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Address Drainage Criteria Manual Vol 1. Chapter 11 Section 11.3.3 (see below)

11.3.3 Embankment Structures

The width of the top of the embankment structure shall be a minimum of 12 feet for embankments less than 25 feet in height. Also, side slopes on embankment structures will vary with materials types used and shall be designed to produce a stable and easily maintained structure. A slope stability analysis shall be required on all Class 1 structures.

An allowance for settlement shall also be factored into the design for all embankment structures. Consideration shall also be given to limiting excessive seepage through the embankment and foundation that may lead to embankment erosion and structure instability for all Class 1 structures.

A geotechnical analysis and report prepared by a Colorado Professional Engineer with recommendations for the foundation preparation and embankment construction shall be submitted to the City/County Engineer with the complete design analysis for all permanent detention facilities.

GEOLOGIC HAZARDS EVALUATION AND PRELIMINARY GEOTECHNICAL INVESTIGATION FOREST LAKES SUBDIVISION (PHASE 2) FOREST LAKES ROAD & WEST BAPTIST ROAD COLORADO SPRINGS, COLORADO

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CTL|T Project No. CS18916-105

July 18, 2018
Revised: December 11, 2018

Add PCD File No. PUDSP181

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SCOPE

This report presents the results of our Geologic Hazards Evaluation and Preliminary Geotechnical Investigation for Phase 2 of the Forest Lakes Subdivision in El Paso County, Colorado. The investigated parcel is planned for development of single-family residential lots. Our purpose was to evaluate the parcel for the occurrence of geologic hazards that may impact development of the property, and to provide preliminary geotechnical design concepts. This report includes a summary of subsurface and groundwater conditions found in our exploratory borings, a description of our engineering analysis of the geologic conditions at the site, and our opinion of the potential influence of the geologic hazards on the planned structures and other site improvements. A debris flow/mudflow analysis was prepared by our firm for Phase 2 under a separate cover. The scope of our services is described in our proposal (CS-18-0033) dated March 29, 2018.

The report was prepared based on conditions interpreted from field reconnaissance of the site, conditions found in our exploratory borings, results of laboratory tests, engineering analysis, and our experience. Observations made during grading or construction may indicate conditions that require revision or re-evaluation of some of the preliminary criteria presented in this report. The criteria presented are for the development as described. Revision in the scope of the project could influence our recommendations. If changes occur, we should review the development plans and the effect of the changes on our preliminary design criteria. Evaluation of the property for the possible presence of potentially hazardous materials (Environmental Site Assessment) was beyond the scope of this investigation. Assessment of the site for the potential for wildfire hazards, corrosive soils, erosion problems, or flooding is also beyond the scope of this investigation.

The following section summarizes the report. A more complete description of the conditions found at the site, our interpretations, and our recommendations are included in the report.

SUMMARY

1. We did not identify geologic hazards that we anticipate will preclude development of the project as planned. The conditions we identified include shallow groundwater and potential for erosion, flooding and debris flow. Slopes within and near the development areas appear to be stable and the construction of the proposed single-family homes should not negatively impact slope stability. Collapsible soils were not identified in this study and given the particle size distribution and fines content of samples, would not be expected. Regional geologic conditions that impact the site include seismicity and radioactivity. We believe each of these conditions can be mitigated with engineering design and construction methods commonly employed in this area.

2. The near-surface soils encountered in the twenty-four exploratory borings drilled during this investigation and our 2001 study consisted of 4 feet to over 50 feet of natural, sand and gravel soils with occasional clay lenses. The near-surface soils were underlain by sandstone bedrock.

3. At the time of drilling, groundwater was encountered in eight of the exploratory borings at depths of 8 to 26 feet below the existing ground surface. When water levels were checked again following the completion of drilling operations, water was measured in eleven of the borings at depths of 6 to 26 feet. The shallowest groundwater was encountered along North Beaver Creek. Groundwater levels will vary with seasonal precipitation and landscaping irrigation.

4. In our opinion, site grading and utility installation across the site can be accomplished using conventional, heavy-duty construction equipment.

5. We anticipate spread footing foundations and slab-on-grade floors will be appropriate for the dwellings constructed at this site. Some of the soil and bedrock may be expansive when wetted. If expansive soil and/or bedrock occurs, sub-excavation of a zone of expansive material from beneath spread footing foundations and reworking the soil as low-swelling, moisture-conditioned fill may be appropriate. Our widely-spaced borings and laboratory test results suggest most of the residential sites can be developed successfully using shallow foundations and slab-on-grade basement floors without soil improvement.

6. Irrigation of landscaping should be minimized to reduce problems associated with expansive soils. Overall plans should provide for the rapid conveyance of surface runoff to the storm sewer system and centralized drainage channels.

SITE CONDITIONS

The investigated parcel of land is situated west of the intersection of Forest Lakes Drive and Mesa Top Drive (portions of Sections 28 and 29, Township 11 South, Range 67 West of the 6th Principal Meridian), El Paso County, Colorado. The revised, overall development plan (dated November 30, 2018) is shown in Fig. 1.

Phase 2 is situated within a broad valley between two east-to-west trending ridges. The ground surface within the portion of the parcel that is to be developed with single-family, residential housing generally slopes downward to the east and southeast at grades of between about 5 and 10 percent. A local mesa dominates the western portion of the parcel. The sides of the mesa are considerably steeper and will not be disturbed during development of the subdivision. Beaver Creek and North Beaver Creek converge in the eastern third of the property. Vegetation on the site consists of mostly grasses, weeds, pine trees, scrub oak, and deciduous trees and bushes. Phase 2 is currently being used as pastureland for cattle. The land to the north and south of the parcel is developed with widely-spaced, single-family residences. Phase 1 of the subdivision is situated to the east.

PROPOSED DEVELOPMENT

We understand the parcel is to be developed with single-family, residential dwelling lots. Paved access roads will be constructed in association with the planned development. We anticipate the residences will be one and two-story, wood-frame structures with basement areas and attached, multi-automobile garages. We anticipate the dwellings will be serviced by a centralized sanitary sewer collection system and potable water distribution system.

PREVIOUS INVESTIGATION

Our firm prepared a Geologic Hazards Evaluation and Preliminary Geotechnical Investigation for the Forest Lakes Master Development Plan (Job No. CS-10,585; report dated August 15, 2001) that included the Phase 2 parcel presented in this study. Thirtynine exploratory borings were drilled in association with the 2001 investigation. Fourteen of the borings were located within the boundaries of Phase 2 and were reviewed as part of this study. Subsurface conditions encountered in the earlier borings were similar to the materials found in the ten borings drilled during this investigation.

SUBSURFACE INVESTIGATION

Subsurface conditions at the site were investigated by drilling ten supplemental exploratory borings (TH-101 through TH-110) and reviewing the subsurface conditions found in fourteen borings drilled during our 2001 study. The locations of the twenty-four borings are shown in Fig. 1. Graphical logs of the conditions found in our recent exploratory borings, the results of field penetration resistance tests, and some laboratory data are presented in Appendix A. Swell-consolidation and gradation test results are presented in Appendix B. Laboratory test data are summarized in Table B-1. Graphical logs of the borings drilled during the 2001 study, the results of field penetration resistance tests, and some laboratory data are presented in Appendix C.

Soil and bedrock samples obtained during this study were returned to our laboratory and visually classified. Laboratory testing was then assigned to representative samples. Testing included moisture content and dry density, swell-consolidation, gradation analysis, and water-soluble sulfate content tests. The swell test samples were wetted under an applied pressure that approximated the overburden pressure (the weight of overlying soil and bedrock).

SUBSURFACE CONDITIONS

The near-surface soils encountered in the twenty-four exploratory borings drilled during this investigation and our 2001 study consisted of 4 feet to over 50 feet of natural, sand and gravel soils with occasional clay lenses. The near-surface soils were underlain by sandstone bedrock. Some of the pertinent engineering characteristics of the soils and bedrock encountered and groundwater conditions are discussed in the following paragraphs.

Natural Sands and Gravels

The predominant soils encountered at the ground surface in each of the borings consisted of clean to silty or clayey to very clayey sand with variable amounts of gravel. Layers of very sandy, slightly silty to silty gravel with cobbles were found to be interbedded with the predominant sands. The granular soil layer encountered in the borings extended to depths of 4 feet to over 50 feet below the existing ground surface. The sand was medium dense to very dense and the gravel was dense to very dense based on the results of field penetration resistance tests. Occasional layers of sandy to very sandy clay were found to be interbedded with the predominant sand. Samples of the sand and gravel tested in our laboratory contained 4 to 37 percent clay and silt-sized particles (passing the No. 200 sieve). The sampling device eliminated any particles greater than about 1-1/2 inches in diameter. Our experience indicates the sands are non-expansive or exhibit generally low measured swell values when wetted. Two samples of the very clayey sand that were subjected to swell-consolidation testing exhibited low measured swell values of 0.1 and 1.1 percent when wetted. Based on the particle size distributions, the silt and clay fines contents, and the natural dry densities of the samples, the compression behavior of the sand samples is believed to be the result of sample disturbance and is not representative of a material that is prone to collapse.

Bedrock

Silty sandstone bedrock was encountered in all but three of the borings, underlying the near-surface soils, at depths of 4 to 29 feet below the existing ground surface. The bedrock was hard to very hard based on the results of field penetration resistance tests and was poorly to well-cemented. Three samples of the sandstone subjected to swell-consolidation testing exhibited low measured swell values of 0 to 0.4 percent when wetted. Samples of the sandstone tested in our laboratory contained 22 to 49 percent clay and silt-sized particles (passing the No. 200 sieve).

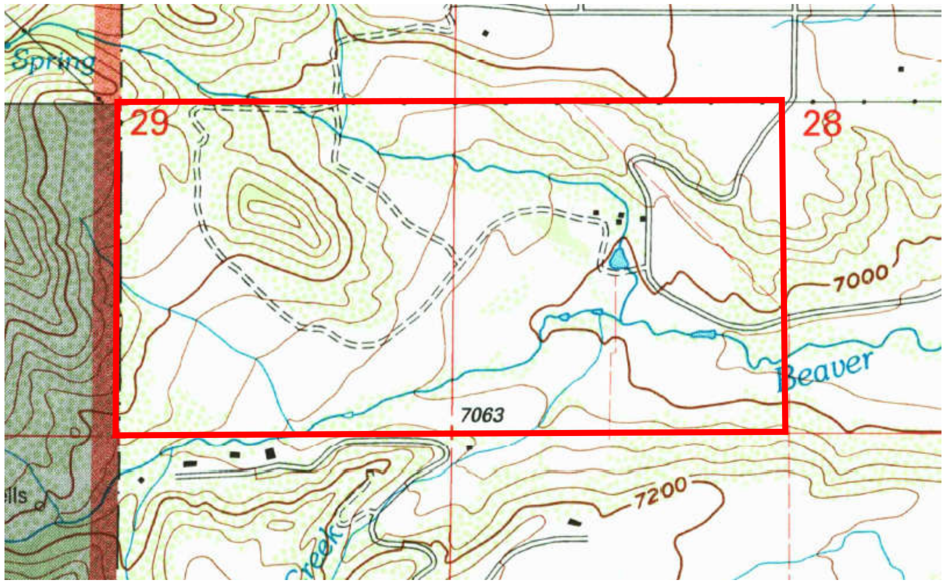
Groundwater

At the time of drilling, groundwater was encountered in eight of the exploratory borings at depths of 8 to 26 feet below the existing ground surface. When water levels were checked again following the completion of drilling operations, water was measured in eleven of the borings at depths of 6 to 26 feet. The shallowest groundwater was encountered along North Beaver Creek. Groundwater levels will vary with seasonal precipitation and landscaping irrigation.

SITE GEOLOGY

Geologic conditions for Forest Lakes (Phase 2) were evaluated through the review of published geologic maps, field reconnaissance, and exploratory borings. As discussed earlier, our Project No. CS-10,585 included Phase 2. Our report dated August 15, 2001 was reviewed and is updated for this current study. Information from these sources was used to produce our interpretation of site geology (Fig. 2). A list of references is included at the end of this report.

The planned, single-family residential development shown in Fig. 1 is situated generally on uplands west of the confluence of North Beaver Creek and Beaver Creek. Slopes within proposed development areas are typically gentle to moderate to the east. A local mesa dominates the west portion of the parcel and contains steeper slopes that will not be developed. The North Beaver Creek drainage gradient flattens along the north border of the parcel. Past floods have left abandoned channels and debris deposits. The main Beaver Creek channel along the south side is at a lower slope, is more defined, and shows less evidence for geologically recent overbank flows. The parcel has been used for agriculture in the past. An excerpt of the 1994 USGS topographic map of the Palmer Lake Quadrangle is reproduced below, with the project area outlined in red.

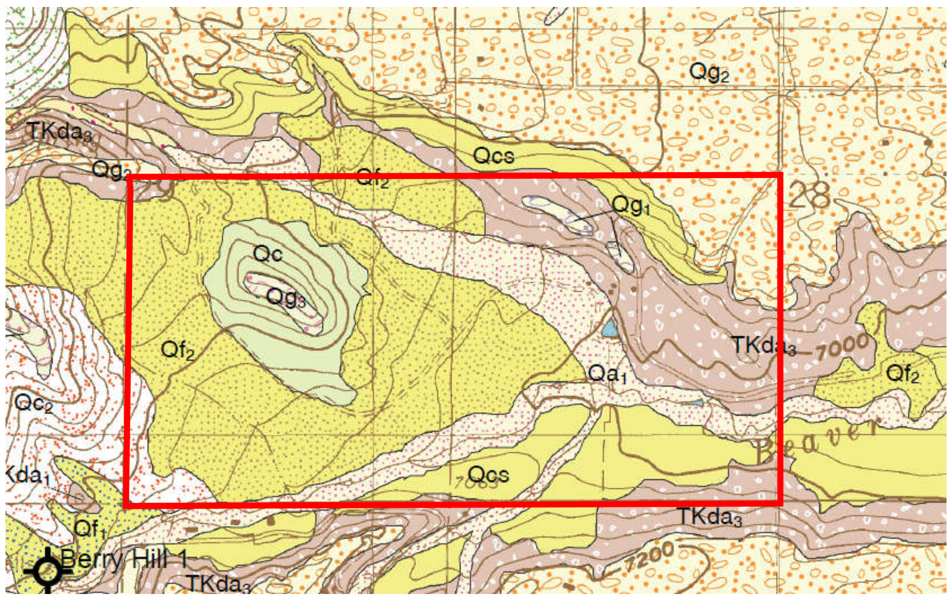


Excerpt from 1994 USGS Topographic Map of the Palmer Lake Quadrangle.

Excerpt from June 2017 Google Earth aerial photography showing the Phase 2 development area. Note man-made pits just west of the confluence of North Beaver and Beaver Creek.

The locality is at the foot of the Front Range of the Rocky Mountains, less than ½-mile east of the Rampart Range Fault, an inactive reverse fault that places Pre-Cambrian crystalline metamorphic and igneous rocks against much younger sedimentary rocks of the Late Cretaceous and Eocene Dawson Formation, which underlie the subject site. Geologic processes of the last several million years have carved drainages and divides, leaving alluvial fan and colluvial-slopewash deposits chiefly composed of sand and gravel. An excerpt from the 2007 "Geologic Map of the Palmer Lake Quadrangle" by Colorado Geological Survey is presented below.

Most of the site contains 4 to more than 50 feet of medium dense to very dense, reddish sand and gravel alluvial soil over hard to cemented sandstone bedrock. Hill slopes on the lone mesa and along the Beaver Creeks may expose slopewash colluvium over bedrock. Bedrock is from the Eocene-aged Facies Unit 3 of the Dawson Formation, dominated by poorly to well-cemented sandstone. Although our borings did not encounter any, claystone may be present. The poorly-cemented sandstone is easily erodible. The material readily weathers into residual soil. The following sections discuss the mapped units.



Excerpt from the 2007 "Geologic Map of the Palmer Lake Quadrangle" by Colorado Geological Survey. Site area shown outlined in red. Our field observations generally concur with CGS' mapping. Our borings show the Dawson Formation (Map Symbol $TKda_3$) is overlain by 4 to more than 50 feet of slopewash colluvium or stream alluvium.

Surficial Deposits

Our borings encountered 4 to more than 50 feet of silty and clayey sand and gravel soil. We believe that for the purposes of engineering geologic evaluation of this site, the surficial soils can be considered as being Alluvial Fan (Map Units Qaf_1, Qaf_2, and Qg_1, Qg_2 and Qg_3) or Slopewash Colluvium (Map Unit Qc). These soils are geologically-recent, Pleistocene and Holocene-age. The dominant stratum is reddish-brown, silty and clayey sand with gravel in the Qaf_2 alluvial fan deposit. This stable, middle fan is persistent in the region and has been eroded by North and South Beaver Creeks. Their younger active alluvial fans are mapped as Qaf_1. The areas mapped as Qaf_1 contain scattered cobble-boulder fields from debris flow events in the geologically recent past. Where North Beaver Creek passes along the north border and into the north portion of the property, the Qaf_1 area exhibits eroded, active and abandoned channels typical of geologically recent flows. Older, higher Quaternary gravel fans are off the parcel to the north and south. An isolated remnant covers the mesa on the west part of the parcel. Colluvium (Qc) forms on the hillsides and between terraces due to slopewash and gravity and is similar to the alluvial soils, but may contain clay from residual weathering of the underlying Dawson Formation.

Our previous report in 2001 described an ancient landslide east of the Rampart Fault that may have encroached on the west border of the site. Indeed, our borings TH-25 (from 2001) and TH-102 from the current study encountered about 20 or more feet more soil than nearby boreholes, but the soil was similar to that encountered in other parts of the Qaf_2 fan deposit, rather than material that might be expected with an ancient landslide in the Dawson Formation. The current CGS map shows the area as Qc_3, old colluvium with remnant or lag boulder deposits. The off-site slopes appear stable and are probably underlain at relatively shallow depth by the Dawson Formation, weakly-cemented sandstone.

Bedrock

Below soil, we encountered firm to very hard, poorly to well-cemented sandstone bedrock from the Eocene-age Facies Unit 3 of the Dawson Formation (Map Symbol $TKda_3$). Exposures were not visible, but available literature suggests the Dawson Formation exhibits a gentle dip toward the east.

GEOLOGIC HAZARDS AND ENGINEERING CONSTRAINTS

Colorado Geological Survey prepared their review comments for the Forest Lakes Phase II PUD Amendment and Preliminary Plan in a letter dated February 6, 2018. They asked for an update of our 2001 investigation and to address debris flow and debris flood, shallow groundwater, collapsible soils, potentially unstable slopes, and erosion hazards to the Phase II lots. These are discussed in this section.

We did not identify geologic hazards that we believe will preclude development of the project as planned. The conditions we identified include shallow groundwater and potential for erosion, flood and debris flow. Slopes within and near development areas appear to be stable and the development of homes should not negatively impact slope stability. Collapsible soils were not identified in this study and given the particle size distribution and fines content of samples, would not be expected. Regional geologic conditions that impact the site include seismicity and radioactivity. These issues do not pose hazards or constraints to development if avoided or mitigated using normally employed methods. We believe each of 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.

Engineering Geologic Mapping

The engineering geology classification from Robinson (1977) was considered and areas were mapped as described below and shown in Fig. 3. The other issues are site-wide concerns and are not depicted in Fig. 3.

Map Unit "2A" depicts stable alluvium, colluvium and bedrock on gentle to moderate slopes of 5 to 12 percent. Most of the lots surrounding the lone mesa lie in areas within this classification. These areas are low risk for problems due to geologic hazards.

Map Unit "3B" depicts expansive and potentially expansive soil and bedrock on flat to moderate slopes of 0 to 12 percent. Some lots along the north border of the property and in the eastern portion of the site lie within this classification. Our borings revealed expansive soil and bedrock risk is nil or low over the site. These areas are low risk for problems due to geologic hazards.

Map Unit "4A" depicts potentially unstable colluvium and bedrock on moderate to steep slopes of 12 to 24 percent. These areas are on the lone mesa and other site locations and are avoided for the current development plan. The mesa hillslope did not exhibit signs of instability.

Map Unit "7A" depicts physiographic flood plain where erosion and deposition presently occur and is generally subject to recurrent flooding. Site evidence suggests debris flow risk along the northeast side of the lone mesa. Some planned lots lie within the area we believe may be in active flood plains. Mitigation can consist of avoidance or channel improvements to convey the design flow.

