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PRELIMINARY GEOTECHNICAL INVESTIGATION STANLEY SITE NORTHWEST OF EAST 25TH AVENUE AND JOLIET STREET AURORA, COLORADO

Prepared For:

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Project No. DN51,256-115-R1

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SCOPE

This report presents the results of our Preliminary Geotechnical Investigation for the property located northwest of East 25th Avenue and Joliet Street in Aurora, Colorado (Fig. 1). The purpose of our investigation was to evaluate the subsurface conditions to assist in due diligence assessment and planning of site development and construction. This report includes descriptions of subsurface conditions found in our exploratory borings and discussions of site development and building construction as influenced by geotechnical considerations. Our scope of service was described in a Service Agreement (DN 21-0433) dated August 6, 2021.

This report was prepared using data obtained during field exploration, field and laboratory testing, engineering analysis of field and laboratory data, and our experience. It is also based on published geologic maps along with our understanding of the development plan. The preliminary recommendations presented in the report are intended for due diligence evaluation and planning purposes only. Additional investigation will be necessary to provide geotechnical design recommendations for buildings and improvements. A summary of our conclusions is presented below with more complete descriptions included in the report.

SUMMARY

1. The site is judged suitable for development. The primary geotechnical concerns are the presence of existing fill, expansive soils, and collapsible soil. We believe these concerns can be mitigated with proper planning, engineering, design, and construction. No geotechnical constraints were identified that would preclude redevelopment.

2. Strata encountered in our exploratory borings consisted of nil to approximately 5 feet of sandy clay fill and sandy-and-silty clay and clayey sand to the maximum depths explored. Clay, sand, and calcareous layers were encountered throughout the samples along with gravels. Bedrock was not encountered to a depth of 30 feet. The clay is expansive and collapsible, and the sand is deemed non-expansive.

3. Water was measured at depths of about 21 and 27 feet below existing grades or approximate elevation 5305 to 5308 feet. Groundwater levels may fluctuate seasonally and rise in response to development, precipitation, landscape irrigation, and changes in land-use.

4. Sub-excavation is merited for all residences to use shallow foundations. We recommend sub-excavation to a depth of at least 12 feet below existing grade, 5 feet below basement foundations, or 10 feet below non-basement foundation elements, whichever is deeper. Sub-excavation may be somewhat limited by maintaining the excavation limits and slopes on the property. Where sub-excavations cannot fit within the property boundaries, deep foundations should be planned.

5. Shallow foundations such as post-tensioned slabs-on-grade and/or footings designed to maintain minimum deadload will likely be suitable for 95 percent of the structures after sub-excavation. The remaining 5 percent may require additional sub-excavation to allow use of shallow foundations. If sub-excavation cannot or is not performed, then deep foundation such as short drilled friction piers, drilled piers bottomed in bedrock, and/or helical piles may be necessary. A supplemental investigation should be performed to determine depth to bedrock if drilled piers are deemed necessary.

6. Structurally supported floors are recommended in all first-floor finished living areas of structures with or without basements. Slab-on-grade floors can be used in basements where the risk of poor performance is judged to be low and the buyer is willing to tolerate about 1 to 2 inches of slab heave and the associated damage. Sub-excavation should result in low risk. The risk will likely be moderate to high if sub-excavation is not performed. Structurally supported floors should be used in basements with high risk of poor performance and where about 1 to 2 inches of movement is not acceptable to the buyer. Slabs can be used in garages provided that at least 5 feet of sub-excavation is performed and some heave related damage is acceptable.

7. Pavement areas will be used as access drives, parking lots, and truck/fire lanes and samples are considered fair to poor sub-grade support material. Sub-excavation to a depth of 2 ½ feet is recommended. The upper 1-foot of pavement subgrade may require chemical or mechanical stabilization per the City of Aurora. We judge the City of Aurora “Default” pavement sections can likely be used. Assuming the project is a multi-family residential site with private streets, at least 6 inches of asphalt pavement will be needed, or an equivalent composite section of 4 inches of asphalt over 8 inches of aggregate base course. If the pavements will be public, it should be noted that full depth asphalt sections are not allowed. A design-level sub-grade investigation should be done prior to paving.

8. Surface drainage should be designed to provide rapid removal of surface water away from the proposed structures and off pavements. Water should not be allowed to pond adjacent to the buildings or on pavements.

SITE CONDITIONS

The approximately 2.8 acres site is located northwest of East 25th Avenue and Joliet Street in Aurora, Colorado (Fig. 1 and Photo 1). It is bordered by residences to the south, east, and west. A drainage with three storm sewer outfalls borders the parcel to the north and residential development is further north. The site was vacant during out visit. Ground cover consisted of tall grass, weeds, and shrubbery. A group of trees splits the site in approximately half. The site is relatively flat and slopes gently to the north drainage with overall topographic relief of about 5 feet.

Photo 1 – Google Earth© Aerial Site Photo, June 2021

As part of our investigation, we reviewed historical Google Earth© photographs to evaluate previous site uses, with the earliest photos dating back to 1985. The site experienced some construction activities during the development of the residential site

(Central Park) to the north. Activity is difficult to decern but may have resulted in stock-piling of soils or equipment staging as seen in the July 2007 (Photo 2). The structures appeared to have been removed between 2007 and 2008.

