GEOLOGIC HAZARDS EVALUATION AND PRELIMINARY GEOTECHNICAL INVESTIGATION AMARA RESIDENTIAL DEVELOPMENT NORTHEAST OF LINK AND SQUIRREL CREEK ROADS EL PASO COUNTY, COLORADO

Prepared for:

LA PLATA COMMUNITIES
1755 Telestar Drive, Suite 211
Colorado Springs, Colorado 80920

Attention: Steve Rossoll, P.E.

CTL|T Project No. CS19053.001-115

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5170 Mark Dabling Blvd | Colorado Springs, Colorado 80918 | Telephone: 719-528-8300 Fax: 719-528-5362

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SCOPE

This report presents the results of our Geologic Hazards Evaluation and Preliminary Geotechnical Investigation for a 2,500-acre portion of AMARA property in El Paso County, Colorado. Two preliminary geotechnical investigations were previously prepared for the remaining 700 acres of the AMARA property, for a property total of 3,200 acres. Our purpose was to evaluate the parcel for the occurrence of potential geologic hazards and geotechnical conditions that we believe impact development of the site, and to provide preliminary geotechnical design concepts. We understand the property is planned for the annexation into the City of Colorado Springs and development for mixed uses including various forms of residential, commercial, office and retail. We understand a Preliminary Geotechnical Investigation and Geologic Hazards Evaluation is required for property annexation into the City of Colorado Springs. This report includes a summary of subsurface and groundwater conditions found in our exploratory borings, a description of our engineering analysis of the geotechnical conditions at the site, and our opinion of the potential influence of the geologic conditions on the planned structures and other site improvements. The scope of our services was described in our proposal (CS-19-0014_CM2).

The report was prepared based on conditions interpreted from field reconnaissance of the site, review of geologic reports readily available, 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 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. We also performed a Phase I Environmental Site Evaluation of the property for the possible presence of potentially hazardous materials provided in a separate report (CTL|T Project No. CS19053.000-115). Assessment of the site for the potential for wildfire hazards, corrosive soils, erosion problems, or flooding is 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 believe preclude development of the 2,500-acre portion of the site for the construction planned. The conditions we identified on the property that may pose hazards or constraints to development include the presence of expansive clay soils and bedrock, potentially hard bedrock in the western portion of the site at depth, very hard bedrock in the extreme northern portion of the site exposed at the ground surface, and flood and erosion potential. 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. Subsurface conditions encountered in the seventeen exploratory borings drilled varies across the site. Conditions found in the majority of the borings (12 of 17 borings) consisted of natural sandy clay and clayey or silty sands at the ground surface and extending to depths of between 17 to deeper than 50 feet. Bedrock was identified at more shallow depths of between 3 and 13 feet in four of the borings, with one boring encountering bedrock at the ground surface. Relatively shallow claystone should be expected along the ridge located along the western edge of sections 26 and 35 (Township 15S, Range 65W) of the site. Moderately cemented sandstone outcroppings were observed along a ridge located in the northwest quarter of Section 7 (Township 15S, Range 64W) (TH-200).
3. At the time of drilling, groundwater was encountered in six of the exploratory borings at depths of 13 to 37 feet below the existing ground surface. Groundwater levels will vary with seasonal precipitation and landscaping irrigation.
4. In our opinion, site grading and utility installation across most of the site can be accomplished using conventional, heavy-duty construction equipment. If shale or moderately cemented sandstone bedrock is encountered, ripping may be required to expedite the process. Heavy duty track hoes with rock buckets and rock teeth will likely be needed for trenching into the shale and sandstone.
5. We believe conventional spread footing foundations designed to apply minimum deadload and slab-on-grade floors will be appropriate for most of the structures constructed at this site, provided a zone of the expansive materials are excavated and re-placed as fill compacted to high density at moisture contents above optimum. Post-tension slab-on-grade foundations on a similar fill zone is an alternative. Straight-shaft, drilled pier foundations and structurally supported floors may be the more reliable

alternative where bedrock occurs at shallow depth. Shallow foundations may be constructed without a layer of sub-excavation in areas containing granular, non-expansive soils.

6. We believe a low risk of poor, long-term performance (movement and damage) will exist for conventional slab-on-grade floors underlain by densely compacted, grading fill placed at high moisture contents. The risk of poor performances is judged to be high without subgrade mitigation. Structurally supported floors (crawl space construction) below the slab may be appropriate alternatives to enhance floor system performance.

7. 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

AMARA is an approximately 3,200-acre parcel located east of Link Road and north of Squirrel Creek Road. The portion of the property included in this report consist of about 2,500 acres. The overall location is shown in Fig. 1. The site is located West of the 6th Principal Meridian, within El Paso County, Colorado within the following:

- West half of Section 7, Township 15 South, Range 64 West;
- West half of Sections 19 and 30, Township 15, Range 64 West;
- South half of the north half and south half of Section 25, Township 15 South, Range 65 West;
- South half of the south half of Section 26, Township 15 South, Range 65 West;
- Section 35, Township 15 South, Range 65 West;
- West half of Section 34, Township 15 South, Range 65 West; and,
- South half of the southeast quarter of Section 27, Township 15 South, Range 65 West.

The parcel is currently being used as ranch land and cattle grazing with a small area of irrigation and crop land consisting of alfalfa grass. Approximately 100 acres located on the western edge of the property consists of irrigated crop consisting of alfalfa grass. Vacant land is to the east of the site. Link Road is present to the west and Squirrel Creek Road borders the site on the south. Scattered residences, the Peaceful Valley Estates, are located to the north and west of the site. A Colorado Interstate Gas Line is located in the western portion of the site, crossing the west half of Section 34 of the site in a north-south direction. A high voltage high tension electrical power line and the

Southern Delivery System pipeline cross the site in a north-south direction, located along the eastern edges of Sections 26 and 35. A major drainage named Williams Creek is located in a north-south direction along and bisecting Sections 19 and 30. Fountain Ditch is in the west half of Section 34. The property is predominately covered with grasses and weeds and is primarily used as cattle range land. The ground surface predominately consists of gently rolling hills separated by local creeks and minor creek tributaries. Overall, the ground surface generally slopes gently downward toward the south. Elevations range from approximately 6,035 in the northern portion of the site near Bradley Road and approximately 5,590 along the south side of the site, adjacent to Squirrel Creek Road.

PROPOSED DEVELOPMENT

We were not provided concept development plans for the site prior to our investigation. We understand the property is planned for mixed use development, primarily including residential, but is also to include commercial, office, and retail. We anticipate the residences will be one and two-story, wood-frame structures with basement areas and attached, multi-automobile garages. We anticipate the structures will be serviced by a centralized sanitary sewer collection system and potable water distribution system. Paved access roads are typically constructed within similar developments. Grading plans had not been developed at the time this report was prepared. We expect local knobs of hills and ridges will be somewhat leveled during the grading process and the cut materials placed, used to fill the lower lying valleys, requiring cuts and fills of about 10 feet.

PREVIOUS INVESTIGATION

We performed a preliminary geotechnical investigation for the 400-acre western part of the property, located in the east half of Section 33 and the west half of Section 34, under CTL|T Project No. CS19053.001-115 R1, report dated April 1, 2019. Two supplemental letters were issued for the site discussing our findings from additional exploratory borings drilled for the site. Our findings are discussed in the report and supplemental letters.

SUBSURFACE INVESTIGATION

Subsurface conditions for this portion of the site were investigated by drilling seventeen exploratory borings at the approximate locations shown in Figs. 1 through 4. Graphical logs of the conditions found in our exploratory borings, the results of field penetration resistance tests, and some laboratory data are presented in Appendix A. Swell consolidation testing and grain size analysis test results are presented in Appendix B and summarized in Table B-1.

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, sieve analysis (passing the No. 200 sieve), Atterberg limits, 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).

SUBSURFACE CONDITIONS

Subsurface conditions encountered in the seventeen exploratory borings drilled for this portion of the property predominately consisted of up to 37 feet of natural, sandy to very sandy clay and up to 38 feet of natural, silty to clayey sand. Generally, the sand and clay were found to be more moist with depth. Claystone bedrock was encountered in fourteen of the borings at depths ranging from 3 to 41 feet below the existing ground surface. Sandstone was encountered at the ground surface in one boring, and shale was encountered in three of the borings at depths of 22 to 46 feet. Bedrock occurs at shallow depths in the western portion of the site, along a local ridge located on the west edge of Sections 26 and 35 (Township 15 South Range 65 West) (TH-209, TH-211, and TH-214) and in the northern portion of the site along a separate ridge located in the northeast quarter of Section 7 (Township 15 South Range 64 West) (TH-200). Some of the pertinent engineering characteristics of the soils and bedrock encountered and groundwater conditions are discussed in the following paragraphs.

Sand

Natural, slightly silty to very silty, and clayey to very clayey sand was encountered at the ground surface or below natural clay in six of the borings. The sand was loose to medium dense and became more moist to wet with depth. Seven samples of the sand tested in our laboratory contained 5 to 47 percent clay and silt-sized particles (passing the No. 200 sieve). Based on our experience, the sand soils are considered non-expansive or slightly expansive when wetted under estimated overburden pressures. Atterberg limits testing was performed for one sample of the natural sands. The sand was non-plastic.

Clay

Natural slightly sandy to very sandy clay was encountered at the ground surface or below natural sands in fifteen of the borings. The clay was soft to very stiff. The clay was slightly moist at the surface and became more moist to wet with depth. Twenty-eight samples of the clay tested in our laboratory contained 59 to 93 percent clay and silt-sized particles (passing the No. 200 sieve). Twenty-one samples of the clay subject to swell-consolidation testing exhibited measured swell values of 0.3 to 6.5 percent. Three samples exhibited consolidation between 0.1 and 0.6 percent. All samples were wetted under estimated overburden pressures. We believe the clay sample that exhibited consolidation had been disturbed during sampling as it was slightly moist. Four of the samples are judged to exhibit high to very high expansion potential. Four samples of the clay were subjected to Atterberg limits testing. Liquid Limits ranged from 29 to 43 and plasticity indices ranged from 8 to 23.

Bedrock

Claystone, sandstone, and shale bedrock were encountered in fifteen of the borings below the natural soils at depths between 3 and 41 feet below the ground surface. Bedrock was encountered at the ground surface in one boring (TH-200). A three-foot-thick layer of medium hard, weathered claystone was encountered in TH-206 at a depth of 13 feet. Bedrock was not encountered in two of the borings drilled to depths of 50 feet.

Slightly sandy to sandy claystone bedrock was encountered in fourteen of the borings at depths ranging from 3 feet to 41 feet and extended to a depth of 46 feet in one boring (TH-204) and to the maximum depth explored of 45 feet in boring TH-201. The claystone was underlain by shale in three of the borings at depths of 22 to 46 feet. The claystone was hard to very hard based on the results of field penetration resistance tests. Eleven samples of the claystone subjected to swell-consolidation testing exhibited measured swell values of 1.0 to 8.6 percent when wetted. Three samples of the claystone tested in our laboratory contained 84 to 91 percent clay and silt-sized particles (passing the No. 200 sieve). Based on existing published geologic mapping and findings during our drilling operation, the claystone bedrock should be expected to occur at shallow depths in the western portions of the site, along the west boundary of Sections 26 and 35 of the site.

Sandstone bedrock outcroppings were observed in the northern portion of the site, northeast quarter of Section 7 (TH-200). The sandstone was judged to be moderately cemented and very hard based on field penetration resistance testing. We judge the sandstone to be non-expansive or exhibit slight expansion when wetted. Additionally, shale was identified in three borings at the site. The shale was found underlying the claystone at depths of 22 to 46 feet below the ground surface and extended to the maximum depth explored of 50 feet. We judge the shale of be non-expansive or exhibit slight expansion when wetted.

Groundwater

At the time of drilling, groundwater was encountered in six of the exploratory borings at depths between 13 and 37 feet below the existing ground surface. Delayed groundwater level checks could not be performed as we were locked out of the site. Groundwater was measured in three of the six borings at 20 feet or more below the existing ground surface. The remaining three borings measured groundwater levels between 13 and 17 feet. Groundwater levels will vary with seasonal precipitation, flows in Jimmy Camp Creek and landscaping irrigation.

SITE GEOLOGY

Geologic conditions were evaluated through the review of published geologic maps, field reconnaissance, and exploratory borings. Information from these sources was used to produce our interpretation of site geology, as shown in Figs. 6 through 9. A list of references is included at the end of this report.

The 2,500-acre AMARA development is situated directly east of Fountain Creek as well as east of Jimmy Camp Creek, and a more local tributary of Fountain Creek. The property covered with grasses and isolated trees and was used as pastureland as well as for irrigated agriculture land, irrigation by canal named the Fountain Ditch. Gently rolling hills and valleys are found throughout the site. Overall, the ground surface of the site slopes generally downward from north to south. The valleys generally run in a north to south direction.

Most of the areas at the lower elevations (valleys) are covered by recent alluvial-colluvial and Loess deposits composed of slightly sandy to very sandy clay, as well as slightly silty to very silty and clayey to very clayey sand deposited by streams, sheet-wash, and wind from the adjacent Pierre Shale hills. Early Holocene-age eolian deposits (sand and clay deposited by wind) form the small hills located in the middle of the site. Bedrock is from the Cretaceous-aged Pierre Shale formation, composed of claystone over shale. The Pierre Shale formation generally forms low colluvium-covered slopes. When exposed, the material readily weathers into residual soil. The following sections discuss the mapped units. Figures 6 through 9 shows our interpretation of site geology, and Figures 10 through 13 shows our interpretation of engineering conditions.

Surficial Deposits (Qp, Qlo)

Our borings encountered 3 to 37 feet of slightly sandy to very sandy clay as well as slightly silty to very silty and clayey to very clayey sand soils. The surficial materials mapped as “Qp” is considered as being sheet-wash and stream deposited pediment gravel, alluvium, and colluvium materials. The surficial soils mapped as “Qlo” are considered as Loess (wind-blown) deposits. The alluvium-colluvium are more recent deposits superimposed over the Loess deposits in flatter areas. These soils are geologically recent, Holocene and Pleistocene-age deposits. The surficial clay alluvium-colluvium and Loess deposits exhibited low to high expansion potential. Our testing indicated the clays found (Qp areas) possess mainly high to very high expansion potential.

Bedrock (Kp, Kps)

We encountered hard to very hard claystone, sandstone and shale bedrock underlying the surficial sands and clays in fifteen of our seventeen test holes recently drilled. Geologic mapping suggests the claystone bedrock may occur more shallow in the most western portion of the site and sandstone occurs at shallow depths or at the ground surface in the northeast portion of the site. The materials are from the Cretaceous-aged Pierre Shale formation (Map Unit Kp), predominately fine-grained, claystone over shale and predominately fine-grained sandstone (Map unit Kps). The formation tends to generally form low, colluvium covered slopes. The parent shale bedrock is fissile and tends to fracture more easily along the bedding plane. The Pierre Shale formation exhibits a gentle dip toward the east. The claystone develops from geologic weathering of the shale. The claystone portion of this formation can exhibit expansion potentials ranging from low to very high.

GEOLOGIC HAZARDS AND ENGINEERING CONSTRAINTS

We did not identify geologic hazards that we believe preclude development of the project for the planned purpose. Conditions we identified at the site that may pose hazards or constraints to development include expansive soil and bedrock and erosion potential. 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. These conditions are discussed in greater detail in the sections that follow.

The Engineering Geology classification developed by Charles Robinson (1977) was considered for evaluation of the parcel of the AMARA development and is mapped as described below. These areas are typically adjacent to physiographic flood plains that are undergoing active bank erosion. The civil engineer should determine the flood potential and inundation areas for site design. The other issues are site-wide concerns and are not depicted in Figs. 10 through 13.

Map Unit “2A” Stable alluvium, colluvium, and bedrock on gentle to moderate slopes (5% -12%). Emphasis on surface and subsurface drainage (0-12%).

Map Unit “2D” Eolian deposits generally flat to gentle slopes of upland areas.

Map Unit “2E” Low terraces and valleys of minor tributary streams subject to periodic high flows, sheet flooding, and stream bank erosion. Emphasis on surface and subsurface drainage.

Map Unit “3B” depicts expansive and potentially expansive alluvium, colluvium and bedrock on flat to moderate slopes (0-12%).

Map Unit “7A” depicts physiographic floodplain and special flood hazard areas. Erosion and deposition presently occur and is generally subject to recurrent flooding.

Expansive Soils

Testing showed the alluvium-colluvium soils (Qac, Qp) and claystone bedrock (Kp) are 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 to create a layer of low-swelling, moisture conditioned fill, as discussed later in the report.

Flooding

Information presented in the “Flood Insurance Rate Map” (FIRM), Map Numbers 08041C0959G, 08041C10000G, 08041C0976G, and 08041C0790G, effective date December 7, 2018, indicates the areas of lower elevation directly adjacent to Williams Creek (Sections 19 and 30, Township 15 South, Range 64 West) physiographic floodplain has a 1% annual chance flood hazard (100-year flood). The area along Williams Creek has no base flood elevation determined, according to mapping. The majority of proposed development is located outside areas mapped as prone to surface flooding. The project Civil Engineer should determine the flood potential and design surface drainage.

Erosion

The subject parcel contains shallow to moderately steep slopes in areas adjacent to local drainages found within the valleys of the site. Site soils are dry clays and sands, and are susceptible to the effects of water erosion, especially along the creek and drainage banks. Maintaining vegetative cover and providing engineered surface drainage will reduce the potential for erosion.

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). We believe the soils on the property classify as Site Class D (stiff soil) according to the 2015 International Building Code (2015 IBC).

Economic Minerals and Underground Mines

We doubt the material we encountered in our borings could be economically mined or permitted given its small extent and surrounding land uses. Energy fuels such as uranium, oil, and gas may or may not be present. The bedrock formation found historically does not contain mineable lenses of coal.

Radon and Radioactivity

We believe no unusual hazard exists from naturally occurring sources of radioactivity on this site. The cited study indicates the materials found in our borings are not likely associated with the production of radon gas and concentrations in excess of EPA guidelines. 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.

SITE DEVELOPMENT CONSIDERATIONS

From an engineering point-of-view, the more significant subsurface conditions impacting construction is the occurrence of expansive materials. The following sections discuss the impact of these conditions on development and possible methods of mitigation.

Site Grading

Grading plans were not provided to us prior to our investigation. We believe excavation into the soils and claystone bedrock can be accomplished using conventional heavy-duty equipment. Bedrock may occur at shallow depths to the west and east. Where the bedrock occurs at shallow depths, very hard shale bedrock may be encountered below the claystone. Very hard sandstone was encountered at the ground surface in the northern portion of the site (TH-200). Cuts into the very hard sandstone and shale bedrock (if found) will likely require ripping to expedite the excavation process. 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.

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 a depth that exposes more 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.

Areas of highly expansive clays and claystone are present across the site. Where clays or claystone are present at or near final grades, sub-excavation of up to about 6 feet may be appropriate in high volume streets and 10 feet below and outside structures. Areas containing granular soils near and at anticipate foundation elevations may not require sub-excavation for new, shallow foundations. Loose granular soils may require sub-excavation to stabilize subsurface soils prior to construction.

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 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. We do not expect benching will be needed.

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 general grading fill composed of cohesive soils (clays and very clayey sands) and claystone 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 standard Proctor dry density (ASTM D 698). We recommend grading fill composed of silty sands containing less than 35 percent passing the number 200 sieve 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). Placement and compaction of the grading fill should be observed and tested by our representative during construction. Guideline specifications for overlot grading are presented in Appendix C.

Buried Utilities

Over most of the site, we believe utility trench excavation into the clay soils and claystone bedrock can be accomplished using heavy-duty track hoes. Although shale was not encountered at depths believed to impact development, moderately cemented sandstone was observed at the ground surface in the northeastern portion of Section 7, northern portion of the site. Claystone bedrock was found to be shallow in the western portion of the site, along a ridge located along the west edges of Sections 26 and 35. Near surface and surface sandstone bedrock was encountered in the northern portion of the site, northeast portion of Section 7. The sandstone is judged to be moderately cemented. Rock buckets and rock teeth may be needed where utility excavations extend well into the shale and sandstone formations. Utility contractors should be made aware of this possibility and anticipate slower rates of utility installation in the shale and sandstone 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 soils and grading fill will classify as Type C materials. The bedrock will likely classify as Type B. 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. Groundwater seepage may be experienced along local drainages within valleys. 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. 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 should include 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 upstream 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 are encountered in the sanitary sewer trench, we recommend an active underdrain system with perforated or slotted pipe for these areas. 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. 14 and 15.

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

With a few exceptions, the borings drilled during our investigation indicate expansive clay and claystone are present at depths likely to affect the performance of shallow foundation and slabs-on-grade for the majority of the site. Based on a 24-foot depth of wetting, we estimate potential ground heave of about 10 inches where thick deposits of clay and claystone occur at shallow depths. To reduce the impact of the expansive materials on shallow foundations, improve slab performance, and create a more uniform layer of support, the expansive clays and claystone bedrock conceptually should be removed below proposed footing elevations to depths preliminarily up to 10-feet or until natural, non to low expansion potential sands are encountered, whichever comes first. The thickness and composition of grading fill influence the appropriate depths of treatment. The clay and claystone that have been sub-excavated should be replaced, moisture conditioned to between 1 and 4 percent above optimum, and densely compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D 698). This procedure has been successfully used in the Pikes Peak Region and results in spread footing foundations and slab-on-grade floors being appropriate.

Some areas of the site were identified by our exploratory borings (TH-202 and TH-205) as containing granular soils at the ground surface and extending to depths of between 6 and 27 feet. Granular soils found at the ground surface were located along Williams Creek, located bisecting the portion of the site within Sections 19 and 30. Sub-excavation below new foundations may be sporadic in these areas and may not be necessary. Sub-excavation of loose granular soils may be necessary to stabilize the sub-surface soils in preparation of construction. Risk of foundation damage associated with expansive soils and poor slab performance is considered low in these areas.

For areas containing expansive soils and bedrock, the risk of slab movement and cracking is believed to be low to possibly moderate if they are underlain by new, densely compacted fill placed at high moisture content as discussed. The risk of poor performance is judged to be very high without subgrade enhancement. Structurally supported floors (crawl space construction) may be an appropriate alternative to enhance floor system performance. 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 clays, sands, claystone bedrock, and new grading fill are expected to be the predominant pavement subgrade materials. Cohesive materials (clay, very clayey sand and claystone) normally exhibit poor subgrade support for pavements. Expansion of the subgrade materials can result in damage of pavements. Sub-excavation and moisture treatment of the subgrade materials may make sub-excavation of 4 to 6 feet appropriate depending on the classification of the roadway. We recommend replacing the sub-excavated clays with moisture conditioned and densely compacted on-site silty to clayey sands. This will improve pavement performance and may help to reduce the pavement thickness.

Based on our laboratory testing, a Hveem stabilometer ("R") value of 5 was assigned to the subgrade materials for preliminary design purposes. On a preliminary basis, we suggest budgeting for the pavement section for low volume streets consisting of 4 inches of asphalt over 6 to 8 inches of aggregate base course. Higher volume street pavement will likely require pavement section of 4+ inches of asphalt over 8 inches or more of aggregate base. Subgrade investigations and pavement design should be conducted after grading and utility installation are completed to develop site-specific pavement sections.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentration from multiple samples obtained across the site. Two samples from the borings drilling for this investigation contained water soluble sulfate concentrations of less than 0.1 percent. Based on our previous investigations located on the southwestern portion of the site, we measured water soluble sulfate concentrations in fourteen total samples between 0.14 and 3.2 percent. For this level of sulfate concentration, ACI 332-08 *Code Requirements for Residential Concrete* indicates concrete shall be made with ASTM C150 Type V cement, or an ASTM C595 or C1157 hydraulic cement meeting high sulfate-resistant hydraulic cement (HS) designation and shall have a specified minimum compressive strength of 4,000 or 4,500 psi at 28 days. Alternative combination of cements and supplementary cementitious materials, such as Class F fly ash, shall be permitted with acceptable test records for sulfate durability.

In our experience, superficial damage may occur to the exposed surfaces of highly permeable concrete. 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 have a total air content of 6% +/- 1.5%. We recommend all foundation walls and grade beams in contact with the subsoils (including the inside and outside faces of garage and crawl space grade beams) be damp-proofed.

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 areas. 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 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.

Patrick Foley, EI
Staff Engineer

Reviewed by:

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

COLORADO REGISTERED PROFESSIONAL ENGINEER
WILLIAM CHARLES HOFFMANN, JR.
12-9-21
19181

PF:WCH:cw
(electronic copy)

Via email: SRossoll@laplatallc.com

REFERENCES

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

2. Federal Emergency Management Agency, Flood Insurance Rate Map, Map Number 08041C0959G, 08041C0976G, 08041C1000G, and 08041C0790G , effective date December 7, 2018.

3. International Building Code (2015 IBC).

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

5. Scott, G.R., Taylor, R.B., Epis, R.C., and Wobus, R.A. (1976). Geologic Map of Pueblo 1 degree x 2 degrees quadrangle, south-central, Colorado, Colorado Geological Survey.

6. 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.

Edited 8/1/17

COLORADO SPRINGS
OLYMPIC CITY USA

Geologic Hazard Study Report

Applicant:	La Plata Communities, LLC	Telephone:	719-867-2256
Address:	9540 Federal Drive	Email:	chumphrey@laplatallc.com
City/State:	Colorado Springs, Colorado 80921	Fax:	
Zip Code:	80921		

The following documents have been included and considered as part of this report (checked off by individual(s) preparing the geologic report):

- [x] Development Plan
- [ ] Landscape Plan (if applicable)
- [ ] Grading Plan
- [ ] Drainage Report (necessary if debris and/or mud flow hazard is present)

ENGINEER'S STATEMENT

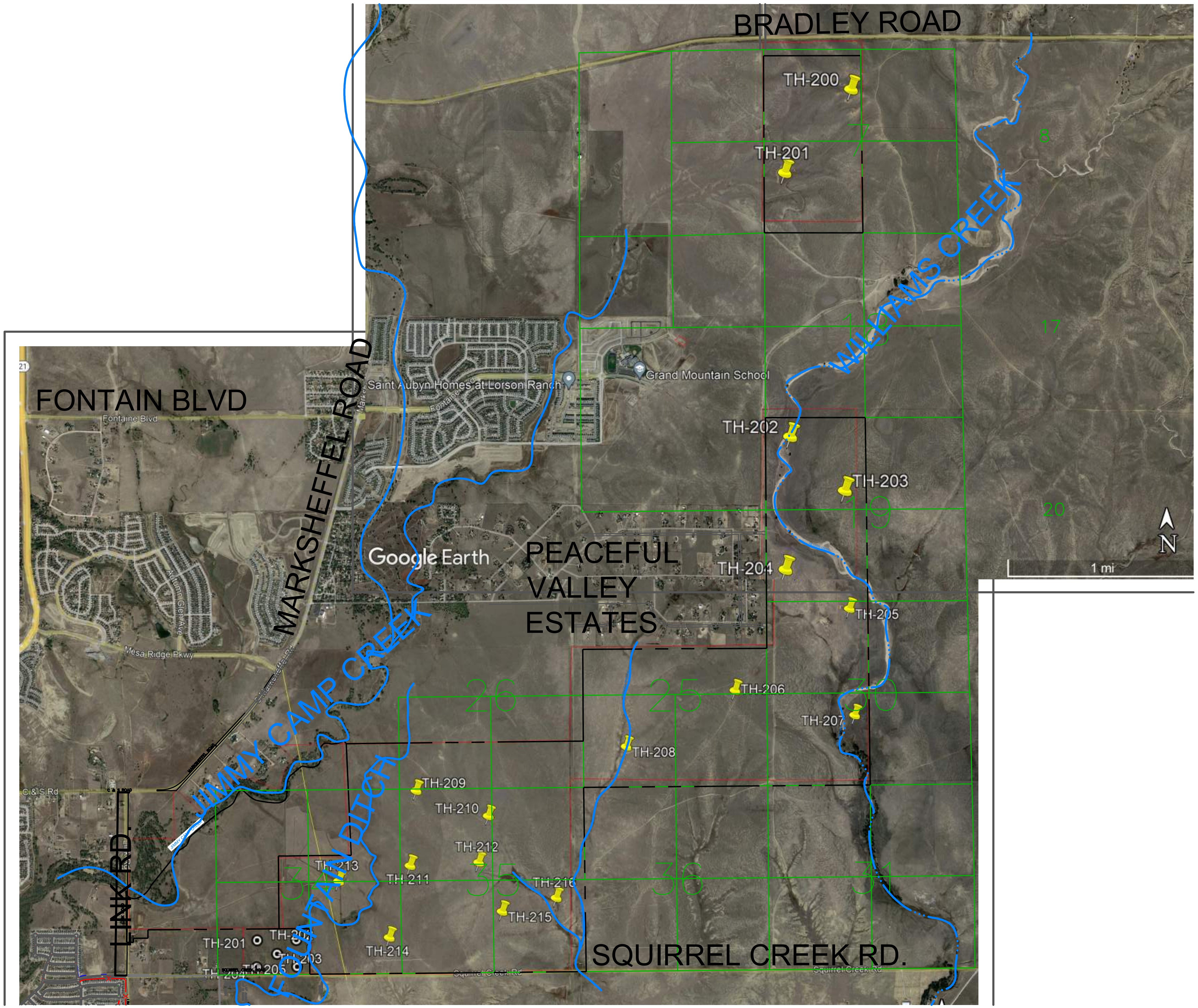
I hereby attest that I am qualified to prepare a Geologic Hazard Study in accordance with the provisions of Section 504 of the Geologic Hazards Ordinance of Colorado Springs. I am qualified as:

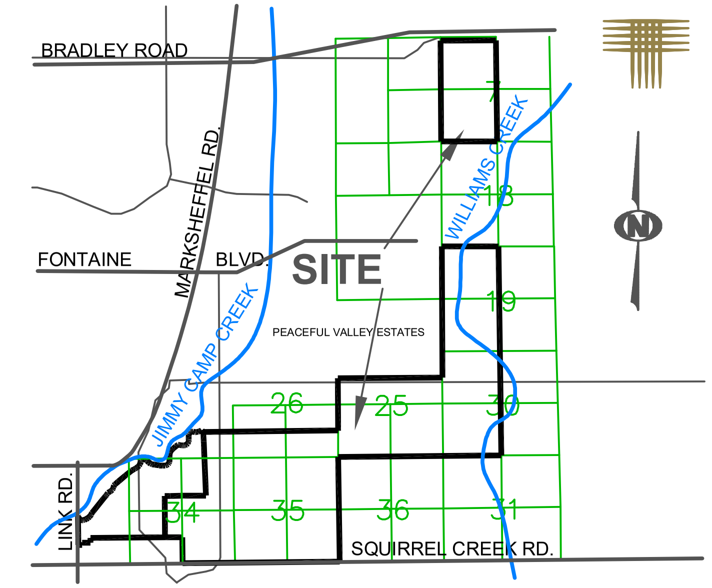
- [ ] A Professional Geologist as defined by CRS 34-1-201(3); or,
- [x] A Professional Engineer as defined by Board Policy Statement 50.2 - "Engineers in Natural Hazard Areas" of the Colorado State Board of Registration for Professional Engineers and Professional Land Surveyors. Board authority as defined by CRS 12-25-107(1).

Submitted by: CTL|Thompson, Inc. (Willaim C. Hoffmann, Jr.)   Date: May 11, 2022

This Geologic Hazard Study is filed in accordance with the Zoning Code of Colorado Springs, 2001, as amended.

