SOAH DOCKET NO. 582-15-2082
TCEQ DOCKET NO. 2015-0069-MSW

APPLICATION OF 130 ENVIRONMENTAL PARK, LLC FOR PROPOSED PERMIT NO. 2383	§ § § § §	**BEFORE THE STATE OFFICE** **OF** **ADMINISTRATIVE HEARINGS**

PROTESTANTS EXHIBIT 6

PREFILED TESTIMONY OF MICHAEL RUBINOV, P.G.

ON BEHALF OF PROTESTANTS TJFA & EPICC

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Exhibit No.	Description	Date
Exhibit 6-A.	Resume of Michael Rubinov. P.G.	Not dated.
Exhibit 6-B	Map of Boring Locations	June 24, 2016
Exhibit 6-C	Summary of Soil Samples	March 30, 2016
Exhibit 6-D	Boring Logs by Mike Rubinov	February 24-26, 2016
Exhibit 6-E	Lab Test Results with Chart	Not dated.
Exhibit 6-F	Photos of soil samples.	Not dated.
Exhibit 6-G	Depth to Top of Unweathered Contact in Proximal Borings	Not dated.

I. INTRODUCTION

Q: Please state your name.

A: Michael Rubinov

Q: Please describe your occupation.

A: I am currently a practicing geologist in the field of geology and hydrogeology.

II. QUALIFICATIONS

Q: Please describe your educational background.

A: I received my B.S. in Environmental Geology from the University of Pittsburgh in 2006.

Q: Please describe the nature of your professional work.

A: I am employed as a hydrogeologist by R.W.Harden and Associates, Inc., a consulting firm specializing in geology, hydrogeology, and engineering.

Q: Are you a licensed geo-scientist in the State of Texas?

A: I am a licensed geo-scientist in the State of Texas.

Q: How long have you been a professional geologist?

A: I received licensure in December of 2012.

Q: Do you have expertise in subsurface investigations and evaluations?

A: Yes.

Q: Please describe your experience in subsurface investigations and evaluations.

A: Throughout my career I have logged over 30,000 feet of sediment. I have experience as the on-site geologist for aquifer exploratory drilling operations, identifying and logging subsurface sediment. I also have experience as the on-site geologic logger and field manager of over-burden lignite coring operations, logging core sediment associated with lignite deposits. Furthermore, I have experience as a geologic logger for geotechnical coring operations.

Q: Do you have expertise in interpreting soil borings?

A: Yes, I have expertise in interpreting soil borings.

Q: Please describe your experience related to interpreting soil borings and subsurface characterization.

A: As a geoscientist, over the last 9 years I have completed numerous projects involving interpretation of subsurface sediment used to produce geologic logs for groundwater development, mining industry, and waste facilities. I have used subsurface sediment collected during filed investigation along with other pertinent information to identify local and regional geologic strata. Throughout my career I have created cross-sections for use in municipal and industrial projects. I have used multiple logs to create cross-section layout of subsurface geology to identify discreet layers of sands, clays, silt, and lignite, as well as water bearing formations.

Q: Can you identify what has been marked as Exhibit 6-A?

A: Yes. This exhibit is a representative resume summarizing my experience in various areas of practice.

Q: Is this a true and accurate copy of your resume?

A: Yes.

PROTESTANTS OFFER EXHIBIT 6-A

Q: What materials have you reviewed in preparation for your testimony?

A: I have reviewed the original permit application submitted to the TCEQ by the Applicant, 130 Environmental Park LLC, as well as the materials produced by the Applicant from the 2016 field investigation. I have consulted the Unified Soil Classification System memorandum and ASTM Standard 2488 for soil description and identification. I have also reviewed the Texas Water Development Board Report titled "Groundwater-Resources of Caldwell County, Texas" and Texas Water Development Board and Bureau of Economic Geology maps. I also reviewed relevant TCEQ rules and relevant rules that govern professional geoscientists.

Q: Did you visit the property of the proposed landfill site?

A: Yes. I made visits to the landfill site in connection with the Applicant's 2016 boring program in January of 2016, and in connection with the boring program conducted by the Protestants from February to March of 2016. I describe the circumstances of my site visits in more detail below.

III. SUMMARY OF OPINIONS

Q: Have you developed any opinions regarding the application by 130 Environmental Park, L.L.C. ("130 EP" or "Applicant") for Permit No. 2383?

A: Yes.

Q: On what subjects have you developed opinions?

A: I have developed opinions regarding the subsurface geology at the site, including failure of the Applicant to properly characterize the subsurface geology at the site.

Relatedly, I have also developed opinions regarding the presence of secondary features and potential migration pathways for fluid within the subsurface.

Q: Please summarize your opinions with regard to the 130 EP's failure to properly characterize subsurface sediment and secondary features.

A: I have examined, visually and tactilely, the subsurface material from a number of borings at the site, observed field operations during the 2016 boring programs, reviewed laboratory analyses performed on sediment collected from the site, reviewed the permit application and have developed opinions and concerns regarding the interpretation of geologic material and potential subsurface fluid migration at the site. I believe the application fails to properly characterize the subsurface geology within the proposed facility boundary and fails to properly identify and characterize subsurface fluid migration pathways and their associated risk. Because of the inadequate subsurface geologic characterization, it is my opinion that the proposed landfill presents increased risks to human safety, welfare, and protection of the environment.

IV. EVALUATION PROCESS

Q: Please describe for us how you first became involved in this case.

A: In early January of 2016 I was asked to be an observer of the Applicant's 2016 boring program, based on my geologic expertise.

Q: Did you do any research before going to the site?

A: Yes. I reviewed the boring logs and geologic data in the original permit application. I also reviewed the Texas Water Development Board report titled

"Groundwater-Resources of Caldwell County, Texas" and Texas Water Development Board and Bureau of Economic Geology maps to conceptualize the regional to local geology in the area of the facility.

Q: So, what information did you glean from your initial review of the available geologic data?

A: Published reports showed Leona gravels at the surface, overlying the Midway Group. However, the permit application logs indicated exclusively fat clays within the subsurface. This appeared to be inconsistent with published data, which describes the Midway consisting of clay, silt, sand, and thin beds of sandstone and limestone.

Q: What was your purpose in going out to the site during Applicant's 2016 boring program?

A: My purpose was to observe the drilling and sampling operations conducted by the Applicant, and to describe the character of the sediment being brought to the surface from the sampling operations. As a geologist I had expected, ideally, to fully observe the sediment, which would include tactically manipulating the sediment to determine the characteristics of the material, including its moisture, plasticity, consolidation, mineral inclusions, bedding, grain size, grading, and secondary features. Because I was limited in my access to the samples I was only able to make visual observations of the sediment.

I was also tasked with creating a record of the events of the Applicant's drilling operations. It was my understanding no such records were kept during Applicant's original boring program conducted in 2013. During my time on the site I kept a record of operations, took photographs of the samples, and recorded my visual observations of the sediments.

Q: In your opinion, is it important to maintain a record of field observations when conducting a subsurface investigation, such as was done here?

A: Yes. A log of drilling operations in concert with the geology log may help determine questions regarding abnormal samples or presence of materials or geology features that are not represented by the sediments brought to the surface. For example, abnormal drilling time can indicate a cemented geologic strata, which may not be easily recovered by a sampling apparatus. A loss of circulation, which occurred during the investigation and will be discussed in further detail later in my testimony, could indicate a feature or material with a high permeability in the subsurface. Without a drilling operations log, this information may not be recorded, and vital data needed for proper subsurface interpretation would be lost. It also important to keep relevant notes relating to geologic interpretation, as it is required by the Texas Board of Professional Geoscientist rules.

Q: Describe the sampling method employed by Applicant.

A: The Applicant was using the Shelby Tube method for sampling. This involved pushing a thin walled metal tube into the subsurface to extract about two feet of sediment core during each core run. The Shelby Tube sample is brought to the surface, the sediment is pushed out of the tube and presented for description and storage. A drill bit slightly larger in diameter than the Shelby Tube is then advanced to the bottom of the interval to create a clean bore and the Shelby Tube is advanced further into the strata. Drilling fluid consisting of a mixture of water and a thickening additive is circulated through the borehole when soil becomes sufficiently tough to advance without the use of fluid to cut through and extract the soil.

Q: Please describe some of your observations from the Applicant's 2016 borings.

A: As I mentioned earlier, my observations were limited to visual observation. Generally, I observed samples that included clays, silts and interbedded gravels. I was able to observe fissures of what at the time appeared to be iron oxide and gypsum or calcite and other secondary features. This was not consistent with the description of fat clays and a lack of fissures as presented in the application. Stefan Stamoulis, who was the drilling supervisor according to his deposition testimony, described and bagged the core samples. He then labeled and boxed the core.

