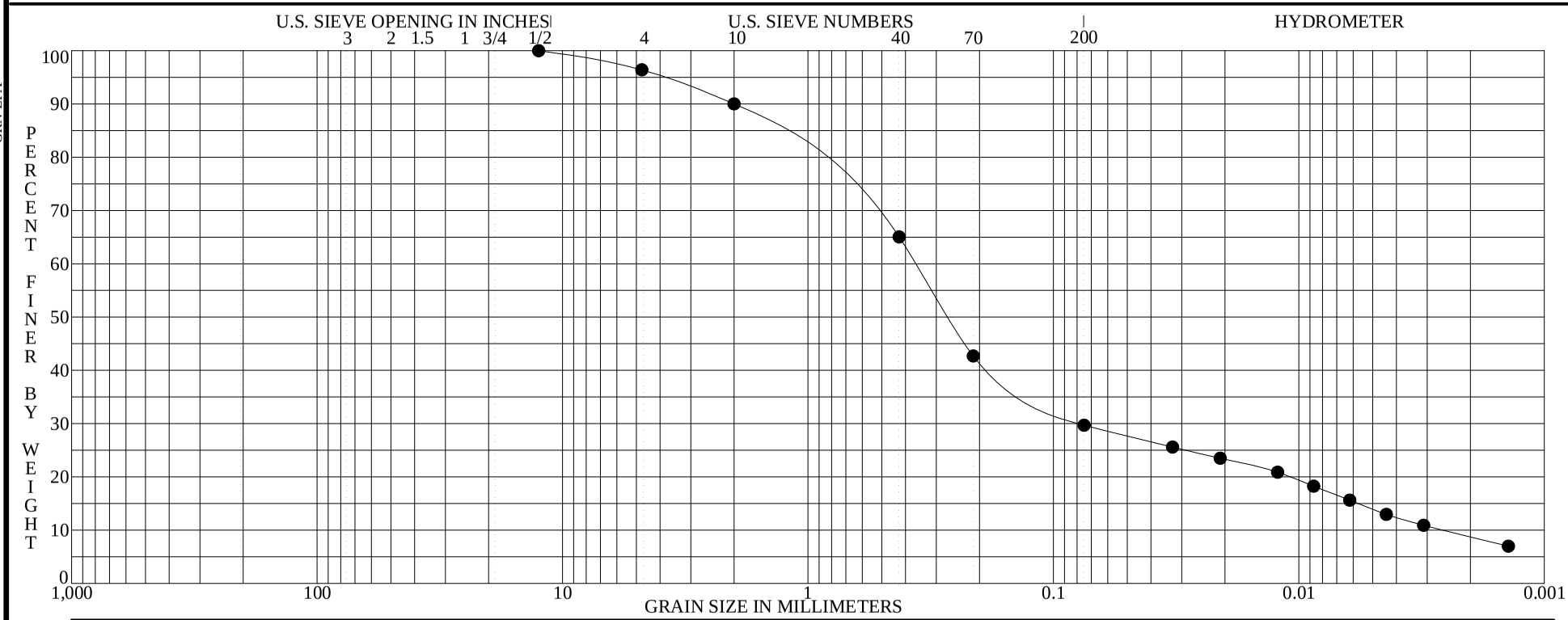
ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 10

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0902 S-21 33.5' to 34.2'**							

	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0902 S-21 33.5' to 34.2'**	**12.5000**	**3.9205**	**0.3632**	**0.2661**	**0.0026**	**3.6**	**66.7**	**20.9**	**8.7**

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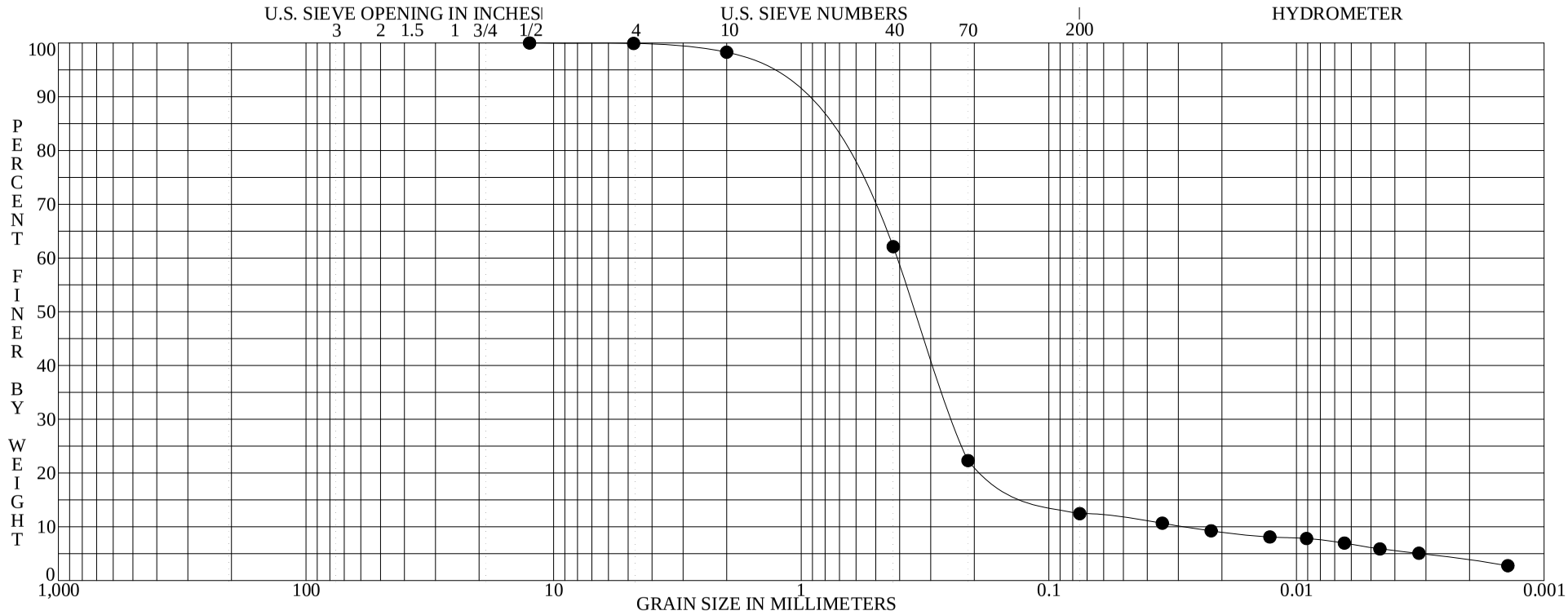
GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 11



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
● **GV-FAD-0902 S-22A 35.0' to 36.1'**		**18**					

Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **GV-FAD-0902 S-22A 35.0' to 36.1'**	**12.5000**	**1.7371**	**0.4096**	**0.3439**	**0.0282**	**0.1**	**87.5**	**8.7**	**3.8**

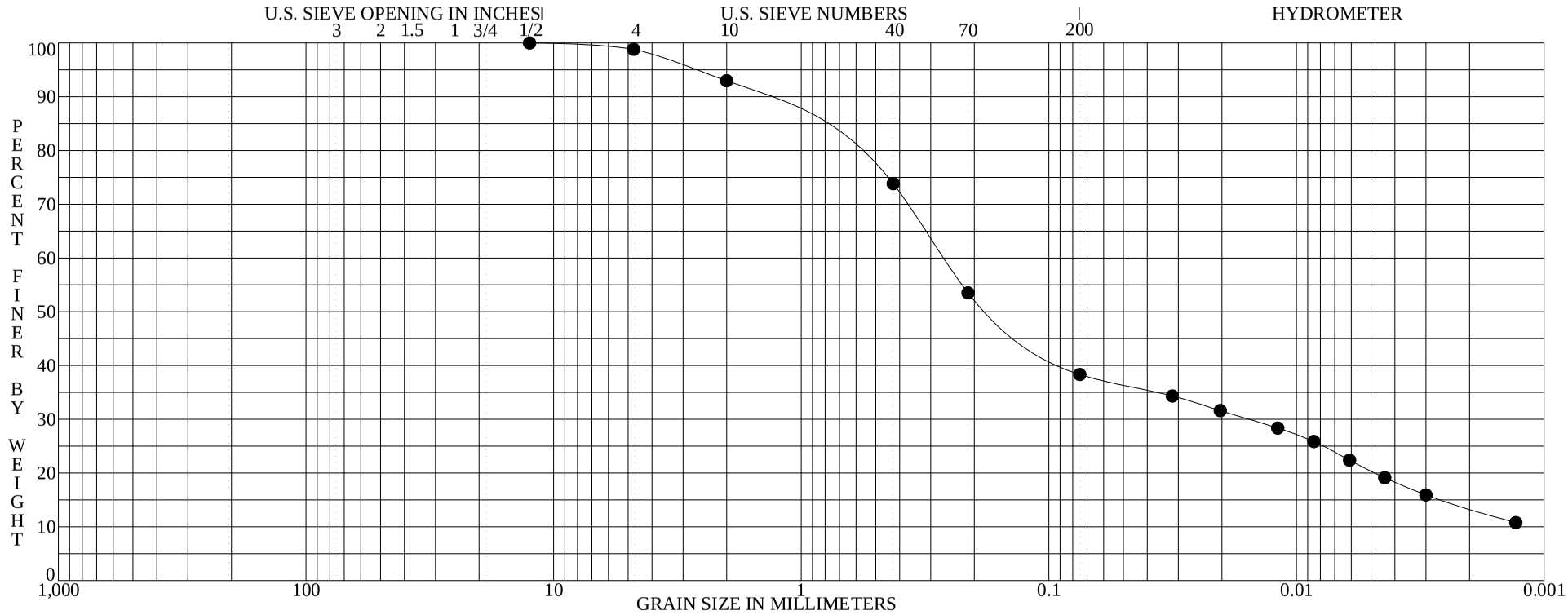
ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 12

