October 8, 2018
Revised: March 30, 2021

Richmond American Homes
4350 South Monaco Street
Denver, Colorado 80237

Attention: Mathew Jenkins

Subject: Geologic Hazard Evaluation and Due Diligence Geotechnical Investigation
Haven Valley (formerly Patriot Village)
Alturas Drive and Cable Lane
Security-Widefield, Colorado
CTL|T Project No. CS18980-115

This letter presents the results of our Geologic Hazard Evaluation and Due Diligence Geotechnical Investigation for Haven Valley. The site is located south of the intersection of Alturas Drive and Cable Lane in Security-Widefield, Colorado (Fig. 1). Site grading has not been performed.

The purpose of our investigation was to evaluate the subsurface conditions within the parcel to assist in your due diligence assessment. This letter contains descriptions of subsoil and groundwater conditions found in our exploratory borings and preliminary discussions of residential construction concepts as influenced by geologic and geotechnical considerations. The report was prepared based on conditions found in our borings, results of laboratory tests, engineering analysis of field and laboratory data, and our experience. Site grading plans were not provided to us during the time of the investigation. The information contained in this letter is intended for due diligence assessment purposes only. Additional investigations will be required to develop design-level criteria. The scope was described in our proposal dated September 21, 2018 (CTL|T Proposal No. CS-18-0143).The report was revised to include a Geologic Hazard Evaluation, to identify potential geologic hazards and determine the impact on the proposed development and adjacent sites.

We understand Richmond plans to construct two-story, 25-foot wide homes (the 25’ collection) at this site. Structures are expected to have a structural floor system with a crawl space and no basements. Attached garages are anticipated.

INVESTIGATION

Subsurface conditions in the area of the subject lots were investigated by our firm by drilling ten exploratory borings spread across the site, to depths between 20 and 30 feet. The approximate locations of the borings are shown in Fig. 1.

Our representative observed drilling operations, logged the soils found in the borings, and obtained samples for laboratory testing. Graphical logs of the borings, including the results of field penetration resistance tests, and some laboratory test data are presented in Figs. 2 and 3.

Soil samples obtained during drilling were visually classified and laboratory testing was assigned to representative samples. Gradation test results are presented in Appendix A. Laboratory test data are summarized in Table A-I.

Fill

Approximately 6 feet of silty to very silty sand fill was encountered from the ground surface in three of the borings (TH-3, TH-4, and TH-9). Field penetration resistance test results indicated the sand fill was medium dense. One sample of the fill contained 36 percent silt and clay-sized particles (passing the No. 200 sieve).

Based on historic aerial photographs, we believe there have been structures present on the site previously. No documentation regarding the construction of the fill, such as the results of field density testing, was available for our review at the time of this study. Because of the lack of documentation regarding the placement and compaction of the existing fill, we must consider this material to be of suspect quality and unsuitable to underlie the proposed structures, in its current condition.

Natural Sand Soils

Natural, slightly silty to silty sand was encountered at the ground surface in seven of the borings and below the fill in three of the borings. The sand was loose to dense. Eleven samples of the sand tested in our laboratory contained 6 to 21 percent silt and clay-sized particles (passing the No. 200 sieve).

Groundwater

At the time of drilling, groundwater was encountered in nine of the borings at depths of 11 to 22 feet below the existing ground surface. The shallower depths were measured in borings TH-6 and TH-9, at the southwest corner of the site. When water levels were checked again six days after the completion of drilling operations, groundwater was not present in any of the test holes. Between 2 and 16 feet of caving had occurred in the test holes when measured six days after the completion of drilling. The groundwater elevation should be expected to rise (typically less than about 5 feet) during the traditionally wetter months of late spring and early summer, and as a result of landscaping irrigation that is associated with residential development.

GEOLOGIC HAZARDS AND ENGINEERING CONSTRAINTS

We did not identify geologic hazards that we believe preclude development of the project. Conditions we identified that may pose hazards or constraints to development include existing undocumented fill. Regional geologic conditions that impact the site include and seismicity and radioactivity. We believe these conditions can be mitigated with engineering design and construction methods commonly employed in this area. These conditions are discussed in greater detail in the sections that follow.

Site Geology

The surficial geology at the site was evaluated by reviewing published geologic maps. The Geologic Map of the Elsmere Quadrangle published by the Colorado Geological Survey in (Madole and Thorson, 2002) covers the project site.

Geologic Map

The site is mapped as late Pleistocene-age eolian sand (wind-deposited sediment) consisting of very pale-brown, pale-brown, and light yellowish-brown sand with silt deposited as sand sheets, overlying the Dawson Formation. The Dawson Formation typically consists of sandstone interbedded with claystone in this area. Our subsurface investigation and observations generally confirm the mapping, although bedrock was not encountered to the depths explored of 20 and 30 feet. A map of the site specific surficial geologic conditions is shown on Figure 1.

Expansive Soils and Bedrock

One of the more significant geologic hazards in Colorado is the presence of swelling clays in bedrock and surficial deposits. Moisture changes to bedrock or surficial deposits containing swelling clays can result in volumetric expansion and collapse of those units. Changes in soil moisture content can result from precipitation, irrigation, pipeline leakage, surface drainage, perched groundwater, drought, or other factors. Swelling of expansive soil and bedrock may cause excessive cracking and heaving of structures with shallow foundations, concrete slabs-on-grade, or pavements supported on these materials.

The soils encountered in the exploratory borings is judged to be non-expansive or have a low swell potential. The rating of a site as low or high swell potential is not absolute; rather, this represents a judgement.