City Engineer	**Date**	**Planning & Development Manager**	**Date**





VICINITY MAP

(NOT TO SCALE)

LEGEND:

25 SECTION NUMBER

QUARTER SECTION BOUNDARY

PROJECT BOUNDARY

0 1500' 3000'

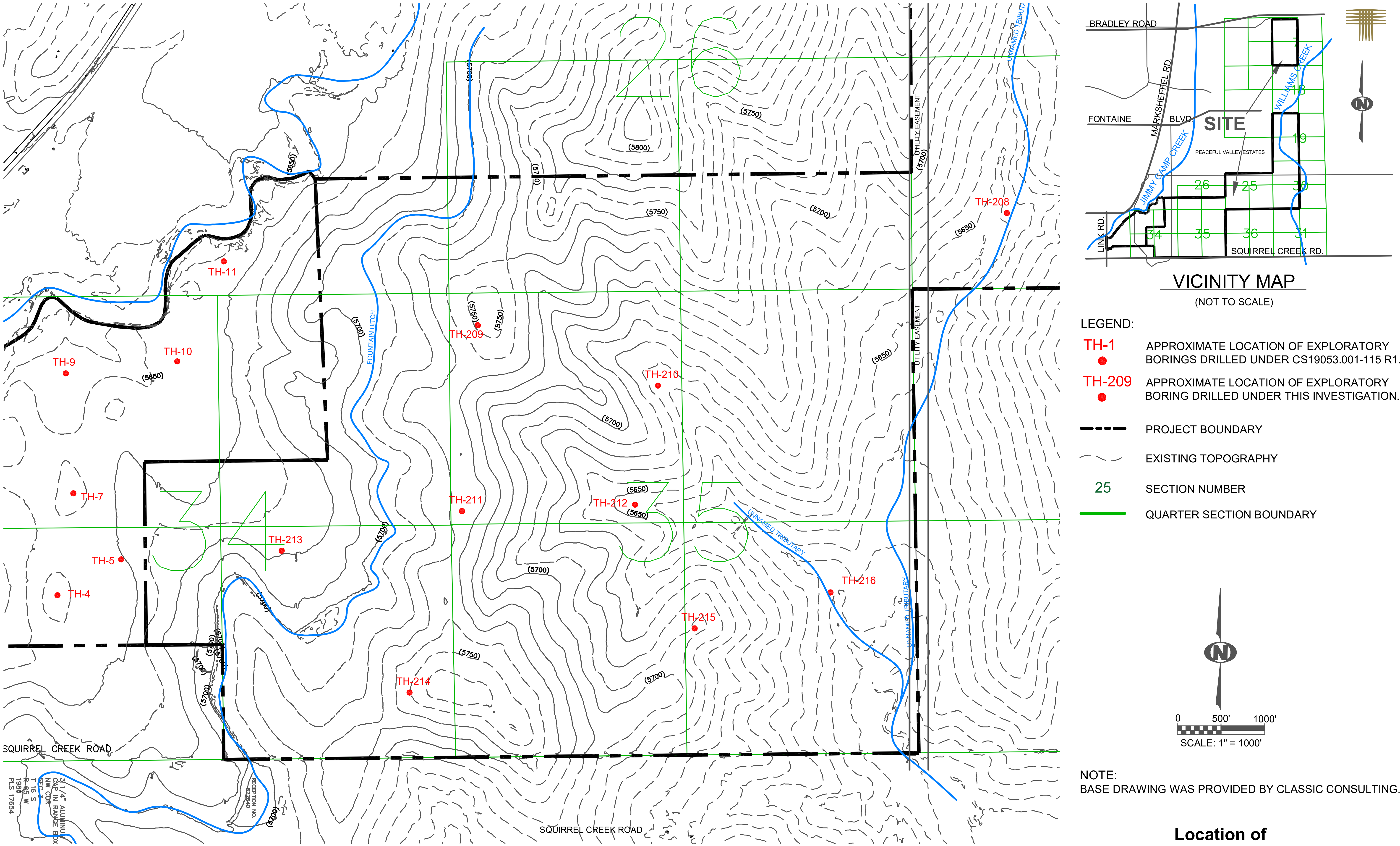
SCALE: 1" = 3000'

NOTE:
BASE DRAWING WAS PROVIDED BY CLASSIC CONSULTING.

LA PLATA COMMUNITIES
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Overall Locations of Exploratory Borings

FIG. 1

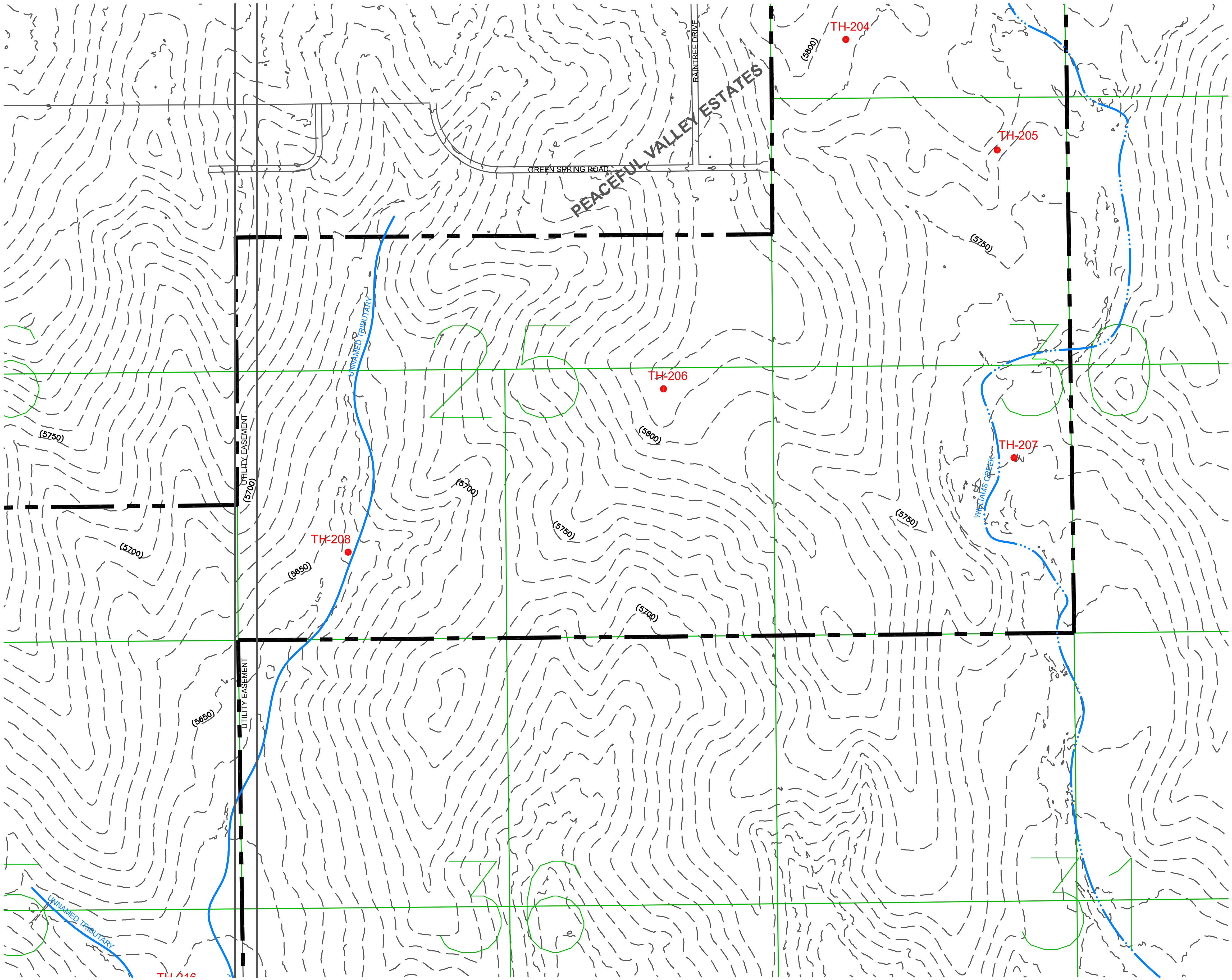


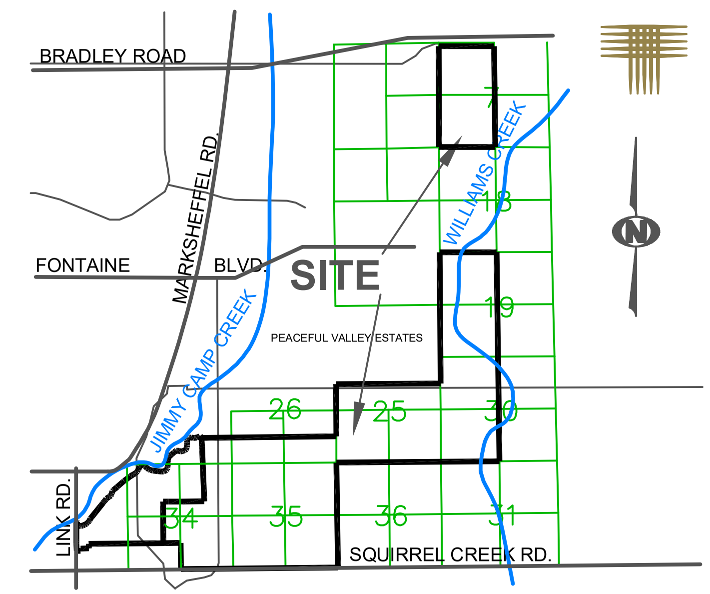
NOTE:
BASE DRAWING WAS PROVIDED BY CLASSIC CONSULTING.

LA PLATA COMMUNITIES
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Location of Exploratory Borings

FIG. 2





VICINITY MAP

(NOT TO SCALE)

LEGEND:

TH-204 ● APPROXIMATE LOCATION OF EXPLORATORY BORING.

PROJECT BOUNDARY

EXISTING TOPOGRAPHY

25 SECTION NUMBER

QUARTER SECTION BOUNDARY

0 500' 1000'

SCALE: 1" = 1000'

NOTE:
BASE DRAWING WAS PROVIDED BY CLASSIC CONSULTING.

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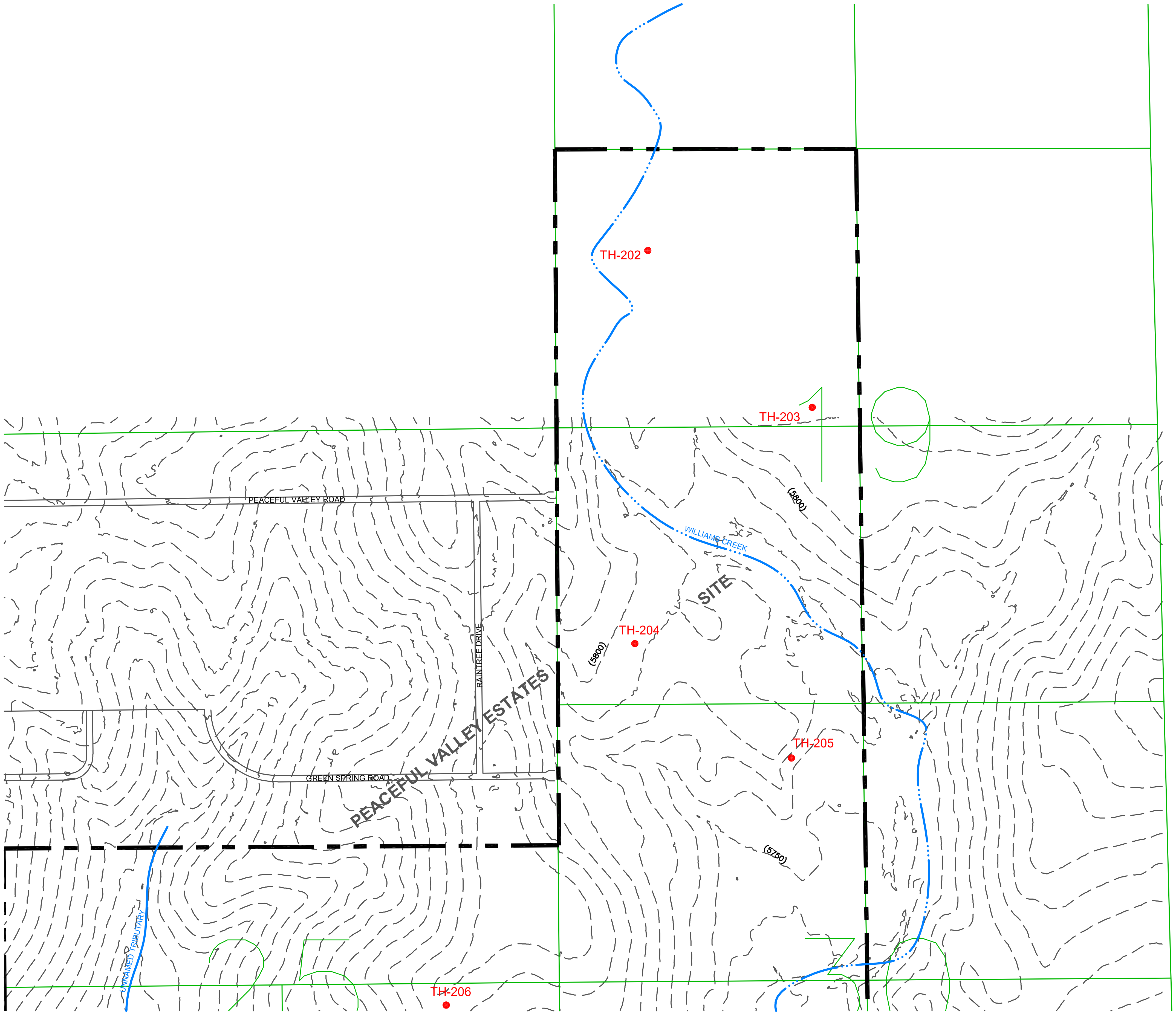
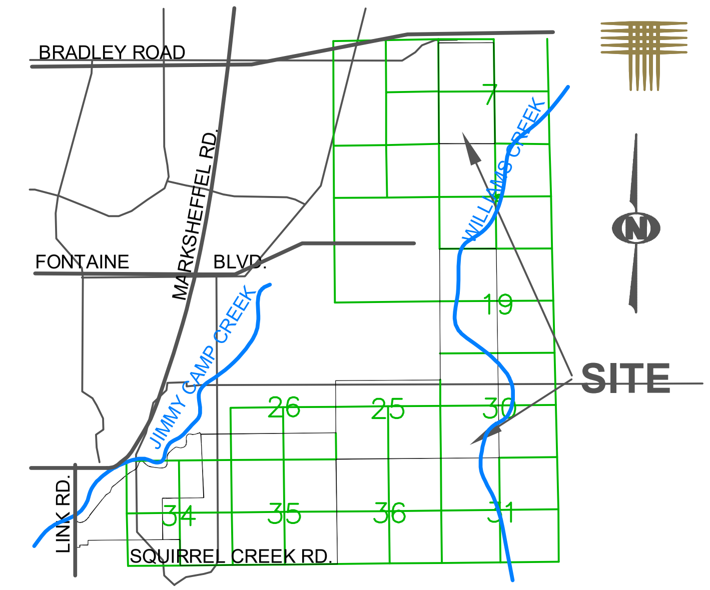
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Location of Exploratory Borings

FIG. 3





VICINITY MAP

(NOT TO SCALE)

LEGEND:

- TH-202 ● APPROXIMATE LOCATION OF EXPLORATORY BORING.
- PROJECT BOUNDARY
- EXISTING TOPOGRAPHY
- 25 SECTION NUMBER
- SECTION BOUNDARY

0 500' 1000'

SCALE: 1" = 1000'

NOTE:
BASE DRAWING WAS PROVIDED BY CLASSIC CONSULTING.

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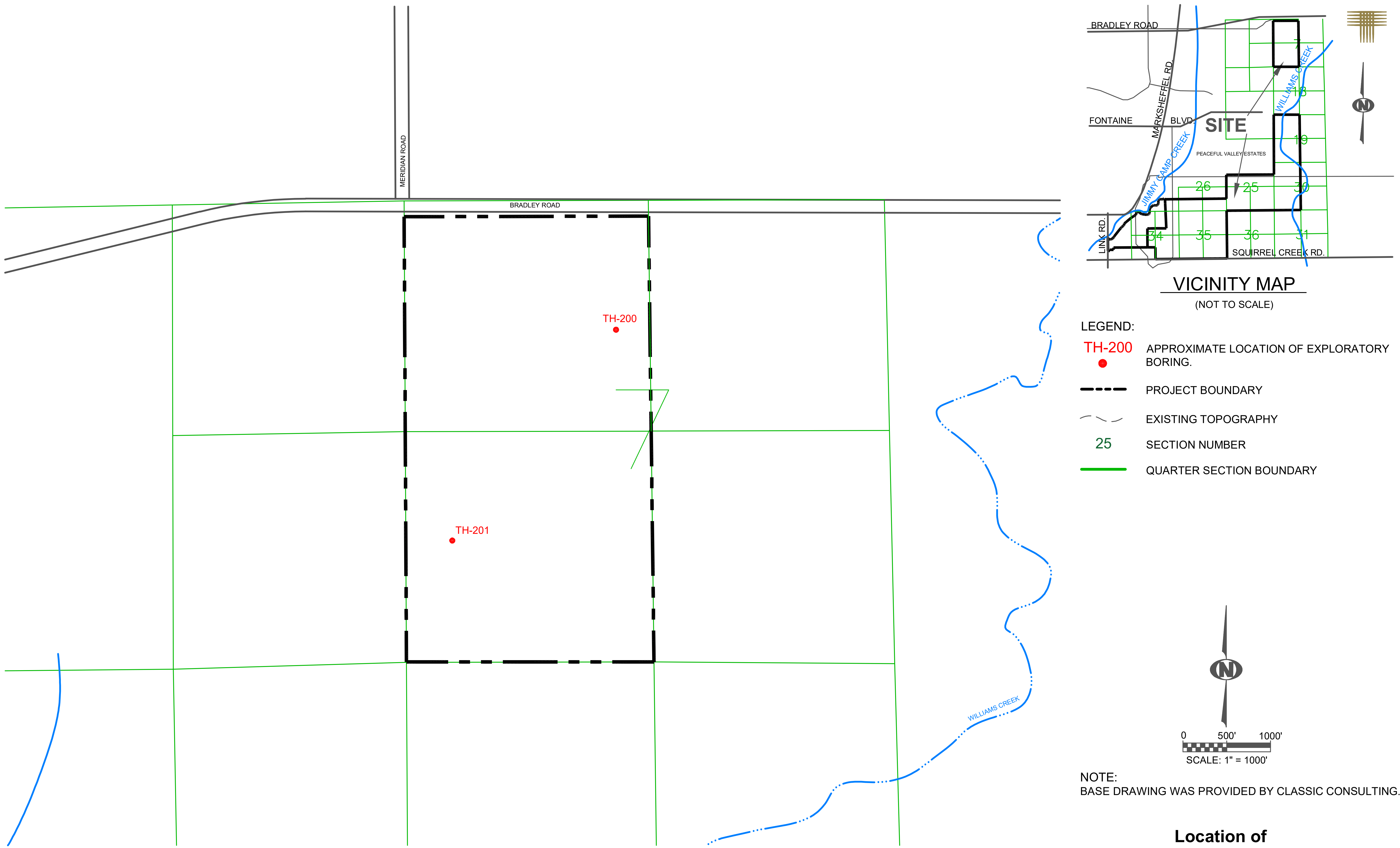
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Location of Exploratory Borings

FIG. 4



VICINITY MAP
(NOT TO SCALE)

LEGEND:

TH-200 ● APPROXIMATE LOCATION OF EXPLORATORY BORING.

PROJECT BOUNDARY

EXISTING TOPOGRAPHY

25 SECTION NUMBER

QUARTER SECTION BOUNDARY

0 500' 1000'

SCALE: 1" = 1000'

NOTE:
BASE DRAWING WAS PROVIDED BY CLASSIC CONSULTING.

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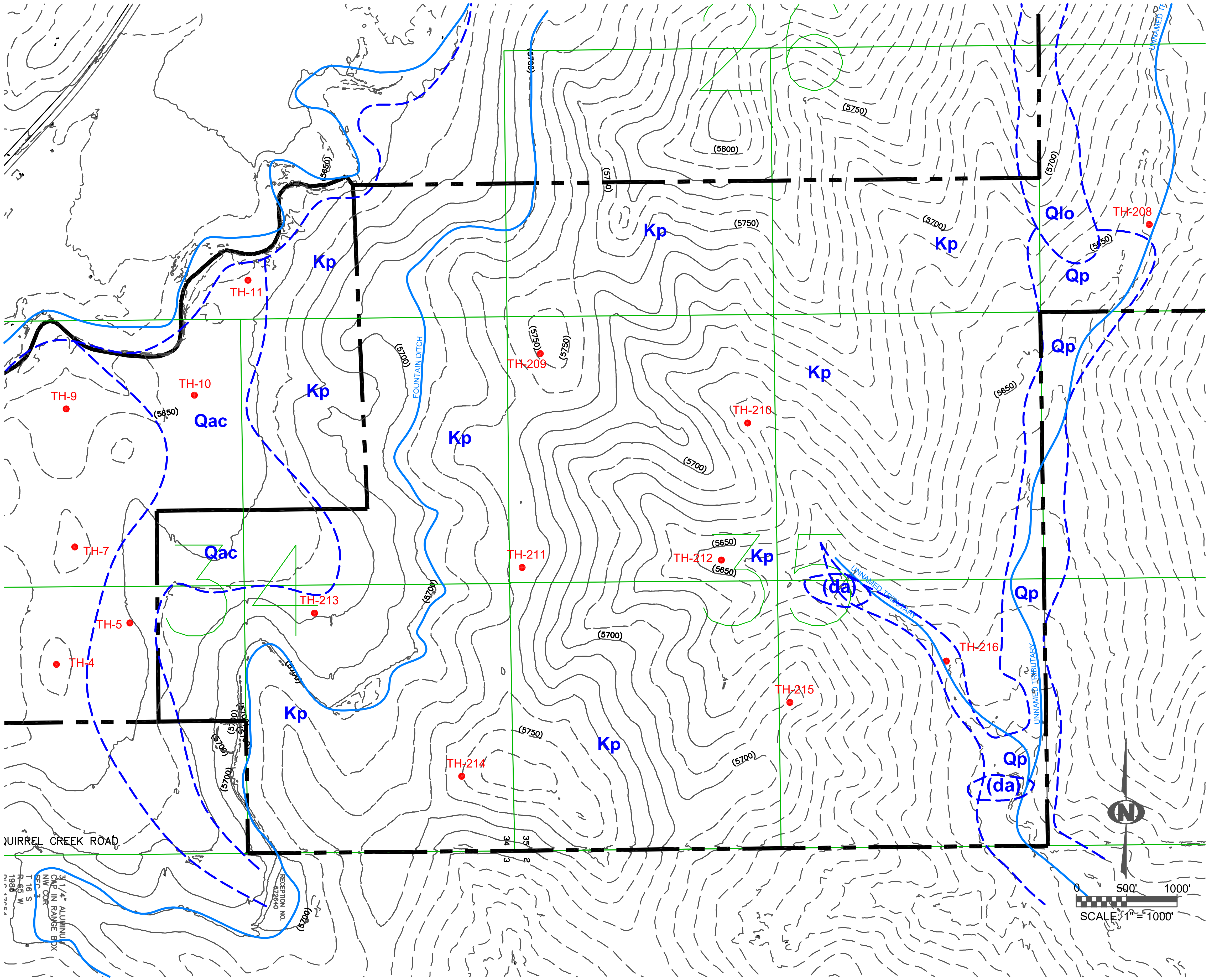
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Location of Exploratory Borings

FIG. 5



LEGEND:

TH-209 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
▬ ▬ ▬	PROJECT BOUNDARY
‒ ‒ ‒	EXISTING TOPOGRAPHY
25	SECTION NUMBER
▬	QUARTER SECTION BOUNDARY

GEOLOGIC UNITS AND (MODIFIERS)

‒ ‒ ‒	SURFICIAL GEOLOGIC CONTACTS
(da)	DISTURBED AREA.
Qac	ALLUVIUM (CLAYEY AND SILTY SAND, AND SANDY, CLAY) DEPOSITED IN PRESENT STREAM VALLEYS AND SLOPE WASH COLLUVIUM. HOLOCENE AGE.
Qp	PINEY CREEK ALLUVIUM. ORGANIC RICH CLAYEY SILT, AND SAND IN TERRACES ALONG MANY PRESENT STREAMS. TOP OF TERRACES ABOUT 20 FEET ABOVE STREAM LEVEL.
Qlo	LOESS. SILT AND VERY FINE-GRAINED SAND DEPOSITED BY WIND.
Kp	PIERRE SHALE. GRAY, BLACK AND OLIVE COLORED, SILICEOUS CLAYSTONE OVER FISSILE SHALE. LATE CRETACEOUS.

NOTES:
1. BASE DRAWING WAS PROVIDED BY CLASSIC CONSULTING.
2. ALL GEOLOGIC BOUNDARIES SHOWN SHOULD BE CONSIDERED APPROXIMATE. THEY ARE BASED UPON A SUBJECTIVE INTERPRETATION OF PUBLISHED MAPS, AERIAL PHOTOGRAPHS AND A BRIEF 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.

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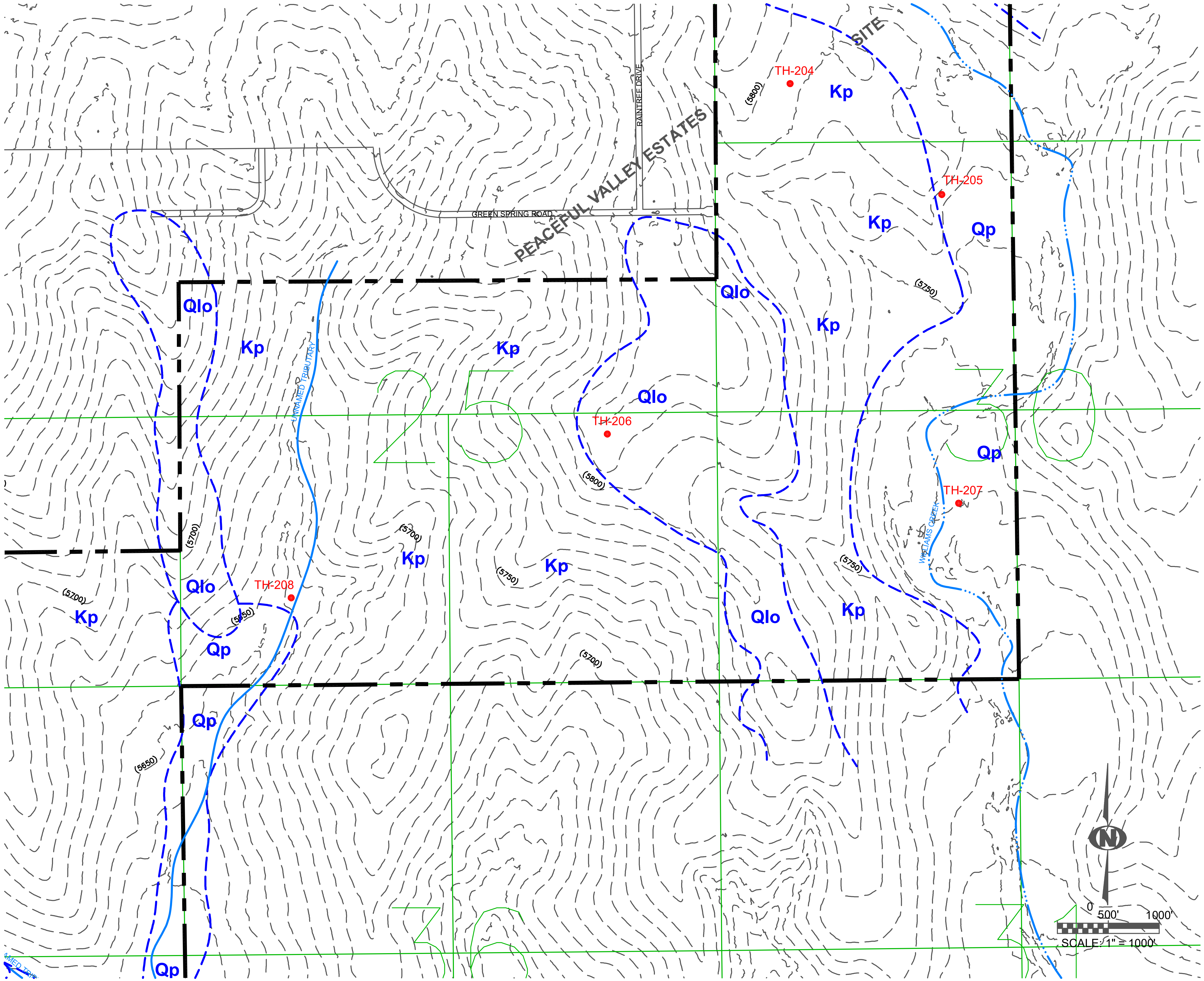
Surficial Geologic Conditions

FIG. 6



LEGEND:

TH-204 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
— — —	PROJECT BOUNDARY
– – –	EXISTING TOPOGRAPHY
25	SECTION NUMBER
——	QUARTER SECTION BOUNDARY

GEOLOGIC UNITS AND (MODIFIERS)

– – –	SURFICIAL GEOLOGIC CONTACTS
Qp	PINEY CREEK ALLUVIUM. ORGANIC RICH CLAYEY SILT, AND SAND IN TERRACES ALONG MANY PRESENT STREAMS. TOP OF TERRACES ABOUT 20 FEET ABOVE STREAM LEVEL.
Qlo	LOESS. SILT AND VERY FINE-GRAINED SAND DEPOSITED BY WIND.
Kp	PIERRE SHALE. GRAY, BLACK AND OLIVE COLORED, SILICEOUS CLAYSTONE OVER FISSILE SHALE. LATE CRETACEOUS.

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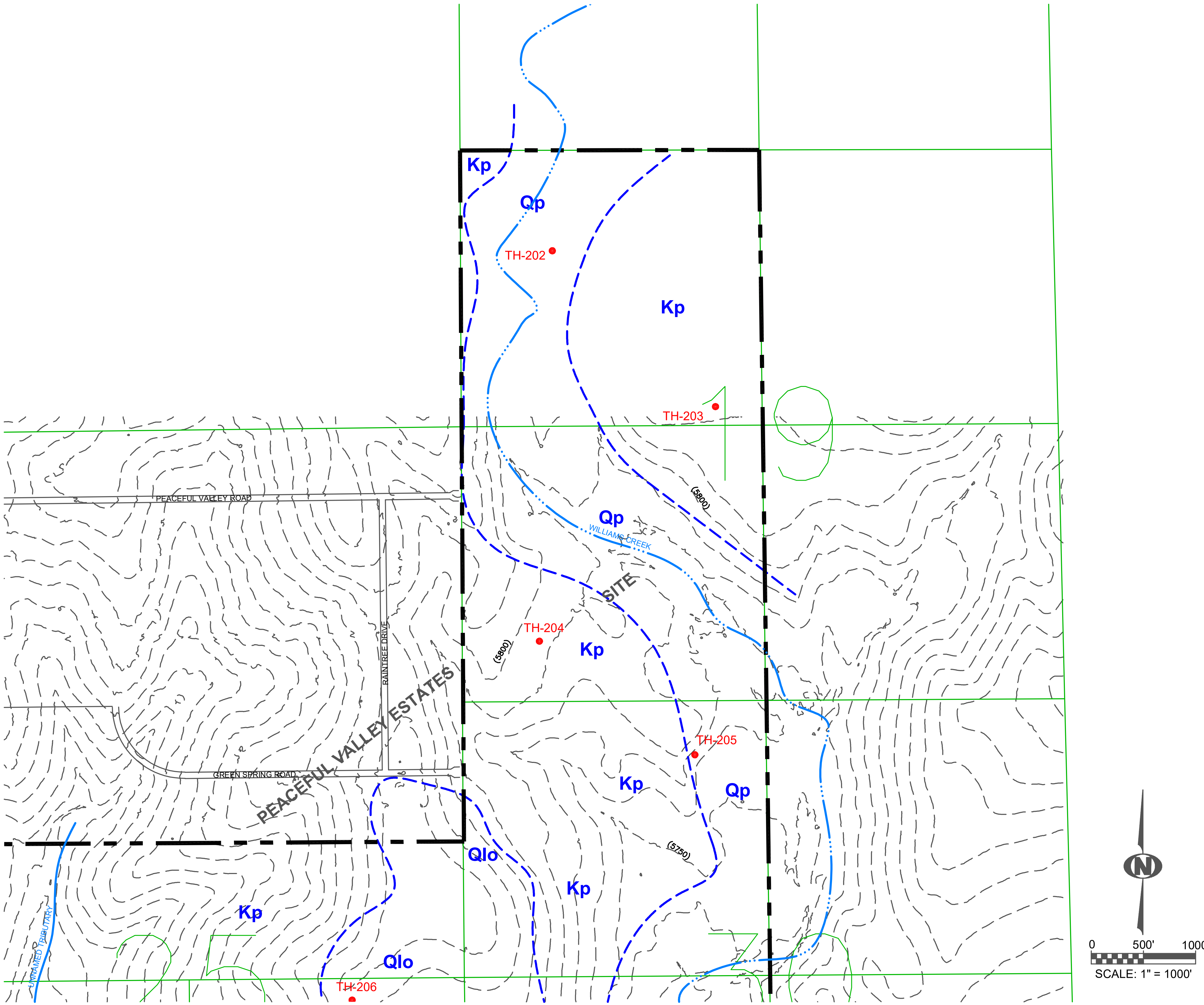
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Surficial Geologic Conditions

FIG. 7



LEGEND:

TH-202 APPROXIMATE LOCATION OF EXPLORATORY BORING.

