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October 7, 2016

Mr. Matt Ballance, PE
Senior Project Engineer
Dynegy Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

RE: Geotechnical Report
Havana Power Station
East Ash Pond

Dear Mr. Ballance:

AECOM is pleased to provide this Geotechnical Report for the Dynegy Midwest Generation, LLC (DMG) East Ash Pond Coal Combustion Residuals (CCR) unit at the Havana Power Station located in Havana, Illinois. This Geotechnical Report has been prepared to document the analyses performed to check that the facility meets the geotechnical slope stability requirements including Factors of Safety required by 40 CFR § 257.73.

AECOM looks forward to providing continued support to Dynegy Midwest Generation, LLC and working together on this important program. Please do not hesitate to call Ron Hager at 314-429-0100 (office) / 440-591-7868 (mobile), if you have any questions or comments on this Geotechnical Report.

Sincerely,

AECOM

Ronald H. Hager

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cc: Mark Rokoff, PE – AECOM

Attachments:

A. Figures
B. Boring Logs
C. CPT Data Report
D. Lab Test Data
E. Material Characterization Calculations
F. Static Slope Stability Analysis
G. Seismic Loading Calculations
H. Dynamic Response Calculations
I. Liquefaction Analysis
J. Seismic Slope Stability Analysis

1. INTRODUCTION

1.1. *Purpose of This Report*

This report presents the results of the geotechnical analysis prepared by AECOM for the Dynegy Midwest Generation, LLC (DMG[1]) Coal Combustion Residuals (CCR) East Ash Pond unit at the Havana Power Station, located in Havana, Illinois (see **Attachment A** for Site Location Map, **Figure 1**). The purpose of the geotechnical investigation and analyses performed is to evaluate the design, performance, and condition of the impoundment and associated structures using the data collected from surface and subsurface investigations, available design drawings, construction records, inspection reports, previous engineering investigations, and other pertinent historic documents provided to AECOM by DMG. This information was then used to evaluate the design and operation of the surface impoundment against the regulatory standards set in 40 CFR § 257.73.

The geotechnical field evaluation was conducted between August 21 and September 22, 2015. The field program consisted of conventional hollow stem auger (HSA) and mud rotary borings, Standard Penetration Testing (SPT), obtaining undisturbed samples of subsurface soils, and Cone Penetration Testing (CPT). Laboratory testing was conducted on the materials obtained through various sampling techniques to assist in characterization of the subsurface conditions, especially with respect to defining material parameters for use in stability analyses. Stability analyses were performed by AECOM to evaluate the potential for slope instabilities, in accordance with the Environmental Protection Agency (EPA) regulation 40 CFR 257.73(d) and (e).

A summary of the geotechnical field program, laboratory testing program, and stability evaluations are presented herein. Detailed interpretations, calculations, and presentation of analysis results are provided in the Attachments to this report.

1.2. *Description of Impoundments*

The Havana Power Station is located on the east bank of the Illinois River, as shown in **Figure 1** of **Attachment A**. The East Ash Pond is located on the Illinois River floodplain east of the power plant and is approximately 1,500 feet east of the river. The East Ash Pond is comprised of four (4) individual cell units (Cells 1 through 4) surrounded by a common exterior dike, with a total area of approximately 99 acres. Cell 1 and Cell 4 have 3-foot thick clay liners and Cells 1 and 2 have a composite liner consisting of 1 foot of clay overlain by a 45-mil polypropylene geomembrane. Cell 1 and Cell 4 have crest elevations ranging from 488 to 490 feet (all elevations in this report are listed in the NAVD88 datum, unless otherwise stated), with maximum embankment heights of 22 feet and 26 feet, respectively. The crest elevation for Cell 2 ranges from 488 to 490 feet and from 494 to 496 feet for Cell 3, with maximum embankment heights of approximately 35 feet and 31 feet, respectively. The typical crest width is 15 feet. Upstream and downstream slopes were constructed at 3 horizontal: 1 vertical (3H:1V).

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[1] Although the Havana Power Station and the East Ash Pond are owned and operated by DMG, Dynegy Administrative Services Company (*Dynegy*) contracted AECOM to develop this geotechnical report on behalf of DMG. Therefore, "Dynegy" is referenced in materials attached to this geotechnical report.

2. SUMMARY OF FIELD INVESTIGATIONS

The subsurface exploration performed for the East Ash Pond included 11 auger borings and 8 cone penetration test (CPT) soundings with seismic shear wave velocity measurements and pore pressure dissipation (PPD) testing. The locations of the borings and CPT soundings are shown in **Figure 2** of **Attachment A**. The borings were drilled by AECOM's subcontractor Frontz Drilling of Wooster, Ohio. Frontz Drilling used an all-terrain CME-750 drill rig in conjunction with 3¼-inch inner diameter hollow stem augers to drill the borings. Three borings; HAV-EB-1T, HAV-EB-2T, and HAV-EB-5T; were drilled at the toe of the embankment. The “T” following the boring number designates that the boring was drilled at the toe of the embankment. The crest borings are designated with a “C”. Eight borings were drilled on the crest; HAV-EB-1C through HAV-EB-8C.

Borings at the toe of the embankment were drilled to depths ranging between 40 and 42.5 feet below ground surface (bgs). Borings drilled on the crest of the embankment were drilled to depths ranging between 40 and 62.5 feet below the embankment crest. All borings were terminated in alluvial soils and were not extended to bedrock. Undisturbed samples of subsurface materials were obtained using thin-walled Shelby tubes advanced in accordance with ASTM D1587. Disturbed samples were obtained with a split spoon sampler in accordance with ASTM D1586 (Standard Penetration Test – SPT). Boring logs are included in **Attachment B**.

CPT soundings were performed by AECOM's subcontractor ConeTec, Inc, of Charles City, Virginia. CPT soundings conducted at the toe of the embankment extended to depths ranging between 40 and 45.1 feet bgs. CPT soundings on the embankment crest extend to a depth of 85.5 feet below the embankment crest. All CPTs were terminated in alluvial soils and were not extended to bedrock. In-situ measurements such as tip resistance, sleeve resistance, and dynamic pore pressure were continuously recorded as the cone was advanced into the ground. Seismic shear wave measurements (SCPTu) were generally taken at 1 meter (3.3 feet) intervals and PPD tests were taken at selected intervals once the tip advanced into saturated materials. A complete report prepared by ConeTec that includes the graphical CPT logs and the results of the SCPTu and PPD tests is included in **Attachment C**.

Table 1 lists pertinent information regarding the auger borings and CPT soundings.

Table 1 - Exploratory Boring and CPT Summary

Boring or CPT Designation	Surface Elevation[(2)] (ft NAVD88)	Northing[(2)] (ft NAD83)	Easting[(2)] (ft NAD83)	Boring or Sounding Depth (ft)
CPT Soundings				
HAV-C001	470.0	1315557	2323963	40.0
HAV-C002	476.8	1317122	2324639	40.0
HAV-C003	466.2	1317190	2323758	45.0
HAV-C004	465(4)	1316558(4)	2323308(4)	40.0
HAV-C005	462.4	1316130	2322125	40.0
HAV-C006	467.5	1315507	2321893	45.1
HAV-C007	489.3(5)	1315619(5)	2322377(5)	85.5
HAV-C008	488.8(5)	1315277(5)	2322411(5)	85.5
Auger Borings				
HAV-EB-1C(1)	495.6	1315651	2323895	61.5
HAV-EB-1T(1)	470.0(3)	1315557(3)	2323963(3)	40.0
HAV-EB-2C	495.9	1317140	2324566	56.0
HAV-EB-2T	476.8(3)	1317122(3)	2324639(3)	42.5
HAV-EB-3C	495.7	1317143	2323860	61.5
HAV-EB-4C	495.4	1316468	2323339	40.0
HAV-EB-5C	490.1	1316096	2322227	62.5
HAV-EB-5T	462.4(3)	1316130(3)	2322125(3)	40.0
HAV-EB-6C	488.8	1315472	2322011	40.0
HAV-EB-7C	489.3	1315619	2322377	42.5
HAV-EB-8C	488.9	1315277	2322411	40.0

Notes:

(1) C and T refer to Crest and Toe locations on the embankment.

(2) The boring and CPT elevations and locations were surveyed by Weaver Consultants and provided to AECOM by DMG.

(3) Toe borings not surveyed, surveyors unable to find boring location; assumed to be the same as CPT borings at respective locations.

(4) Not surveyed, surveyors unable to find boring location; northing/easting and elevation are approximate.

(5) HAV-C007 and C008 not surveyed, no evidence of boring; assumed to have same elevation and northing/easting as HAV-EB-7C and 8C.

3. SUMMARY OF SITE-SPECIFIC SUBSURFACE CONDITIONS

The subsurface profile over the site included embankment fill materials and native alluvial sand. Fine-grained (clayey) soils were not encountered in significant quantities within the alluvium at the boring locations. Four representative material horizons were identified and are briefly described below with Unified Soil Classification System (USCS) designations where available.