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
● **GV-FAD-0902 S-25B 40.3' to 40.7'**							

Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **GV-FAD-0902 S-25B 40.3' to 40.7'**	**12.5000**	**2.6985**	**0.2647**	**0.1667**		**1.2**	**60.5**	**24.9**	**13.4**

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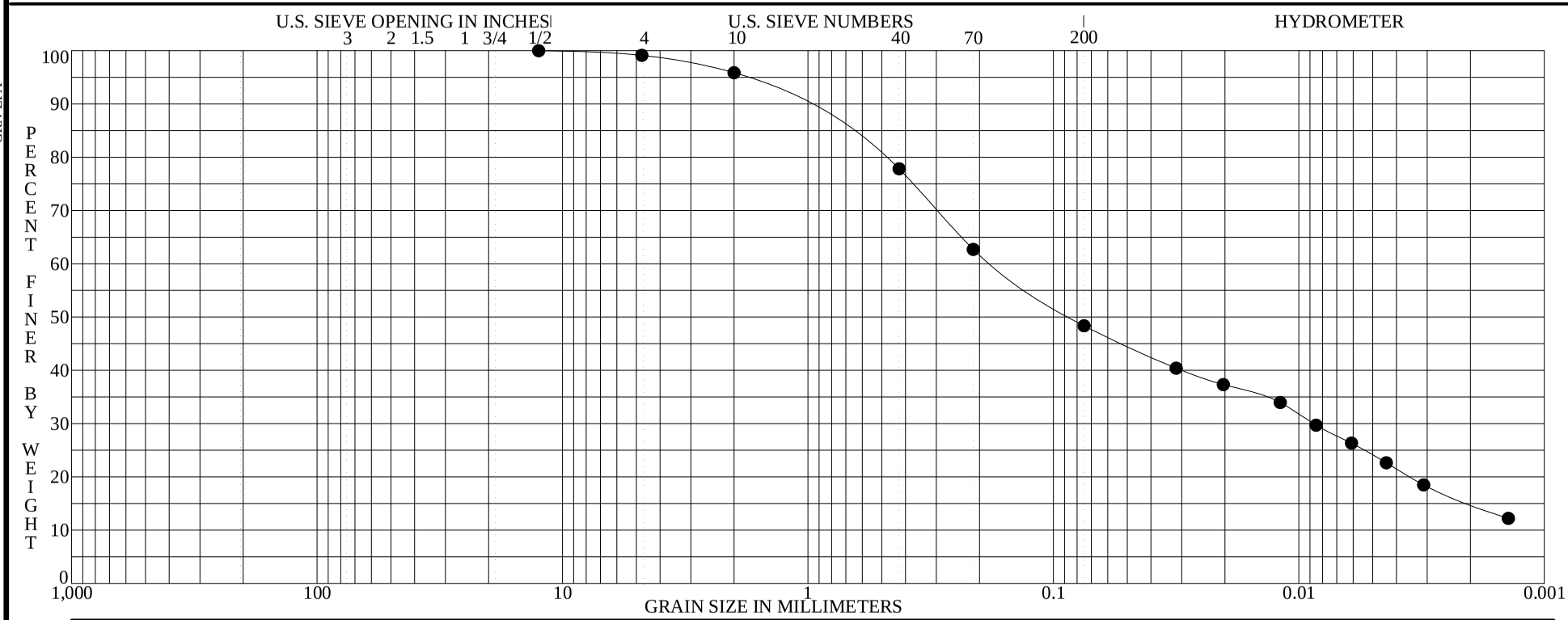
GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 13



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
● **GV-FAD-0902 S-27B 42.9' to 43.6'**	**CLAYEY SAND SC**	**18**	**28**	**17**	**11**		

Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **GV-FAD-0902 S-27B 42.9' to 43.6'**	**12.5000**	**1.8564**	**0.1743**	**0.0845**		**0.9**	**50.8**	**33.3**	**15.0**

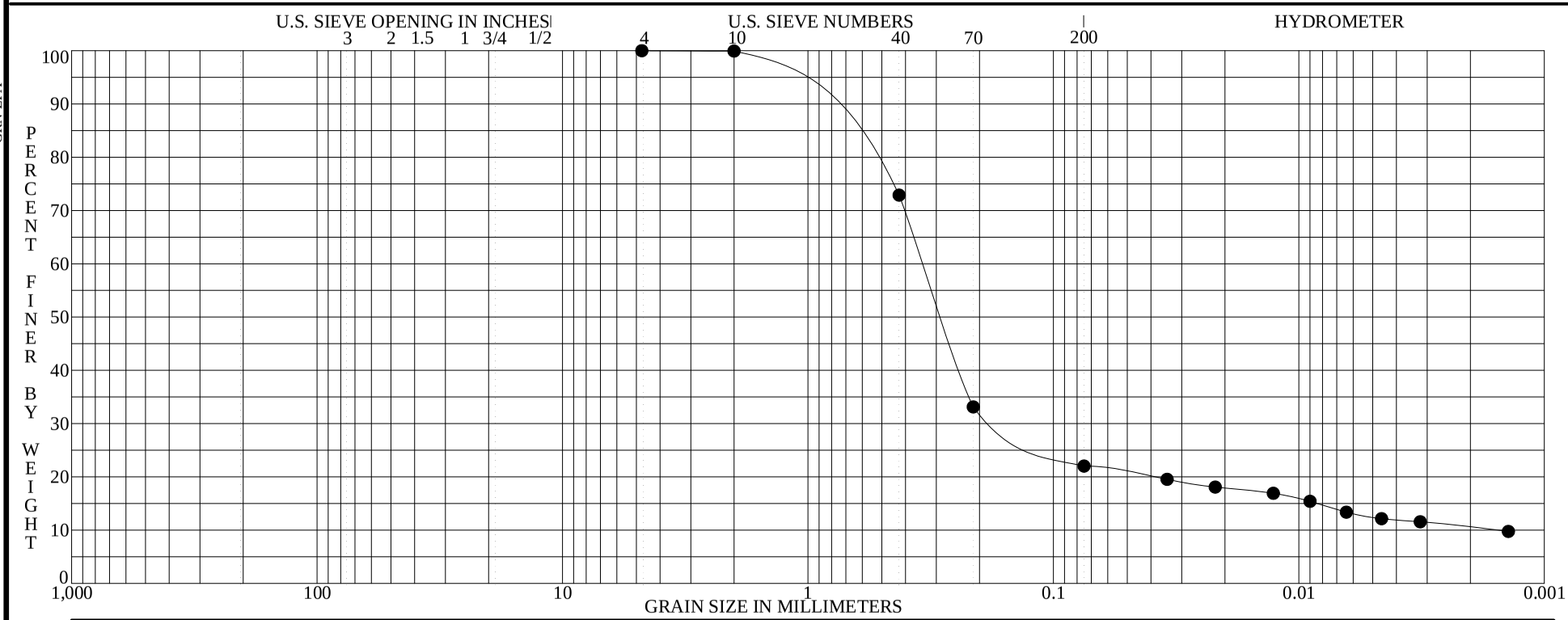
ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

GRN-EPA

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
● **GV-FAD-0903 S-15A 34.0' to 34.4'**							

Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **GV-FAD-0903 S-15A 34.0' to 34.4'**	**4.7500**	**1.5076**	**0.3392**	**0.2848**	**0.0016**	**0.0**	**78.0**	**11.5**	**10.5**