Expansive Soil and Bedrock

Site soils are predominantly silty and clayey sand with gravel with less than 30 percent fines. Swell potential in a few cohesive samples was about 1 percent or less, which is considered low. Weakly to well-cemented sandstone bedrock was found in our borings. Site soils and bedrock are expected to be predominantly non-expansive. Some of the soil and bedrock may be expansive when wetted. Issues associated with the expansive soil and bedrock can be mitigated through engineered foundations and floor systems, possibly in conjunction with ground modification such as sub-excavation and reworking the soil as low-swelling, moisture-conditioned fill. Current data implies most sites will be able to successfully use shallow foundations and slab-on-grade basement floors without soil improvement.

Flood, Debris Flow and Erosion

Site evidence for flooding and debris flow has been observed by our personnel and others, particularly along North Beaver Creek adjacent to the lone mesa. Concurrent to this Geologic Hazards Evaluation and Preliminary Geotechnical Investigation, CTL|Thompson, Inc. performed analyses of the potential for flooding, debris flow, and mudflow along the drainageways of North Beaver Creek, South Beaver Creek, Hell Creek, and Beaver Creek. A discussion of our observations and methodology, as well as our opinions and recommendations, are presented in a separate report.

The subject parcel contains drainages that are subject to flooding and that exhibit moderate to steep slopes. Site soils are sandy and susceptible to the effects of erosion. Maintaining vegetative cover and providing engineered surface drainage will reduce the potential for erosion. The project Civil Engineer should design the site to arrest downcutting and prevent flood damage to improvements.

Shallow Groundwater

We noted groundwater was shallow (depths of 6 to 7.5 feet) in four of our borings (TH-105, 107, 108 and 109) located along the north fork of Beaver Creek. Other areas of the site have groundwater depths exceeding about 15 feet. Mitigation for groundwater usually consists of raising grades or keeping basements at least 3 and preferably 5 feet above the water. To the extent channel improvements in Beaver Creek lower the elevation, it is possible the groundwater level will drop as well.

Collapsible Soils

Our 2001 report had a few loose sand samples at a 4-foot depth and described compression of up to 7 percent under conditions of loading and wetting. Our current study found no loose sand samples and of the few samples that were fine enough to test, very little compression was noted. We tested three samples to evaluate their Atterberg Limits and found two to be non-plastic and one had a Plasticity Index of 11 with 37 percent silt and clay fines. The site soils are not expected to be collapsible because of their particle size gradation (they have significant gravel and low fines content) and high in-place density. We believe the compression potential measured in a few samples in 2001 is due to the extreme difficulty in preparing granular specimens for testing that represent the actual soil matrix condition.

Unstable Slopes

Other than a few steeply-eroded stream banks outside planned development areas, there appear to be no unstable, steep slopes that affect development.

Economic Minerals and Underground Mines

While the site does contain sand and gravel deposits, we doubt permitting for mining of the material is feasible, considering the surrounding land uses. Energy fuels such as uranium, oil and gas may or not be present. Two oil and gas prospect wells are mapped by CGS less than ½-mile southwest of the site. We do not know the status of these wells. No record of underground mining was encountered.

Seismicity

This area, like most of central Colorado, is subject to a degree of seismic activity. Geologic evidence indicates that movement along some Front Range faults has occurred during the last two million years (Quaternary). This includes the Rampart Range Fault, which is located less than a half mile west of the site. We believe the soils on the property classify as Site Class D (stiff soil profile) according to the 2015 International Building Code (2015 IBC).

Radon and Radioactivity

We believe no unusual hazard exists from naturally occurring sources of radioactivity on this site. However, the materials found in our borings can be associated with the production of radon gas and concentrations in excess of EPA guidelines can occur. Radon tends to collect in below-grade, residential areas due to limited outside air exchange and interior ventilation. 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 (if present) and sealing the joints and cracks in concrete floors and foundation walls. If the occurrence of radon is a concern, we recommend the structures be tested after they are enclosed, and mitigation systems installed to reduce the risk.

Low-level gamma radiation levels were measured in the cuttings from our exploratory borings using a LUDLUM Micro R Meter (Model 19). The meter provides readings of low-level gamma radiation in terms of micro R/Hr (micro Roentgens per hour). Background readings ranged between 18 and 21 micro R/Hr. Readings on the drill cuttings ranged between 18 and 21 micro R/Hr. The “background” level of low-level gamma radiation in this area generally ranges from 15 to 20 micro R/Hr with the level of concern being established at about twice background. This would imply remediation should be performed for materials which exceed about 30 to 40 micro R/Hr at this site. Our readings were lower than the action level.

SITE DEVELOPMENT CONSIDERATIONS

From an engineering point-of-view, the more significant conditions impacting construction are the occurrence of shallow groundwater and potential for erosion, flooding and debris flow. The following sections discuss the impact of these conditions on development and possible methods of mitigation.

Site Grading

No grading plans were available for our review at the time of this study. We anticipate comparatively shallow cuts and fills (less than 10 feet) will be necessary to achieve the desired building pad elevations for most of the area that will be developed. The presence of shallow, hard to very hard, sandstone bedrock in the southwestern portion of the site may influence basement excavation and construction of utility lines. The sandstone is this area appears to be generally poorly cemented. We believe site grading can likely be accomplished using conventional, heavy-duty earthmoving equipment. We recommend grading plans consider long-term cut and fill slopes no steeper than 3:1 (horizontal to vertical). This ratio considers that no seepage of groundwater occurs. If groundwater seepage does occur, a drain system and flatter slopes may be appropriate.

Comparatively shallow groundwater (less than 10 feet below the existing ground surface) was encountered along North Beaver Creek. We recommend site grading cuts be limited in this area and that final grades be raised as much as possible to reduce the impact of the groundwater on basement construction and utility installation.

On-site evidence of flooding and debris flow has been observed, particularly along the north fork of Beaver Creek adjacent to the mesa. A combination of channel improvements and energy dissipation structures with debris storage capacity may be needed to allow development of the planned homes along Beaver Creek. These topics are discussed in more detail in our debris flow/mudflow analysis report. The project Civil Engineer will need to consider these issues when preparing development design plans.

Vegetation and organic materials should be removed from the ground surface in areas to be filled. Soft or loose soils, if encountered, should be stabilized or removed to stable material prior to placement of fill. Organic soils should be wasted in landscaping areas. If insufficient landscaping areas are planned, topsoil can be mixed with clean fill soils at a ratio of 15:1 (fill:topsoil) and placed as fill deeper than 8 feet below final grade.

Where the natural slopes are steeper than 20 percent (5:1, horizontal to vertical) and fill is to be placed, horizontal benches must be cut into the hillside prior to fill placement. The benches must be at least 12 feet wide or 1-1/2 times the width of the compaction equipment and be provided at a vertical spacing of not more than 5 feet (minimum of two benches). Larger bench widths may be required.

The ground surface in areas to receive fill should be scarified, moisture conditioned and compacted. The properties of the fill will affect the performance of foundations, slabs-on-grade, and pavements. We recommend grading fill composed of the on-site sands and sandstone be placed in thin, loose lifts, moisture conditioned to within 2 percent of optimum moisture content, and compacted to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557). Natural clay and claystone incorporated in grading fills should be placed at high moisture content to help mitigate potential swell. Clay and claystone fill should be moisture conditioned to between 1 and 4 percent above optimum moisture content and compacted in thin, loose lifts to at least 95 percent of maximum standard Proctor dry density (ASTM D 698). Placement and compaction of the grading fill should be observed and tested by our representative during construction. Guideline specifications for site grading are presented in Appendix C.

Buried Utilities

Over most of the site, we believe utility trench excavation can be accomplished using heavy-duty track hoes. The bedrock encountered in our borings was medium hard to very hard, but predominantly poorly cemented. The bedrock formation could include some layers of somewhat more cemented materials. Rock buckets and rock teeth may be needed where utility excavations extend well into the bedrock formation and the bedrock is cemented. Utility contractors should be made aware of this possibility and anticipate slower rates of pipeline installation in the very hard bedrock.

Excavations for utilities should be braced or sloped to maintain stability and should meet applicable local, state, and federal safety regulations. The contractor should identify the soils encountered in trench excavations and refer to Occupational Safety and Health Administration (OSHA) standards to determine appropriate slopes. We anticipate the near-surface sand soils and grading fill, and bedrock will classify as Type C and Type B materials, respectively. Temporary excavations in Type C and Type B materials require a maximum slope inclination of 1.5:1 and 1:1 (horizontal to vertical), respectively, unless the excavation is shored or braced. Where groundwater seepage occurs, flatter slopes will likely be required. Excavations deeper than 20 feet should be designed by a professional engineer.

Water and sewer lines are usually constructed beneath paved roads. Compaction of trench backfill will have a significant effect on the life and serviceability of pavements. We recommend trench backfill be moisture conditioned and compacted in accordance with El Paso County specifications. Personnel from our firm should observe and test the placement and compaction of the trench backfill during construction.

Underdrain Systems

Underdrains incorporated into the design of sanitary sewer systems can provide a positive gravity outlet for individual, below-grade foundation drains, if desired. Where no groundwater is encountered in sanitary sewer excavations, “passive” underdrains may be used. The drain pipe should consist of smooth wall, rigid PVC pipe placed at a minimum slope of 0.5 percent. An “active” section of smooth, perforated or slotted, rigid PVC pipe should be placed for a minimum distance of one pipe length downstream of manholes. The perforated pipe should be encased in at least 6 inches of free-draining gravel, separated from the surrounding trench backfill by geotextile fabric. Seepage collars should be constructed at the manhole locations to force water flowing through pipe bedding into the underdrain. The seepage collars can be constructed of concrete or clay.

If high moisture conditions or groundwater is encountered in the sanitary sewer trench, we recommend an active underdrain system with perforated or slotted pipe for these areas. Active underdrains could help to lower the shallow groundwater elevation found in portions of the development. A cutoff collar should be constructed around the sewer pipe and underdrain pipe immediately downstream of the point where the underdrain pipe exits the sewer trench or changes from active to passive. Solid pipe should be used down-gradient of this cutoff collar to the point of discharge. The underdrain should be maintained at least 3 to 5 feet below the lowest nearby foundation elevation. Conceptual drain details are presented in Figs. 4 and 5.

As-built plans for the underdrain system should be prepared including location, elevations, and cleanouts. The entity responsible for maintenance of the underdrain system should retain the as-built plans for future reference.

FOUNDATION AND FLOOR SYSTEM CONCEPTS

We anticipate spread footing foundations and slab-on-grade floors will be appropriate for the dwellings constructed at this site. Some of the soil and bedrock may be somewhat expansive when wetted. If expansive soil and/or bedrock occurs, sub-excavation of a zone of the expansive material from beneath spread footing foundations and reworking the soil as low-swelling, moisture-conditioned fill may be appropriate. This approach should allow for the installation of spread footing foundations, possibly designed utilizing a minimum deadload, and slab-on-grade basement floors. The results of our widely-spaced borings and laboratory testing suggest most of the residences within Phase 2 will be able to be constructed using shallow foundations and slab-on-grade basement floors without soil improvement being necessary. Soils and foundation investigation reports prepared after completion of site grading should address appropriate foundation systems and floor system alternatives on a lot-by-lot basis.

PAVEMENTS

Natural sands, sandstone, and granular grading fill are expected to be the predominant pavement subgrade materials. These materials exhibit generally good subgrade support for pavements. Sandy clay and/or claystone bedrock may be encountered at pavement subgrade elevations in some areas. From a pavement standpoint, the clay and claystone provide poor subgrade support characteristics, compared to the granular, natural soils, sandstone, and grading fill. Pavements supported by expansive clay materials will likely require thicker sections. The clayey subgrade soils could be removed to a depth of approximately 2 feet beneath pavements and replaced with granular soils. For the granular materials, we anticipate composite asphalt concrete and aggregate base course pavement sections on the order of 4 inches of asphalt over 6 to 7 inches of base course may be needed for the local streets. This pavement thickness may not be sufficient for construction traffic and some maintenance and repair work may be needed prior to completion of the project. A subgrade investigation and pavement design should be performed after site grading and utility installation are complete.

CONCRETE

Concrete in contact with soils can be subject to sulfate attack. We measured the water-soluble sulfate concentration in three samples from the site at less than 0.1 percent. Sulfate concentrations of less than 0.1 percent indicate Class 0 exposure to sulfate attack for concrete in contact with the subsoils, according to ACI 201.2R-01, as published in the 2008 American Concrete Institute (ACI) Manual of Concrete Practice. For this level of sulfate concentration, the ACI indicates Type I cement can be used for concrete in contact with the subsoils. 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 material 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 subjected to freeze-thaw cycles should be air entrained.

SURFACE DRAINAGE AND IRRIGATION

The performance of structures, flatwork, and roads within the subdivision will be influenced by surface drainage. When developing an overall drainage scheme, consideration should be given to drainage around each structure and pavement area. Drainage should be planned such that surface runoff is directed away from foundations and is not allowed to pond adjacent to or between residences or over pavements. Ideally, slopes of at least 6 inches in the first 10 feet should be planned for the areas surrounding the houses, where possible. Roof downspouts and other water collection systems should discharge well beyond the limits of all backfill around the structures. Proper control of surface runoff is also important to prevent the erosion of surface soils. Concentrated flows should not be directed over unprotected slopes. Permanent overlot slopes should be seeded or mulched to reduce the potential for erosion. Backfill soils behind the curb and gutter adjacent to streets and in utility trenches within individual lots should be compacted. If surface drainage between preliminary development and construction phases is neglected, performance of the roadways, flatwork, and foundations may be compromised.

RECOMMENDED FUTURE INVESTIGATIONS

Based on the results of this study, we recommend the following investigations and services be provided by our firm:

1. Construction materials testing and observation services during site development and construction.
2. Individual lot Soils and Foundation Investigations for foundation design.
3. Subgrade Investigation and Pavement Design for on-site pavements.

LIMITATIONS

The recommendations and conclusions presented in this report were prepared based on conditions disclosed by our exploratory borings, geologic reconnaissance, engineering analyses, and our experience. Variations in the subsurface conditions not indicated by the borings are possible and should be expected.

We believe this report was prepared with that level of skill and care ordinarily used by geologists and geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.

Should you have any questions regarding the contents of this report or the project from a geotechnical engineering point-of-view, please call.

CTL | THOMPSON, INC.

Richard A. Phillips, P.E.
Senior Principal Engineer

David A. Glater, P.E., C.P.G.
Principal Geological Engineer

Reviewed by:

William C. Hoffmann, Jr., P.E.
Senior Principal Engineer

RAP:DAG:WCH:cw

(3 copies sent)

Via email: jboulton@classichomes.com
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REFERENCES

1. Colorado Geological Survey, Results of the 1987-88 EPA Supported Radon Study in Colorado, with a Discussion on Geology, Colorado Geological Survey Open File Report 91-4 (1991).

2. Federal Emergency Management Agency, Flood Insurance Rate Maps, Map Number 08041C0260F, Panel 260 of 1300, effective date March 17, 1997 and Map Number 08041C0270F, Panel 270 of 1300, effective date March 17, 1997.

3. International Building Code (2015 IBC).

4. Kirkham, R.M. & Rogers, W.P. (1981). Earthquake Potential in Colorado. Colorado Geological Survey, Bulletin 43.

5. Robinson and Associates, Inc. (1977). El Paso County, Colorado - Potential Geologic Hazards and Surficial Deposits, Environmental and Engineering Geologic Maps and Tables for Land Use, Maps 1A and 1B.

6. State of Colorado, Division of Mined Land Reclamation (April 1985). Prepared by Dames and Moore. Colorado Springs Subsidence Investigation.

7. Keller, John W., Morgan, Matthew L., Thorson, Jon P., Lindsay, Neil R., and Barkmann, Peter E. Geologic Map of the Palmer Lake Quadrangle, El Paso County, Colorado, Colorado Geological Survey (2007).

8. Topographic Map of the Palmer Lake Quadrangle, El Paso County, Colorado, United States Geological Survey (1994).

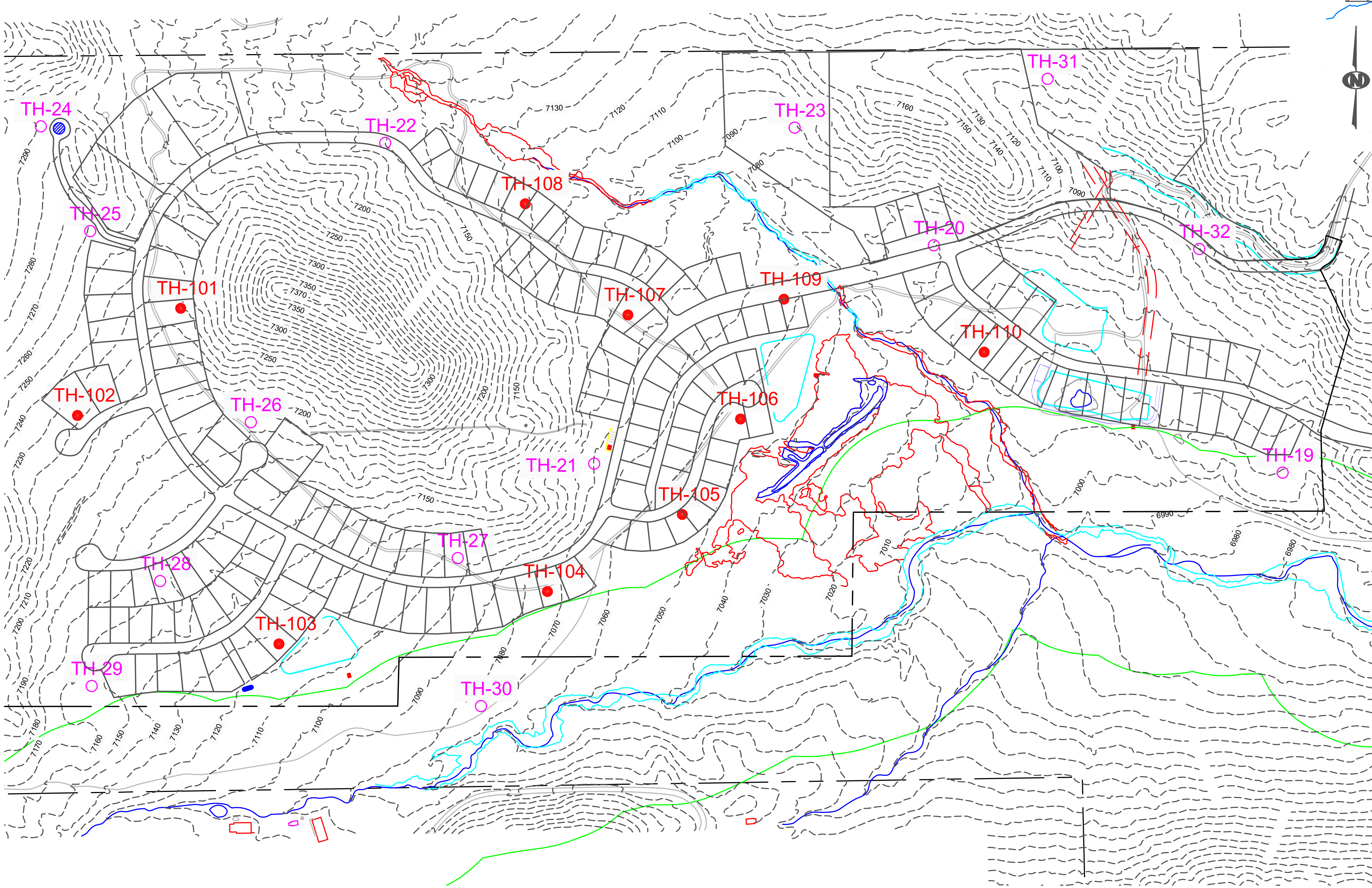
LEGEND:

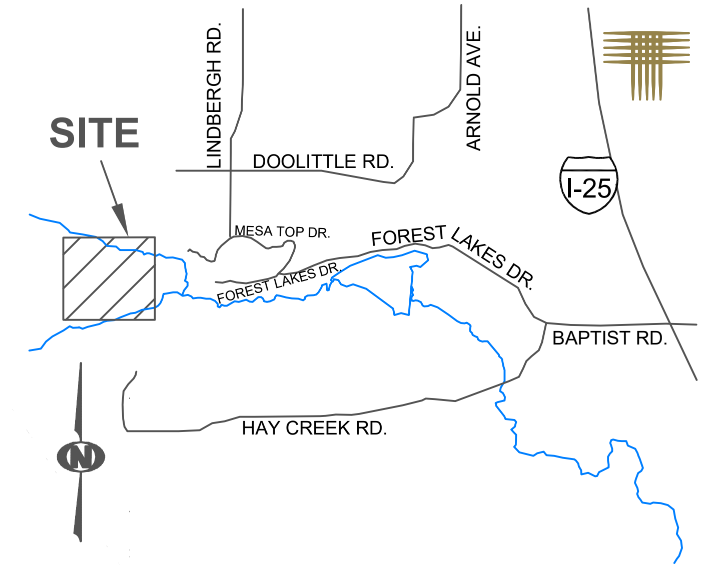
TH-101 ● APPROXIMATE LOCATION OF EXPLORATORY BORING DRILLED DURING THIS STUDY.