PROJECT BOUNDARY

EXISTING TOPOGRAPHY

25 SECTION NUMBER

QUARTER SECTION BOUNDARY

GEOLOGIC UNITS AND (MODIFIERS)

SURFICIAL GEOLOGIC CONTACTS

Qp PINEY CREEK ALLUVIUM. ORGANIC RICH CLAYEY SILT, AND SAND IN TERRACES ALONG MANY PRESENT STREAMS. TOP OF TERRACES ABOUT 20 FEET ABOVE STREAM LEVEL.

Qlo LOESS. SILT AND VERY FINE-GRAINED SAND DEPOSITED BY WIND.

Kp PIERRE SHALE. GRAY, BLACK AND OLIVE COLORED, SILICEOUS CLAYSTONE OVER FISSILE SHALE. LATE CRETACEOUS.

NOTES:
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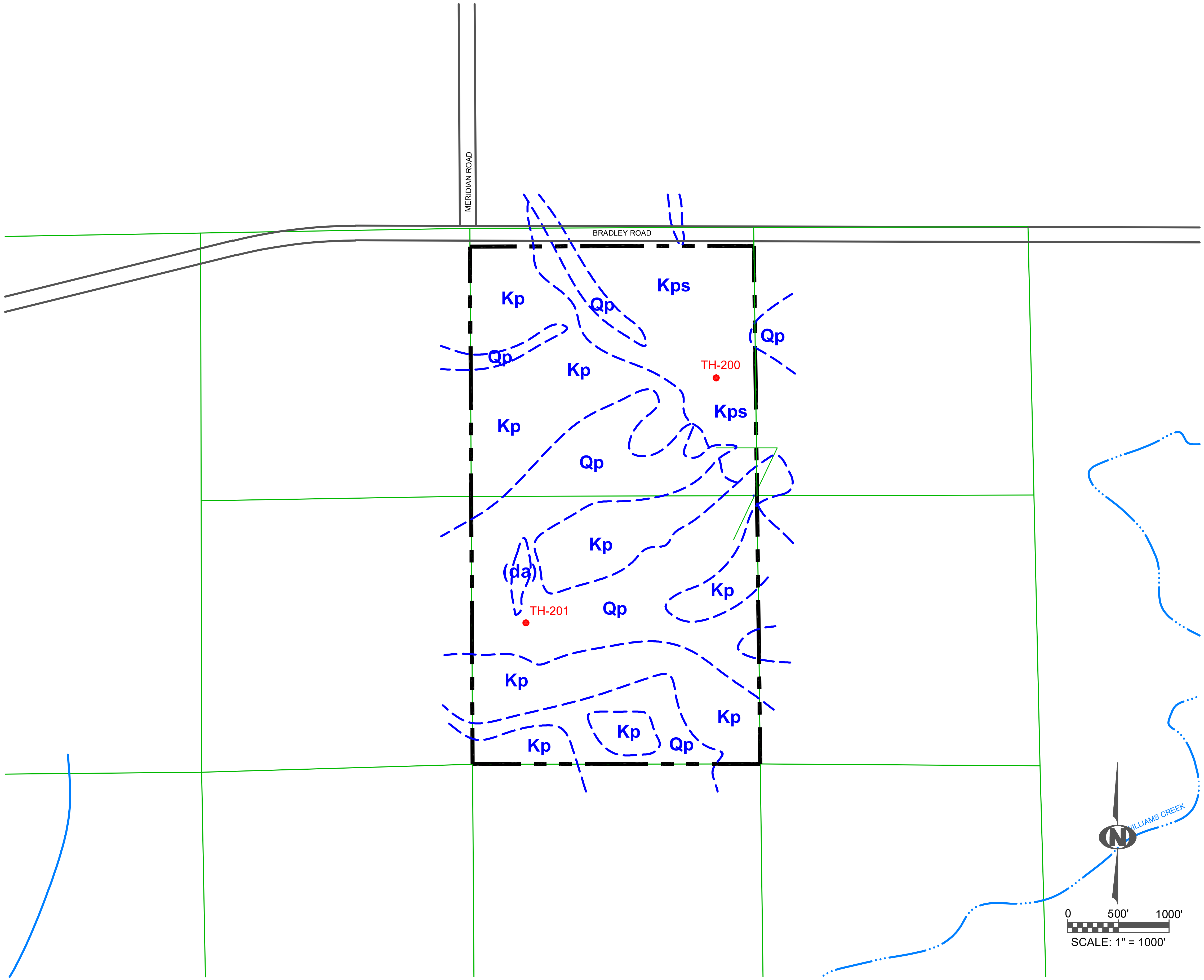
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Surficial Geologic Conditions

FIG. 8



LEGEND:

TH-200 APPROXIMATE LOCATION OF EXPLORATORY BORING.

PROJECT BOUNDARY

EXISTING TOPOGRAPHY

25 SECTION NUMBER

QUARTER SECTION BOUNDARY

GEOLOGIC UNITS AND (MODIFIERS)

SURFICIAL GEOLOGIC CONTACTS

(da) DISTURBED AREA.

Qp PINEY CREEK ALLUVIUM. ORGANIC RICH CLAYEY SILT, AND SAND IN TERRACES ALONG MANY PRESENT STREAMS. TOP TERRACES ABOUT 20 FEET ABOVE STREAM LEVEL.

Kp PIERRE SHALE. GRAY, BLACK AND OLIVE COLORED, SILICEOUS CLAYSTONE OVER FISSILE SHALE. LATE CRETACEOUS.

Kps PIERRE SHALE. BROWN TO RUST COLORED, LOCALLY SUBDIVIDED SILTY SANDSTONE AND SAND DERIVED FROM SANDSTONE OVER FISSILE SHALE. LATE CRETACEOUS.

NOTES:
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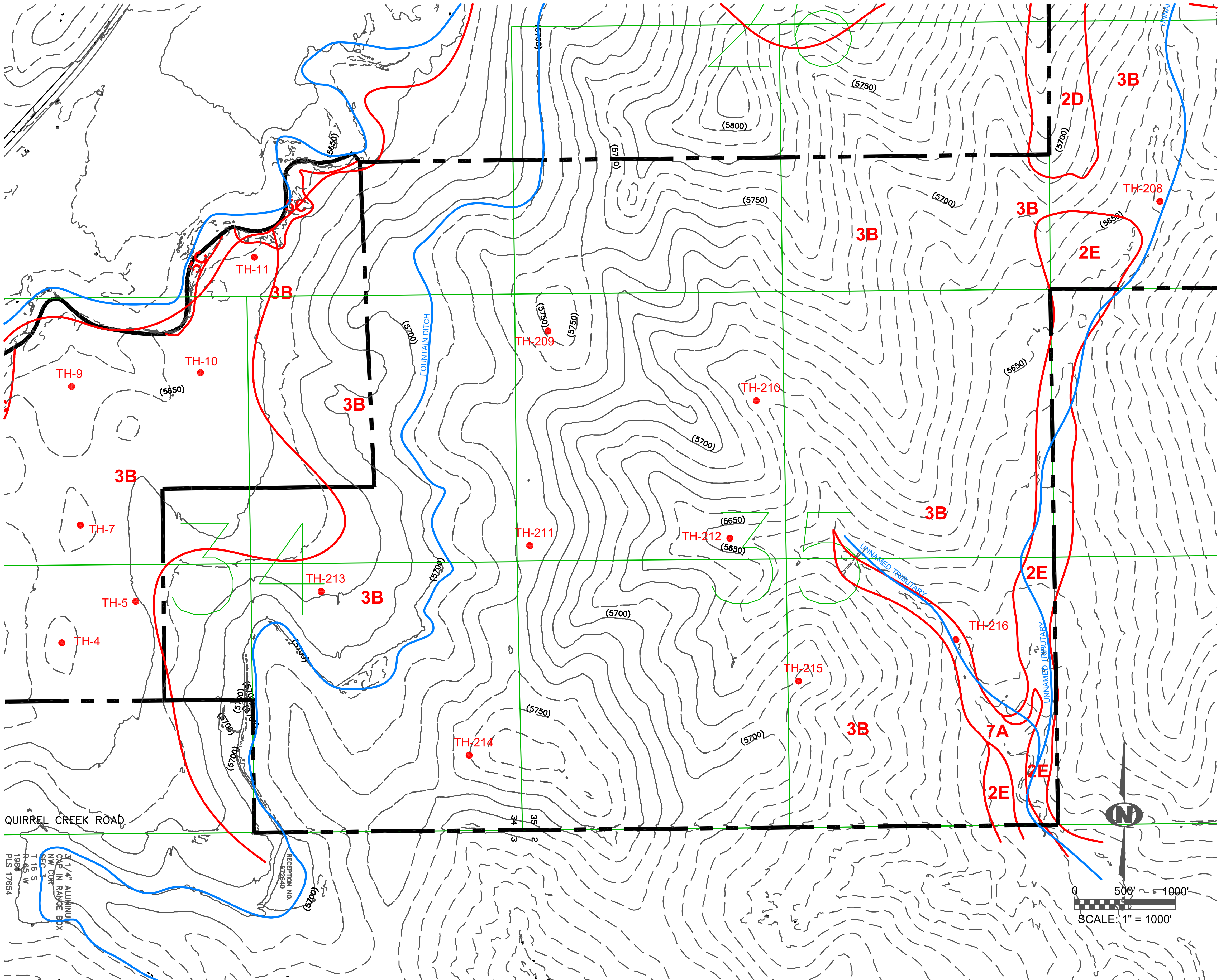
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Surficial Geologic Conditions

FIG. 9



LEGEND:

TH-209 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
	PROJECT BOUNDARY
	EXISTING TOPOGRAPHY
25	SECTION NUMBER
	QUARTER SECTION BOUNDARY

ENGINEERING UNITS AND (MODIFIERS)

	ENGINEERING CONTACTS
2D	EOLIAN DEPOSITS GENERALLY ON FLAT TO GENTLE SLOPES OF SUPLAND AREAS.
2E	LOW TERRACES AND VALLEYS OF MINOR TRIBUTARY STREAMS SUBJECT TO PERIODIC HIGH FLOWS, SHEET FLOODING, AND STREAM BANK EROSION. EMPHASIS ON SURFACE AND SUBSURFACE DRAINAGE.
3B	EXPANSIVE AND POTENTIALL EXPANSIVE SOIL AND BEDROCK ON FLAT TO MODERATE SLOPES (0 - 12%).
5C	POTENTIALLY UNSTABLE COLLUVIUM AND BEDROCK ON STEEP SLOPES (12 - 30%).
7A	PHYSIOGRAPHIC FLOODPLAIN AND SPECIAL FLOOD HAZARD AREAS. EROSION AND DEPOSITION PRESENTLY OCCUR AND IS GENERALLY SUBJECT TO RECURRENT FLOODING.

NOTES:

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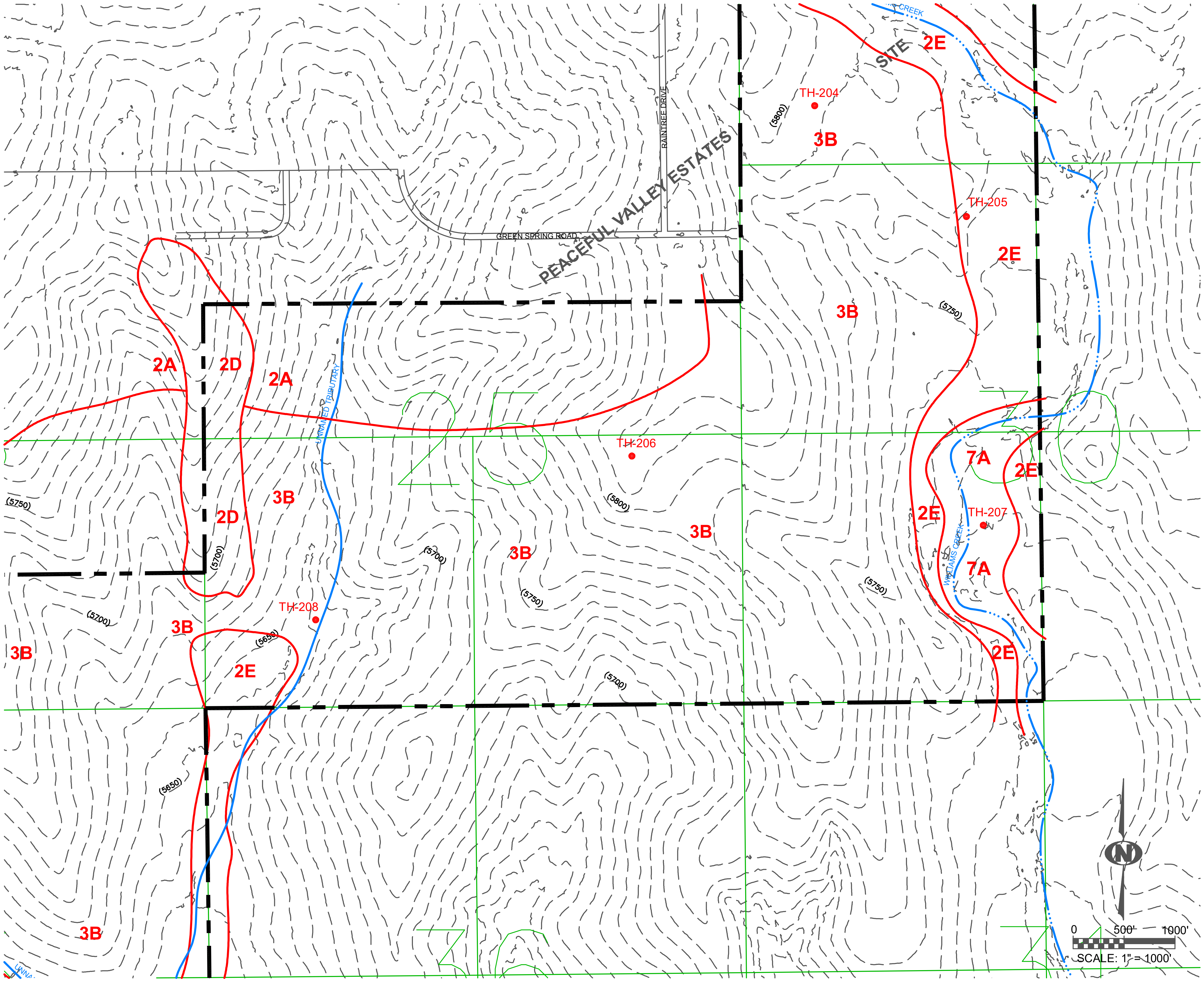
3. MAP LEGEND IS MODIFIED FROM CHARLES S. ROBINSON & ASSOCIATES, INC., GOLDEN, COLORADO, DATED 1977.

LA PLATA COMMUNITIES
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Engineering Conditions

FIG. 10



LEGEND:

TH-205 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
▬ ▬ ▬	PROJECT BOUNDARY
╱╲	EXISTING TOPOGRAPHY
25	SECTION NUMBER
▬▬	QUARTER SECTION BOUNDARY

ENGINEERING UNITS AND (MODIFIERS)

～	ENGINEERING CONTACTS
2A	STABLE ALLUVIUM, COLLUVIUM, AND BEDROCK ON GENTLE TO MODERATE SLOPES (5% TO 12%).
2D	EOLIAN DEPOSITS GENERALLY ON FLAT TO GENTLE SLOPES OF SUPLAND AREAS.
2E	LOW TERRACES AND VALLEYS OF MINOR TRIBUTARY STREAMS SUBJECT TO PERIODIC HIGH FLOWS, SHEET FLOODING, AND STREAM BANK EROSION. EMPHASIS ON SURFACE AND SUBSURFACE DRAINAGE.
3B	EXPANSIVE AND POTENTIALL EXPANSIVE SOIL AND BEDROCK ON FLAT TO MODERATE SLOPES (0 - 12%).
7A	PHYSIOGRAPHIC FLOODPLAIN AND SPECIAL FLOOD HAZARD AREAS. EROSION AND DEPOSITION PRESENTLY OCCUR AND IS GENERALLY SUBJECT TO RECURRENT FLOODING.

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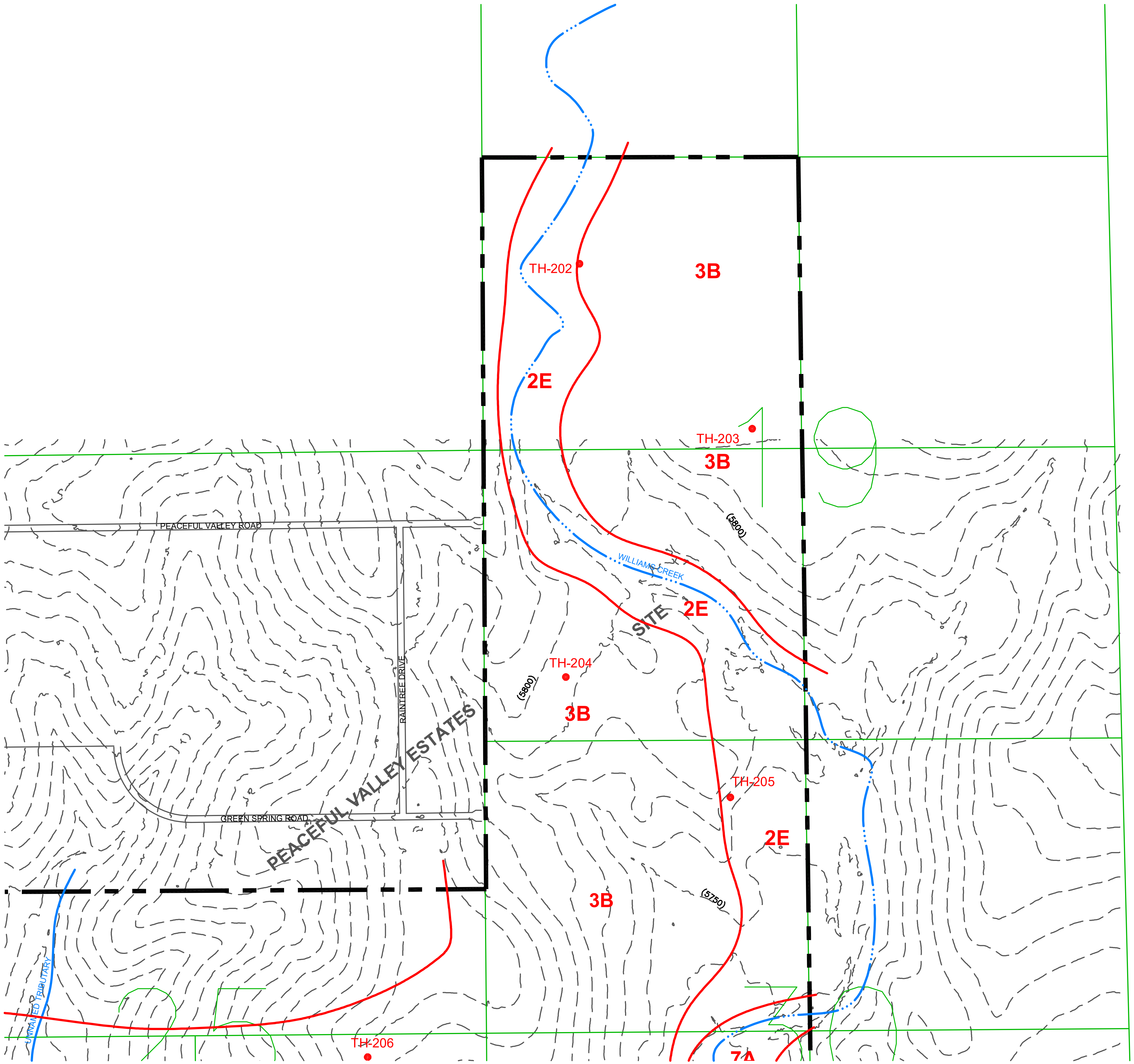
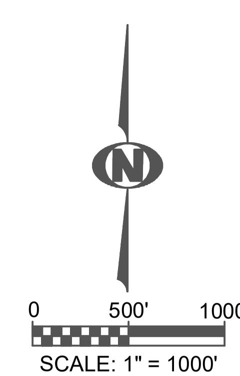
CTL|T PROJECT NO. CS19053.001-115

Engineering Conditions

FIG.11





LEGEND:

TH-202 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
▬ ▬ ▬	PROJECT BOUNDARY
⁓ ⁓	EXISTING TOPOGRAPHY
25	SECTION NUMBER
▬▬	QUARTER SECTION BOUNDARY

ENGINEERING UNITS AND (MODIFIERS)

⁓	ENGINEERING CONTACTS
2E	LOW TERRACES AND VALLEYS OF MINOR TRIBUTARY STREAMS SUBJECT TO PERIODIC HIGH FLOWS, SHEET FLOODING, AND STREAM BANK EROSION. EMPHASIS ON SURFACE AND SUBSURFACE DRAINAGE.
3B	EXPANSIVE AND POTENTIALL EXPANSIVE SOIL AND BEDROCK ON FLAT TO MODERATE SLOPES (0 - 12%).
7A	PHYSIOGRAPHIC FLOODPLAIN AND SPECIAL FLOOD HAZARD AREAS. EROSION AND DEPOSITION PRESENTLY OCCUR AND IS GENERALLY SUBJECT TO RECURRENT FLOODING.

NOTES:

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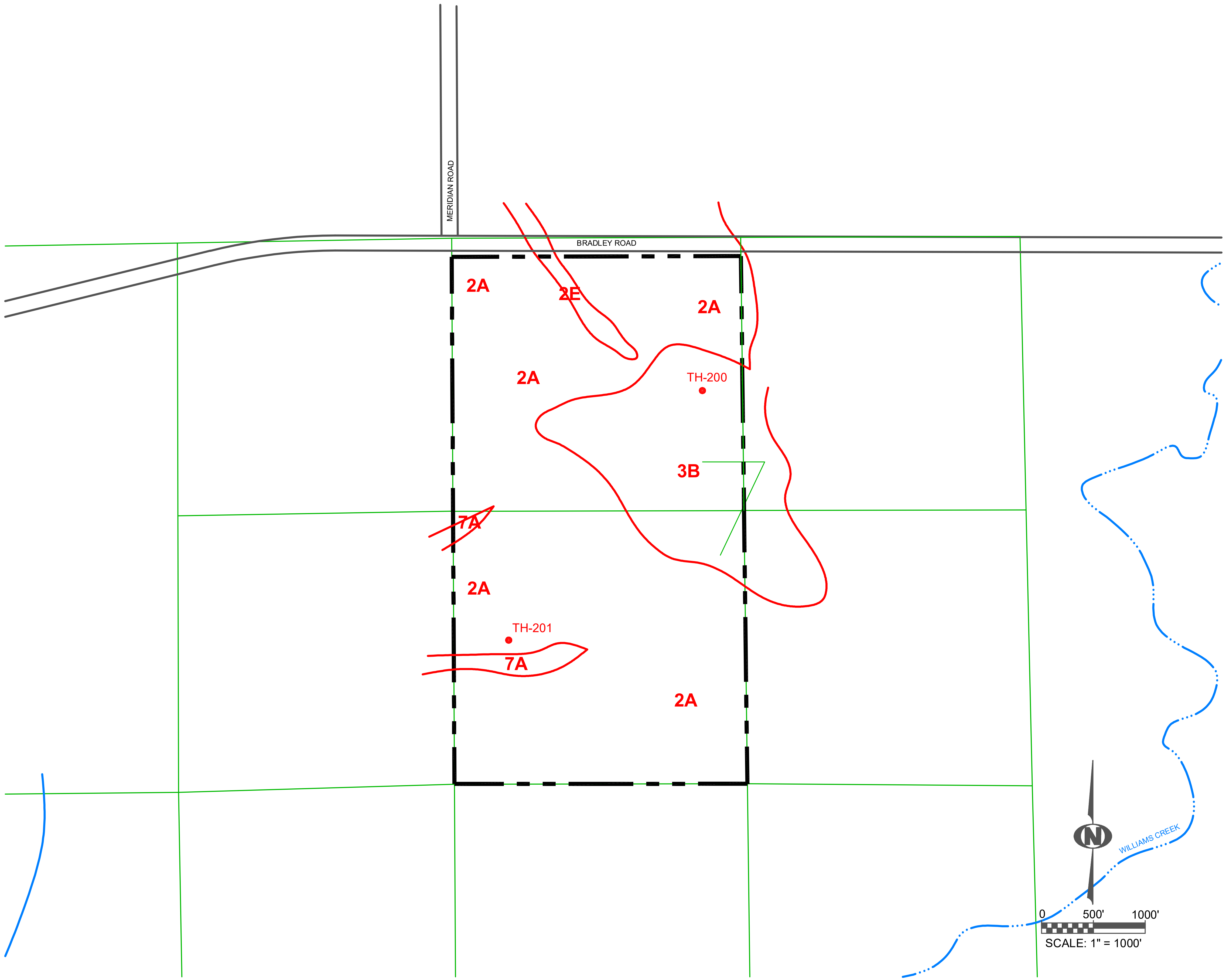
AMARA DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115

Engineering Conditions

FIG. 12



LEGEND:

- TH-200 ● APPROXIMATE LOCATION OF EXPLORATORY BORING.
- PROJECT BOUNDARY
- EXISTING TOPOGRAPHY
- 25 SECTION NUMBER
- QUARTER SECTION BOUNDARY

ENGINEERING UNITS AND (MODIFIERS)

- ENGINEERING CONTACTS

2E LOW TERRACES AND VALLEYS OF MINOR TRIBUTARY STREAMS SUBJECT TO PERIODIC HIGH FLOWS, SHEET FLOODING, AND STREAM BANK EROSION. EMPHASIS ON SURFACE AND SUBSURFACE DRAINAGE.

3B EXPANSIVE AND POTENTIALL EXPANSIVE SOIL AND BEDROCK ON FLAT TO MODERATE SLOPES (0 - 12%).

7A PHYSIOGRAPHIC FLOODPLAIN AND SPECIAL FLOOD HAZARD AREAS. EROSION AND DEPOSITION PRESENTLY OCCUR AND IS GENERALLY SUBJECT TO RECURRENT FLOODING.

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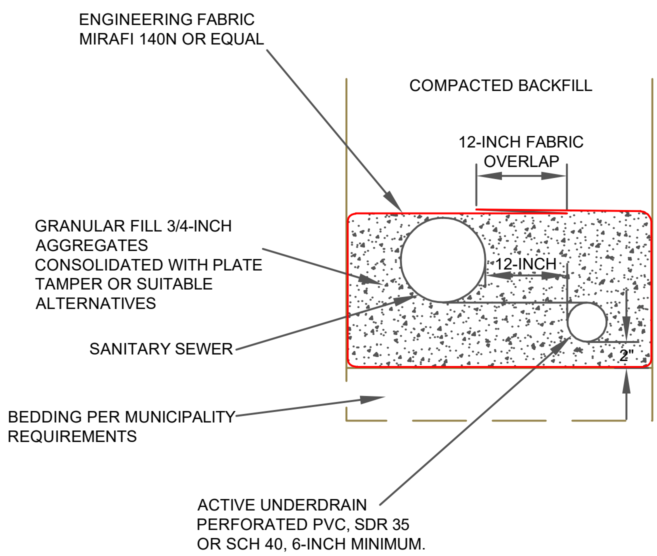
CTL|T PROJECT NO. CS19053.001-115

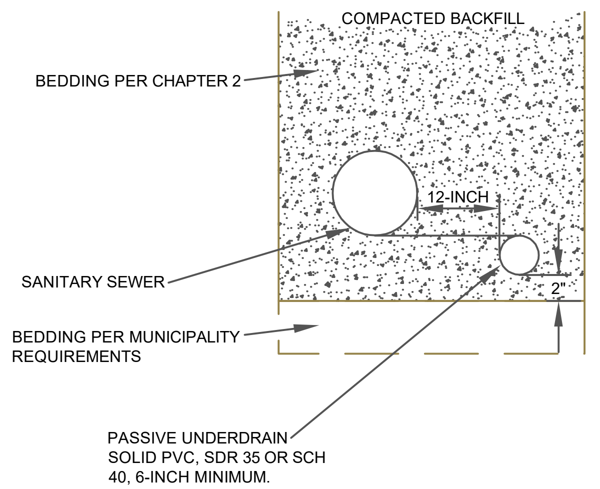
Engineering Conditions

FIG. 13

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



ACTIVE UNDERDRAIN PIPE



(ACTIVE RELIEF SECTION 10 FEET DOWNSTREAM OF EACH MANHOLE)

PASSIVE UNDERDRAIN PIPE

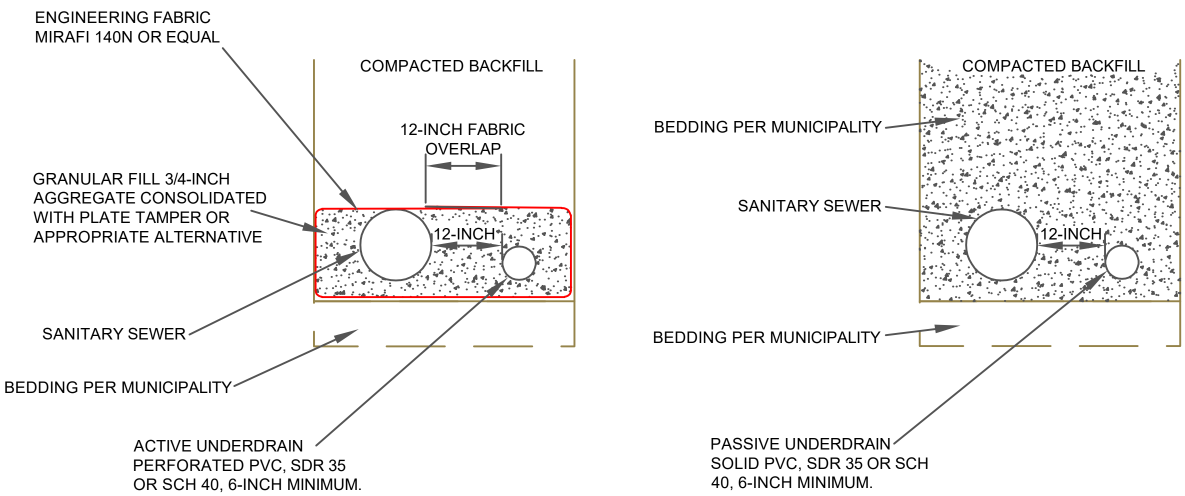
GENERAL NOTES:
1. MINIMUM UNDERDRAIN SIZE OF MAINLINE PIPE TO BE SIX (6") INCHES.
2. UNDERDRAIN TO BE LOCATED OPPOSITE THE WATERLINE LOCATION.
3. TO BE BEDDED PER APPLICABLE MUNICIPALITY.
4. BEDDING MATERIAL SPECIFICATIONS CLASS I, II OR III FOR PIPE SLOPE GREATER THAN 1.04 PERCENT FOR SLOPE OF 1.04 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

FIG. 14

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. UNDERDRAIN TO BE LOCATED ON THE SOUTH AND WEST OF THE SANITARY SEWER LINE, OPPOSITE THE WATERLINE LOCATION.
3. TO BE BEDDED PER APPLICABLE MUNICIPALITY.
4. BEDDING MATERIAL SPECIFICATIONS CLASS I, II OR III FOR PIPE SLOPE GREATER THAN 1.04 PERCENT FOR SLOPE OF 1.04 PERCENT OR FLATTER.