Embankment Fill: The East Ash Pond embankments consist of poorly graded sand, poorly graded sand with silt, and silty sand. Based on uncorrected SPT N-values, the embankment materials are well compacted for the majority of the embankment, ranging from medium dense to very dense. Zones of loose sand were encountered at boring HAV-EB-6C from 7 feet to 12 feet bgs and in boring HAV-EB-7C from 10 feet to 25 feet bgs. Fines content (the material passing the number 200 sieve), typically ranged between 5% and 25% with an average of 13%, indicating clean to silty sands. A clayey sand (SC) was encountered between depths of 0 and 7 feet bgs in boring HAV-EB-6C. Boring HAV-EB-6C encountered a layer of silty sand (SM) with a fines content of 35% at a depth of 10 feet below the embankment crest. A 0.5-foot thick layer of sandy lean clay (CL) was encountered between a depth of 4 and 5 feet at Boring HAV-EB-8C. These were the only fine-grained soils encountered in the embankment fill boring locations.

Clay Liner: Samples of the clay liner were not collected in order to avoid puncturing the liner system. Consequently, conservative soil properties were assigned based on AECOM's experience.

Fly Ash: CCR materials were not encountered in the embankment fill during this exploration, and borings or CPTs were not advanced through the retained CCRs due to the risk of puncturing the liner system. Consequently, conservative engineering properties were assigned based on AECOM's experience.

Native Alluvial Foundation: The native alluvial materials typically consisted of poorly graded sand and sand with silt. The native material begins at elevations ranging between approximately 463 and 470 feet at the boring locations. Measured densities from corrected SPT N-values ranged between very loose and medium dense. Fines content was typically lower than the embankment fill and ranged between 1% and 30% with an average of 5%. A clayey sand (SC) layer was encountered between depths of 9 feet and 12 feet bgs in Boring HAV-EB-2T and a silty, clayey sand (SC-SM) was encountered between 27 and 32 feet bgs in Boring HAV-EB-6C. No other zones of relatively high fines content material were encountered.

Tables 2 and **3** summarize the uncorrected SPT N-values and the uncorrected CPT tip resistance values in tons per square foot (tsf) for the embankment fill and native alluvial foundation materials. The N-values shown were taken as the number of blows per foot (bpf) for the last 12 inches of SPT sampler advancement. Complete results of the boring and CPT logs are included in **Attachments B** and **C**, respectively.

Table 2 - Embankment Fill Field Measurement Summary

Category	Minimum	Maximum	Average
SPT N-values (bpf)	6	66	32
Cone Resistance, q_c (tsf)	2	544	221
Sleeve Resistance, f (tsf)	0.0	6.2	2.2
Friction Ratio, R_f (%)	0.0	4.3	1.2
SCPTu Shear Wave Velocity (ft/sec)	515	869	709

Table 3 - Native Alluvial Foundation Field Measurement Summary

Category	Minimum	Maximum	Average
SPT N-values (bpf)	4	34	11
Cone Resistance, q_c (tsf)	2	446	137
Sleeve Resistance, f (tsf)	0.0	5.4	0.7
Friction Ratio, R_f (%)	0.1	3.9	0.6
SCPTu Shear Wave Velocity (ft/sec)	407	1206	789

3.1. *Phreatic Water Conditions*

Phreatic conditions within the foundation soils were evaluated using the nine existing monitoring wells present in the area of the East Ash Pond. Phreatic levels in these wells were measured by Natural Resource Technology (NRT) in November 2015. Data from the November 2015 measurements, which reasonably agreed with phreatic conditions measured during the CPT investigation, was used by AECOM to develop piezometric conditions for use in the stability analyses. Based on borings advanced through the embankments, the embankment soils are unsaturated due to the presence of the liner system.

4. SUMMARY OF LABORATORY TESTING

Soil samples collected from the exploratory borings were sealed at the site and transported to the AECOM Overland Park, Kansas office, where a geotechnical engineer visually examined the samples and selected samples for laboratory testing. The selected soil samples were then sent to Alpha Omega Geotech's Kansas City, Kansas office for testing. The sections below summarize the number of tests performed and results of the soil testing

4.1. *Summary of Laboratory Testing Scope*

A total of 81 samples were tested using ASTM D422, Standard Test Methods for Particle Size Analysis of Soils, and ASTM D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 Sieve, where appropriate. The classification tests included 35 tests for the embankment fill and 46 tests for the native alluvial foundation materials. In addition to the classification tests, ASTM D2216, Test Method for Laboratorial Determination of Water Content, and ASTM D4318, Test Method for Liquid Limit, Plastic Limit and Plasticity Index, were also performed for selected samples.

4.2. *Summary of Laboratory Testing Results*

A brief summary of the laboratory testing results for water content, fines content and the Atterberg Limits is provided below in **Table 4** and **Table 5**. The isolated clay layers were omitted from the fines content averages listed below. The gradation curves and complete summary of the laboratory data are included in **Attachment D**.

Table 4 - Summary of Moisture and Fines Contents

	Water Content			Fines Content		
Material	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**	**Mean**
Embankment Fill	4.6	17.4	8.8	4.6	61	13
Native Alluvial Foundation	-	-	-	0.8	38	9

Table 5 - Summary of Atterberg Limits

Boring Designation	Depth of Sample (feet bgs)	Liquid Limit	Plastic Limit	Plasticity Index
HAV-EB-1C	26-27.5	Non-plastic		
HAV-EB-2C	3.5-5	Non-plastic		
HAV-EB-3C	11-12.5	Non-plastic		
HAV-EB-4C	33.5-34	14	13	1
HAV-EB-6C	3.5-5	25	14	11
HAV-EB-6C	8.5-10	14	13	1
HAV-EB-6C	28.5-30	18	13	5
HAV-EB-8C	3.5-5	30	15	15

5. SLOPE STABILITY ANALYSES

Slope stability analyses were performed for varying loading conditions at three cross-sections: A, B, and C. Cross section locations are shown in **Figure 2** of **Attachment A.** Surface topography, subsurface stratigraphy and soil parameters were established from the results of the site geotechnical exploration and pertinent historic data. A discussion of the selection of the cross sections and soil properties used for the stability analysis are presented in the following sub-sections.

5.1. *Cross-Sections for Analysis*

Three cross-sections, identified as Cross Sections A, B, and C in **Figure 2** of **Attachment A**, were selected for stability analysis. The sections were selected to analyze representative areas of embankment stability in regards to embankment height, slope orientation, and subsurface conditions. Cross section C was selected for analysis because the embankment is the highest (35 feet) at this location, and a layer of weaker material is present at the embankment/foundation interface. Sections A and B were selected for analysis because liquefaction-susceptible materials are present in the foundation at these sections. While liquefaction-susceptible materials were also found to be present in other portions of the foundation where an analysis cross-section is not present, the thickness of the liquefaction-susceptible materials as well as the height of the embankment were less than observed at Sections A and B, and additional sections were therefore not analyzed as the post-liquefaction factors of safety would be higher than at Sections A and B, by inspection.

Table 6 - Geotechnical Explorations at Cross Sectional Locations

Cross Section	Geotechnical Subsurface Data Used in Cross-Section
A	HAV-EB-3C and HAV-C003
B	HAV-EB-1T, HAV-EB-1C, HAV-C001
C	HAV-EB-5T, HAV-EB-5C, HAV-C005

The topography for the cross sections was taken from the 2015 ground and bathymetric survey prepared by Weaver Consultants Group in November 2015. Original ground surfaces and pond bottom elevations were estimated using the 2015 survey and design drawings provided by DMG. The borings and CPT soundings used to construct the cross sections are shown in **Table 6**.

5.2. *Stability Analysis Conditions Considered*

Consistent with the criteria provided in the USEPA CCR Rule § 257.73(e), the stability of the East Ash Pond embankment was evaluated for four load cases

Static, Long-Term Maximum Storage Pool Condition: This case models the conditions under static, long-term conditions, under the maximum storage water level within the impoundment. Water elevations used for analysis were 486.0, 485.0, 492.0 and 484.5 feet for Cells 1, 2, 3, and 4, respectively, as listed in AECOM's hydrologic and hydraulic report (AECOM, 2016) for the East Ash Pond. Drained (effective stress) shear strength parameters were used for all materials. The phreatic conditions were estimated based on water level readings in nearby wells made by NRT in November 2015. ***Target Factor of Safety = 1.50.***

Static, Maximum Surcharge Pool Condition: This case models the conditions under a short-term surcharge elevation of 487.1, 486.8, 492.9 and 486.7 feet for Cells 1, 2, 3, and 4, respectively, as listed in AECOM's hydrologic and hydraulic report (AECOM, 2016) for the East Ash Pond. Drained strengths were used for the analysis, as the material comprising the embankment and foundation are primarily free-draining and granular and thus are expected to behave in a drained manner during surcharge pool loading. Phreatic conditions within the embankment and foundations were assumed to be the same as the maximum storage pool condition due to the presence of a liner system in the East Ash Pond. ***Target Factor of Safety = 1.40.***

