GEOLOGIC HAZARDS EVALUATION AND PRELIMINARY GEOTECHNICAL INVESTIGATION
OVATION
CHAPEL RIDGE DRIVE AND RHINESTONE DRIVE
COLORADO SPRINGS, COLORADO

Prepared for:

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SCOPE

This report presents the results of our Geologic Hazards Evaluation and Preliminary Geotechnical Investigation for an approximately 57.8-acre parcel of land located north of the intersection of Chapel Ridge Drive and Rhinestone Drive in Colorado Springs, Colorado. 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 development of single-family residences. 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-23-0045), dated March 17, 2023.

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. Assessment of the site for the potential for wildfire hazards, corrosive soils, erosion problems, flooding, or a Phase I Environmental Site Assessment 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 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, comparatively shallow bedrock and groundwater, as well as 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 ten exploratory borings drilled at the site consisted of 8 to 20.5 feet of slightly silty to silty sand and sandy to very sandy clay. Weathered to intact claystone and sandstone bedrock was encountered underlying the natural sand and clay and extended to the maximum depths explored of up to 30 feet. Very hard sandstone was encountered at the site at depths as shallow as 12 and 13 feet.
3. At the time of drilling, groundwater was encountered in five of the exploratory borings at depths of between 19 and 23.5 feet below the existing ground surface. When water levels were checked again seven days after the completion of drilling operations, groundwater was encountered in six of the exploratory borings at depths of 7 and 27 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 much of the site can be accomplished using conventional, heavy-duty construction equipment. If 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 sandstone.
5. We believe conventional spread footing foundations and slab-on-grade floors will be appropriate for most of the residences constructed at this site. Where near surface, expansive materials occur, removal and replacement of a zone of expansive materials from beneath spread footings foundations or use of straight shaft, drilled pier foundations and structurally supported floors may be appropriate.
6. We believe a low risk of poor, long-term performance (movement and damage) will exist for conventional slab-on-grade floors underlain by natural, granular materials or moisture conditioned and densely compacted fill. Risk of poor slab performance is moderate to high when expansive clays and bedrock are present near anticipated shallow elevations. 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

The property referred to as the Ovation Property contains 57.78 acres of undeveloped land located north of the intersection of Chapel Ridge Drive and Rhinestone Drive. The property is generally described as being located in the southeast quarter of the northeast quarter of section 21, the southwest quarter of the northwest quarter of section 22, and the northwest quarter of the southwest quarter of section 22, Township 12 South, Range 66 West of the 6th Principal Meridian, within El Paso County, Colorado. The overall location is shown in Fig. 1.

The majority of the parcel is currently undeveloped. Underground utilities are present within the property and include natural gas, water, sanitary sewer and electric. A high-pressure natural gas line crosses the property in a northwest-southeast orientation. Vacant land is to the north and west. Powers Boulevard bounds the property along the northeast and a developed residential subdivision bounds the property on the south. The property is predominately covered with grasses, weeds, shrubs, and medium to large trees. Past uses of the property likely include cattle grazing. Overall, the ground surface generally slopes gently downward to the southwest. Elevations range from approximately 6,800 feet along the west side to approximately 6,880 feet along the east side of the site.

PROPOSED DEVELOPMENT

We were not provided with a development plan for the parcel prior to our investigation. We understand the property is planned for development of single-family residences. 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.

SUBSURFACE INVESTIGATION

Subsurface conditions at the site were investigated by drilling ten exploratory borings at the approximate locations shown in Fig. 1. Graphical logs of the conditions found in our exploratory borings, the results of field penetration resistance tests, and laboratory data are presented in Appendix A.

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, 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). Swell-consolidation test results and gradation test results are presented in Appendix B. All laboratory test data are summarized in Table B-1.

SUBSURFACE CONDITIONS

Subsurface conditions encountered in the ten exploratory borings drilled at the site predominately consisted of between 8 and 20.5 feet of slightly silty to silty or clayey sand and sandy to very sandy clay. Claystone and sandstone bedrock was encountered in each of our borings underlying the natural sand and clay materials. A layer of weathered bedrock ranging in thickness from 1.5 to 5 feet was identified overlying intact bedrock in each of the exploratory borings. Some of the pertinent engineering characteristics of the soils and bedrock encountered and groundwater conditions are discussed in the following paragraphs.

Natural Sand

Natural slightly silty to silty sand was encountered at the ground surface eight of the borings. The sand was loose to dense based on field penetration resistance testing. Seven samples of the sand tested in our laboratory contained 5 to 28 percent clay and silt-sized particles (passing the No. 200 sieve). Based on experience, the natural sands are non-expansive to slightly expansive when wetted.

Clay

Natural sandy to very sandy clay was encountered at the ground surface in two of the borings. The clay was judged to be very stiff based on field penetration resistance testing. One sample of the clay tested in our laboratory contained 66 percent clay and silt- sized particles (passing the No. 200 sieve). Two samples of the clay subject to swell-consolidation testing exhibited measured swell values of 3.1 to 5.7 percent when wetted under estimated overburden pressures. The samples exhibited moderate to high expansion potential.

Bedrock

Weathered claystone and sandstone bedrock was encountered below the natural soils in each of the borings at depths of between 8 to 13 feet below the existing ground surface. The upper 1.5 to 5 feet of the bedrock was judged to be weathered and medium hard based on field penetration resistance testing. The intact bedrock encountered underlying the weathered bedrock consisted of various layers of claystone and sandstone at depths of about between 11 to 22.5 feet below the existing ground surface. The claystone and sandstone bedrock was medium hard to very hard based on the results of field penetration resistance tests.

Samples of the weathered and intact bedrock were subjected to gradation analysis as well as swell-consolidation testing, wetted under estimated overburden pressures. Four samples of the weathered bedrock exhibited measured swell of between 0.1 to 3.2 percent. Two samples of the weathered bedrock contained 54 and 56 percent clay and silty-sized particles (passing the No. 200 sieve). Three samples of the intact claystone subjected to swell-consolidation testing exhibited measured swell values of 1.5 to 1.6 percent and one sample exhibited consolidation of 0.4 percent. Three samples of the sandstone tested in our laboratory contained between 10 to 32 percent clay and silt-sized particles. Based on existing published geologic mapping, the bedrock will likely be encountered at the lower elevations across portions of the site.

Groundwater

At the time of drilling, groundwater was encountered in five of the exploratory borings at depths between 19 to 23.5 feet below the existing ground surface. When water levels were checked seven days after the completion of drilling operations, groundwater was encountered in six of the exploratory borings at depths of 7 and 27 feet below the existing ground surface. Groundwater was not encountered in three of the borings drilled to depths of between 20 and 25 feet. Shallowest groundwater was generally encountered near the tributary drainage crossing the southern half of the property. Groundwater levels will vary with seasonal precipitation 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 Fig. 2. A list of references is included in the references section of this report.

The parcel included in this study is situated directly southeast of Kettle Creek, a tributary of Monument Creek. The parcel was likely used as pastureland and for cattle grazing. The ground surface slopes generally downward from the northeast portion of the site toward the southwest. Shallow, unnamed tributaries of Kettle Creek cross the property in a west and southwest direction. The tributaries are generally dry or experience seasonal flow and stormwater runoff from nearby streets and developments to the northeast and east.

The site is generally covered by young alluvial-colluvial deposits composed of slightly silty to silty sand and sandy to very sandy clay deposited by wind and water. Materials deposited across the site range from Holocene to late Pleistocene-age Alluvium, Colluvium, and Eolian deposits (sand and clay deposited by wind and water). Bedrock is from the Cretaceous and Paleocene-aged Dawson Formation, composed of thick beds of sandstone with thin to thick beds of claystone. The Dawson formation generally erodes to silty sand and sandy clay overburden soils, when exposed to the elements. Our borings generally confirm the mapping. The following sections discuss the mapped units. Figure 2 shows our interpretation of site geology, and Figure 3 shows our interpretation of engineering conditions.

Surficial Deposits (Qac, Qes)

Our borings encountered up to 20.5 feet of slightly silty to silty sand and sandy to very sandy clay soil. We believe that for the purposes of engineering geologic evaluation of this site, the surficial soils mapped as "Qac" can be considered as being sheet-wash and stream deposited alluvium-colluvium. The surficial soils mapped as "Qes" can be considered as eolian (wind-blown) deposits. The alluvium-colluvium are more recent deposits superimposed over the eolian deposits in flatter areas. These soils are geologically recent, Holocene and Pleistocene-age deposits. The surficial clay alluvium-colluvium and eolian deposits exhibited low to high expansion potential. Our testing indicated the clays found at the site possess mainly low to high expansion potential.

Bedrock ($Tkda_3$)

We encountered medium hard to very hard claystone and/or sandstone bedrock underlying the surficial sands and clays in each of the exploratory borings. Geologic mapping suggests the bedrock may occur the lower lying areas of the site. The materials are from the Cretaceous and Paleocene-aged Dawson formation (Map Unit $Tkda_3$), predominately of very coarse to fine grained, sandstone containing beds of sandy claystone. The formation tends to generally form low, alluvium to colluvium covered slopes. The Dawson formation exhibits a gentle dip toward the north-northeast. The claystone portion of this formation can exhibit low to high expansion potential.

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, shallow bedrock and shallow groundwater, as well as 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) and United States Geological Survey of the Pikeview Quadrangle (2001) was considered for evaluation of the parcel and is mapped as described below. Based on mapping flood potential is low; however, the civil engineer should ultimately determine the flood potential and inundation areas for site design. The other issues are site-wide concerns and are not depicted in Fig. 3.

Map Unit "1A" depicts stable alluvium, colluvium, and bedrock on flat to gentle slopes (0-5%). Emphasis on surface and subsurface drainage.

Expansive Soils

Testing showed the alluvium-colluvium soils (Qac) and claystone bedrock ($Tkda_3$) 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 Number 08041C0507G, effective date December 7, 2018, indicates no flood hazard areas exist within the bounds of the property. The project Civil Engineer should determine the flood potential and design surface drainage.

Erosion

The subject parcel is generally flat to slightly sloping. Site soils are dry clays and sands and are susceptible to the effects of wind and water erosion. Minor slopes are located near the west right-of-way of Powers Boulevard and along a rough cut access roadway and utility easement located along the southwest property boundary. We anticipate the slopes will be graded to a flatter slope during over lot site grading. Maintaining vegetative cover and providing engineered surface drainage will reduce the potential for erosion.

Seismicity

According to the USGS, Colorado's Front Range and eastern plains are considered low seismic hazard zones. The earthquake hazard exhibits higher risk in western and southern Colorado compared to other parts of the state. The Denver Metropolitan area has experienced earthquakes within the past 100 years, shown to be related to deep drilling, liquid injection, and oil/gas extraction. Naturally occurring earthquakes along faults due to tectonic shifts are rare in this area.

The soil and bedrock at this site are not expected to respond unusually to seismic activity. The 2021 International Building Code (Section 16.13.2.2) defers the estimation of Seismic Site Classification to ASCE 7-22, a structural engineering publication. The table below summarizes ASCE 7-22 Site Classification Criteria.

ASCE 7-22 SITE CLASSIFICATION CRITERIA

Seismic Site Class	$\bar{v}_s$ Calculated Using Measured or Estimated Shear Wave Velocity Profile (ft/s)
A. Hard Rock	>5,000
B. Medium Hard Rock	>3,000 to 5,000
BC. Soft Rock	>2,100 to 3,000
C. Very Dense Sand or Hard Clay	>1,450 to 2,100
CD. Dense Sand or Very Stiff Clay	>1,000 to 1,450
D. Medium Dense Sand or Stiff Clay	>700 to 1,000
DE. Loose Sand or Medium Stiff Clay	>500 to 700
E. Very Loose Sand or Soft Clay	≥500
F. Soils requiring Site Response Analysis	See Section 20.2.1

Based on the results of our investigation, the reduced, empirically estimated average shear wave velocity values for the upper 100 feet range between 1,143 feet per second and 1,502 feet per second with an average value of 1,366 feet per second. The subsurface likely ranges between Seismic Site Classification C and CD. The field penetration test results along with the empirical estimates imply that shear-wave velocity seismic tests to directly measure $\bar{v}_s$ could likely result in a better Seismic Site

Classification. The subsurface conditions indicate low susceptibility to liquefaction from a materials and groundwater perspective.

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 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 soils and bedrock, shallow bedrock, and shallow groundwater. 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 sand and clay soils as well as the bedrock can be accomplished using conventional heavy-duty equipment. Bedrock may occur at shallow depths in various areas. As the bedrock occurs at shallow depth, very hard sandstone bedrock may be encountered. Cuts into the very hard sandstone 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 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 6 feet may be required in high volume streets and between 4 to 10 feet below and outside structures.