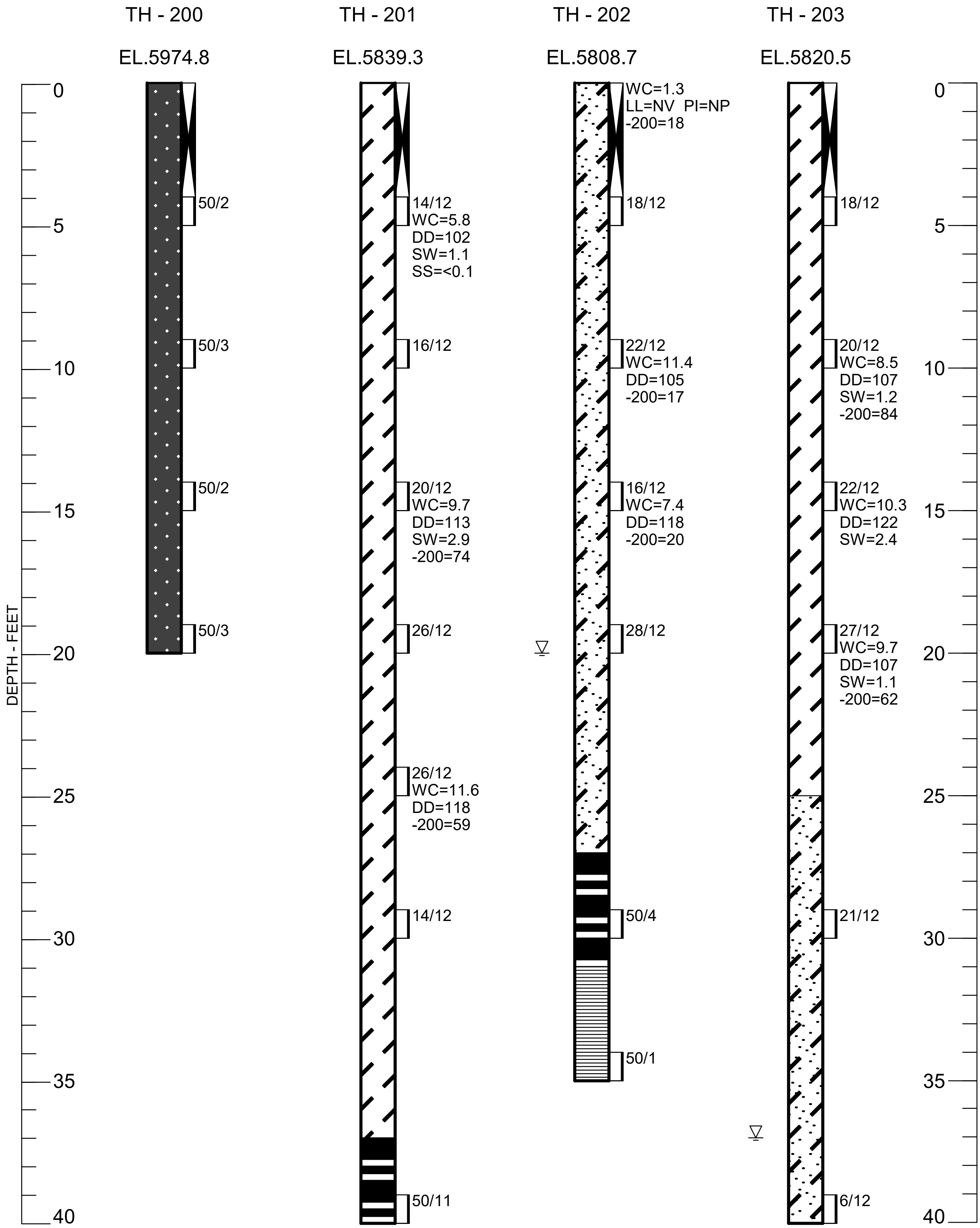
SIEVE SIZE	PERCENT PASSING
1 1/2"	100
3/4"	0 TO 100
#40	0 TO 100
#50	0 TO 80
#100	0 TO 40
#200	0 TO 26

Alternate 2 Underdrain Trench Details

FIG. 15

APPENDIX A

SUMMARY LOGS OF EXPLORATORY BORINGS



NOTE:
DRILLING CONTINUED TO 45 FEET (N=50/5 AT 44 FEET).

NOTE:
DRILLING CONTINUED TO 50 FEET (N=17/12 AT 49 FEET).

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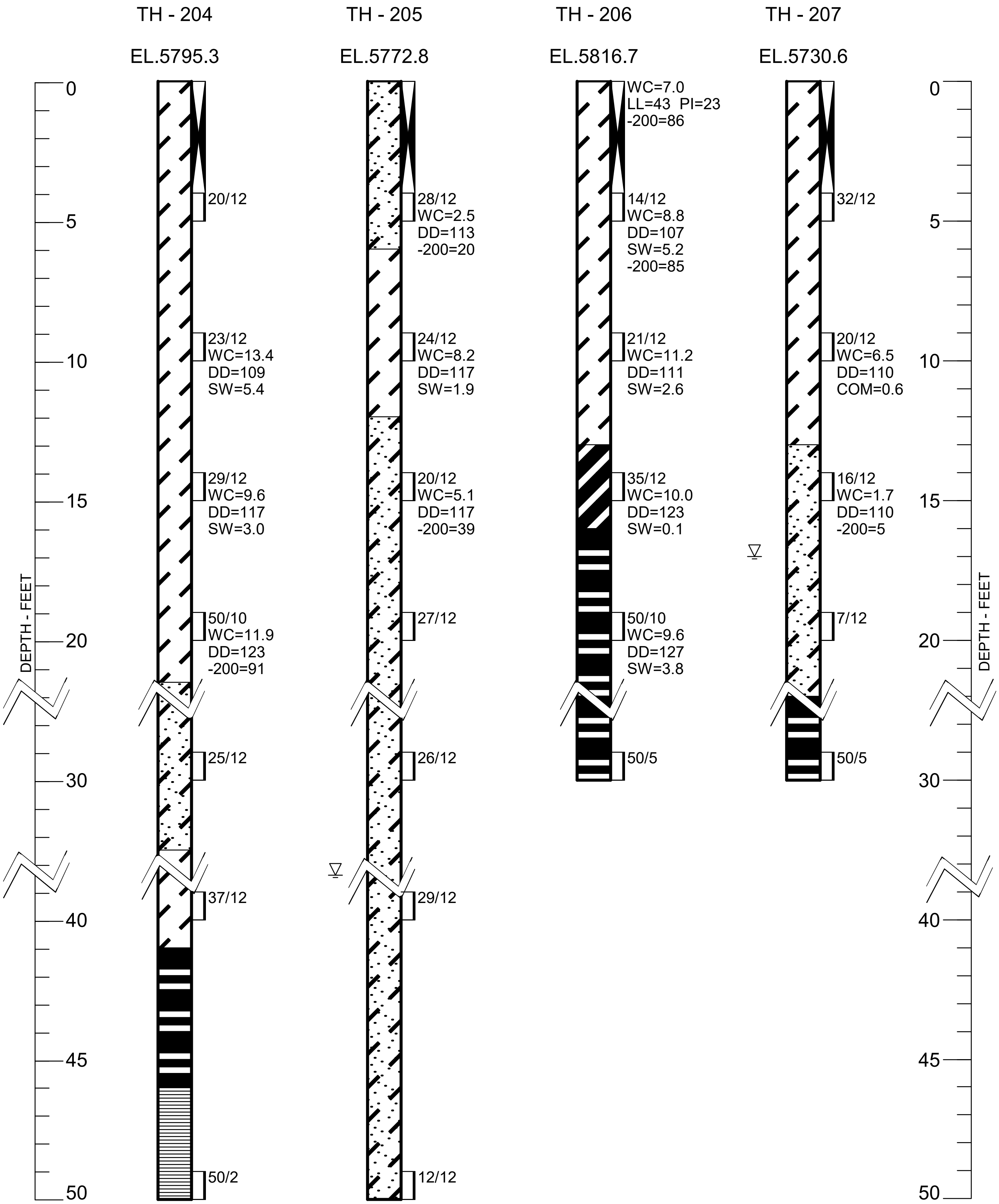
Summary Logs of Exploratory Borings

FIG. A-1



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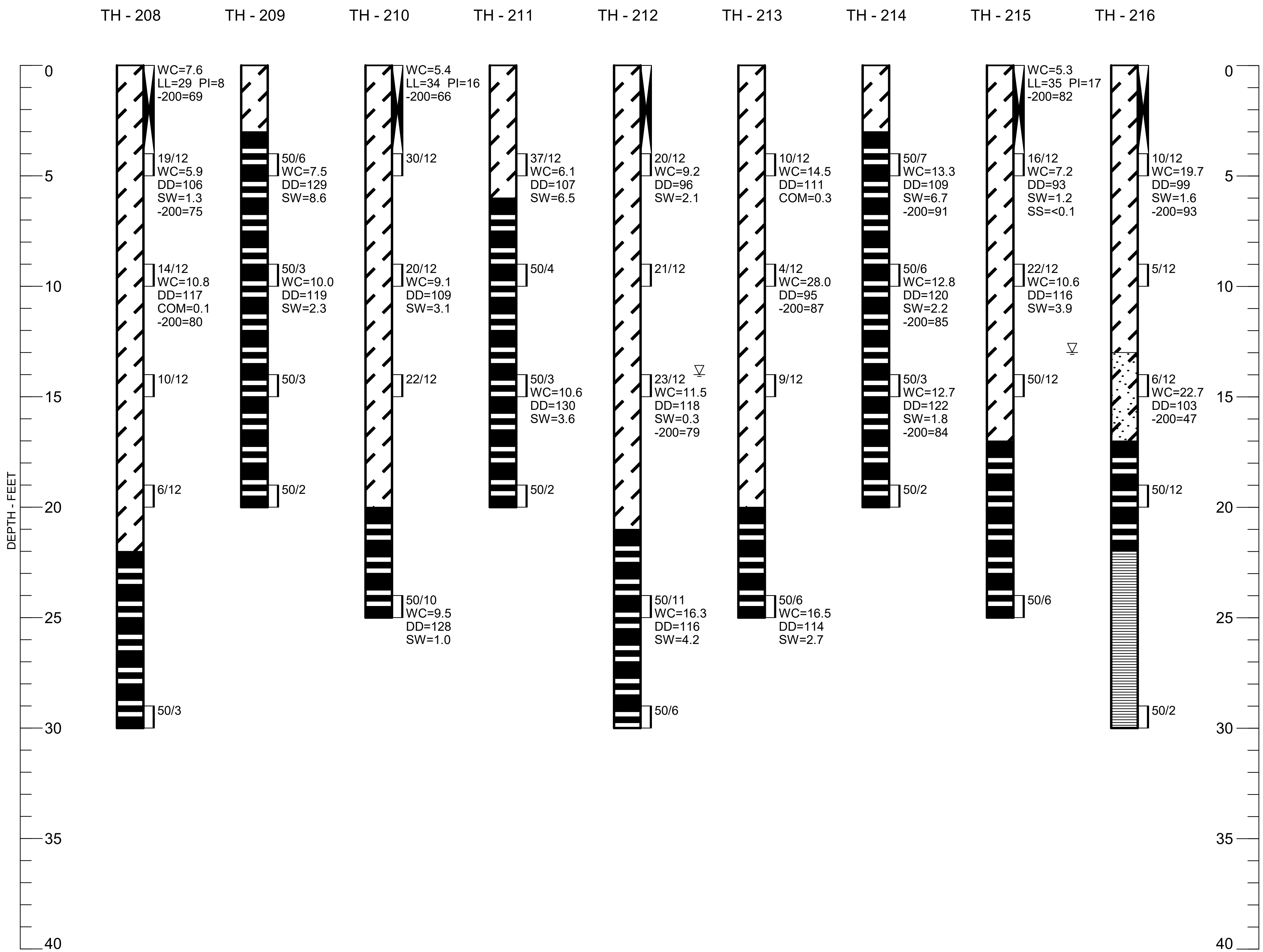
Summary Logs of Exploratory Borings

FIG. A-2



LEGEND:

CLAY, SLIGHTLY SANDY TO VERY SANDY, MEDIUM STIFF TO VERY STIFF, MOIST TO WET, MEDIUM BROWN TO BROWN (CL).

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

WEATHERED BEDROCK, CLAYSTONE, SANDY, MEDIUM HARD, MOIST, BROWN TO DARK BROWN.

BEDROCK. CLAYSTONE, SLIGHTLY SANDY TO SANDY, HARD TO VERY HARD, MOIST, BROWN TO DARK BROWN AND GRAY TO DARK GRAY.

BEDROCK. SANDSTONE, SILTY, VERY HARD, SLIGHTLY MOIST, RED BROWN, RUST, BROWN.

BEDROCK. SHALE, FISSILE, VERY HARD, SLIGHTLY MOIST TO MOIST, GRAY TO DARK GRAY.

DRIVE SAMPLE. THE SYMBOL 19/12 INDICATES 19 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

INDICATES BULK SAMPLE OBTAINED FROM AUGER CUTTINGS.

GROUNDWATER LEVEL MEASURED AT TIME OF DRILLING.

NOTES:

1. THE BORINGS WERE DRILLED NOVEMBER 3, 4, 5, AND 8, 2021 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. THE BORING ELEVATIONS WERE DETERMINED DURING A FIELD SURVEY PERFORMED BY .
3. WC - INDICATES MOISTURE CONTENT. (%)
   DD - INDICATES DRY DENSITY. (PCF)
   SW - INDICATES SWELL WHEN WETTED UNDER 1 KSF LOAD. (%)
   COM - INDICATES COMPRESSION WHEN WETTED UNDER 1 KSF LOAD. (%)
   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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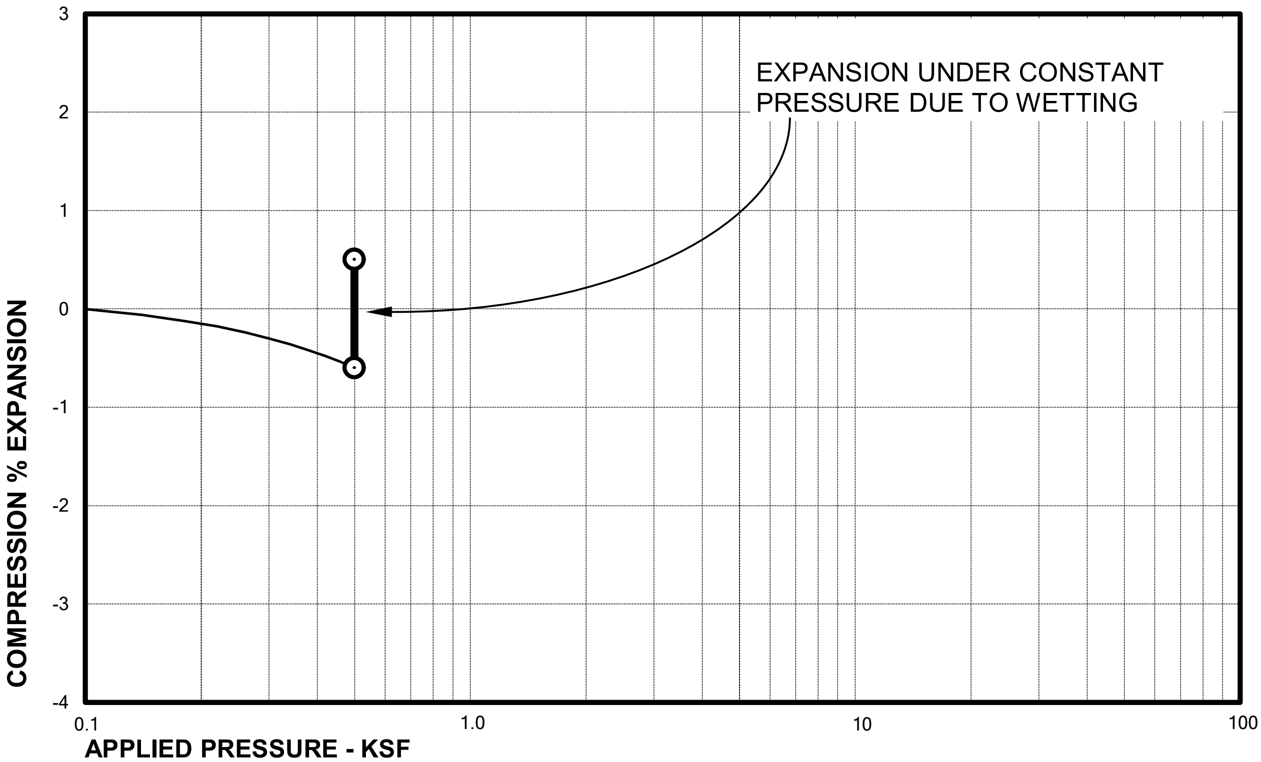
Summary Logs of Exploratory Borings

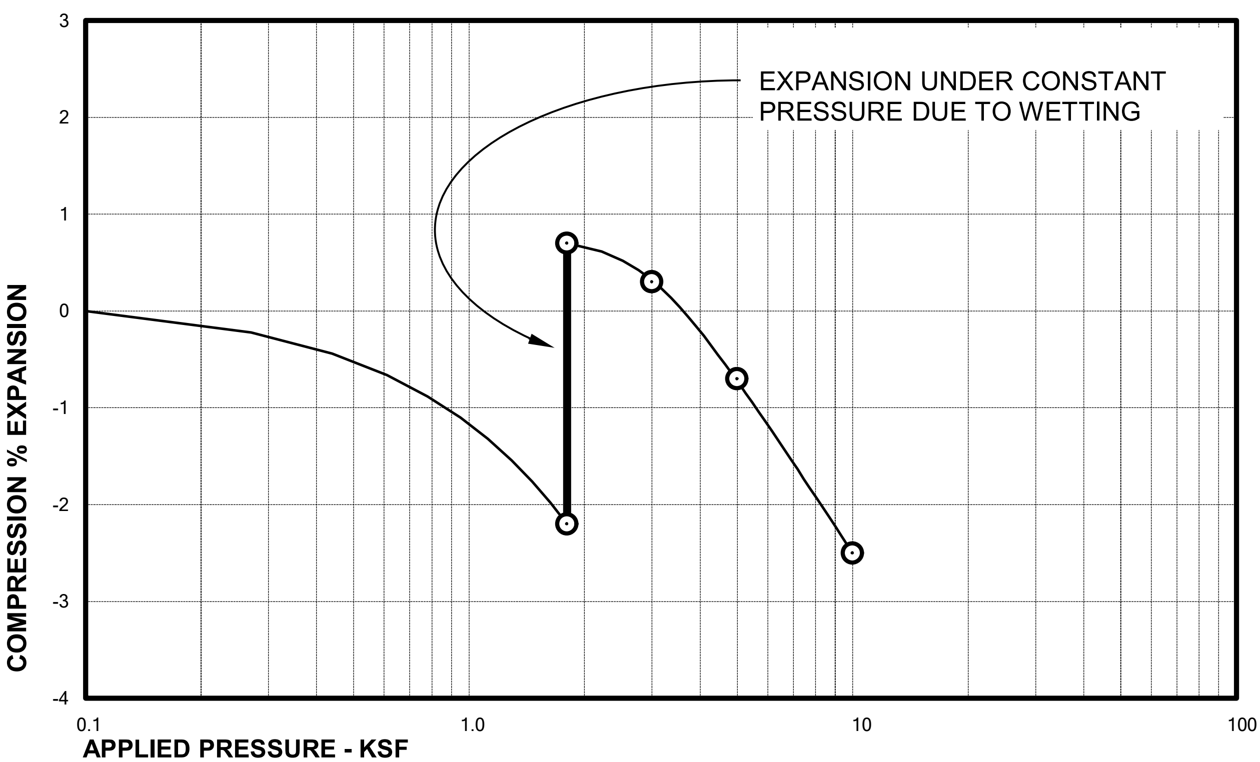
FIG. A-3

APPENDIX B

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



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	102	PCF
From	TH-201 AT 4 FEET	MOISTURE CONTENT=	5.8	%



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	113	PCF
From	TH-201 AT 14 FEET	MOISTURE CONTENT=	9.7	%

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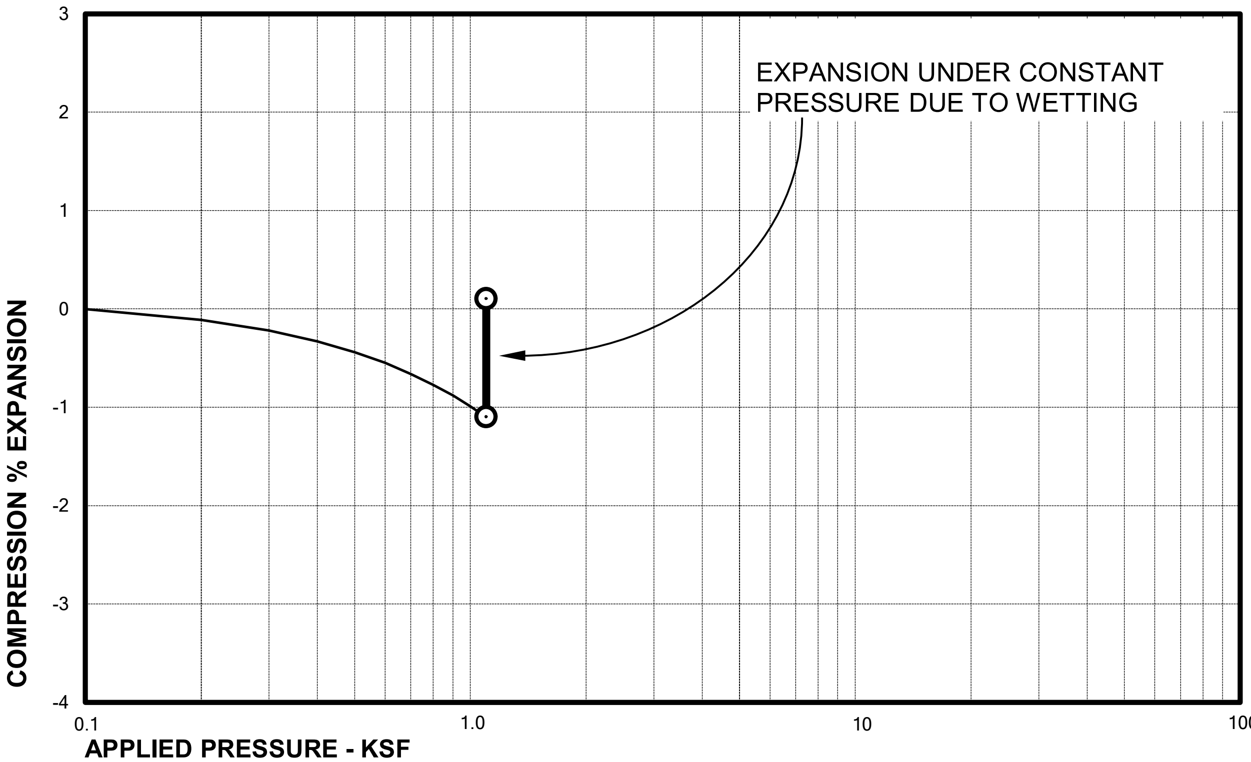
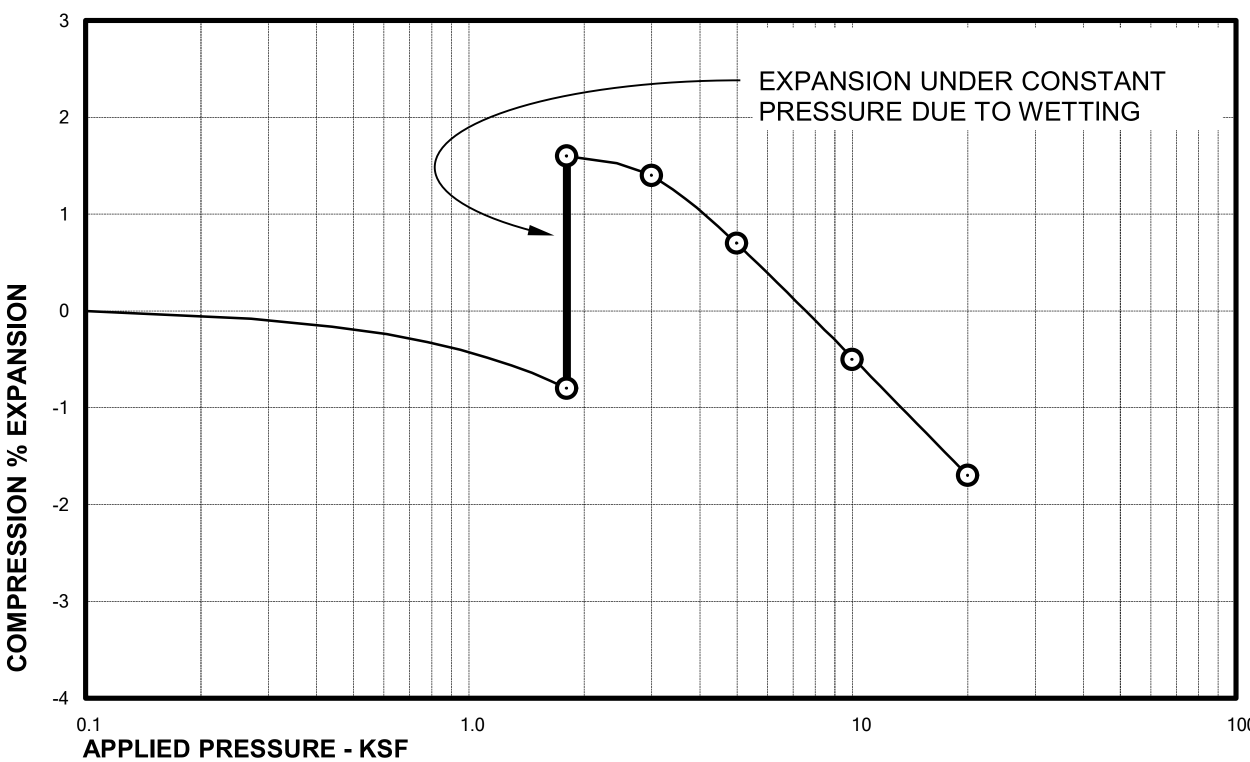
CTL|T PROJECT NO. CS19053.001-115 R2

Swell Consolidation



Sample of CLAY, SANDY (CL)
From TH-203 AT 9 FEET

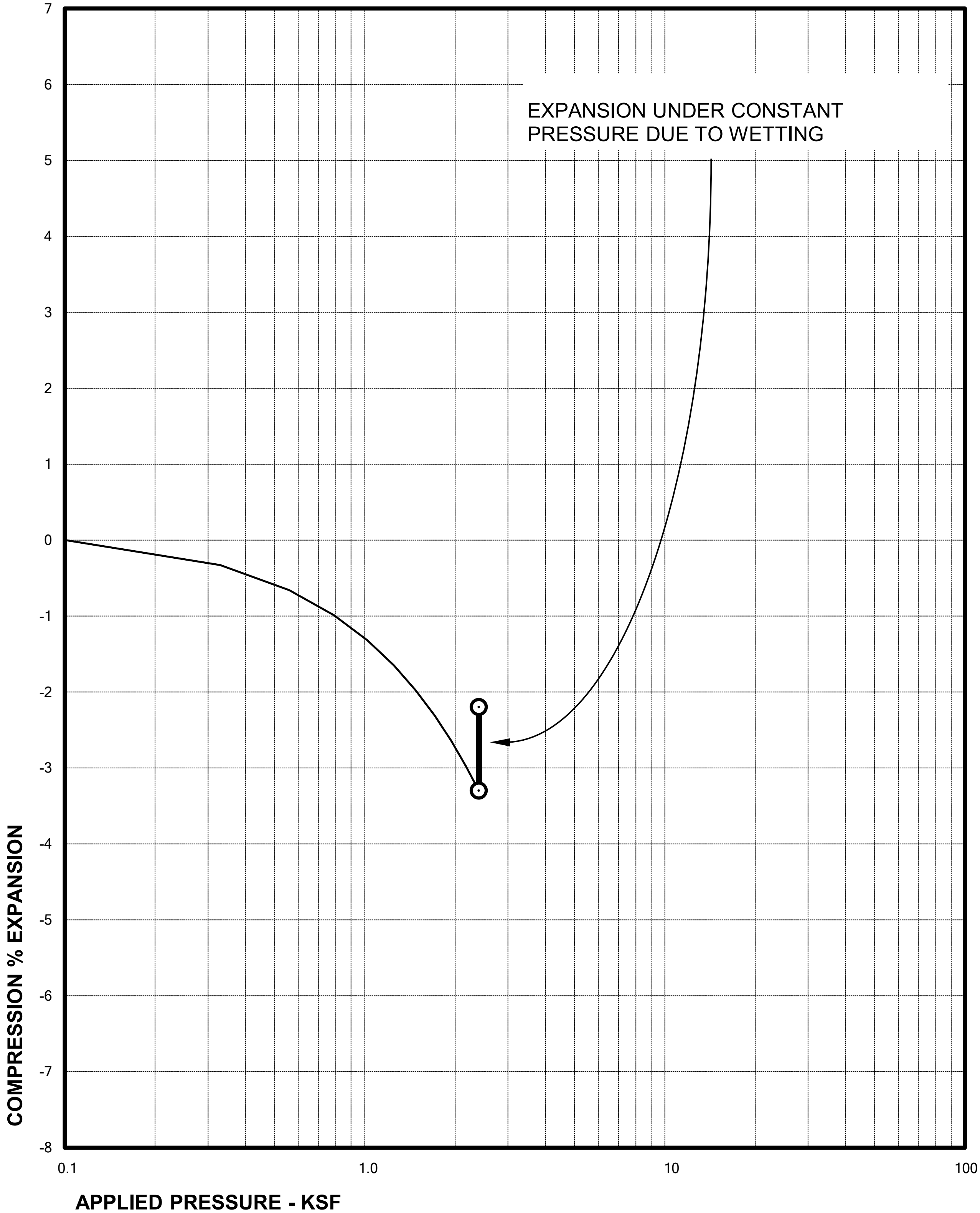
DRY UNIT WEIGHT= 107 PCF
MOISTURE CONTENT= 8.5 %



Sample of CLAY, SANDY (CL)
From TH-203 AT 14 FEET

DRY UNIT WEIGHT= 122 PCF
MOISTURE CONTENT= 10.3 %

Swell Consolidation



Sample of CLAY, VERY SANDY (CL)