Seismic Slope Stability Analysis: These analyses incorporate a horizontal seismic coefficient (k_h) selected to be representative of expected loading during the 2,500-yr return period design earthquake event (i.e., a "pseudostatic" analysis). The analyses utilized drained strengths because the soils are free-draining and granular and thus are expected to behave in a drained manner during seismic loading. The same pool level and phreatic conditions as the maximum storage pool condition case were used for this analysis. ***Target Factor of Safety = 1.00***

Post-Liquefaction Condition: Liquefaction triggering analyses (see **Section 5.3.2.3**) identified the presence of soils susceptible to liquefaction within the foundation of the East Ash Pond. The triggering analysis did not identify any soils susceptible to liquefaction within the East Ash Pond dikes. Therefore, a post-earthquake (i.e. liquefaction) slope stability analysis is not required per §257.73(e), as the dikes soils are not susceptible to liquefaction). However, a post-earthquake slope stability analysis was performed to evaluate the effects of liquefaction in the foundation at the East Ash Pond, in order to support the evaluation of foundation stability, per §257.73(d)(1)(i). The target factor of safety for post-earthquake analysis listed in §257.73(e) of 1.20 was also used as the target factor of safety for this analysis, as §257.73(d)(1)(i) does not specify a minimum factor of safety for post-earthquake slope stability analysis. No horizontal seismic coefficient is included in these analyses. Sluiced CCRs retained by the dikes were assumed to liquefy for this analysis, although he material is not located within the dikes themselves or with the foundation. These analyses were performed at stability cross sections A and B because liquefaction triggering analyses found liquefaction-susceptible soils within the foundation soils at these locations. Liquefaction-susceptible soils were not found at cross section C. The same pool level and phreatic conditions as the maximum storage pool condition case were used for this analysis. ***Target Factor of Safety = 1.20.***

5.3. Methodology of Analyses

Limit equilibrium slope stability analyses were performed using the computer software program SLOPE/W 2012 v.8 from GeoStudio International. Factors of safety were calculated using Spencer’s method and using both circular and wedge search routines to evaluate the failure surface for each analysis section and load case because this method satisfies both moment and force equilibrium. Critical surfaces were considered to be those which intersected the embankment crest and could result in a release of CCR materials. Pore pressures were assigned as hydrostatic pressure under the piezometric line.

The following sections briefly summarize the analysis and soil parameters used for the static, seismic, and post-liquefaction conditions. Detailed presentation of the analyses are provided in **Attachment F** for static slope stability analysis and **Attachments G, H,** and **I** for development of ground motions and liquefaction triggering analyses for the earthquake loading conditions. Seismic slope stability results are contained in **Attachment J**.

5.3.1. Static Analysis Conditions

The strength parameters for static analysis conditions are listed in **Table 7**.

Table 7 - Static Material Properties for Stability Analysis

Material	Total Unit Weight(pcf)	Effective (drained) Shear Strength Parameters	
		c’ (psf)	Φ’ (°)
Embankment Fill	120	0	40
Lower Strength Embankment	120	0	30
Clay Liner	110	50	29
Fly Ash	90	0	20
Native Alluvial Foundation	115	0	30

The primary shear strength parameter for cohesionless soils is the effective internal friction angle, phi (f ’). This was developed using the corrected N-values from the SPT and correlating them with the effective stress at each SPT location using a chart from Coduto, 2012. Data and calculation spreadsheets provided by ConeTec show that the CPT data was correlated to f ’ using Kulhawy and Mayne (1990).

The lower SPT N-values near the embankment/foundation interface at borings HAV-EB-2C and HAV-EB-3C were accounted for in Section A stability analysis. The inclusion of this layer was considered to be conservative because the depths at which the SPTs were taken were likely part of the foundation but no further evidence allowed for the layer to be discounted.

Further details regarding the calculations of the shear strength parameters are presented in **Attachment E**.

5.3.2. Earthquake Analysis Conditions

Published seismic data from the United States Geological Survey (USGS) for the area of the Havana East Ash Pond were referenced to obtain the parameters needed for a liquefaction analysis and to analyze the seismic loading condition. The procedures used are described below.

5.3.2.1. Seismic Loading

Seismic loading was evaluated using the USGS 2008 online Probabilistic Seismic Hazard Deaggregation tool in order to determine the Peak Ground Acceleration (PGA) at top-of-rock with an exceedance probability of 2% in 50 years. This resulted in a PGA-rock of 0.072g, with the greatest contribution to hazard coming from an earthquake with mean moment magnitude (Mw) = 6.95 at a distance of 246 km. Refer to **Attachment G** for more information on the Seismic Loading.

5.3.2.2. Dynamic Response Analysis

The USGS 2008 Deaggregation Tool was used to provide a simplified estimate of the site's dynamic responses. The tool provides for PGA on rock as input to calculate the dynamic response of the foundation soil using International Building Code (IBC) and National Earthquake Hazards Reduction Program (NEHRP) information or procedures. The East Ash Pond foundation was first classified as a stiff soil profile, site Class D, based on the shear wave velocity (V_s) measurements obtained from the CPT soundings. This resulted in an amplification of the PGA-rock = 0.072 g to PGA-design = 0.12 g.

The design acceleration was converted from a peak transverse base acceleration to a peak transverse crest acceleration, using a correlation provided by Idriss (2015). The maximum crest acceleration was calculated to be 0.33 g. The PGA was converted to an equivalent horizontal force (k_h) that was used as input into the programs for seismic analysis using Makdisi-Seed procedure (1978). **Attachment G** includes a more detailed description of the processes and methods used to obtain the final k_h = 0.11 g value.

5.3.2.3. Liquefaction Triggering Analysis

The potential for liquefaction was evaluated using a liquefaction triggering analysis based on the SPT and CPT data. The analysis was conducted by using the Idriss and Boulanger (2008) procedure. The SPT- and CPT-based triggering analyses use the stress-based framework of the Cyclic Resistance Ratio (CRR) and the Cyclic Stress Ratio (CSR) parameters. The CRR is an empirical correlation between N-values or q_c-values, corrected for overburden and fines content. The CSR is likewise an empirical function of PGA and is corrected for magnitude and overburden stress. The fines content for the CPT-based analysis was developed from relationships using the Soil Behavior Type Index reported on the ConeTec CPT logs in **Attachment C**. These were compared with the lab data in **Attachment D** at the appropriate depths. The lab data was used solely in the SPT-based correlation for fines. The SPT and CPT triggering results for the loose layers were typically in good agreement. The complete liquefaction analysis is in **Attachment I**.

5.3.2.4. Strength Parameter Selection

Post-liquefaction slope stability analyses were performed at Sections A and B, where liquefaction-susceptible soils were found in the foundation. The shear strength for the liquefaction-susceptible portions of the native alluvial foundation, as well as the sluiced ash retained in the East Ash Pond, is shown in **Table 8.** The shear strengths were selected using published correlations in Idriss and

Boulanger (2008). Material strengths for materials not susceptible to liquefaction were assumed to be the same as those presented in **Table 7**, as the soils not susceptible to liquefaction are granular and free-draining, and are therefore assumed to behave in a drained manner during post-earthquake loading. Refer to **Attachment E** for the complete material strength characterization used in the seismic analysis.

Table 8 - Seismic Material Properties for Stability Analysis

Material	Total Unit Weight (pcf)	Shear/Normal Stress Ratio
Liquefied Foundation Layer	115	0.06
Fly Ash-Liquefied	90	0.05

6. RESULTS

6.1. *Results of Static Analyses*

The results of the limit equilibrium slope stability analyses for the static load cases are summarized in **Table 9** below. The output figures showing the slip surfaces and details of the analyses are included in **Attachment F**.

Table 9 – Static Analysis Results

Loading Condition	Program Criteria	A	B	C
Steady State (Normal Pool)	FS ≥ 1.50	2.23	2.47	2.10
Steady State (Flood Pool)	FS ≥ 1.40	2.23	2.47	2.10

6.2. *Results of Earthquake Analyses*

6.2.1. Liquefaction Triggering Analysis

Liquefaction-susceptible soils were not identified within the dikes at the East Ash Pond, as the dikes are unsaturated and well-compacted. The native alluvial foundation material was found to be susceptible to liquefaction in limited, relatively thin loose layers at depths of 17 to 31 feet below the toe of the embankment. Section B had the thickest layer of liquefiable material, ranging from approximately elevation 446 feet to elevation 439 feet (depth 24 feet to 31 feet), based on CPT and SPT data. Section A had a thinner layer of liquefiable material based on CPT data that ranged approximately from elevation 448.1 feet to 442.5 feet (depth 17.1 feet to 22.5 feet). The liquefaction analysis identified thin (e.g. 1 foot or less), isolated zones of potentially-liquefiable material at other locations in the foundation, however these zones are not assumed to represent a laterally or vertically-continuous layer as they are spatially disconnected. The sluiced fly ash retained by the embankment is also assumed to be susceptible to liquefaction, due to its wet-sluiced nature. All other soils within the embankment and foundation were not found to be susceptible to liquefaction during the design seismic event. Details of the liquefaction analysis can be found in **Attachment I**.