His technique involved cutting the ends of the sample, and then it appeared that his field log descriptions were based on observing the material at either end of the core. He did not scrape the length of the core to expose fresh material between the ends. This is important to note because it is difficult to ascertain sediment characteristics of the entire core without exposing fresh surface. The outside surface of the core is smeared as the Shelby Tube penetrates the subsurface, obstructing, for example, secondary features, layers, grains, etcetera. It is necessary to scrape this thin outside layer to observe the native material.

I observed multiple occasions where the Shelby Tube was bent during sampling, which likely occurred if hard material, such as a cobble or a cemented layer was encountered.

I observed a loss of circulation at site BME-43.

Q: Please describe what a loss of circulation means.

A: As I mentioned earlier, fluid may be introduced during drilling operations. A trough with a circular hole is placed over the borehole and filled with a mixture of water and thickening additive. The fluid is pumped through the drill bit into the bottom of the hole. The fluid then moves up the hole through the action of an above ground, inline pump, carrying with it sediment cut by the bit, and comes to the surface into the trough. A hose at the end of the trough draws fluid up through the pump and back down to the drill bit, in effect creating a circle of fluid. Loss of circulation occurs when the drilling fluid is quickly evacuated from this wet rotary drilling system. Unless there is a mechanical failure, which would be visible, drilling fluid is lost into the strata penetrated by the drill bit. In this case, the fluid in the trough and the hole, equating to approximately 100 to 200 gallons, evacuated quickly into the subsurface. New water with a larger amount of the thickening additive was then mixed, recirculated and drilling continued. A loss of circulation like the one that I observed is not consistent with the presence of a dense clay, which contains no porosity or interconnected spaces for the fluid to migrate into. This indicated to me that a feature such as a fault with permeability, was encountered.

Q: Did you document these observations in your field notes?

A: Yes, I did.

V. ROLE IN PROTESTANTS' BORING PROGRAM

Q: Please identify what is labeled as Exhibit 6-B.

A: This is a map of the site, with approximate locations of the Protestants' and Applicant's sampling sites explored in 2016, and Piezometers completed in 2013 by the Applicant.

PROTESTANTS OFFER EXHIBIT 6-B.

Q: Please describe the plan for Protestants' boring and sampling locations shown on this map?

A: The Protestants proposed a number of locations for borings to explore the site geology. A number of locations were also proposed for trenching operations to explore gravels in the shallow subsurface. Due to the limited time allotted for the program, only a few locations were proposed.

Several of the proposed locations were adjacent to or in close proximity to Applicant's borings. For example, Protestants' Boring MP-1 was located next to Applicant's Piezometer 32 (boring BME-32 site) where groundwater has been historically present. Protestants' Boring MP-3 was located in the vicinity of Applicant's boring BME-43 where the loss of circulation occurred. Dr. Lauren Ross and Scott Courtney were responsible for trenching and collection of materials at the trenches; I was on site for part of the operations at site T5.

Q: Describe the boring and sampling methods used by Protestants' experts.

A: Borings completed by the Protestants were accomplished using the hollow stem auger method, a standard geotechnical boring method recommended by the Texas Commission of Environmental Quality rules for softer sediment. This method involves advancing a sampling tube into the borehole either immediately before or concurrently with a large diameter metal casing used to stabilize the walls of the borehole. Sample apparatus included Shelby Tube, Split Spoon or continuous core samplers. It was the goal of the Protestants to recover continuous samples from each boring. A sampling method that allowed for the best results was chosen based on in-situ drilling conditions. If a significant amount of material was not recovered from a borehole due to subsurface conditions, drilling equipment would be moved to a location in proximity to the original location, and boring would commence again in order to fully analyze the subsurface material. These second boreholes would be designated with an "A".

Sample material was brought to the surface and placed on a table for my analysis. I exposed fresh core material using a knife, by either scraping the entire length of the core or cutting through the middle of the core. I would then observe the material visually and tactically using field equipment such as a knife, hand lens, pocket penetrometer, and water. I recorded my observations in a field log, noting sediment character, color, plasticity, cohesion, mineral inclusion, stratification, structure, relative compaction, grain size, grading, and secondary features. I would then bag and label the samples with the help of Dr. Lauren Ross and place the samples in a storage container for later review, if necessary.

Trench samples were also taken by the Protestants' experts. Although I was not present during the majority of this sampling, what I did observe and from what was relayed to me, the sampling method involved creating a trench by the use of a backhoe. Samples of the sediment were taken directly from the backhoe bucket, noting the specific depth on the sample bag, measured by a tape inserted into the trench. This sampling method was chosen due to the large size of gravel cobbles observed at the surface and indicated during the Applicant's 2016 drilling operations. Conventional drilling and sampling methods such as the Shelby Tube or continuous coring method cannot bring material to the surface that is larger than the inner diameter of the sampler itself, being approximately 3" and 4", respectively. Large cobbles are simply pushed aside into the surrounding sediment or crushed by the cutting bit during drilling. We determined that trenching was the best method to obtain representative samples of these sediments.

Also, three samples were collected from the outside of the augers at Protestants' borehole IV-2A in the top ten feet. These samples were collected from auger cuttings due to the gravelly nature of the sediment, which prevented sample collection using either Shelby Tube or Split Spoon.

Q: Was any analysis of the material conducted after the field investigation?

A: Yes, a number of samples were sent to an independent third party laboratory for geotechnical analysis. I also reviewed a number of the samples at a later date to verify my observations.

Q: Can you identify what has been marked as Exhibit 6-C?

A: Yes, this is a laboratory summary of geotechnical analyses of the samples collected by the Protestants' experts.

Q: Can you identify what has been marked as Exhibit 6-D?

A: Yes, these are my final geologic logs of the boreholes completed by the Protestants.

Q: Please describe your observations of the sediment.

A: The most significant or notable observations I made were at these locations: Boreholes MP-1 and MP-1A, completed by the Protestants, located within the vicinity of Applicant's BME-32 and P-32, which were completed by the Applicant during the initial field investigation in 2013. My visual and tactile examination of the sediments in MP-1 and MP-1A, as well as laboratory analyses, suggest remnant gravel, lean clays (CL), fat clays (CH), silts (ML) and sandstone are present within the subsurface. In contrast, the log for BME-32 states the subsurface sediment at the site consists solely of fat clays (CH) with remnant gravels in the top four feet.

I also observed lean clays in borehole MP-2, located in the vicinity of Applicant's borehole BME-26 and P-26. The lab sample from borehole MP-2 reported lean clay as well, which is inconsistent with how Applicant described the sediments in its logs for BME-26 and P-26.

I also observed lean clays, mixtures of lean and fat clays, or mixtures of silt and lean to fat clay at almost all the other sites completed by the Protestants during the 2016 field investigation.

Five boreholes completed by the Protestants during the 2016 investigation were completed at sites in close proximity to borings drilled by the Applicant for the original permit. At two of these sites, I noted gravel in the subsurface that extended farther than what was originally reported at the sites in the permit application. Notably, I observed gravel in the top 9 feet of borehole MP-1, whereas the Applicant's log of BME-32 shows gravel in only the top 4 feet. I also observed gravel in the top 10.3 feet at borehole IV-3, in proximity to P-26 and BME-26, whereas the Applicant reported pebbles to 6 feet below ground level at the site.

During my time on site I also observed areas where significant amounts of gravel were present at the surface. Samples from a number of trenches contained large cobbles a well. For example, a sample collected from T3 at 1.1 to 1.4 feet contains cobbles up to 3 inches in size. Cobbles from the top foot at site T2 are up to approximately 3.75 inches. A Shelby Tube sampler, utilized by the Applicant for their boring exploration program, cannot retrieve cobbles of this size and could not be used to properly characterize them.

PROTESTANTS OFFER EXHIBIT 6-C AND 6-D.

VI. OPINIONS REGARDING FAILURE OF APPLICANT TO PROPERLY CHARACTERIZE SUBSURFACE SEDIMENT

Q: What concern do you have regarding the characterization of subsurface sediments at the facility?

A: In regards to the subsurface sediment characterization, it is my opinion that the application presents an inadequate and inaccurate characterization of the subsurface geology—an overly simplistic characterization. In the application the Applicant failed to properly identify the geologic material in the subsurface. Specifically, Attachment E, Section 4.2 of the application identifies the sediment underneath the site consisting solely of silty fat clay (CH), with Stratum I also containing remnant gravel. My observations and logs of sediment recovered during the drilling programs conducted in 2016 and geotechnical sediment analysis conducted by a third party laboratory of the Applicant's and Protestants' sediment samples from the 2016 field investigations show presence of lean clays (CL), silts (ML), and fat clays (CH), clayey sands (SC) as wells as gravels intermixed with clay (GC), sandstone, and siltstone in the subsurface. Based on these observations and analyses, it is my opinion that the Applicant has not fully characterized the subsurface sediment.

Q: Can you provide examples of how the Applicant's assertions contradict local conditions and your own personal experience and knowledge?