TH-19 ○ APPROXIMATE LOCATION OF EXPLORATORY BORING FROM CTL|THOMPSON JOB NO. CS-10,585.

- - - - PROJECT BOUNDARY

~ ~ EXISTING TOPOGRAPHY





VICINITY MAP

(NOT TO SCALE)

NOTE:
BASE DRAWING DATED NOVEMBER 30, 2018 WAS PROVIDED BY NES, INC.

0 200' 400'
SCALE: 1" = 400'

CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Location of Exploratory Borings

FIG. 1

LEGEND:

TH-101 ● APPROXIMATE LOCATION OF EXPLORATORY BORING DRILLED DURING THIS STUDY.

TH-19 ○ APPROXIMATE LOCATION OF EXPLORATORY BORING FROM CTL|THOMPSON JOB NO. CS-10,585.

PROJECT BOUNDARY

EXISTING TOPOGRAPHY

GEOLOGIC UNITS AND (MODIFIERS)

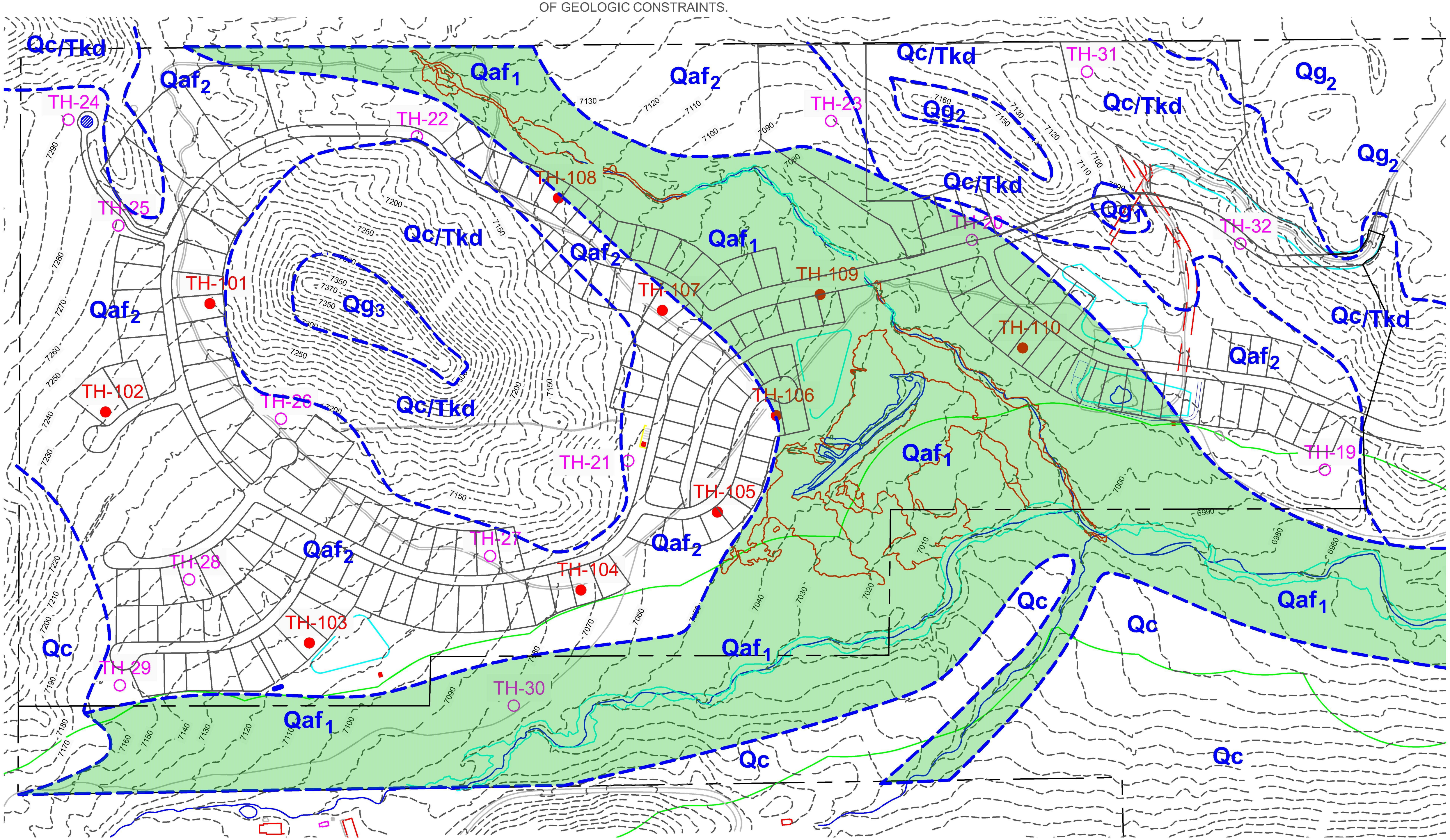
SURFICIAL GEOLOGIC CONTACTS. CONTACTS BETWEEN UNITS ARE SHOWN APPROXIMATELY. MAPPING MODIFIED SLIGHTLY FROM COLORADO GEOLOGICAL SURVEY, GEOLOGY OF THE PALMER LAKE QUADRANGLE, (2007) AND CTL|THOMPSON (2001).

Qaf_1, Qaf_2 YOUNGER ALLUVIAL FAN (Qaf_1) CONSISTS OF BROWN AND REDDISH BROWN SAND AND GRAVEL WITH COBBLES AND OCCASIONAL BOULDERS AND ROUGHLY DEFINES FLOOD PLAINS. OLDER ALLUVIAL FAN (Qaf_2) CONSISTS OF REDDISH BROWN, GRAVELLY AND SOMETIMES COBBLY, SAND IN AREAS GENERALLY CONSIDERED RELATIVELY FREE OF GEOLOGIC CONSTRAINTS.

Qc SLOPEWASH COLLUVIUM, CLAYEY SAND WITH SOME GRAVEL DEPOSITED BY GRAVITY. UNSTABLE SLOPES AND EXPANSIVE SOILS ARE POTENTIALLY PRESENT.

Qg_1, Qg_2, Qg_3 YOUNG (Qg_1) TO RELATIVELY OLDER AND HIGHER (Qg_3) ALLUVIAL TERRACE REMNANTS LEFT BY EROSION OF PRESENT STREAMS. THESE CONSIST OF SAND AND GRAVEL DEPOSITS WITH SCATTERED TO FREQUENT COBBLES AND BOULDERS. THESE AREAS ARE CONSIDERED TO BE RELATIVELY STABLE.

Tkd FACIES UNIT 3 OF THE DAWSON FORMATION OF EOCENE AGE IS PRESENT AT MODERATE TO SHALLOW DEPTH ON THE PARCEL. MOST BORINGS PENETRATED WEAKLY TO WELL-CEMENTED ARKOSIC SANDSTONE. SOME EXPANSIVE CLAYSTONE MAY BE PRESENT.



NOTES:

1. BASE DRAWING DATED NOVEMBER 30, 2018 WAS PROVIDED BY NES, INC.
2. ALL BOUNDARIES SHOWN SHOULD BE CONSIDERED APPROXIMATE. THEY ARE BASED UPON A SUBJECTIVE INTERPRETATION OF PUBLISHED MAPS, AERIAL PHOTOGRAPHS AND AN INITIAL FIELD RECONNAISSANCE. CHANGES IN THE MAPPED BOUNDARIES SHOWN ARE POSSIBLE AND SHOULD BE EXPECTED WITH MORE DETAILED WORK AND FURTHER INFORMATION. ALL INTERPRETATIONS AND CONDITIONS SHOWN ARE PRELIMINARY AND FOR LAND-USE PLANNING ONLY.

N

0 200' 400'

SCALE: 1" = 400'

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FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Site Geology

FIG. 2

LEGEND:

TH-101 ● APPROXIMATE LOCATION OF EXPLORATORY BORING DRILLED DURING THIS STUDY.

TH-19 ○ APPROXIMATE LOCATION OF EXPLORATORY BORING FROM CTL|THOMPSON JOB NO. CS-10,585.

PROJECT BOUNDARY

EXISTING TOPOGRAPHY

ENGINEERING UNITS AND (MODIFIERS)

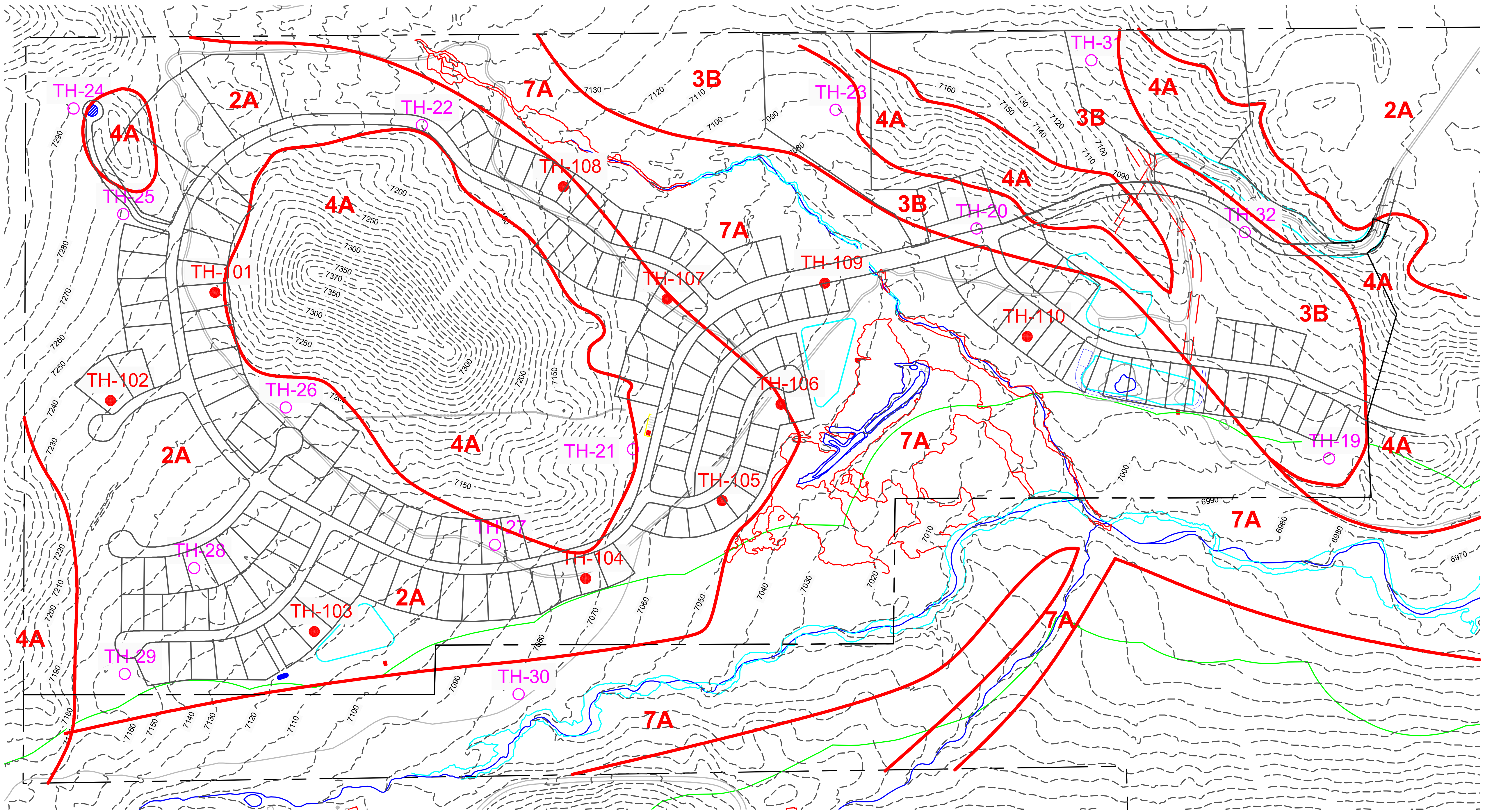
ENGINEERING CONTACTS

2A STABLE ALLUVIUM, COLLUVIUM, AND BEDROCK ON GENTLE TO MODERATE SLOPES OF 5 TO 12 PERCENT. MOST OF THE LOTS SURROUNDING THE LONE MESA LIE WITHIN THIS CLASSIFICATION. THESE AREAS ARE LOW RISK FOR PROBLEMS DUE TO GEOLOGIC HAZARDS.

3B EXPANSIVE AND POTENTIALLY EXPANSIVE SOIL AND BEDROCK ON FLAT TO MODERATE SLOPES OF 0 TO 12 PERCENT. SOME LOTS IN THE NORTH AND EAST PORTIONS OF THE DEVELOPMENT LIE IN AREAS WITHIN THIS CLASSIFICATION. OUR BORINGS REVEALED EXPANSIVE SOIL AND BEDROCK RISK IS NIL OR LOW OVER THIS SITE. THESE AREAS ARE LOW RISK FOR PROBLEMS DUE TO GEOLOGIC HAZARDS.

4A POTENTIALLY UNSTABLE COLLUVIUM AND BEDROCK ON MODERATE TO STEEP SLOPES OF 12 TO 24 PERCENT. THESE AREAS ARE ON THE LONE MESA AND ARE AVOIDED FOR THE CURRENT DEVELOPMENT PLAN. THE MESA HILLSLOPE DID NOT EXHIBIT SIGNS OF INSTABILITY.

7A PHYSIOGRAPHIC FLOOD PLAIN WHERE EROSION AND DEPOSITION PRESENTLY OCCUR AND IS GENERALLY SUBJECT TO RECURRENT FLOODING. SITE EVIDENCE SUGGESTS THERE IS DEBRIS FLOW RISK ALONG THE NORTHEAST SIDE OF THE LONE MESA. SOME PLANNED LOTS LIE WITHIN THE AREA WE BELIEVE MAY BE IN ACTIVE FLOOD PLAINS. MITIGATION CAN CONSIST OF AVOIDANCE OR CHANNEL IMPROVEMENTS TO CONVEY THE DESIGN FLOW.



NOTES:

1. BASE DRAWING DATED NOVEMBER 30, 2018 WAS PROVIDED BY NES, INC.
2. ALL BOUNDARIES SHOWN SHOULD BE CONSIDERED APPROXIMATE. THEY ARE BASED UPON A SUBJECTIVE INTERPRETATION OF PUBLISHED MAPS, AERIAL PHOTOGRAPHS AND AN INITIAL FIELD RECONNAISSANCE. CHANGES IN THE MAPPED BOUNDARIES SHOWN ARE POSSIBLE AND SHOULD BE EXPECTED WITH MORE DETAILED WORK AND FURTHER INFORMATION. ALL INTERPRETATIONS AND CONDITIONS SHOWN ARE PRELIMINARY AND FOR INITIAL LAND-USE PLANNING ONLY.
3. MAP LEGEND IS MODIFIED FROM CHARLES S. ROBINSON & ASSOCIATES, INC., GOLDEN, COLORADO, DATED 1977.

CLASSIC HOMES
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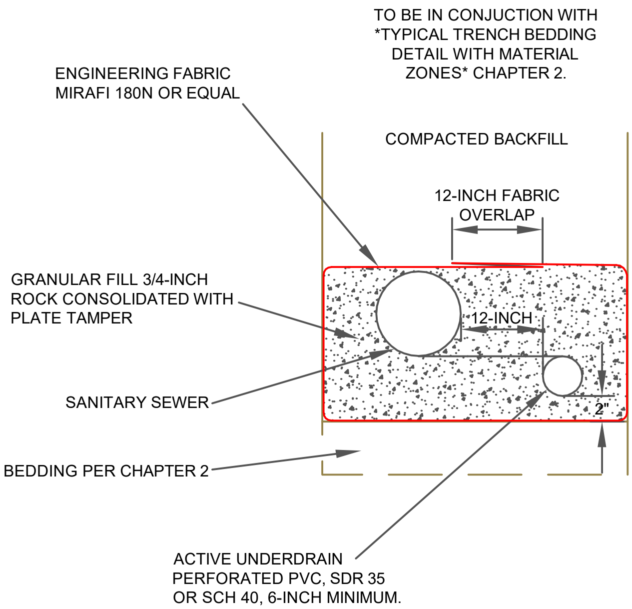
CTL|T PROJECT NO. CS18916-105

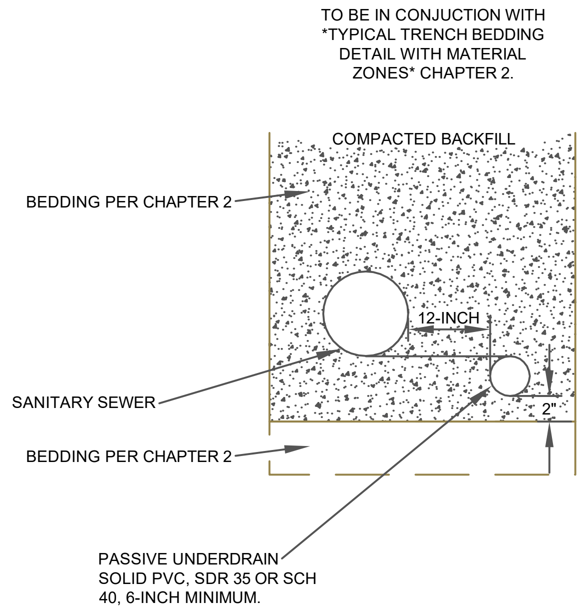
Engineering Geologic Considerations

FIG. 3

NOTE:

- POINT OF DISCHARGE TO PUBLIC SYSTEM REQUIRED.
- UNDERDRAIN SERVICE LINE CONNECTIONS SHALL BE 3" SCH 40.





(ACTIVE RELIEF SECTION 10 FEET DOWNSTREAM OF EACH MANHOLE)

ACTIVE UNDERDRAIN PIPE

PASSIVE UNDERDRAIN PIPE

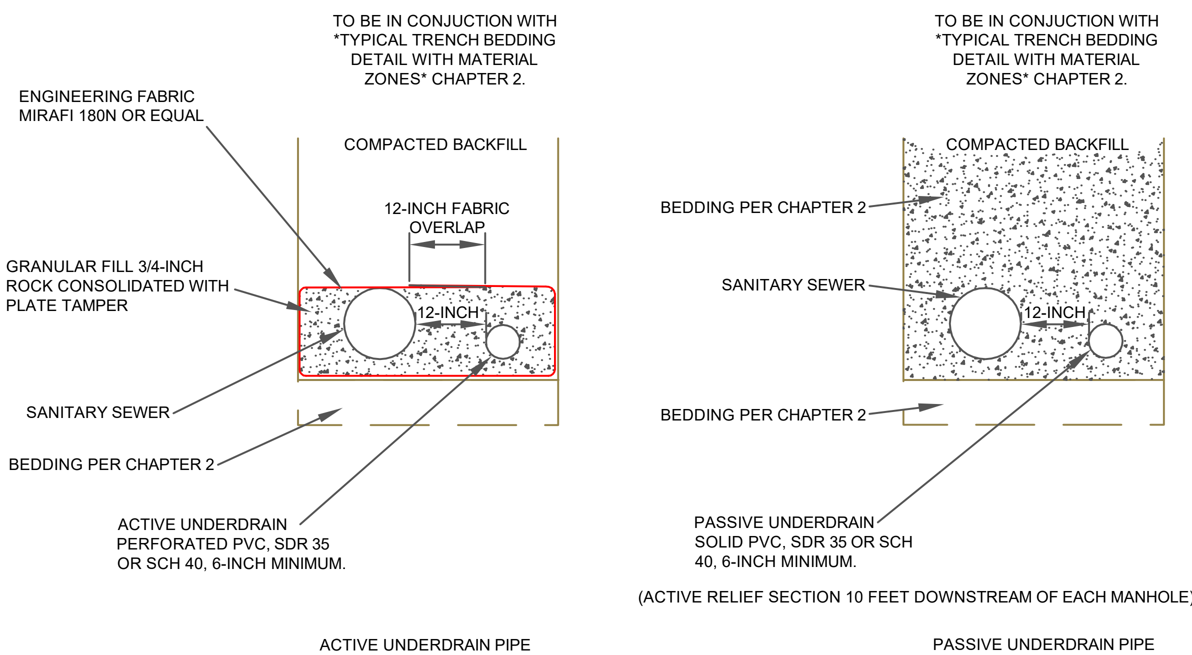
GENERAL NOTES:

1. MINIMUM UNDERDRAIN SIZE OF MAINLINE PIPE TO BE SIX (6") INCHES.
2. TO BE READ IN CONJUNCTION WITH COLORADO SPRINGS UTILITIES WASTEWATER CHAPTER 13 - UNDERDRAINS.
3. BEDDING MATERIAL SPECIFICATIONS CLASS I, II OR III FOR PIPE SLOPE GREATER THAN 1.04 PERCENT FOR SLOPE OF 1.04 PERCENT OR FLATTER.