The ground surface in areas to receive fill should be scarified, moisture conditioned and compacted. If natural clay and/or claystone are used for grading fill, they should be placed at high moisture content to help mitigate potential swell. The properties of the fill will affect the performance of foundations, slabs-on-grade, and pavements. We recommend overlot 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). 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 overlot 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 weakly cemented. The bedrock formation could include layers of somewhat more cemented materials. Rock buckets and rock teeth may be needed where utility excavations extend well into the bedrock formation or if the bedrock is cemented. No cemented bedrock was encountered during this preliminary study. 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 and bedrock 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 bedrock will classify as Type C and Type A materials, respectively. Temporary excavations in Type A and Type C materials require a maximum slope inclination of ¾:1 and 1.5:1 (horizontal to vertical), respectively, unless the excavation is shored or braced. Where groundwater seepage occurs, flatter slopes will likely be required. Dewatering and/or stabilization of the bottom of utility trenches may be required if excavations extend to depths near or below groundwater levels. 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 City of Colorado Springs 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 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. 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

Our investigation indicates granular, non-expansive materials are present at the ground surface across most of the site; however, expansive clay and claystone were encountered in various areas across the site at depths likely to affect the performance of shallow foundation and slabs-on-grade. We estimate potential ground heave of about

5 inches where thick deposits of clay and claystone occur at or near the ground surface based on a 24-foot depth of wetting. To reduce the impact of the expansive materials on shallow foundations and improve slab performance and create a more uniform layer of support, expansive clays and claystone bedrock should be sub-excavated below proposed footing elevations. Typically, sub-excavations in this formation are in the range of 4 to 10 feet. The thickness and composition of grading fill will influence the appropriate depths of treatment. The excavated clay and claystone should be moisture conditioned to between 1 and 4 percent above optimum moisture contents, 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.

Overall, 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 low to moderate 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 (sandy clay 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 sands.

Based on our laboratory testing, subgrade materials present at the site generally classify as A-1-b and A-2-4, according to ASHTOO classification. For preliminary design purposes, we assigned a Hveem stabilometer (“R”) value of 30 to the subgrade materials at the site. 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 concentrations of less than 0.1 percent in one sample. As indicated in our tests and ACI 318-19, the sulfate exposure class is *Not Applicable* or *S0.* Deviations from the exposure class may occur as a result of additional sampling and testing, especially considering the varying subsurface soils types present at the site.

SULFATE EXPOSURE CLASSES PER ACI 318-19

Exposure Classes		Water-Soluble Sulfate (SO_4) in Soil [A] (%)
Not Applicable	S0	< 0.10
Moderate	S1	0.10 to 0.20
Severe	S2	0.20 to 2.00
Very Severe	S3	> 2.00

A) Percent sulfate by mass in soil determined by ASTM C1580

For this level of sulfate concentration, ACI 318-19 *Code Requirements* indicates there are no cement type requirements for sulfate resistance as indicated in the table below.

CONCRETE DESIGN REQUIREMENTS FOR SULFATE EXPOSURE PER ACI 318-19

Exposure Class		Maximum Water/ Cement Ratio	Minimum Compressive Strength (psi)	Cementitious Material Types[A]			Calcium Chloride Admixtures
				ASTM C150/ C150M	ASTM C595/ C595M	ASTM C1157/ C1157M	
S0		N/A	2500	No Type Restrictions	No Type Restrictions	No Type Restrictions	No Restrictions
S1		0.50	4000	II[B]	Type with (MS) Designation	MS	No Restrictions
S2		0.45	4500	V [B]	Type with (HS) Designation	HS	Not Permitted
S3	Option 1	0.45	4500	V + Pozzolan or Slag Cement [C]	Type with (HS) Designation plus Pozzolan or Slag Cement [C]	HS + Pozzolan or Slag Cement [C]	Not Permitted
S3	Option 2	0.4	5000	V [D]	Type with (HS) Designation	HS	Not Permitted

A) Alternate combinations of cementitious materials shall be permitted when tested for sulfate resistance meeting the criteria in section 26.4.2.2(c).
B) Other available types of cement such as Type III or Type I are permitted in Exposure Classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.
C) The amount of the specific source of pozzolan or slag to be used shall not be less than the amount that has been determined by service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slab to be used shall not be less than the amount tested in accordance with ASTM C1012 and meeting the criteria in section 26.4.2.2(c) of ACI 318.
D) If Type V cement is used as the sole cementitious material, the optional sulfate resistance requirement of 0.040 percent maximum expansion in ASTM C150 shall be specified.

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 percent ± 1.5 percent. We advocate damp-proofing of all foundation walls and grade beams in contact with the subsoils.

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.

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Geologic Hazard Study Report

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City/State:	Colorado Springs, Colorado	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):

- ☐ 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:

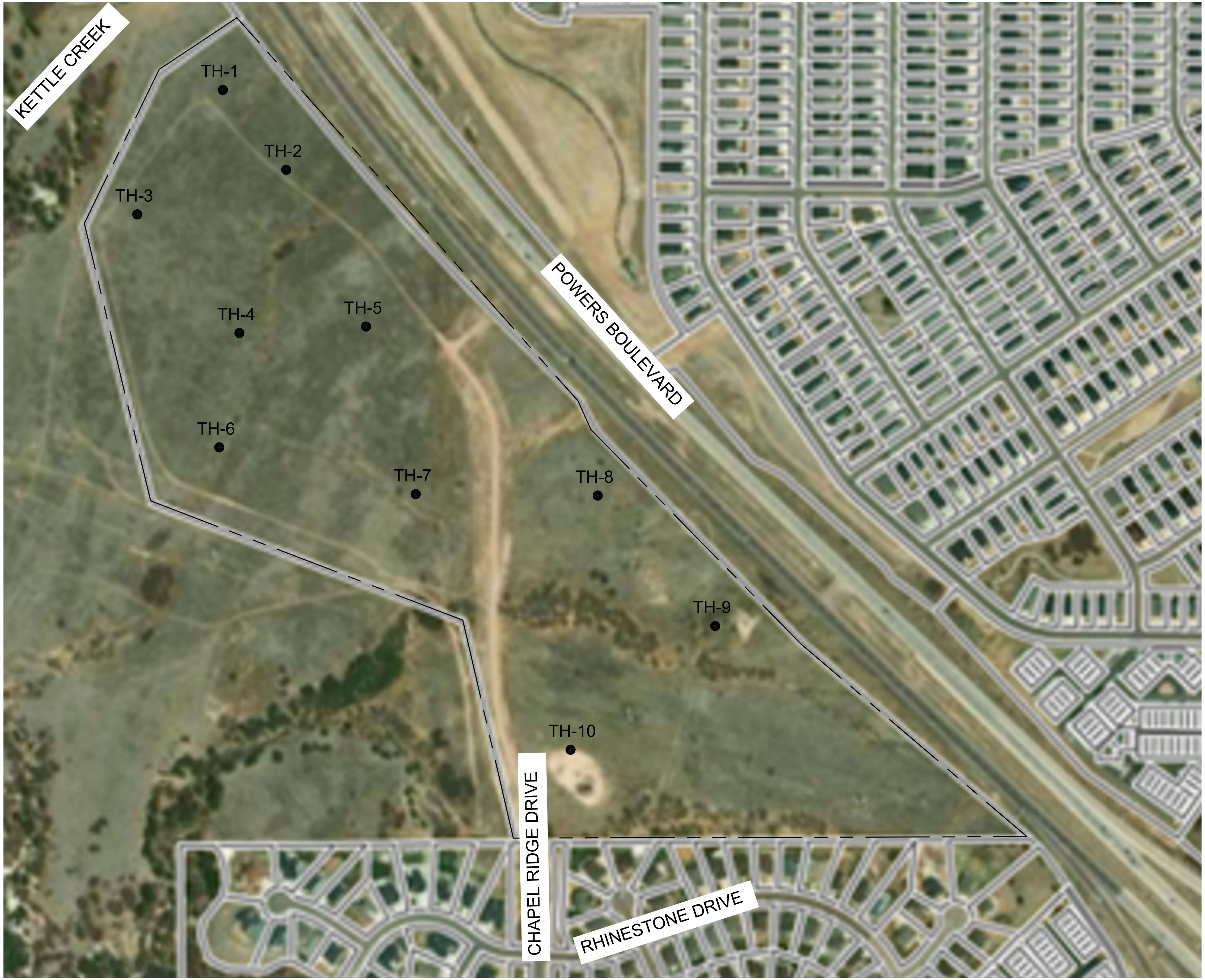
- ☐ A Professional Geologist as defined by CRS 34-1-201(3); or,
- ☒ A Professional Engineer as defined by Board Policy Statement 50.2 - "Engineers in Natural Hazard Areas" of the Colorado State Board of Registration for Professional Engineers and Professional Land Surveyors. Board authority as defined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

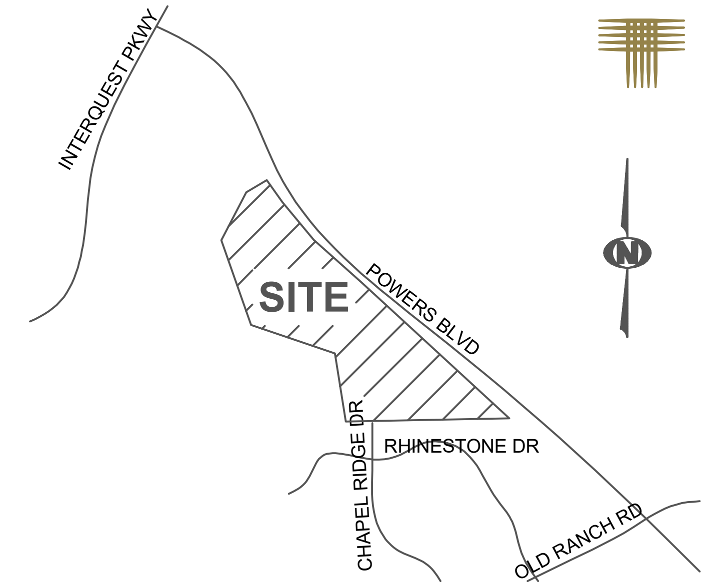
Submitted by: CTL|Thompson, Inc (Jeffrey Jones)   Date: April 24, 2023

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

[signature]   10/12/23

For the City Engineer   **Date**





VICINITY MAP

(NOT TO SCALE)

LEGEND:

TH-1 ● APPROXIMATE LOCATION OF EXPLORATORY BORING.

— — — PROJECT BOUNDARY

0 150' 300'

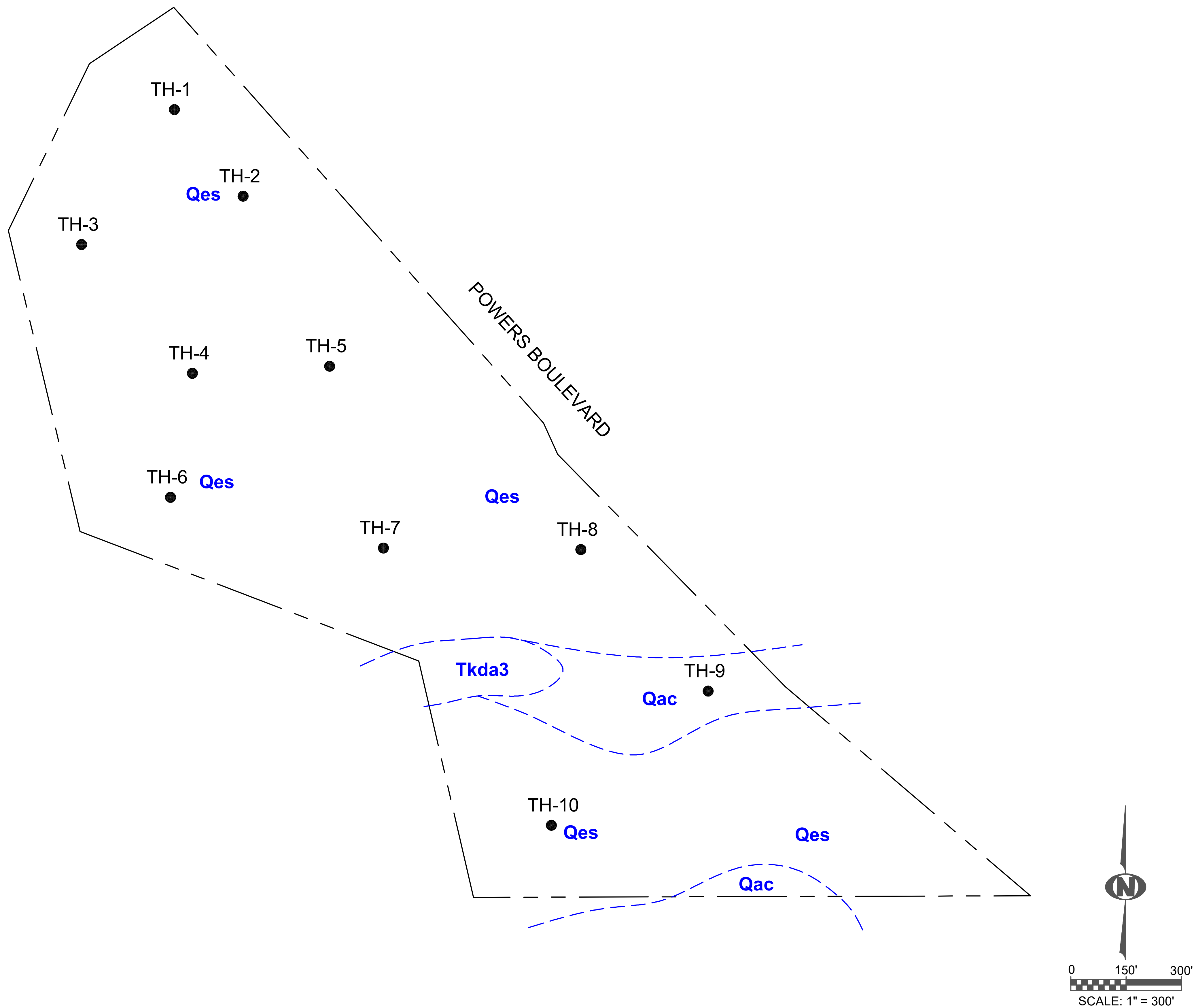
SCALE: 1" = 300'

NOTE:
BASE DRAWING WAS OBTAINED BY PLSS VIEWER, esri, BUREAU OF LAND MANAGEMENT (BLM), NATIONAL OPERATIONS CENTER (NOC)

Location of Exploratory Borings

LA PLATA COMMUNITIES
OVATION
CTL|T PROJECT NO. CS19669-115

FIG. 1



LEGEND:

TH-1 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
— - - —	PROJECT BOUNDARY

GEOLOGIC UNITS AND (MODIFIERS)

Qes	EOLIAN SAND, FINE TO COURSE GRAINED, SILTY SAND DEPOSITED BY WIND AND PRESERVED ON SURFACES DOWNWIND (EAST) OF MONUMENT CREEK.
Qac	ALLUVIUM AND COLLUVIUM, STREAM CHANNEL ALLUVIUM IN TRIBUTARY DRAINAGES OF MONUMENT CREEK AND LOCAL HILL SLOPES.
Tkda3	DAWSON FORMATION. BEDROCK. THICK BEDDED, MASSIVE AND CROSSBEDDED VERY COURSE GRAINED TO FINE GRAINED SANDSTONE WITH THIN TO THICK BEDS OF SANDY CLAYSTONE.
	SURFICIAL GEOLOGIC CONTACTS

NOTES:

1. BASE DRAWING WAS PROVIDED BY UNITED STATES GEOLOGICAL SURVEY, PIKEVIEW QUADRANGLE, 2001).
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.