Collapsible Soils

Eolian soils are occasionally susceptible to collapse. Soil collapse (or hydro-collapse) is a phenomenon where soils undergo a significant decrease in volume upon an increase in moisture content, with or without an increase in external loads. Buildings, structures, and other improvements may be subject to excessive settlement-related distress when collapsible soils are present. The results of the subsurface evaluation and laboratory testing indicate the collapse potential of the eolian deposits is low.

Undocumented Fill

The site has been previously disturbed, and there were structures located at the northeast corner of the site. Aerial photos indicate the structures were razed between 2006 and 2011. We encountered fill in three of the borings. Two of these borings were near the previous structures and one boring was near the southwest corner of the site. The approximate extents of undocumented fill are shown on Figure 1. The remainder of the site has likely been surficially disturbed and there is evidence of contouring to control surface water. Undocumented fill should be removed and re-worked or replaced, according to the recommendations set forth in the **Fill Placement and Compaction** section of this report. Design-level geotechnical studies should be undertaken to confirm the presence of fill and depths of fill and to provide recommendations for reworking. If documentation of the fill, such as density test records are found, we should review them to determine if they are adequate for the proposed construction.

Shallow Bedrock

Based on our investigation shallow bedrock is not a concern at the site.

Shallow Groundwater

Groundwater was measured in nine of the borings at depths of 11 to 22 feet below the existing ground surface. Based on the grades at the site, we do not anticipate groundwater will be a concern for crawl space level construction.

Debris Flow and Debris Fans

The geologic mapping does not indicate the presence of debris flows, or debris fans on this property.

Rockfall

The project is not located within areas mapped as rockfall susceptible, as mapped in the Colorado Geological Survey Open-File Report 06-3 (2006) by Jonathan L. White and T.C. Wait, and does not appear susceptible per our observations.

Subsidence and Abandoned Mining Activity

The site is not included in the "Colorado Springs Subsidence Investigation" completed by Dames & Moore of the State of Colorado, Division of Mine Reclamation, dated April 1985. We understand the investigation reported areas that have been or could potentially be affected by mine subsidence activity. The subject site was not located within the investigated area. We observed no evidence of subsurface mining at the site. Based upon the results of the State's investigation, the project site is not underlain by underground mine workings.

Flooding

Information presented on "Flood Insurance Rate Map" (FIRM), Map Number 08041C0763G, with an effective date of December 7, 2018, indicates the project site is in Zone X, an area of minimal flood hazard. The project Civil Engineer should address localized flood potential.

Faults

The geologic mapping does not indicate the presence of faulting on the project site. The nearest fault is the Rampart Range fault approximately 10 miles west of the site.

Steeply Dipping Bedrock

We reviewed mapping of "Areas Susceptible to Differential Heave in Expansive, Steeply Dipping Bedrock, City of Colorado Springs, Colorado" (1999) by John W. Himmelreich, Jr., and David C. Noe published by the Colorado Geologic Survey. Mapping the site is well outside of areas mapped as having steeply dipping bedrock.

Elevated Radioactivity and Radon

We believe no unusual hazard exists from naturally occurring sources of radioactivity on the site. However, the materials found in this area are often associated with the production of radon gas and concentrations in excess of those currently accepted by the EPA can occur. Passive and active mitigation procedures are commonly employed in this region to effectively reduce the buildup of radon gas. Measures that can be taken after a structure is enclosed during construction include installing a blower connected to the foundation drain and sealing the joints and cracks in concrete floors and foundation walls. If the occurrence of radon is a concern, we recommend structures be tested after they are enclosed. Commonly utilized mitigation techniques may minimize risk. The EPA provides information concerning building techniques to address radon in homes.

DISCUSSION

Because of the lack of documentation regarding the placement and compaction of the existing fill, we must consider this material to be of suspect quality and unsuitable to underlie the proposed structures, in its current condition. The existing fill should be excavated to expose the underlying natural soils and if free of deleterious materials, reused as new, densely compacted fill to achieve desired building pad elevations and site grades.

Loose sand was encountered in five of our borings. If loose sand is present at footing elevations, it will need to be moisture conditioned and densely compacted.

CONCLUSIONS AND RECOMMENDATIONS

The following discussions are preliminary and are not intended for design or construction. Additional site-specific investigations will be required to evaluate the subsurface conditions on each lot within the filing, and provide design and construction recommendations for foundations and floor systems.

Conditions encountered in our exploratory borings and laboratory testing suggest conventional spread footing foundations are appropriate. Suspect quality fill was encountered in three of the ten borings. These borings were generally spread across the site. The depth of fill encountered was about 6 feet from the existing ground surface. This material should be removed and compacted as new fill, prior to placing site grading fill, or construction of the residences.

Relatively loose materials were also encountered in five of the ten borings. We anticipate these soils may result in somewhat lower bearing capacities for a portion of the lots, or that a relatively thin layer of fill may be used to improve bearing capacities.

We anticipate up to about 20 to 25 percent of the site might require removal of the existing fill, based on our borings. Our firm can provide design criteria at the time of the site-specific Soils and Foundation Investigations, if requested.

Based on our experience, the estimated potential ground heave will be less than 0.5 inches, as the sands are not expansive generally, a depth of wetting of 24 and 26 feet was considered for the heave evaluation. Research suggests there is about a 90 percent probability that wetting will be less than 24 feet[1] and 95 percent for less than 26 feet. We judge the risk of poor garage floor slab performance to be low. We understand structurally supported floors will be constructed for the proposed residences. Garage

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[1] "Method for Evaluation of Depth of Wetting in Residential Area," Walsh, Colby, Houston and Houston, ASCE, February 2009.

slabs and driveways may settle and crack. Construction details designed to mitigate the potential for damage caused by movement of slabs-on-grade will be needed.