A: During the field investigation conducted by the Protestants in 2016, where I was the on-site geologist, I observed material other than fat clay and remnant gravels in multiple boreholes as I mentioned earlier. Laboratory results also showed materials other than fat clays present in a number of boreholes completed by the Applicant and the Protestants.

Q: Describe the lab analyses that were conducted and the results of those analyses.

A: Thirteen samples were sent by the Protestants to a geotechnical laboratory for analysis. Of these, ten samples were obtained through coring using a hollow stem auger drilling method, two were collected from the top 5 feet in trenches dug by a backhoe, and one was collected from the top 10 feet of sediment returned to the surface as cuttings by the hollow stem auger. The sample intervals were chosen based on the interest of the Protestant's experts to further characterize the sediment. Generally, samples that appeared to represent material that was not identified as existing at the site by the original application were chosen for laboratory analyses. Lab analyses included Atterberg Limits, sieve analyses and hydraulic conductivity. Atterberg Limits are used to classify fine grained material into the four major categories of fat clay (CH), lean clay (CL), low-elasticity silt (ML), and elastic silts (MH). Sieve analyses provide a grain profile to classify the sediment into fine grained or course grained, and, used in concert with the Atterberg Limits, provide the basis for a final classification such as "clayey sand" (SC). Hydraulic conductivities were conducted on two samples to determine the permeability of the sediment. A chain of custody was kept for the samples sent to the lab or exchanged between parties.

Of the ten samples collected by core, five samples are classified as a lean clay (CL), one sample is classified as a fat clay (CH), one sample is classified as a silt (ML), one sample is classified as a sandstone, and one is classified as a claystone by the laboratory. The trench samples are classified as clayey gravel (GC), and the sample taken from auger flight cuttings is classified as a clayey sand with gravel

(SC). These results further demonstrate that notable amounts of material other than fat clay (CH) is present in the subsurface.

Q: Were you able to analyze samples collected by the Applicant during their 2016 boring program as well?

A: Yes, we did this by "splitting" samples to the extent possible. The Applicant's samples were analyzed by the Protestants' chosen laboratory, and vice versa. Sediment collected by the Protestants was split in the presence of both parties, and one set presented to the Applicant. For intervals where insufficient material was available for both parties, material remaining after Protestants' laboratory analyses were completed was relinquished to the Applicant for analyses at their chosen lab. Sediment collected and sampled by the Applicant was first sent to their chosen laboratory for analysis. After Applicant's laboratory analyses were completed, the remainder of the sediment, if available, was relinquished to the Protestants for testing.

Q: Can you identify what has been labeled Exhibit 6-E?

A: Yes, these are the laboratory results and a chart of the sediment analyzed by the Protestants' laboratory.

PROTESTANTS OFFER EXHIBIT 6-E.

Q: Could you summarize what is in this report?

A: Overall, Protestants' laboratory results show sediment classified as something other than a fat clay (CH) in a notable number of samples within the facility boundary. Of the 57 fine grained samples analyzed by the Protestants' laboratory, 18 samples are classified as a lean clay (CL) and two samples are classified as a silt (ML). This is significant in demonstrating the presence of materials at the proposed landfill site that are not described in the permit application.

VII. OPINION REGARDING FAILURE TO PROPERLY CHARACTERIZE SUBSURFACE SECONDARY FEATURES

Q: What about your second criticism or opinion? Can you start off by describing your observations of secondary features?

A: Yes. During the 2016 field investigations conducted by both the Applicant and the Protestants, I noted numerous secondary features indicative of potential migration pathways. I observed numerous fissures or layers of gypsum and iron oxide in a number of boreholes and depths. I also observed evidence of a possible fault in the subsurface that would act as a preferential fluid pathway for leachate from the proposed landfill.

Q: Can you explain the significance of these features that you observed?

A: Yes. Fissures and layers filled with minerals are indicative of water movement through the subsurface. Fissures filled with gypsum indicate that water saturated with calcium sulfate migrated into the fractures within the subsurface, precipitating out the minerals to form the gypsum-filed fissure. Iron oxide filled fissures and layers indicate oxidation created by the presence of water or movement of water through the feature. I observed gypsum and iron oxide fissures or layers at every site where a borehole was completed by the Protestants, with numerous fissures or layers present in the majority of the boreholes.

I also observed silt seams or layers at every boring drilled by the Protestants. These silt features represent further possible migration pathways for fluid, as they are typically more conductive than clay layers. Many of these layers are already filled with iron oxide material, indicating that water has moved through these layers preferentially in the past.

Although it is difficult to confirm the distinction between fine silt and clay material based on visual observation only, I also observed silt seams and layers in borings completed by the Applicant during their 2016 field investigation. Laboratory tests of samples from these borings confirm the presence of silt within the facility boundary as well.

Q: Can you identify what has been labeled 6-F?

A: Yes, these are photos of some of the soils/samples that were extracted from our borings at locations MP-1A, MP 2, MP 3, and IV 3. These sediment samples provide examples of some of the materials, secondary features and stratification that I described here and in my geologic log. In these samples I showcase gypsum fissures, iron oxide filled fissures, silt laminations, and fat clay versus silt or lean clay material.

PROTESTANTS OFFER EXHIBIT 6-F

Q: What is the basis for your opinion regarding the possible presence of a fault near the proposed landfill site?

A: During 2016 drilling operations conducted by the Applicant, a loss of circulation was observed at site BME-43 at about 30 feet below ground level. About 100 to

200 gallons of water was very quickly evacuated into the subsurface, indicating that a feature with a large enough permeability to accommodate this volume and rate of evacuation is present in the subsurface. During the Protestants' drilling operations, borehole MP-3 was completed within the direct vicinity of BME-43. Abundant gypsum fissures were observed between 45 and 50 feet below ground level at this site, indicating the possible presence of a fault plane, exemplified by abundant fractures. Furthermore, the weathered to unweathered contact at MP-3 was encountered between 46.5 and 50 feet, while the contact was encountered at 30 feet in the nearby borehole BME-43. In other word, at two boreholes approximately 20-30 feet apart, the weathered to unweatherd contact changes by 16.5 to 20 feet vertically. These three pieces of evidence indicate to me a likely fault with preferential pathways for fluid transmission is present at this site.

Q: Can you identify what is labeled at Exhibit 6-G?

A: Yes this is a table showing a comparison of depths to the weathered/unweathered contact at sites with boreholes drilled in close proximity of one another. The offset at site MP-3 versus BME-43 is significantly greater than at any of the other locations.

PROTESTANTS OFFER EXHIBIT 6-G.

Q: So, can you sum up your opinion regarding the presence of these secondary features?

A: The mineral filled fissures and seams and the loss of circulation are direct evidence of migration pathways within the subsurface at the site. Seams of silt and the apparent evidence of a fault present further possibility for migration pathways in the subsurface. Additionally, I have observed gravel at the surface and interbedded with clay in the subsurface at the site. Although the Protestants' field investigation was limited and not designed to identify areas with contiguous gravel in the subsurface, during the field investigation I observed scattered gravel on the surface in a number of locations and a Bureau of Economic Geology map shows the Leona Formation outcropping at the site. If a lens or channel of gravel exits in the subsurface or surrounding this site, it would present another preferential pathway for the fluid migration.

If a fluid, such as leachate, were to be introduced into the subsurface, multiple interconnected pathways could allow the fluid to migrate with a speed significantly higher than through the surrounding clay materials. The fluid could travel through these preferential and discreet pathways off of the site and into surrounding areas such as creeks, which may increase risks to human safety, welfare, and protection of the environment.

VIII. CONCLUSIONS

Q: Can you summarize your overall conclusions based on your observations and concerns?

A: Yes. Based on my observation of the subsurface materials, I believe that the original permit application did not provide an accurate and comprehensive characterization of the subsurface geology; it did not include proper characterization of all sediments present at the site or secondary features present in the geology.

It is my professional opinion that lean clays, silt layers, minor sands, and gravels are present in the subsurface, and these are not properly reflected in the application. The geology beneath the site is quite variable, with fat clays, silts, and lean clays interbedded throughout the subsurface. Although fat clays do exist, they are not the sole material at this site as stated in the application. Secondly, secondary features exist in the subsurface and are not properly addressed in the Applicant's analysis of the geology. These features have the capacity to preferentially transmit fluid, which can be transported off site and can increase risks to human safety, welfare, and protection of the environment.

Q: Does this conclude your testimony?

A: Yes. I do reserve the right to timely supplement or amend my prefiled testimony.

Michael Rubinov, P.G.

Professional Experience

2007 - Present	Hydrologist R.W. Harden and Associates, Inc. Austin, Texas
2006 - 2007	Lab Technician 1 Wiss, Janney, Elstner and Associates, Inc. Austin, Texas

Professional Experience

Oversight of field operations and drilling activities for municipal water supply.
Water and observation well operations associated with lignite industry.
Coring activities associated with mining and waste facilities.