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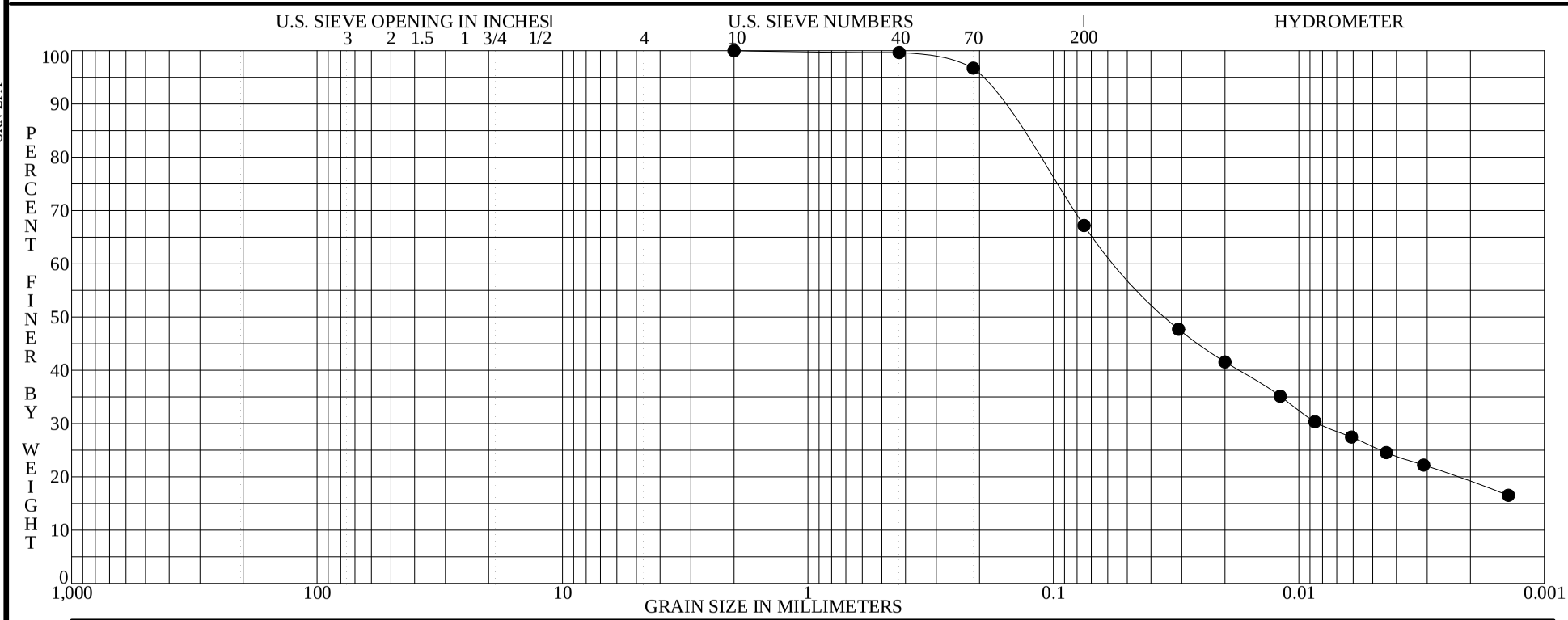
GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 15



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0903 S-16 35.5' to 37.0'**	**SANDY LEAN CLAY CL**	**23**	**29**	**16**	**13**		

	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0903 S-16 35.5' to 37.0'**	**2.0000**	**0.1995**	**0.0541**	**0.0343**		**0.0**	**32.8**	**48.1**	**19.1**

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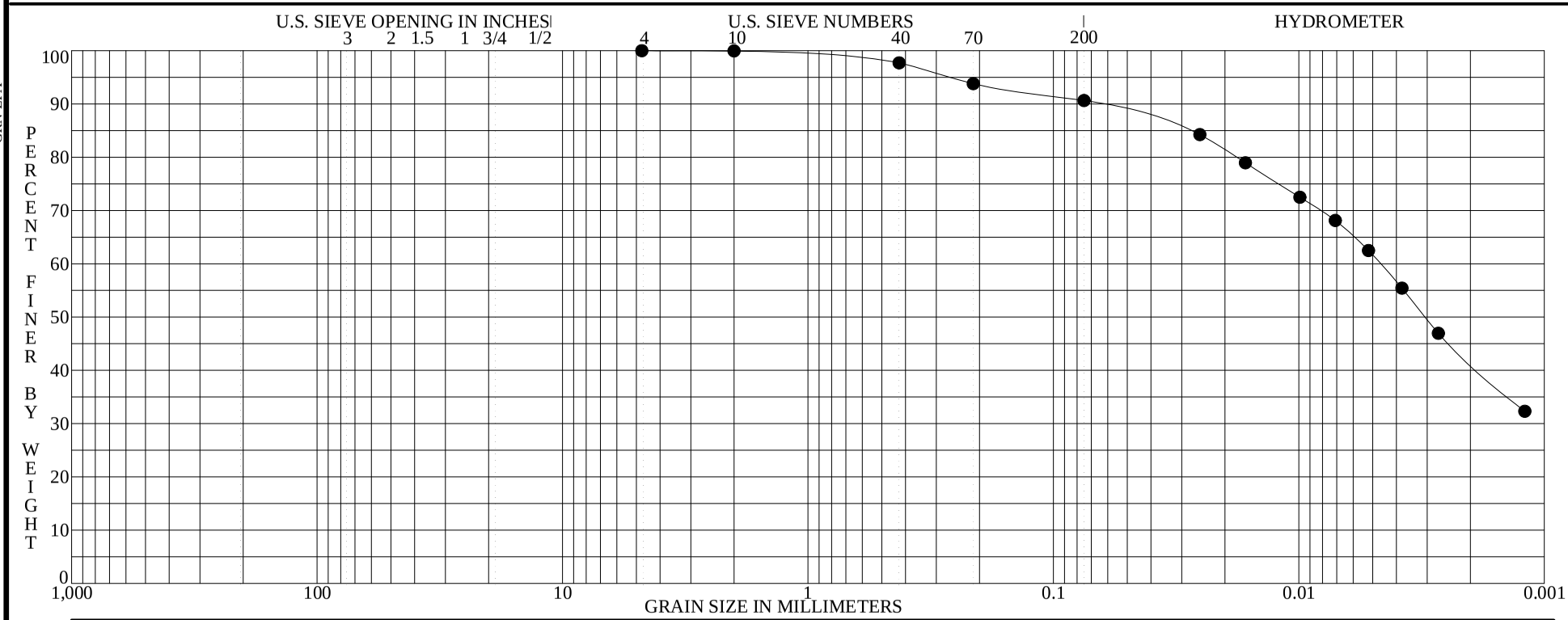
GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0903 S-19 41.0' to 41.7'**	**LEAN CLAY CL**	**24**	**39**	**20**	**19**		

	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0903 S-19 41.0' to 41.7'**	**4.7500**	**0.2617**	**0.0047**	**0.0031**		**0.0**	**9.4**	**49.1**	**41.5**

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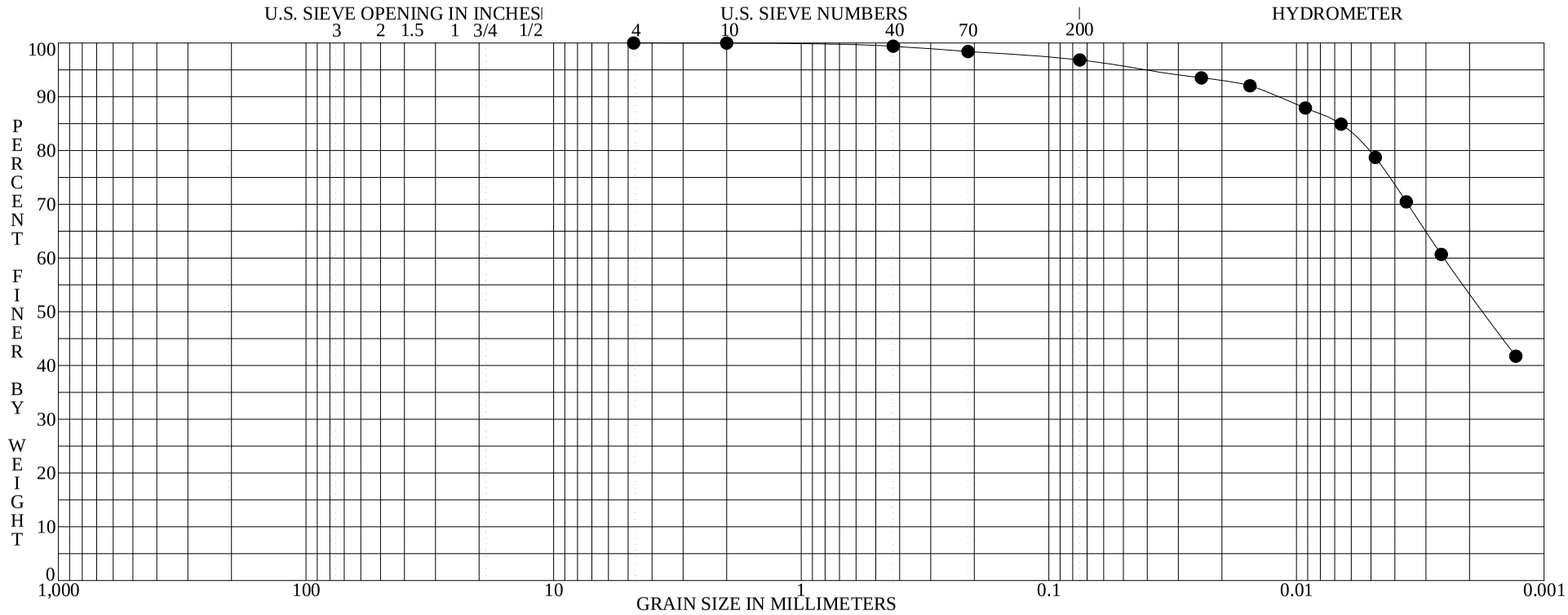
GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 17

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0903 S-21 44.0' to 45.5'**	**LEAN CLAY CL**	**27**	**49**	**21**	**28**		

	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0903 S-21 44.0' to 45.5'**	**4.7500**	**0.0401**	**0.0025**	**0.0018**		**0.0**	**3.1**	**43.4**	**53.5**