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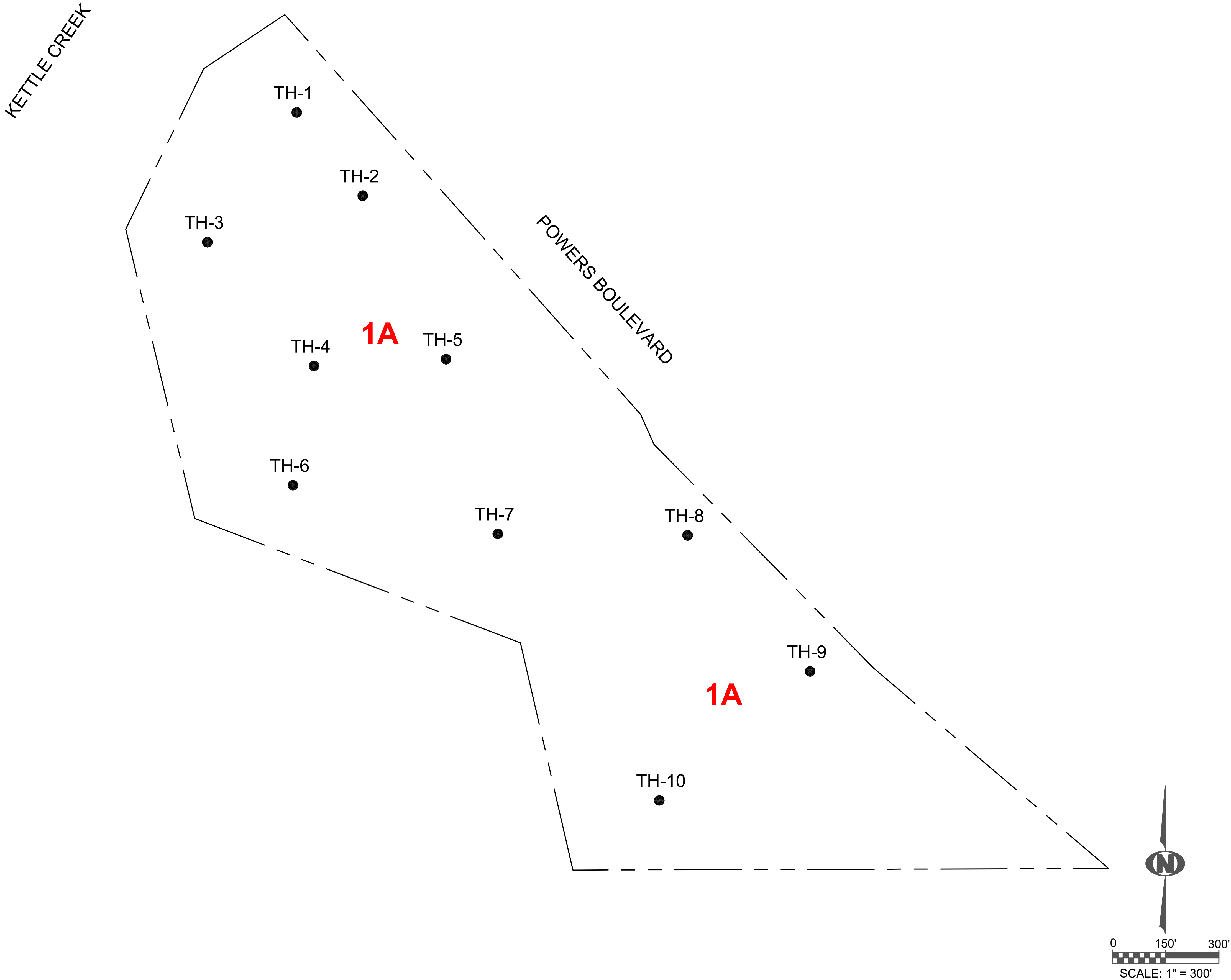
Surficial Geologic Conditions

FIG. 2



LEGEND:

TH-1 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
— - - —	PROJECT BOUNDARY

ENGINEERING UNITS AND (MODIFIERS)

1A	DEPICTS STABLE ALLUVIUM, COLLUVIUM, AND BEDROCK ON FLAT TO GENTLE SLOPES (0-5%). EMPHASIS ON SURFACE AND SUBSURFACE DRAINAGE.
(red line)	ENGINEERING CONTACTS

NOTES:

1. 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.
2. MAP LEGEND IS MODIFIED FROM CHARLES S. ROBINSON & ASSOCIATES, INC., GOLDEN, COLORADO, DATED 1977.

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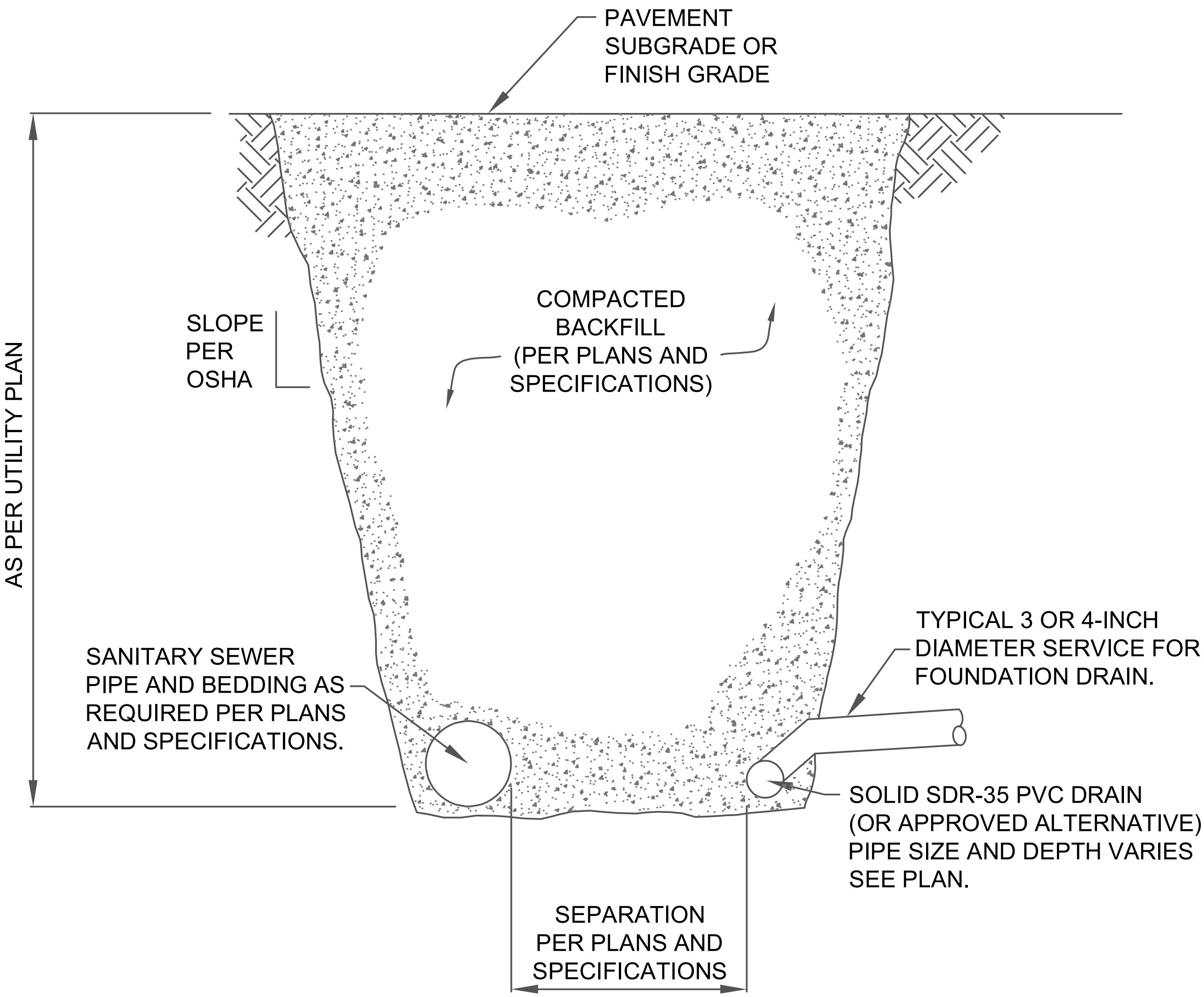
Engineering Conditions

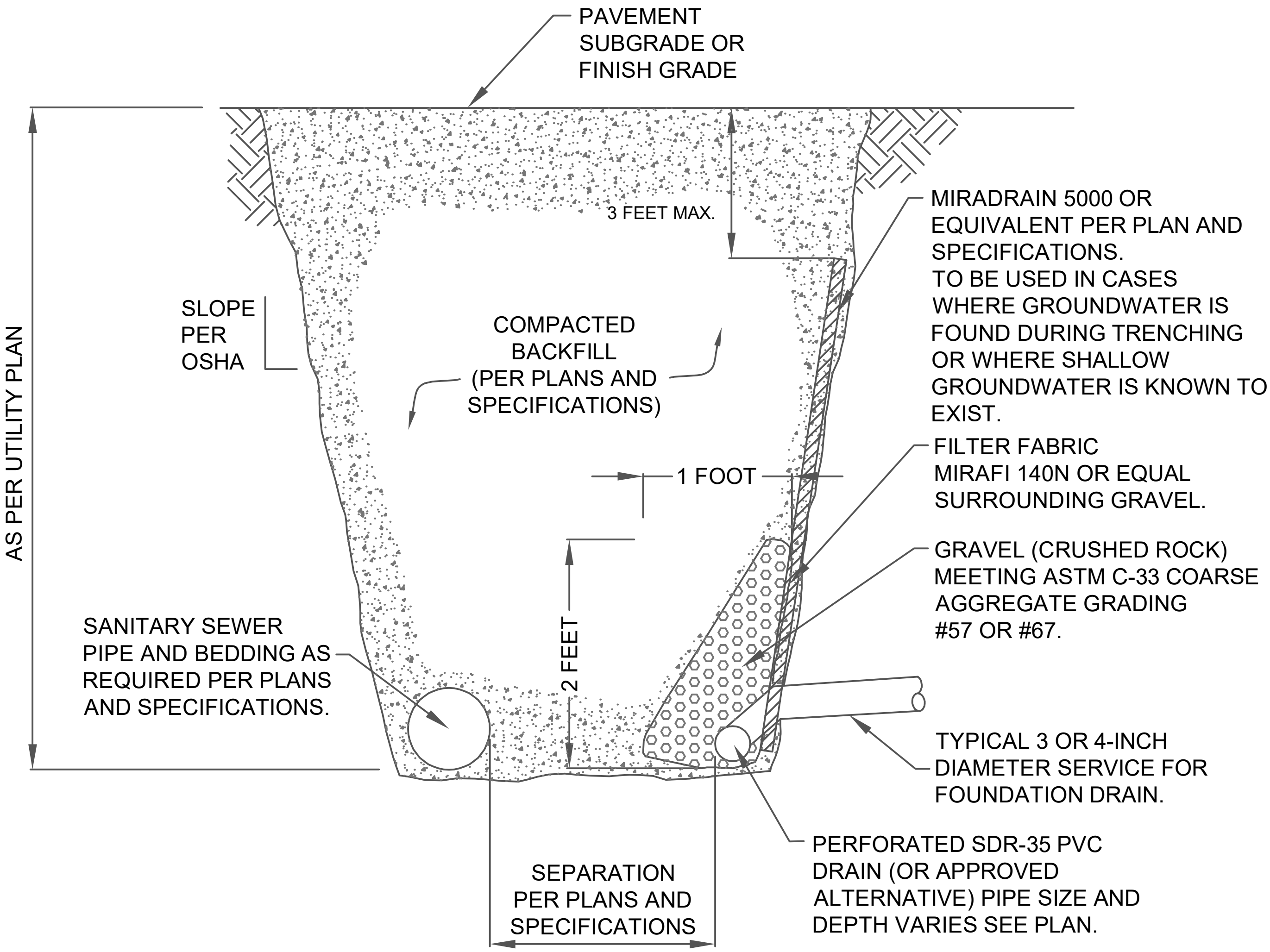
FIG. 3



NOTE:
TO BE USED IN CASES WHERE NO
GROUND WATER IS KNOWN TO EXIST.