Registration/Certification

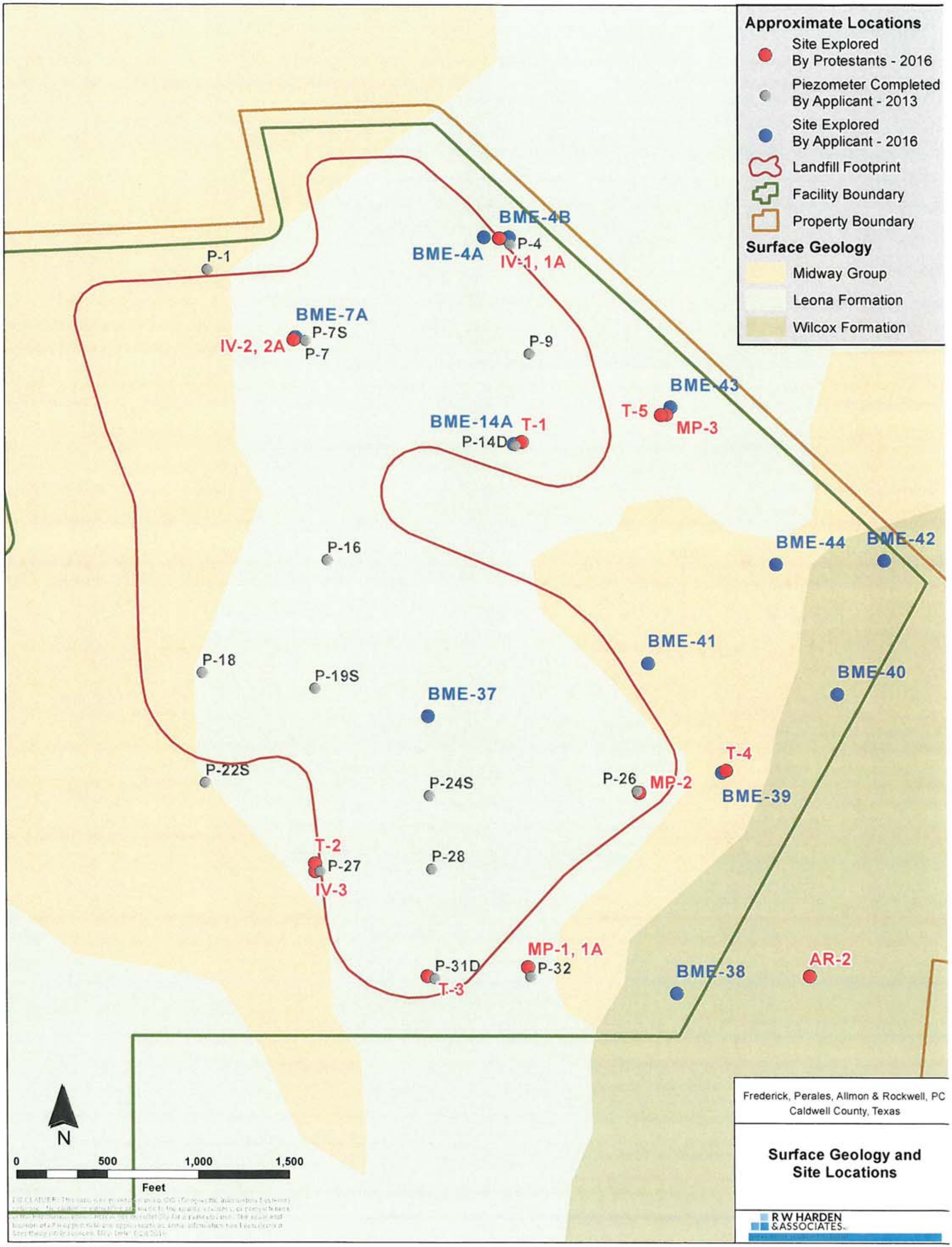
Licensed Professional Geoscientist:
State of Texas No. 11429

Education/Training

B.S., Environmental Geology, The University of Pittsburgh, 2006
Certificate in GIS, The University of Pittsburgh, 2006

Professional Affiliations

Geologic Society of America
National Ground Water Association
Texas Groundwater Association


Approximate Locations
Site Explored By Protestants - 2016
Piezometer Completed By Applicant - 2013
Site Explored By Applicant - 2016
Landfill Footprint
Facility Boundary
Property Boundary
Surface Geology
Midway Group
Leona Formation
Wilcox Formation
BME-4B
BME-4A
P-4
IV-1, 1A
P-1
BME-7A
P-7S
IV-2, 2A
P-7
P-9
BME-43
T-5
MP-3
BME-14A
T-1
P-14D
P-16
BME-44
BME-42
BME-41
BME-40
P-18
P-19S
BME-37
T-4
P-22S
P-24S
P-26
MP-2
BME-39
T-2
P-27
IV-3
P-28
MP-1, 1A
P-31D
P-32
T-3
BME-38
AR-2
N
0
500
1,000
1,500
Feet
Frederick, Perales, Allmon & Rockwell, PC
Caldwell County, Texas
Surface Geology and Site Locations
R W HARDEN & ASSOCIATES

<u>SUMMARY OF LABORATORY TEST RESULTS</u>

CALDWELL COUNTY LANDFILL
CALDWELL COUNTY, TEXAS
RETL Project No.: G216156
March 30, 2016

Boring No.	Sample Depth (ft.)	Visual Description & Unified Soil Classification (ASTM D-2488)	Moist. (%)	Atterberg Limits LL	PL	PI	Hydraulic Conductivity k (cm/sec)	Sieve Analysis, % Passing 1"	3/4"	1/2"	3/8"	#4	#8	#30	#50	#100	#200
IV-2A	7-8	Reddish-Brown Clayey Sand with Gravel (SC)	5	43	13	30		100	100	94.8	91.7	72.0	52.2	36.8	33.8	30.7	27.4
MP-1	16.5-17	Light Brown/Light Gray Lean Clay with Sand (CL)	18.5	49	18	31	1.68E-07	100	100	100	100	98.1	97.0	96.6	96.4	94.6	82.9
	20-21	Light Brown Lean Clay with Sand (CL)	14.3	48	18	30		100	100	100	100	99.6	99.6	99.4	99.0	96.0	78.5
	25-26	Light Brown Lean Clay (CL)	14.9	45	20	25		100	100	100	100	100	99.9	99.5	99.2	97.0	89.7
	31-32	Light Brown Fat Clay (CH)	20.6	67	22	45		100	100	100	100	100	99.8	99.6	99.5	97.9	94.4
	44-45	Light Brown Silt with Sand (ML)	18	45	28	17		100	100	100	100	100	100	100	99.7	98.4	81.2
MP-1A	43-44	Light Brown Lean Clay with Sand (CL)	22	48	26	22	1.19E-06	100	100	100	100	100	100	99.9	99.5	97.7	83.0
	45-45.5	Light Gray Sandstone	3.8	24	15	9		100	100	93.2	87.9	65.5	52.5	41.1	38.0	35.2	31.8
	45.5-46	Grayish-Brown Lean Clay (CL)	19.4	47	20	27		100	100	100	100	100	99.6	99.0	98.6	96.1	87.1
MP-2	26-27	Light Brown Lean Clay with Sand (CL)	12	46	18	28		100	100	100	100	98.1	97.2	96.0	95.4	93.7	84.3
MP-3	38-38.5	Reddish-Brown Laminated Claystone	21.1	69	23	46		100	91.2	76.7	56.4	47.9	43.5	39.2	38.5	36.8	35.3
T2-2	1.3	Brown Clayey Gravel (GC)	5.5	55	18	37		68.6	56.1	43.1	30.1	20.8	17.3	15.9	15.7	14.1	12.4
T5-3	3.0	Brown Clayey Gravel (GC)	6.1	52	18	34		54.0	44.8	35.6	32.0	27.5	24.6	22.0	20.9	19.0	17.5

Note: T2-2 Sample % Passing 2" Sieve = 100%, % Passing 1½" Sieve = 86.7%
T5-3 Sample % Passing 2" Sieve = 100%, % Passing 1½" Sieve = 71.7%