From TH-203 AT 19 FEET

DRY UNIT WEIGHT= 107 PCF

MOISTURE CONTENT= 9.7 %

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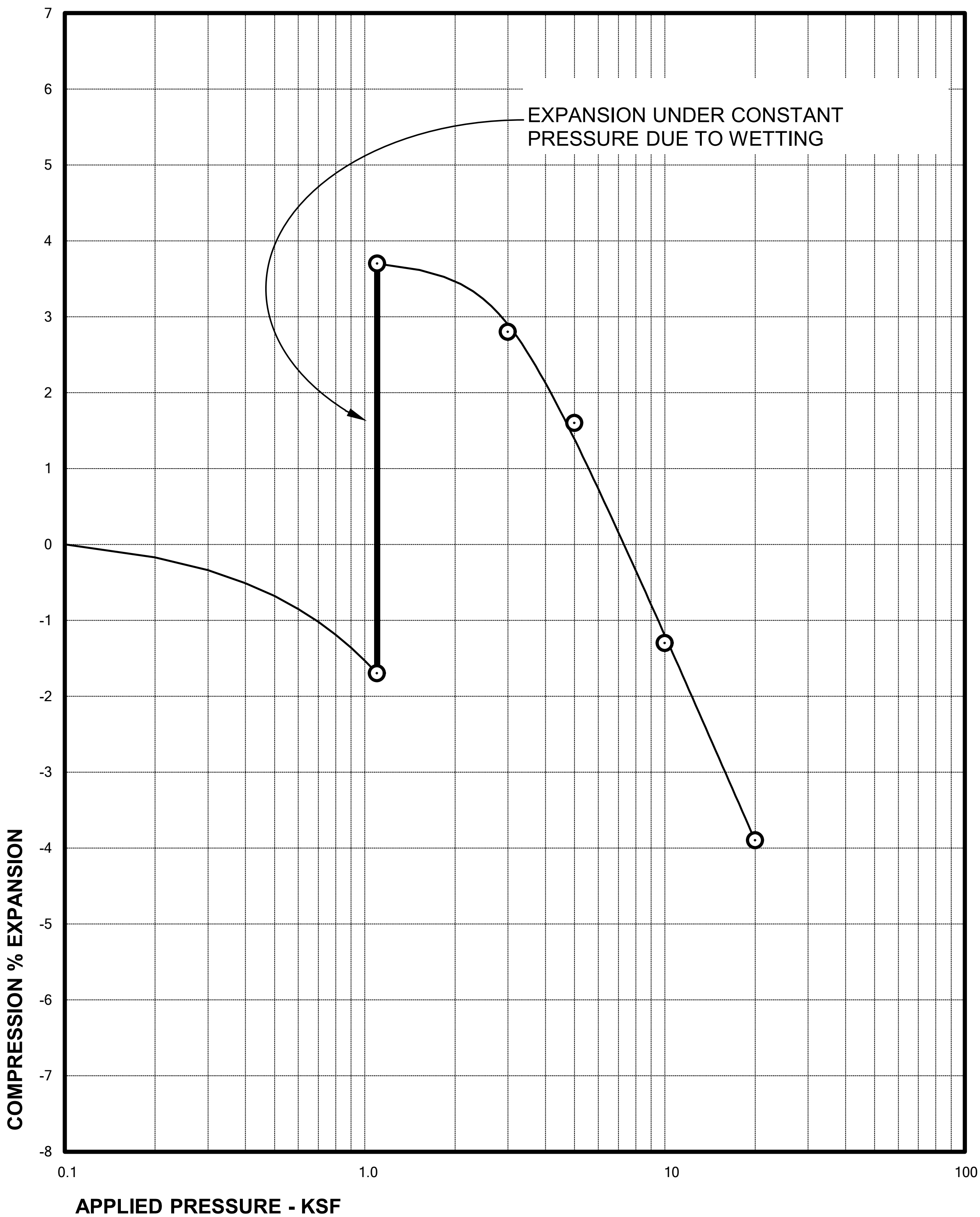
Swell Consolidation Test Results

FIG. B-3



Sample of CLAY, SANDY (CL)
From TH-204 AT 9 FEET

DRY UNIT WEIGHT= 109 PCF
MOISTURE CONTENT= 13.4 %

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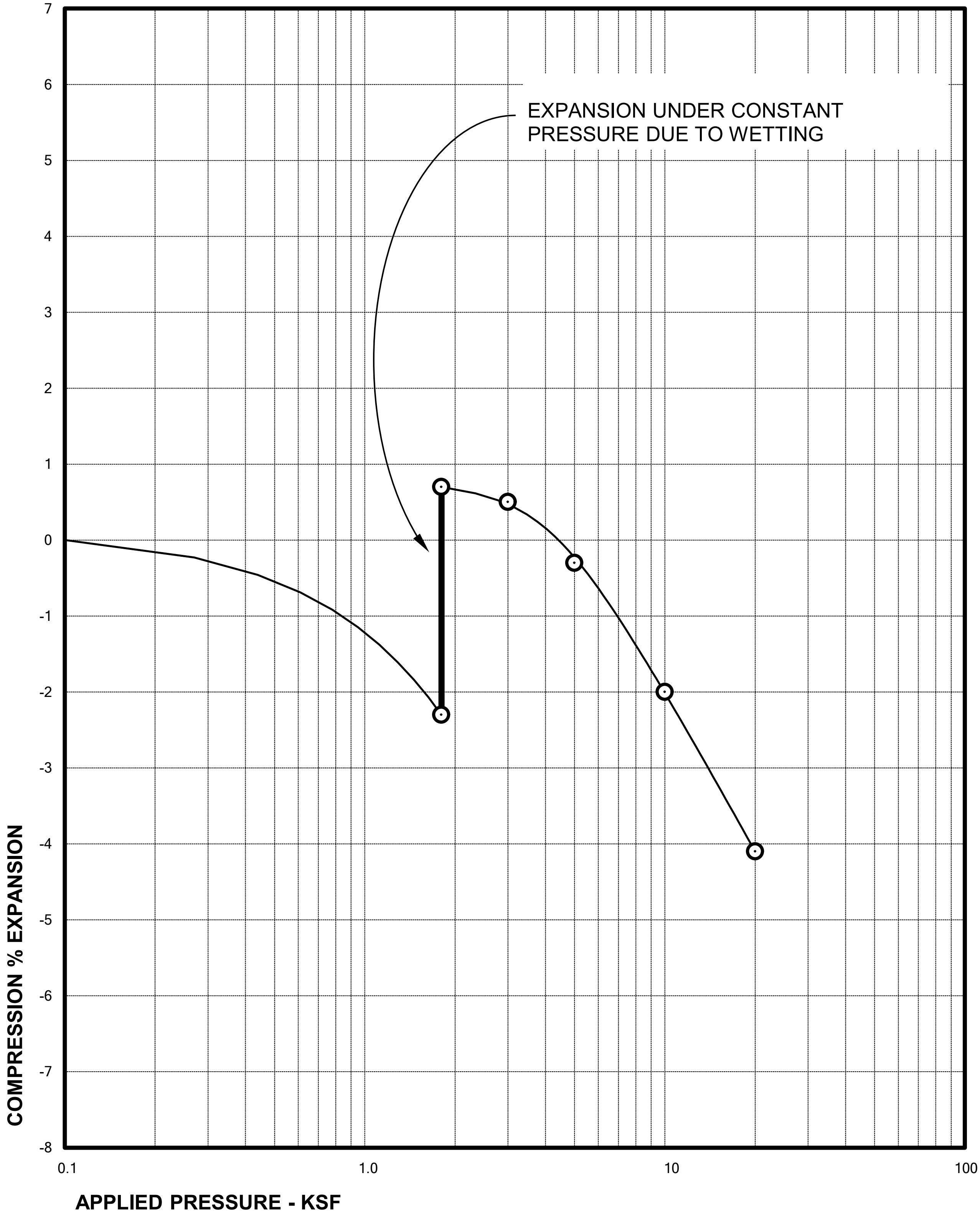
Swell Consolidation Test Results



Sample of CLAY, SANDY (CL)
From TH-204 AT 14 FEET

DRY UNIT WEIGHT= 117 PCF
MOISTURE CONTENT= 9.6 %

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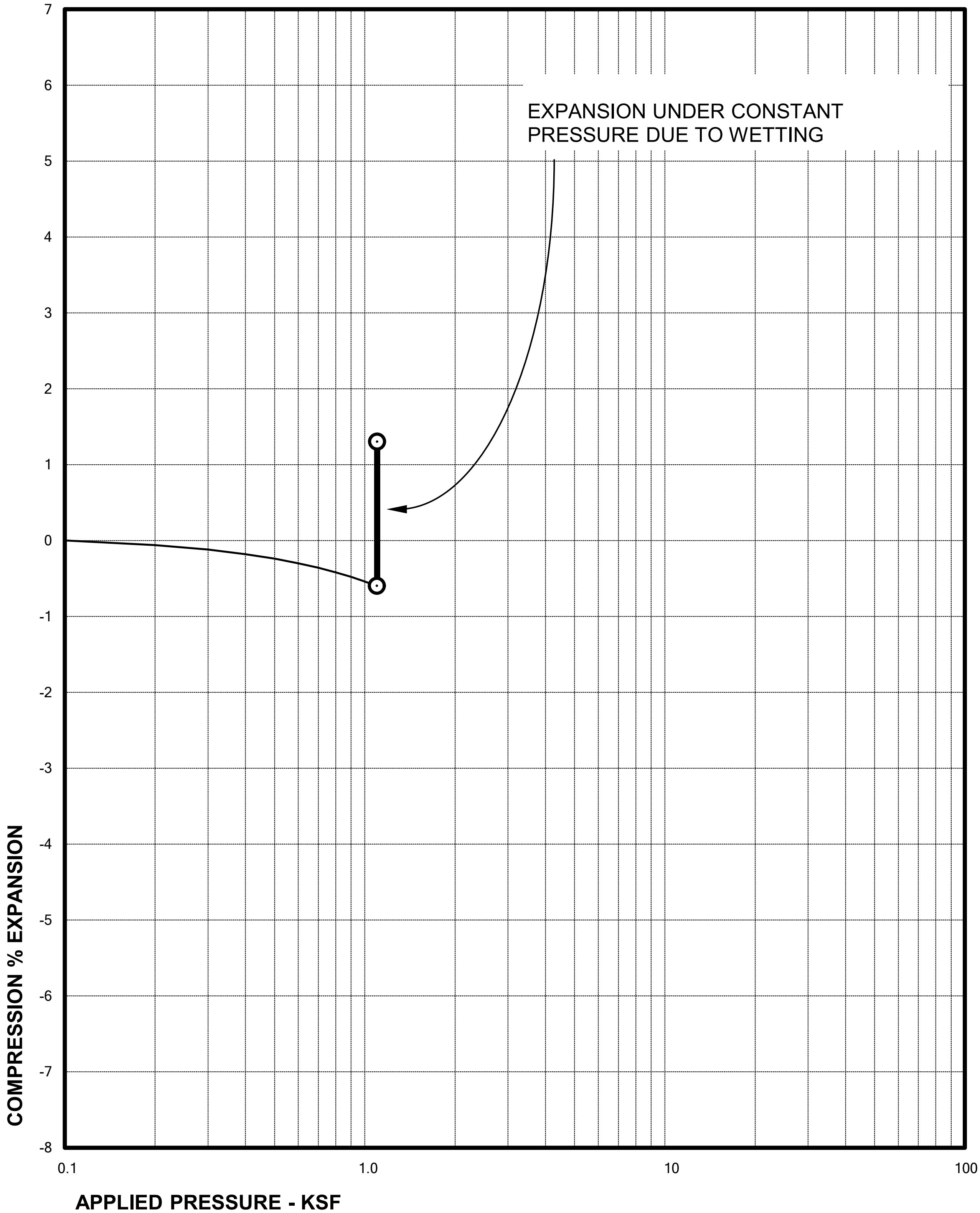
Swell Consolidation Test Results

FIG. B-5



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	117	PCF
From	TH-205 AT 9 FEET	MOISTURE CONTENT=	8.2	%

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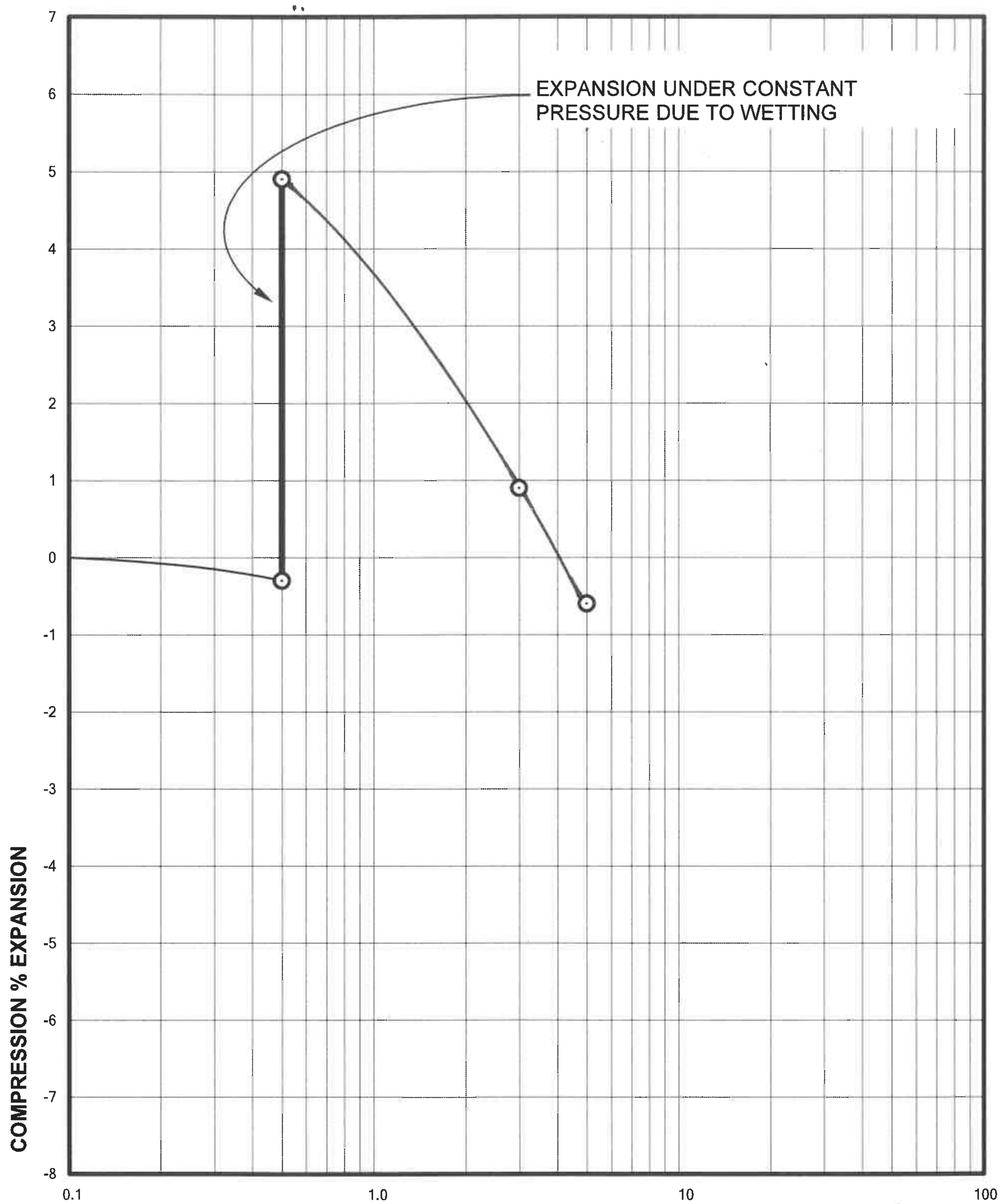
CTL|T PROJECT NO. CS19053.001-115 R2

Swell Consolidation Test Results

FIG. B-6



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	107	PCF
From	TH-206 AT 4 FEET	MOISTURE CONTENT=	8.8	%

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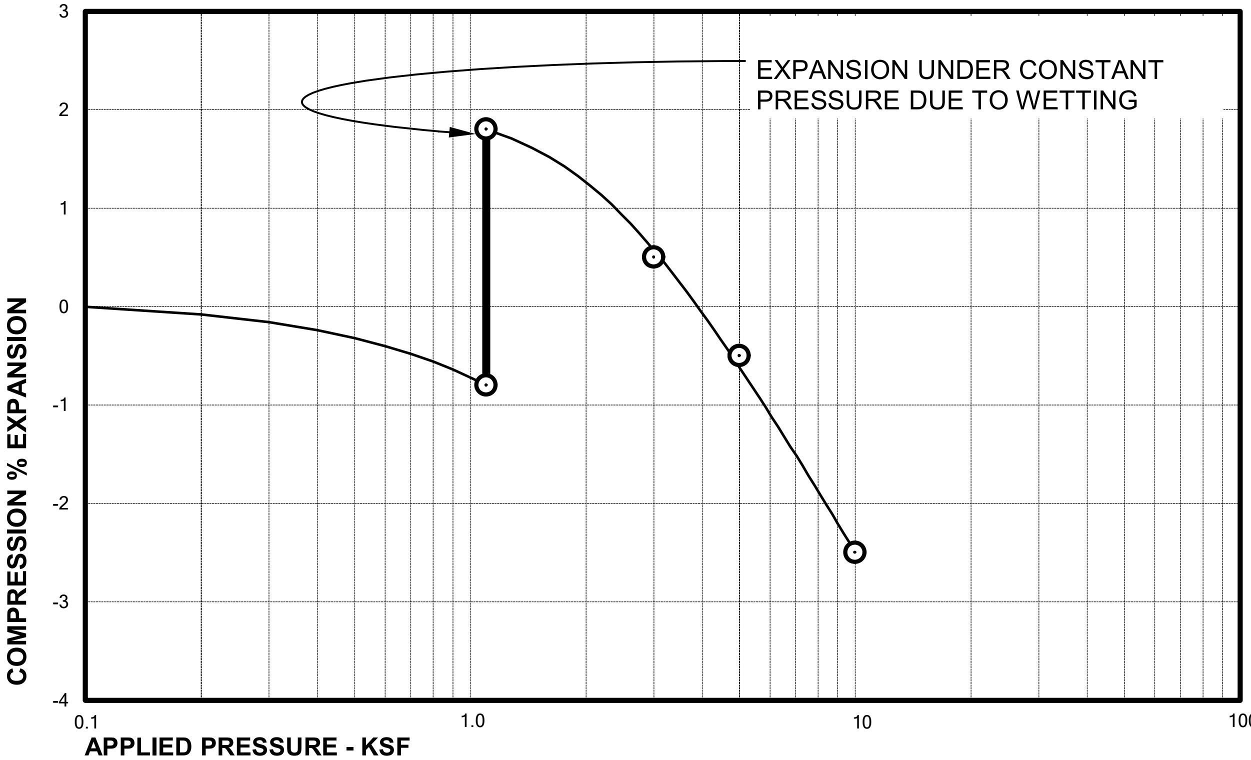
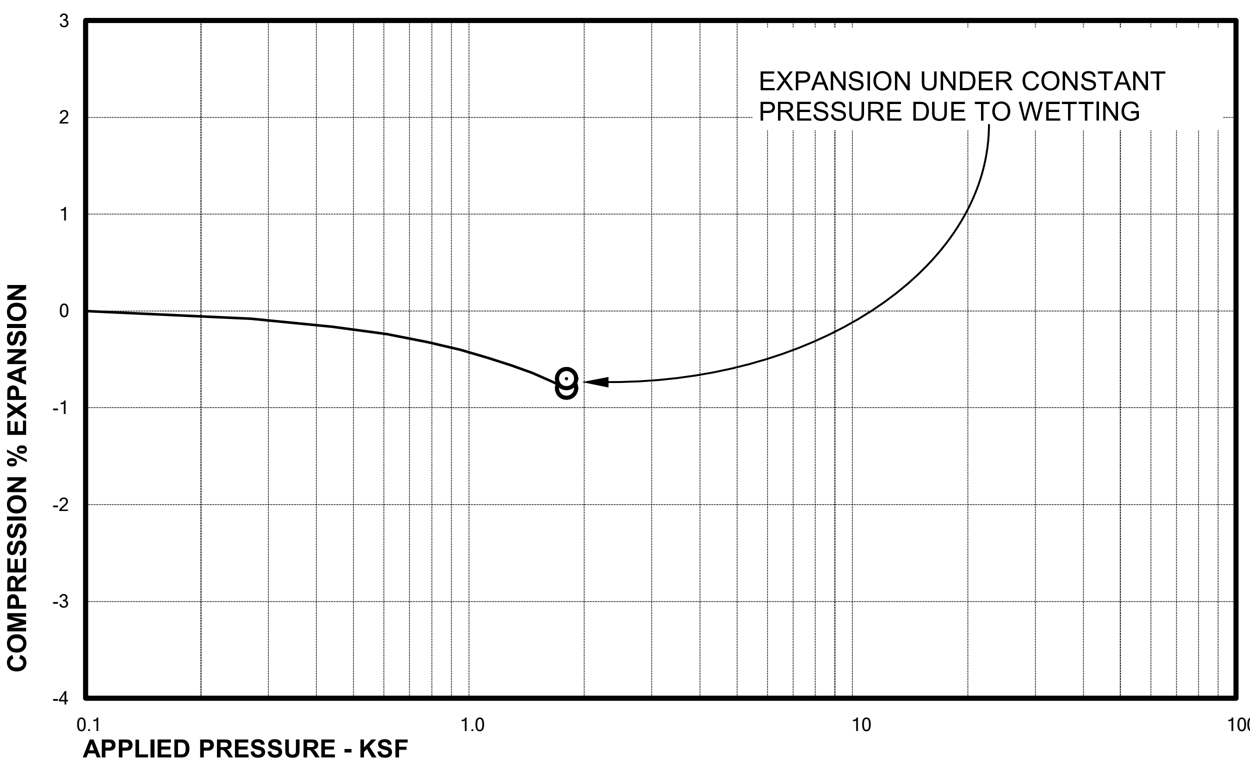
CTL|T PROJECT NO. CS19053.001-115 R2

Swell Consolidation Test Results



Sample of CLAY, SANDY (CL)
From TH-206 AT 9 FEET

DRY UNIT WEIGHT= 111 PCF
MOISTURE CONTENT= 11.2 %



Sample of WEATHERED CLAYSTONE
From TH-206 AT 14 FEET

DRY UNIT WEIGHT= 123 PCF
MOISTURE CONTENT= 10.0 %

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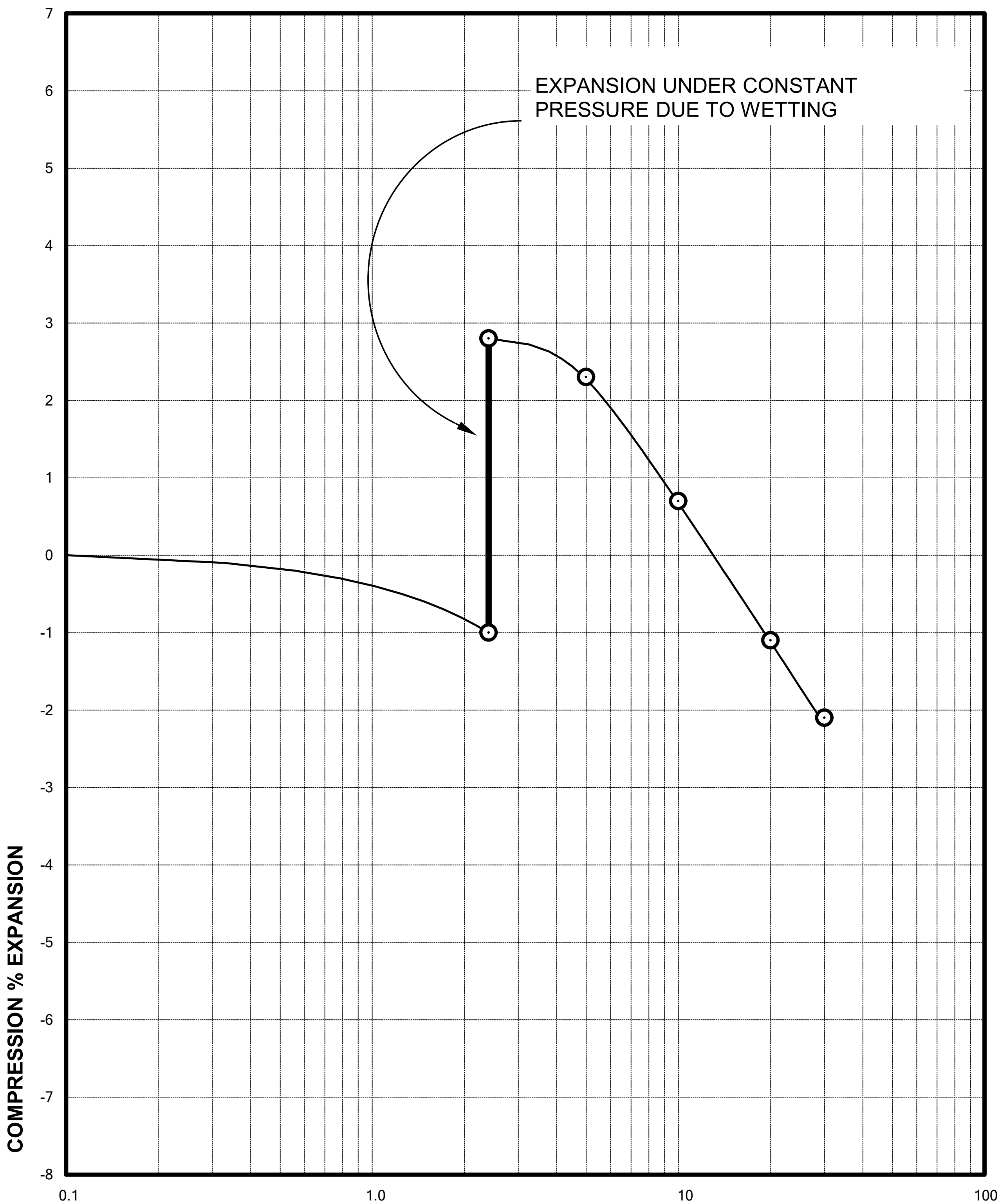
Swell Consolidation



Sample of CLAYSTONE, SANDY

From TH-206 AT 19 FEET

DRY UNIT WEIGHT= 127 PCF

MOISTURE CONTENT= 9.6 %

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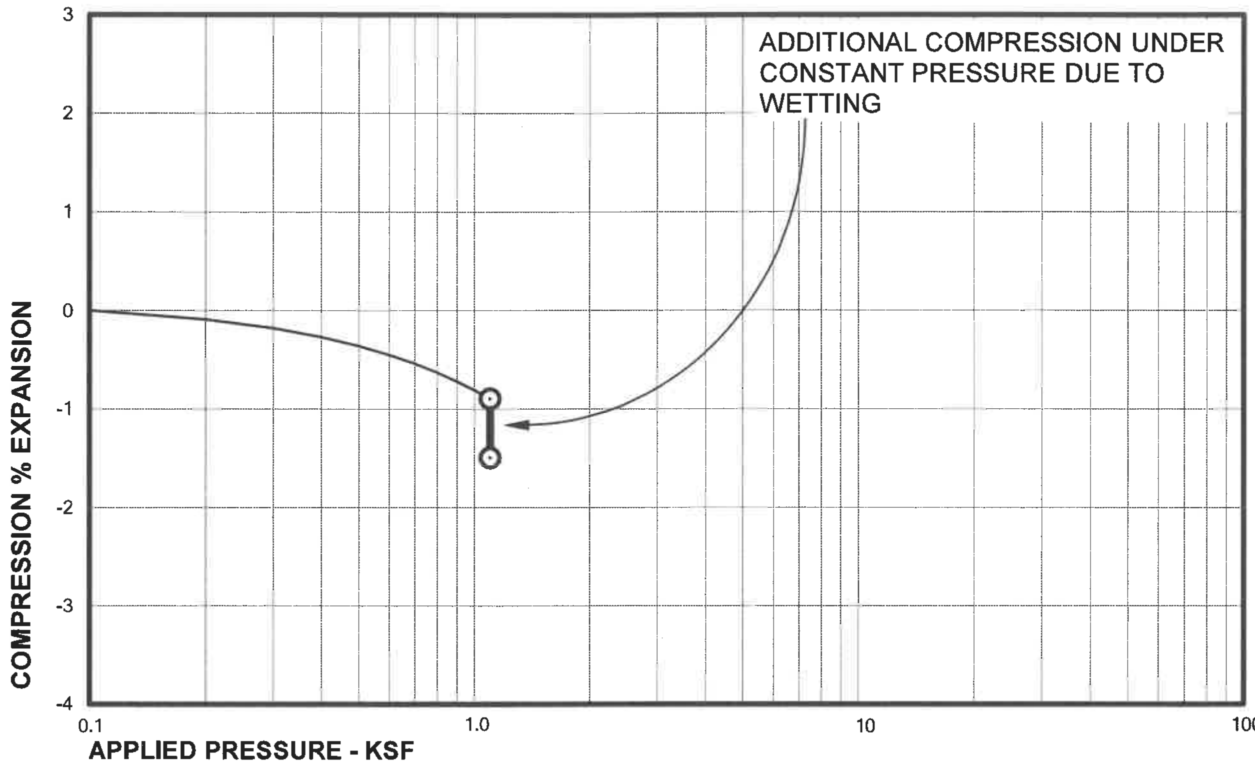
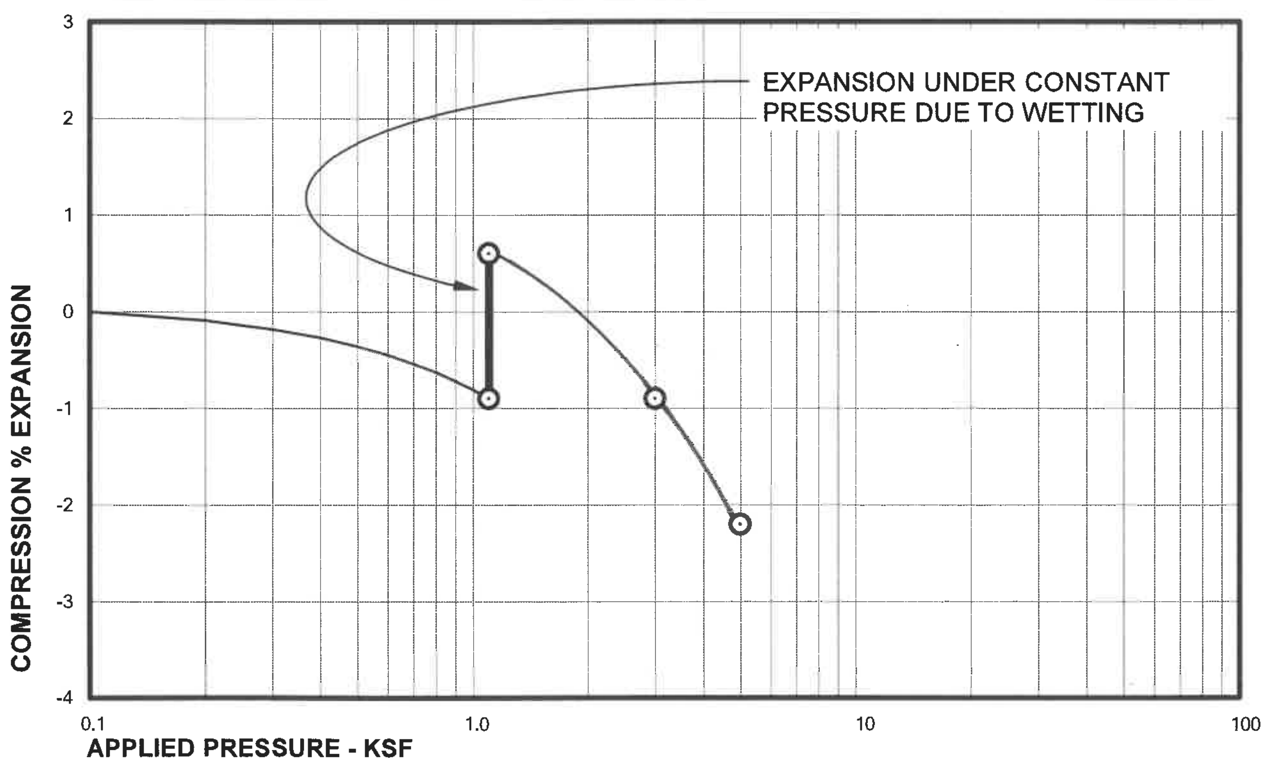
Swell Consolidation Test Results