Passive Drain
Beside Sewer

FIG. 4



GRADING REQUIREMENTS FOR COARSE AGGREGATES PER ASTM C-33

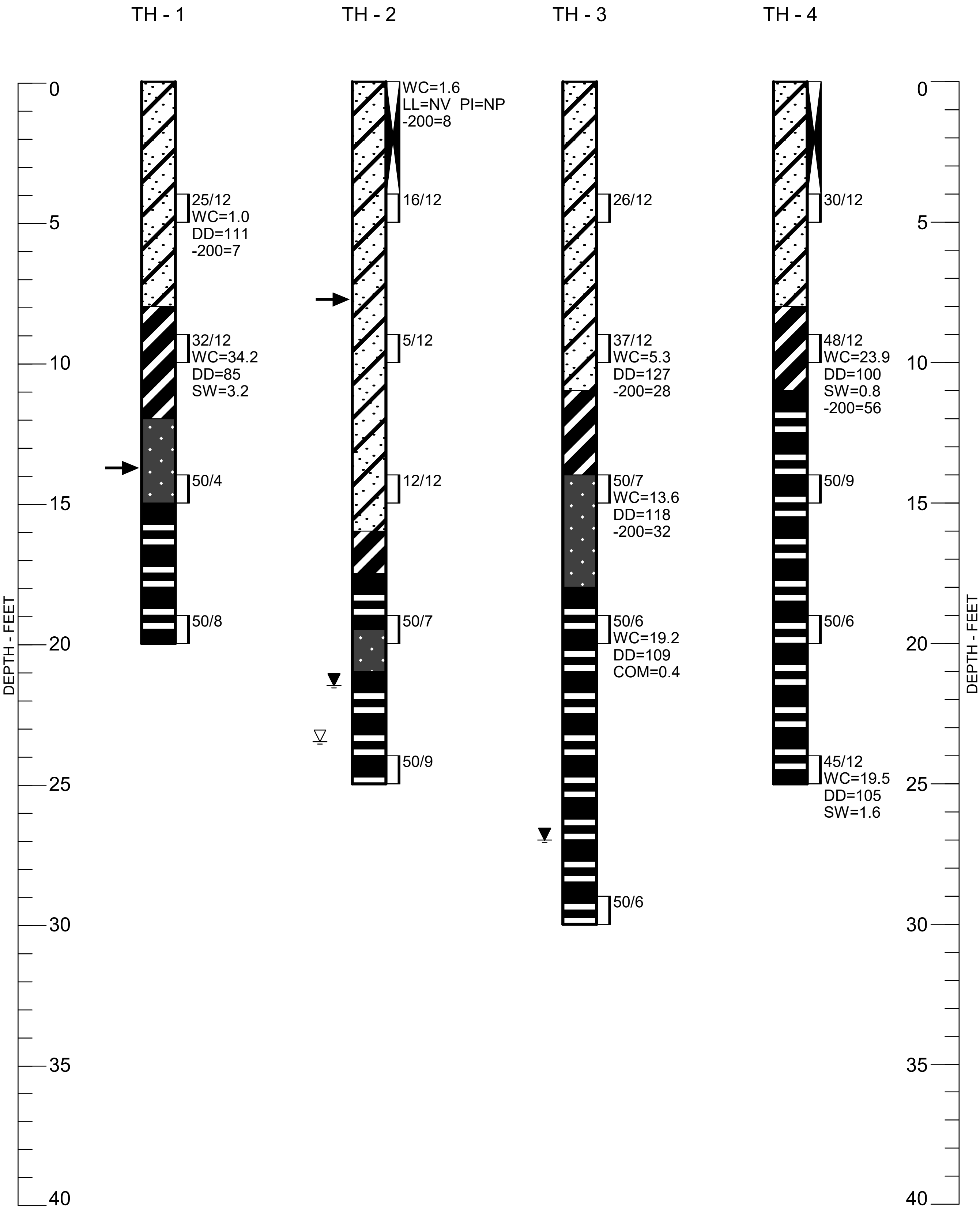
SIZE NUMBER	NOMINAL SIZE (SIEVES WITH SQUARE OPENINGS)	AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS), WEIGHT PERCENT						
		1 1/2 INCH (37.5 mm)	1 INCH (25.0 mm)	3/4 INCH (19.0 mm)	1/2 INCH (12.5 mm)	3/8 INCH (9.5 mm)	NO. 4 (4.5 mm)	NO. 8 (2.36 mm)
67	3/4 INCH TO NO. 4 (19.0 TO 4.75 mm)	--	100	90 TO 100	--	20 TO 55	0 TO 10	0 TO 5
57	1 INCH TO NO. 4 (25.0 TO 9.5 mm)	100	95 TO 100	--	25 TO 60	--	0 TO 10	0 TO 5

NOTE:
TO BE USED IN CASES WHERE GROUNDWATER IS FOUND DURING TRENCHING OR WHERE SHALLOW GROUNDWATER IS KNOWN TO EXIST, AND UPSTREAM OF MANHOLES.

Active Drain Beside Sewer

APPENDIX A

SUMMARY LOGS OF EXPLORATORY BORINGS



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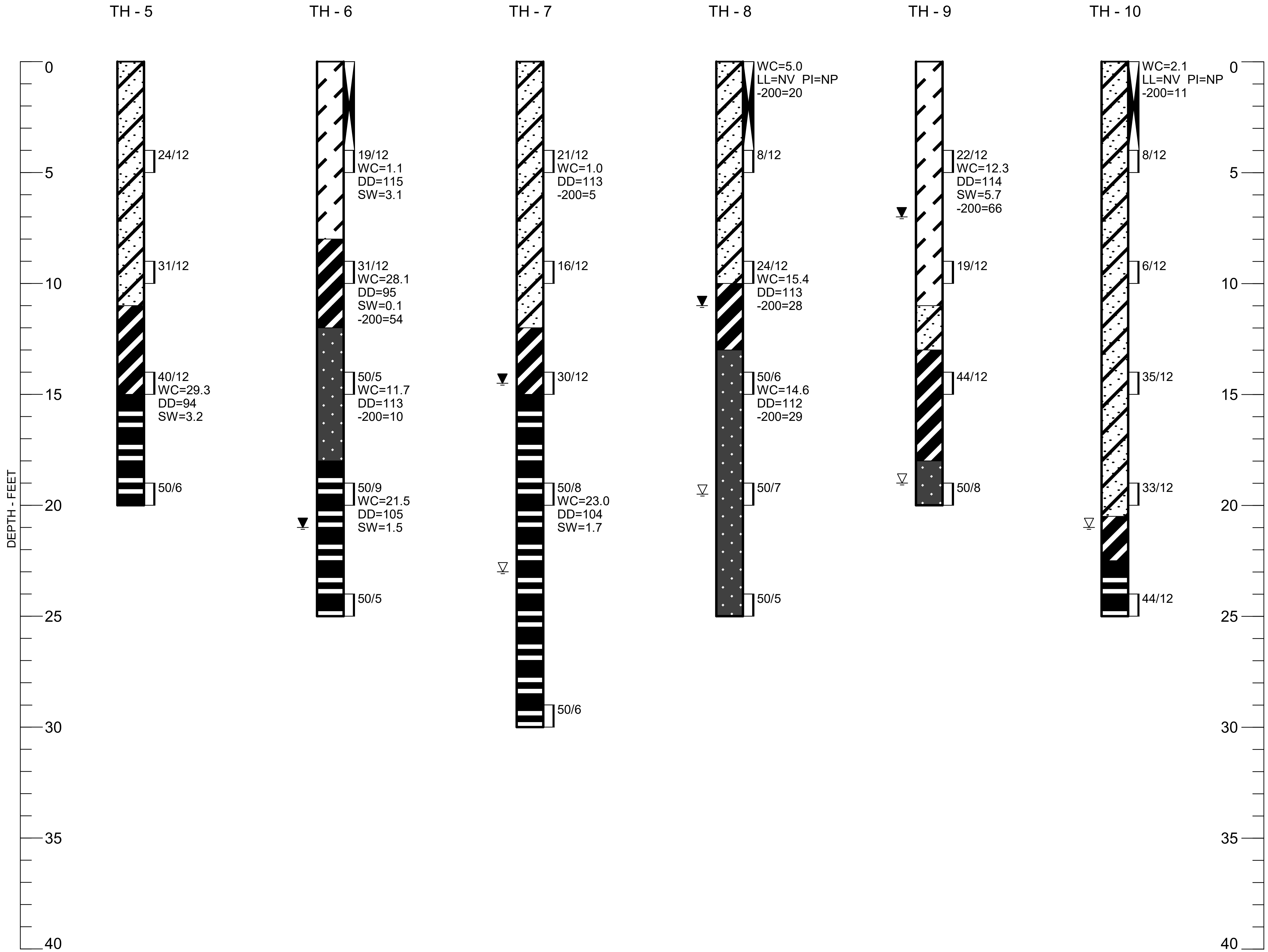
OVATION
CTL|T PROJECT NO. CS19669-115

Summary Logs of Exploratory Borings

FIG. A-1



LEGEND:

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

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

WEATHERED CLAYSTONE OR SANDSTONE BEDROCK, SANDY TO VERY SANDY (CLAYSTONE), CLAYEY TO SILTY (SANDSTONE), MEDIUM HARD, MOIST, BROWN TO DARK BROWN, OLIVE BROWN.

BEDROCK. CLAYSTONE, SANDY, MEDIUM HARD TO VERY HARD, MOIST, BROWN TO GRAY BROWN.

BEDROCK. SANDSTONE, SLIGHTLY SILTY TO SILTY, HARD TO VERY HARD, MOIST, LIGHT BROWN TO BROWN, OLIVE BROWN.

DRIVE SAMPLE. THE SYMBOL 25/12 INDICATES 25 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.

GROUNDWATER LEVEL MEASURED AFTER DRILLING.

INDICATES DEPTH WHERE THE TEST HOLE CAVED DURING DRILLING.

NOTES:

1. THE BORINGS WERE DRILLED MARCH 29, 2023 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-45, TRUCK-MOUNTED DRILL RIG.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.
3. WC - INDICATES MOISTURE CONTENT. (%)
   DD - INDICATES DRY DENSITY. (PCF)
   SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
   COM - INDICATES COMPRESSION WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
   LL - INDICATES LIQUID LIMIT. (NV : NO VALUE)
   PI - INDICATES PLASTICITY INDEX. (NP : NON-PLASTIC)
   -200 - INDICATES PASSING NO. 200 SIEVE. (%)