6.2.2. Earthquake Analysis Conditions

The results of the slope stability analyses for the seismic load cases are summarized in **Table 10**. The output figures showing the slip surfaces and details of the analyses are included in **Attachment J**. It should be noted that a post-liquefaction analysis was not performed at Section C as neither the embankment or foundation soils at Section C are susceptible to liquefaction.

Table 10 – Seismic Analysis Results

Loading Condition	Program Criteria	A	B	C
Seismic Pseudo-Static (Normal Pool)	FS ≥ 1.00	1.64	1.76	1.51
Post-Earthquake Liquefaction (Normal Pool)	FS ≥ 1.20	1.31	1.78	N/A

7. CONCLUSIONS

The calculated factors of safety from the limit equilibrium slope stability analyses satisfy the USEPA CCR Rule §257.73(e) requirements for all the load cases analyzed at the cross sections for the embankment that comprise the perimeter of the Havana East Ash Pond. Load cases analyzed for this study include static (steady-state)maximum storage pool, maximum flood surcharge pool, seismic (pseudo-static), and static post-liquefaction.

8. LIMITATIONS

Background information, design basis, and other data have been furnished to AECOM by DMG, which AECOM has used in preparing this report. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information. Our recommendations are based on available information from previous and current investigations. These recommendations may be updated as future investigations are performed.

Borings have been spaced as closely as economically feasible, but variations in soil properties between borings, that may become evident at a later date, are possible. The recommendations made in this report are based on the assumption that the subsurface soil, rock, and phreatic conditions do not deviate appreciably from those disclosed in the site-specific exploratory borings. If any variations or undesirable conditions are encountered in any future exploration, we should be notified so that additional recommendations can be made, if necessary.

The conclusions presented in this report are intended only for the purpose, site location, and project indicated. The recommendations presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. The conclusions and recommendations are based on AECOM's understanding of current plant operations, maintenance, storm water handling, and ash handling procedures at the station, as provided by DMG. Changes in any of these operations or procedures may invalidate the findings in this report until AECOM has had the opportunity to review the changes, and revise the report if necessary.

This geotechnical investigation was performed in accordance with the standard of care commonly used as state-of-practice in our profession. Specifically, our services have been performed in accordance with accepted principles and practices of the geological and geotechnical engineering profession. The conclusions presented in this report are professional opinions based on the indicated project criteria and data available at the time this report was prepared. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

9. REFERENCES

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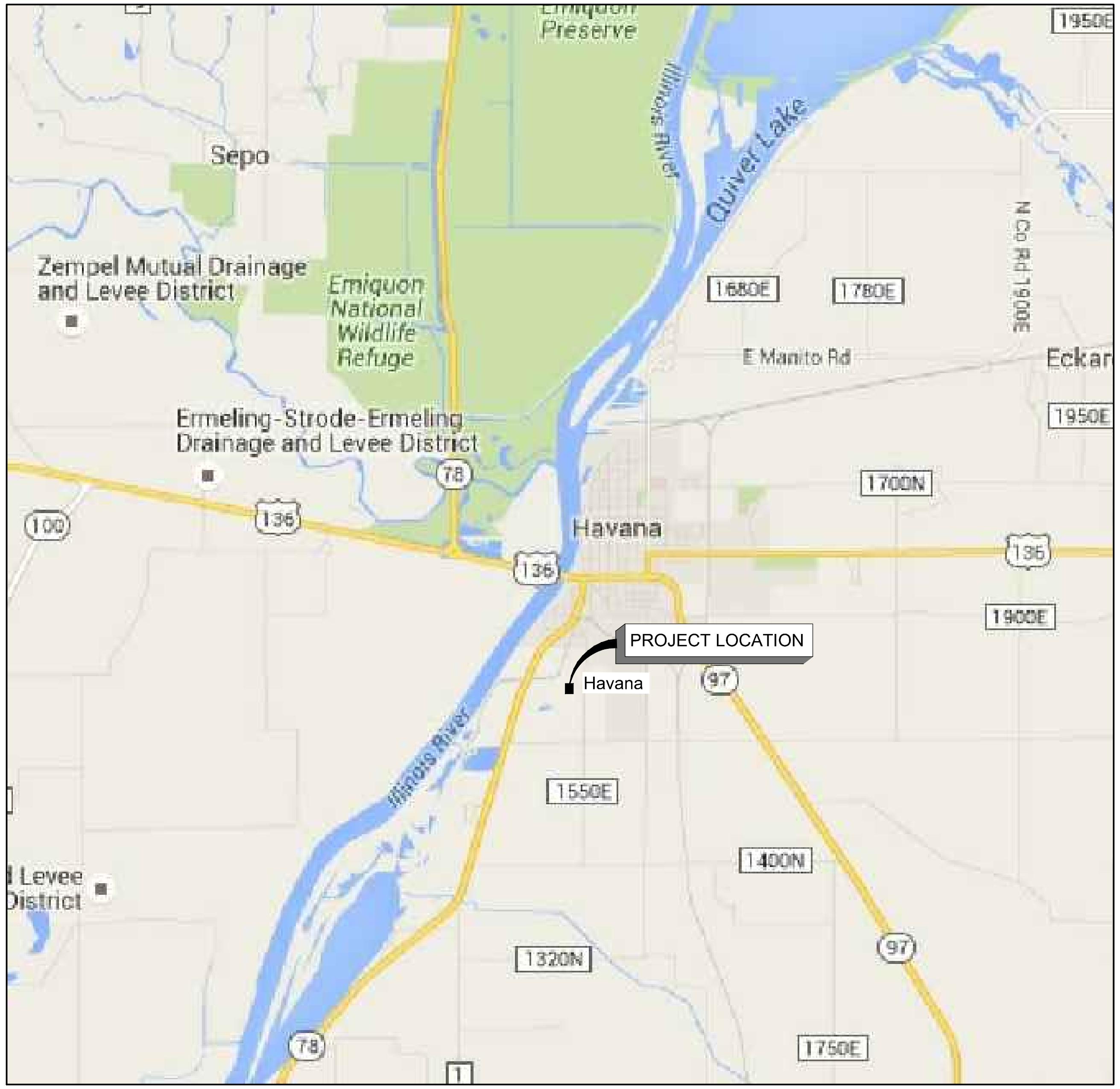
2015 – Havana Topography Weaver Consultants Group November 2015

ATTACHMENT A

FIGURES



N

LOCATION MAP

NOT TO SCALE

N

VICINITY MAP

NOT TO SCALE

AECOM
8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

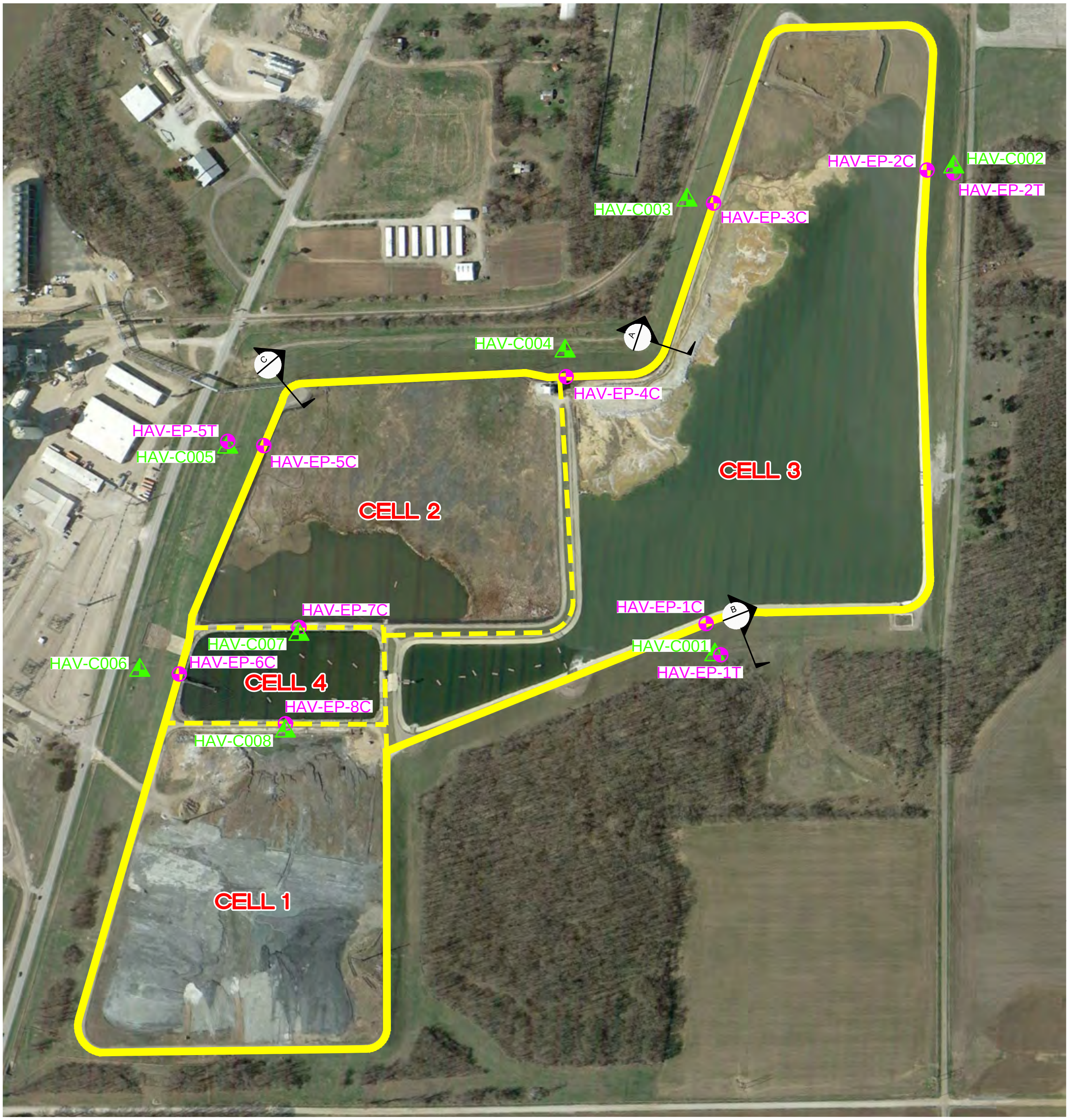
CLIENT: DYNEGY MIDWEST GROUP, INC.