ASTM D422

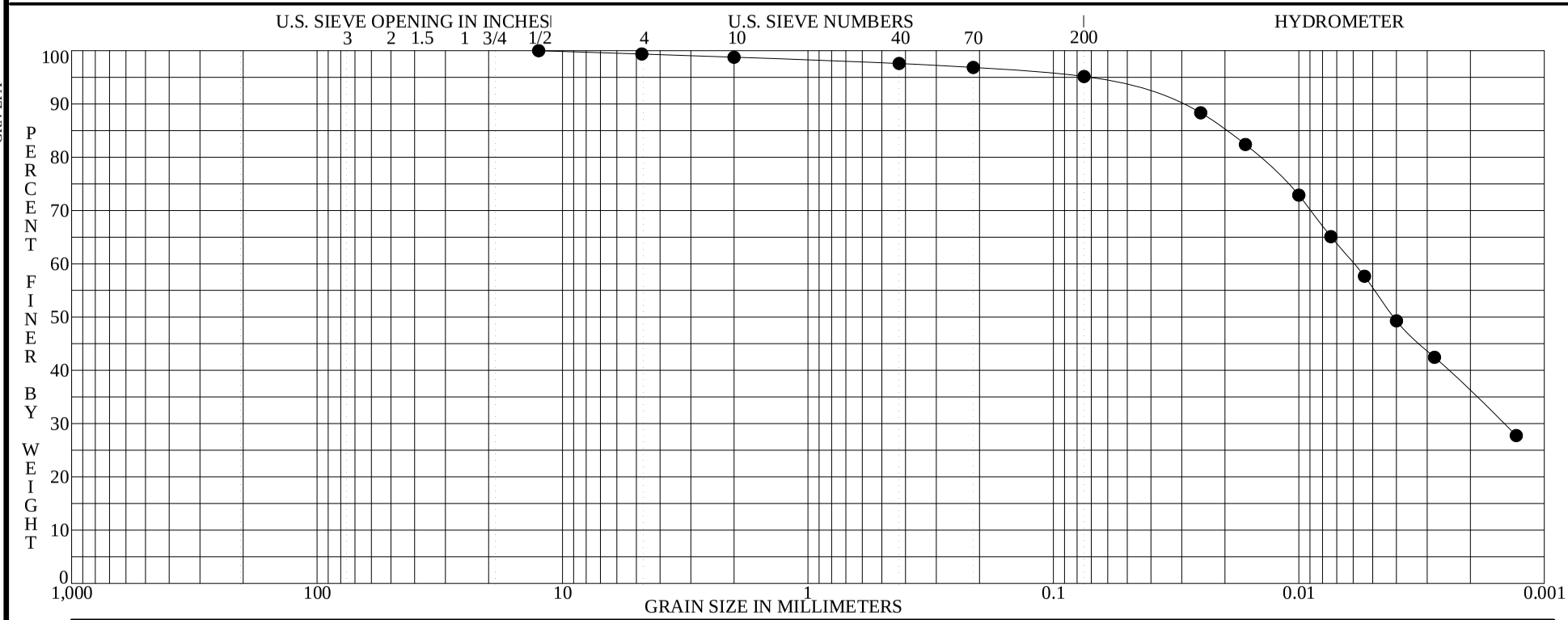
GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION

LOCATION CHESHIRE, OHIO

JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 18



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0903 S-27 53.5' to 55.0'**	**LEAN CLAY CL**	**19**	**41**	**20**	**21**		

	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0903 S-27 53.5' to 55.0'**	**12.5000**	**0.0731**	**0.0060**	**0.0041**		**0.6**	**4.2**	**59.2**	**36.0**

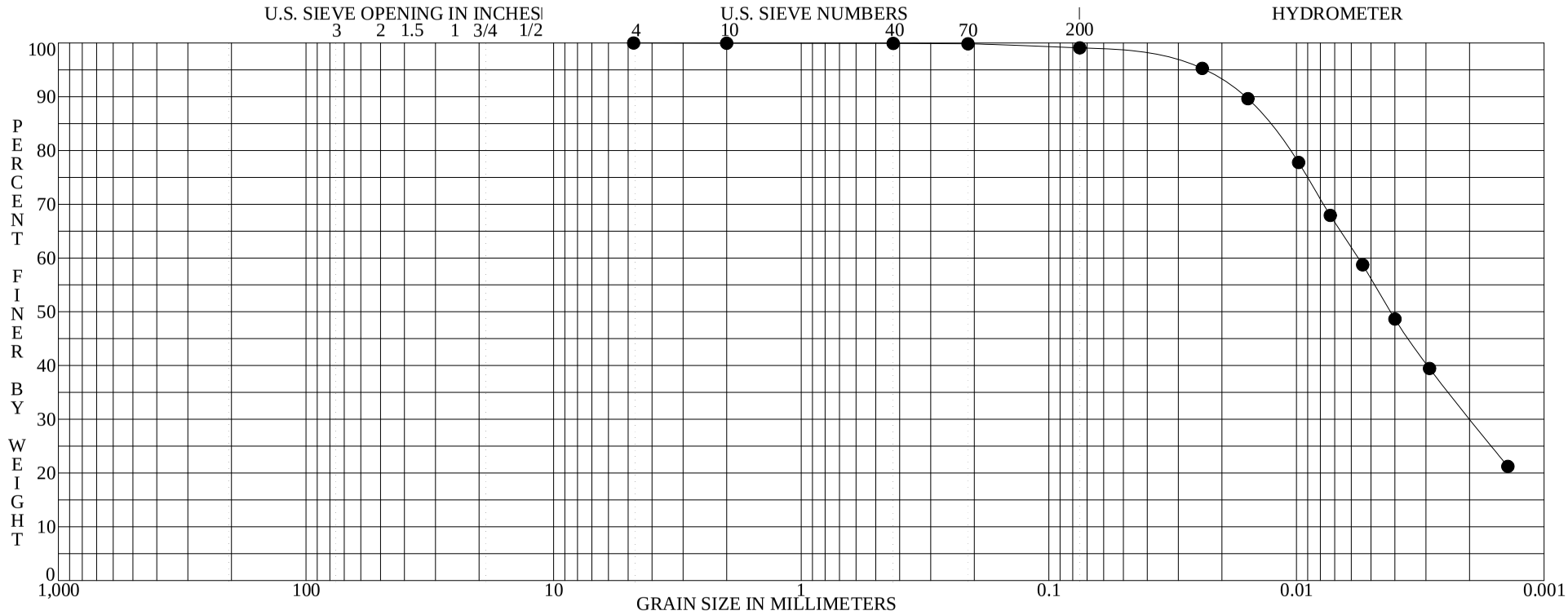
ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

GRN-EPA

GRN-EPA



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	opt mc%	max pcf
●	**GV-FAD-0903 S-31 59.5' to 61.0'**	**LEAN CLAY CL**	**11**	**35**	**21**	**14**		

	Specimen Identification	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**GV-FAD-0903 S-31 59.5' to 61.0'**	**4.7500**	**0.0235**	**0.0056**	**0.0042**		**0.0**	**0.9**	**69.0**	**30.1**

ASTM D422

GRADATION CURVE

PROJECT GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION
LOCATION CHESHIRE, OHIO
JOB NO. 011.11497.014 **DATE** 3/4/10

PLATE 20

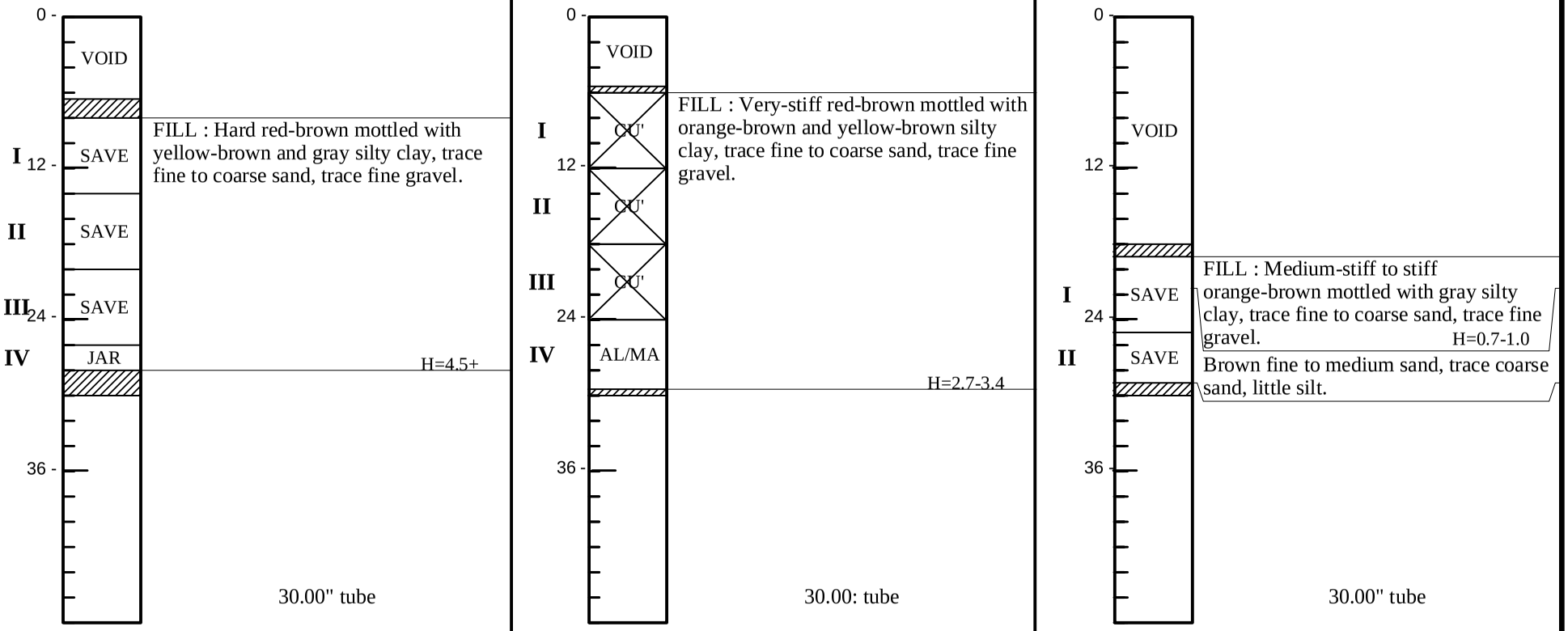
SHELBY TUBE LOG 111497014.GPJ BBCM.GDT 3/4/10