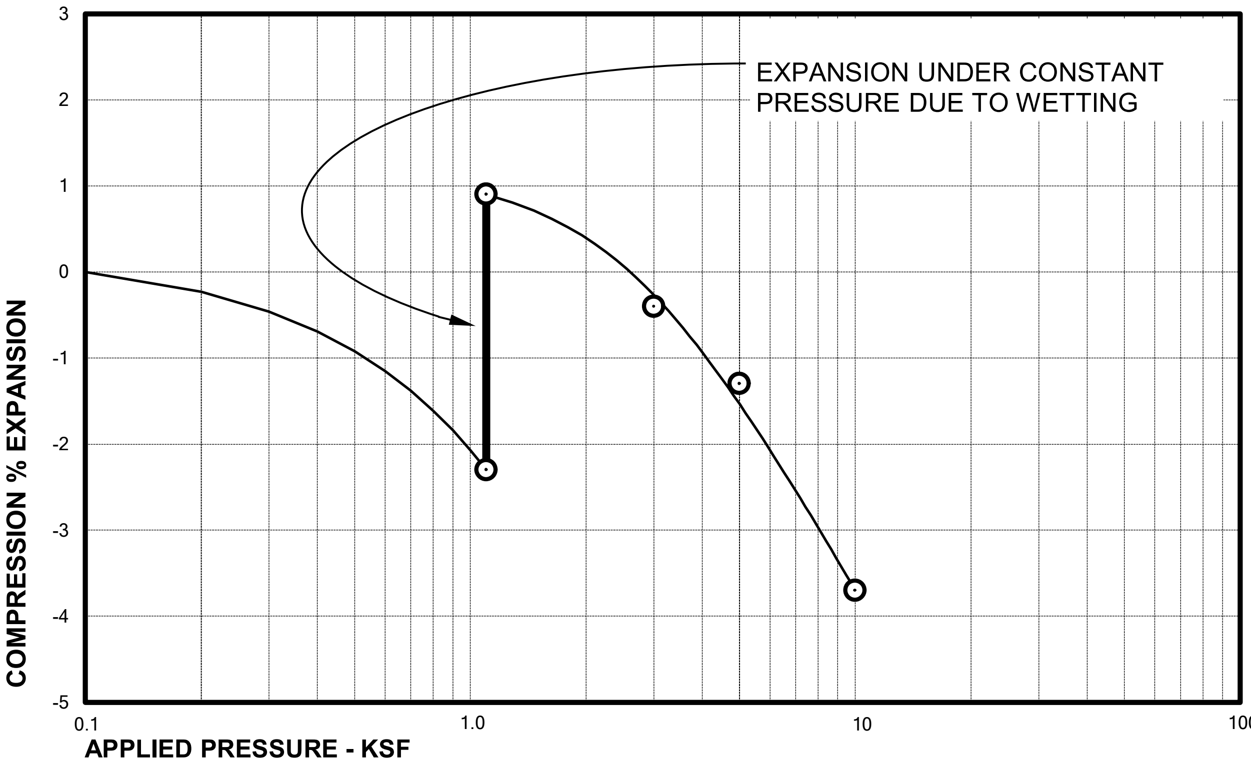
LA PLATA COMMUNITIES
OVATION
CTL|T PROJECT NO. CS19669-115

Summary Logs of Exploratory Borings

FIG. A-2

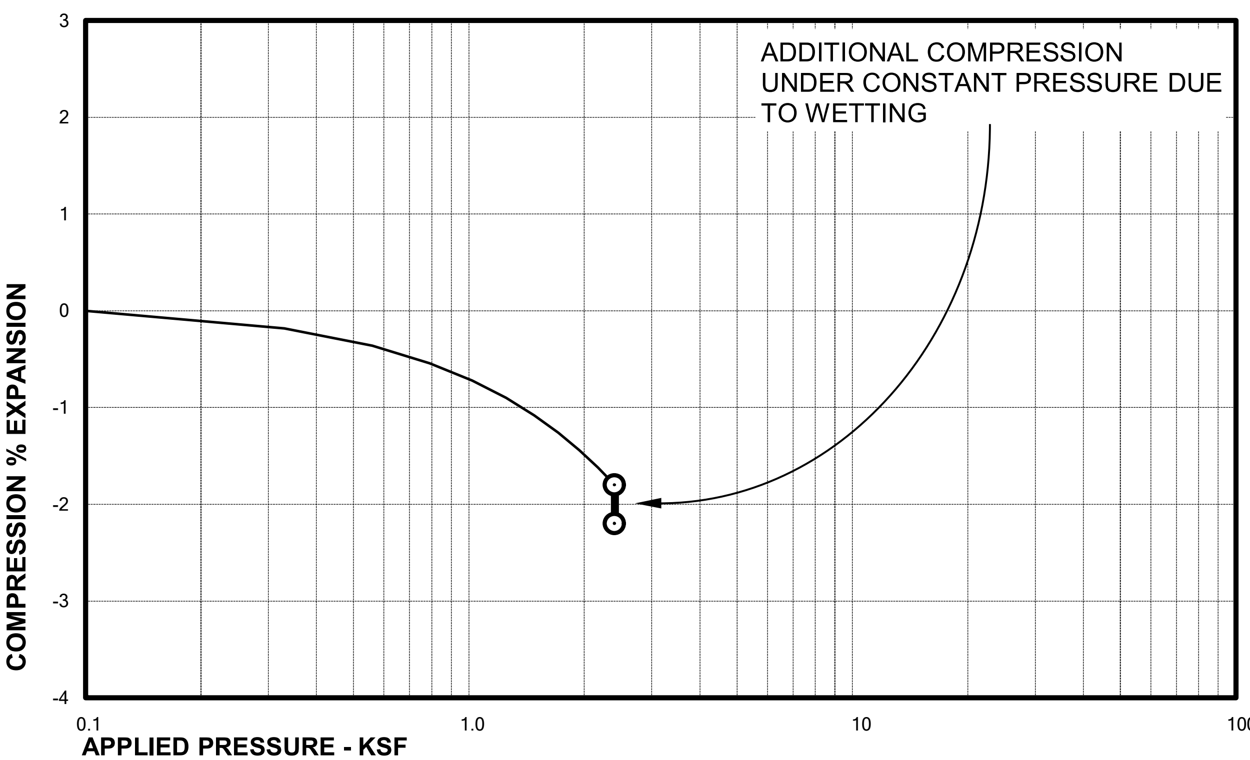
APPENDIX B

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



Sample of WEATHERED CLAYSTONE
From TH-1 AT 9 FEET

DRY UNIT WEIGHT= 85 PCF
MOISTURE CONTENT= 34.2 %



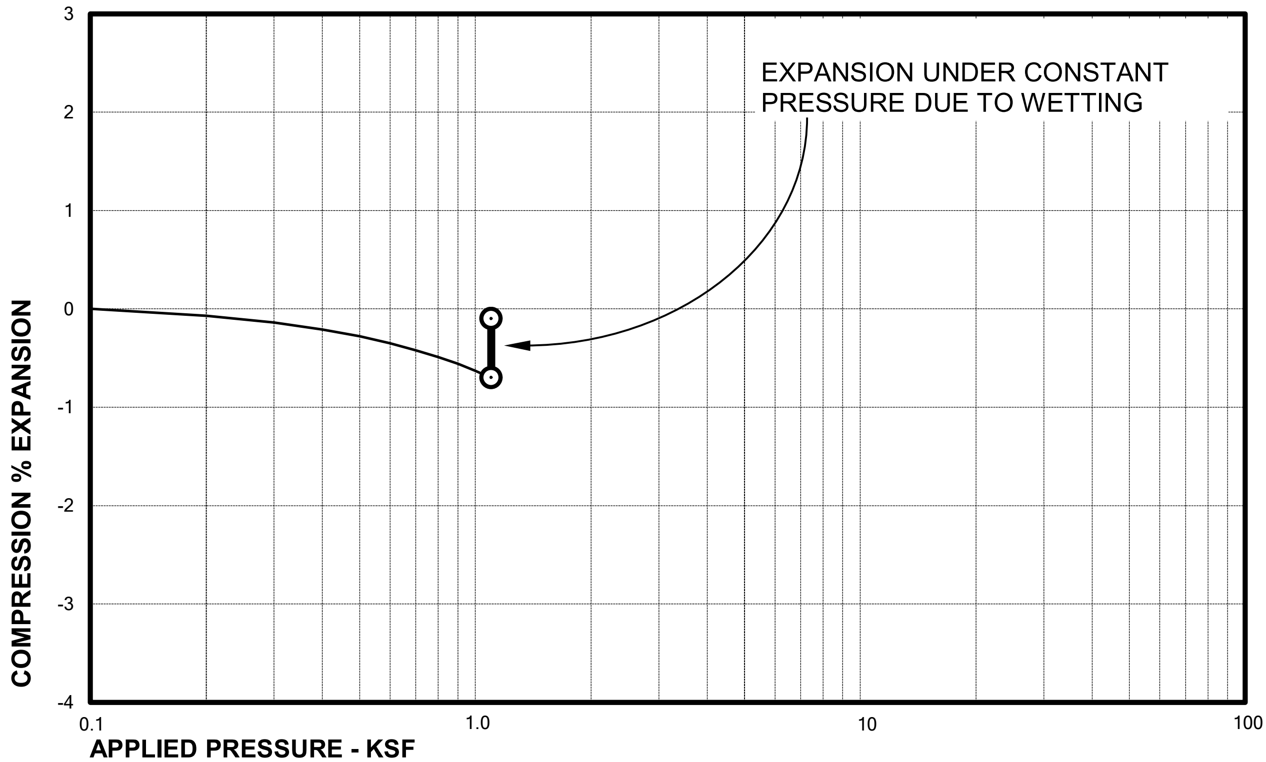
Sample of CLAYSTONE, SANDY
From TH-3 AT 19 FEET

DRY UNIT WEIGHT= 109 PCF
MOISTURE CONTENT= 19.2 %

LA PLATA COMMUNITIES
OVATION
CTL|T PROJECT NO. CS19669-115

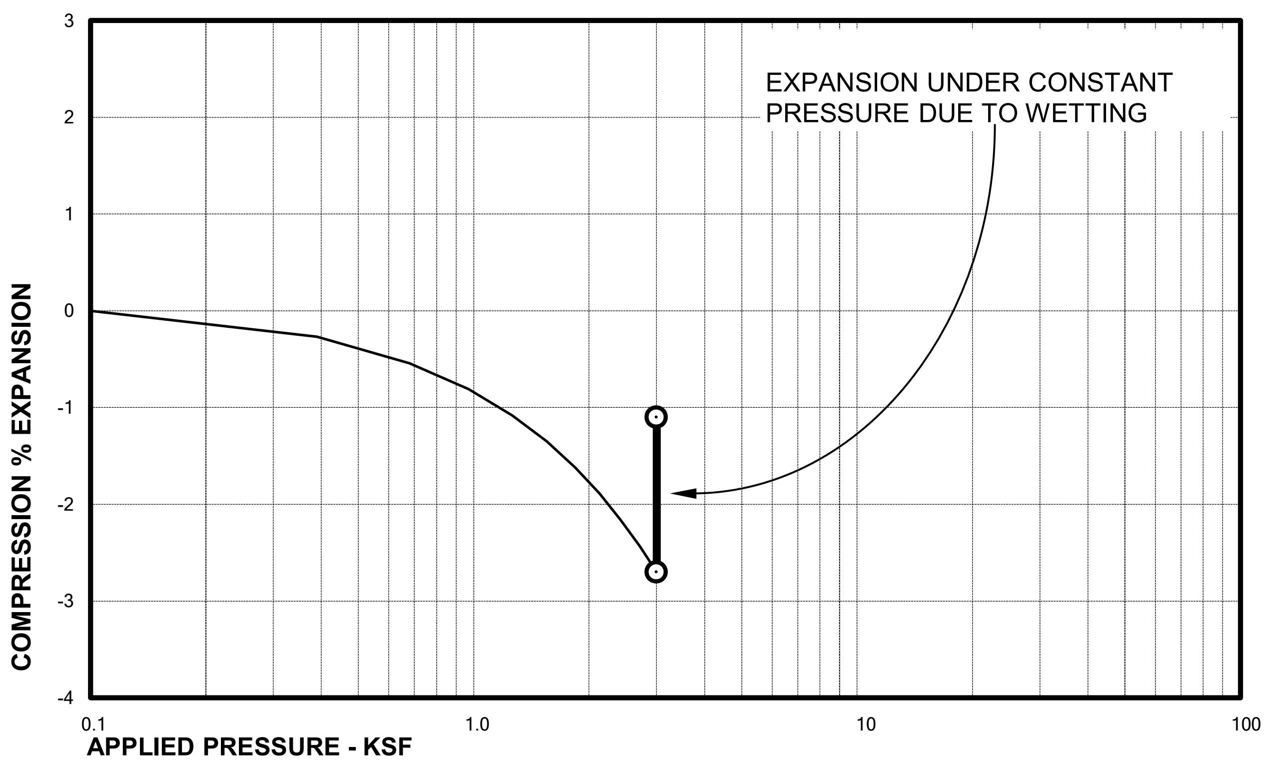
Swell Consolidation Test Results

FIG. B-1



Sample of WEATHERED CLAYSTONE
From TH-4 AT 9 FEET

DRY UNIT WEIGHT= 100 PCF
MOISTURE CONTENT= 23.9 %



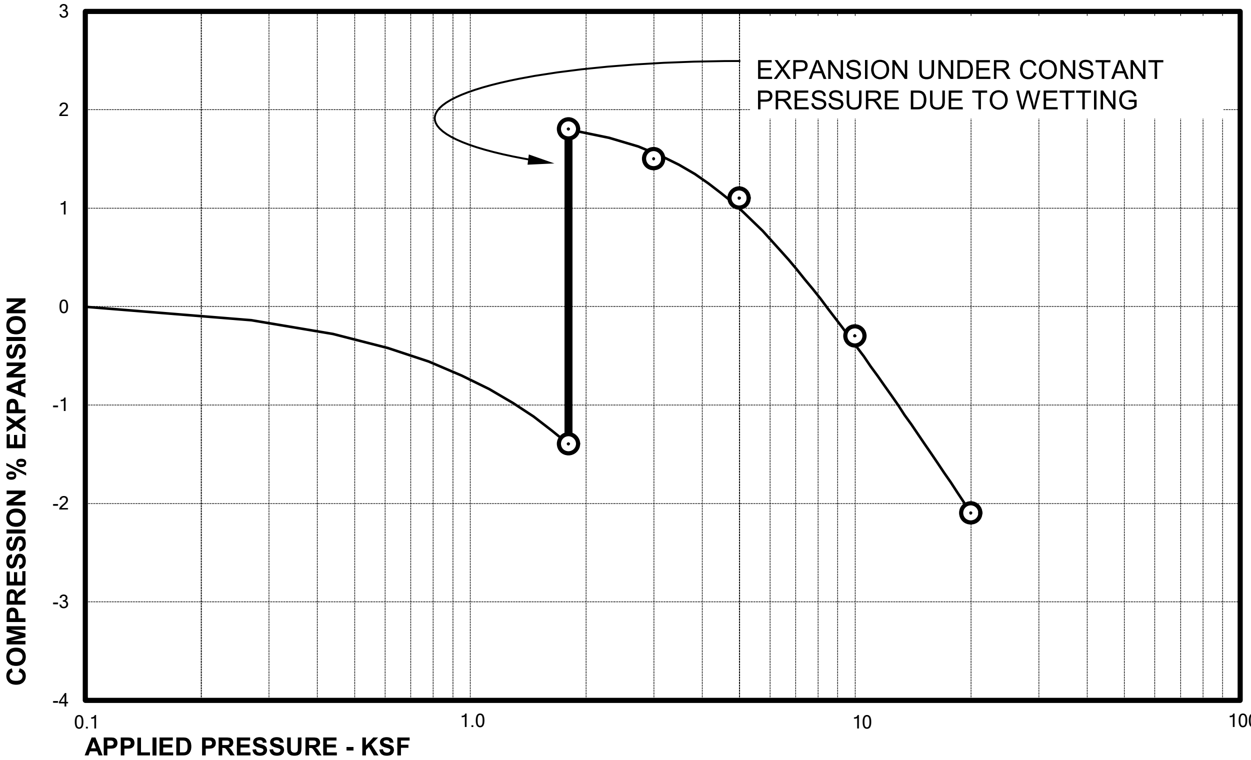
Sample of CLAYSTONE, SANDY
From TH-4 AT 24 FEET