STATE OF TEXAS
KYLE D. HAMMOCK
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PROFESSIONAL ENGINEER

03/30/16

Kyle D. Hammock, P.E.
TXPE # 72963
Vice President - San Antonio

ROCK ENGINEERING & TESTING LABORATORY INCORPORATED

ROCK ENGINEERING AND TESTING LABORATORY, INC.
TXPE FIRM #2101
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SAN ANTONIO, TX 78216
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Site: MP-1	**Date:** 2/24/16 - 2/25/16	**Driller:** Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Shelby Tube, hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1		1	Shelby Tube	CL/OL	(0 - 1.0) Dark brownish gray SILTY LEAN CLAY to ORGANIC SOIL; moist, medium stiff, low to medium plasticity.				
2									
3		1.5		CL/CH	(2.0 - 9.0) Olive green SILTY FAT CLAY to SILTY LEAN CLAY with GRAVEL; medium to coarse gravel, moist, very stiff to hard, medium to high plasticity. Stratified layers of clay and fat clay. Rare calcareous/gypsum nodules.				
4									
5		1							
6									
7		1							
8									
9		1							
10									
11		2	Hollow Stem Core Barrel	CL	(10.0 - 32.4) Light brownish gray to brown SILTY LEAN CLAY with SILT; dry to moist, non plastic to low plasticity, noncohesive. Occasional seams and nodules of gypsum. Hard streak from 11.7 - 12.0 ft. Iron oxide mottling abundant from 20.0 -23.0 ft. Laminated gray silt and brownish clay from 25 - 28 ft. Slightly more clay content from 26.8 - 28.0 ft. Abundant laminated to stratified (larger than 0.5") iron oxide filled layers from 30.0 - 32.4 ft.				
12									
13									
14									
15									
16									
16.5		2.5				49	18	31	82.9
17									
18									
19									
20									
21		3.0				48	18	30	78.5
22									
23									
24									
25									
26		3.0				45	20	25	89.7
27									
28									
29									
30									
31		5.0		CH					
32						67	22	45	94.4
33									
34				CL/ML	(32.4 - 35.0) Light greenish gray to brown SILTY LEAN CLAY to CLAYEY SILT; dry to moist, hard, non to low plasticity, cohesive to noncohesive. Stratified (larger than 0.5") to laminated silty clay and clayey silt layers, frequent silt nodules.				
35									
36		5.0		CL	(35.0- 43.8) Light greenish gray to brown SILTY LEAN CLAY with SILT; dry to moist, hard, low to high plasticity, cohesive to noncohesive. Stratified (larger than 0.5") to laminated silty clay and clayey silt layers, frequent silt nodules.				
37									
38									
39									
40									

Site: MP-1 (continued)	Date: 2/24/16 - 2/25/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Shelby Tube, hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
41									
42				CL	*(Continued)* (35.0 - 43.8)				
43		5.0							
44									
45			Hollow Stem Core Barrel	ML	(43.8 - 45.0) Light brown to brown CLAYEY SILT; dry to moist, non plastic to low plasticity, cohesive	45	28	17	81.2
46									
47									
48									
49									
50		0.3		CL	(49.7 - 50.0) Dark greenish gray SILTY LEAN CLAY				

Site: MP-1A	Date: 2/25/16 - 2/26/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Shelby Tube, Split Spoon, hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1–10			Not Sampled						
11–12		~0.3	Shelby Tube/SS		(10.0 - 12.0) Light brown cemented SILT (rock); very hard, little recovery				
13–14			Shelby Tube/SS						
15–31			Not Sampled						
32–33		1.8	Shelby	CL	(31.0 - 32.8) (as MP-1) Light greenish gray to brown SILTY LEAN CLAY; dry to moist, hard, non plastic to low plasticity, cohesive to noncohesive. Stratified (larger than 0.5") to laminated silty clay and clayey silt layers, abundant iron mottling.				
34–40			Not Sampled						

Site: MP-1A (continued)	Date: 2/25/16 - 2/26/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Shelby Tube, Split Spoon, hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
41									
42									
43									
44		1.0	Shelby	CL	(43.0 - 44.0) Light brown to brown SILTY LEAN CLAY; dry to moist, non plastic to low plasticity, cohesive.	48	26	22	83.0
45									
45.5					(45.0 - 45.5) Light greenish gray cemented SAND (rock); dry, hard, non plastic silt layer. Rock layer.				
46		3.0	Hollow Stem Core Barrel	CL/ ML		47	20	27	87.1
47									
48					(45.5 - 50.8) Light greenish gray to brown SILTY LEAN CLAY to CLAYEY SILT; dry, non plastic to medium plasticity, hard. Stratified (larger than 0.5") light greenish gray clay and light brown to brown clayey silt layers. Abundant iron oxide mottling and frequent silt lenses.				
49		2.0							
50									
51		5.0							
52									
53					(50.8 - 55.0) Dark greenish gray SILTY LEAN CLAY to CLAYEY SILT; dry, non plastic to medium plasticity. Silty clay interbedded with silt lenses and laminated layers. Rare fissures of iron oxide.				
54									
55									

Site: MP-2	**Date:** 2/29/16 - 3/1/16	**Driller:** Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1			Hollow Stem Core Barrel	CH/OH	(0 - 0.5) Dark brownish gray SILTY FAT CLAY to ORGANIC SOIL with GRAVEL; medium gravel, moist, stiff, high plasticity.				
2–5		4.8		CH	(0.5 - 6.0) Olive green SILTY FAT CLAY with GRAVEL; medium gravel, moist, medium stiff to hard, medium to high plasticity. Rare calcareous/gypsum nodules.				
6–7		2.0		CL	(6.0 - 7.0) Light greenish gray to brown SILTY LEAN CLAY; dry, hard, low to medium plasticity. Occasional iron oxide mottling and calcareous/gypsum nodules.				
8–10									
11–17		3.0; 2.5		CL/ CH	(10.0 - 17.5) Light greenish gray to brown SILTY LEAN CLAY to SILTY FAT CLAY; dry, hard, medium to high plasticity. Iron oxide mottling and iron fissures occasional, laminated layers of silty clay and silt from 15 to 17.5 ft.				
18–20									
21–37		2.5; 3.1; 3.2		CL/ CH; CL	(20.0 - 37.0) Light greenish gray to brown SILTY LEAN CLAY to SILTY FAT CLAY with SILT; dry, hard, non plastic to high plasticity. Stratified (larger than 0.5") silty clay layers with laminated silt layers. Cemented silt layer from about 25.0-25.5 ft. Rare iron oxide lenses from 30.0 - 37.0 ft.	46	18	28	84.3
38–40		5.0			(37.0 - 46.5) Dark greenish gray to light greenish gray and brown SILTY LEAN CLAY to SILTY FAT CLAY with SILT; dry, hard, none to high plasticity. Transitional zone from weathered to unweathered. (*continued*)				

Site: MP-2 (continued)	Date: 2/29/16 - 3/1/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
41–46		5.0	Hollow Stem Core Barrel	CL/ CH	(*Continued*) (37.0 - 46.5) Occasional to frequent gypsum fissures, laminations, nodules. Very hard cemented iron material in bottom 1 foot.				
46–50		5.0	Hollow Stem Core Barrel	CH	(46.5 - 50.0) Dark greenish gray SILTY FAT CLAY; dry, hard, high plasticity. Occasionally stratified (larger than 0.5") to laminated light green gray to brown silt and fissures of gypsum.				

Site: MP-3	Date: 2/29/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1		2.4		CH/OH	(0 - 2.0) Dark brownish gray SILTY FAT CLAY to ORGNAIC SOIL with GRAVEL; medium to coarse gravel, moist, very stiff, high plasticity. Trace roots. Darker color in top 1 ft.				
2									
3					(2.0 - 10.0) Light greenish gray to brown STILY LEAN CLAY to SILTY FAT CLAY; dry, hard, medium to high plasticity. Medium to coarse gravel from 2.0 - 2.4 ft. Frequently laminated silt layers.				
4									
5									
6		5.0							
7									
8									
9									
10									
11		5.0		CL/ CH	(10.0 - 38.5) Light greenish gray to brown SILTY LEAN CLAY to SILTY FAT CLAY; dry, hard, medium to high plasticity. Frequently stratified (larger than 0.5") to laminated silt layers. Blocky texture from 10 - 15 ft. Frequent vertical iron oxide fissures from 25 - 30 ft. Rare iron oxide fissures from 30 - 35 ft. Gypsum crystals present at 31 ft. Hard iron oxide clay layer with gypsum crystals and gypsum seams from 37 to 38 ft.				
12									
13									
14									
15									
16		5.0	Hollow Stem Core Barrel						
17									
18									
19									
20									
21		4.0							
22									
23									
24									
25									
26		5.0							
27									
28									
29									
30									
31		5.0							
32									
33									
34									
35									
36		3.5							
37									
38									
38.5									
39									
40									

Site: MP-3 (continued)	Date: 2/29/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
41 42 43 44 45		5.0	Hollow Stem Core Barrel	CL/ CH	(40.0 - 46.5) Light greenish gray to brown SILTY LEAN CLAY to SILTY FAT CLAY; dry, hard, medium to high plasticity. Frequent laminated silt layers. Vertical gypsum and iron oxide fissures abundant throughout 45 - 50 ft interval - possible fault plane.				
46 47 48 49 50		5.0			(46.5 - 50.0) Light greenish gray to dark greenish gray SILTY LEAN CLAY; dry, hard, medium plasticity. Stratified (larger than 0.5") layers of light greenish gray and dark greenish gray material (transition zone). Gypsum nodules and iron oxide seams at 48 ft.				
51 52 53 54 55		5.0			(50.0 - 55.0) Dark greenish gray SILTY LEAN CLAY to FAT CLAY; dry, hard, medium to high plasticity. Frequent shell fragments.				