LOCATION: HAVANA, IL

TITLE:
LOCATION MAP & SITE VICINITY MAP

DRAWN BY SMS	CHECKED BY BDL	APPROVED BY BDL
PROJECT NO. 60439304	DATE FEB. 2016	FIGURE NO. 1

February 26, 2016 11:29:49 am (stu)
J:\Dynegy Havana Station CCR Designation\CAD\Plan Sheets\Location Map and Vicinity Map Figure 1.dwg



LEGEND:

HAV-EP-5T
● APPROXIMATE LOCATION FOR
PROPOSED EXPLORATORY BORING LOCATION

HAV-C003
▲ CPT LOCATION AND NUMBER

SLOPE STABILITY CROSS
SECTION NUMBER AND LOCATION

N

0 500
SCALE FEET

SOURCE: GOOGLE EARTH PRO IMAGE

DYNEGY MIDWEST GENERATION, LLC
HAVANA, IL

PROJECT NO.
60439304

AECOM

DRN. BY:djd September 2016
DSGN. BY:bt
CHKD. BY:lc

Havana East Ash Pond Exploratory
Boring Locations, CPT Locations, &
Cross Sections for Stability Analysis

FIG. NO.
2

P:\Projects\Geotech\60428794_DynegyCCR\21_Revised_Cert_Reports\07_HAV\Rev 1\Geotech\Live files from KC\Figure\Figure 2 East Ash Pond Boring-CPT-Xsect Location.dwg User:david_deguire Sep 21, 2016 - 2:08pm

ATTACHMENT B

BORING LOGS

The exploratory borings for Havana Station East Ash Pond were drilled between August 31 and September 4, 2015. AECOM subcontracted with Frontz Drilling to drill a total of 11 exploratory borings. Borings drilled on the crest of the embankment included HAV-EB-1C through HAV-EB-8C, while toe borings included HAV-EB-1T, HAV-EB-2T, and HAV-EB-5T. The locations of the exploratory borings are shown in Figure 1.

All of the exploratory borings were drilled by Frontz Drilling using an all-terrain Central Mine Equipment (CME-750) drill rig. The borings were advanced using hollow stem augers. Borings on the crest of the embankment were drilled to termination depths ranging between approximately 40 and 62.5 feet below ground surface (bgs), while borings at the toe of embankment were drilled to depths ranging between approximately 40 and 42.5 feet bgs. All borings were backfilled with cement-bentonite grout upon completion.

Relatively undisturbed samples of subsurface materials were obtained using thin-walled Shelby tubes that were advanced with a standard Shelby tube head in general accordance with ASTM D1587. The push length of the thin-walled tubes was approximately 18 inches. Disturbed samples were obtained with a split barrel sampler in general accordance with ASTM D1586 (Standard Penetration Test – SPT).

Recovered soil samples were initially identified and field logged by a geologist by observing the drilling characteristics, cuttings, and soil samples. All soil samples were transported to the AECOM laboratory in Overland Park, Kansas for designation of testing. Selected samples were sent to the Alpha-Omega laboratory located in Kansas City, Kansas. The field boring logs were revised based on review of the laboratory test results.

The final boring logs presented in this appendix were generated using gINT geotechnical software by Bentley Systems. The gINT software tools utilize a geotechnical database and graphics package to present various geotechnical outputs (i.e., boring logs, test summaries, etc.). The gINT logs herein show the soil classification in accordance with Unified Soil Classification System (USCS), sampler type, sample depths, recovery, resistance, and drilling method, as well as laboratory testing data such as moisture content, dry unit weight, Atterberg limits, and unconfined compression. The descriptions used to describe the consistency on the final logs are based on the strengths obtained by field testing.

BORING LOG NOMENCLATURE SHEET

TERM		IDENTIFICATION AND DESCRIPTION
SPT		Split-Spoon Sample (Standard Penetration Test): A 2-inch O.D., 1.5-inch I.D., split-barrel, 18 to 30-inch long sampler is driven by blows from a 140-pound hammer falling 30-inches. The number of blows required to advance the sampler three 6-inch increments are counted (See Sampling resistance below).
C	C	California Sample: Thick-wall sampler containing four nominal 2-inch diameter, 4-inch long brass liners. The sampler is hydraulically pushed a maximum of 12 inches.
ST	ST	Shelby Tube sample: Hydraulically-pushed, 3-inch diameter, thin-walled tube used for obtaining undisturbed soil samples.
CME	CME	CME 3-inch diameter continuous soil sampling system.
PS	PS	Nominal 3-inch diameter Shelby tube piston sampler.
D		Disturbed sample or auger cuttings
NX	NX	NX-size (2.155-inch diameter) rock core sample obtained using a diamond bit and recirculating water (See RQD below).
PP		Pocket Penetrometer measurement indicative of soil unconfined compressive strength (ksf).
TV		Torvane measurement of soil shear strength (tsf).
W %		As-received water content (percent)
LL		Liquid Limit
L		Plastic Limit
USC		Unified Soil Classification
Qu		Unconfined compressive strength (ksf).
RQD		Rock Quality Designation: The sum of the lengths of intact core pieces 4 or more inches (10 cm) in length, measured along the center line of the core, and expressed as a percentage of the length cored.
REC		Recovery: The length of recovered soil or rock sample expressed as a percentage of the sample length or depth cored.
∇		Point of groundwater entry.
▼		Stabilized groundwater level at some time after drilling.

SAMPLING RESISTANCE

P	Sampler pushed by hydraulic system.
3 6 9	Numbers indicate the number of blows from a 140-pound hammer falling freely for 30 inches required to drive the SPT sampler 6 inches. The SPT test result, N-value, or blow count, is the number of blows required to drive the sampler the last 12 inches. The N value for this example is 15.
50/2"	The split-spoon sampler was driven 2 inches by 50 blows; the Standard Penetration Resistance, or N-value, is set at 100.

ABBREVIATIONS USED

HSA	Hollow-Stem Auger
SSA	Solid-Stem Auger
ATD	At the time of drilling
AD	After Drilling
ATD	None at Time of Drilling
DWL	Drill Water Loss

The relative density of coarse-grained soils (sands and gravels having less than 50 percent passing the number 200 sieve) is indicated by the uncorrected SPT test result (N-Value or blow count) in accordance with the relationships given below:

RELATIVE DENSITY	BLOW COUNT (N-VALUE)
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Greater than 50

The shear strengths of silts and clays (fine-grained soils having more than 50 percent passing the #200 sieve) are directly related to the torvane reading (TV) and my be taken to be equal to one half of the unconfined compressive strength (Qu) of the soil. Furthermore, the pocket penetrometer reading (PP) approximates Qu which is related to consistency and manual methods as indicated in the following table:

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (ksf)	MANUAL PROCEDURE
Very Soft	< 0.5	Extrudes between fingers
Soft	> 0.5 to 1	Molded by slight pressure
Medium Stiff	> 1 to 2	Molded by strong pressure
Stiff	>2 to 4	Indented by thumb
Very Stiff	> 4 to 8	Indented by thumbnail
Hard	> 8	Difficult to indent

Minor Soil Constituant Terms and Definitions

Trace	Less than 5 percent
Few	Between 5 and 10 percent
Little	Between 10 and 25 percent
Some	Between 25 and 50 percent

Coarse Grain Descriptors

Boulder	> 12 inches
Cobble	3 inches to 12 inches
Coarse Gravel	3 inches to 3/4 inches
Fine Gravel	3/4 inches to #4 sieve

The Graphical Key to Boring Logs shows the graphical symbols used on boring logs and generalized, geologic cross-sections of selected boring logs. The basic Unified Soil Classification System (USCS) designations are used for soils. The basic letter types are as follows: G - Gravels, S - Sands, M - Silts (M comes from the Swedish word mo for rock flour), W - Well graded, P - Poorly graded, C - Clay, H - High Plastic (fat), and L - Low Plastic (lean). Dual classification designations show the primary soil type throughout the graphic column, and the secondary soil type appears in the right half of the column. CL-CH, SP-GP, and GP-SP are examples.