DRY UNIT WEIGHT= 105 PCF
MOISTURE CONTENT= 19.5 %

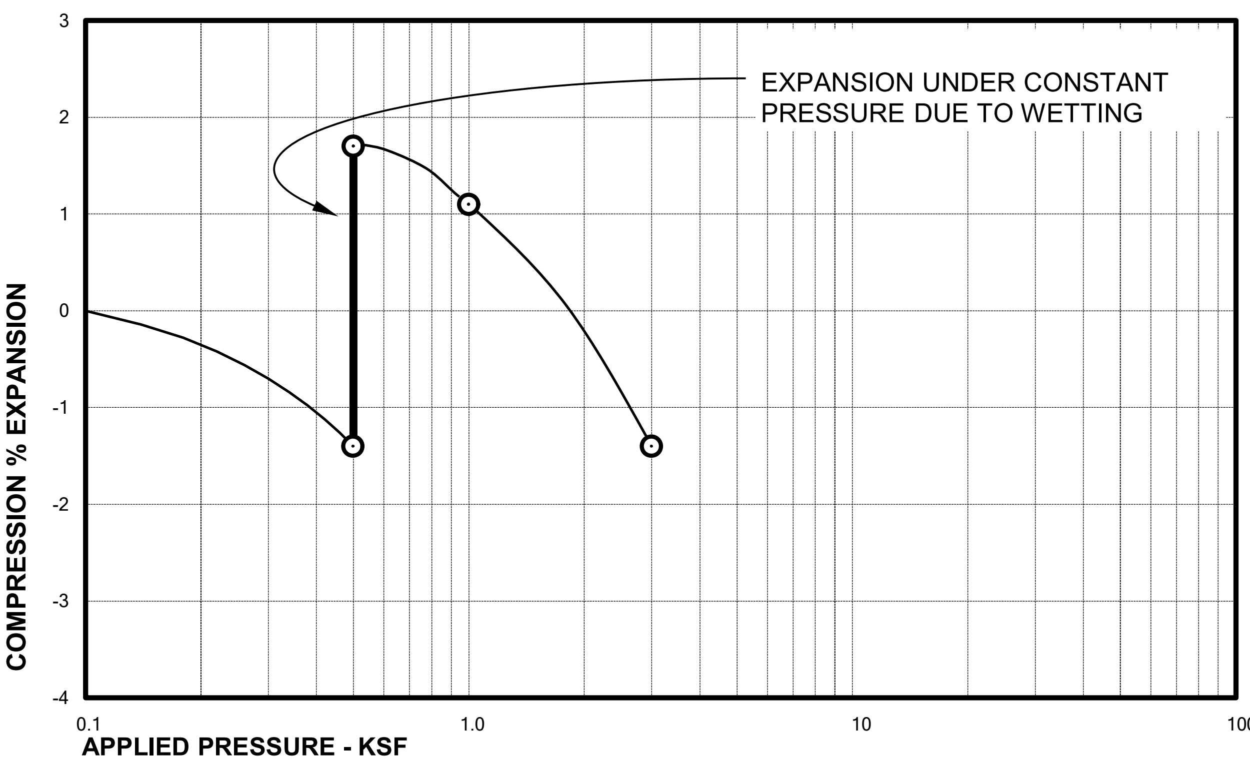
LA PLATA COMMUNITIES
OVATION
CTL|T PROJECT NO. CS19669-115

Swell Consolidation Test Results

FIG. B-2



Sample of	WEATHERED CLAYSTONE	DRY UNIT WEIGHT=	94	PCF
From	TH-5 AT 14 FEET	MOISTURE CONTENT=	29.3	%



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	115	PCF
From	TH-6 AT 4 FEET	MOISTURE CONTENT=	1.1	%

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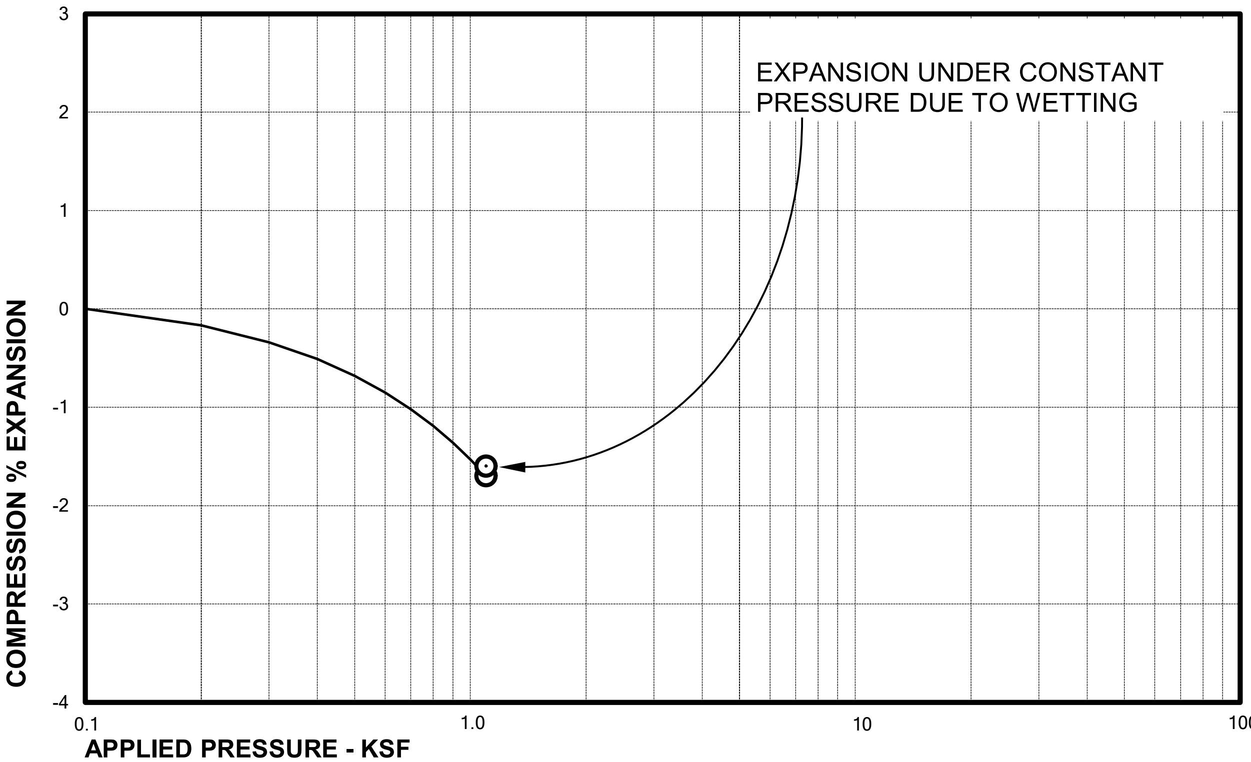
CTL|T PROJECT NO. CS19669-115

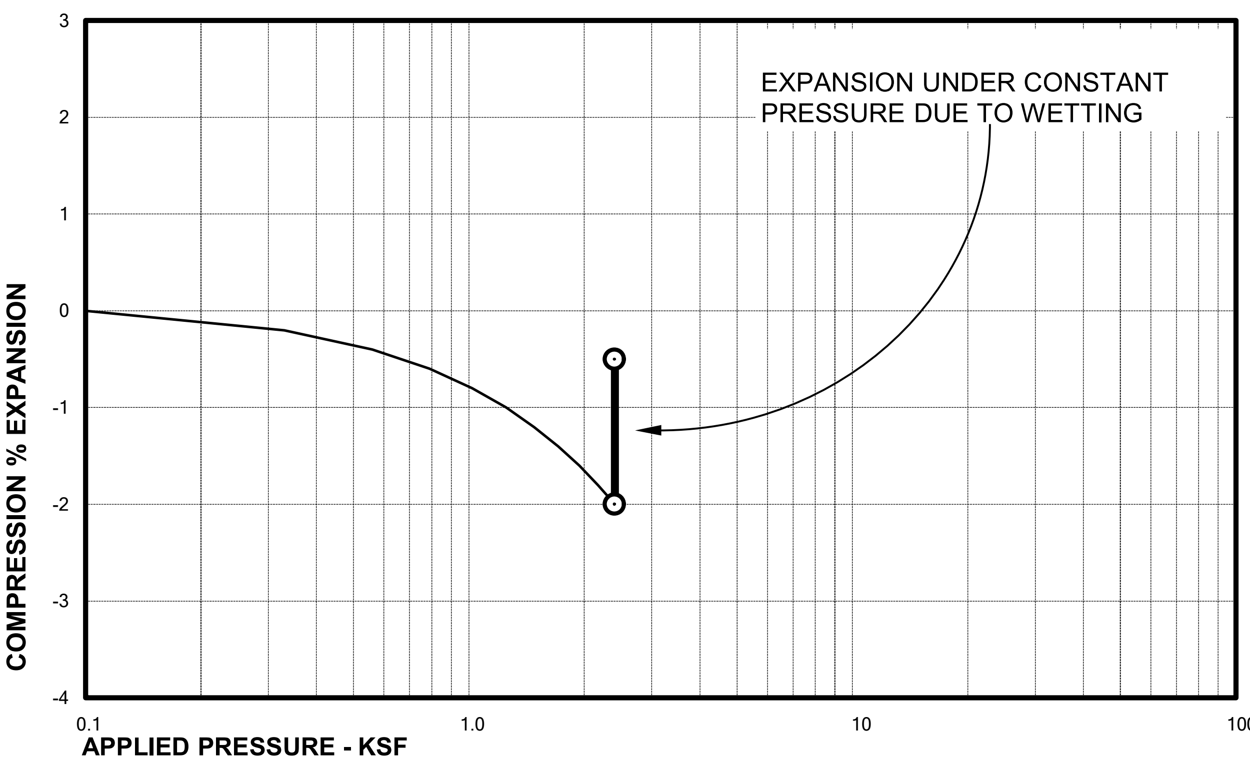
Swell Consolidation Test Results

FIG. B-3



Sample of WEATHERED SANDSTONE
From TH-6 AT 9 FEET

DRY UNIT WEIGHT= 95 PCF
MOISTURE CONTENT= 28.1 %



Sample of CLAYSTONE, SANDY
From TH-6 AT 19 FEET

DRY UNIT WEIGHT= 105 PCF
MOISTURE CONTENT= 21.5 %

LA PLATA COMMUNITIES
OVATION
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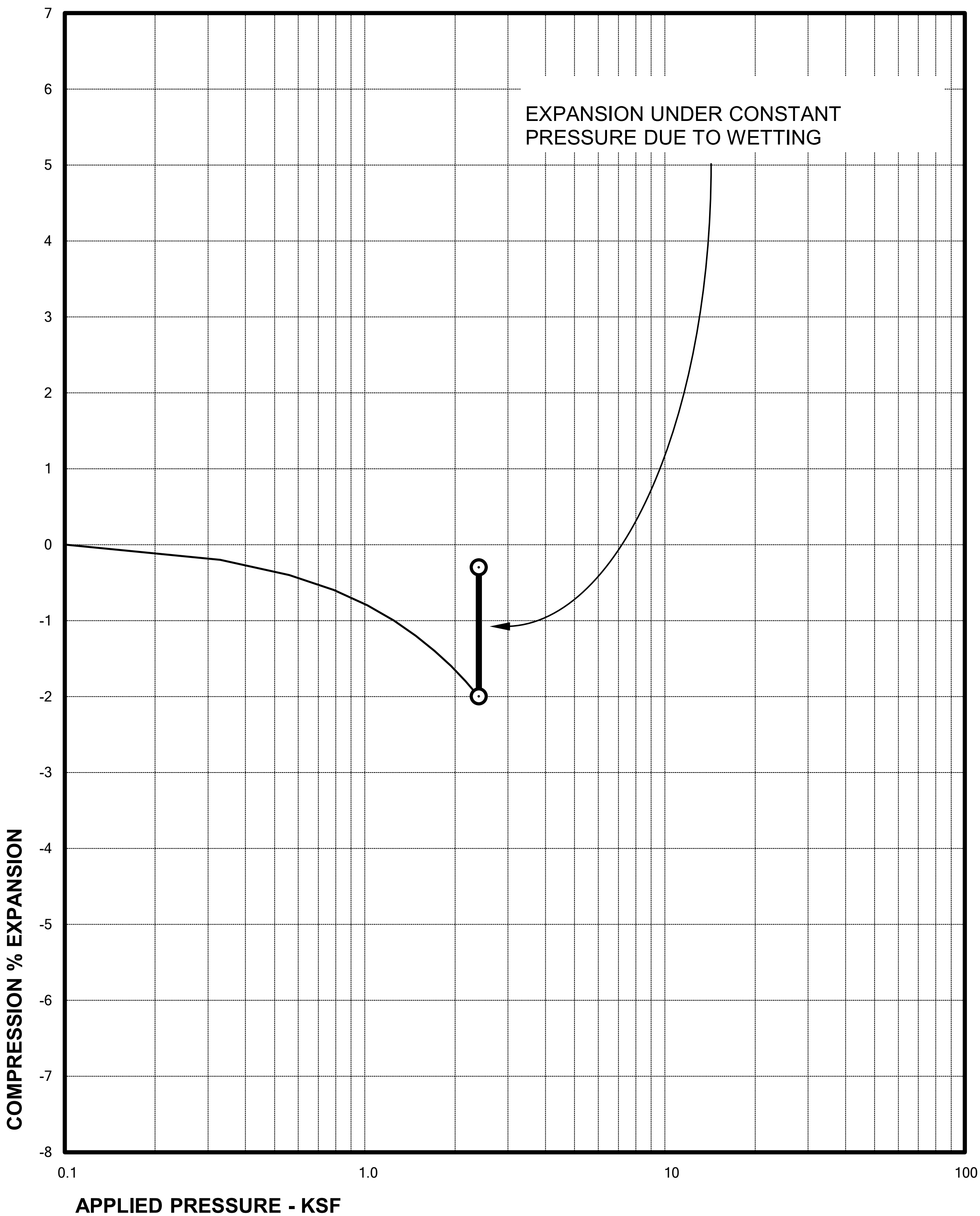
Swell Consolidation Test Results