Photo 2 – Google Earth© Aerial Site Photo, July 2007

PROPOSED DEVELOPMENT

The site vegetation and trees will be cleared to make ready for new construction. A conceptual site plan indicates 18 duplex-residences separated by three access drives/alleys and attached or tuck-under garages may be constructed. The access drive in the center of the site is proposed to connect to the storm sewer outfall to the north. The residences will be serviced by paved alleyways, buried utilities, and other infra-structure. We anticipate the buildings will be wood-framed, one or two-story structures with no basements. We anticipate light to moderate foundation loads for the residences. Grading plans are not available currently but we anticipate minimal grading cuts and fills due to the urban infill scenario.

INVESTIGATION

We investigated subsurface conditions on September 2, 2021 by drilling and sampling six exploratory borings at the approximate locations shown on Fig. 1. Prior to drilling, we contacted the Utility Notification Center of Colorado and local sewer and water districts to identify locations of buried utilities in the vicinity of the boring locations. A private utility locator was also retained. The borings were drilled to depths of 20 and 30 feet below the existing ground surface using 4-inch diameter, continuous-flight solid-stem auger powered by a truck-mounted UAD Big BK drill rig. Samples were obtained at approximate 5-feet intervals using 2.5-inch diameter (O.D.) modified California barrel samplers driven by blows of an automatic 140-pound hammer falling 30 inches. Our field representative was present to observe drilling operations, log the strata encountered, and obtain samples. We determined the boring elevations with limited precision using a Leica GS18 GPS unit referencing the North American Datum of 1983 (NAD83). Summary logs of the borings are presented in Appendix A.

Samples were returned to our laboratory where they were examined by our engineer. Laboratory tests included moisture content, dry density, particle-size analysis (percent passing No. 200 sieve), swell consolidation, and Atterberg limits. The swell consolidation tests were performed by wetting a sample under approximate overburden pressure (i.e. the pressure exerted by the overlying soil). Laboratory test results are presented in Appendix B and summarized on Table B-I.

SUBSURFACE CONDITIONS

Strata encountered in our exploratory borings consisted of nil to approximately 5 feet of sandy clay fill and sandy-and-silty clay and clayey sand to the maximum depths explored. Clay, sand, and calcareous materials were encountered throughout the samples along with gravel. Bedrock was not encountered to a depth of 30 feet. Pertinent engineering characteristics of the soil are described in the following paragraphs.

Existing Fill

One sample in the eastern part of the site and historical aerial site photos indicate existing fill is likely present. The fill sample possessed 55 percent fines and exhibited moderate plasticity. We anticipate nil to variable depths of fill across the site. Existing fill is unsuitable to support foundations and floor slabs.

Clay

Sandy-and-silty clay with gravel, sand, and calcareous layers was the predominate soil type encountered in our investigation. This stratum is often characterized as interlayered clay and sand deposited by wind. The clay was stiff to very stiff based on results of field penetration resistance testing and became less stiff at depth where groundwater was encountered. Relatively softer soils were encountered above groundwater measurement. Eight samples of clay swelled between 0.5 to 8.1 percent and four samples compressed from 0.1 to 2.5 percent when wetted under an applied overburden pressure. Five samples had 53 to 79 percent clay- and silt-size particles (passing the number 200 sieve) and one sample exhibited moderate plasticity. The clay contains both expansive and collapsible layers.

Sand

Clayey sand with clay layers and gravel was encountered between 13.5 to 14.5 feet and as deep as 19.5 feet below the ground surface. Two samples had 34 and 45 percent fines. The sand is considered non-expansive.

Groundwater

Groundwater was encountered during drilling in two holes at depths of about 23 and 28 feet below existing grades. Delayed water checks were obtained on September 7, 2021, and groundwater was encountered in four borings between 21.5 and 27.2 feet or approximate elevations from 5305 to 5308. Groundwater could be encountered in excavations extending with a few feet of the referenced depths and sub-excavation should be cut-off within 3 and preferably 5 feet above ground water depths. Groundwater levels may fluctuate seasonally and rise in response to development, precipitation, landscape irrigation, and changes in land-use.

GEOLOGIC HAZARDS

Colorado is a challenging location to practice geotechnical engineering. The climate is relatively dry, and the near-surface soils are typically dry and comparatively stiff. These soils and related sedimentary bedrock formations react to changes in moisture conditions. Some of the soils swell as they increase in moisture and are referred to as expansive soils. Other soils can compress significantly upon wetting and are identified as collapsible soils. Most of the land available for development east of the Front Range is underlain by expansive clay or claystone bedrock near the surface. The soils that exhibit collapsible behavior are more likely west of the Continental Divide; however, both types of soils occur throughout the state.