TERM	MOISTURE CONDITION
Dry	Water content is less than the plastic limit; dry to the touch
Moist	Water content is greater than the plastic limit, but the soil may be damp but no visible water
Wet	Soil exhibits free water or is obviously saturated.

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GRAPHICAL KEY TO BORING LOGS

SOIL TYPE	GRAPHICAL SYMBOLS				
GRAVELS	Well-Graded		Poorly-Graded		
	GW	GP-SP	GP	GM	GC
	GW-GM	GW-GC	GP-GM	GP-GC	GC-GM
SANDS	Well-Graded		Poorly-Graded		
	SW	SP-GP	SP	SM	SC
	SW-SM	SW-SC	SP-SM	SP-SC	SC-SM
SILTS and CLAYS	Silts		Clays		
	ML	MH	CL	CH	CL-ML
SPECIAL SYMBOLS	CL w/Sand	CH w/Sand	Low Plastic Till	High Plastic Till	Loess
ORGANIC SOILS	Organic Silts		Organic Clays		
	OL	OH	OL	OH	Peat
MISCEL-LANEOUS	Asphalt	Concrete	Topsoil	Fill	Void
IGNEOUS ROCKS	Granite	Breccia	Basalt	Lava	Tuff
METAMORPHIC ROCKS	Quartzite	Gneiss	Schist	Soapstone	Marble
SEDIMENTARY ROCKS	Limestone	Dolomite	Shale	Sandstone	Marl
	Coal	Conglomerate	Siltstone	Claystone	Chalk
MODIFIERS	Weathered	Calcareous	Cemented	Caliche	Chert
	These symbols may be overlaid on basic symbols to form new symbols. The fill symbol (see Miscellaneous above) may replace the right half of any primary (single-style) soil symbol to differentiate between fill types. The CL and CH symbols can be combined to represent medium plastic clays.				
DRILLING METHODS	Solid-Stem Auger	Hollow-Stem Auger	Tri-Cone/ Mud-Rotary	NX Rock Core	Rock Drilling

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-1C

Date(s) Drilled	08/31/2015 12:00 AM to 08/31/2015 12:00 AM	Logged By	Rick Horner	Checked By	JAA and BDL
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	Finger Bit	Borehole Depth	61.5 ft
Drill Rig Type	ATV-CME 750	Drilling Contractor	Frontz	Surface Elevation	495.58 ft NAVD88
Borehole Backfill	Cement bentonite grout	Sampling Method(s)	Split Spoon/Shelby Tube	Hammer Data	Auto Hammer, 140 pound
Boring Location	N 1315650.768 E 2323895.167 (ft NAD83)	Groundwater Level(s)	41 ft ATD		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
495.6	0.0					EMBANKMENT FILL: Dense, brown, poorly graded SAND with silt (SP-SM), fine grained with little medium grained, dry								
		▤	1		100		7.2	7.8						
		▨	1	10 16 25	94	becoming with few medium grained sand	5.8	9.2						
		▤	2		56	becoming with little medium grained sand	9.4	9.7						
		▨	2	19 26 33	100	becoming very dense with few medium grained sand	9.8	11.9						
471.6	24.0					ALLUVIAL FOUNDATION: Dense to medium dense, brown and dark brown, silty SAND (SM), fine grained with few medium grained, dry								
		▤	3		94		9.6	20.4						

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-1C

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	Elevation (feet)	MATERIAL DESCRIPTION	Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30																
465																	
		▨	3	13 13 17	100												
460	35						460.6	ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND (SP), fine grained with little medium grained and trace fines, wet	35.0								
		☰	4		100												
455	40																
		▨	4	3 5 5	89						3.4						
450	45																
		▨	5	3 5 11	100			becoming medium dense									
							448.5	ALLUVIAL FOUNDATION: Medium dense, brown, silty SAND (SM), fine grained, wet	47.1								
445	50																
		▨	6	3 3 8	89			becoming with little medium grained sand			30.8						
440	55																
		▨	7	4 6 9	100		438.9	ALLUVIAL FOUNDATION: Medium dense, brown, poorly graded SAND (SP), medium grained with some fine grained and few coarse grained, few fines, and little fine gravel, wet	56.7		5.7						
435	60																
		▨	8	3 8 11	100			increasing grain size with depth									
							434.1	End of Boring at 61.5 ft	61.5								
	65																

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-1T

Sheet 1 of 2

Date(s) Drilled	**09/01/2015 12:00 AM to 09/01/2015 12:00 AM**	Logged By	**Rick Horner**	Checked By	**JAA and BDL**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**Finger Bit**	Borehole Depth	**40.0 ft**
Drill Rig Type	**ATV-CME 750**	Drilling Contractor	**Frontz**	Surface Elevation	**470.014 ft NAVD88**
Borehole Backfill	**Cement bentonite grout**	Sampling Method(s)	**Split Spoon**	Hammer Data	**Auto Hammer, 140 pound**
Boring Location	**N 1315557.387 E 2323962.772 (ft NAD83)**	Groundwater Level(s)	**18.5 ft ATD**		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
470	0						470.0 / 0.0 ALLUVIAL FOUNDATION: Medium dense, dark brown, silty SAND (SM), fine grained with few medium grained, dry								
		▨	1	6 8 8	94			9.6	25.3						
465	5														
		▨	2	2 2 2	100		becoming very loose, with trace medium grained sand, moist	13.9	16.3						
460	10														
							458.0 / 12.0 ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND (SP), fine grained with little medium grained and trace fines, moist								
		▨	3	3 3 5	94			20.5	2.0						
455	15														
		▨	4	1 2 2	100		becoming very loose, wet, with some medium grained sand and few fines								
450	20														
		▨	5	1 2 2	67				6.3						*Add drilling mud to augers*
445	25														
		▨	6	2 4 4	67		becoming loose, poorly graded sand with gravel, trace fines								
	30														

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-1T

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	 Number	 Sampling Resist. OR Core RQD (%)	 Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
440	30														
		▨	7	4 5 7	89		becoming medium dense		4.8						
435	35														
							becoming medium grained with some fine grained, trace coarse grained, trace fine gravel, and trace fines								
		▨	8	6 9 9	89				5.0						
430	40						430.0 / 40.0 End of Boring at 40 ft								
425	45														
420	50														
415	55														
410	60														
405	65														

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Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-2C

Sheet 1 of 2

Date(s) Drilled	**09/02/2015 12:00 AM to 09/02/2015 12:00 AM**	Logged By	**Rick Horner**	Checked By	**JAA and BDL**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**Finger Bit**	Borehole Depth	**56.0 ft**
Drill Rig Type	**ATV-CME 750**	Drilling Contractor	**Frontz**	Surface Elevation	**495.879 ft NAVD88**
Borehole Backfill	**Cement bentonite grout**	Sampling Method(s)	**Split Spoon/Shelby Tube**	Hammer Data	**Auto Hammer, 140 pound**
Boring Location	**N 1317139.899 E 2324566.088 (ft NAD83)**	Groundwater Level(s)	**Not observed prior to introduction of drilling fluid**		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	0						495.9 EMBANKMENT FILL: Dense, brown, poorly graded SAND with silt (SP-SM), fine grained with little medium grained, dry	0.0								
495																
		▤	1		83				6.5	7.4						
490	5															
		▨	1	8 20 20	100				7.6							
485	10															
							483.9 LOWER STRENGTH EMBANKMENT FILL: Loose, brown, poorly graded SAND (SP), fine grained with few medium grained and trace fines, dry	12.0								
		▤	2		83				5.3	4.6						
480	15															
		▨	2	4 4 4	100		476.9 ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND (SP), fine grained with few medium grained and trace fines, dry	19.0								*Stratified in lifts*
475	20															
		▤	3		100				6.4	2.8						
470	25															
		▨	3	4 4 4	94											
	30															

Report: GEO_SOIL_HAV; File G:\GINTFILES\PROJECTS\60439304 HAVANA DYNEGY_2015.GPJ; 2/26/2016 9:50:14 AM

AECOM

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-2C

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30														
465															
			4		100		becoming with trace medium grained sand	5.2	3.3						
	35														
460															
			4	5 8 8	89		becoming medium dense, light brown, with little medium grained sand and trace fine gravel		4.6						*Add drilling mud to augers*
	40														
455															
			5	5 6 6	78		becoming light brown								
	45														
450															
448.9	47.0						ALLUVIAL FOUNDATION: Medium dense, light brown, poorly graded SAND with silt (SP-SM), fine grained with little medium grained, wet								
			6	4 5 6	83				8.0						
	50														
445															
			7	3 7 8	89										
441.4	54.5						ALLUVIAL FOUNDATION: Medium dense, brown, poorly graded SAND (SP), fine grained with trace medium grained and trace fines								
	55														
			8	2 3	67				4.5						*Auger bound up in boring at 55 ft*
440															
439.9	56.0						End of Boring at 56 ft								
	60														
435															
	65														