FIG. B-4



Sample of CLAYSTONE, SANDY

From TH-7 AT 19 FEET

DRY UNIT WEIGHT= 104 PCF

MOISTURE CONTENT= 23.0 %

LA PLATA COMMUNITIES
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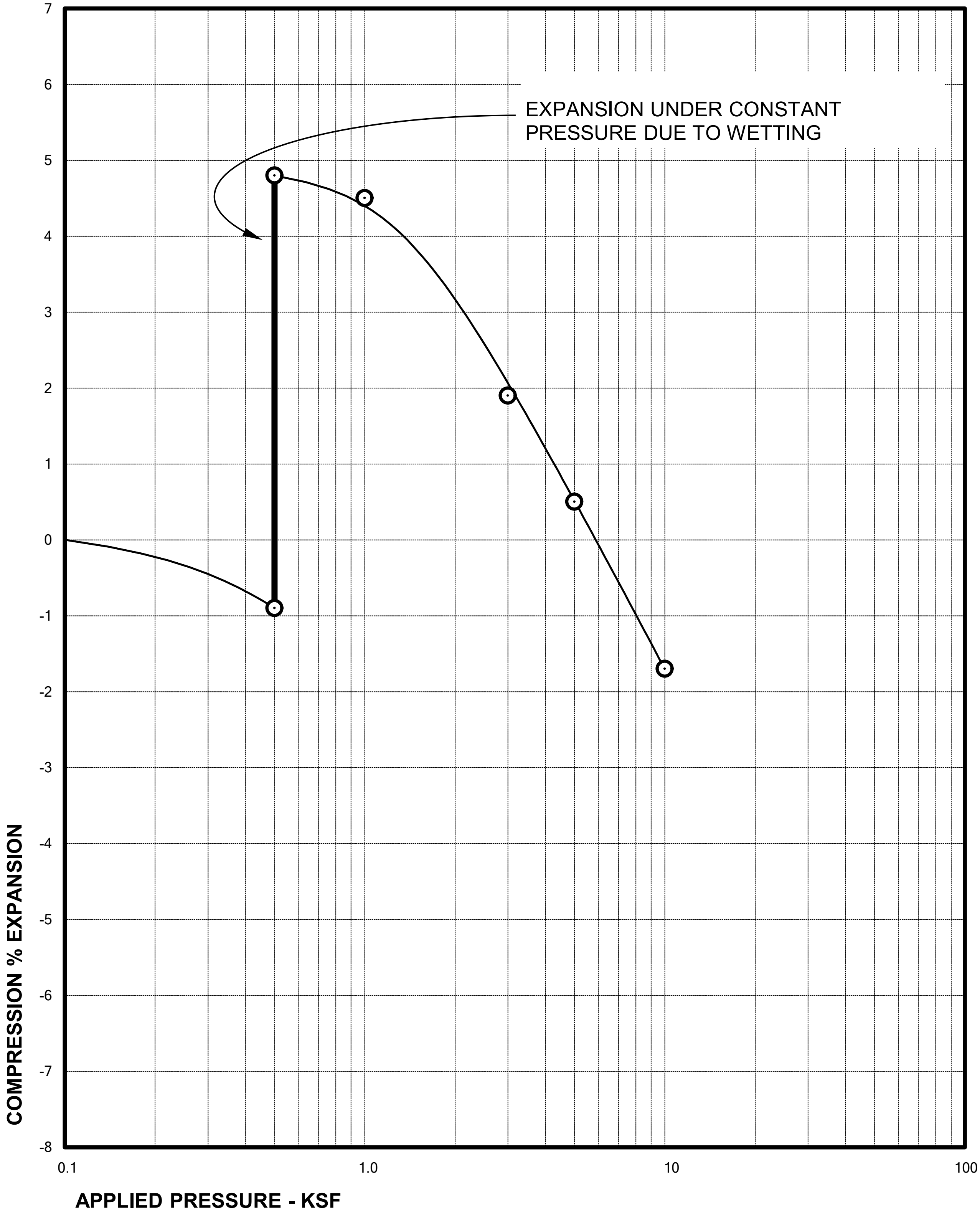
CTL|T PROJECT NO. CS19669-115

Swell Consolidation Test Results

FIG. B-5



Sample of	CLAY, VERY SANDY (CL)		DRY UNIT WEIGHT=	114	PCF
From	TH-9 AT 4 FEET		MOISTURE CONTENT=	12.3	%

LA PLATA COMMUNITIES
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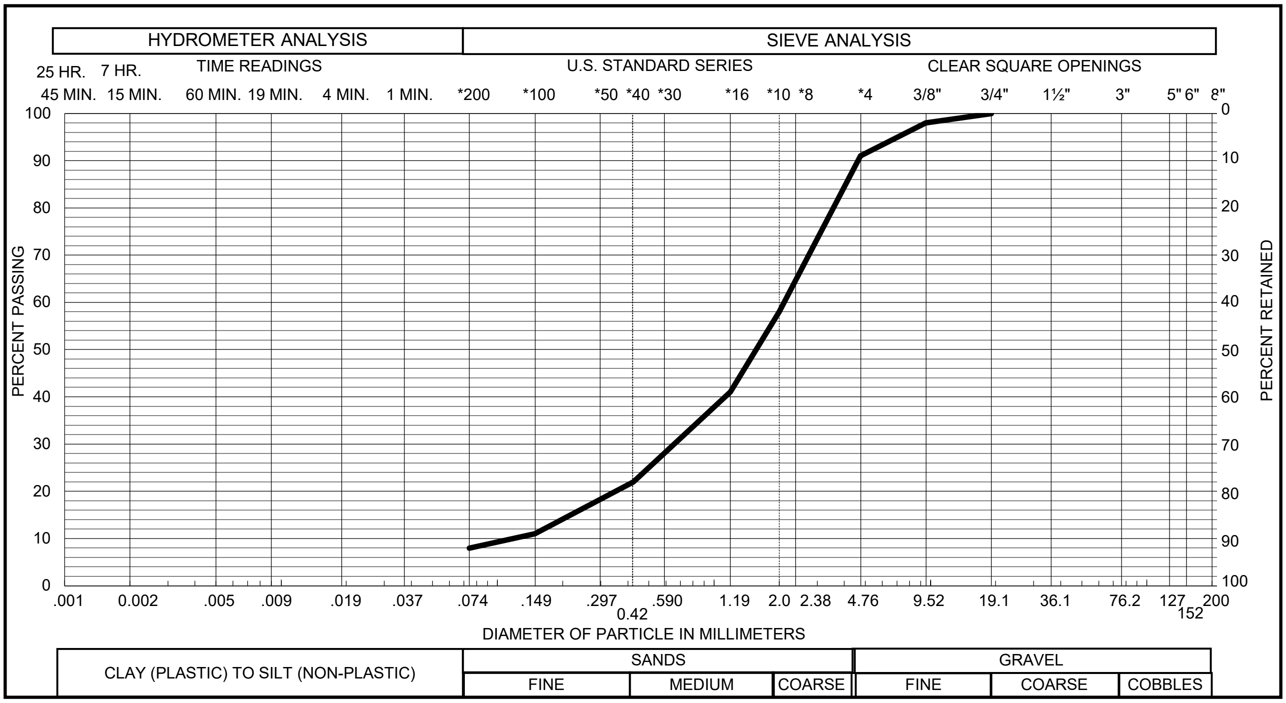
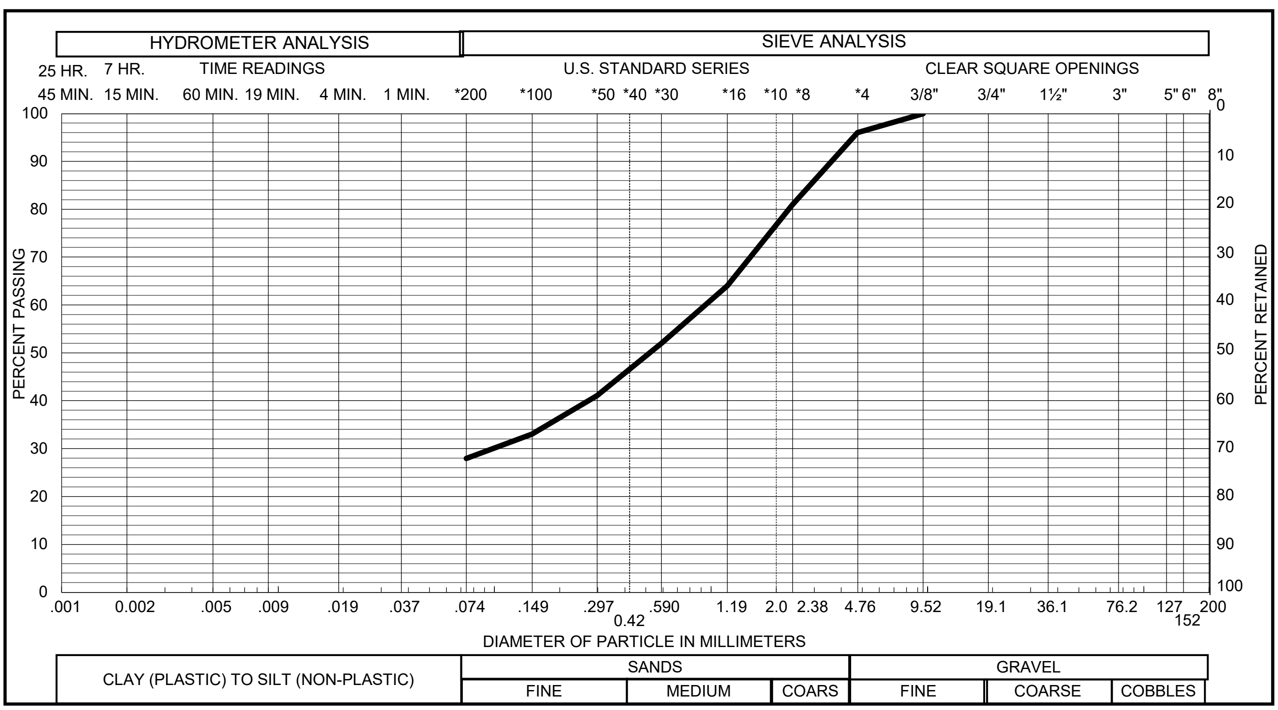
Swell Consolidation Test Results

FIG. B-6



Sample of	SAND, SLIGHTLY SILTY (SW-SM)	GRAVEL 9 %	SAND 83 %
From	TH - 2 AT 0-4 FEET	SILT & CLAY 8 %	LIQUID LIMIT NV
		PLASTICITY INDEX	NP