Site: IV-1	Date: 2/24/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1		1.0	Hollow Stem Core Barrel	CH/OH	(0 - 1.0) Dark brownish gray SILTY FAT CLAY to ORGANIC SOIL with GRAVEL; coarse gravel, moist, stiff, high plasticity.				
2									
3									
4									
5									
6									
7									
8									
9									
10									

Site: IV-1A	Date: 2/24/16	Driller: Brian Kern
Project: 130 Environmental Park	Observer: Dr. Lauren Ross	Drilling Co: Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	Observer (Green Grp): Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	Sampler Type: Shelby Tube, hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1		1.0	Shelby Tube	CH/OH	(0 - 1.0) Dark brownish gray SILTY FAT CLAY to ORGANIC SOIL with GRAVEL; coarse gravel, moist, stiff, high plasticity.				
2									
3		1.0		CH	(3.0 - 4.3) Dark brownish grey SILTY FAT CLAY with GRAVEL; fine to coarse gravel to 3.3 ft, moist, hard, high plasticity. Frequent calcite/gypsum nodules.				
4									
5		1.9							
6									
7		1.0							
8									
9		1.1							
10									
11		2.5	Hollow Stem Core Barrel						
12									
13									
14									
15									
16		4.5							
17									
18									
19				CL/CH	(4.3 - 35.0) Light greenish gray to brown SILTY LEAN CLAY to FAT CLAY; dry, hard, medium to high plasticity. Occasional to frequent laminated and stratified (larger than 0.5") layers of iron oxide and silt. Frequent to occasional iron and silt nodules. Blocky texture from 5 - 10 ft and 15 - 20 feet. Occasional gypsum crystals from 5 - 15 ft and 25 - 30 ft. Cemented iron oxide and gypsum layer at 28.5 ft. Rare shell fragments from 30 - 35 ft.				
20									
21		5.0							
22									
23									
24									
25									
26		5.0							
27									
28									
29									
30									
31		5.0							
32									
33									
34									
35									
36		4.7		CH	(35.0 - 48.0) Light greenish gray to brown SILTY FAT CLAY; dry, hard, high plasticity. Rare to occasional shell fragments. Frequent laminated to stratified (larger than 0.5") gypsum layers from 35 - 38 ft, rare laminated and stratified (larger than 0.5") gypsum layers from 42 - 45 ft. Frequent silty iron oxide fissures and laminated to stratified iron oxide layers. Blocky texture from 42 - 45 ft.				
37									
38									
39									
40									

Site: IV-1A (continued)	Date: 2/24/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Shelby Tube, hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
41		1.0	Shelby	CH	*(Continued)* (35.0 - 48.0)				
42		0.8							
43-45		3.0	Hollow Stem Core Barrel						
46-50		5.0			(48.0 - 51.0) Light greenish gray SILTY FAT CLAY; dry, hard, high plasticity. Rare stratified iron oxide layers.				
51-55		5.0			(51.0 - 67.0) Dark greenish gray SILTY FAT CLAY; dry, hard, high plasticity. Abundant shell fragment. Weathered zone from 56.5 - 57 ft.				
56-60		5.0							
61-65		5.0							
66-67		1.8	Shelby						

Site: IV-2	Date: 2/22/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Shelby Tube, Split Spoon	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1		0.8	Shelby	CL/OL	(0 - 0.8) Dark brownish gray SILTY LEAN CLAY to ORGANIC SOIL with GRAVEL; coarse gravel, dry, hard, low to medium plasticity.				
2		0.3	SS	CL/CH	(0.8 - 1.1) Brown SILTY LEAN CLAY to FAT CLAY with GRAVEL; coarse gravel, dry to moist, very stiff, medium to high plasticity. Calcite/gypsum fissures and lenses. 15/13/5 blows (split spoon 0.7 - 2.2 ft).				
3									
4		1.2	Shelby Tube	CH	(2.5 - 8.0) Light brown SILTY FAT CLAY with GRAVEL; coarse gravel, dry to moist, stiff to very stiff, high plasticity. Frequent gypsum/calcite fissures and lenses. 14/29/50 blows (split spoon 6.8 - 8 ft).				
5		1.0							
6									
7		0.5							
8		1.5	SS						
9		1.5			(8.0 - 10.3) Light greenish gray SILTY FAT CLAY with GRAVEL; coarse gravel, dry, hard, high plasticity. Calcite/gypsum fissures and lenses.				
10									
11		0.3	Shelby						
12									
13									
14									
15		0.3		CL/CH	(14.0 - 16.0) Light greenish gray to brown SILTY LEAN to SILTY FAT CLAY; dry, hard, medium to high plasticity. Iron oxide mottling and iron oxide and gypsum nodules. Blocky structure. 39/14/21 blows (split spoon 14.3 - 16 ft).				
16		1.5	SS						
17		0.3		CH	(16.0 - 18.5) Light greenish gray to brown SILTY FAT CLAY; dry to moist, hard, high plasticity. Abundant iron oxide mottling.				
18			Shelby						
19		0.5							
20			SS						

Site: IV-2A	Date: 2/22/16 - 2/23/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Auger, Shelby Tube, hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1									
2									
3									
4									
5									
6									
7									
8			Auger						
9									
10									
11									
12									
13									
14									
15									
16									
17		1.25		CL/ML	(16.0 -17.25) Light greenish gray to brown SILTY LEAN CLAY to CLAYEY SILT; dry to moist, non plastic to medium plasticity. Layers of hard silt interbedded in clay layers.				
18									
19		1.0							
20				CH	(18.0 - 21.5) Light greenish gray to brown SILTY FAT CLAY; dry to moist, hard, high plasticity. Occasional to freequent shell fragments. Abundant Iron oxide mottling.				
21		1.5							
22									
23		1.8	Shelby Tube						
24				CL	(22.0 - 25.5) Light greenish gray to brown SILTY LEAN CLAY; dry to moist, hard, medium plasticity. Frequent shell fragments. Occasional to frequent stratified (larger than 0.5") iron oxide layers and fissures.				
25		1.5							
26									
27		1.5							
28				CH	(26.0 - 29.2) Light greenish gray to brown SILTY FAT CLAY; dry to moist, hard, high plasticity. Occasional to frequent shell fragments. Occasional to frequent stratified (larger than 0.5") iron oxide layers and fissures. Iron oxide nodules from 28 - 29.2 ft.				
29		1.2							
30									
31									
32									
33		5.0		CH/ML	(30.0 - 35.0) Light greenish gray to brown SILTY FAT CLAY to CLAYEY SILT; dry to moist, hard, low to high plasticity. Rare iron oxide nodules. Stratified occasional silt layers (larger than 0.5").				
34									
35			Hollow Stem Core Barrel						
36									
37									
38		5.0		CH	(35.0 - 40.0) Light greenish gray to brown SILTY FAT CLAY; dry to moist, hard, medium to high plasticity. Frequent laminated to stratified iron oxide layers, nodules and fissures. Gypsum nodules from 39 - 40 ft.				
39									
40									

Site: IV-2A (continued)	Date: 2/22/16 - 2/23/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Auger, Shelby Tube, hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
41–42		5.0	Hollow Stem Core Barrel	CL	(40.0 - 42.0) Light greenish gray SILTY LEAN CLAY; dry, hard, low to medium plasticity. Shell fragments and glauconite present.				
43–44				CH	(42.0 - 44.0) Light brown SILTY FAT CLAY; dry, hard, medium to high plasticity. Blocky texture, iron oxide and gypsum fissures, and shell fragments present. Abundant iron oxide mottling.				
45–55		5.0 (46–50); 5.0 (51–55)		CL	(44.0 - 55.0) Light greenish gray to brown SILTY LEAN CLAY; dry, hard, low to medium plasticity. Gypsum crystals from 47.5 - 49 ft. Frequent laminated to stratified iron oxide layers and fissures. Frequent shell fragments. Frequent gypsum crystals from 50 - 53 ft. Dark greenish gray color from 53.8 - 54.2 ft (transition zone).				
56–58		5.0 (56–60)		CH/ CL	(55.0 - 58.5) Light greenish gray to brown SILTY FAT CLAY to SILTY LEAN CLAY; dry, hard, low to high plasticity. Frequent gypsum crystals, stratified iron oxide layers, and shell fragments.				
59–70		5.0 (61–65); 5.0 (66–70)		CL	(58.5 - 70.0) Dark greenish gray SILTY LEAN CLAY; dry, hard, low to medium plasticity. Frequent shell fragments. Rare stratified iron oxide layers (larger than 0.5") from 60 - 65 ft.				