SIEVE SIZE	PERCENT PASSING
1 1/2"	100
3/4"	0 TO 100
#40	0 TO 100
#50	0 TO 80
#100	0 TO 40
#200	0 TO 26

Alternate 1
Underdrain
Trench Details

NOTE:
- POINT OF DISCHARGE TO PUBLIC SYSTEM REQUIRED.
- UNDERDRAIN SERVICE LINE CONNECTIONS SHALL BE 3" SCH 40.



ACTIVE UNDERDRAIN PIPE

PASSIVE UNDERDRAIN PIPE

GENERAL NOTES:
1. MINIMUM UNDERDRAIN SIZE OF MAINLINE PIPE TO BE SIX (6") INCHES.
2. TO BE READ IN CONJUNCTION WITH COLORADO SPRINGS UTILITIES WASTEWATER CHAPTER 13 - UNDERDRAINS.
3. BEDDING MATERIAL SPECIFICATIONS CLASS I, II OR III FOR PIPE SLOPE GREATER THAN 1.04 PERCENT FOR SLOPE OF 1.04 PERCENT OR FLATTER.

SIEVE SIZE	PERCENT PASSING
1 1/2"	100
3/4"	0 TO 100
#40	0 TO 100
#50	0 TO 80
#100	0 TO 40
#200	0 TO 26

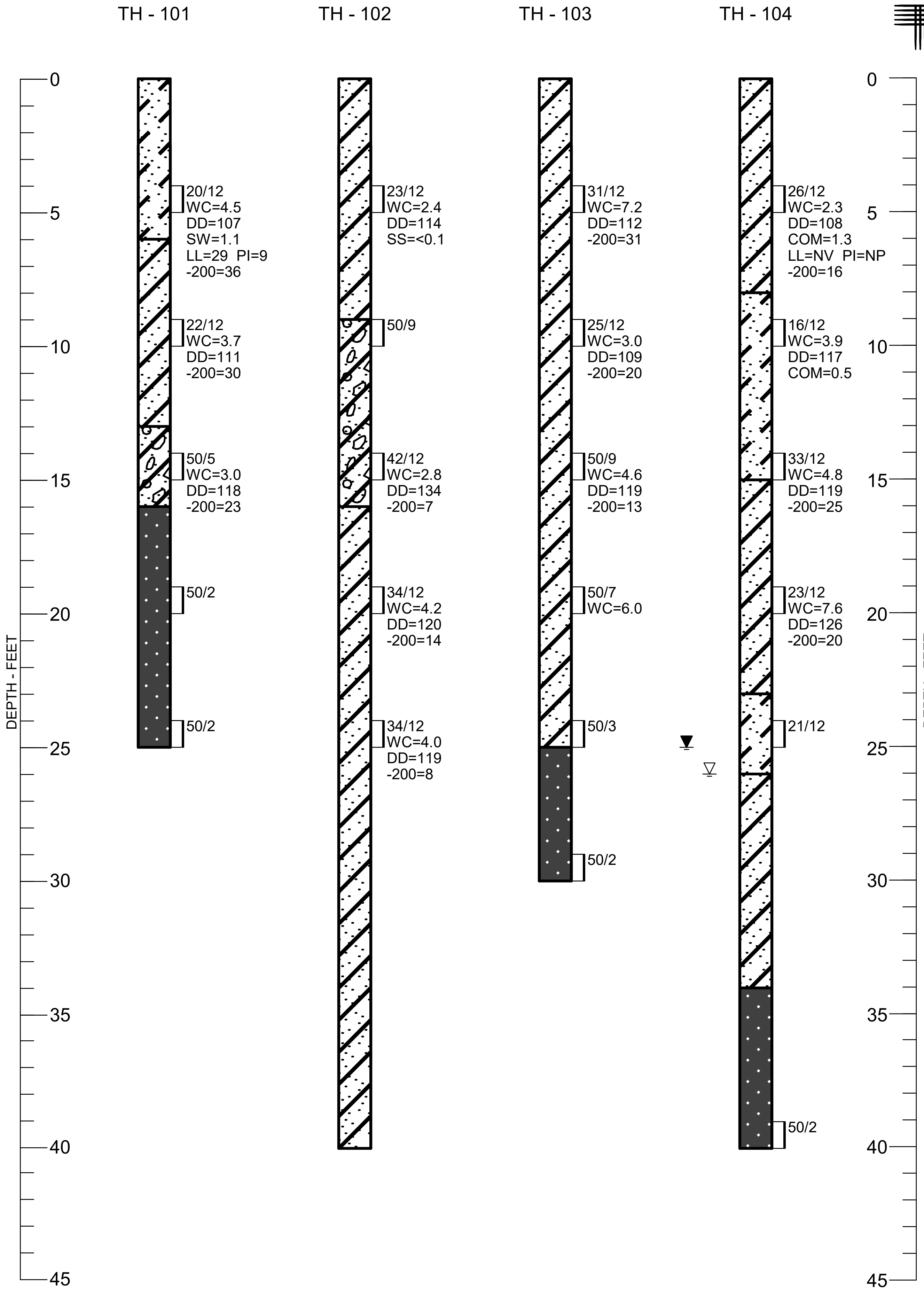
CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Alternative 2 Underdrain Trench Details

FIG. 5

APPENDIX A

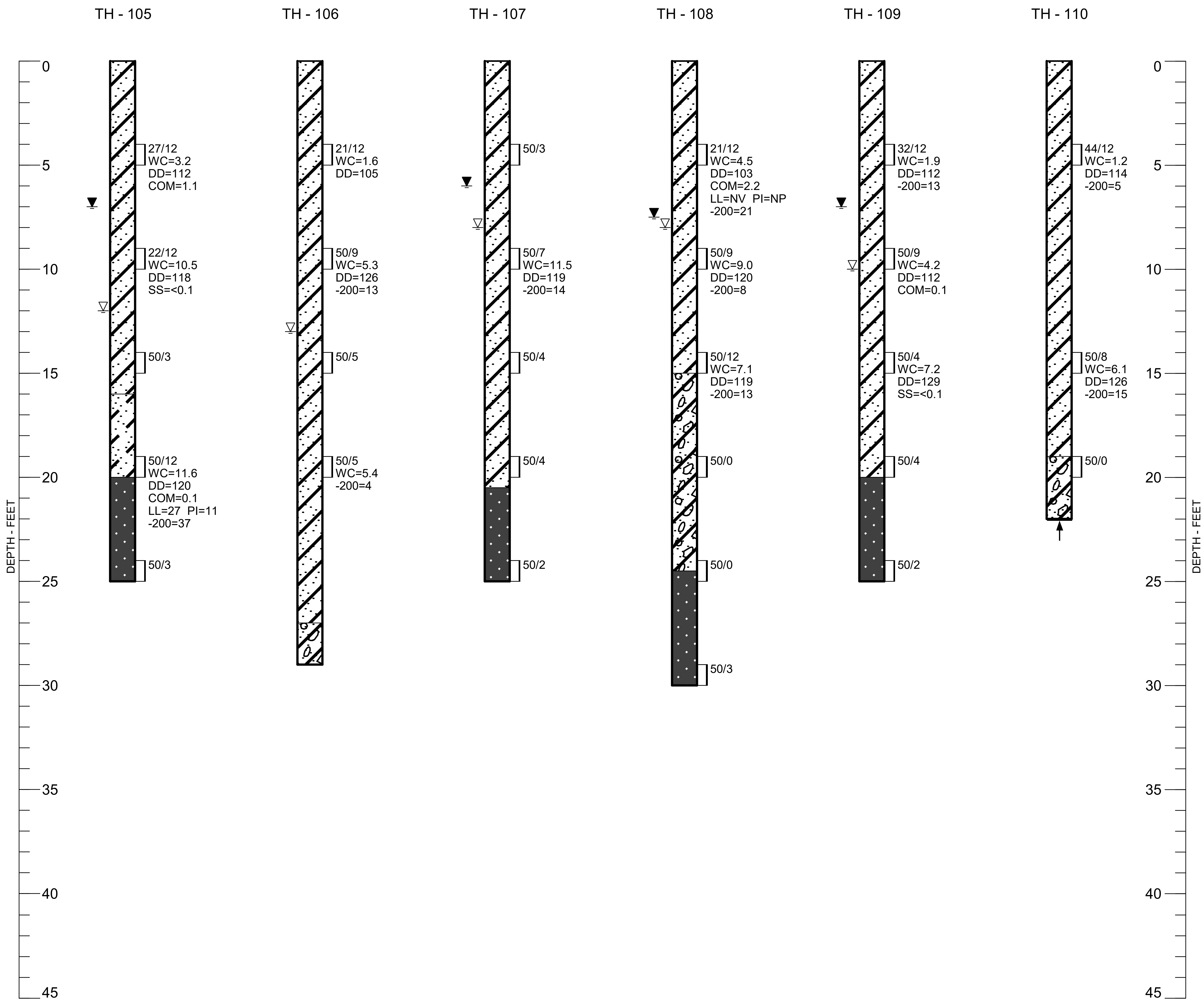
SUMMARY LOGS OF EXPLORATORY BORINGS



CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Summary Logs of Exploratory Borings

FIG. A-1



LEGEND:

- SAND, CLAYEY TO VERY CLAYEY, MEDIUM DENSE TO DENSE, MOIST TO VERY MOIST, RED BROWN, WITH GRAVELLY LAYERS. (SC)
- SAND, CLEAN TO SILTY, WITH GRAVELLY LAYERS AND COBBLES, MEDIUM DENSE TO VERY DENSE, SLIGHTLY MOIST TO WET, RED BROWN, LIGHT BROWN. (SP, SP-SM, SW-SM, SM)
- GRAVEL, VERY SANDY, SLIGHTLY SILTY TO SILTY, WITH COBBLES, DENSE TO VERY DENSE, SLIGHTLY MOIST TO WET, RED BROWN. (GP-GM, GW-GM, GM)
- BEDROCK. SANDSTONE, SILTY, VERY HARD, SLIGHTLY MOIST TO MOIST, LIGHT BROWN, RED BROWN, WITH WELL-CEMENTED LAYERS.
- DRIVE SAMPLE. THE SYMBOL 20/12 INDICATES 20 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.
- GROUNDWATER LEVEL MEASURED SEVEN DAYS AFTER DRILLING.
- INDICATES REFUSAL TO PRACTICAL AUGER DRILLING USING A CME-55, TRUCK-MOUNTED DRILL RIG.

NOTES:

1. THE BORINGS WERE DRILLED APRIL 11, 2018 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-55, 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)
   SW - INDICATES SWELL WHEN WETTED UNDER ESTIMATED OVERBURDEN PRESSURE. (%)
   COM - INDICATES COMPRESSION WHEN WETTED UNDER ESTIMATED OVERBURDEN PRESSURE. (%)
   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. (%)

CLASSIC HOMES
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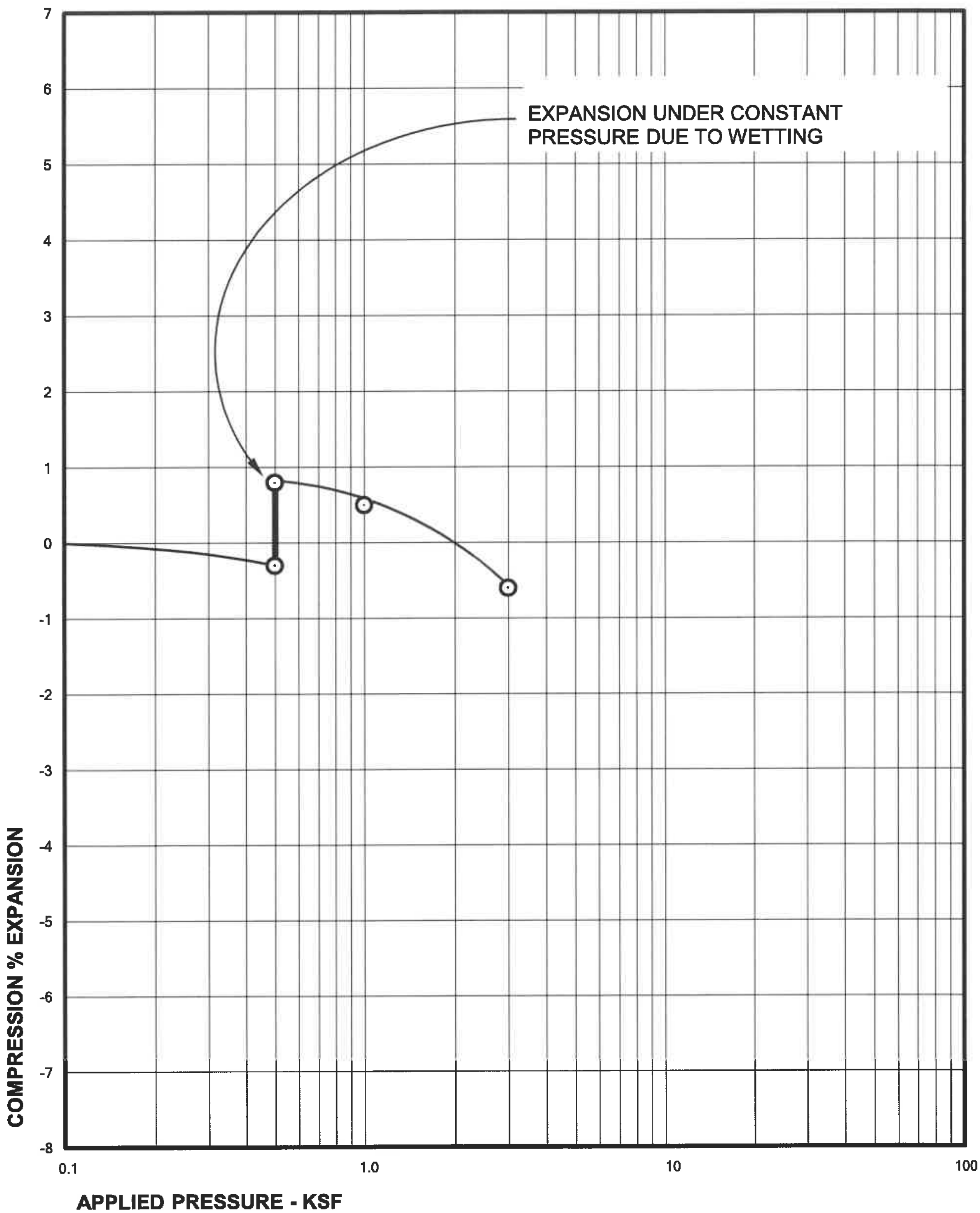
CTL|T PROJECT NO. CS18916-105

Summary Logs of Exploratory Borings

FIG. A-2

APPENDIX B

LABORATORY TEST RESULTS
TABLE B-1: SUMMARY OF LABORATORY TESTING



Sample of SAND, VERY CLAYEY (SC)
From TH-101 AT 4 FEET

DRY UNIT WEIGHT= 107 PCF
MOISTURE CONTENT= 4.5 %

CLASSIC HOMES
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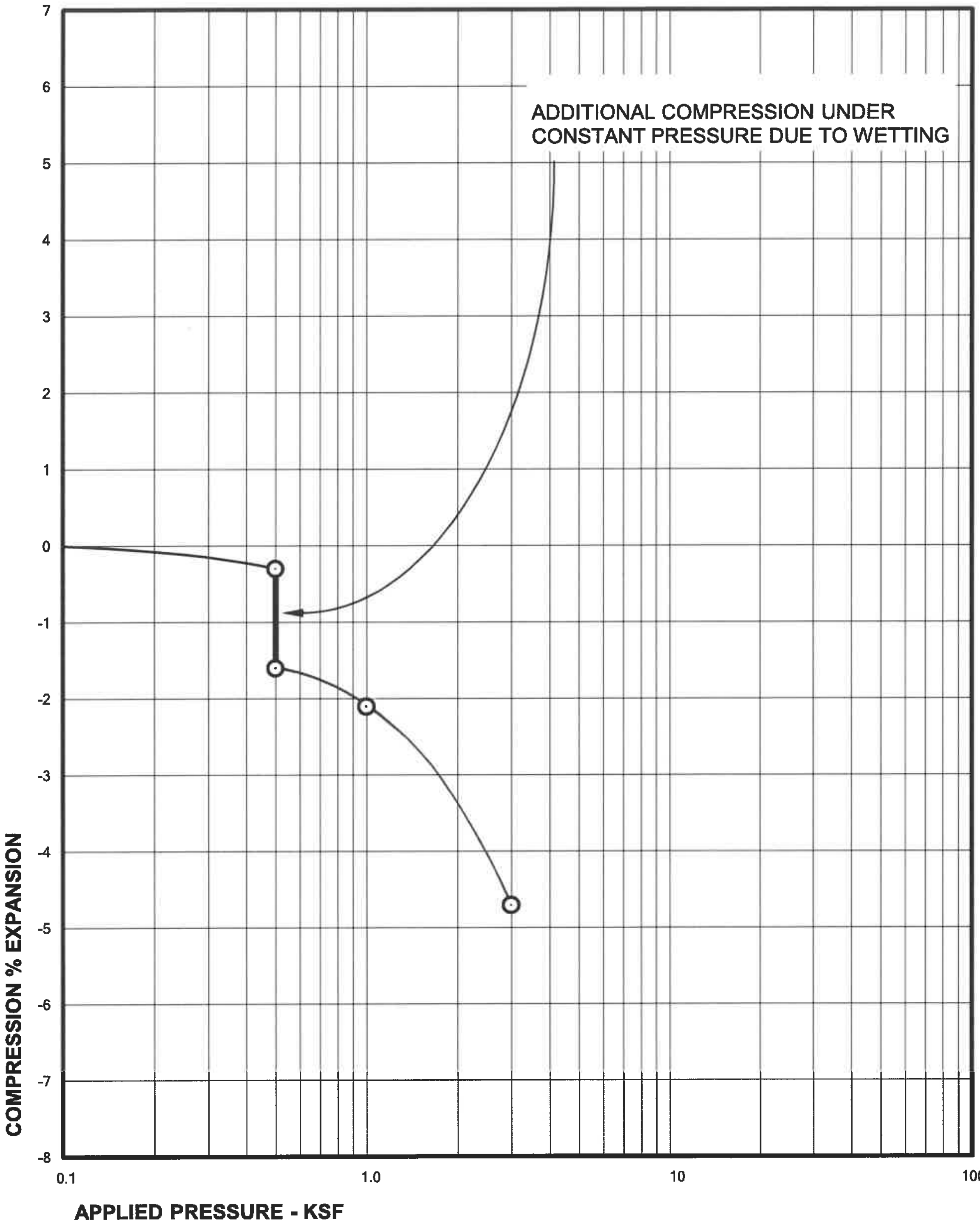
Swell Consolidation Test Results

FIG. B-1



Sample of SAND, SILTY (SM)