FIG. B-9



Sample of CLAY, SANDY (CL)
From TH-207 AT 9 FEET

DRY UNIT WEIGHT= 110 PCF
MOISTURE CONTENT= 6.5 %



Sample of CLAY, SANDY (CL)
From TH-208 AT 4 FEET

DRY UNIT WEIGHT= 106 PCF
MOISTURE CONTENT= 5.9 %

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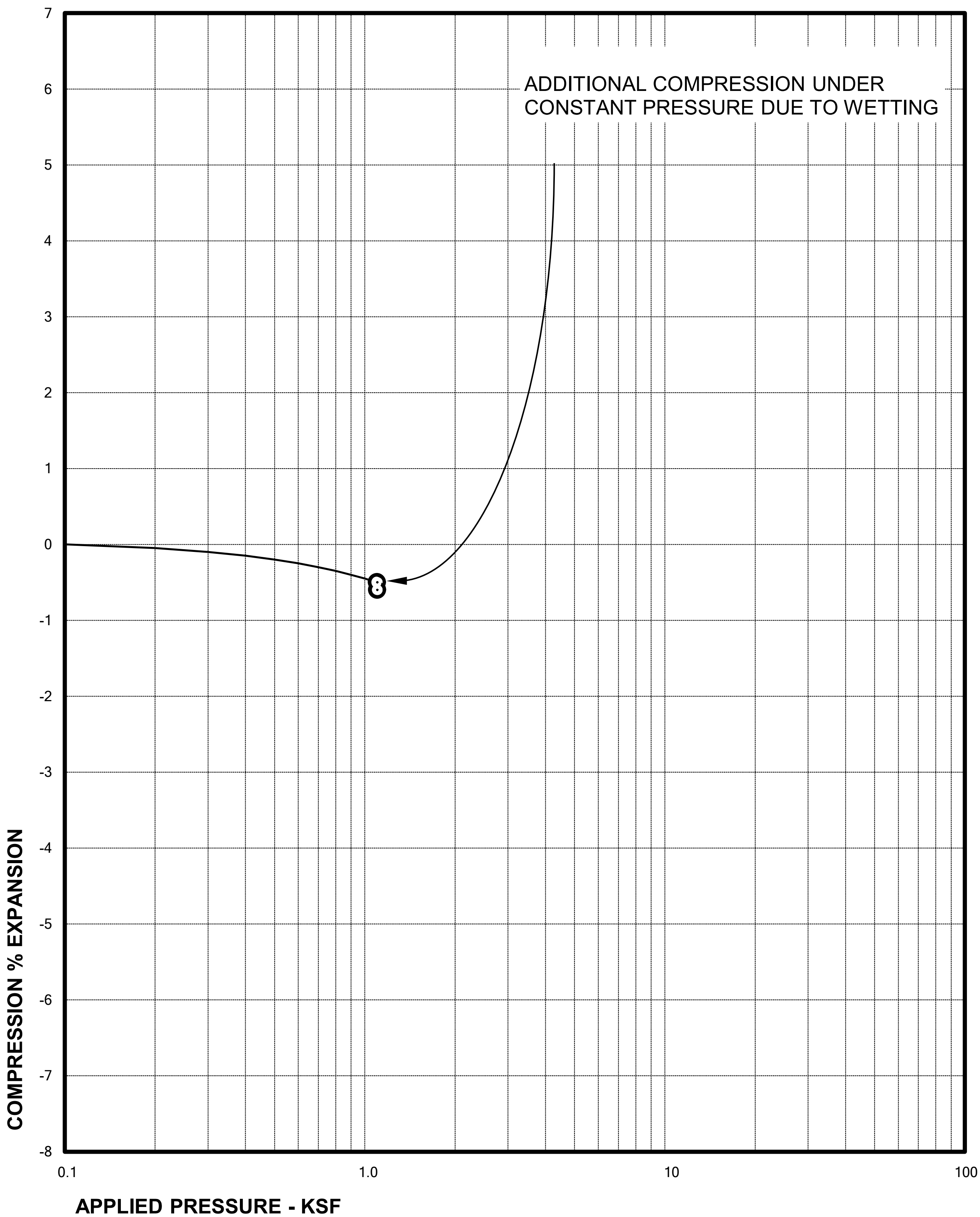
Swell Consolidation



Sample of CLAY, SANDY (CL)
From TH-208 AT 9 FEET

DRY UNIT WEIGHT= 117 PCF
MOISTURE CONTENT= 10.8 %

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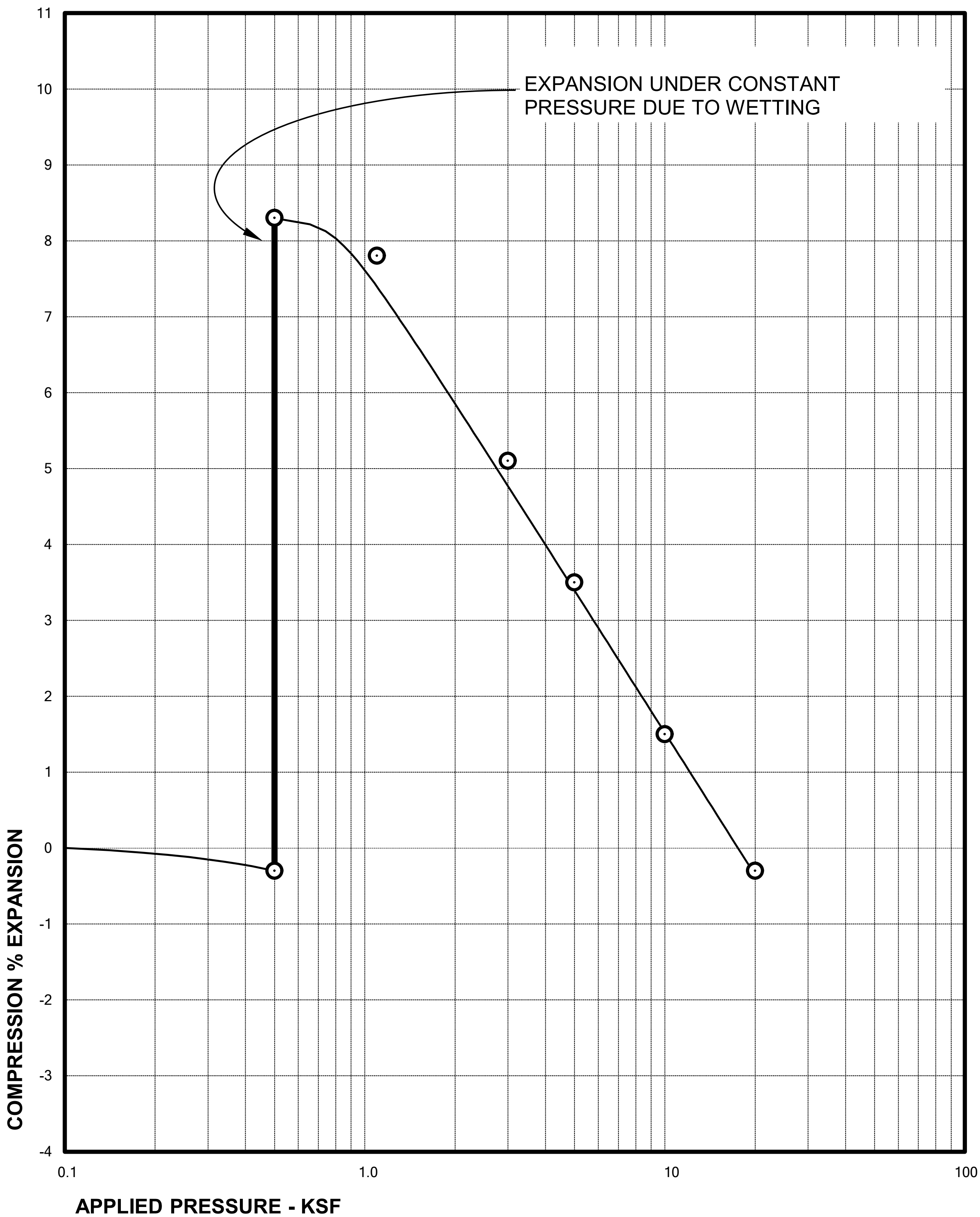
Swell Consolidation Test Results

FIG. B-11



Sample of CLAYSTONE, SANDY

From TH-209 AT 4 FEET

DRY UNIT WEIGHT= 129 PCF

MOISTURE CONTENT= 7.5 %

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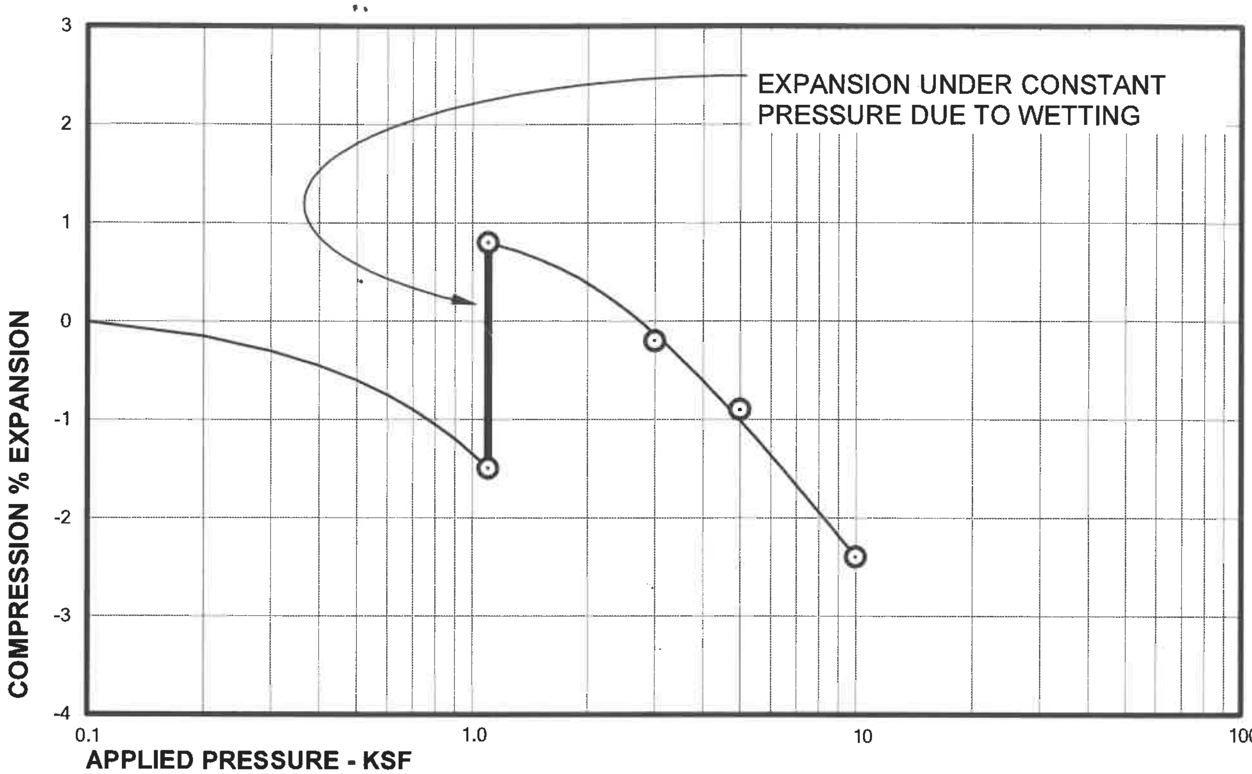
Swell Consolidation Test Results

FIG. B-12

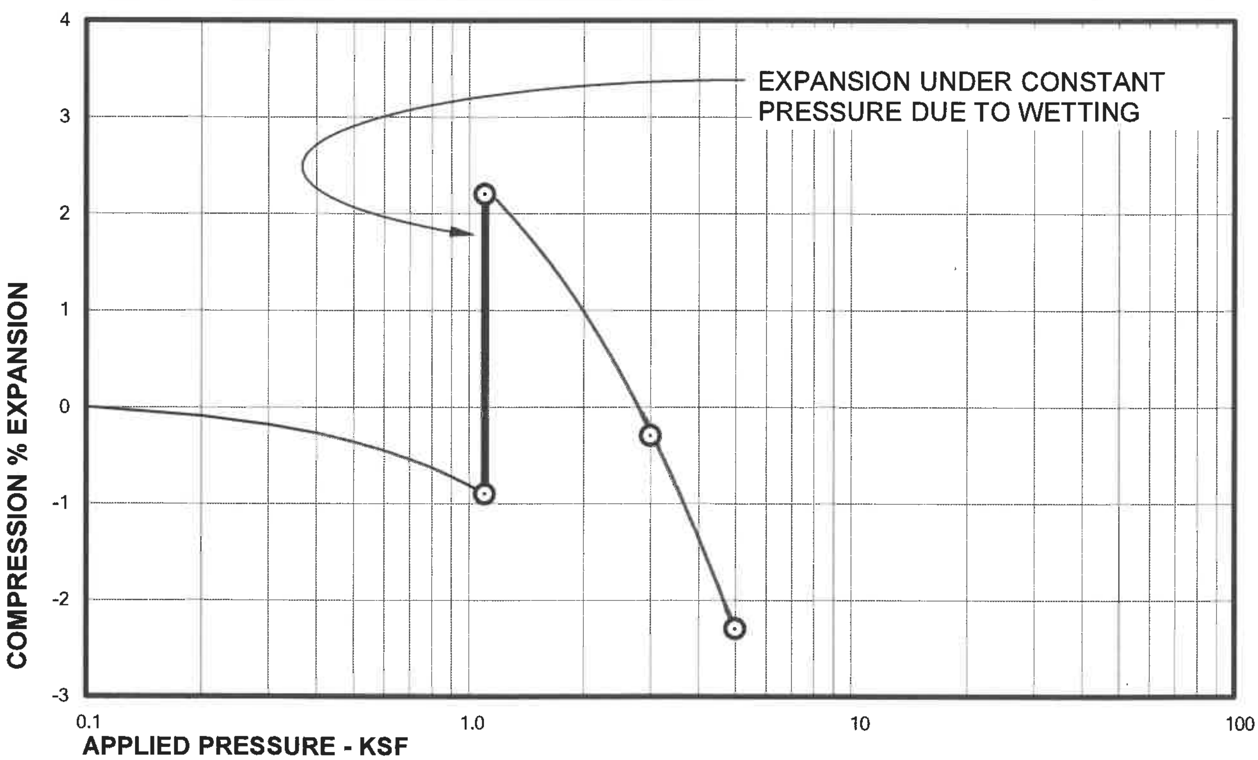


Sample of CLAYSTONE, SANDY

From TH-209 AT 9 FEET

DRY UNIT WEIGHT= 119 PCF

MOISTURE CONTENT= 10.0 %



Sample of CLAY, SANDY (CL)

From TH-210 AT 9 FEET

DRY UNIT WEIGHT= 109 PCF

MOISTURE CONTENT= 9.1 %

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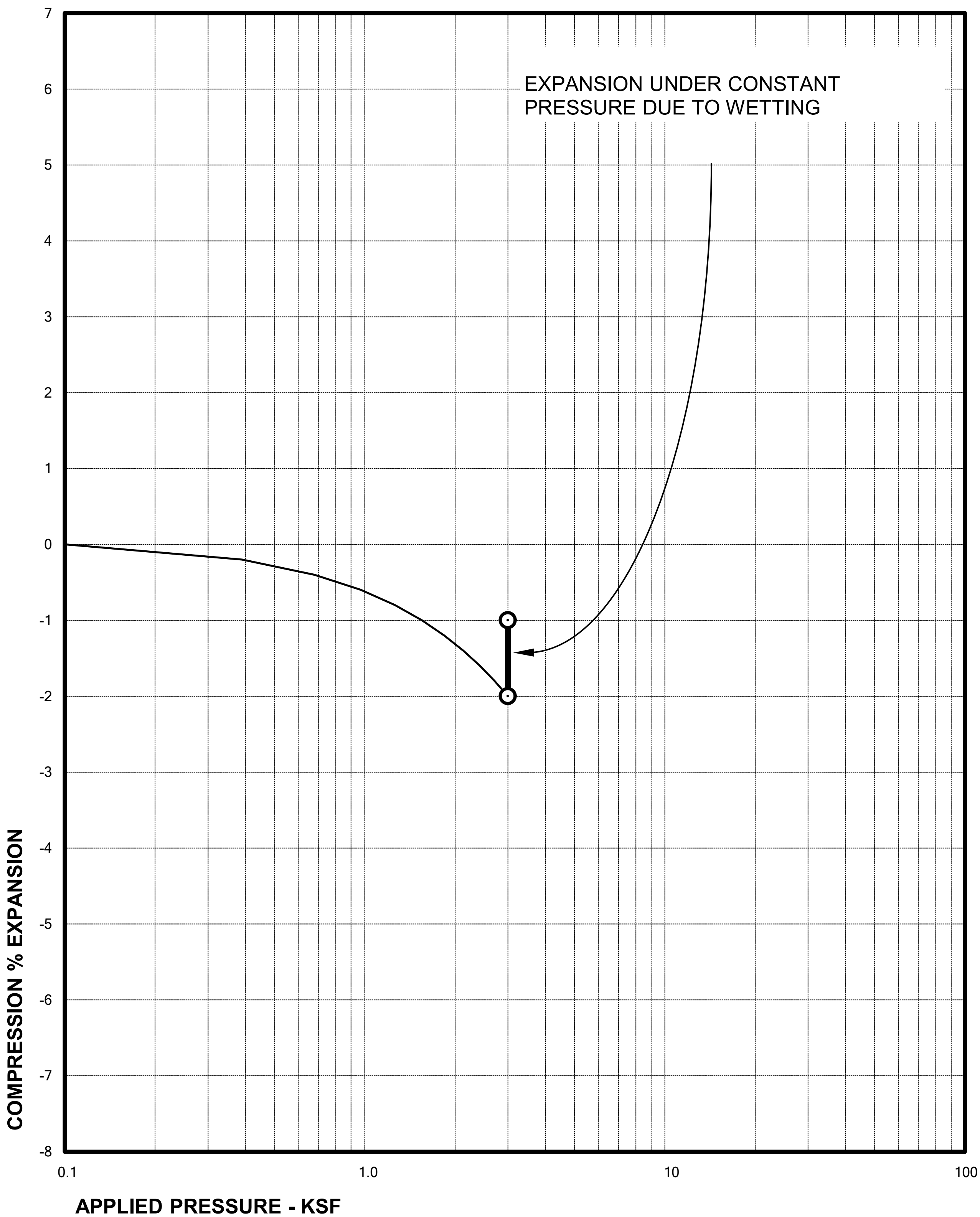
Swell Consolidation



Sample of CLAYSTONE, VERY SANDY

From TH-210 AT 24 FEET

DRY UNIT WEIGHT= 128 PCF

MOISTURE CONTENT= 9.5 %

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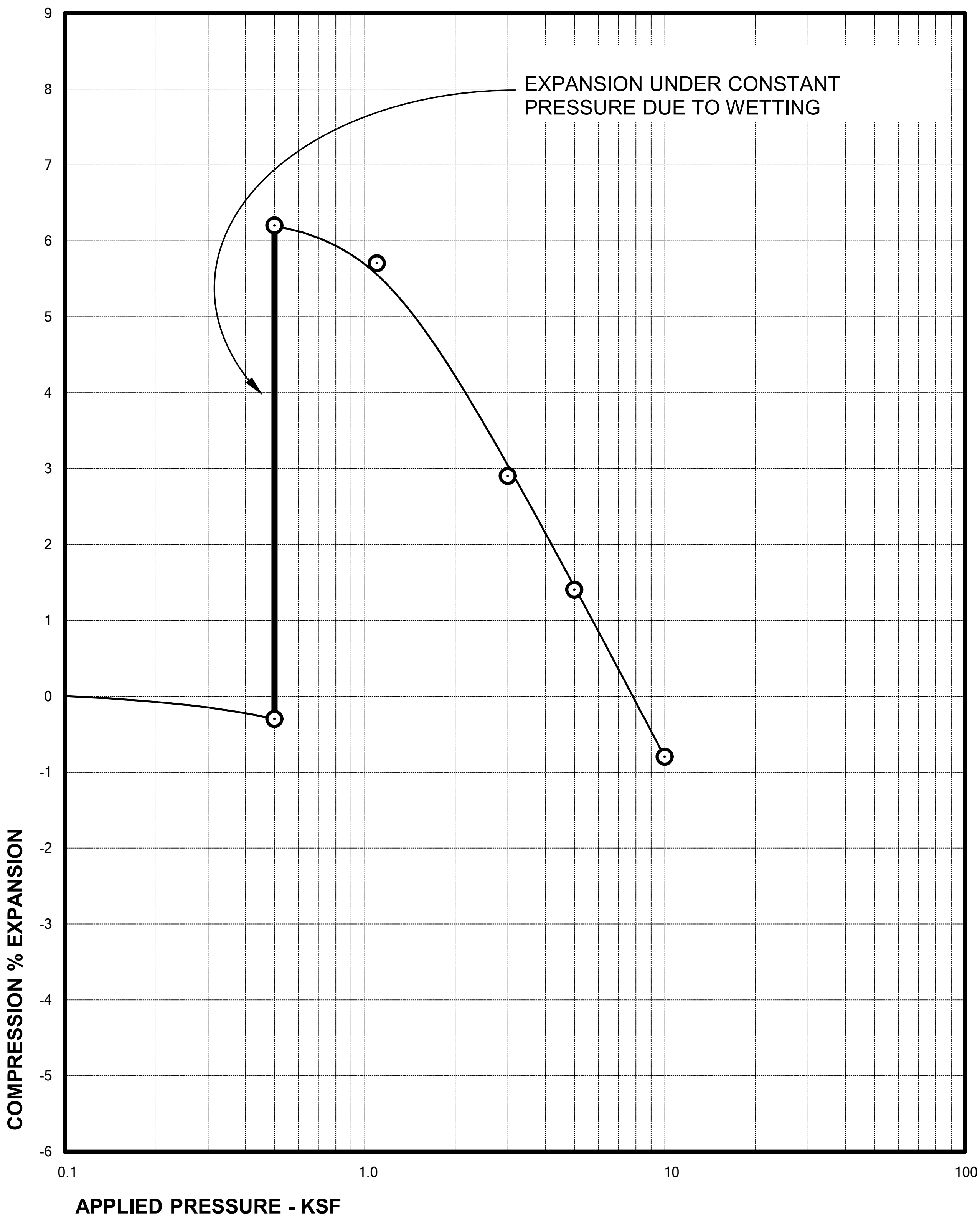
CTL|T PROJECT NO. CS19053.001-115 R2

Swell Consolidation Test Results

FIG. B-14



Sample of	CLAY, SANDY (CL)		DRY UNIT WEIGHT=	107	PCF
From	TH-211 AT 4 FEET		MOISTURE CONTENT=	6.1	%

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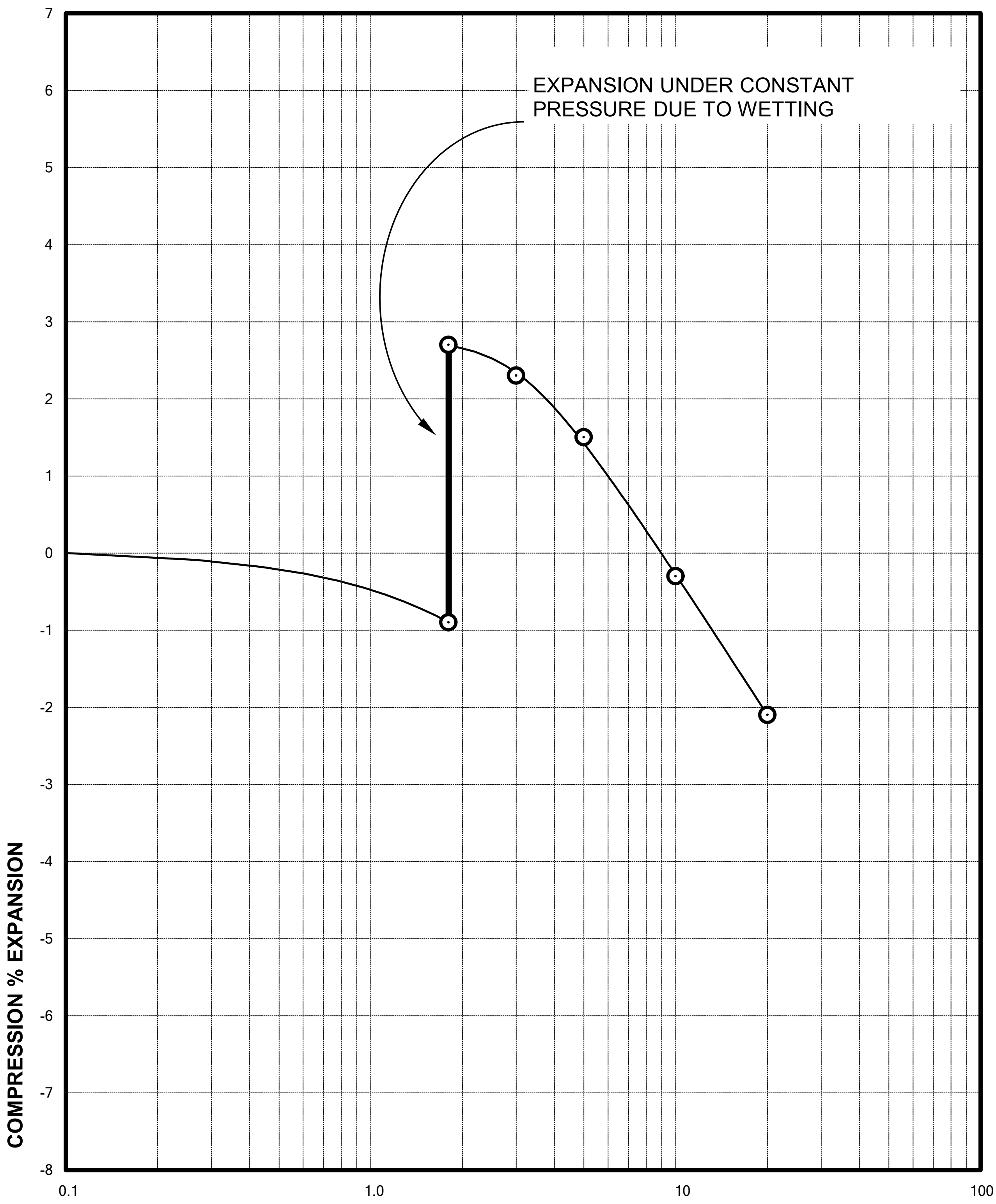
Swell Consolidation Test Results

FIG. B-15



Sample of CLAYSTONE, SANDY

From TH-211 AT 14 FEET

DRY UNIT WEIGHT= 130 PCF

MOISTURE CONTENT= 10.6 %

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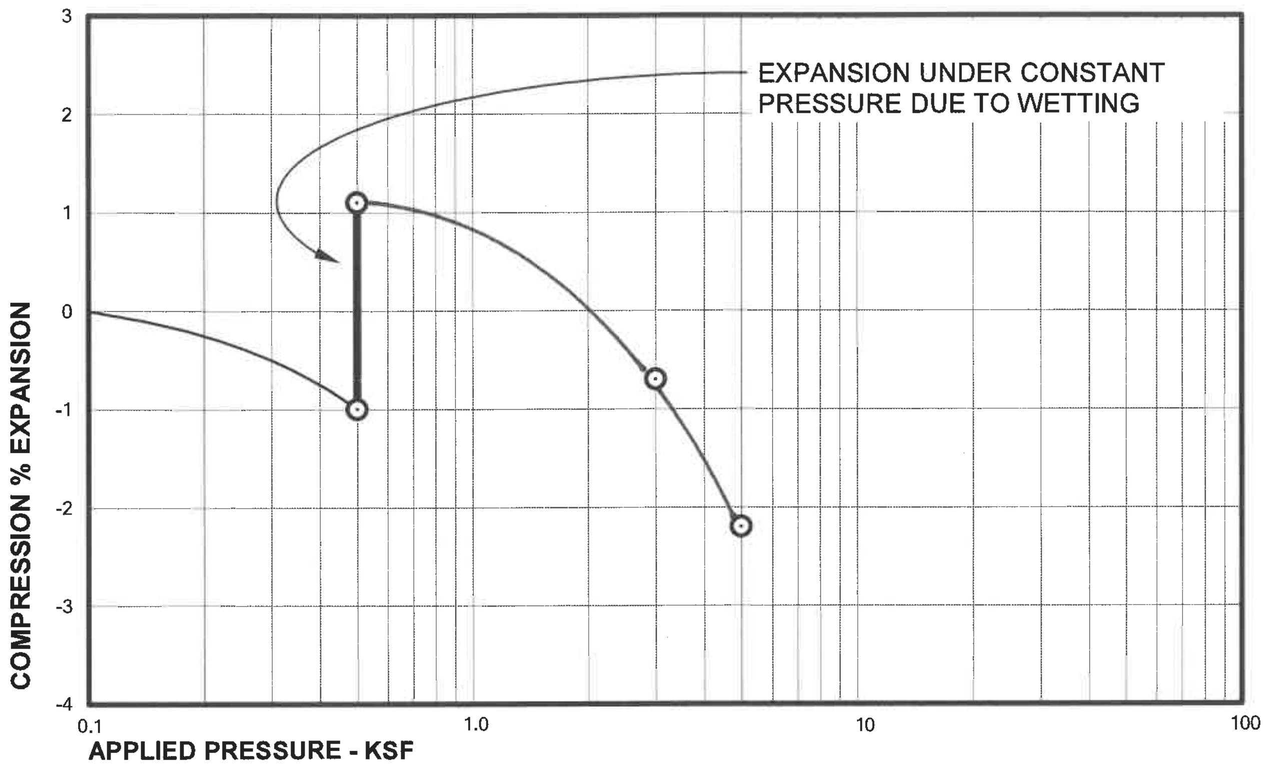
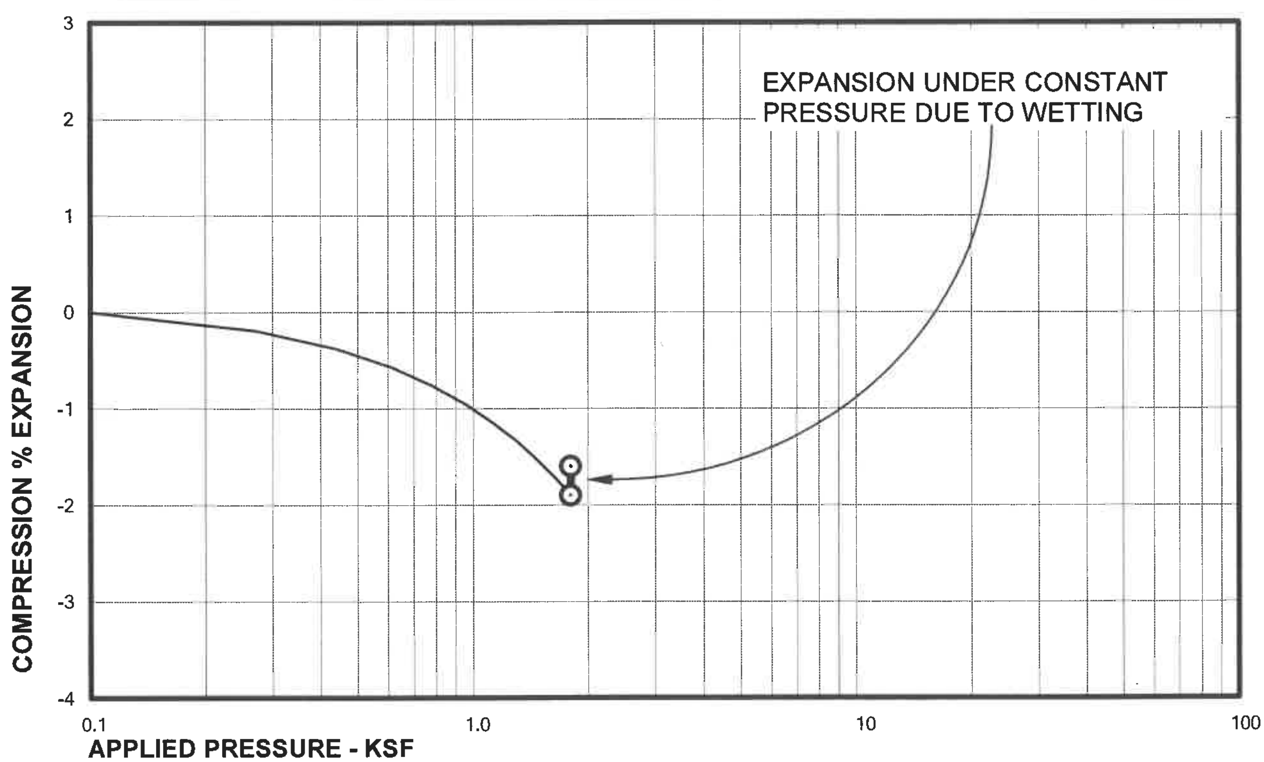
Swell Consolidation Test Results