FILL PLACEMENT AND COMPACTION

Reconstruction of undocumented fill will be necessary for construction of this project. In addition, cuts and fills are expected for streets and the lots, as well as for stormwater detention measures. Where new fill is needed to raise site grades, replace excavated undocumented fill, or to establish earthen embankments for the proposed stormwater detention, the onsite soils may be reused as compacted fill provided debris, vegetation, organics, and other deleterious materials are substantially removed prior to placement. Areas to receive new fill should be scarified to a depth of about 8 inches prior to fill placement, moisture conditioned to near optimum moisture content and densely compacted. Subsequent fill materials should be placed in thin (8 inches or less) loose lifts. Granular fill materials should be moisture conditioned to within 2 percent of optimum moisture content and compacted to at least 95 percent of a modified Proctor dry density (ASTM D 1557). Fill consisting of cohesive materials (if encountered) should be moisture conditioned to between 1 and 4 percent over optimum moisture content and compacted to at least 95 percent of the standard Proctor dry density (ASTM D 698) where buildings are planned. Moisture contents within 2 percent of optimum are appropriate in other areas of the site. Placement and compaction of fill and backfill should be observed and tested by a representative of our firm during construction.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentrations of less than 0.1 percent in two soil samples obtained during this study. For this level of sulfate concentration, ACI 332-08 Code Requirements for Residential Concrete indicates there are no special requirements for sulfate resistance.

In our experience, superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious materials ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high water tables. Concrete should be air entrained where exposed to freeze/thaw conditions. We recommend all foundation walls and grade beams in contact with the subsoils (including the inside and out-side faces of garage and crawl space grade beams) be damp-proofed.

LIMITATIONS

Our boring locations were selected to provide a general characterization of subsurface conditions beneath the investigated development for a due diligence assessment. Conditions between borings will vary. Individual site-specific investigations will be necessary on each lot to provide design-level criteria.

We believe this investigation was conducted in a manner consistent with that level of care and skill ordinarily used by geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.

If we can be of further service in discussing either the contents of this letter or the analysis of the influence of subsurface conditions on the design of the proposed residences, please call.

Sincerely,

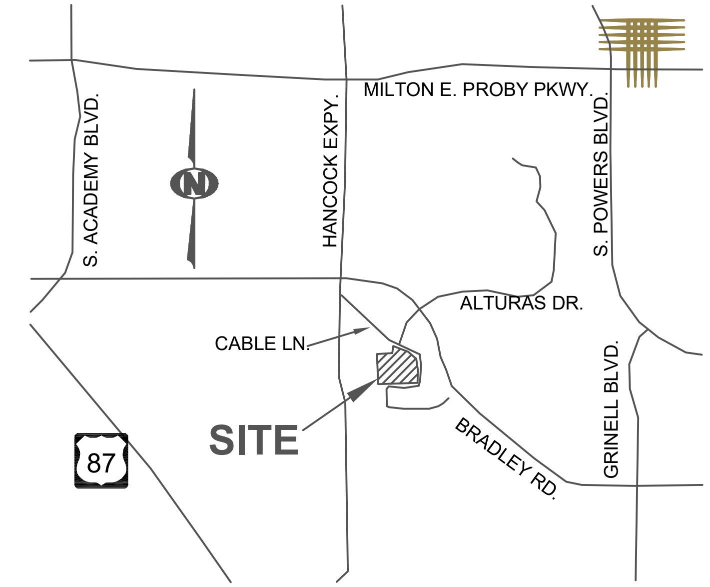
CTL | THOMPSON, INC.

Timothy A. Mitchell, P.E.
Division Manager

Timothy Mitchell
Mar 30, 2021, 7:17 PM

MBR:TAM:JMJ:tam

Via Email: Matthew.Jenkins@mdch.com



VICINITY MAP
(NOT TO SCALE)

LEGEND:

TH-1 APPROXIMATE LOCATION OF EXPLORATORY BORING.

APPROXIMATE GEOLOGIC BOUNDARY

Af AREA WHERE MANMADE FILL MAY BE PRESENT

Qes/Da AREA WHERE EOLIAN SAND MAY BE PRESENT WITH SURFICIAL DISTURBANCE

0 50' 100'
SCALE: 1" = 100'