From TH-104 AT 4 FEET

DRY UNIT WEIGHT= 108 PCF

MOISTURE CONTENT= 2.3 %

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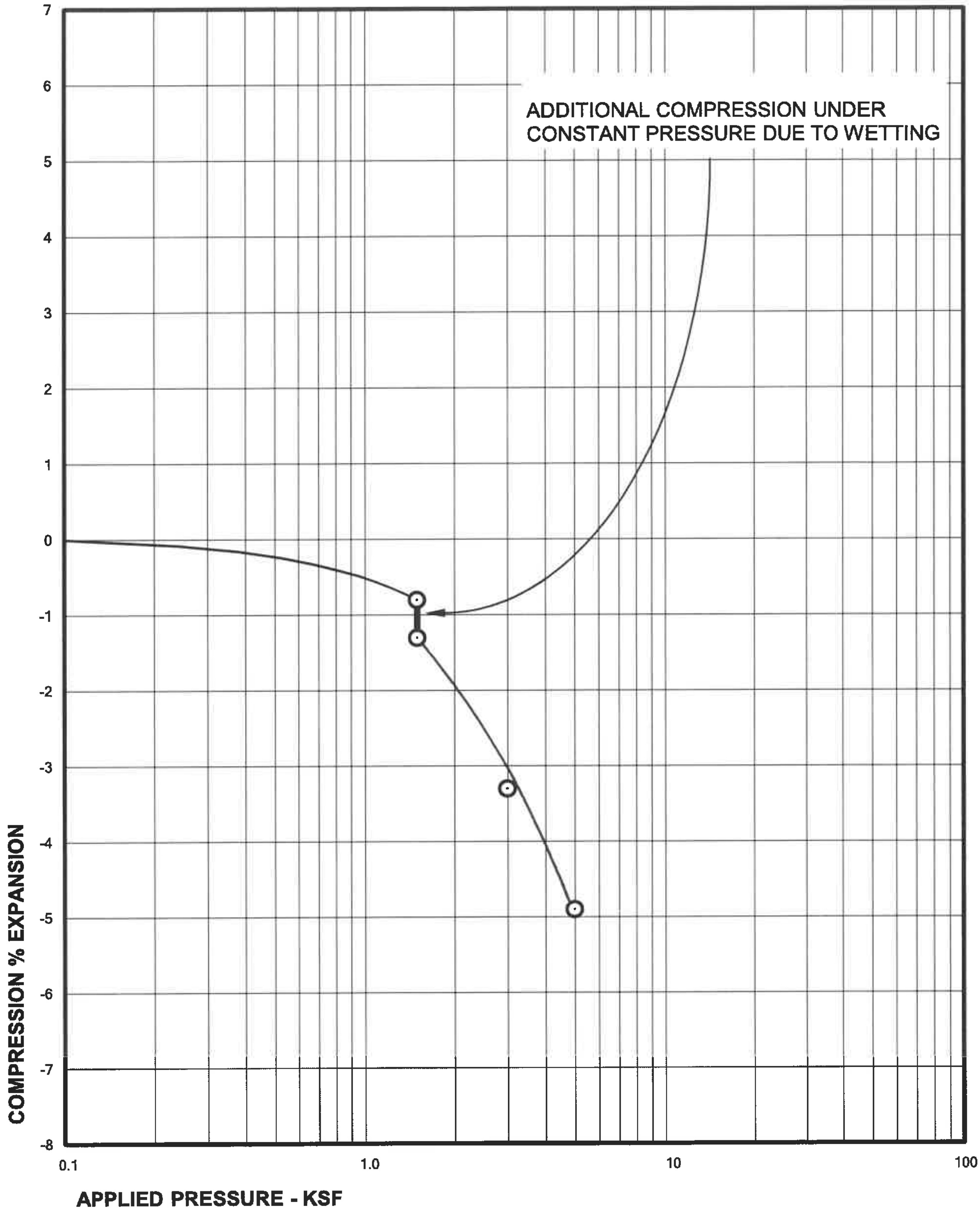
Swell Consolidation Test Results

FIG. B-2



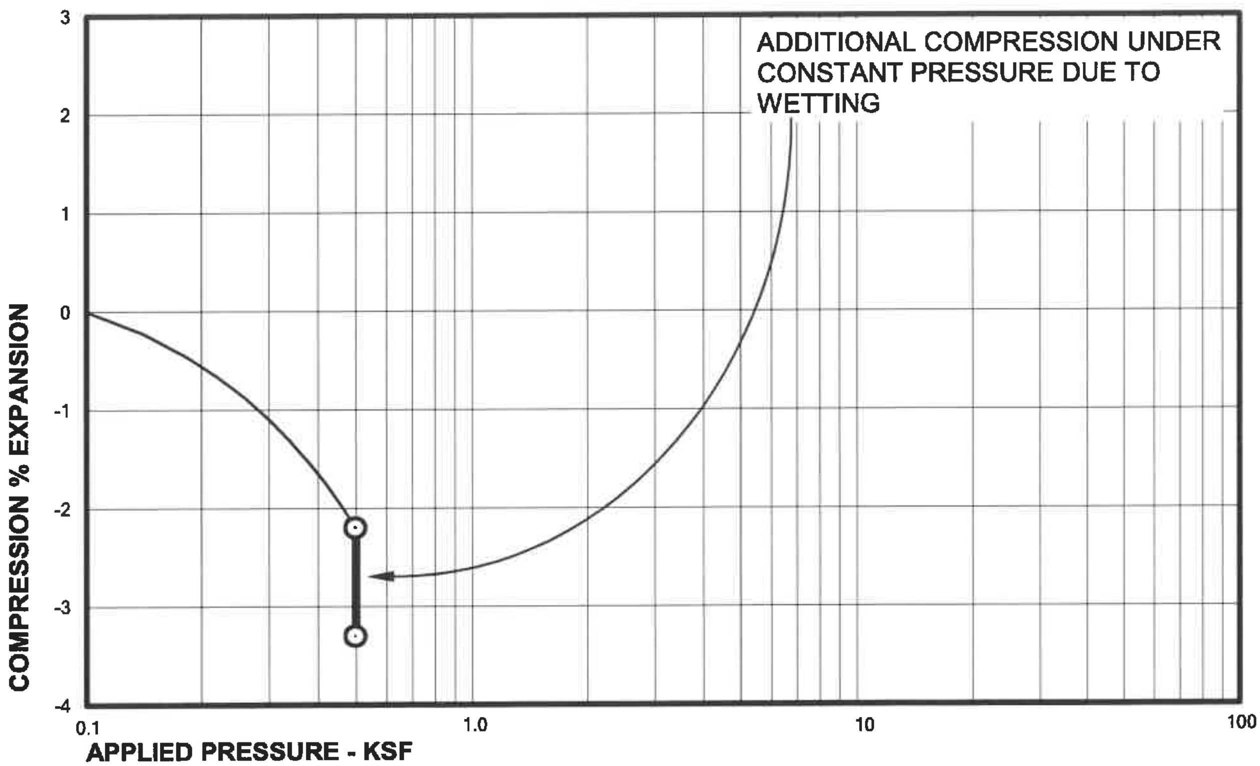
Sample of SAND, CLAYEY (SC)
From TH-104 AT 9 FEET

DRY UNIT WEIGHT= 117 PCF
MOISTURE CONTENT= 3.9 %

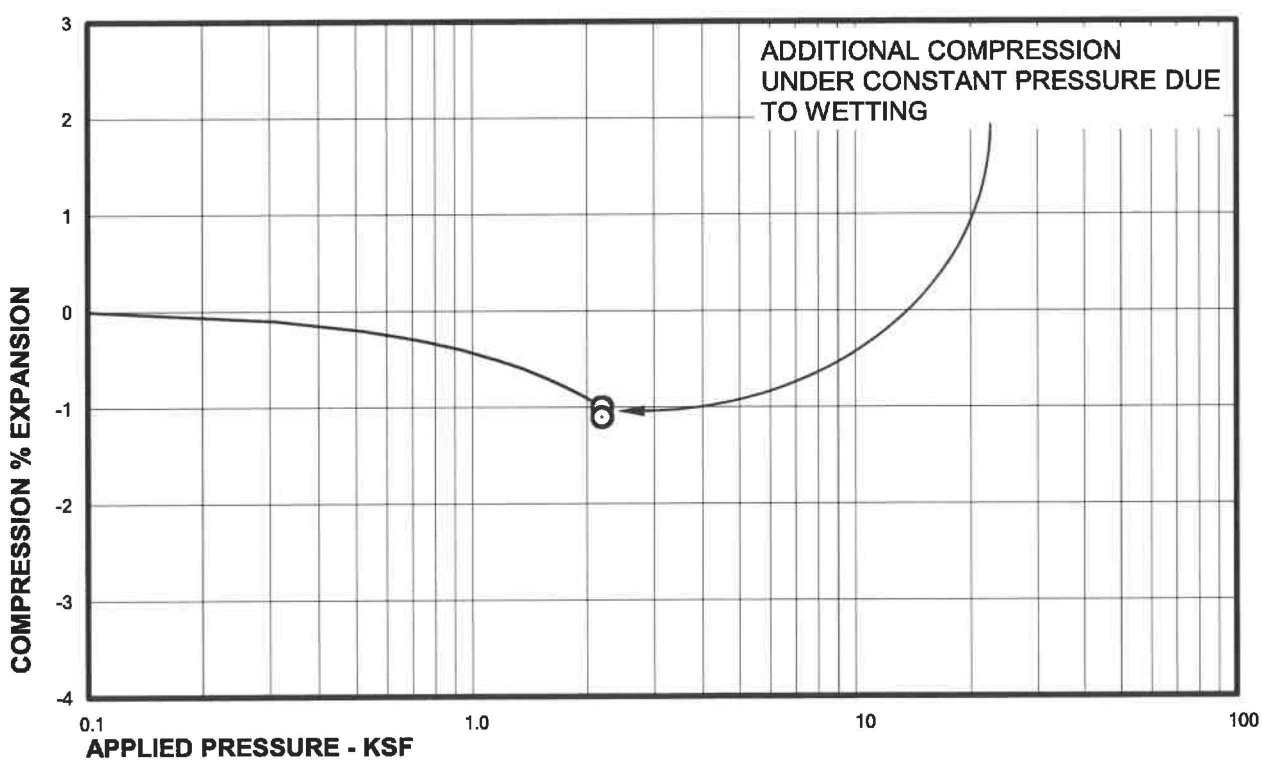
CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Swell Consolidation Test Results

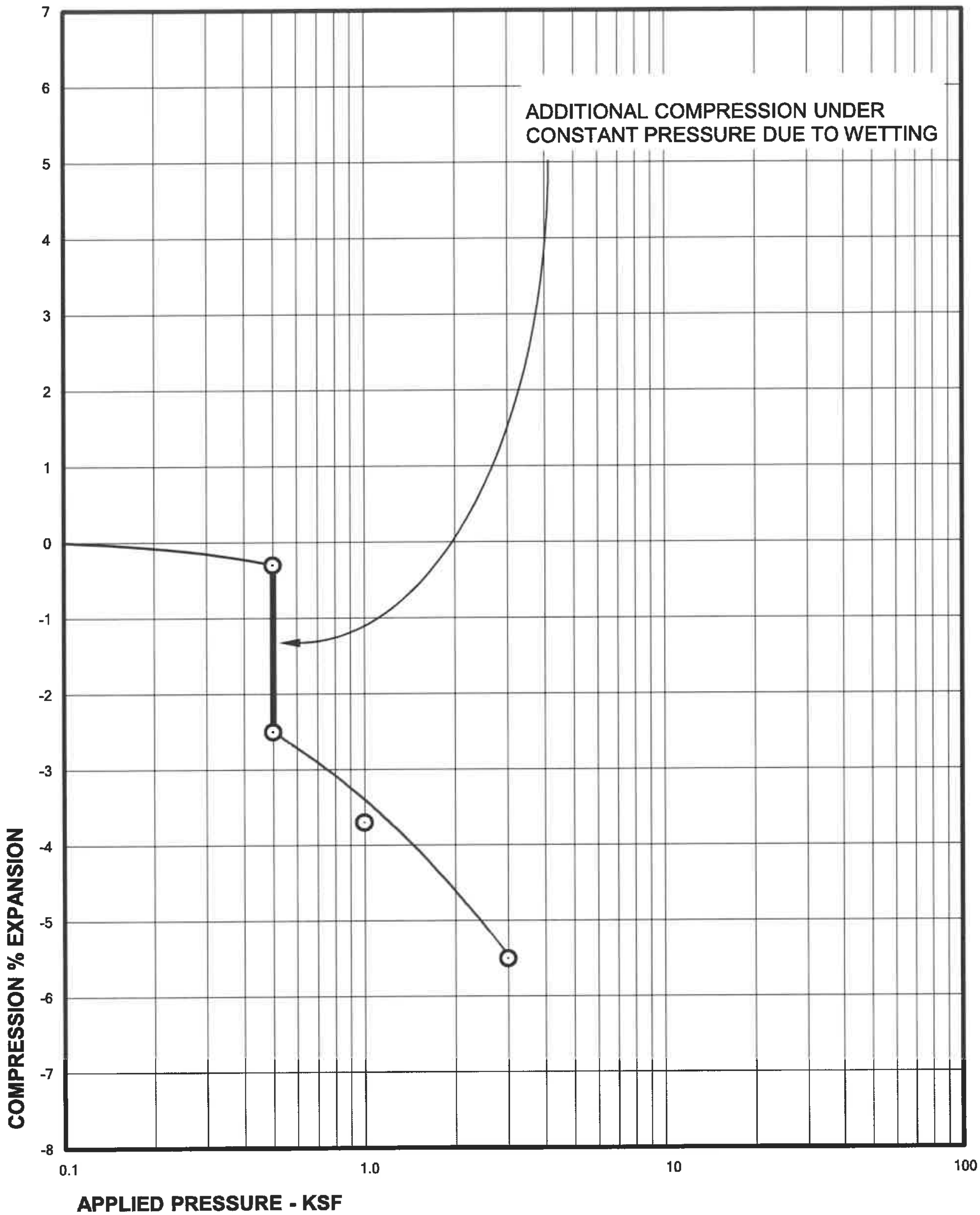
FIG. B-3



Sample of	SAND, SILTY (SM)	DRY UNIT WEIGHT=	112	PCF
From	TH-105 AT 4 FEET	MOISTURE CONTENT=	3.2	%



Sample of	SAND, VERY CLAYEY (SC)	DRY UNIT WEIGHT=	120	PCF
From	TH-105 AT 19 FEET	MOISTURE CONTENT=	11.6	%



Sample of SAND, SILTY (SM)

From TH-108 AT 4 FEET

DRY UNIT WEIGHT= 103 PCF

MOISTURE CONTENT= 4.5 %

CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
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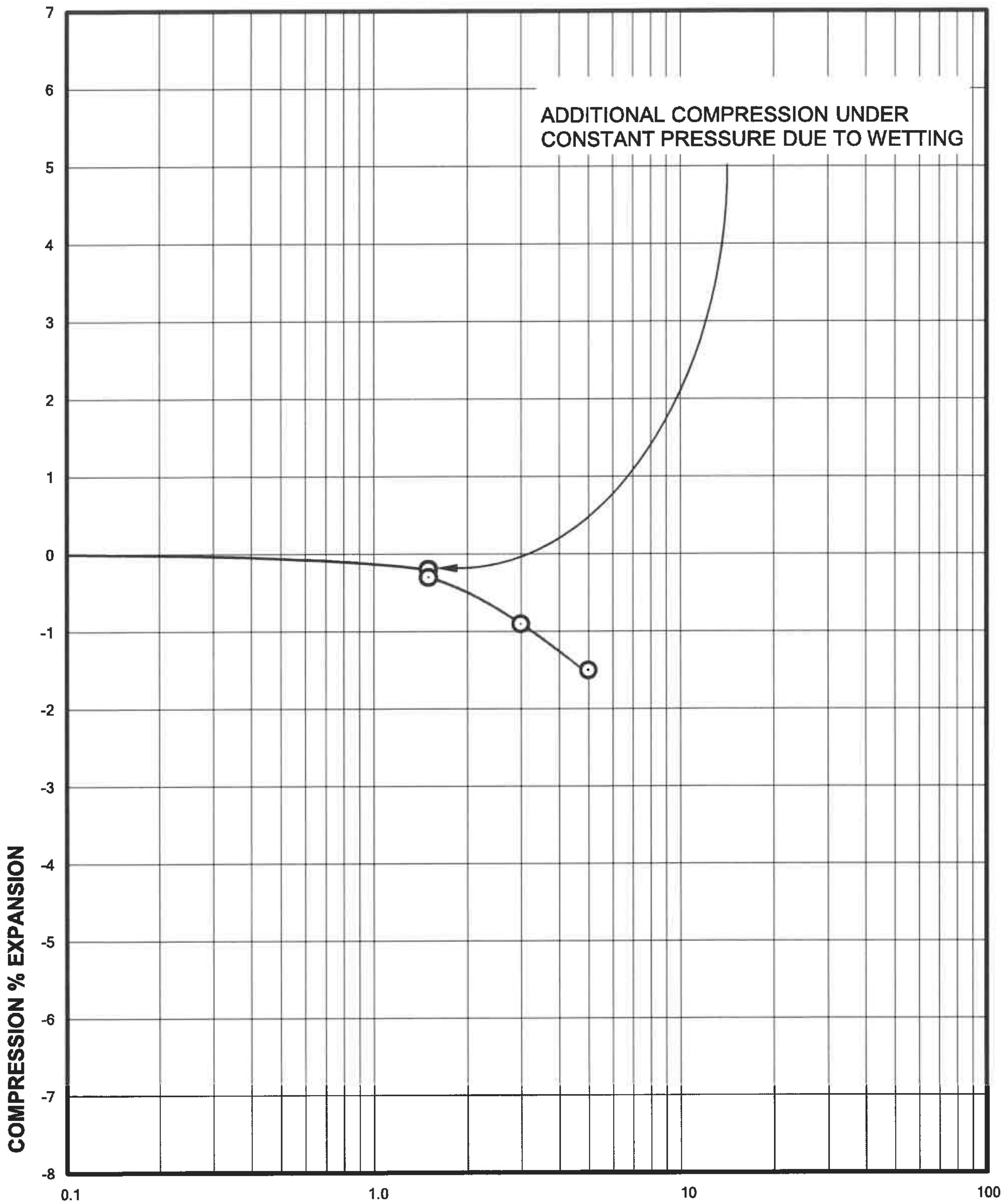
Swell Consolidation Test Results

FIG. B-5



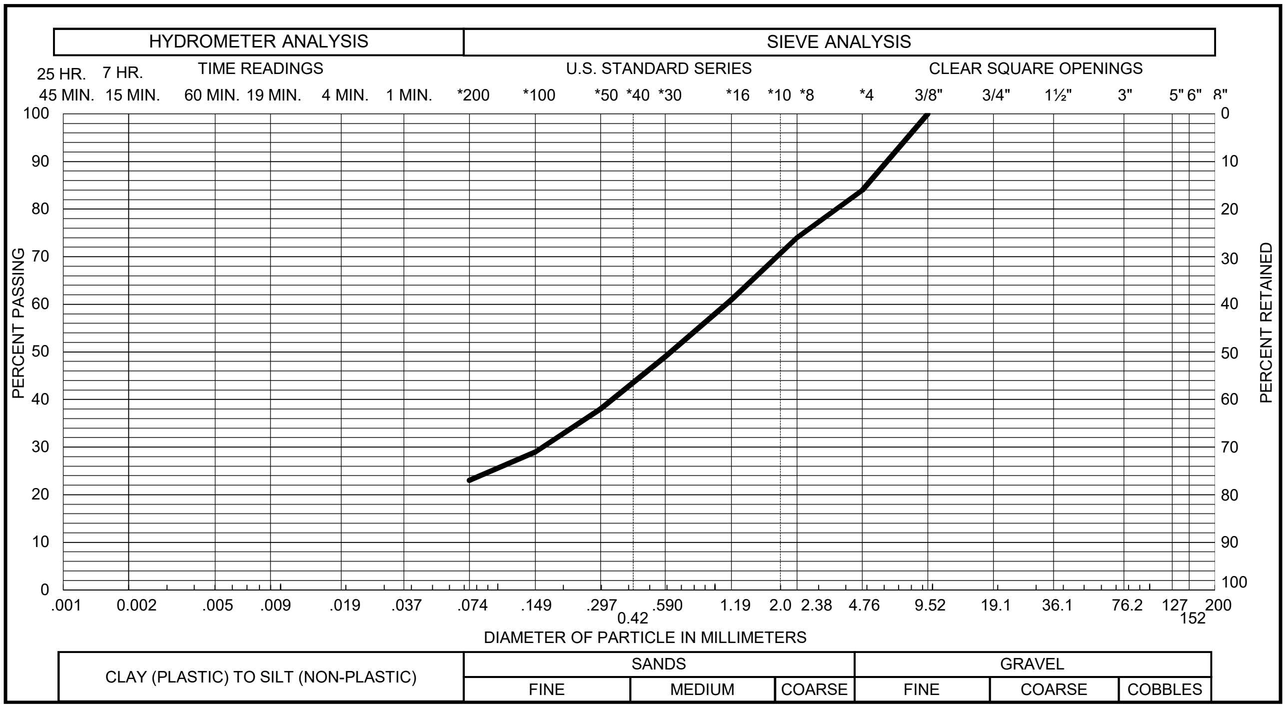
Sample of SAND, GRAVELLY, SILTY (SM)
From TH-109 AT 9 FEET