JOB NUMBER : **011.11497.014**
PROJECT : **GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION**
LOCATION : **CHESHIRE, OHIO**

BBCM

LABORATORY LOG OF SHELBY TUBES

Boring : **FAD-0901** Sample : **3**	Boring : **FAD-0901** Sample : **7**	Boring : **FAD-0902** Sample : **5**
Depth : **4.5' to 6.5'** Recovery : **20.00"**	Depth : **11.5' to 13.5'** Recovery : **23.50"**	Depth : **7.5' to 8.5'** Recovery : **10.00"**



LEGEND

- Consolidation, Incremental
- Swelling, Test
- Wax
- C R S — Consolidation, C R S
- P' P — Permeability, Vertical / Horizontal
- Unconfined Compression Test
- Triaxial Compression Test

H - Hand Penetrometer (tsf)
Ds - Direct Shear
LOI - Loss on Ignition
AL - Atterberg Limits
MA - Sieve/Hydrometer
SG - Specific Gravity
SL - Shrinkage Limit
POR - Porosity
UDW - Unit Dry Weight
MC - Moisture Content
D_R - Relative Density
S - Sieve

PLATE 21

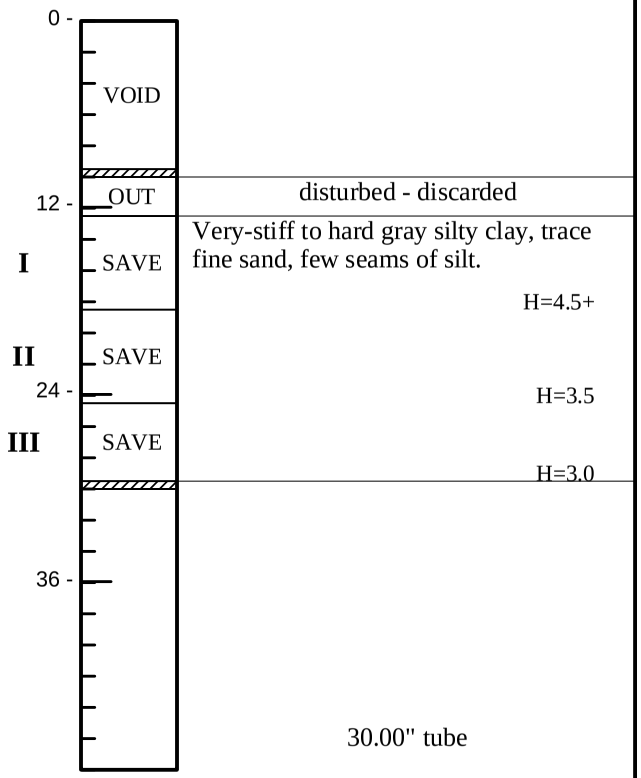
SHELBY TUBE LOG 111497014.GPJ BBCM.GDT 3/4/10

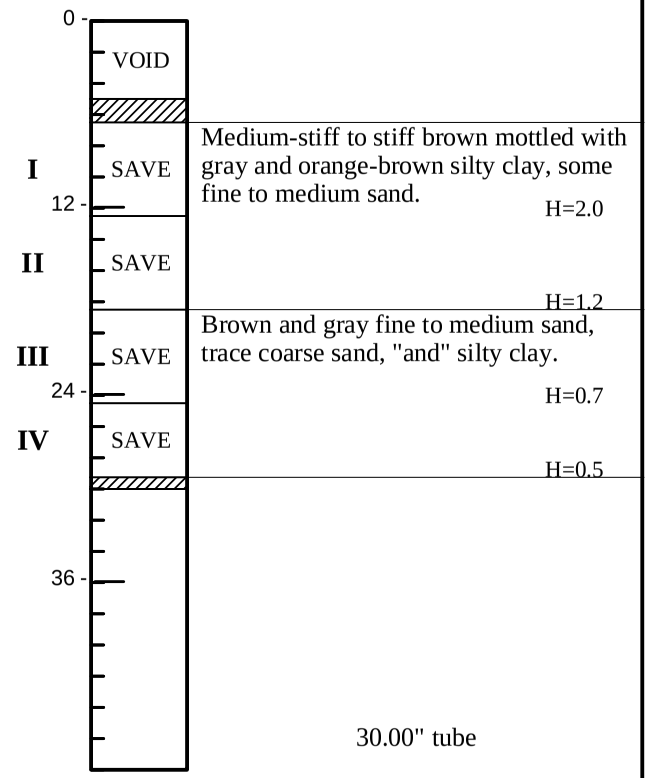
JOB NUMBER : **011.11497.014**
PROJECT : **GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION**
LOCATION : **CHESHIRE, OHIO**

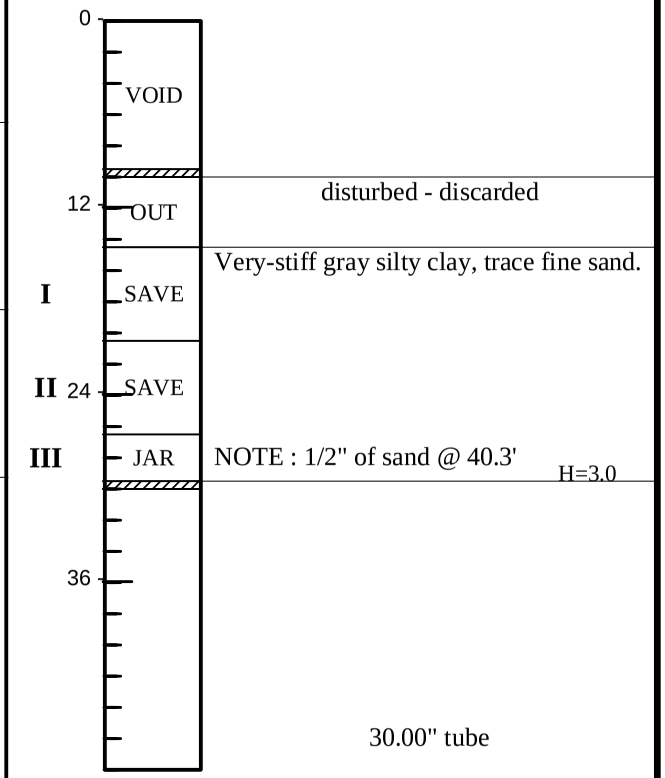
BBCM

LABORATORY LOG OF SHELBY TUBES

Boring : **FAD-0902** Sample : **14**	Boring : **FAD-0903** Sample : **14**	Boring : **FAD-0903** Sample : **18**
Depth : **22.5' to 24.2'** Recovery : **17.00"**	Depth : **32.0' to 33.9'** Recovery : **22.75"**	Depth : **39.0' to 40.7'** Recovery : **15.00"**







LEGEND

- Consolidation, Incremental
- Swelling, Test
- Wax
- C R S — Consolidation, C R S
- P | P — Permeability, Vertical / Horizontal
- Unconfined Compression Test
- Triaxial Compression Test

H - Hand Penetrometer (tsf)	SL - Shrinkage Limit
Ds - Direct Shear	POR - Porosity
LOI - Loss on Ignition	UDW - Unit Dry Weight
AL - Atterberg Limits	MC - Moisture Content
MA - Sieve/Hydrometer	D_R - Relative Density
SG - Specific Gravity	S - Sieve