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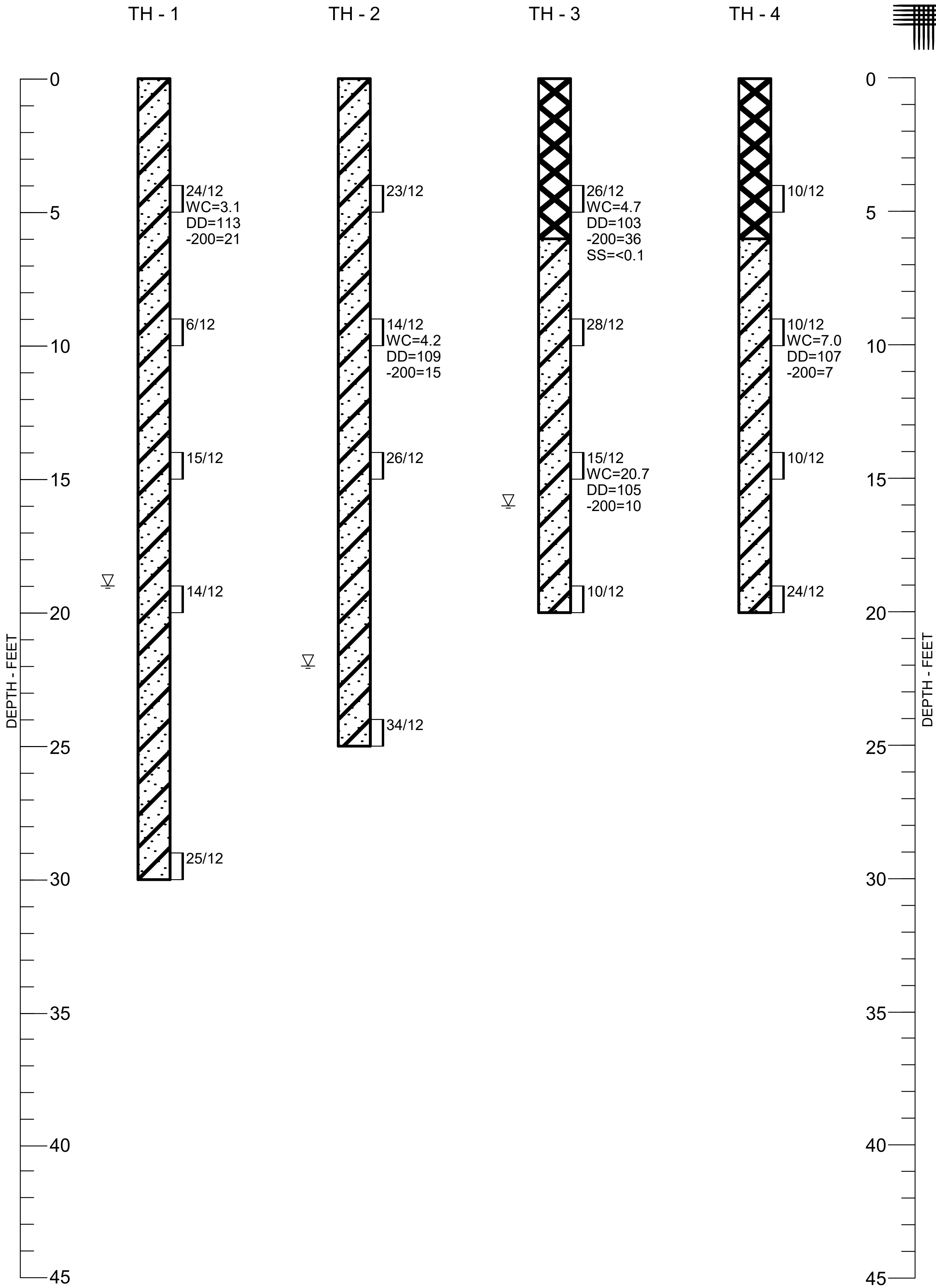
Location of Exploratory Borings

FIG. 1



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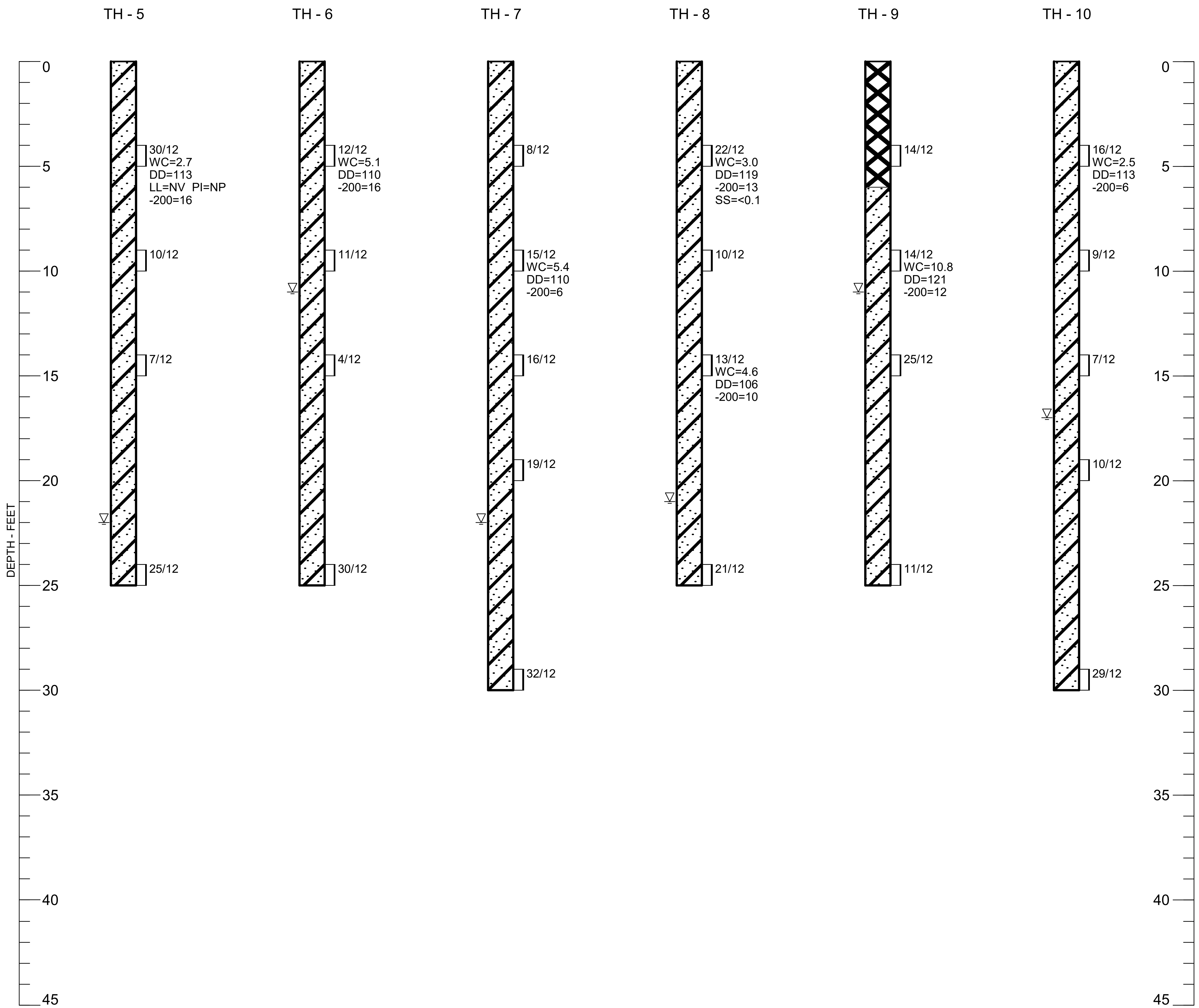
Summary Logs of Exploratory Borings

FIG. 2



LEGEND:

FILL, SAND, SILTY TO VERY SILTY, MEDIUM DENSE, MOIST, MEDIUM BROWN.