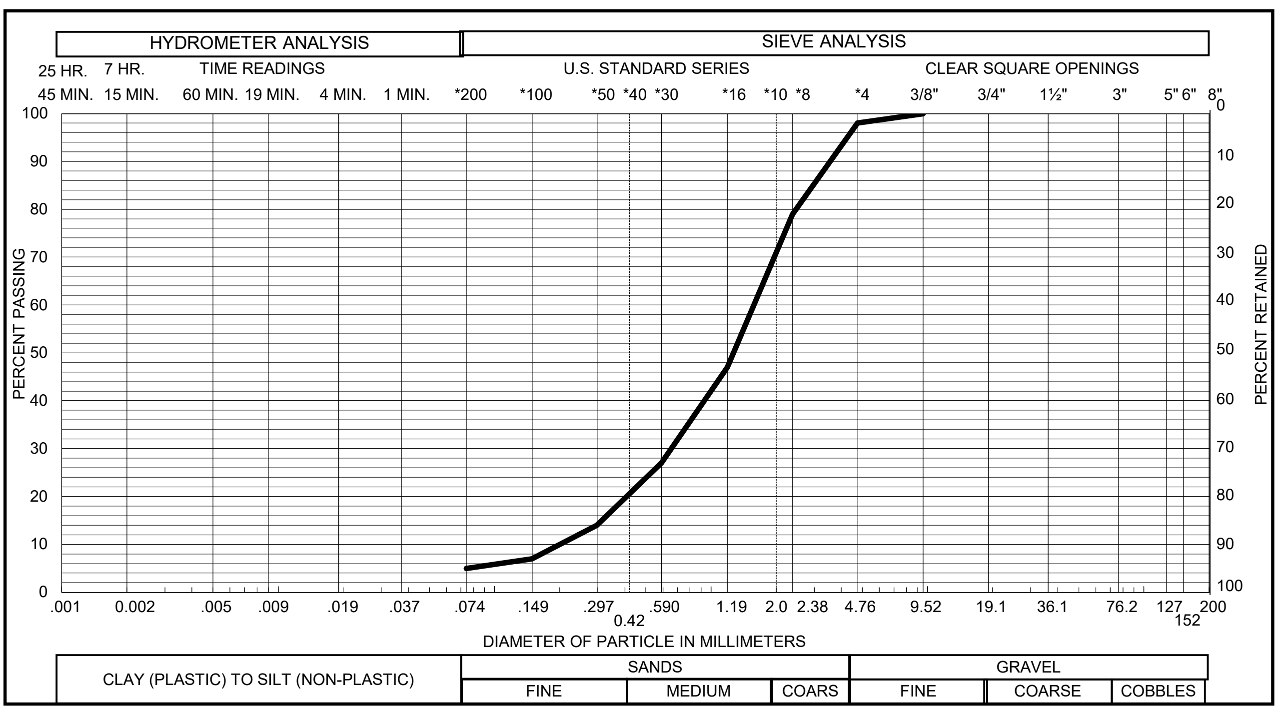
Sample of	SAND, SILTY (SM)	GRAVEL 4 %	SAND 68 %
From	TH - 3 AT 9 FEET	SILT & CLAY 28 %	LIQUID LIMIT
		PLASTICITY INDEX	

LA PLATA COMMUNITIES
OVATION
CTL|T PROJECT NO. CS19669-115

Gradation Test Results

FIG. B-7

Sample of	SANDSTONE, SLIGHTLY SILTY	GRAVEL	0 %	SAND	90 %
From	TH - 6 AT 14 FEET	SILT & CLAY	10 %	LIQUID LIMIT	
		PLASTICITY INDEX			

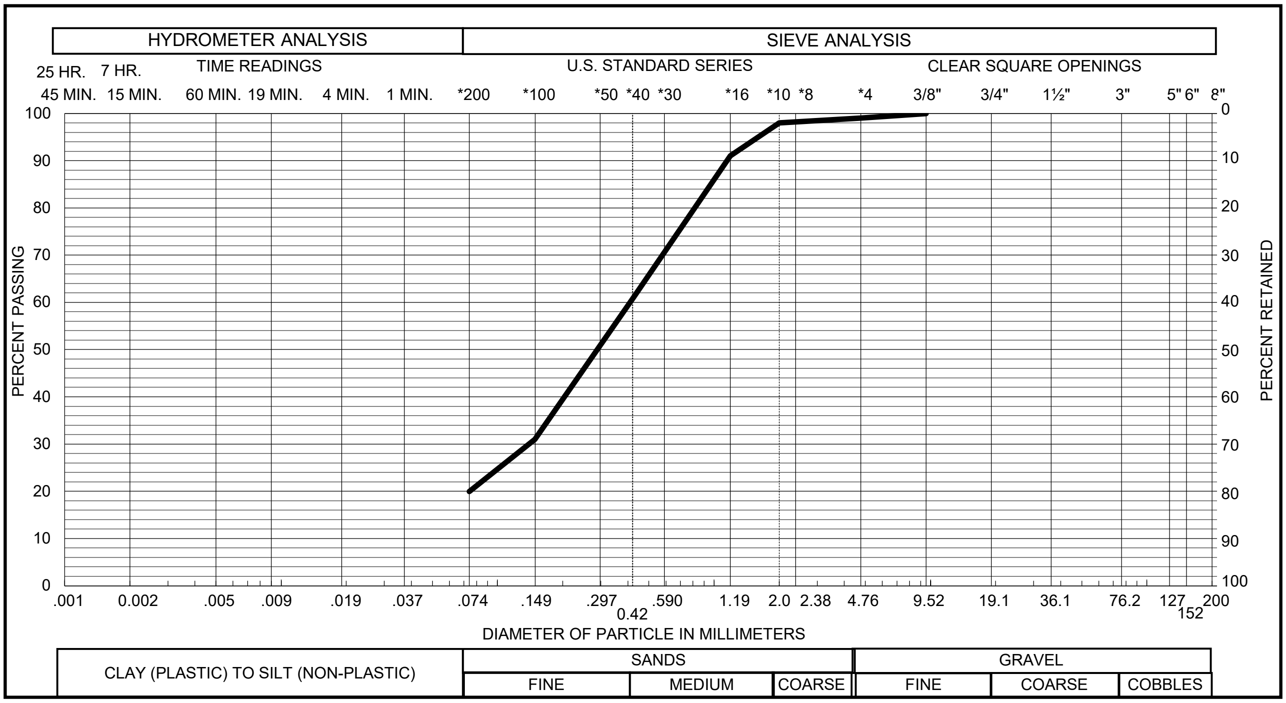


Sample of	SAND, SLIGHTLY SILTY (SW-SM)	GRAVEL	2 %	SAND	93 %
From	TH - 7 AT 4 FEET	SILT & CLAY	5 %	LIQUID LIMIT	
		PLASTICITY INDEX			

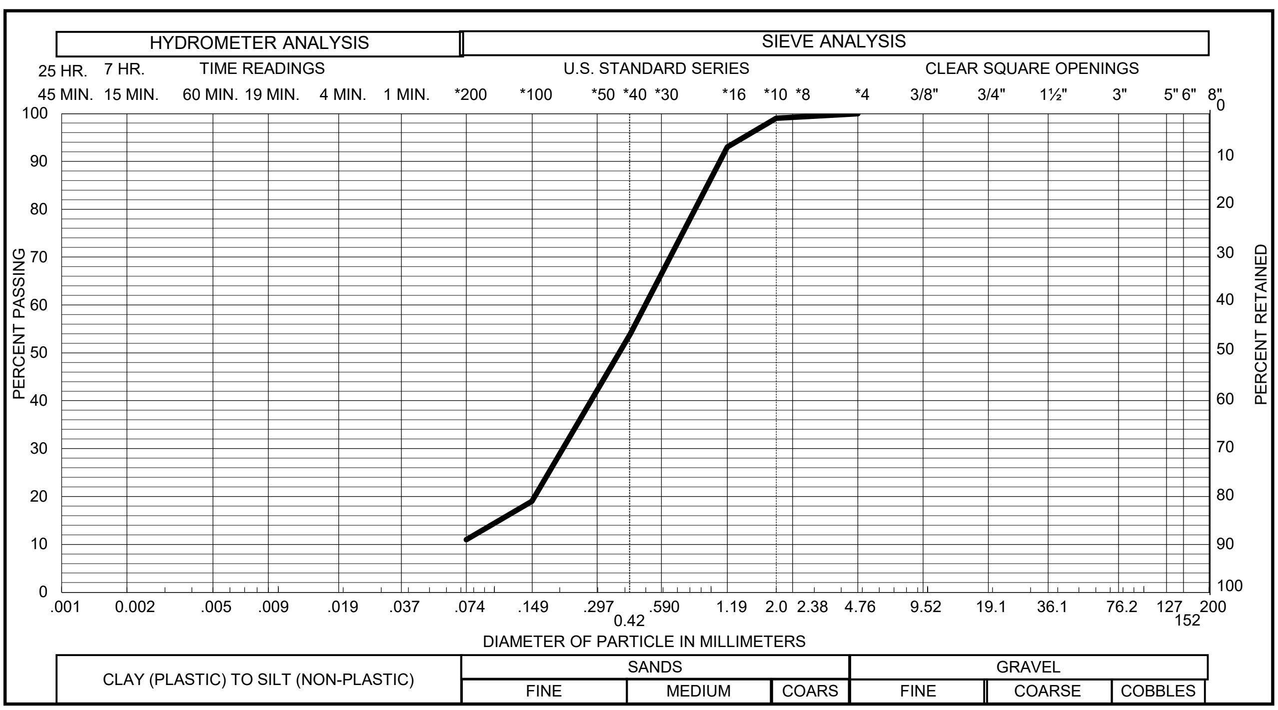
LA PLATA COMMUNITIES
OVATION
CTL|T PROJECT NO. CS19669-115

Gradation Test Results

FIG. B-8



Sample of	SAND, SILTY (SM)	GRAVEL 1 %	SAND 79 %
From	TH - 8 AT 0-4 FEET	SILT & CLAY 20 %	LIQUID LIMIT NV
		PLASTICITY INDEX	NP



Sample of	SAND, SLIGHTLY SILTY (SP-SM)	GRAVEL 0 %	SAND 89 %
From	TH - 10 AT 0-4 FEET	SILT & CLAY 11 %	LIQUID LIMIT NV
		PLASTICITY INDEX	NP

LA PLATA COMMUNITIES
OVATION
CTL|T PROJECT NO. CS19669-115

Gradation Test Results

FIG. B-9

TABLE B-I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19669-115

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-1	4	1.0	111						7		SAND, SLIGHTLY SILTY (SP-SM)
TH-1	9	34.2	85			3.2	1100				WEATHERED CLAYSTONE
TH-2	0-4	1.6		NV	NP				8		SAND, SLIGHTLY SILTY (SW-SM)
TH-3	9	5.3	127						28		SAND, SILTY (SM)
TH-3	14	13.6	118						32		SANDSTONE, SILTY
TH-3	19	19.2	109			-0.4	2400				CLAYSTONE, SANDY
TH-4	9	23.9	100			0.8	1100		56		WEATHERED CLAYSTONE
TH-4	24	19.5	105			1.6	3000				CLAYSTONE, SANDY
TH-5	14	29.3	94			3.2	1800				WEATHERED CLAYSTONE
TH-6	4	1.1	115			3.1	500				CLAY, SANDY (CL)
TH-6	9	28.1	95			0.1	1100		54		WEATHERED SANDSTONE
TH-6	14	11.7	113						10		SANDSTONE, SLIGHTLY SILTY
TH-6	19	21.5	105			1.5	2400				CLAYSTONE, SANDY
TH-7	4	1.0	113						5		SAND, SLIGHTLY SILTY (SW-SM)
TH-7	19	23.0	104			1.7	2400				CLAYSTONE, SANDY
TH-8	0-4	5.0		NV	NP				20		SAND, SILTY (SM)
TH-8	9	15.4	113						28		SAND, SILTY (SM)
TH-8	14	14.6	112						29		SANDSTONE, SILTY
TH-9	4	12.3	114			5.7	500		66		CLAY, VERY SANDY (CL)
TH-10	0-4	2.1		NV	NP				11		SAND, SLIGHTLY SILTY (SP-SM)

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

APPENDIX C

GUIDELINE SITE GRADING SPECIFICATIONS
OVATION PROPERTY
COLORADO SPRINGS, COLORADO

GUIDELINE SITE GRADING SPECIFICATIONS
OVATION PROPERTY
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, 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 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. 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 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.

COLORADO GEOLOGICAL SURVEY

1801 Moly Road
Golden, Colorado 80401

Matthew L. Morgan
State Geologist and Director

October 6, 2023

Patrick Morris
Engineering Development Review
30 S. Nevada, Suite 401
Colorado Springs, CO 80901

Location:
E½ Section 21 &
W½ Section 22,
T12S, R66W of the 6th PM
38.9897, -104.7745

Subject: Ovation Chapel Ridge Drive and Rhinestone Drive Land Use Plan, MAPN-22-0002, City of Colorado Springs, El Paso County, CO; CGS Unique No. EP-24-0018

Dear Patrick:

Colorado Geological Survey has reviewed the above-referenced referral for approval of a Land Use Plan (Master Plan/Concept Plan) for a 57-acre parcel north of the intersection of Chapel Ridge Drive and Rhinestone Drive in Colorado Springs. We understand the project is planned for single-family residences. With this referral, we received an Email requesting CGS's review (September 26, 2023), Geologic Hazards Evaluation and Preliminary Geotechnical Investigation (CTL|Thompson, Inc. (CTL), May 2, 2023), and Land Use Plan (May 3, 2023).

The site does not contain steep slopes, is located outside of any mapped FEMA flood hazard zones, is not undermined, and is not exposed to or located within any identified geologic hazard areas that would preclude the residential use. According to available geologic mapping, the site is underlain by eolian (windblown) soils overlying the bedrock of the Dawson Formation (interbedded sandstone and claystone). The claystone and clay soils weathered from the Dawson Formation can be expansive and, in places, can exhibit significant volume changes (shrink-swell) in response to changes in water content. Sandstone layers within the Dawson formation may be difficult to excavate, and perched groundwater can occur at the sandstone claystone interfaces.

We concur in general with the geologic description and geologic hazard identification provided by CTL. They identify expansive soil and bedrock, shallow bedrock, and shallow groundwater as geologic hazards requiring mitigation at this location. Provided CTL's *preliminary* recommendations are adhered to, **CGS has no objection to the approval of the Land Use Plan.**

Thank you for the opportunity to review and comment on this project. If you have questions or need further review, please call me at (303) 384-2632, or email acrandall@mines.edu.

Sincerely,

Amy Crandall

Amy Crandall, P.E.
Engineering Geologist