Site: IV-3	Date: 2/26/16	Driller: Brian Kern
Project: 130 Environmental Park	Observer: Dr. Lauren Ross	Drilling Co: Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	Observer (Green Grp): Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	Sampler Type: Hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1–2		1.8	Hollow Stem Core Barrel	CH/OH	(0.0 - 0.5) Dark gray SILTY FAT CLAY to ORANIC SOIL with GRAVEL; coarse gravel, moist, stiff, high plasticity.				
3–5		3.2		CH	(0.5 - 6.5) Olive green to light brown SILTY FAT CLAY with GRAVEL; medium to coarse gravel, moist, hard, high plasticity. Coarse gravel from 0.5 - 2.0, medium gravel from 2.0 - 5.5 ft. Gypsum lenses from 3.0 - 6.5 ft.				
6–10		5.0							
11–15		4.5							
16–20		5.0		CH/CL	(6.5.0 - 30.0) Light greenish gray to brown SILTY FAT CLAY to SILTY LEAN CLAY with SILT; dry, hard, low to high plasticity. Startified (larger than 0.5") to laminated silt layers throughout. Frequent iron oxide staining. Rare calcite/gypsum nodules from 6.5 - 10 ft. Iron oxide filled fissures at 25 ft. *Interval ~25-28 ft lost during material observation - part of interval fell off table				
21–25		5.0							
26–30		5.0*							
31–35		5.0		CH	(30.0 - 45.0) Light greenish gray to brown SILTY FAT CLAY; dry, hard, high plasticity. Frequent gypsum crystals from 34 to 35 ft. Rare gypsum fissures from 35 - 40 ft. Frequent iron oxide fissures and silt nodules from 30 - 40 ft. Frequent gypsum fissures from 40 - 44 ft.				
36–40		5.0							

Site: IV-3 (continued)	Date: Date: 2/26/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Stefan Stamoulis	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
41–45		5.0	Hollow Stem Core Barrel	CH	(*Continued*) (30.0 - 45.0)				
46–50		5.0	Hollow Stem Core Barrel	CH	(45.0 - 49.9) Light greenish gray to dark greenish gray SILTY FAT CLAY; dry, hard, high plasticity. Dark greenish gray color from 46.5 - 46.8 ft and 49 - 49 ft. Transitional zone.				
51–55		5.0	Hollow Stem Core Barrel	CL/CH	(49.9 - 55.0) Dark greenish gray SILTY LEAN CLAY to SILTY FAT CLAY; dry, hard, medium to high plasticity. Frequent silt fissures and nodules. Oxidized zones with laminated silt layers from 50.5 - 51.5 ft and 52.7 - 53.0 ft.				

Site: AR-2	Date: 2/27/16	Driller: Brian Kern
Project: 130 Environmental Park	**Observer:** Dr. Lauren Ross	**Drilling Co:** Total Support Services
Location: Hunter Family Ranch, Caldwell Co.	**Observer (Green Grp):** Gregory Adams	
Geologist: Mike Rubinov, P.G.	**Sampler Type:** Hollow stem core barrel	

Depth	Sample Interval	Sample Recovery	Sampler	USCS	Lithologic Description	Liquid Limit	Plastic Limit	Plastic Index	% Passing No.200 Sieve
0									
1		1.8		CH/OH	(0.0 - 0.5) Dark gray SILTY FAT CLAY to ORGANC SOIL; moist, stiff, high plasticity.				
2									
3									
4		3.2							
5					(0.5 - 11.0) Light greenish gray to brown SILTY FAT CLAY with GRAVEL; fine to medium gravel, moist to dry, very stiff, high plasticity. Laminated clay and silt. Frequent gypsum nodules, laminated silt layers, and iron oxide nodules. Cemented iron oxide layers from 10 - 11 ft.				
6									
7									
8		5.0							
9									
10									
11				CH					
12									
13		4.5							
14									
15					(11.0 - 20.0) Light greenish gray SILTY FAT CLAY; moist to dry, hard, high plasticity. Occasional laminated iron oxide layers and rare gypsum fissures from 11 - 15 ft. Frequent gypsum nodules and rare shell fragments from 15 - 20 ft. Glauconitic from 15 - 20 ft.				
16									
17			Hollow Stem Core Barrel						
18		5.0							
19									
20									
21									
22									
23		5.0			(20.0 - 27.5) Light greenish gray to brown SILTY LEAN CLAY to SILTY FAT CLAY; dry, hard, medium to high plasticity. Glauconitic and frequent laminated iron oxide layers, fissures, gypsum nodules and shell fragments from 20 - 25 ft. Frequent gypsum crystals from 25 - 26 ft. Frequent shell fragments throughout.				
24									
25									
26									
27									
28		5.0		CL/ CH					
29									
30									
31					(27.5 - 35.0) Dark greenish gray SILTY LEAN CLAY to SILTY FAT CLAY; dry, hard, medium to high plasticity. Stratified light and dark greenish gray layers with iron oxide mottling from 27.5 - 30 ft. Frequent shell fragments throughout.				
32									
33		5.0							
34									
35									