SAND, SLIGHTLY SILTY TO SILTY, LOOSE TO DENSE, MOIST TO VERY MOIST, LIGHT BROWN, BROWN. (SP-SM, SM)

DRIVE SAMPLE. THE SYMBOL 24/12 INDICATES 24 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

∇ GROUNDWATER LEVEL MEASURED AT TIME OF DRILLING.

NOTES:

1. THE BORINGS WERE DRILLED SEPTEMBER 18, 2018 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-45, TRUCK-MOUNTED DRILL RIG.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.
3. WC - INDICATES MOISTURE CONTENT. (%)
   DD - INDICATES DRY DENSITY. (PCF)
   LL - INDICATES LIQUID LIMIT. (%)
   (NV : NO VALUE)
   PI - INDICATES PLASTICITY INDEX. (%)
   (NP : NON-PLASTIC)
   -200 - INDICATES PASSING NO. 200 SIEVE. (%)
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT. (%)

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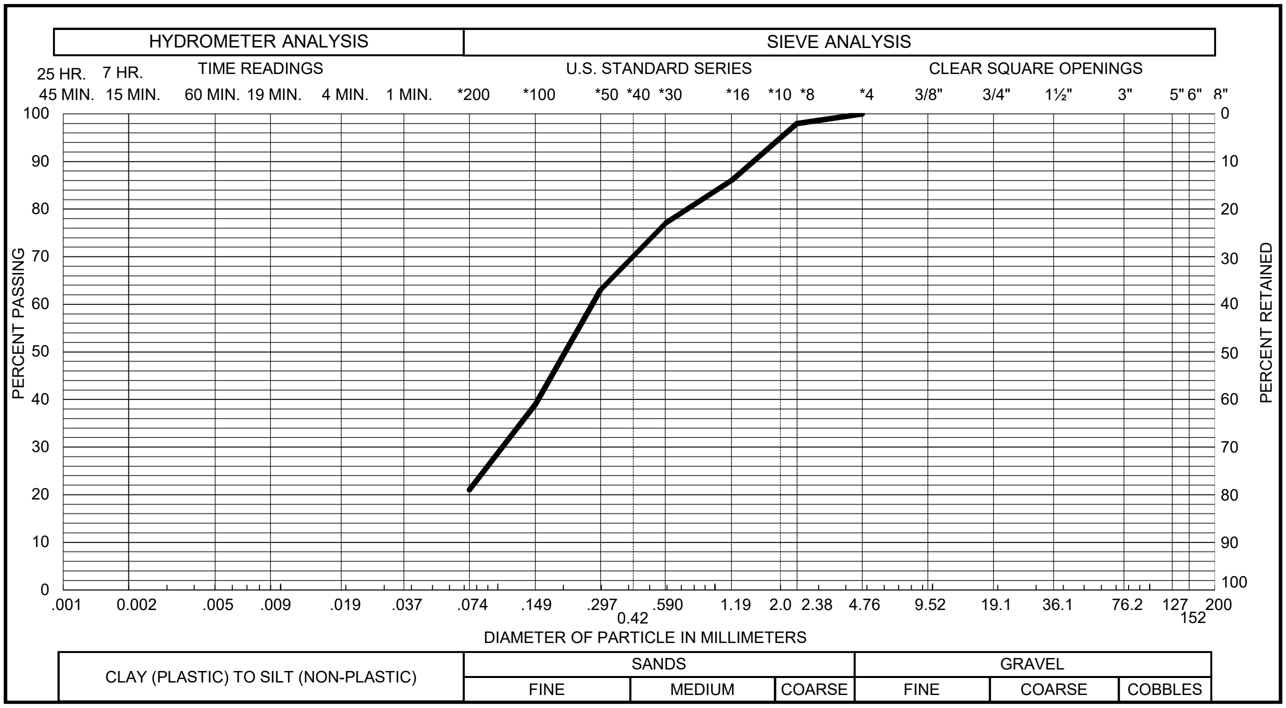
Summary Logs of Exploratory Borings