FIG. B-16



Sample of CLAY, SANDY (CL)
From TH-212 AT 4 FEET

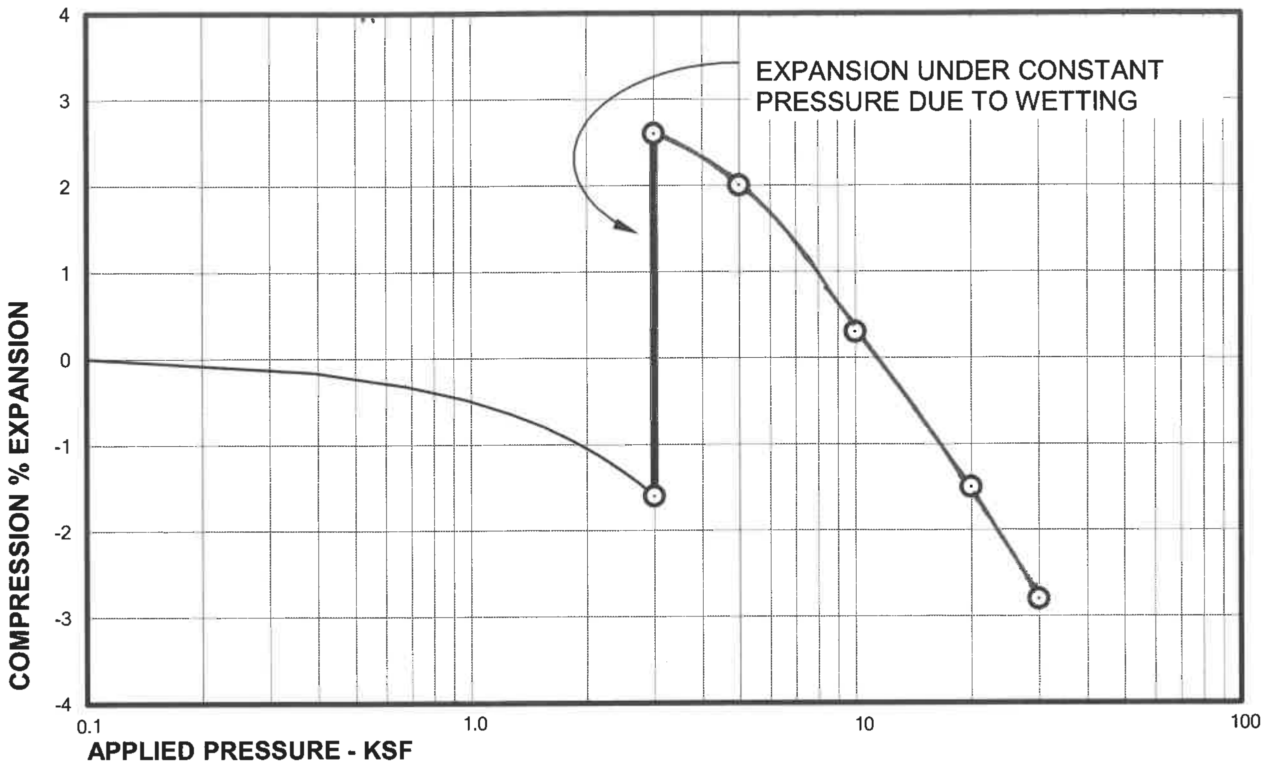
DRY UNIT WEIGHT= 96 PCF
MOISTURE CONTENT= 9.2 %



Sample of CLAY, SANDY (CL)
From TH-212 AT 14 FEET

DRY UNIT WEIGHT= 118 PCF
MOISTURE CONTENT= 11.5 %

Swell Consolidation

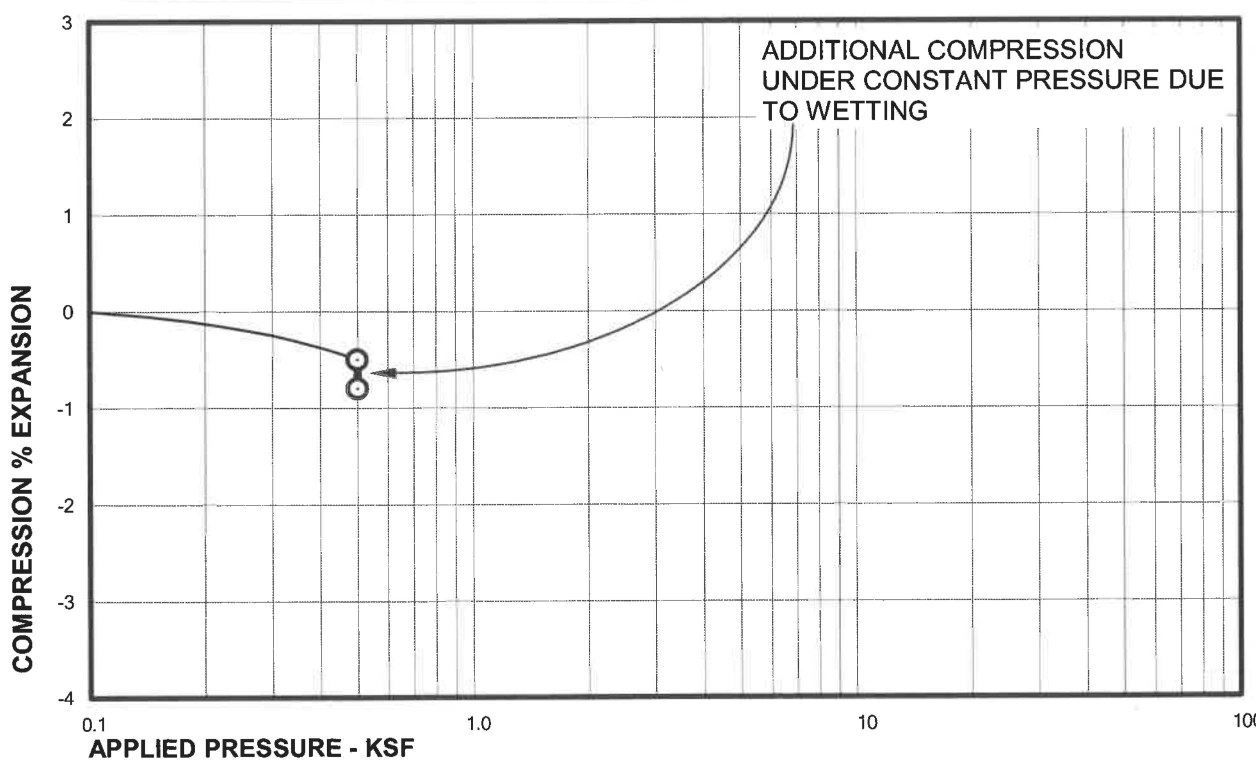


Sample of CLAYSTONE, SANDY

From TH-212 AT 24 FEET

DRY UNIT WEIGHT= 116 PCF

MOISTURE CONTENT= 16.3 %



Sample of CLAY, SANDY (CL)

From TH-213 AT 4 FEET

DRY UNIT WEIGHT= 111 PCF

MOISTURE CONTENT= 14.5 %

LA PLATA CUZE HOLDINGS, LLC
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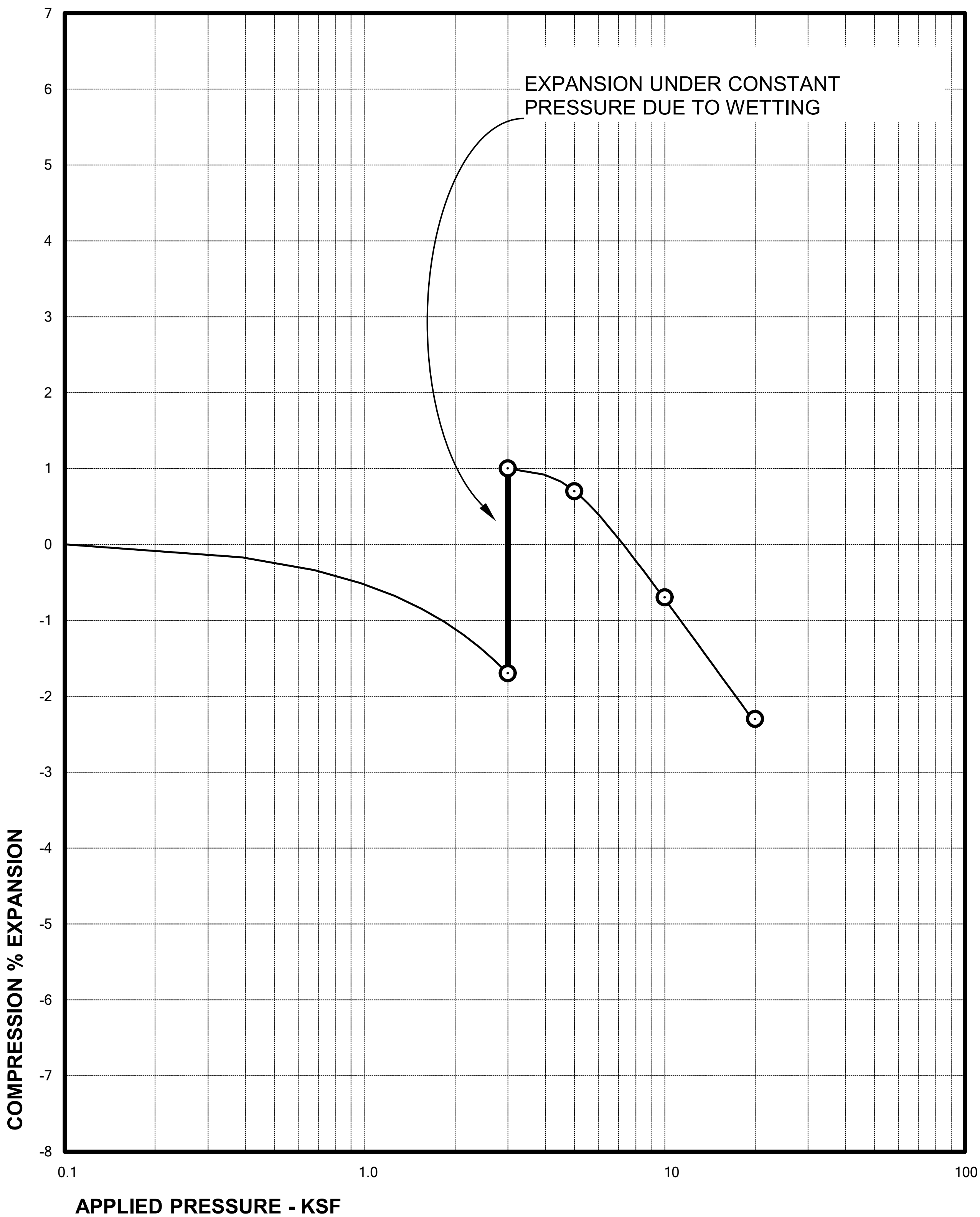
Swell Consolidation

FIG. B-18



Sample of CLAYSTONE, SANDY
From TH-213 AT 24 FEET

DRY UNIT WEIGHT= 114 PCF
MOISTURE CONTENT= 16.5 %

LA PLATA CUZE HOLDINGS, LLC
AMARA RESIDENTIAL DEVELOPMENT
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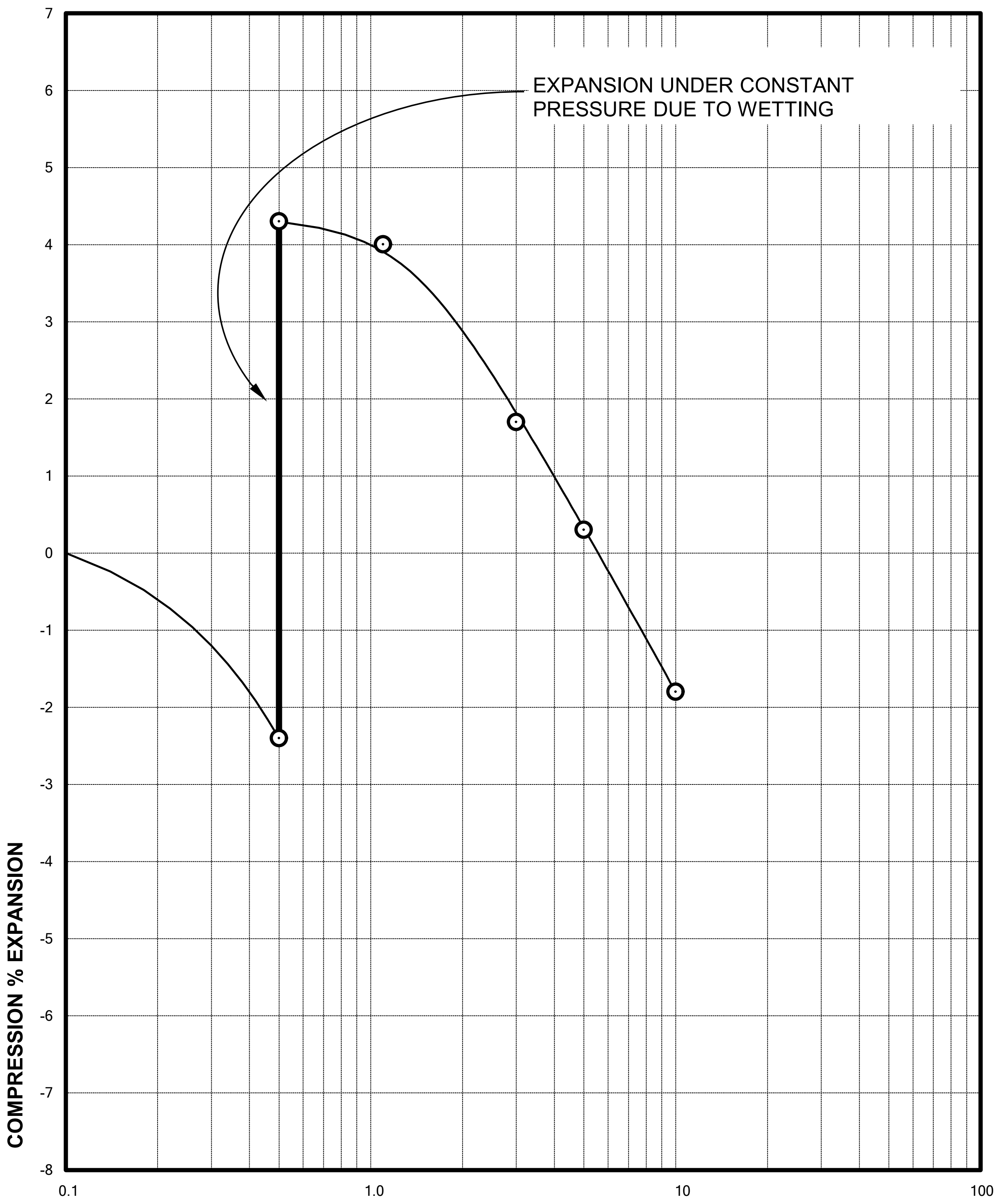
Swell Consolidation Test Results

FIG. B-19



Sample of CLAYSTONE, SLIGHTLY SANDY
From TH-214 AT 4 FEET

DRY UNIT WEIGHT= 109 PCF
MOISTURE CONTENT= 13.3 %

LA PLATA CUZE HOLDINGS, LLC
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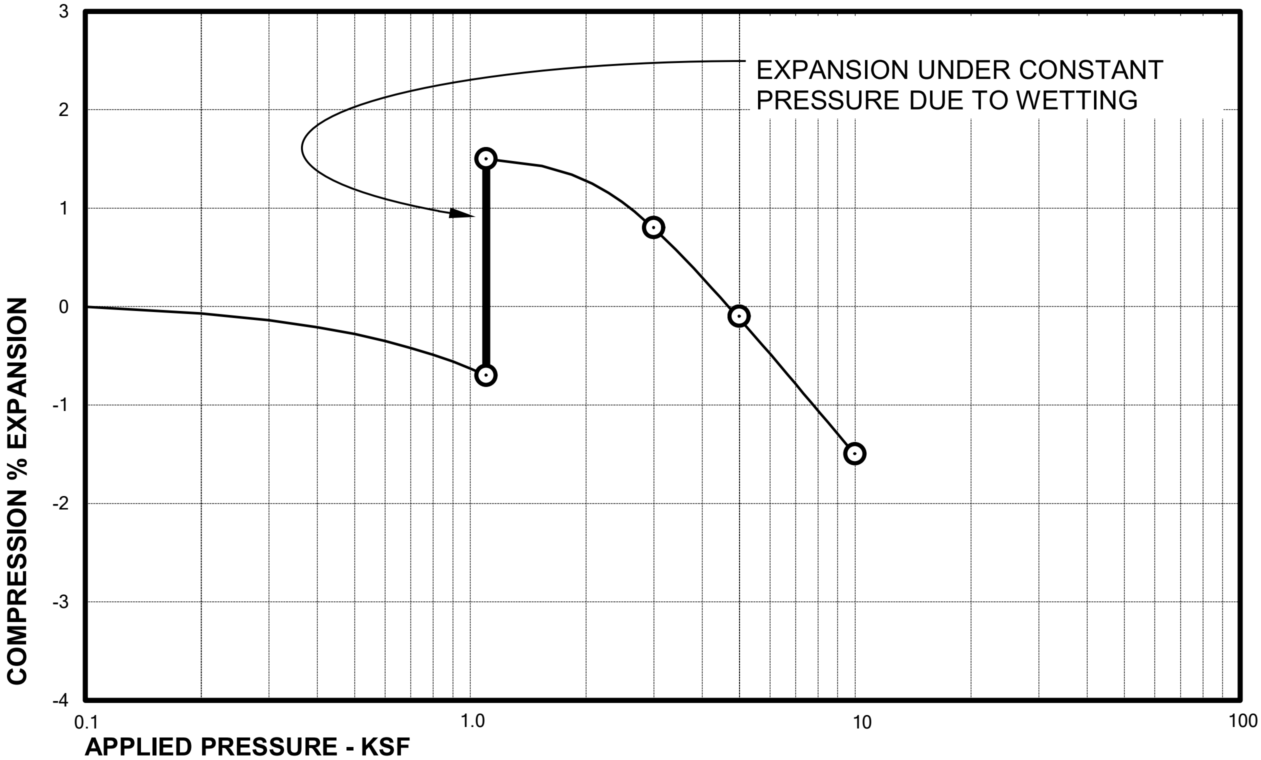
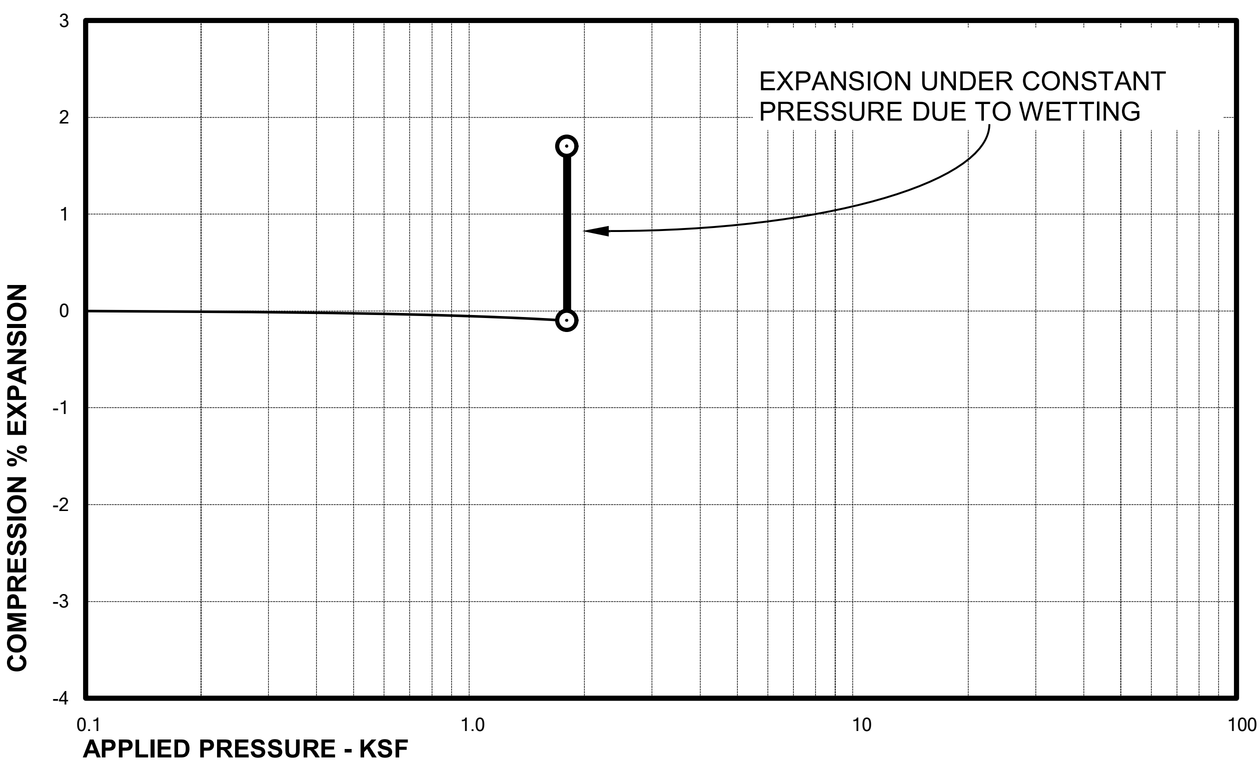
Swell Consolidation Test Results

FIG. B-20



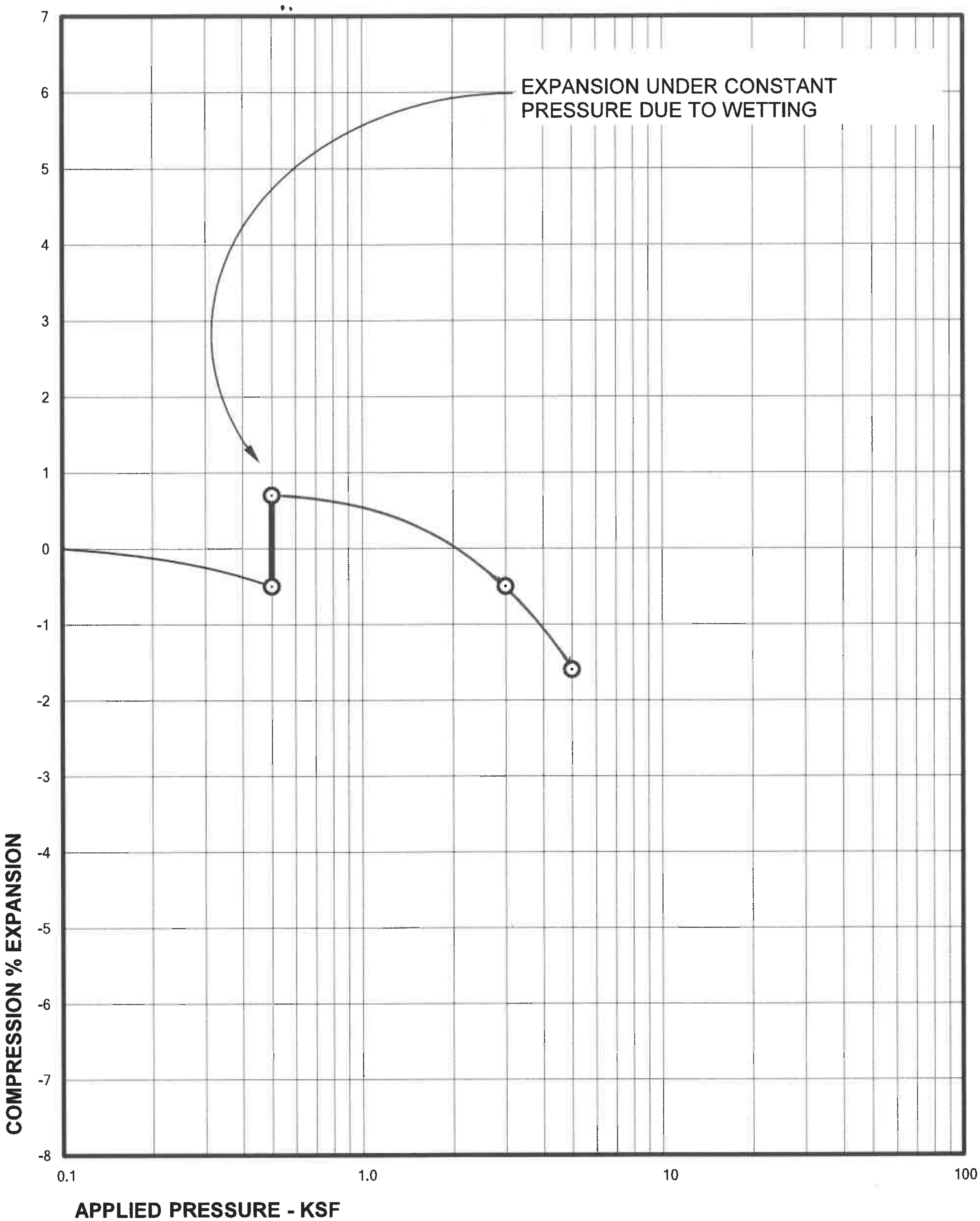
Sample of CLAYSTONE, SANDY
From TH-214 AT 9 FEET

DRY UNIT WEIGHT= 120 PCF
MOISTURE CONTENT= 12.8 %



Sample of CLAYSTONE, SANDY
From TH-214 AT 14 FEET

DRY UNIT WEIGHT= 122 PCF
MOISTURE CONTENT= 12.7 %



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	93	PCF
From	TH-215 AT 4 FEET	MOISTURE CONTENT=	7.2	%

LA PLATA CUZE HOLDINGS, LLC
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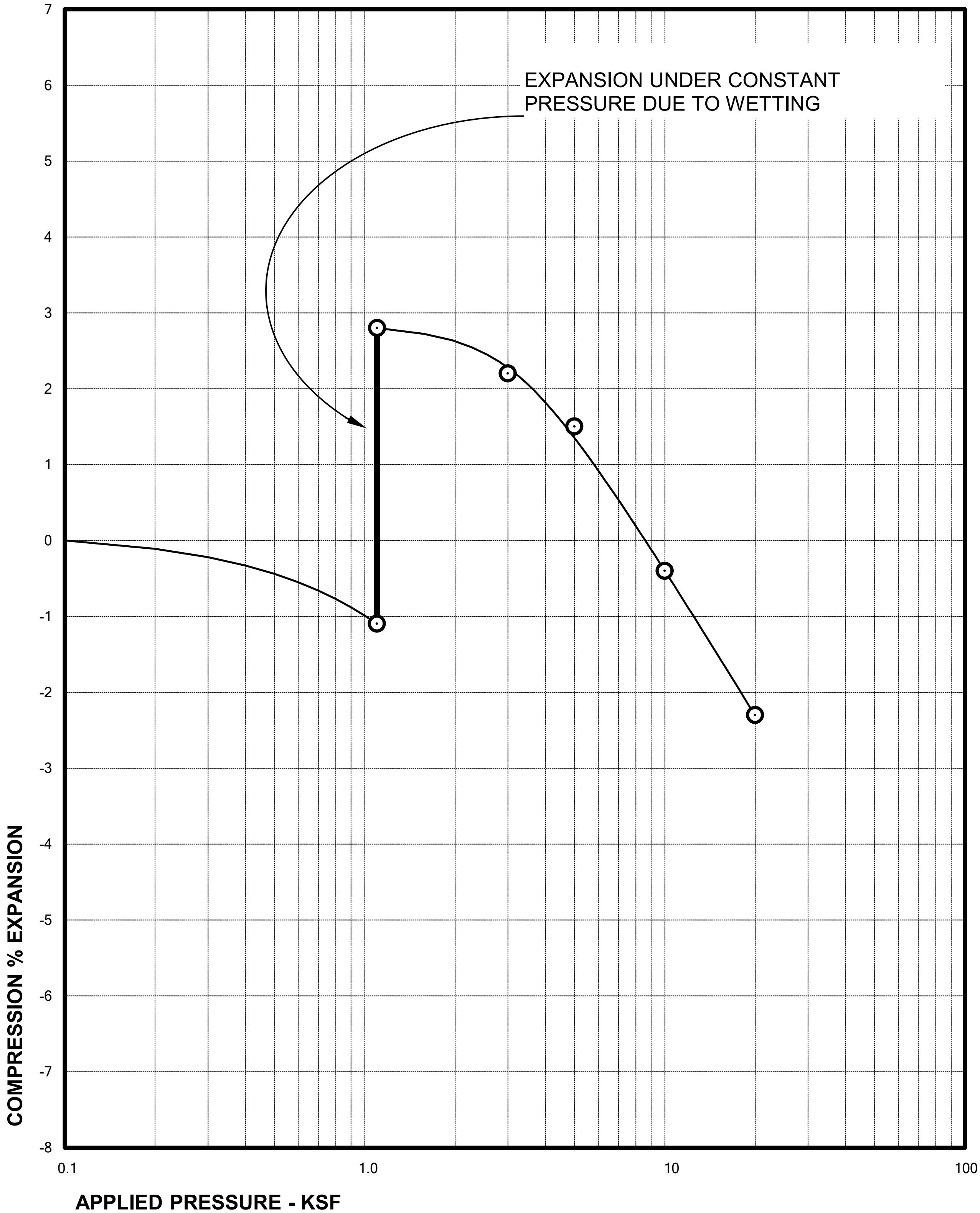
Swell Consolidation Test Results

FIG. B-22



Sample of CLAY, SANDY (CL)
From TH-215 AT 9 FEET

DRY UNIT WEIGHT= 116 PCF
MOISTURE CONTENT= 10.6 %

LA PLATA CUZE HOLDINGS, LLC
AMARA RESIDENTIAL DEVELOPMENT
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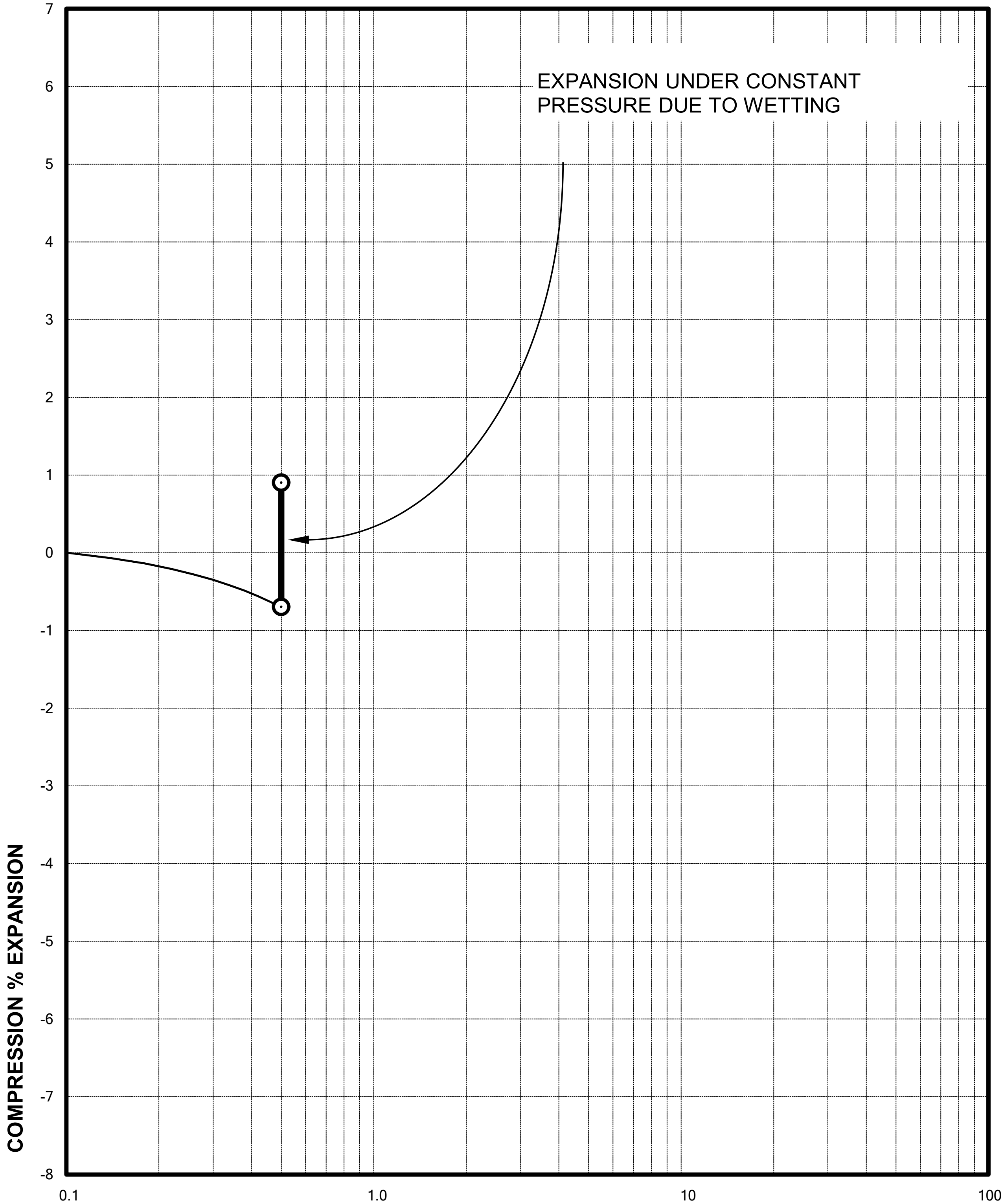
Swell Consolidation Test Results