DRY UNIT WEIGHT= 112 PCF
MOISTURE CONTENT= 4.2 %

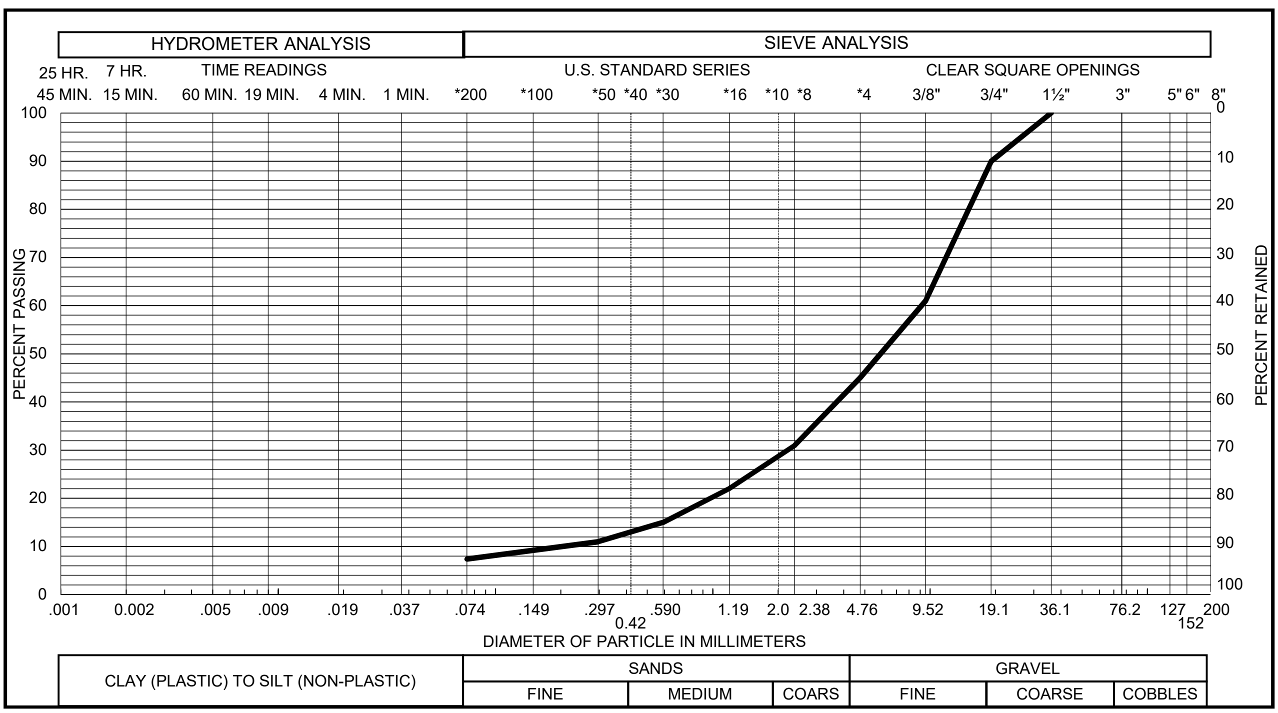
CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Swell Consolidation Test Results

FIG. B-6



Sample of	SAND, SILTY, GRAVELLY (SM)	GRAVEL	16 %	SAND	61 %
From	TH - 101 AT 14 FEET	SILT & CLAY	23 %	LIQUID LIMIT	%
		PLASTICITY INDEX			%

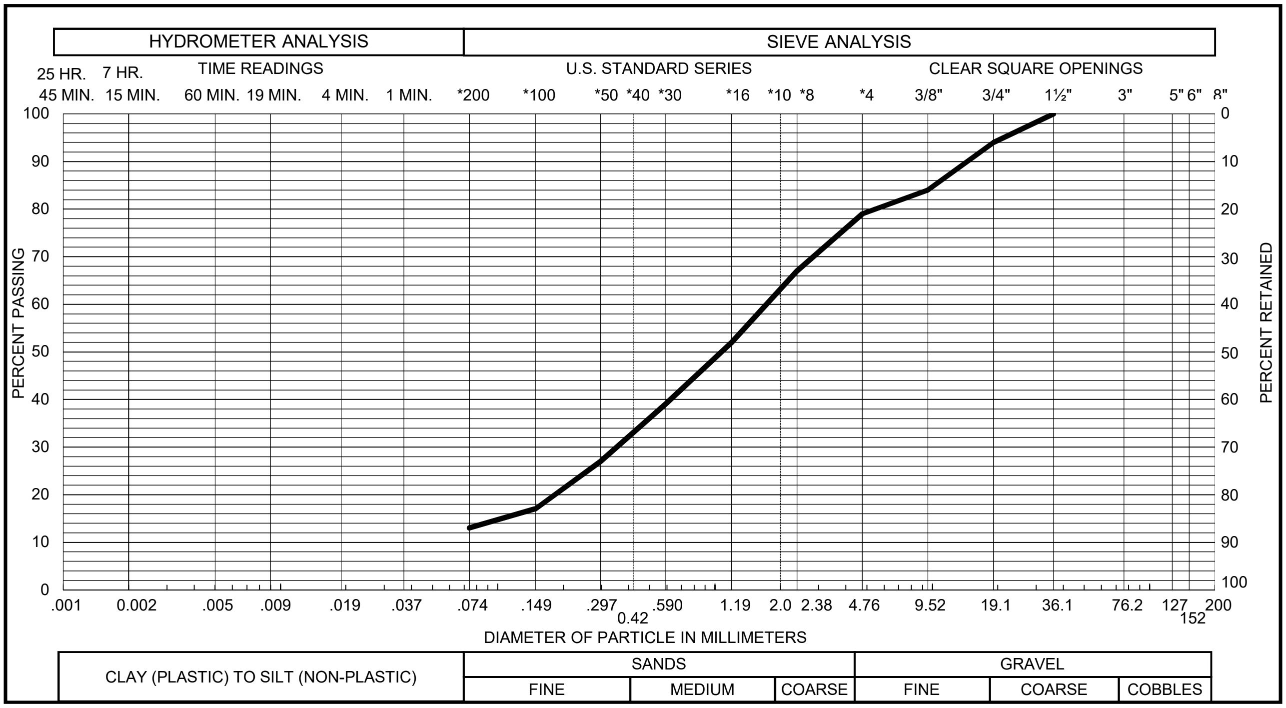


Sample of	GRAVEL, V. SANDY, SLT. SILTY (GW-GM)	GRAVEL	55 %	SAND	38 %
From	TH - 102 AT 14 FEET	SILT & CLAY	7 %	LIQUID LIMIT	%
		PLASTICITY INDEX			%

CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

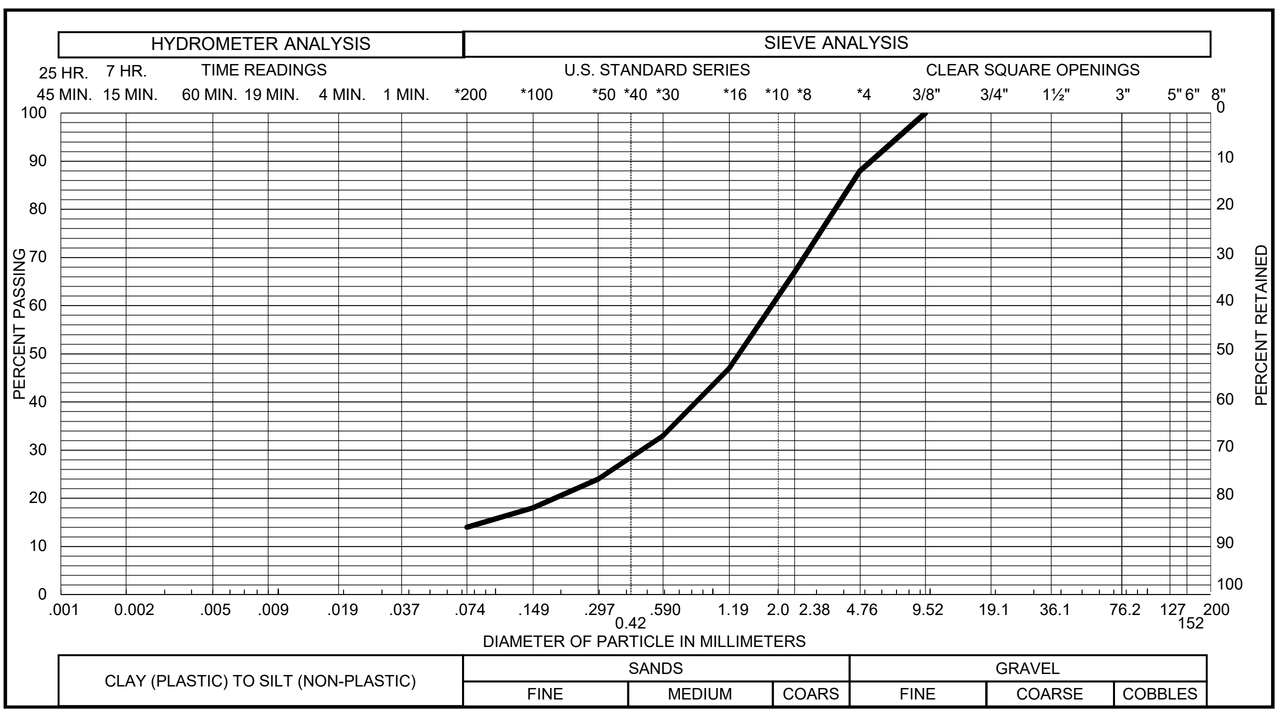
Gradation Test Results

FIG. B-7



Sample of SAND, GRAVELLY, SILTY (SM)
From TH - 103 AT 14 FEET

GRAVEL 21 % SAND 66 %
SILT & CLAY 13 % LIQUID LIMIT %
PLASTICITY INDEX %



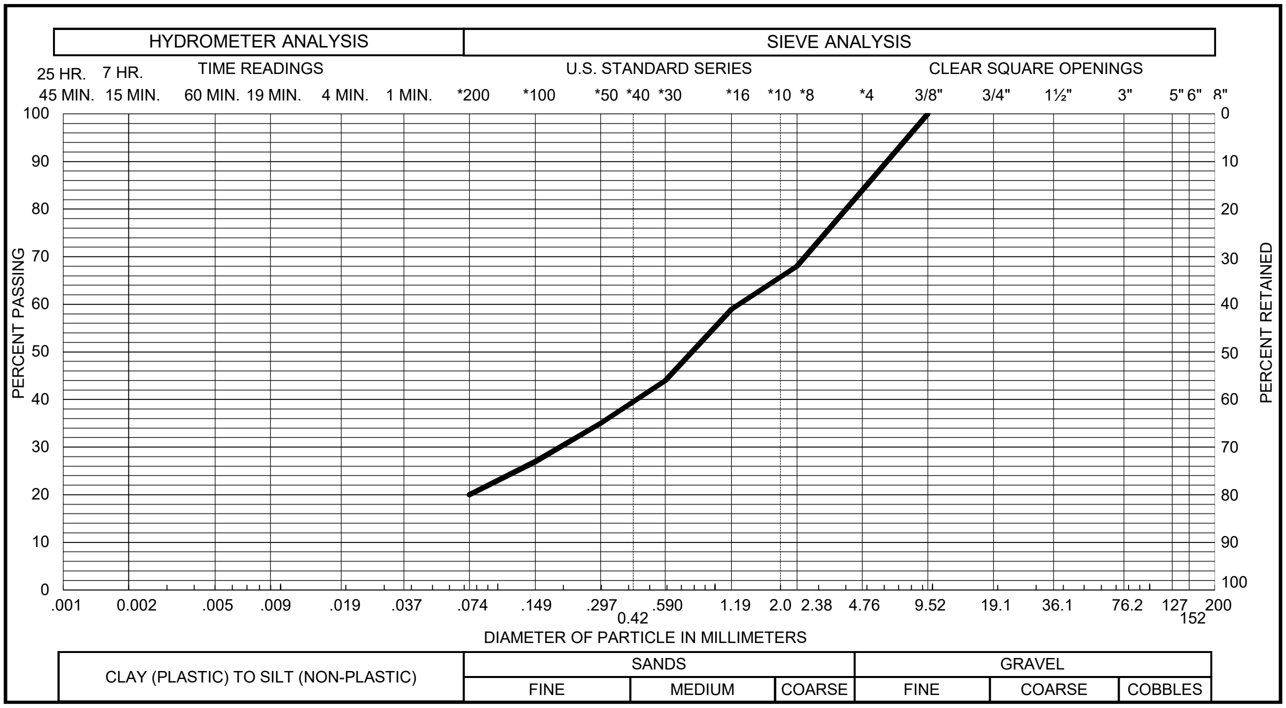
Sample of SAND, SILTY (SM)
From TH - 103 AT 19 FEET

GRAVEL 12 % SAND 74 %
SILT & CLAY 14 % LIQUID LIMIT %
PLASTICITY INDEX %

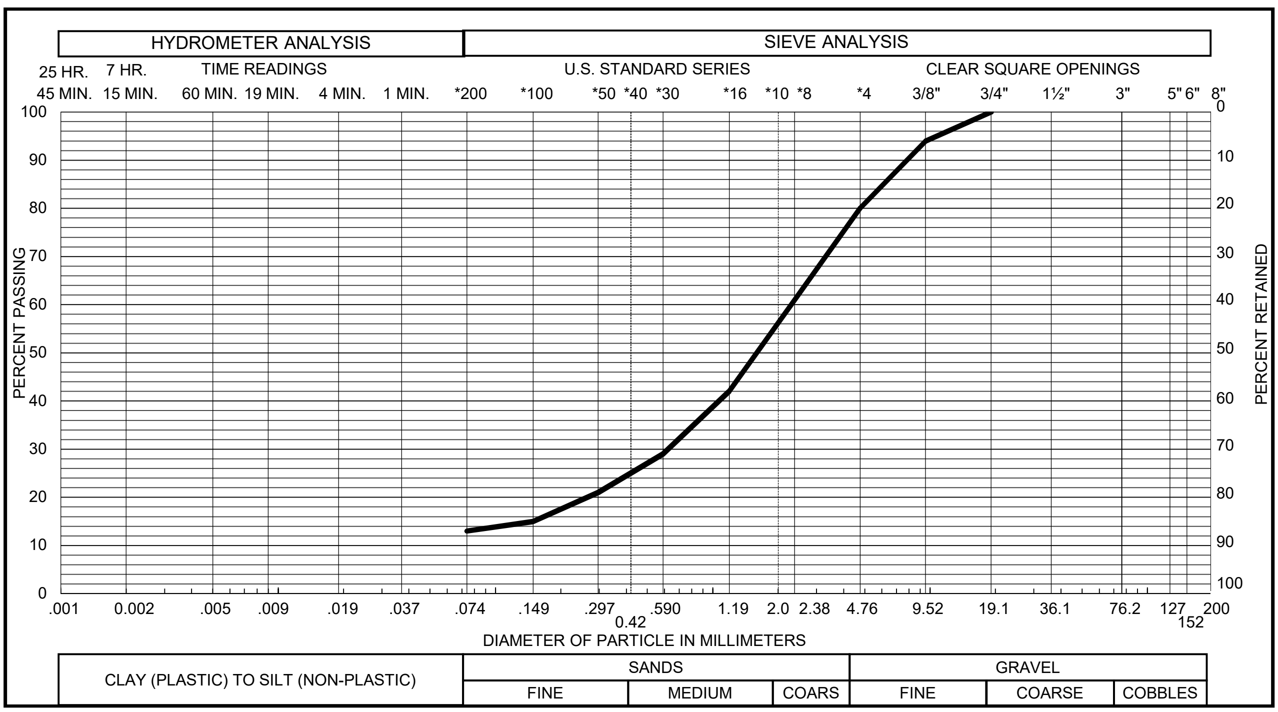
CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Gradation Test Results

FIG. B-8



Sample of	SAND, GRAVELLY, SILTY (SM)	GRAVEL	16 %	SAND	64 %
From	TH - 104 AT 19 FEET	SILT & CLAY	20 %	LIQUID LIMIT	%
		PLASTICITY INDEX	%		

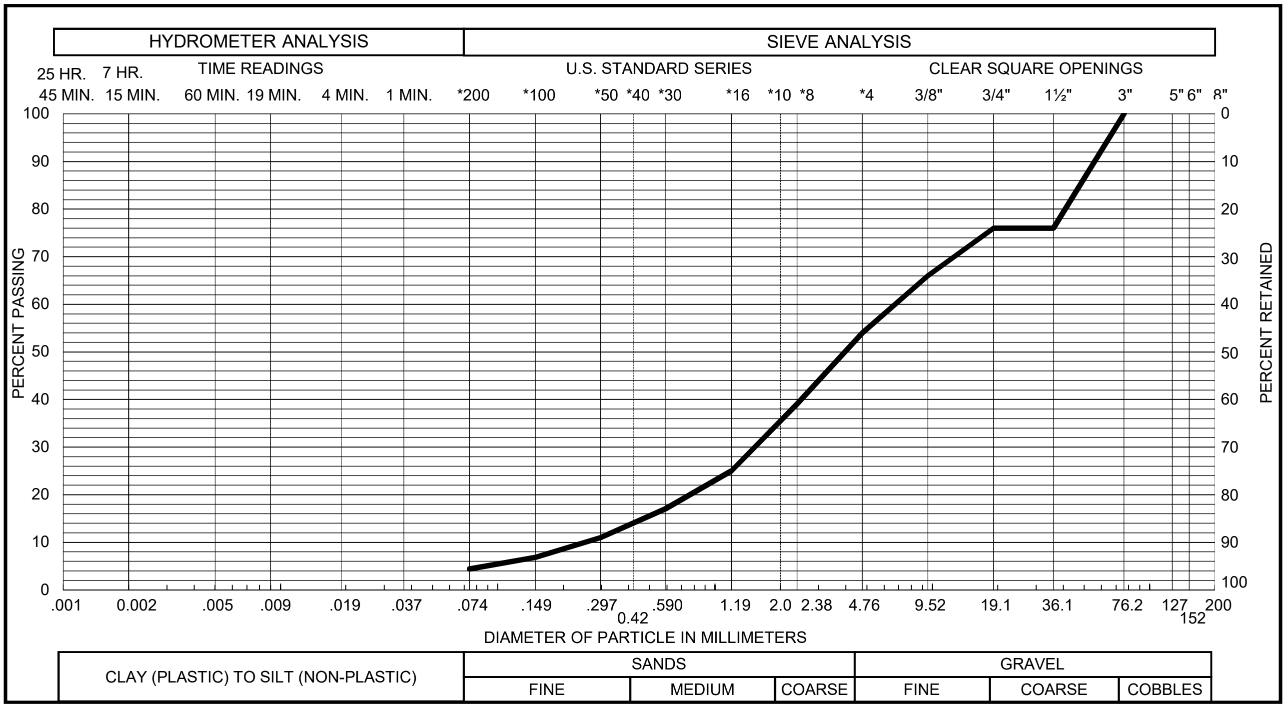


Sample of	SAND, GRAVELLY, SILTY (SM)	GRAVEL	20 %	SAND	67 %
From	TH - 106 AT 9 FEET	SILT & CLAY	13 %	LIQUID LIMIT	%
		PLASTICITY INDEX	%		

CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

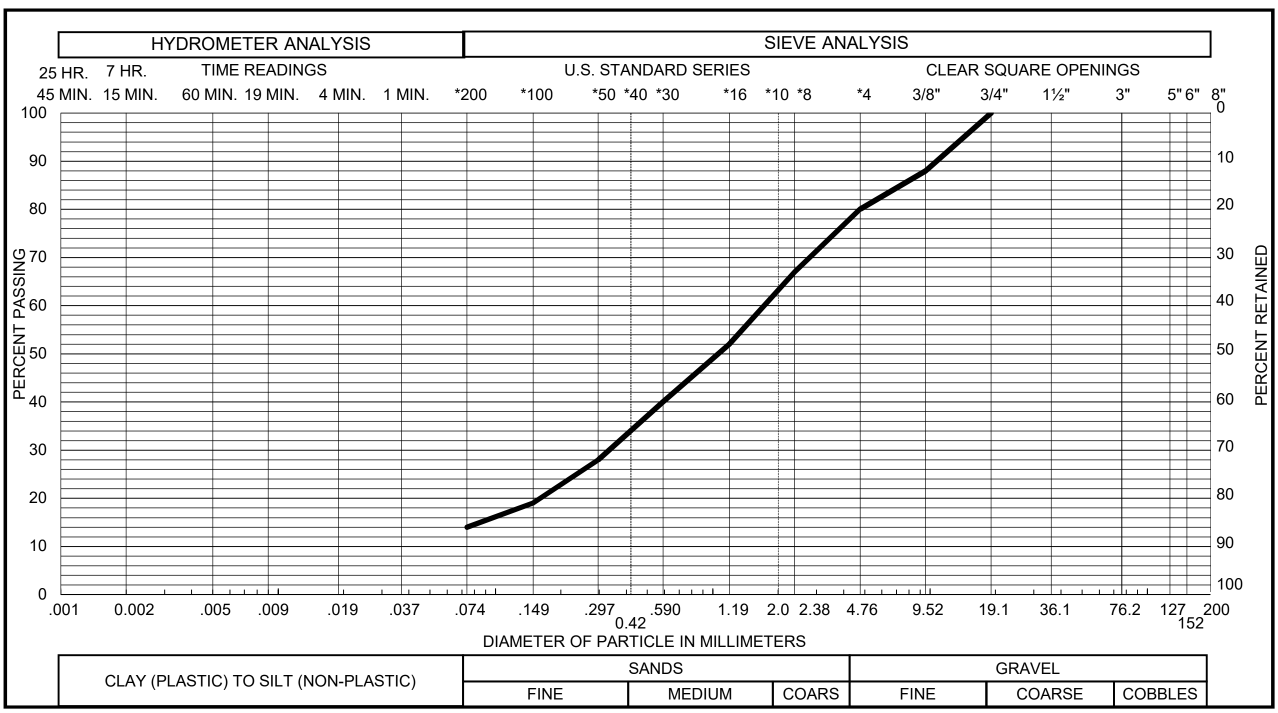
Gradation Test Results

FIG. B-9



Sample of SAND, VERY GRAVELLY (SP)
From TH - 106 AT 19 FEET

GRAVEL 46 % SAND 50 %
SILT & CLAY 4 % LIQUID LIMIT %
PLASTICITY INDEX %



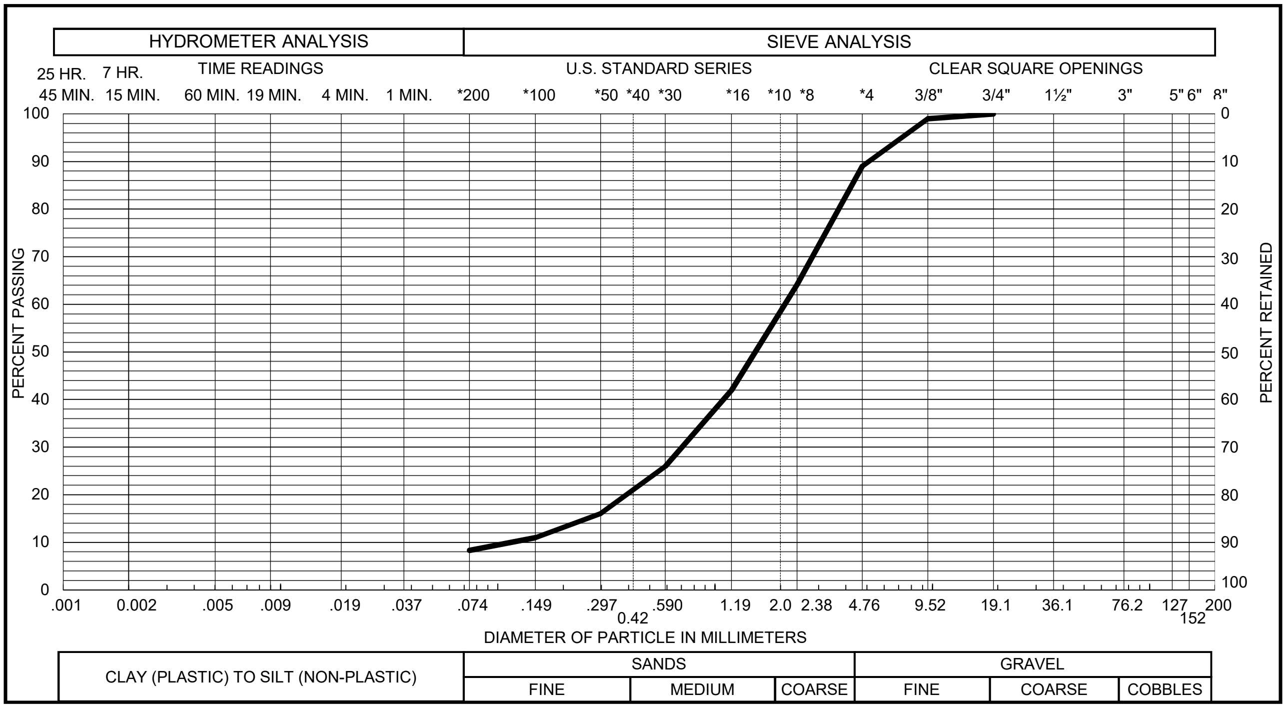
Sample of SAND, GRAVELLY, SILTY (SM)
From TH - 107 AT 9 FEET

GRAVEL 20 % SAND 66 %
SILT & CLAY 14 % LIQUID LIMIT %
PLASTICITY INDEX %

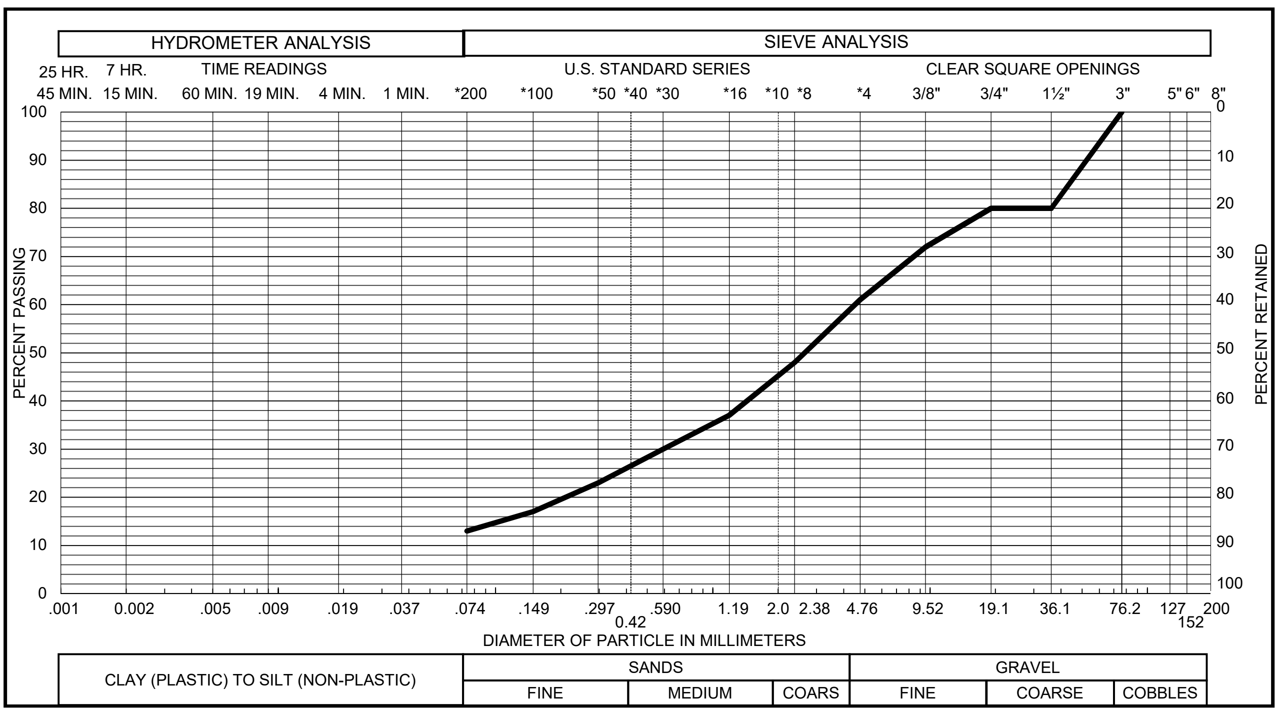
CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Gradation Test Results

FIG. B-10



Sample of	SAND, SLIGHTLY SILTY (SW-SM)	GRAVEL	11 %	SAND	81 %
From	TH - 108 AT 9 FEET	SILT & CLAY	8 %	LIQUID LIMIT	%
		PLASTICITY INDEX	%		

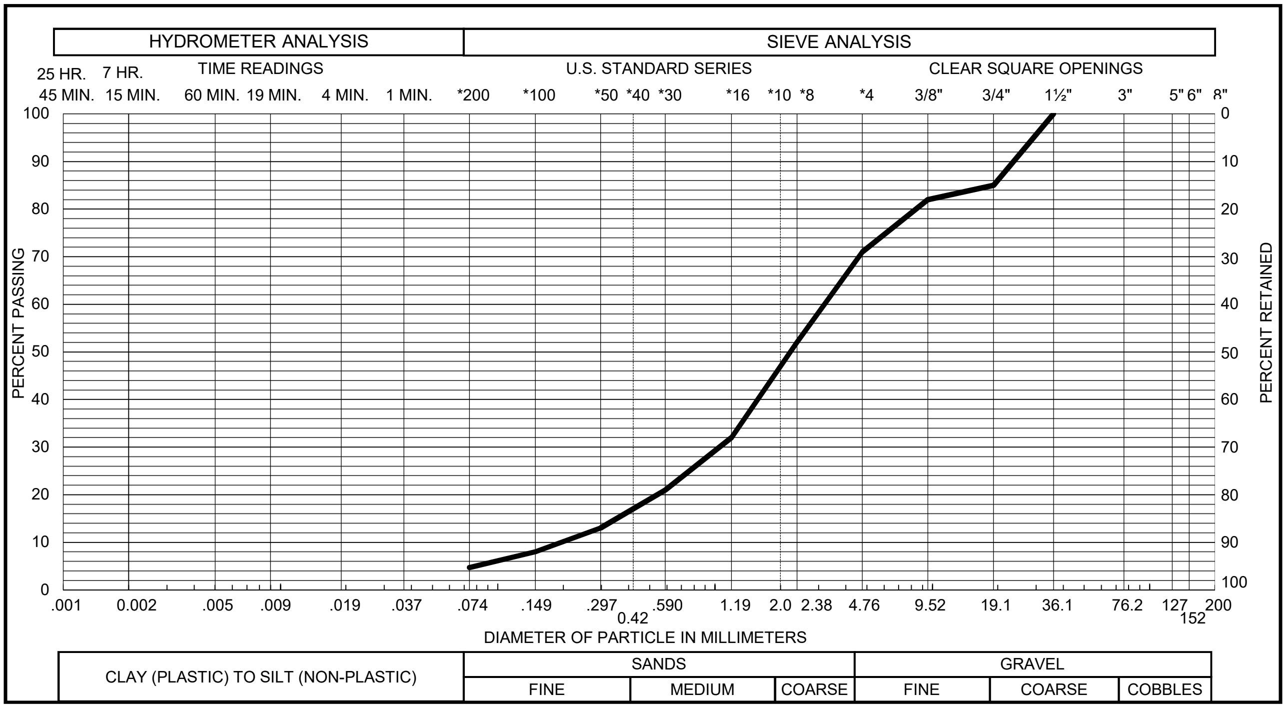


Sample of	SAND, V. GRAVELLY, SILTY (SM)	GRAVEL	39 %	SAND	48 %
From	TH - 108 AT 14 FEET	SILT & CLAY	13 %	LIQUID LIMIT	%
		PLASTICITY INDEX	%		

CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

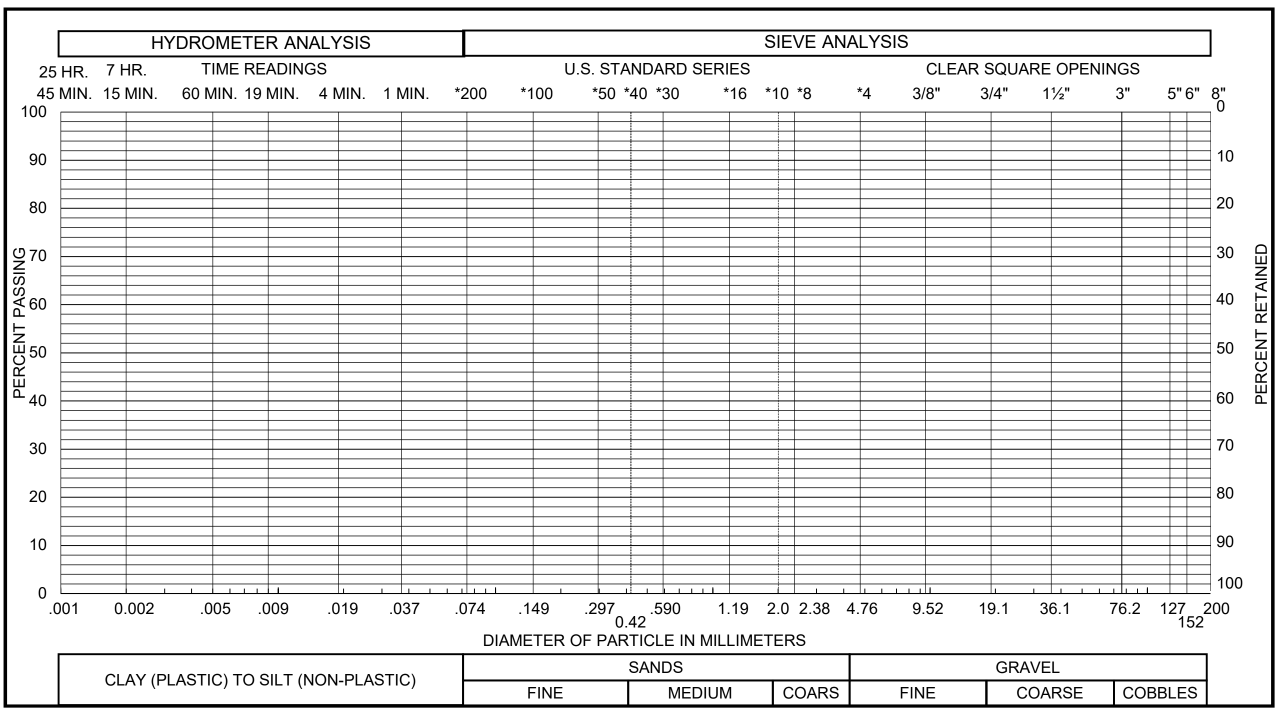
Gradation Test Results

FIG. B-11



Sample of SAND, GRAVELLY, SLT. SILTY (SW-SM)
From TH - 110 AT 4 FEET

GRAVEL 29 % SAND 66 %
SILT & CLAY 5 % LIQUID LIMIT %
PLASTICITY INDEX %



Sample of
From

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

CLASSIC HOMES
FOREST LAKES SUBDIVISION (PHASE 2)
CTL|T PROJECT NO. CS18916-105

Gradation Test Results

FIG. B-12

TABLE B-1

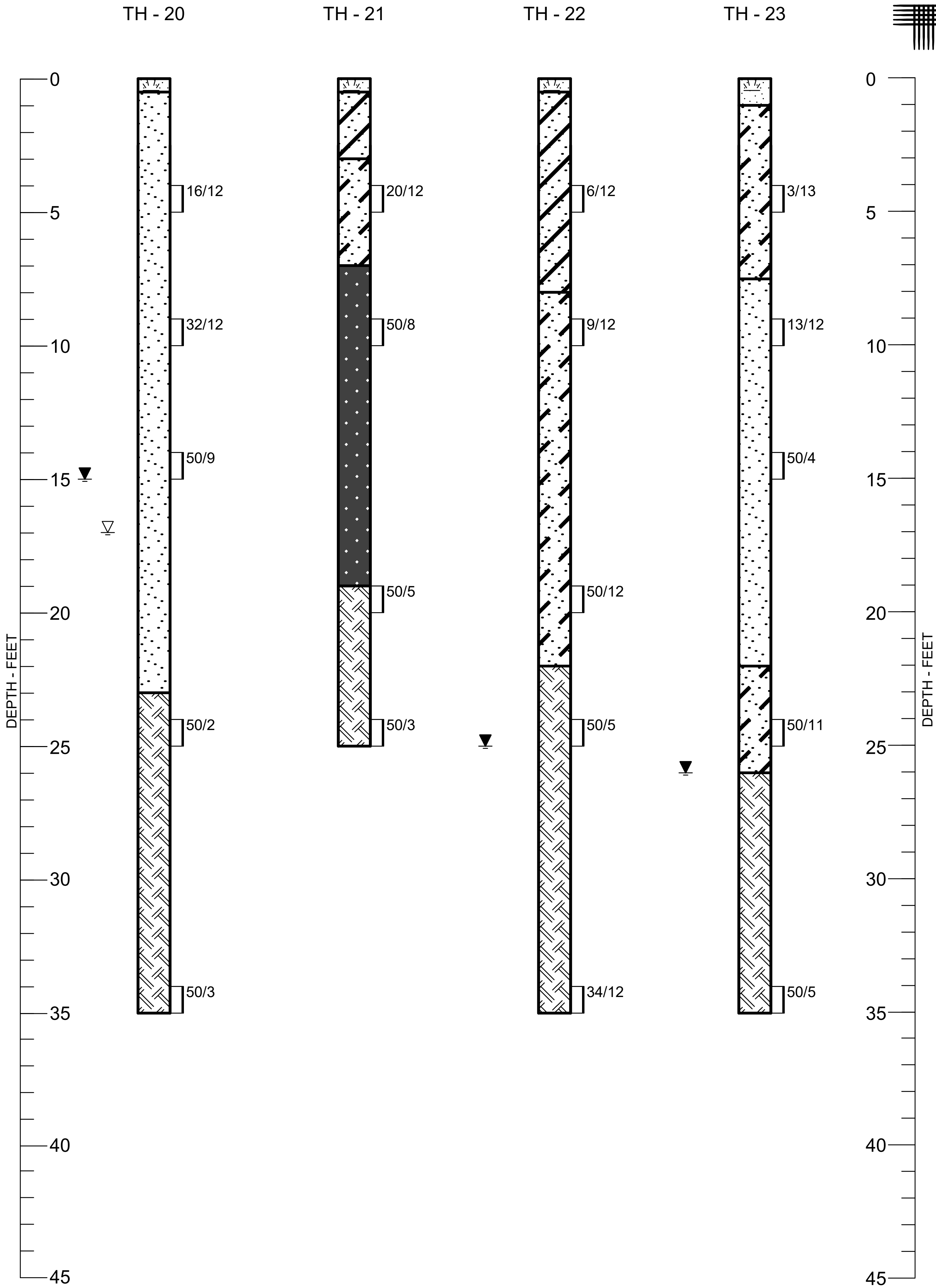
SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS18916-105

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	SWELL TEST RESULTS* SWELL (%)	SWELL TEST RESULTS* APPLIED PRESSURE (PSF)	SWELL TEST RESULTS* SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
TH-101	4	4.5	107	29	9	1.1	500		36		SAND, VERY CLAYEY (SC)
TH-101	9	3.7	111						30		SAND, SILTY (SM)
TH-101	14	3.0	118						23		SAND, SILTY, GRAVELLY (SM)
TH-102	4	2.4	114							<0.1	SAND, SILTY (SM)
TH-102	14	2.8	134						7		GRAVEL, V. SANDY, SL.SILTY (GW-GM)
TH-102	19	4.2	120						14		SAND, SILTY (SM)
TH-102	24	4.0	119						8		SAND, SLIGHTLY SILTY (SP-SM)
TH-103	4	7.2	112						31		SAND, SILTY (SM)
TH-103	9	3.0	109						20		SAND, SILTY (SM)
TH-103	14	4.6	119						13		SAND, GRAVELLY, SILTY (SM)
TH-103	19	6.0							14		SAND, SILTY (SM)
TH-104	4	2.3	108	NV	NP	-1.3	500		16		SAND, SILTY (SM)
TH-104	9	3.9	117			-0.5	1100				SAND, CLAYEY (SC)
TH-104	14	4.8	119						25		SAND, CLAYEY (SC)
TH-104	19	7.6	126						20		SAND, GRAVELLY, SILTY (SM)
TH-105	4	3.2	112			-1.1	500				SAND, SILTY (SM)
TH-105	9	10.5	118							<0.1	SAND, SILTY (SM)
TH-105	19	11.6	120	27	11	-0.1	2400		37		SAND, VERY CLAYEY (SC)
TH-106	4	1.6	105								SAND, SILTY (SM)
TH-106	9	5.3	126						13		SAND, GRAVELLY, SILTY (SM)
TH-106	19	5.4							4		SAND, VERY GRAVELLY (SP)
TH-107	9	11.5	119						14		SAND, GRAVELLY, SILTY (SM)
TH-108	4	4.5	103	NV	NP	-2.2	500		21		SAND, SILTY (SM)
TH-108	9	9.0	120						8		SAND, SLIGHTLY SILTY (SW-SM)
TH-108	14	7.1	119						13		SAND, V. GRAVELLY, SILTY (SM)
TH-109	4	1.9	112						13		SAND, GRAVELLY, SILTY (SM)
TH-109	9	4.2	112			-0.1	1100				SAND, GRAVELLY, SILTY (SM)
TH-109	14	7.2	129							<0.1	SAND, SILTY, GRAVELLY (SM)
TH-110	4	1.2	114						5		SAND, GRAVELLY, SL.SILTY (SW-SM)
TH-110	14	6.1	126						15		SAND, SILTY (SM)