FIG. 3

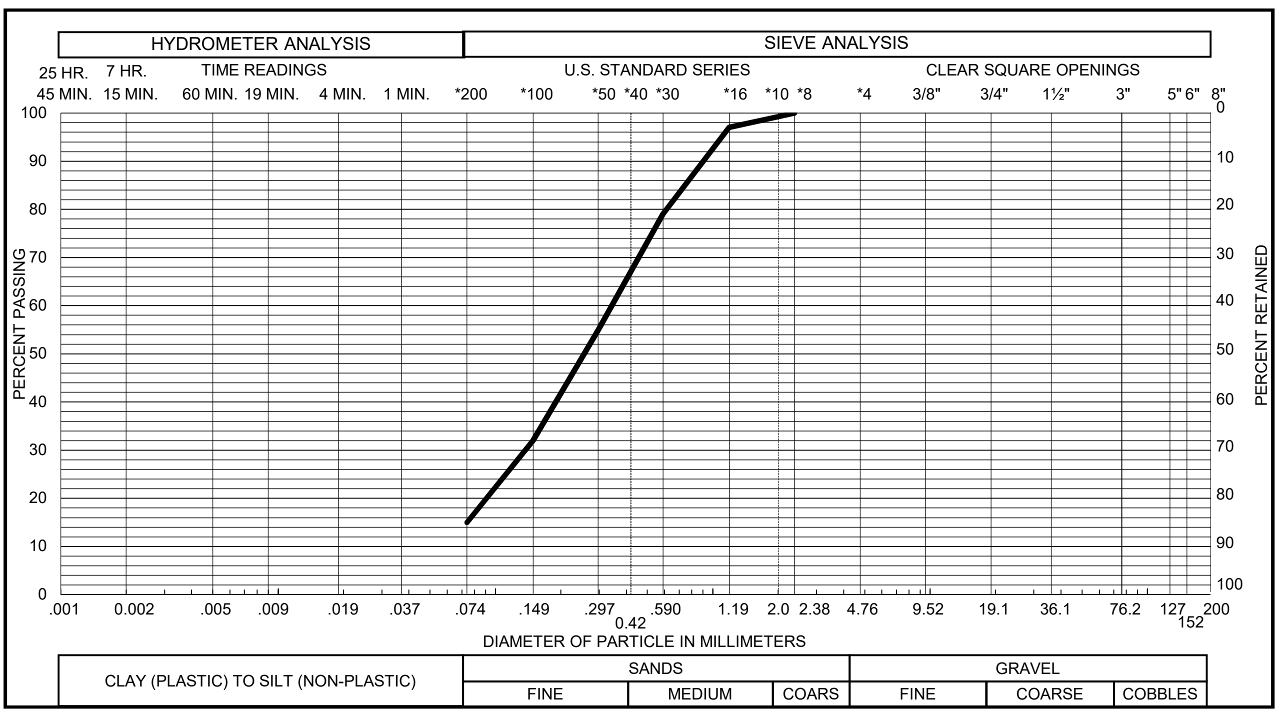
APPENDIX A

LABORATORY TEST RESULTS
TABLE A-1 – SUMMARY OF LABORATORY TESTING



Sample of SAND, SILTY (SM)
From TH - 1 AT 4 FEET

GRAVEL 0 % SAND 79 %
SILT & CLAY 21 % LIQUID LIMIT %
PLASTICITY INDEX %