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-2T

Sheet 1 of 2

Date(s) Drilled	**09/01/2015 12:00 AM to 09/01/2015 12:00 AM**	Logged By	**Rick Horner**	Checked By	**JAA and BDL**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**Finger Bit**	Borehole Depth	**42.5 ft**
Drill Rig Type	**ATV-CME 750**	Drilling Contractor	**Frontz**	Surface Elevation	**476.808 ft NAVD88**
Borehole Backfill	**Cement bentonite grout**	Sampling Method(s)	**Split Spoon**	Hammer Data	**Auto Hammer, 140 pound**
Boring Location	**N 1317122.482 E 2324639.284 (ft NAD83)**	Groundwater Level(s)	**Not observed prior to introduction of drilling fluid**		

Elevation (feet)	Depth (feet)	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resist. OR Core RQD (%)	SAMPLES Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	MATERIAL DESCRIPTION	MATERIAL DESCRIPTION Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	0						476.8	ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND with silt (SP-SM), fine grained with few medium grained, dry	0.0								
475																	
	5																
470			1	2 2 3	100						6.3						
							467.8	ALLUVIAL FOUNDATION: Loose, brown, clayey SAND (SC), fine grained with few medium grained, moist	9.0								
	10																
465			2	2 4 4	100						22.0						
							464.8	ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND (SP), fine grained with few medium grained and trace fines, dry	12.0								
	15																
460			3	2 4 4	100												
	20																
455			4	2 2 3	94			becoming with little medium grained sand			2.0						*Add drilling mud to augers*
	25																
450			5	3 4 4	78			becoming with some medium grained sand, moist									
	30																

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-2T

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30														
445		▨	6	2 4 4	83				4.8						
	35														
440		▨	7	3 4 5	72		becoming wet								
	40	▨	8	2 3 4	67		becoming poorly graded sand with gravel, trace fines		2.3						
435															
							434.3 / 42.5 End of Boring at 42.5 ft								
	45														
430															
	50														
425															
	55														
420															
	60														
415															
	65														

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-3C

Sheet 1 of 2

Date(s) Drilled	**09/02/2015 12:00 AM to 09/02/2015 12:00 AM**	Logged By	**Rick Horner**	Checked By	**JAA and BDL**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**Finger Bit**	Borehole Depth	**61.5 ft**
Drill Rig Type	**ATV-CME 750**	Drilling Contractor	**Frontz**	Surface Elevation	**495.687 ft NAVD88**
Borehole Backfill	**Cement bentonite grout**	Sampling Method(s)	**Split Spoon/Shelby Tube**	Hammer Data	**Auto Hammer, 140 pound**
Boring Location	**N 1317142.772 E 2323859.689 (ft NAD83)**	Groundwater Level(s)	**Not observed prior to introduction of drilling fluid**		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
495.7	0.0						EMBANKMENT FILL: Dense, dark brown, silty SAND (SM), fine grained with few medium grained, dry								
		▤	1		100			8.7	21.5						
		▨	1	12 20 24	100			7.8	19.4						
481.7	14.0						EMBANKMENT FILL: Dense, brown, poorly graded SAND with silt (SP-SM), fine grained with little medium grained, dry								
		▤	2		67			6.5	6.8						
		▨	2	14 16 17	100		interbedded dark brown fine grained with brown medium grained								
		▤	3		100		becoming reddish brown with few medium grained sand		10.7						

Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Elevation (feet)	MATERIAL DESCRIPTION	Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
▨	3	4 4 3	100											
				463.4	LOWER STRENGTH EMBANKMENT FILL: Loose, brown, poorly graded SAND (SP), fine grained with some medium grained and trace fines, moist	32.3								
▤	4		100					3.7						
				456.7	ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND (SP), fine grained with some medium grained and trace fines, moist	39.0								
▨	4	2 4 6	100		increasing grain size									*Add drilling mud to augers*
				451.7	ALLUVIAL FOUNDATION: Medium dense, brown, silty SAND (SM), some fine grained, some medium grained, trace coarse grained, trace fine gravel, wet	44.0								
▨	5	6 10 12	78					20.2						
▨	6	4 6 8	89											
				443.4	ALLUVIAL FOUNDATION: Medium dense, brown, poorly graded SAND with silt (SP-SM), fine grained with some medium grained, trace coarse grained, and trace fines, wet	52.3								
▨	7	4 8 10	89					5.4						
▨	8	2 3 3	78		becoming loose									
				434.2	End of Boring at 61.5 ft	61.5								

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-4C

Sheet 1 of 2

Date(s) Drilled	09/01/2015 12:00 AM to 09/01/2015 12:00 AM	Logged By	Rick Horner	Checked By	JAA and BDL
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	Finger Bit	Borehole Depth	40.0 ft
Drill Rig Type	ATV-CME 750	Drilling Contractor	Frontz	Surface Elevation	495.379 ft NAVD88
Borehole Backfill	Cement bentonite grout	Sampling Method(s)	Split Spoon/Shelby Tube	Hammer Data	Auto Hammer, 140 pound
Boring Location	N 1316468.402 E 2323338.783 (ft NAD83)	Groundwater Level(s)	Not observed prior to introduction of drilling fluid		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
495.4	0.0	▤	1		100		EMBANKMENT FILL: Brown, poorly graded SAND with silt (SP-SM), fine grained with little medium grained, dry		5.2						
488.4	7.0	▨	1	9 17 20	89		EMBANKMENT FILL: Dense, brown, silty SAND (SM), fine grained with few medium grained, dry		13.8						
483.4	12.0	▤	2		100		EMBANKMENT FILL: Brown, poorly graded SAND with silt (SP-SM), fine grained with few medium grained, dry		11.2						
478.4	17.0	▨	2	9 14 15	89		EMBANKMENT FILL: Medium dense, brown, mottled dark brown, silty SAND (SM), fine grained with few medium grained, dry		13.6						
473.4	22.0	▤	3		100		EMBANKMENT FILL: Gray, mottled light reddish brown, poorly graded SAND with silt (SP-SM), fine grained with little medium grained, dry		7.3						
468.4	27.0	▨	3	17 27 37	94		EMBANKMENT FILL: Very dense, brown, silty SAND (SM), fine grained with little medium grained, dry		12.9						

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-4C

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
465	30																
		▤	4		33		becoming dark brown with few medium grained sand				28.6	14	1				
460	35																
							ALLUVIAL FOUNDATION: Loose, light brown, poorly graded SAND with silt (SP-SM), fine to medium grained, moist, stratified as placed in lifts	458.4	37.0								
		▨	4	2 3 5	100												
455	40						End of Boring at 40 ft	455.4	40.0								
450	45																
445	50																
440	55																
435	60																
	65																

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-5C

Sheet 1 of 2

Date(s) Drilled	09/04/2015 12:00 AM to 09/04/2015 12:00 AM	Logged By	Rick Horner	Checked By	JAA and BDL
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	Finger Bit	Borehole Depth	62.5 ft
Drill Rig Type	ATV-CME 750	Drilling Contractor	Frontz	Surface Elevation	490.085 ft NAVD88
Borehole Backfill	Cement bentonite grout	Sampling Method(s)	Split Spoon/Shelby Tube	Hammer Data	Auto Hammer, 140 pound
Boring Location	N 1316095.545 E 2322227.332 (ft NAD83)	Groundwater Level(s)	46 ft ATD		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) 490.1 / Depth (feet) 0.0)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
490	0						EMBANKMENT FILL: Very dense, reddish brown, poorly graded SAND with silt (SP-SM), fine grained with few medium grained								
485	5														
		▤	1		89			9.1	10.1						
480	10														
		▨	1	19 25 27	89		becoming moist with little medium grained sand and trace coarse grained sand	7.2	9.2						
475	15														
		▤	2		67		becoming with some medium grained sand	7.0	6.4						
470	20														
		▨	2	16 27 39	89										
465	25														
		▤	3		89		becoming with little medium grained sand	8.0	5.8						
	30														

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-5C

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
460	30																
		▨	3	3 4 4	100		becoming loose, dry										
								457.1	33.0								
							ALLUVIAL FOUNDATION: Loose to medium dense, brown, poorly graded SAND (SP), fine grained with little medium grained and trace fines, moist										
455	35																
		▨	4	4 8 4	100												
450	40																
		▤	4		83						0.8						
445	45																
		▨	5	1 3 3	67		becoming wet				1.1						*Add drilling mud to augers*
440	50																
		▨	6	2 2 3	83		increasing grain size										
435	55																
		▨	7	2 6 7	89		becoming medium grained sand with some fine grained sand, trace coarse grained sand, few fine gravel, trace coarse gravel, and trace fines				2.2						
430	60																
		▨	8	4 6 7	78												
								427.6	62.5								
							End of Boring at 62.5 ft										
	65																