PLATE 22

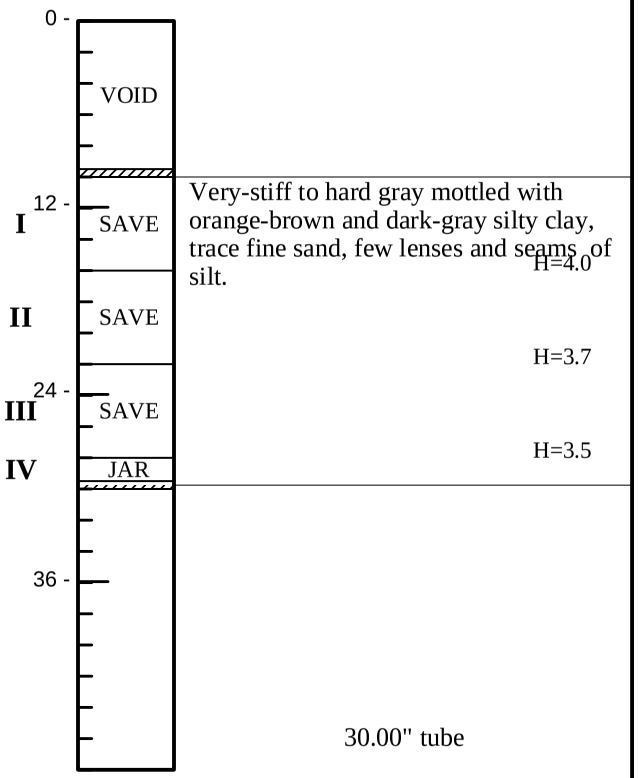
SHELBY TUBE LOG 111497014.GPJ BBCM.GDT 3/4/10

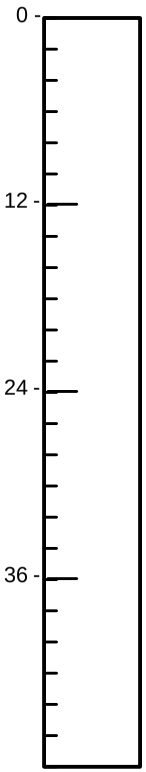
JOB NUMBER : **011.11497.014**
PROJECT : **GAVIN PLANT FLY ASH RESERVOIR DAM INVESTIGATION**
LOCATION : **CHESHIRE, OHIO**

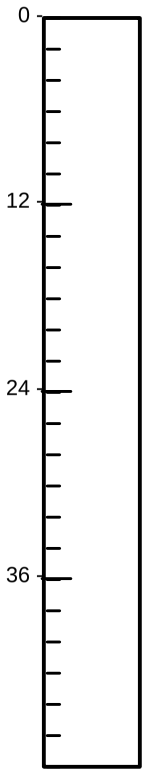
BBCM

LABORATORY LOG OF SHELBY TUBES

Boring : **FAD-0903** Sample : **22**	Boring : Sample :	Boring : Sample :
Depth : **45.5' to 47.1'** Recovery : **19.75"**	Depth : Recovery :	Depth : Recovery :





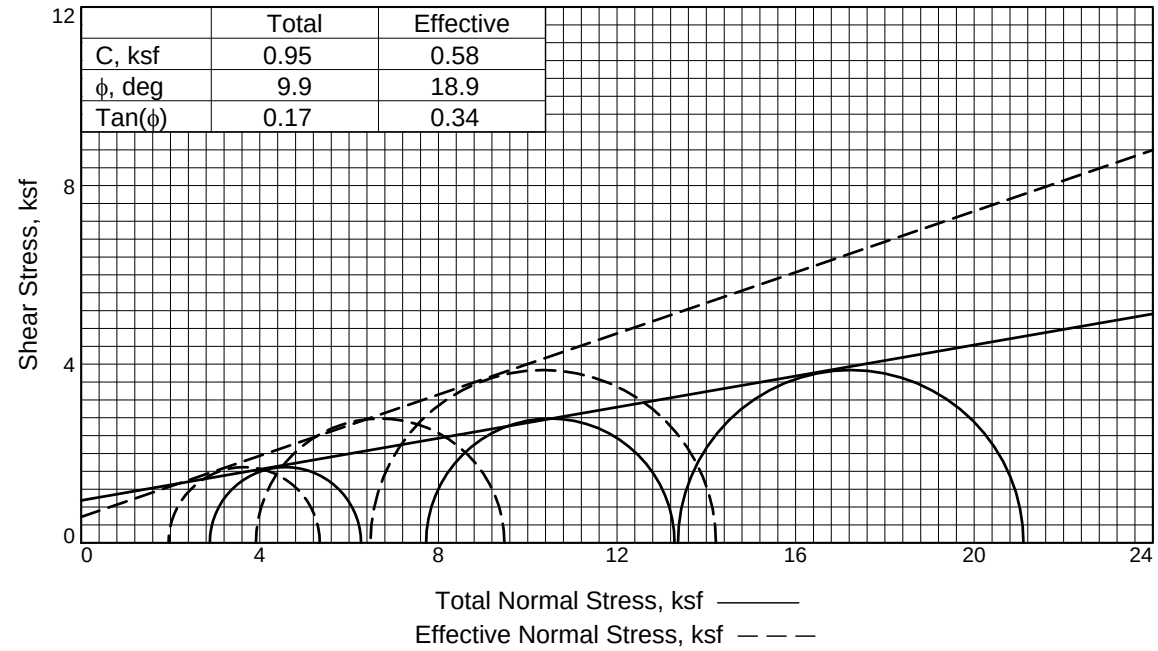


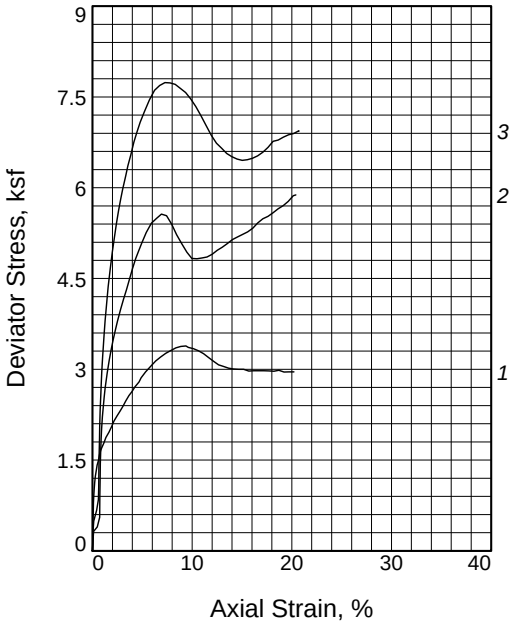
LEGEND

- Consolidation, Incremental
- Swelling, Test
- Wax
- C R S — Consolidation, C R S
- P | P — Permeability, Vertical / Horizontal
- Unconfined Compression Test
- Triaxial Compression Test

H - Hand Penetrometer (tsf)
Ds - Direct Shear
LOI - Loss on Ignition
AL - Atterberg Limits
MA - Sieve/Hydrometer
SG - Specific Gravity
SL - Shrinkage Limit
POR - Porosity
UDW - Unit Dry Weight
MC - Moisture Content
D_R - Relative Density
S - Sieve

PLATE 23





Sample No.		1	2	3
Initial	Water Content, %	21.4	21.1	19.6
	Dry Density, pcf	104.7	106.3	109.4
	Saturation, %	91.0	93.2	94.6
	Void Ratio	0.6514	0.6272	0.5694
	Diameter, in.	2.82	2.83	2.80
	Height, in.	5.59	5.59	5.59
At Test	Water Content, %	22.1	20.6	19.6
	Dry Density, pcf	107.3	110.1	111.6
	Saturation, %	100.2	100.1	100.0
	Void Ratio	0.6121	0.5705	0.5390
	Diameter, in.	2.80	2.80	2.82
	Height, in.	5.54	5.50	5.41
Strain rate, %/min.		0.02	0.02	0.02
Eff. Cell Pressure, ksf		2.9	7.7	13.4
Fail. Stress, ksf		3.4	5.6	7.7
Total Pore Pr., ksf		9.6	12.4	15.5
Strain, %		9.4	6.9	7.3
Ult. Stress, ksf		3.0	5.9	6.9
Total Pore Pr., ksf		8.8	11.5	14.7
Strain, %		20.2	20.4	20.7
$\bar{\sigma}_1$ Failure, ksf		5.3	9.5	14.2
$\bar{\sigma}_3$ Failure, ksf		2.0	3.9	6.5

Type of Test:
CU with Pore Pressures
Sample Type: Shelby Tube
Description: FILL : Very-stiff red-brown silty clay, trace fine to coarse sand, trace
LL= 54 **PL=** 24 **PI=** 30
Assumed Specific Gravity= 2.77
Remarks:

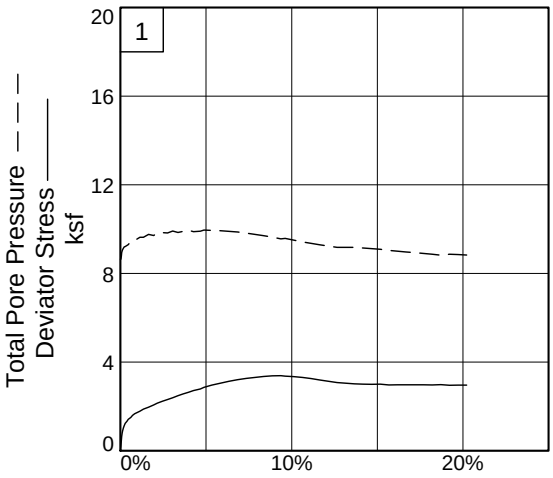
Figure 1

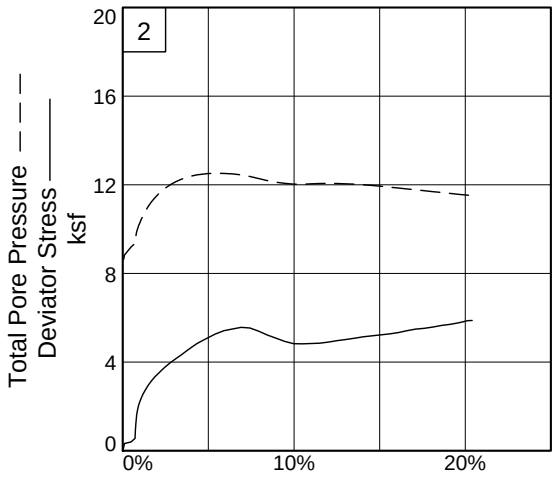
Client: AEP

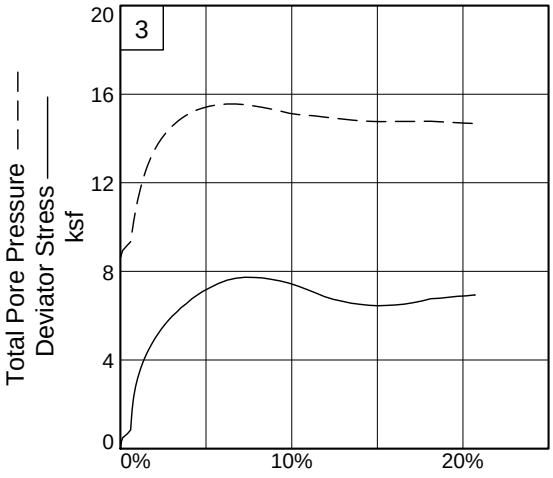
Project: GAVIN PLANT ASH POND INVESTIGATION
CHESHIRE, OHIO
Location: GV-FAD-0901
Sample Number: S-7 I,II,III
Proj. No.: 011.11497.014 **Date Sampled:** 01/12-23/10

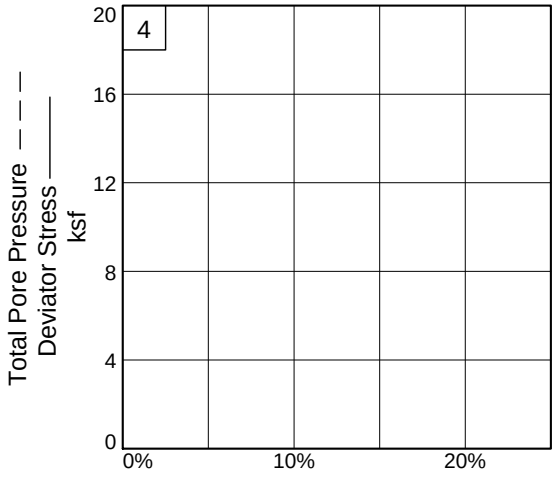
TRIAXIAL SHEAR TEST REPORT
BBC&M Engineering, Inc.
Dublin, Ohio

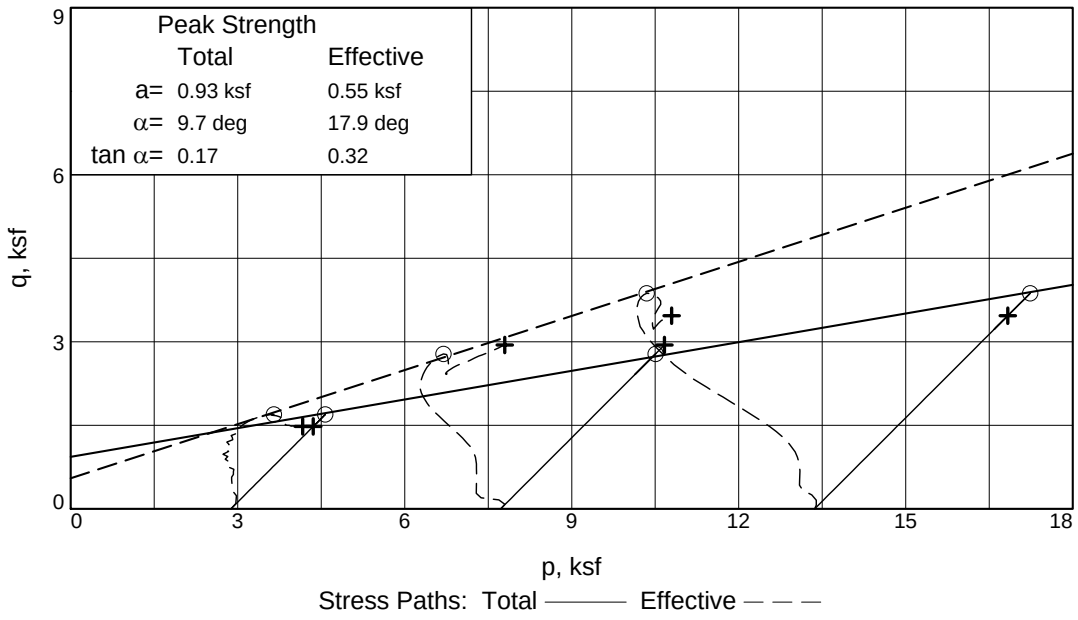
Tested By: PJM/JJ **Checked By:** JJ









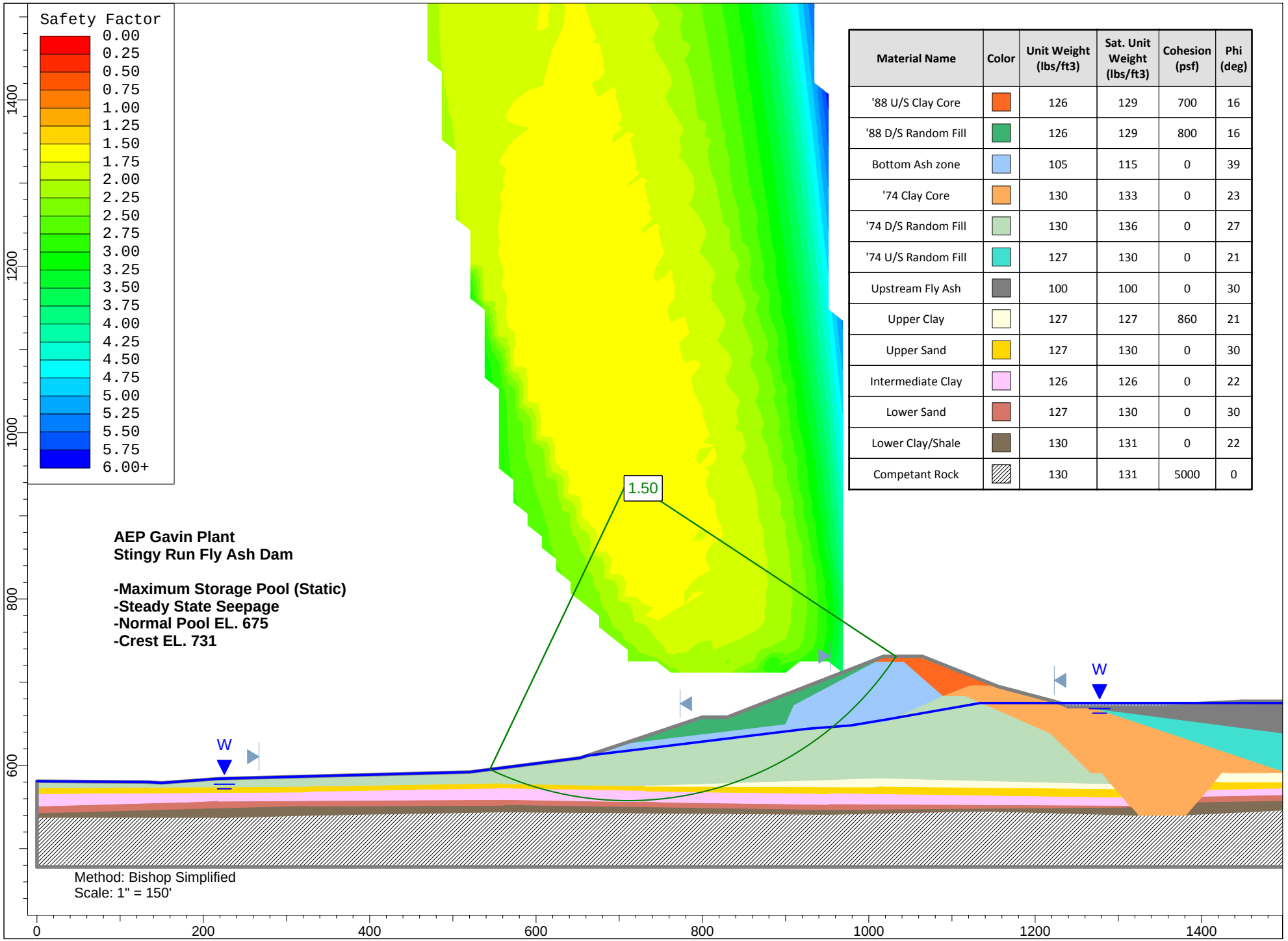


Client: AEP
Project: GAVIN PLANT ASH POND INVESTIGATION
Location: GV-FAD-0901 **Depth:** 11.5' to 13.5' **Sample Number:** S-7 I,II,III
Project No.: 011.11497.014 **Figure** 2