Sample of SAND, SILTY (SM)
From TH - 2 AT 9 FEET

GRAVEL 0 % SAND 85 %
SILT & CLAY 15 % LIQUID LIMIT %
PLASTICITY INDEX %

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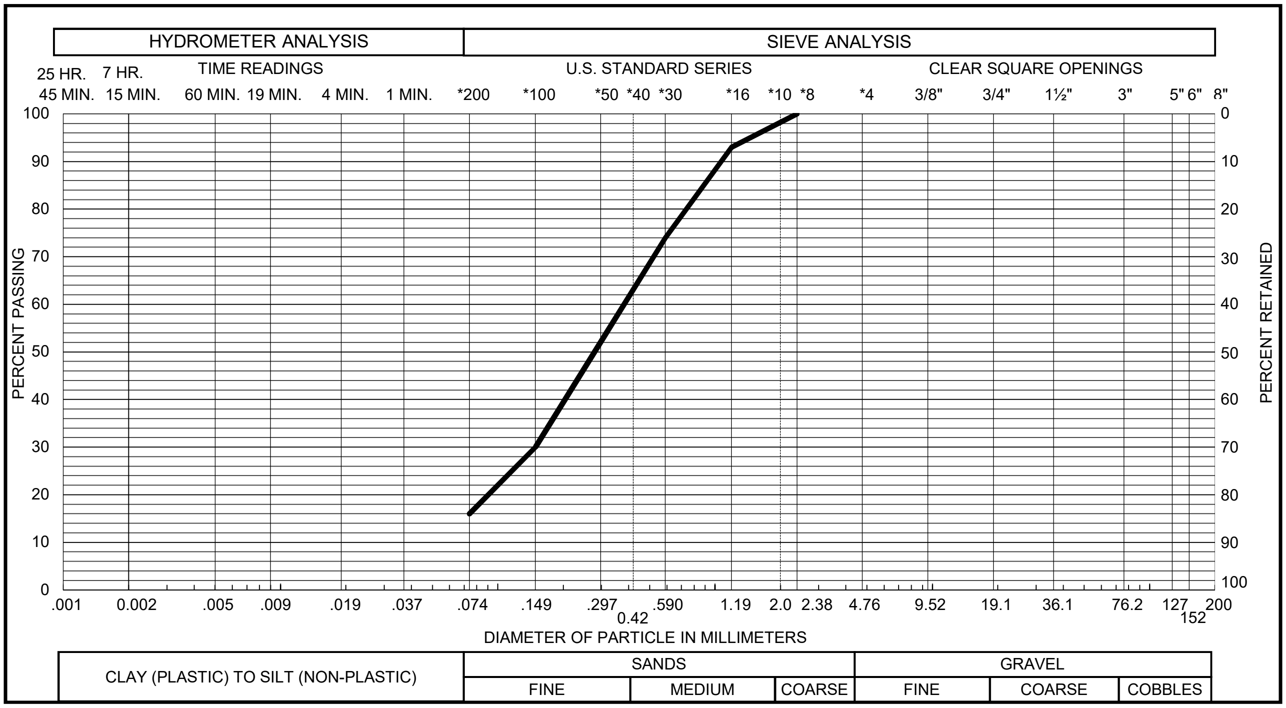
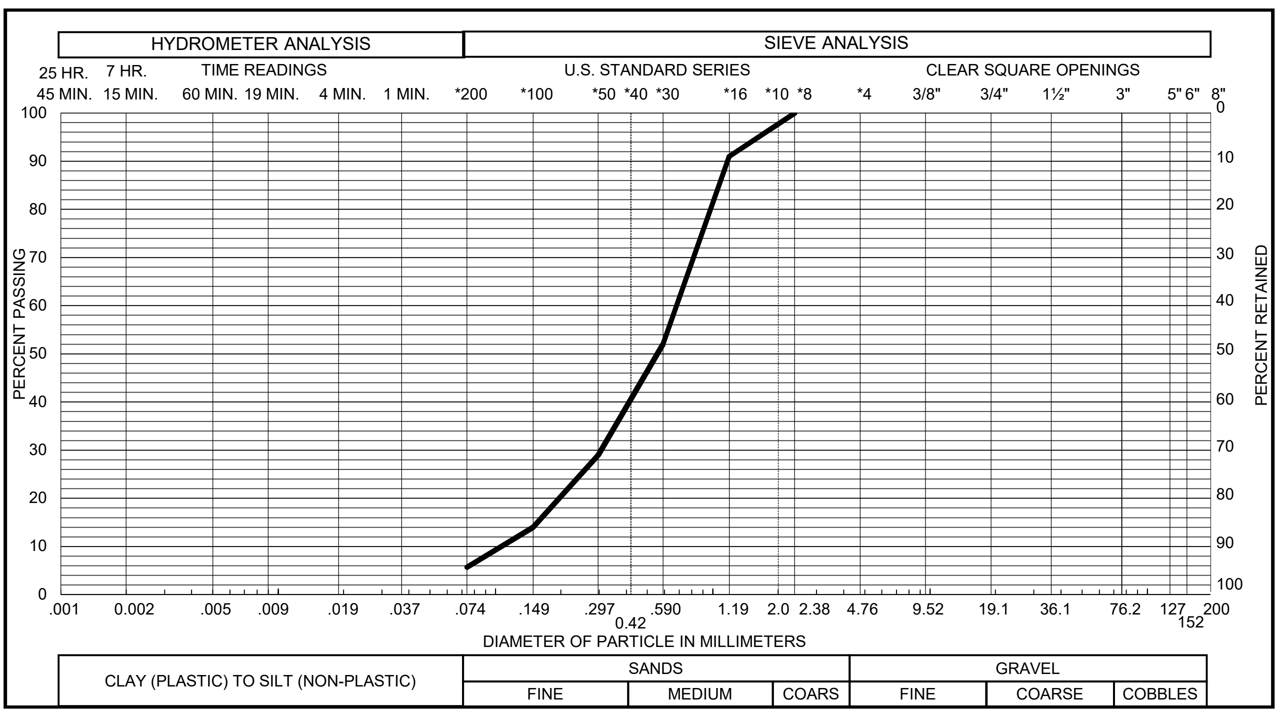
Gradation Test Results