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-5T

Sheet 1 of 2

Date(s) Drilled	**09/03/2015 12:00 AM to 09/03/2015 12:00 AM**	Logged By	**Rick Horner**	Checked By	**JAA and BDL**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**Finger Bit**	Borehole Depth	**40.0 ft**
Drill Rig Type	**ATV-CME 750**	Drilling Contractor	**Frontz**	Surface Elevation	**462.361 ft NAVD88**
Borehole Backfill	**Cement bentonite grout**	Sampling Method(s)	**Split Spoon**	Hammer Data	**Auto Hammer, 140 pound**
Boring Location	**N 1316129.918 E 2322124.964 (ft NAD83)**	Groundwater Level(s)	**18.5 ft ATD**		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
462.4	0.0						ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND with silt (SP-SM), fine grained with trace medium grained, dry								
		▨	1	3 4 4	100				8.0						
455.4	7.0						ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND (SP), fine grained with some medium grained and trace fines, dry								
		▨	2	2 3 3	100		trace fine gravel at 9.25 ft		4.6						
450.4	12.0						ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND with silt (SP-SM), fine grained with little medium grained, moist								
		▨	3	2 3 2	94				5.8						
445.4	17.0						ALLUVIAL FOUNDATION: Very loose, brown, poorly graded SAND (SP), some fine grained, some medium grained, trace coarse grained, trace fines, trace fine gravel, wet								
		▨	4	2 2 2	100				4.0						*Add drilling mud to augers*
		▨	5	2 2 2	78										
435.4	27.0						ALLUVIAL FOUNDATION: Medium dense, brown, poorly graded SAND with silt (SP-SM), fine grained with few medium grained, wet								
		▨	6	4 5 7	83				5.3						

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Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-5T

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
430.4	32.0						ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND (SP), fine grained with some medium grained, trace coarse grained, few fine gravel, and trace fines, wet								
			7	2 3 5	78										
			8	3 3 6	72				2.2						
422.4	40.0						End of Boring at 40 ft								

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-6C

Sheet 1 of 2

Date(s) Drilled	**09/03/2015 12:00 AM to 09/03/2015 12:00 AM**	Logged By	**Rick Horner**	Checked By	**JAA and BDL**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**Finger Bit**	Borehole Depth	**40.0 ft**
Drill Rig Type	**ATV-CME 750**	Drilling Contractor	**Frontz**	Surface Elevation	**488.816 ft NAVD88**
Borehole Backfill	**Cement bentonite grout**	Sampling Method(s)	**Split Spoon/Shelby Tube**	Hammer Data	**Auto Hammer, 140 pound**
Boring Location	**N 1315472.242 E 2322011.383 (ft NAD83)**	Groundwater Level(s)	**33.5 ft ATD**		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
488.8	0.0					▨	EMBANKMENT FILL: Dark brown, mottled gray, clayey SAND (SC), some fine grained, trace medium and coarse grained, and few fine gravel, dry								
485	5	▤	1		100	▨		12.3	43.1	25	11				
481.8	7.0					░	EMBANKMENT FILL: Loose, brown, silty SAND (SM), fine grained with trace medium and coarse grained sand and trace fine gravel								
480	10	▨	1	4 5 5	89	░			36.3	14	1				
476.8	12.0					░	EMBANKMENT FILL: Dense, brown, poorly graded SAND with silt (SP-SM), fine grained with trace medium grained, dry								
475	15	▤	2		100	░		9.3	10.0						
470	20	▨	2	11 13 19	89	░									
465	25	▤	3		50	░	becoming brown and dark brown with few medium grained sand	12.1	6.4						
461.8	27.0					▨	ALLUVIAL FOUNDATION: Medium dense, dark brown, silty, clayey SAND (SC-SM), fine grained with trace medium grained, dry								
460	30	▨	3	9 11 11	100	▨			37.7	18	5				

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-6C

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30					▨									
456.8	32.0						ALLUVIAL FOUNDATION: Very loose, brown, poorly graded SAND (SP), fine grained with little medium grained and trace fines, wet								
455		▤	4		100	░			3.4						
	35														
450		▨	4	2 2 2	100	░	becoming moist with trace medium grained sand		4.1						
448.8	40.0														
	40						End of Boring at 40 ft								
445															
	45														
440															
	50														
435															
	55														
430															
	60														
425															
	65														

Report: GEO_SOIL_HAV; File G:\GINTFILES\PROJECTS\60439304 HAVANA DYNEGY_2015.GPJ; 2/26/2016 9:50:47 AM

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-7C

Sheet 1 of 2

Date(s) Drilled	09/03/2015 12:00 AM to 09/03/2015 12:00 AM	Logged By	Rick Horner	Checked By	JAA and BDL
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	Finger Bit	Borehole Depth	42.5 ft
Drill Rig Type	ATV-CME 750	Drilling Contractor	Frontz	Surface Elevation	489.253 ft NAVD88
Borehole Backfill	Cement bentonite grout	Sampling Method(s)	Split Spoon/Shelby Tube	Hammer Data	Auto Hammer, 140 pound
Boring Location	N 1315618.981 E 2322377.352 (ft NAD83)	Groundwater Level(s)	26 ft ATD		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
489.3	0.0						EMBANKMENT FILL: Brown, mottled dark brown and gray, silty SAND (SM), fine grained with trace medium grained, dry								
485	5														
		▤	1		100			8.0	21.8						
480	10														
		▨	1	3 3 3	89		becoming loose	4.6	17.8						
475.3	14.0						EMBANKMENT FILL: Loose, brown, poorly graded SAND with silt (SP-SM), fine grained with trace medium grained								
475	15														
		▤	2		100			7.9	11.7						
470	20														
		▨	2	4 5 5	100		becoming moist	8.2	10.6						
467.3	22.0						ALLUVIAL FOUNDATION: Loose, brown, poorly graded SAND with silt (SP-SM), fine grained with trace medium grained, moist								
465	25														
		▨	3	5 13 21	100		becoming dense, wet lense of stiff, dry, dark brown, low plastic silty clay								*Lost sample in tube, drove split spoon in place*
460	30														

Report: GEO_SOIL_HAV; File G:\GINTFILES\PROJECTS\60439304 HAVANA DYNEGY_2015.GPJ; 2/26/2016 9:50:52 AM

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-7C

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30														
		▨	4	4 6 7	83		becoming medium dense, with few medium grained sand		10.0						
															Add drilling mud to augers
455															
	35														
		▨	5	6 7 9	89										
450															
	40														
		▨	6	6 8 11	83		becoming with little medium grained sand, trace coarse grained sand, and trace fine gravel		8.7						
							446.8 / 42.5 End of Boring at 42.5 ft								
445															
	45														
440															
	50														
435															
	55														
430															
	60														
425															
	65														

Project: Dynegy

Project Location: Havana Power Plant, Havana, IL

Project Number: 60439304

Log of Boring HAV-EB-8C

Sheet 1 of 2

Date(s) Drilled	08/31/2015 12:00 AM to 08/31/2015 12:00 AM	Logged By	Rick Horner	Checked By	JAA and BDL
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	Finger Bit	Borehole Depth	40.0 ft
Drill Rig Type	ATV-CME 750	Drilling Contractor	Frontz	Surface Elevation	488.839 ft NAVD88
Borehole Backfill	Cement bentonite grout	Sampling Method(s)	Split Spoon/Shelby Tube	Hammer Data	Auto Hammer, 140 pound
Boring Location	N 1315276.961 E 2322410.504 (ft NAD83)	Groundwater Level(s)	38.5 ft ATD		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
488.8	0.0						EMBANKMENT FILL: Brown, silty SAND (SM), fine grained with few medium grained and trace fine gravel								
484.8	4.0	▤	1					17.4 12.8 12.2	24.7 60.8 17.6	30	15				
484.3	4.5						EMBANKMENT FILL: Dark gray sandy CLAY (CL), with trace fine gravel and few coarse gravel								
							EMBANKMENT FILL: Dense, brown, silty SAND (SM), fine grained with trace medium grained								
		▨	1	20 21	72			9.1	19.0						
476.8	12.0						EMBANKMENT FILL: Brown, poorly graded SAND with silt (SP-SM), fine grained with trace medium grained								
		▤	2		89			6.9	6.7						
471.8	17.0						EMBANKMENT FILL: Medium dense, brown, silty SAND (SM), fine grained with trace medium grained								
		▨	2	8 9 8	72			9.5	27.7						
466.8	22.0						ALLUVIAL FOUNDATION: Brown, poorly graded SAND with silt (SP-SM), fine grained with few medium grained								
		▤	3		67			11.5 9.7	8.5 26.7						
464.6	24.2						ALLUVIAL FOUNDATION: Medium dense, dark brown, silty SAND (SM), fine grained with trace medium grained								
		▨	3	5 8 8	100		becoming reddish brown to brown, slight increase in grain size								

Log of Boring HAV-EB-8C

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
457.8	31.0						ALLUVIAL FOUNDATION: Medium dense, brown, poorly graded SAND (SP), fine grained with few medium grained and trace fines								
			4		100				3.1						
			4	5 8 11	89		becoming wet, with some medium and fine grained sand, few coarse grained sand, trace fine gravel, and trace fines		3.1						
448.8	40.0						End of Boring at 40 ft								