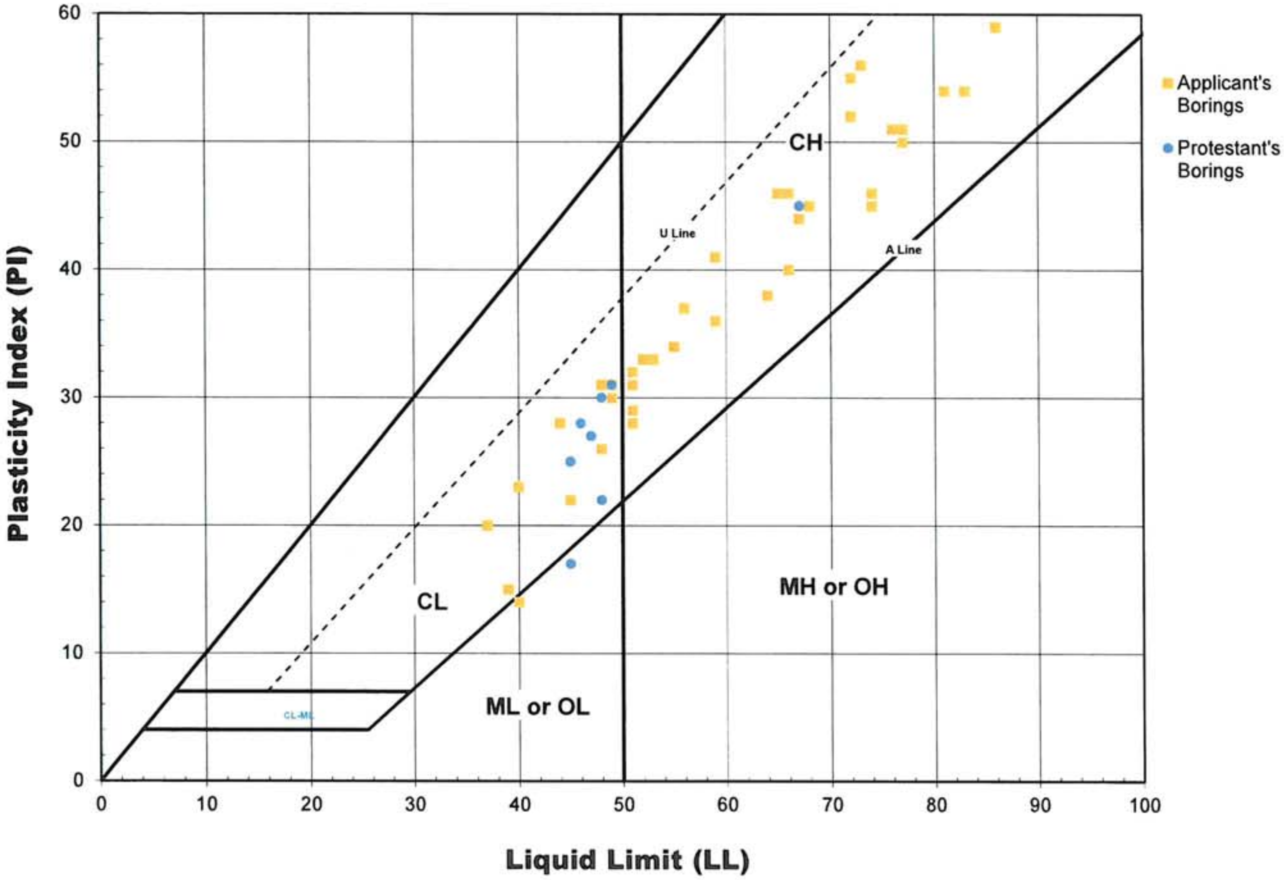
Lab Test Results

Site	Sample Top (ft)	Sample Bottom (ft)	Rock Engineering and Testing Laboratory Results			
			LL	PI	% passing #200	% passing #200 Note
BME-14A	4	5	91	61	98	
BME-14A	18	19	90	65	99	
BME-14A	38	39	97	68	100	
BME-38	4	5	52	33	53	
BME-38	6	7	44	28	56	
BME-38	8	9	40	23	64	
BME-38	14	15	49	31	63	
BME-38	18	19	56	37	67	
BME-38	26	27	77	50	99	
BME-38	36	37	48	26	87	
BME-38	44	45	45	22	68	
BME-39	10	11	51	31	71	
BME-39	18	19	51	29	91	
BME-39	22	23	37	20	85	
BME-39	30	31	48	26	96	
BME-39	44	45	49	30	98	
BME-39	50	51	53	33	72	
BME-40	10	11	51	32	94	Hydrometer Data
BME-40	14	15	49	31	97	Hydrometer Data
BME-40	22	23	55	34	95	Hydrometer Data
BME-40	26	27	40	14	82	Hydrometer Data
BME-40	34	35	73	56	67	
BME-40	46	47	51	32	94	Hydrometer Data
BME-41	6	7	64	38	95	
BME-41	18	19	83	54	99	
BME-41	30	31	77	51	93	
BME-41	44	45	68	45	99	
BME-42	4	5	59	41	98	Hydrometer Data
BME-42	8	9	48	31	61	
BME-42	12	13	49	30	96	Hydrometer Data
BME-42	26	27	51	28	83	
BME-42	38	39	74	46	100	
BME-42	40	41	39	15	68	
BME-43	6	7	81	54	98	
BME-43	12	13	86	59	98	
BME-43	16	17	76	51	100	
BME-43	28	29	74	45	95	
BME-43	34	35	94	64	100	
BME-43	42	43	90	61	98	
BME-44	16	17	67	44	98	
BME-44	26	27	59	36	93	Hydrometer Data
BME-44	32	33	65	46	99	Hydrometer Data
BME-44	44	45	66	46	96	Hydrometer Data

BME-44	58	59	66	40	98	Hydrometer Data
BME-7A	8	9	72	55	82	
BME-7A	16	17	87	61	98	Hydrometer Data
BME-7A	26	27	87	63	100	Hydrometer Data
BME-7A	38	39	72	52	78	Hydrometer Data
BME-7A	48	49	89	62	96	Hydrometer Data
MP-01	16.5	17.5	49	31	82.9	
MP-01	20	21	48	30	78.5	
MP-01	25	26	45	25	89.7	
MP-01	31	32	67	45	94.4	
MP-01	44	45	45	17	81.2	
MP-02	26	27	46	28	84.3	
MP-1A	43	44	48	22	83	
MP-1A	45.5	46.5	47	27	87.1	
Number of Samples			57			
Number Less than 50 LL			20			
Numberof ML Samples			2			
Numberof CL Samples			18			

Lower Than 50% Passing #200					
Site	**Sample Top (ft)**	**Sample Bottom (ft)**	**LL**	**PI**	**% passing #200**
MP-1A	45	46	24	9	31.8
MP-3	38	39	69	46	35.3
T2-2	1.3		55	37	12.4
T5-3	3		52	34	17.5
BME-44	8	9	43	23	
BME-38	46	47	42	20	44
BME-39	54	55	52	30	49

Atterberg Limits - 2016 Field Investigation Samples



Protestants' Exhibit 6-E, p.

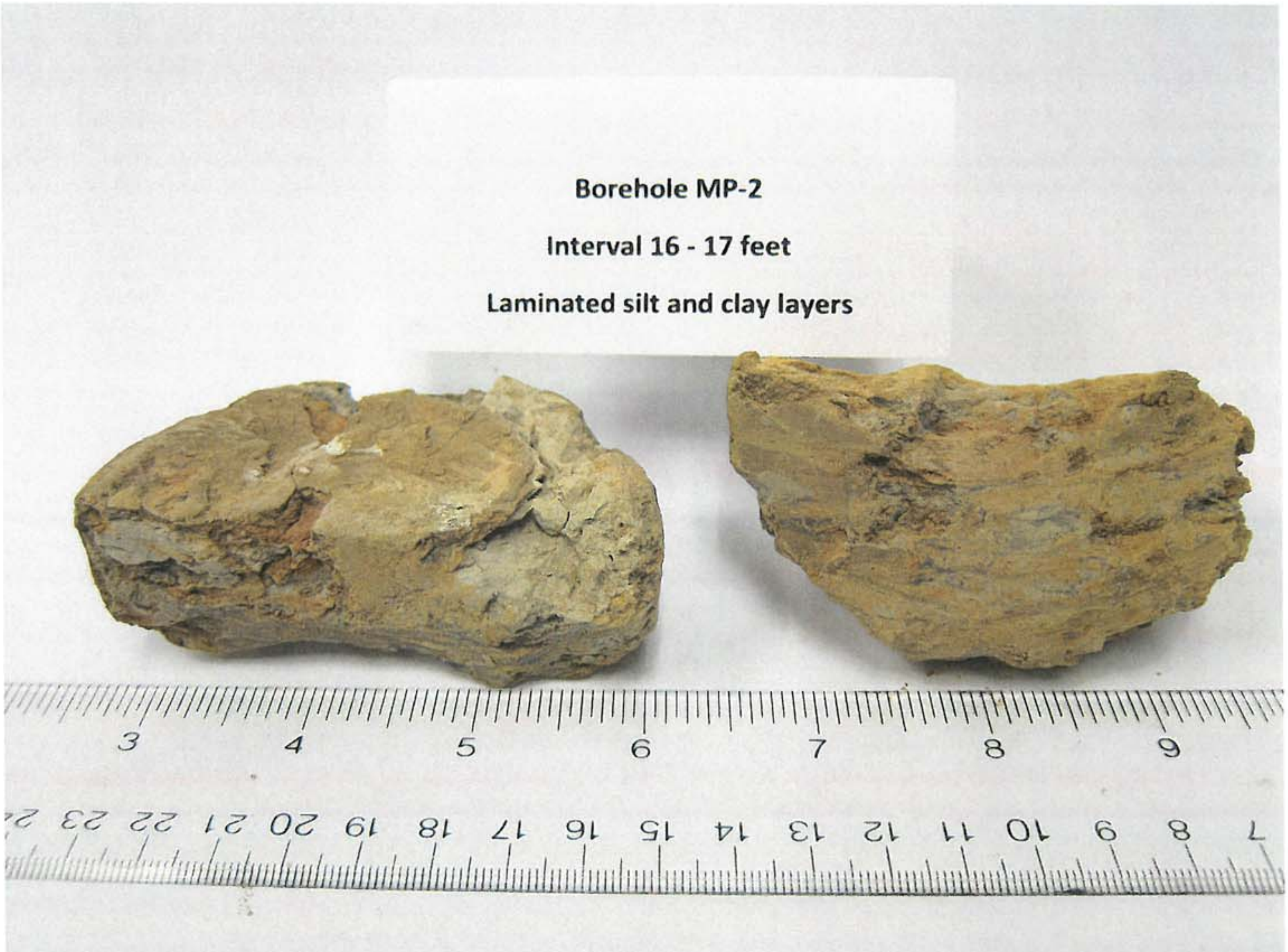

Borehole IV-3
Interval 24 - 25 feet
Iron oxide filled fissure
3 4 5 6 7 8

Interval 24 - 25 feet

Iron oxide filled fissure


Borehole MP-1A
Interval 54 - 54 feet
Iron oxide filled fissure


Borehole MP-1A
Interval 54 - 54 feet
Iron oxide filled fissure


Borehole MP-2
Interval 16 - 17 feet
Laminated silt and clay layers


Borehole MP-2
Interval 37 – 38 feet
Fat Clay and Lean Clay to Silt


Borehole MP-2
Interval 37 – 38 feet
Fat Clay and Lean Clay to Silt


Borehole MP-3
Interval 44 - 45 feet
Gypsum filled fissure


44 - 45 feet
Gypsum filled fissure

Depth to Top of Unweathered Contact in Proximal Borings			
	BME 4B	IV-1/A	BME 4A
Depth to Contact (ft)	50	51	52
	BME-7A	IV-2/A	
Depth to Contact (ft)	54	58.5	
	BME 14	BME 14A	
Depth to Contact (ft)	57	54	
	BME 43	MP-3	
Depth to Contact (ft)	36	46.5 - 50	
	BME 26	MP-2	
Depth to Contact (ft)	43	37.0 - 46.5	
	BME 27	IV-3	
Depth to Contact (ft)	48	45 - 50	
	BME 32	MP-1/A	
Depth to Contact (ft)	48	50.8	

Note: Range of values indicates beginning to end of transition zone