FIG. A-1



Sample of SAND, SILTY (SM)
From TH - 5 AT 4 FEET

GRAVEL 0 %
SAND 84 %
SILT & CLAY 16 %
LIQUID LIMIT NV %
PLASTICITY INDEX NP %



Sample of SAND, SLIGHTLY SILTY (SP-SM)
From TH - 7 AT 9 FEET

GRAVEL 0 %
SAND 94 %
SILT & CLAY 6 %
LIQUID LIMIT %
PLASTICITY INDEX %

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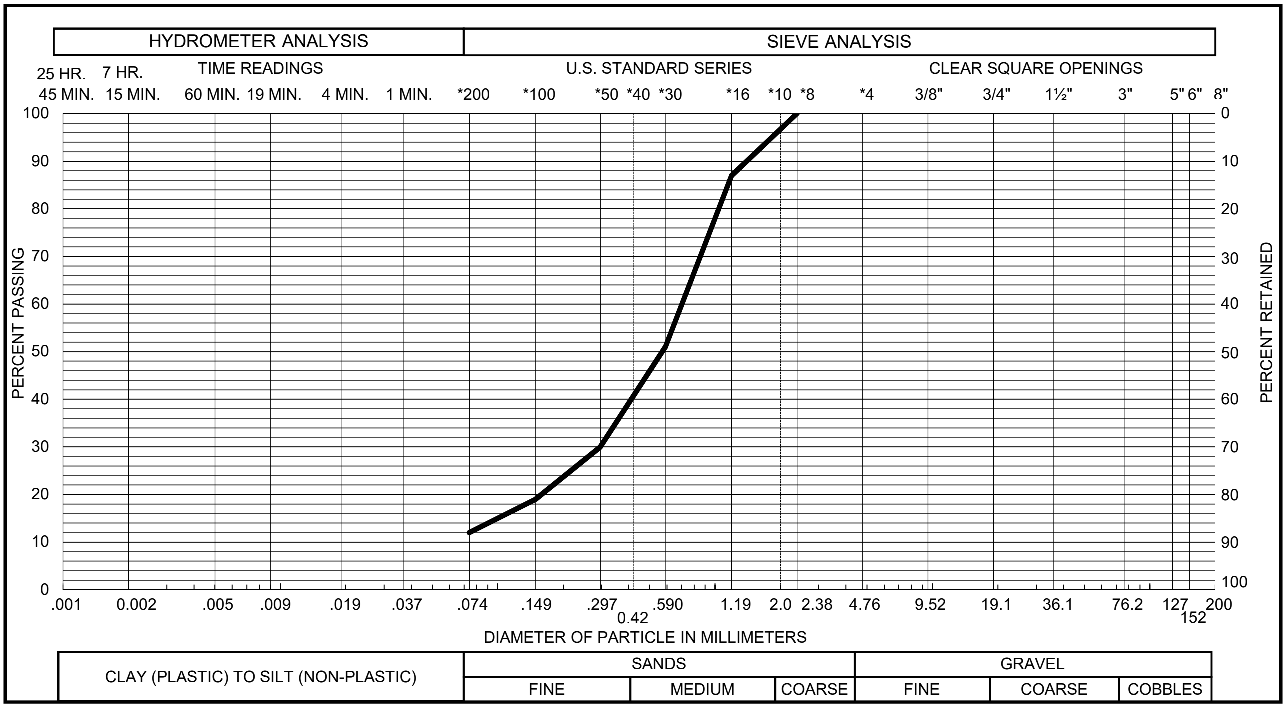
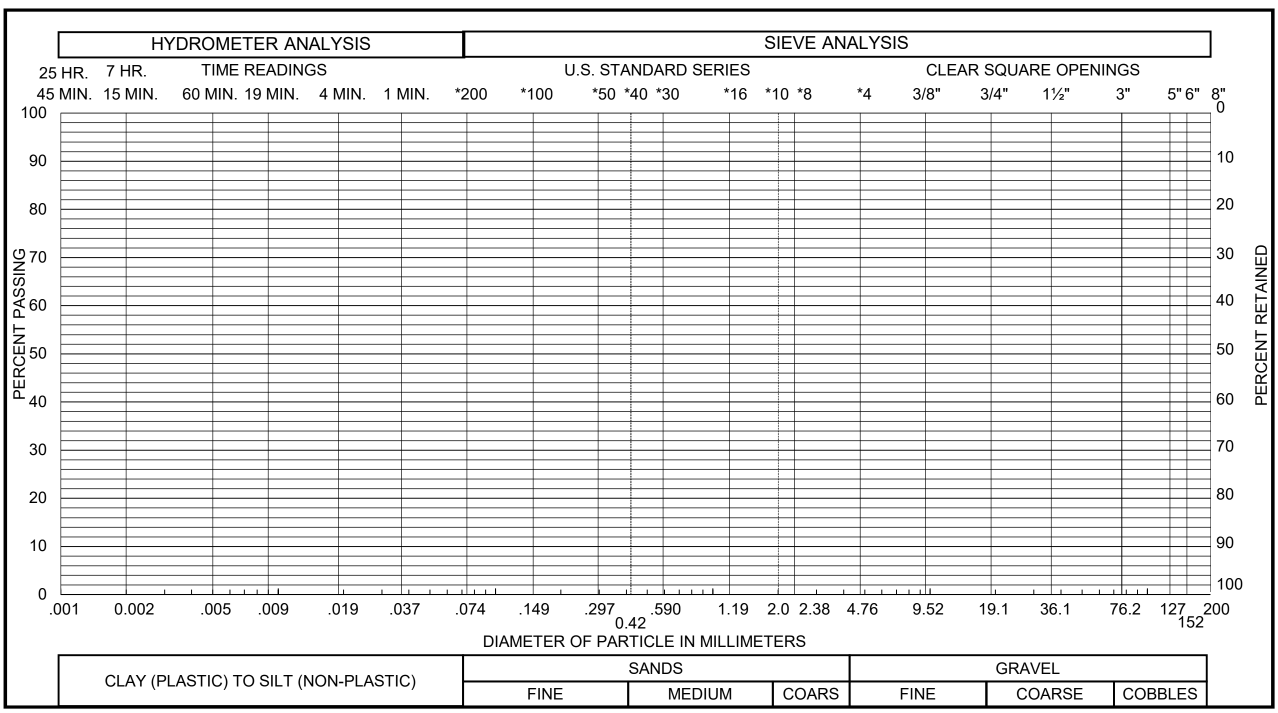
Gradation Test Results

FIG. A-2



Sample of SAND, SLIGHTLY SILTY (SP-SM)
From TH - 9 AT 9 FEET

GRAVEL 0 % SAND 88 %
SILT & CLAY 12 % LIQUID LIMIT %
PLASTICITY INDEX %



Sample of
From

GRAVEL % SAND %
SILT & CLAY % LIQUID LIMIT %
PLASTICITY INDEX %

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Gradation Test Results

FIG. A-3

TABLE A-1

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS18980-115

				ATTERBERG LIMITS		SWELL TEST RESULTS*					
BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
TH-1	4	3.1	113						21		SAND, SILTY (SM)
TH-2	9	4.2	109						15		SAND, SILTY (SM)
TH-3	4	4.7	103						36	<0.1	FILL, SAND, VERY SILTY
TH-3	14	20.7	105						10		SAND, SLIGHTLY SILTY (SP-SM)
TH-4	9	7.0	107						7		SAND, SLIGHTLY SILTY (SP-SM)
TH-5	4	2.7	113	NV	NP				16		SAND, SILTY (SM)
TH-6	4	5.1	110						16		SAND, SILTY (SM)
TH-7	9	5.4	110						6		SAND, SLIGHTLY SILTY (SP-SM)
TH-8	4	3.0	119						13	<0.1	SAND, SILTY (SM)
TH-8	14	4.6	106						10		SAND, SLIGHTLY SILTY (SP-SM)
TH-9	9	10.8	121						12		SAND, SLIGHTLY SILTY (SP-SM)
TH-10	4	2.5	113						6		SAND, SLIGHTLY SILTY (SP-SM)

* SWELL MEASURED UNDER ESTIMATED IN-SITU OVERBURDEN PRESSURE.
NEGATIVE VALUE INDICATES COMPRESSION.