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

APPENDIX C

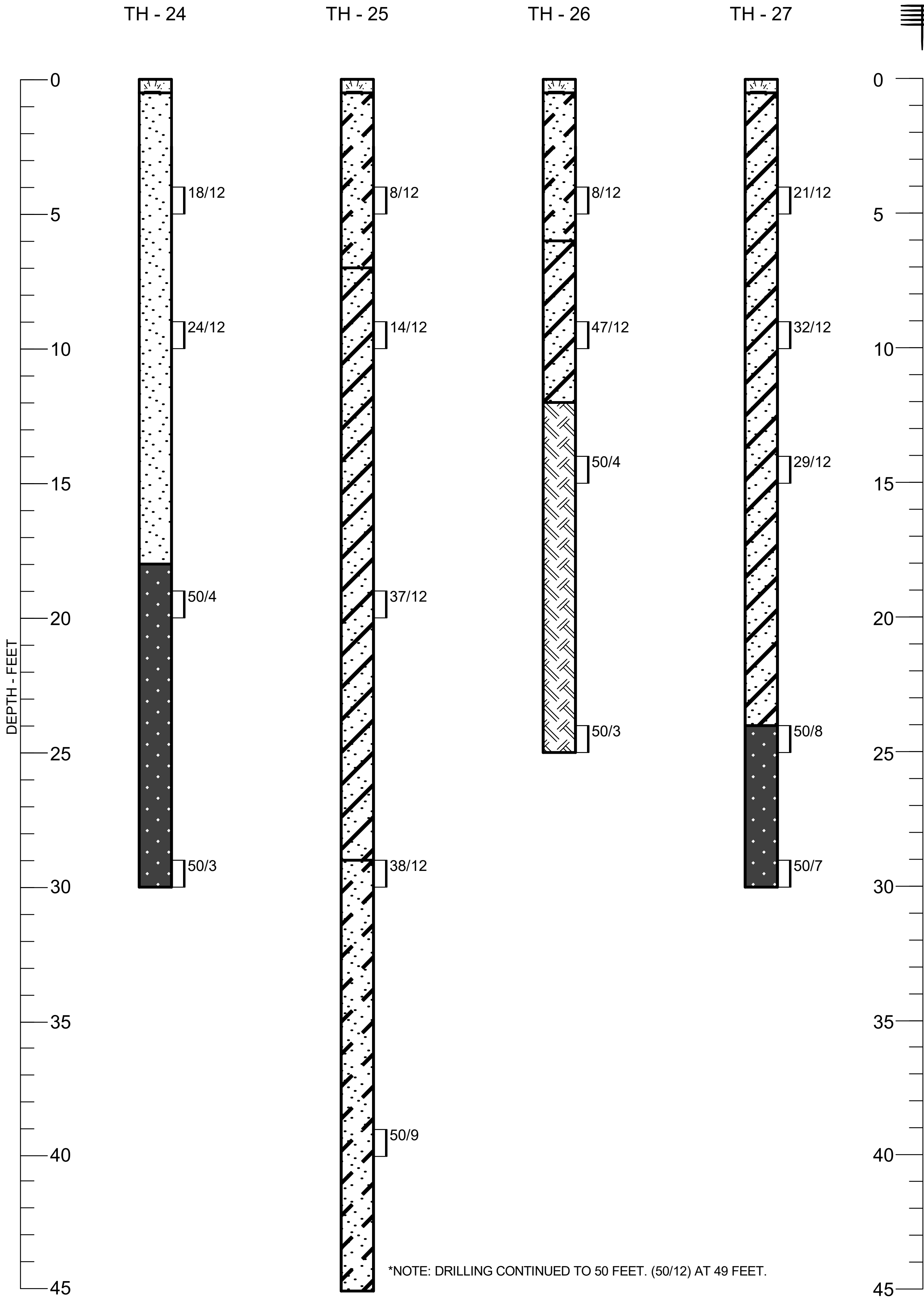
SUMMARY LOGS OF EXPLORATORY BORINGS
(CTL | T JOB NO. CS-10,585; DATED AUGUST 15, 2001)



SHUCK INTERESTS
RESIDENTIAL PARCEL FOREST LAKES
CTL|T PROJECT NO. CS-10,585

Summary Logs of Exploratory Borings

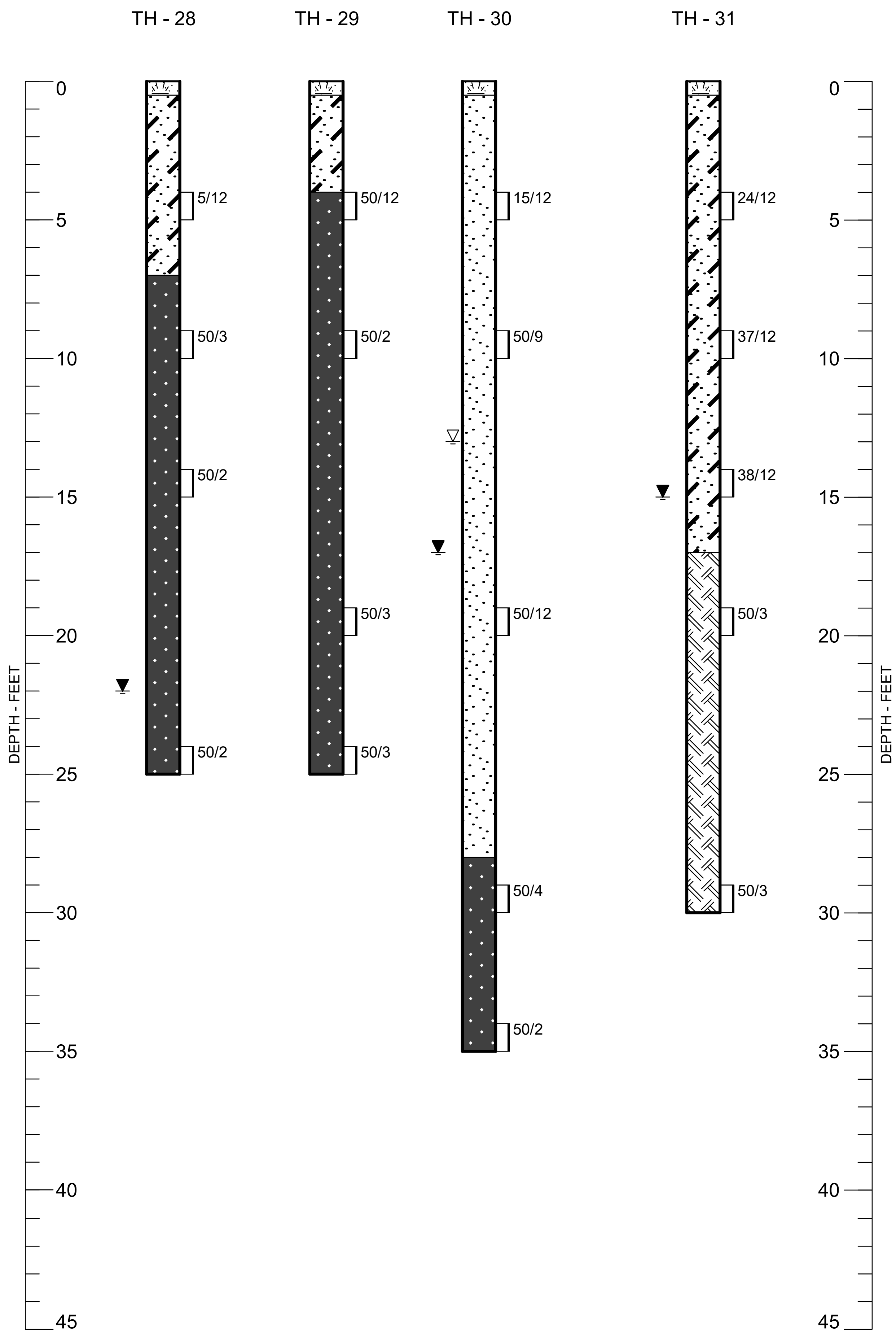
FIG. C-1



SHUCK INTERESTS
RESIDENTIAL PARCEL FOREST LAKES
CTL|T PROJECT NO. CS-10,585

Summary Logs of Exploratory Borings

FIG. C-2



NOTES:

1. THE BORINGS WERE DRILLED FEBRUARY 18 AND MARCH 6, 2000 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT, TRUCK-MOUNTED, POWER AUGER.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.

LEGEND:

TOPSOIL.

SAND, SILTY TO GRAVELLY WITH CLAY AND GRAVEL LENSES AND OCCASIONAL COBBLES, LOOSE TO VERY DENSE, SLIGHTLY MOIST, REDDISH BROWN. (SM)

SAND, CLAYEY TO GRAVELLY WITH SILT AND GRAVEL LENSES AND OCCASIONAL COBBLES, MEDIUM DENSE TO VERY DENSE, SLIGHTLY MOIST, REDDISH BROWN. (SC)

SAND, GRAVELLY AND SILTY WITH CLAY AND GRAVEL LENSES AND OCCASIONAL COBBLES, LOOSE TO VERY DENSE, SLIGHTLY MOIST, REDDISH BROWN. (SW-SM)

BEDROCK. SANDSTONE, HARD TO VERY HARD, MOIST, OLIVE.

BEDROCK. CEMENTED SANDSTONE, VERY HARD, MOIST, OLIVE.

DRIVE SAMPLE. THE SYMBOL 16/12 INDICATES 16 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.

▼ GROUNDWATER LEVEL MEASURED FOURTEEN TO FORTY-FIVE DAYS AFTER DRILLING.

SHUCK INTERESTS
RESIDENTIAL PARCEL FOREST LAKES
CTL|T PROJECT NO. CS-10,585

Summary Logs of Exploratory Borings

FIG. C-3

TABLE C-1

SUMMARY OF LABORATORY TESTING
CTL|T JOB NO. CS-10,585

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	SWELL TEST RESULTS* SWELL (%)	SWELL TEST RESULTS* SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	DESCRIPTION
TH-19	9	1.9	97			-2.0		5	SAND, GRAVELLY WITH SILT (SW-SM)
	24	10.5	122					53	BEDROCK, CLAYSTONE
TH-20	4	2.6						4	SAND, GRAVELLY WITH SILTY (SW)
	9	2.4	96					13	SAND, (SM)
	24	9.4	114			0.0			BEDROCK, SANDSTONE
	34	9.7	122						BEDROCK, SANDSTONE
TH-21	4	12.0	122	27	16	-0.1			SAND (SC)
	9	9.2	126			0.4		49	BEDROCK, SANDSTONE
TH-22	4	6.8	104					29	SAND, SILTY WITH GRAVEL (SM)
	9	15.5	91			-0.3			SAND (SC)
	19	11.0						35	SAND, CLAYEY WITH GRAVEL (SC)
	24	8.9	112						BEDROCK, SANDSTONE
TH-23	4	6.6	100			-5.5		35	SAND, CLAYEY WITH GRAVEL (SC)
	9	2.4						8	SAND, GRAVELLY WITH SILT (SW-SM)
	24	9.8	118					45	BEDROCK, SANDSTONE
TH-24	4	2.4						8	SAND, GRAVELLY WITH SILT (SW-SM)
	9	3.2	110			-2.8			SAND (SM)
TH-25	4	3.9	110	NL	NV	-2.7		15	SAND (SM)
	9	11.2	117					22	SAND, SILTY WITH GRAVEL (SM)
	29							28	SAND, CLAYEY WITH GRAVEL (SC)

* SWELL MEASURED WITH 1000 PSF APPLIED PRESSURE.
NEGATIVE VALUE INDICATES COMPRESSION.

TABLE C-1

SUMMARY OF LABORATORY TESTING
CTL|T JOB NO. CS-10,585

				ATTERBERG LIMITS		SWELL TEST RESULTS*		PASSING	
BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SWELL (%)	SWELL PRESSURE (PSF)	NO. 200 SIEVE (%)	DESCRIPTION
TH-26	9							20	SAND, SILTY WITH GRAVEL (SM)
	14							50	SANDSTONE / CLAYSTONE
TH-27	4	2.1						6	GRAVEL, SANDY WITH SILT (GP)
	14	8.0	85	NL	NV			14	SAND, GRAVELLY WITH SILTY (SM)
	24	9.9	113	28	9			26	BEDROCK, SANDSTONE
TH-28	4	36.9	86	34	19	-0.4		34	SAND, CLAYEY WITH GRAVEL (SC)
	14	8.9	94						BEDROCK, SANDSTONE
TH-29	4	3.8	127			0.1		22	BEDROCK, SANDSTONE
TH-30	4	5.1	110					12	SAND, SILTY WITH GRAVEL (SW-SM)
	19	6.4	111					11	SAND (SM)
TH-31	4	11.3	120			0.0		54	CLAY (CL)
	14	12.0	117			0.1		35	SAND (SC)
TH-32	9	6.7						16	SAND, SILTY, GRAVELLY (SM)
	19	2.1						6	SAND, GRAVELLY WITH SILT (SW-SM)

* SWELL MEASURED WITH 1000 PSF APPLIED PRESSURE.
NEGATIVE VALUE INDICATES COMPRESSION.

APPENDIX D

GUIDELINE SITE GRADING SPECIFICATIONS
FOREST LAKES SUBDIVISION (PHASE 2)
EL PASO COUNTY, COLORADO

GUIDELINE SITE GRADING SPECIFICATIONS
FOREST LAKES SUBDIVISION (PHASE 2)
EL PASO COUNTY, COLORADO

1. DESCRIPTION

This item consists of the excavation, transportation, placement and compaction of materials from locations indicated on the plans, or staked by the Civil Engineer, as necessary to achieve preliminary pavement and building pad elevations. These specifications also apply to compaction of materials that may be placed outside of the project.

2. GENERAL

The Geotechnical Engineer will be the Owner's representative. The Geotechnical Engineer will approve fill materials, method of placement, moisture contents and percent compaction.

3. CLEARING JOB SITE

The Contractor shall remove all trees, brush and rubbish before excavation or fill placement is begun. The Contractor shall dispose of the cleared material to provide the Owner with a clean, neat appearing job site. Cleared material shall not be placed in areas to receive fill or where the material will support structures of any kind.

4. SCARIFYING AREA TO BE FILLED

All topsoil, vegetable matter, and existing fill shall be removed from the ground surface upon which fill is to be placed. The surface shall then be plowed or scarified until the surface is free from ruts, hummocks or other uneven features that would prevent uniform compaction by the equipment to be used.

5. PLACEMENT OF FILL ON NATURAL SLOPES

Where natural slopes are steeper than 20 percent (5:1, horizontal to vertical) and fill placement is required, horizontal benches shall be cut into the hillside. The benches shall be at least 12 feet wide or 1-1/2 times the width of the compaction equipment and be provided at a vertical spacing of not more than 5 feet (minimum of two benches). Larger bench widths may be required by the Geotechnical Engineer. Fill shall be placed on completed benches as outlined within this specification.

6. COMPACTING AREA TO BE FILLED

After the foundation for the fill has been cleared and scarified, it shall be disced or bladed until it is free from large clods, brought to a workable moisture content and compacted.

7. FILL MATERIALS

Fill soils shall be free from vegetable matter or other deleterious substances and shall not contain rocks or lumps having a diameter greater than six (6) inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Civil Engineer or imported to the site.

8. MOISTURE CONTENT

For fill material classifying as CH or CL, the fill shall be moisture treated to between 1 and 4 percent above optimum moisture content as determined by ASTM D 698 if it is to be placed within 15 feet of the final grade. For deep cohesive fill (greater than 15 feet below final grade) it shall be moisture conditioned to within ±2 percent of optimum. Soils classifying as SM, SC, SW, SP, GP, GC and GM shall be moisture treated to within 2 percent of optimum moisture content as determined by ASTM D 1557. Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas.

The Contractor may be required to add moisture to the excavation materials in the borrow area if, in the opinion of the Geotechnical Engineer, it is not possible to obtain uniform moisture content by adding water on the fill surface. The Contractor may be required to rake or disc the fill soils to provide uniform moisture content throughout the soils.

The application of water to embankment materials shall be made with any type of watering equipment approved by the Geotechnical Engineer, which will give the desired results. Water jets from the spreader shall not be directed at the embankment with such force that fill materials are washed out.

Should too much water be added to any part of the fill, such that the material is too wet to permit the desired compaction to be obtained, all work on that section of the fill shall be delayed until the material has been allowed to dry to the required moisture content. The Contractor will be permitted to rework wet material in an approved manner to hasten its drying.

9. COMPACTION OF FILL AREAS

Selected fill material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted to not less than the specified percentage of maximum density. Granular fill placed less than 15 feet below final grade shall be compacted to at least 95 percent of maximum dry density as determined in accordance with ASTM D 1557. Cohesive fills placed less than 15 feet below final grade shall be compacted to at least 95 percent of maximum dry density as determined in accordance with ASTM D 698. For deep, cohesive fill (to be placed 15 feet or deeper below final grade), the material shall be compacted to at least 98 percent of maximum standard Proctor dry density (ASTM D 698). Granular fill placed more than 15 feet below final grade shall be compacted to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557). Deep fills shall be placed within 2 percent of optimum moisture content. Fill materials shall be placed such that the thickness of loose materials does not exceed 10 inches and the compacted lift thickness does not exceed 6 inches.

Compaction, as specified above, shall be obtained using sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved by the Geotechnical Engineer for soils classifying as claystone, CL, CH or SC. Granular fill shall be compacted using vibratory equipment or other equipment approved by the

Geotechnical Engineer. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over the entire area. Compaction equipment shall make sufficient trips to ensure that the required density is obtained.

10. COMPACTION OF SLOPES

Fill slopes shall be compacted by means of sheepsfoot rollers or other suitable equipment. Compaction operations shall be continued until slopes are stable, but not too dense for planting, and there is no appreciable amount of loose soil on the slopes. Compaction of slopes may be done progressively in increments of 3 to 5 feet in height or after the fill is brought to its total height. Permanent fill slopes shall not exceed 3:1 (horizontal to vertical).

11. DENSITY TESTS

Field density tests will be made by the Geotechnical Engineer at locations and depths of his/her choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests will be taken in compacted material below the disturbed surface. When density tests indicate the density or moisture content of any layer of fill or portion thereof is below that required, the particular layer or portion shall be reworked until the required density or moisture content has been achieved. The criteria for acceptance of fill shall be:

A. Moisture:

The allowable ranges for moisture content of the fill materials specified above in "Moisture Content" are based on design considerations. The moisture shall be controlled by the Contractor so that moisture content of the compacted earth fill, as determined by tests performed by the Geotechnical Engineer, shall be within the limits given. The Geotechnical Engineer will inform the Contractor when the placement moisture is less than or exceeds the limits specified above and the Contractor shall immediately adjust the procedures as necessary to maintain placement moisture content within the specified limits.

B. Density:

1. The average dry density of all material shall not be less than the dry density specified.

2. No more than 20 percent of the material represented by the samples tested shall be at dry densities less than the dry density specified.

3. Material represented by samples tested having a dry density more than 2 percent below the specified dry density will be rejected. Such rejected materials shall be reworked until a dry density equal to or greater than the specified dry density is obtained.

12. SEASONAL LIMITS

No fill material shall be placed, spread or rolled while it is frozen, thawing, or during unfavorable weather conditions. When work is interrupted by heavy precipitation, fill operations shall not be resumed until the Geotechnical Engineer indicates the moisture content and density of previously placed materials are as specified.

13. NOTICE REGARDING START OF GRADING

The Contractor shall submit notification to the Geotechnical Engineer and owner advising them of the start of grading operations at least three (3) days in advance of the starting date. Notification shall also be submitted at least three days in advance of any resumption dates when grading operations have been stopped for any reason other than adverse weather conditions.

14. REPORTING OF FIELD DENSITY TESTS

Density tests made by the Geotechnical Engineer, as specified under “Density Tests” above, will be submitted progressively to the Owner. Dry density, moisture content and percent compaction will be reported for each test taken.

Markup Summary

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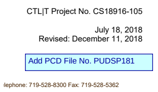
CTL|T Project No. CS18916-105
July 18, 2018
Revised: December 11, 2018
Add PCD File No. PUDSP181
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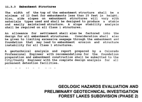
GEOLOGIC HAZARDS EVALUATION AND
PRELIMINARY GEOTECHNICAL INVESTIGATION
FOREST LAKES SUBDIVISION (PHASE 3)

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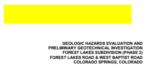
GEOLOGIC HAZARDS EVALUATION AND
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FOREST LAKES SUBDIVISION (PHASE 3)
FOREST LAKES ROAD & WEST BAPTIST ROAD
COLORADO SPRINGS, COLORADO

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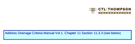

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Address Drainage Criteria Manual Vol 1. Chapter 11 Section 11.3.3 (see below)