FIG. B-23



Sample of CLAY, SLIGHTLY SANDY (CL)

From TH-216 AT 4 FEET

DRY UNIT WEIGHT= 99 PCF

MOISTURE CONTENT= 19.7 %

LA PLATA CUZE HOLDINGS, LLC
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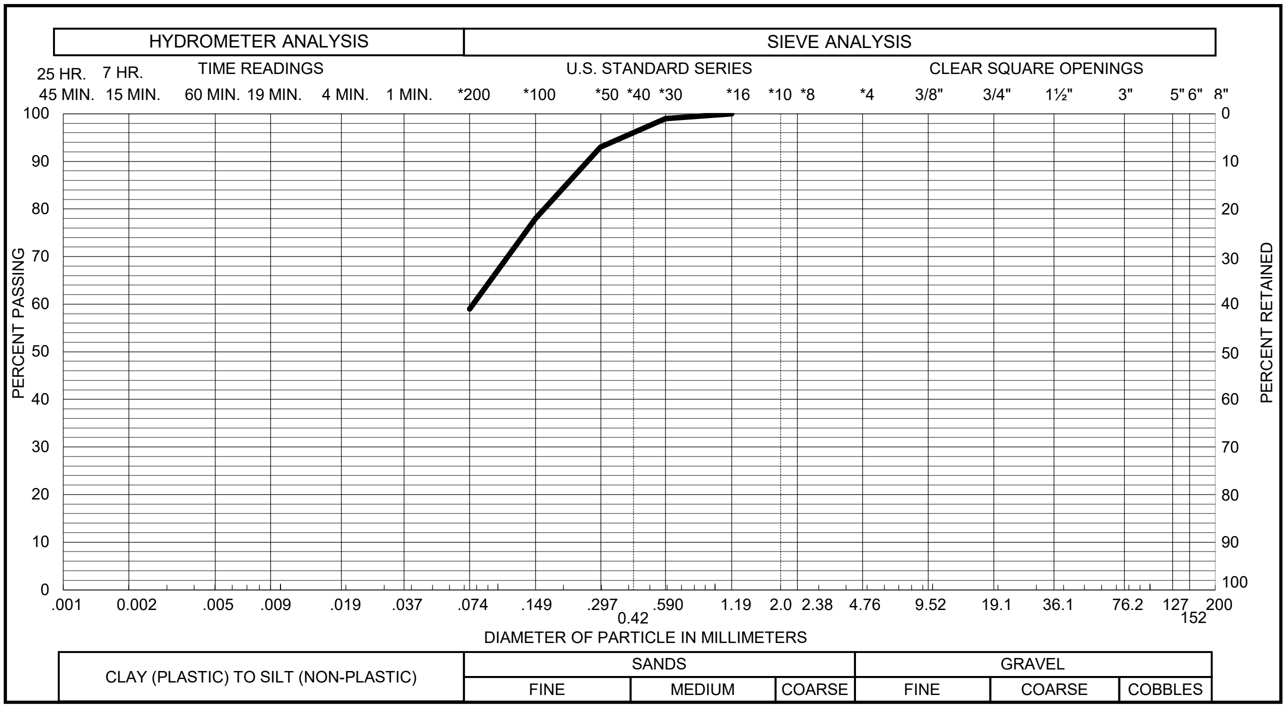
Swell Consolidation Test Results

FIG. B-24



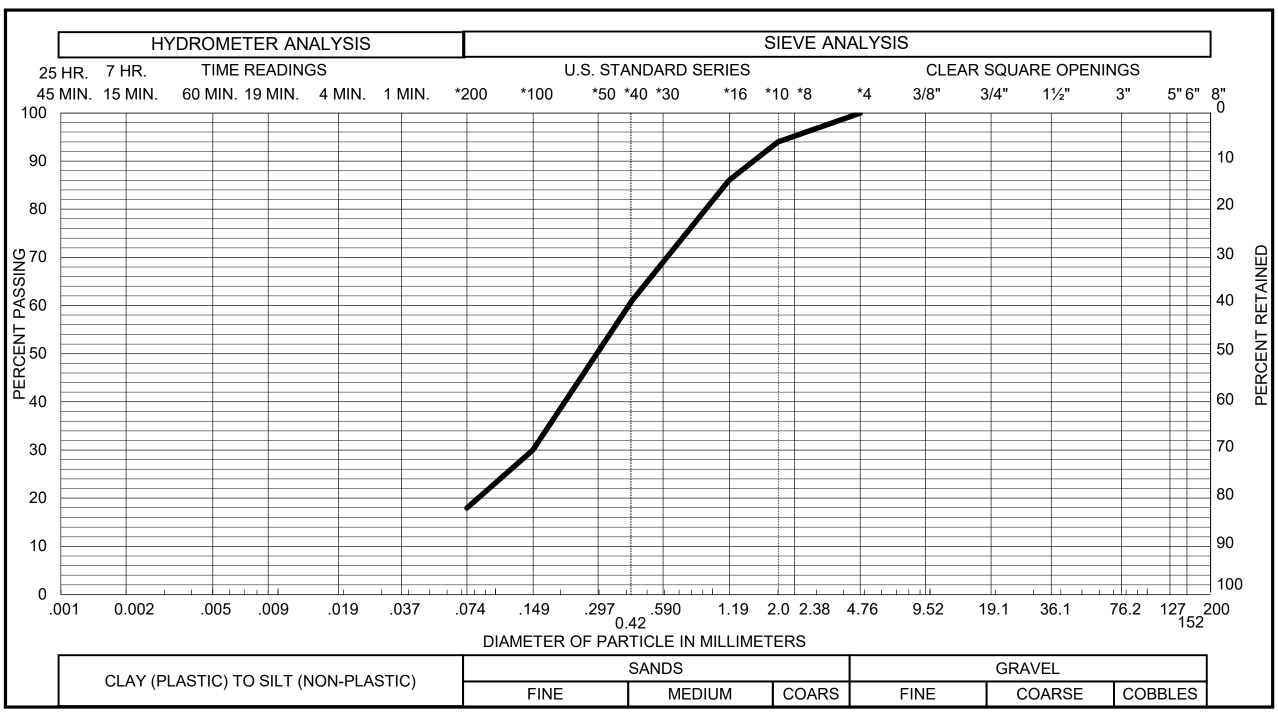
Sample of CLAY, VERY SANDY (CL)

From TH - 201 AT 24 FEET

GRAVEL 0 % SAND 41 %

SILT & CLAY 59 % LIQUID LIMIT

PLASTICITY INDEX



Sample of SAND, VERY SILTY (SM)

From TH - 202 AT 0-4 FEET

GRAVEL 0 % SAND 82 %

SILT & CLAY 18 % LIQUID LIMIT NV

PLASTICITY INDEX NP

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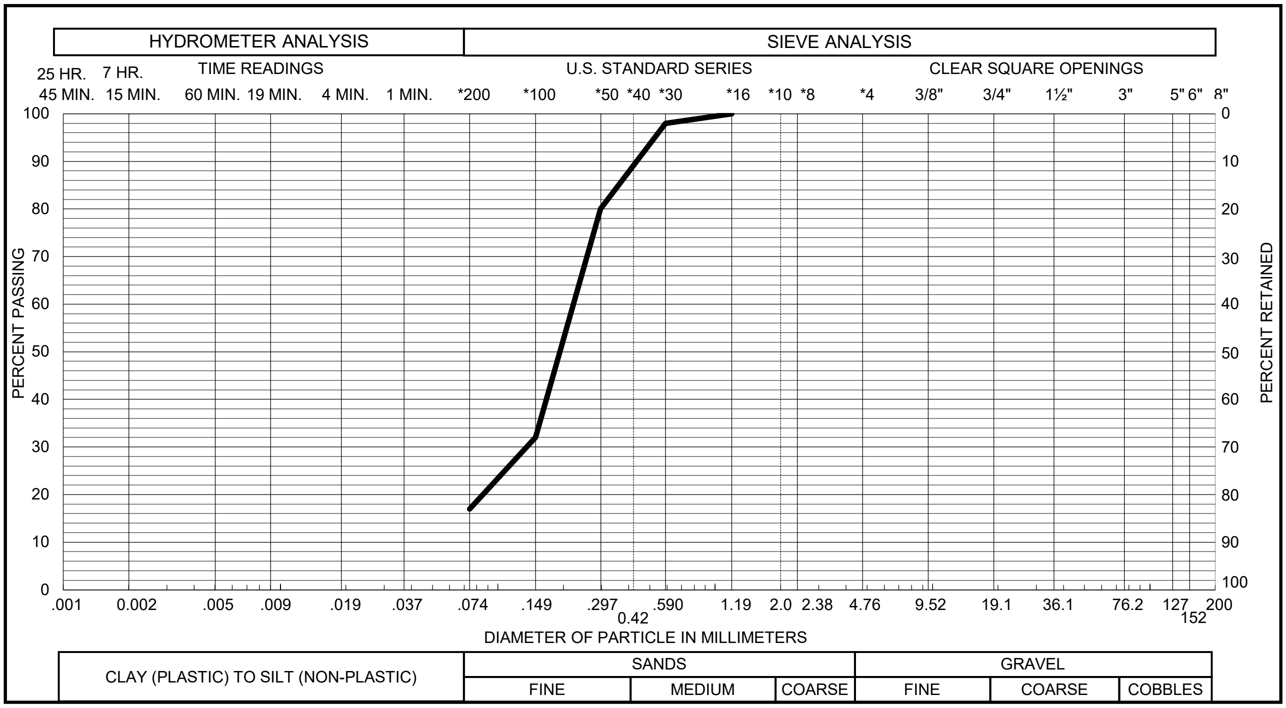
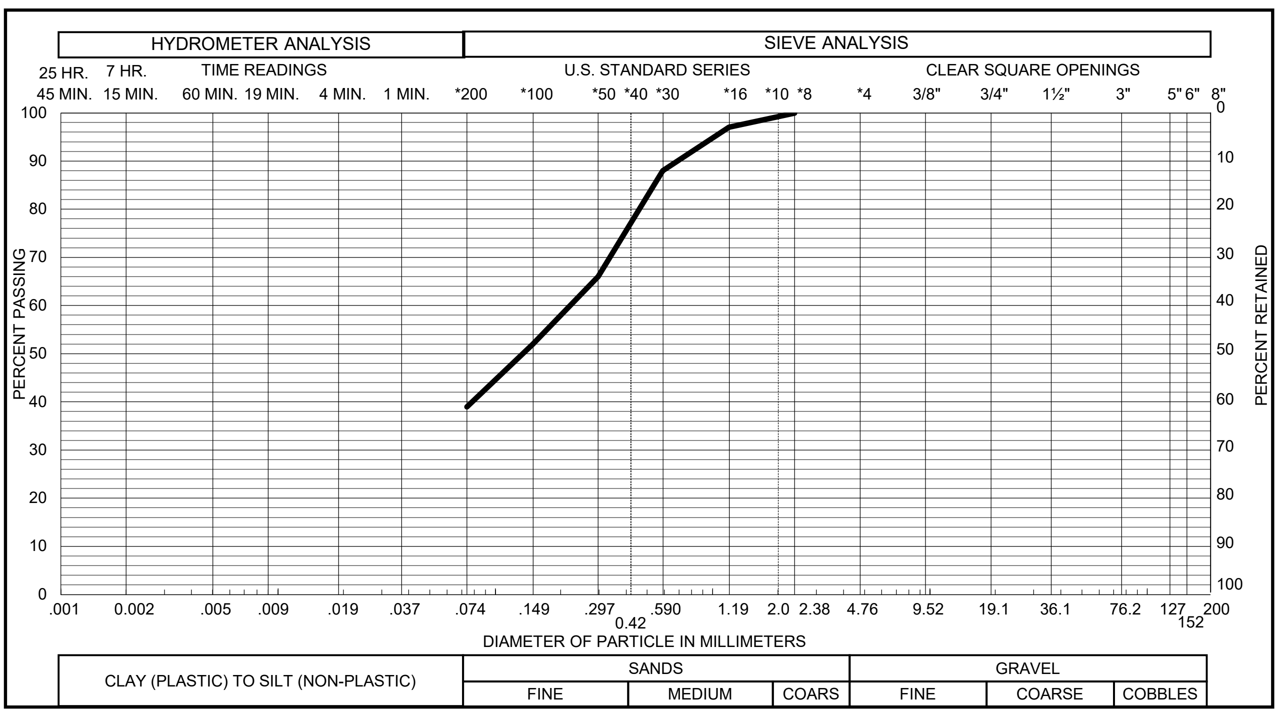
Gradation Test Results

FIG. B-25



Sample of SAND, CLAYEY (SC)
From TH - 202 AT 9 FEET

GRAVEL 0 % SAND 83 %
SILT & CLAY 17 % LIQUID LIMIT
PLASTICITY INDEX



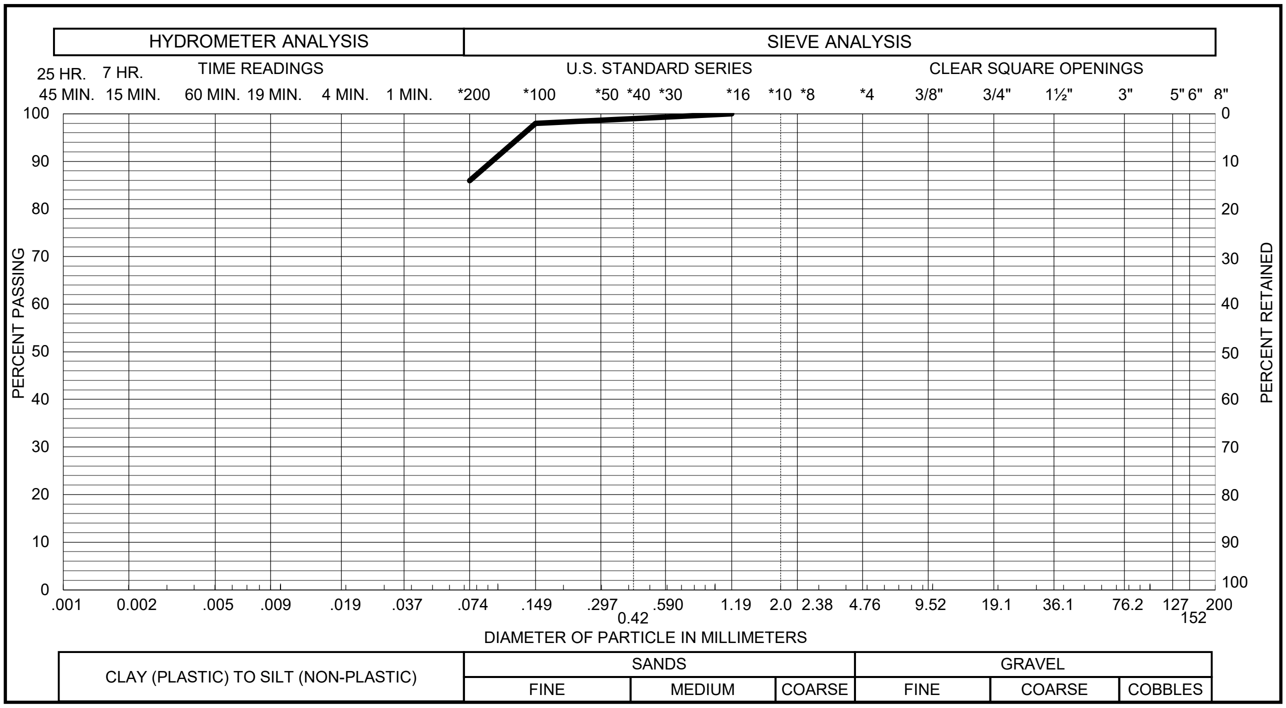
Sample of SAND, VERY SILTY (SM)
From TH - 205 AT 14 FEET

GRAVEL 0 % SAND 61 %
SILT & CLAY 39 % LIQUID LIMIT
PLASTICITY INDEX

LA PLATA CRUZE HOLDINGS, LLC
AMARA RESIDENTIAL DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115 R2

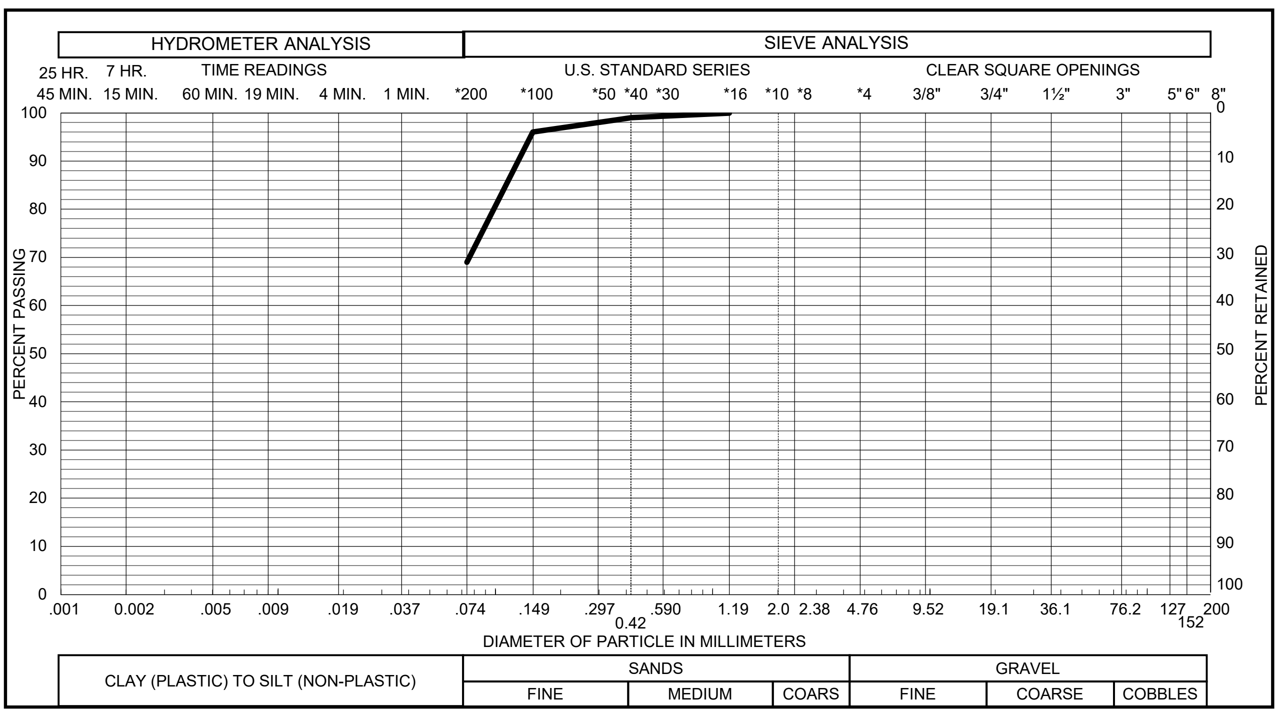
Gradation Test Results

FIG. B-26



Sample of CLAY, SANDY (CL)
From TH - 206 AT 0-4 FEET

GRAVEL	0 %	SAND	14 %
SILT & CLAY	86 %	LIQUID LIMIT	43
PLASTICITY INDEX			23



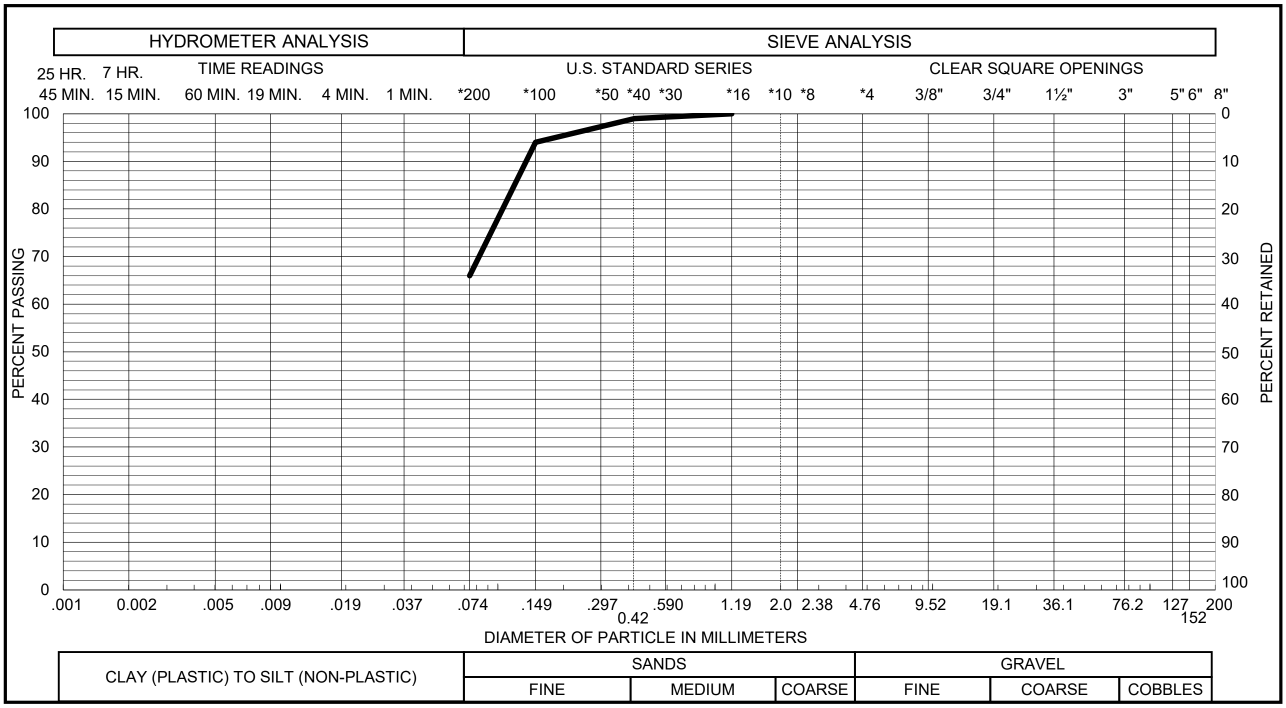
Sample of CLAY, SANDY (CL)
From TH - 208 AT 0-4 FEET

GRAVEL	0 %	SAND	31 %
SILT & CLAY	69 %	LIQUID LIMIT	29
PLASTICITY INDEX			8

LA PLATA CRUZE HOLDINGS, LLC
AMARA RESIDENTIAL DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115 R2

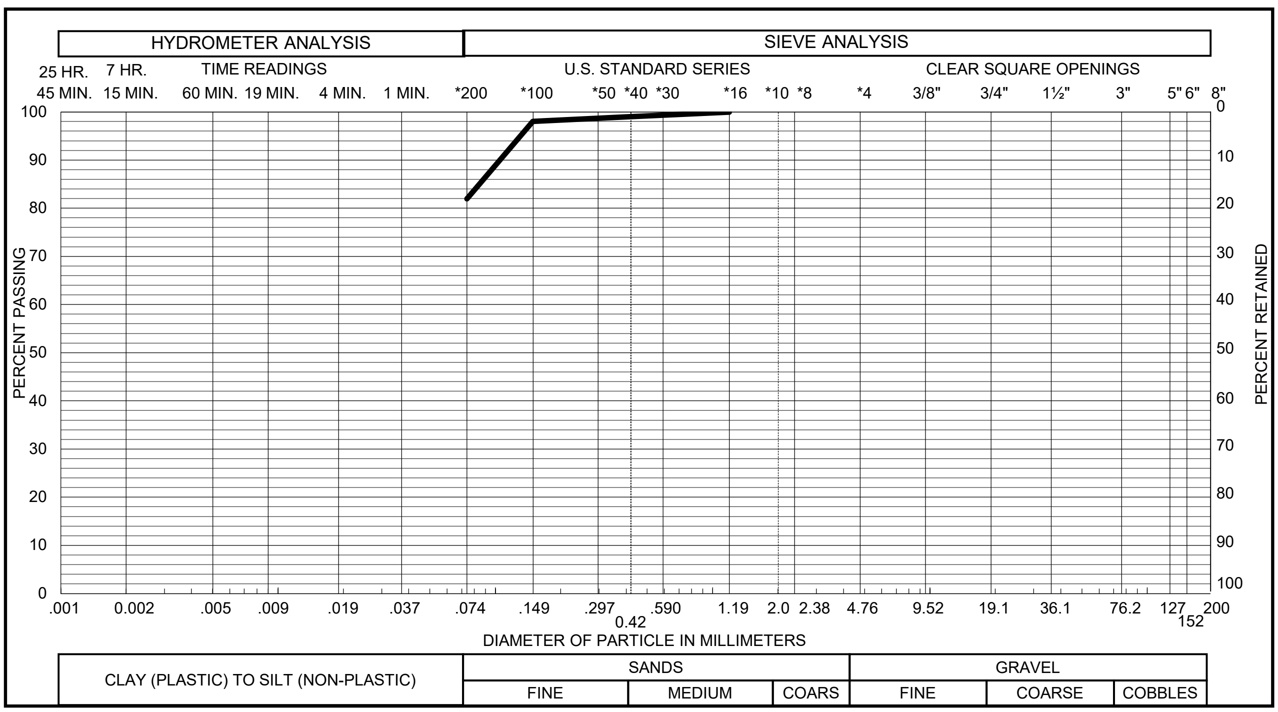
Gradation Test Results

FIG. B-27



Sample of CLAY, SANDY (CL)
From TH - 210 AT 0-4 FEET

GRAVEL	0 %	SAND	34 %
SILT & CLAY	66 %	LIQUID LIMIT	34
PLASTICITY INDEX			16



Sample of CLAY, SANDY (CL)
From TH - 215 AT 0-4 FEET

GRAVEL	0 %	SAND	18 %
SILT & CLAY	82 %	LIQUID LIMIT	35
PLASTICITY INDEX			17

LA PLATA CRUZE HOLDINGS, LLC
AMARA RESIDENTIAL DEVELOPMENT
CTL|T PROJECT NO. CS19053.001-115 R2

Gradation Test Results

FIG. B-28

TABLE B-I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19053-115

				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-201	4	5.8	102			1.1	500			<0.1	CLAY, SANDY (CL)
TH-201	14	9.7	113			2.9	1800		74		CLAY, SANDY (CL)
TH-201	24	11.6	118						59		CLAY, VERY SANDY (CL)
TH-202	0-4	1.3		NV	NP				18		SAND, SILTY (SM)
TH-202	9	11.4	105						17		SAND, CLAYEY (SC)
TH-202	14	7.4	118						20		SAND, CLAYEY (SC)
TH-203	9	8.5	107			1.2	1100		84		CLAY, SANDY (CL)
TH-203	14	10.3	122			2.4	1800				CLAY, SANDY (CL)
TH-203	19	9.7	107			1.1	2400		62		CLAY, VERY SANDY (CL)
TH-204	9	13.4	109			5.4	1100				CLAY, SANDY (CL)
TH-204	14	9.6	117			3.0	1800				CLAY, SANDY (CL)
TH-204	19	11.9	123						91		CLAY, SLIGHTLY SANDY (CL)
TH-205	4	2.5	113						20		SAND, SILTY (SM)
TH-205	9	8.2	117			1.9	1100				CLAY, SANDY (CL)
TH-205	14	5.1	117						39		SAND, VERY SILTY (SM)
TH-206	0-4	7.0		43	23				86		CLAY, SANDY (CL)
TH-206	4	8.8	107			5.2	500		85		CLAY, SANDY (CL)
TH-206	9	11.2	111			2.6	1100				CLAY, SANDY (CL)
TH-206	14	10.0	123			0.1	1800				WEATHERED CLAYSTONE
TH-206	19	9.6	127			3.8	2400				CLAYSTONE, SANDY
TH-207	9	6.5	110			-0.6	1100				CLAY, SANDY (CL)
TH-207	14	1.7	110						5		SAND, SLIGHTLY SILTY (SP-SM)
TH-208	0-4	7.6		29	8				69		CLAY, SANDY (CL)
TH-208	4	5.9	106			1.3	1000		75		CLAY, SANDY (CL)
TH-208	9	10.8	117			-0.1	1100		80		CLAY, SANDY (CL)
TH-209	4	7.5	129			8.6	500				CLAYSTONE, SANDY
TH-209	9	10.0	119			2.3	1100				CLAYSTONE, SANDY
TH-210	0-4	5.4		34	16				66		CLAY, SANDY (CL)
TH-210	9	9.1	109			3.1	1100				CLAY, SANDY (CL)
TH-210	24	9.5	128			1.0	3000				CLAYSTONE, VERY SANDY
TH-211	4	6.1	107			6.5	500				CLAY, SANDY (CL)
TH-211	14	10.6	130			3.6	1800				CLAYSTONE, SANDY
TH-212	4	9.2	96			2.1	500				CLAY, SANDY (CL)

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

TABLE B-I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19053-115

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS		SWELL TEST RESULTS*			PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
				LIQUID LIMIT	PLASTICITY INDEX	SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)			
TH-212	14	11.5	118			0.3	1800		79		CLAY, SANDY (CL)
TH-212	24	16.3	116			4.2	3000				CLAYSTONE, SANDY
TH-213	4	14.5	111			-0.3	500				CLAY, SANDY (CL)
TH-213	9	28.0	95						87		CLAY, SANDY (CL)
TH-213	24	16.5	114			2.7	3000				CLAYSTONE, SANDY
TH-214	4	13.3	109			6.7	500		91		CLAYSTONE, SLIGHTLY SANDY
TH-214	9	12.8	120			2.2	1100		85		CLAYSTONE, SANDY
TH-214	14	12.7	122			1.8	1800		84		CLAYSTONE, SANDY
TH-215	0-4	5.3		35	17				82		CLAY, SANDY (CL)
TH-215	4	7.2	93			1.2	500			<0.1	CLAY, SANDY (CL)
TH-215	9	10.6	116			3.9	1100				CLAY, SANDY (CL)
TH-216	4	19.7	99			1.6	500		93		CLAY, SLIGHTLY SANDY (CL)
TH-216	14	22.7	103						47		SAND, VERY CLAYEY (SC)

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

APPENDIX C

GUIDELINE SITE GRADING SPECIFICATIONS
AMARA DEVELOPMENT
EL PASO COUNTY, COLORADO

GUIDELINE SITE GRADING SPECIFICATIONS
AMARA DEVELOPMENT
COLORADO SPRINGS, 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, SC or CL, (cohesive) the fill shall be moisture treated to within 2 percent of optimum moisture content as determined by ASTM D698. Soils classifying as SM, SW, SP, GP, and GM (non-cohesive) shall be moisture treated to within 2 percent of optimum moisture content as determined by ASTM D1557. 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. Non-cohesive 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 D698. 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 make adjustments in 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.