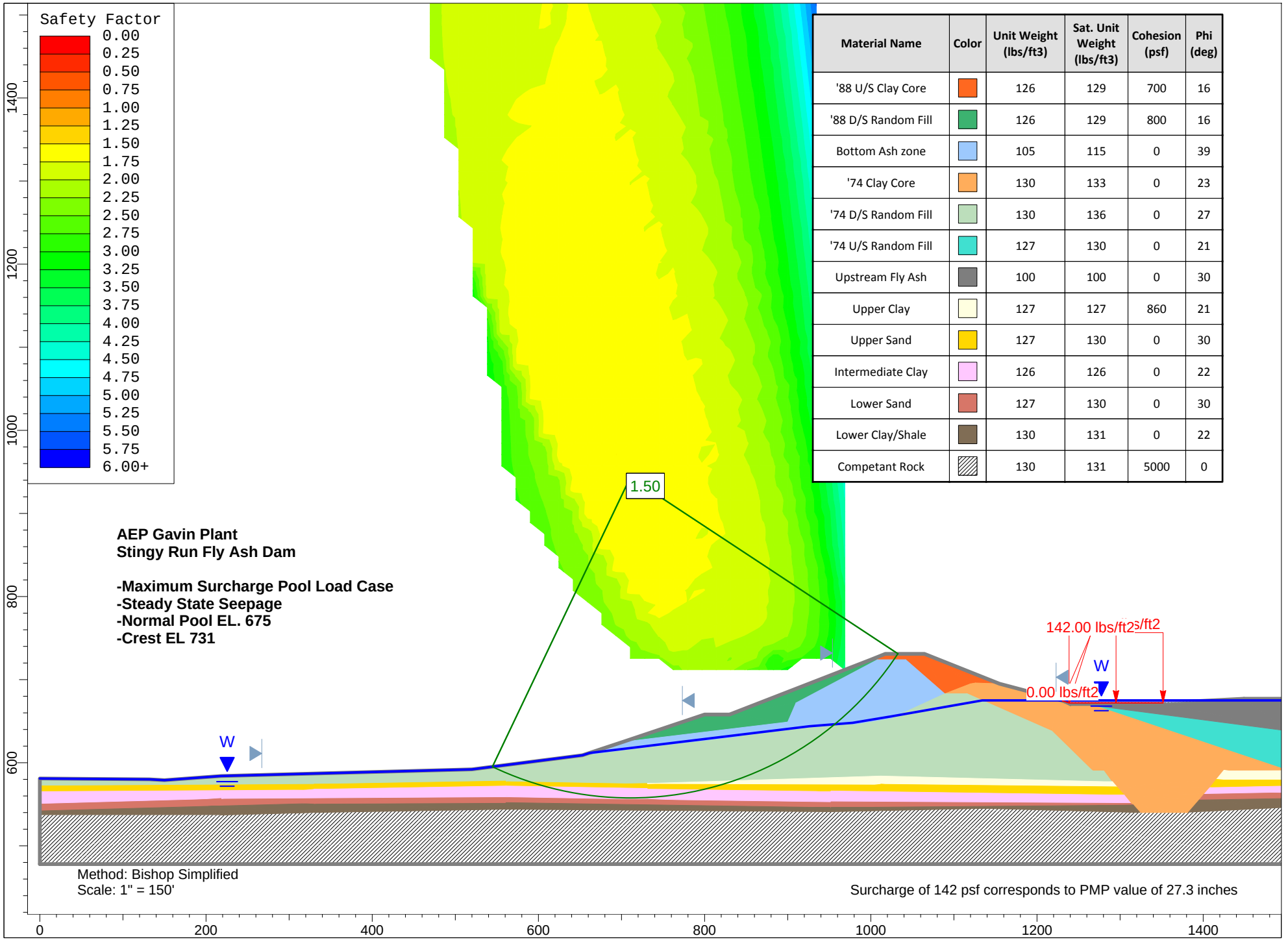
BBC&M Engineering, Inc.

Tested By: PJM/JJ **Checked By:** JJ

Appendix III – Safety Factor Assessment Figures



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
'88 U/S Clay Core		126	129	700	16
'88 D/S Random Fill		126	129	800	16
Bottom Ash zone		105	115	0	39
'74 Clay Core		130	133	0	23
'74 D/S Random Fill		130	136	0	27
'74 U/S Random Fill		127	130	0	21
Upstream Fly Ash		100	100	0	30
Upper Clay		127	127	860	21
Upper Sand		127	130	0	30
Intermediate Clay		126	126	0	22
Lower Sand		127	130	0	30
Lower Clay/Shale		130	131	0	22
Competant Rock		130	131	5000	0



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Upper Clay		127	127	860	21
Upper Sand		127	130	0	30
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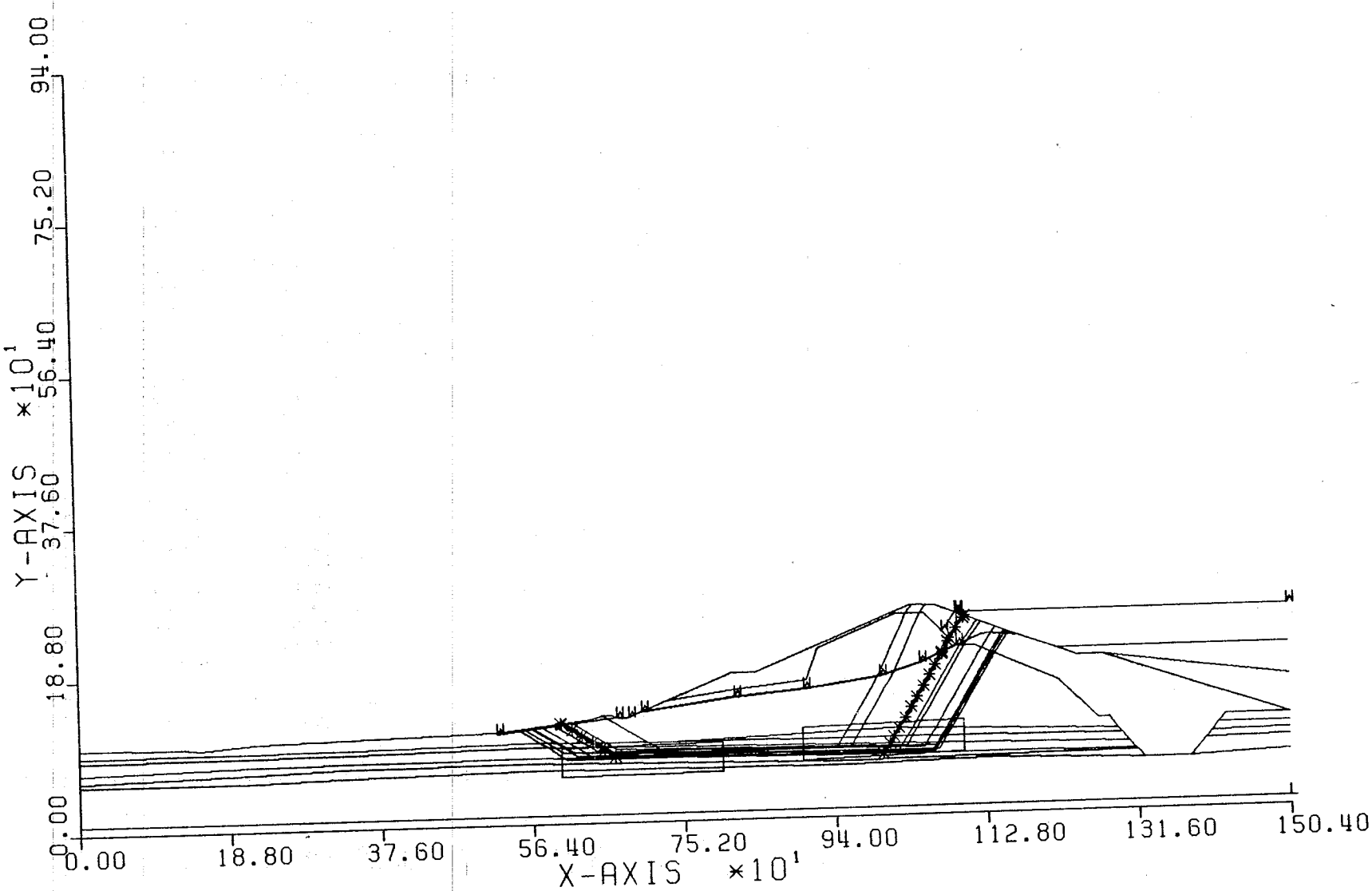
Lower Sand		127	130	0	30
Lower Clay/Shale		130	131	0	22
Competant Rock		130	131	5000	0

Dam Raising (Phase II) Design Report
December, 1986
Slope Stability Analysis

STINGY RUN FLY ASH DAM-D/S WEDGE CU FINA
L CONDITIONS EARTHQUAKE

10 MOST CRITICAL OF SURFACES GENERATED

MINIMUM FACTOR OF SAFETY = 1.221



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