Covering the ground with buildings, flatwork, pavements, landscaping, etc., coupled with landscape irrigation and changing drainage patterns, leads to an increase in subsurface moisture conditions. As a result, some soil movement due to heave or settlement is inevitable. Expansive and collapsible soil and existing fill are present at this site which constitute geologic hazards. There is risk that foundations and slab-on-grade floors will experience heave and subsequent damage. It is critical that precautions are taken to increase the chances that foundations and slabs-on-grade will perform satisfactorily. Engineered design of grading, pavements, foundations, slabs-on-grade, and drainage can mitigate, but not eliminate, the effects of expansive and collapsible soils. Sub-excavation is a ground improvement method to reduce potential heave and settlement and provide more uniform support of shallow lightly-loaded foundations and slab-on-grade floors.

Seismicity

The soil and bedrock are not expected to respond unusually to seismic activity. According to the 2018 International Residential Code (IRC, Standard Penetration Resistance method of Chapter 16), and based upon the results of our investigation, we judge the site classifies as Seismic Site Class D.

Radioactivity

It is normal in the Front Range of Colorado and nearby eastern plains area to measure radon gas in poorly ventilated spaces (e.g., full-depth residential basements or crawl spaces) in contact with soil or bedrock. Radon 222 gas is considered a health hazard and is just one of several radioactive products in the chain of the natural decay of uranium into lead. Radioactive nuclides are common in the soil and bedrock underlying the subject site. Because these sources exist or will exist on most sites in the area, there is a potential for radon gas accumulation in poorly ventilated spaces. The concentration of radon that can develop is a function of many factors, including the radionuclide activity of the soil and bedrock, construction methods and materials, soil gas pathways, and accumulation areas. The only reliable method to determine if a hazard exists is to perform radon testing of completed residential structures. Typical mitigation methods consist of sealing soil gas entry areas, ventilation of below-grade spaces, and venting from foundation drain systems. We recommend provisions for ventilation of foundation drain systems to allow venting if a radon problem is discovered.

Other Considerations

From a geotechnical perspective, erosion potential is considered low based on the materials encountered. Erosion potential is a function of materials, ground surface slope, and surface runoff exposure. Uncontrolled and concentrated surface runoff has the potential to create damaging erosion. Erosion potential will increase during construction but should return to pre-construction rates or less if proper grading practices, surface drainage design, and re-vegetation efforts are implemented. Construction sites within the Denver Metropolitan area are subject to the U.S. Environmental Protection Agency (EPA) regulations regarding the control of storm water discharge and soil erosion.

We saw no evidence of unstable slopes on the site due to the relatively gentle slopes present across the site. Development will increase the relative amount of impervious surfaces, which can lead to drainage problems and erosion if surface water flow is not adequately designed. Surface drainage design and evaluation of flood potential and erosion should be performed by a civil engineer as part of the project design.

ESTIMATED POTENTIAL HEAVE

Grading plans were not available during this investigation. We should review grading plans once they are available to assess potential changes to the following estimates. We estimate total potential ground heave may range from less than 1 inch to 6 inches based on a 24-foot depth of wetting, which is considered typical for this type of construction and geologic setting (multi-family with landscape irrigation). If plans change, we should be contacted to revise our assumptions. Potential ground heave is summarized in the table below.

Potential Ground Heave - Estimate (inches) Based on 24-ft Depth of Wetting	
TH-1	3 ½
TH-2	2 ½
TH-3	1 ½
TH-4	2
TH-5	5 ¾
TH-6	1

We judge there is low to high risk of potential damage to structures and improvements due to expansive soils. Ground improvement through sub-excavation is a technique used to reduce potential heave and provide more uniform support conditions; sub-excavation is discussed in the following section.

DEVELOPMENT CONSIDERATIONS

The site is judged suitable for development as currently planned. The primary geotechnical concern is the presence of expansive and collapsible soils and possible existing fill. We believe these concerns can be mitigated with proper planning, engineering, design, and construction. No geotechnical constraints were identified that would preclude development. The recommendations are based on widely spaced borings. Variations in subsurface condition from our borings are possible.

Existing Fill

We encountered existing fill in one exploratory boring located in the southeastern corner of the site. It is probable that existing fill is present across the site at varying depths, and specifically on the eastern edge of property where previous construction activity was seen in historical aerials. Existing fill (where present) is considered unsuitable to support improvements and should be removed and replaced as moisture conditioned, compacted fill. Utilities, structural elements, slabs, and other debris should be removed and replaced with moisture-conditioned, compacted fill, where/if encountered.

Excavation

We believe the soils encountered in our exploratory borings can be excavated with conventional, heavy-duty excavation equipment. We recommend the owner and contractors become familiar with applicable local, state, and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards. We believe the clay will classify as Type B soil and the sand will classify as Type C. Type B and C soils require maximum slope inclinations of 1:1 (horizontal:vertical) and 1½:1 for temporary excavations in dry conditions, respectively. Flatter slopes will be required where seepage is present (if any).

Excavation slopes specified by OSHA are dependent upon soil type and groundwater conditions encountered. The contractor's "competent person" is required to review excavation conditions and refer to OSHA standards to determine appropriate slopes. Subcontractors should be familiar with these regulations and take whatever precautions they deem necessary to comply with the requirements. Stockpiles of soils and equipment should not be placed within a horizontal distance equal to the excavation depth from the edge of an excavation.

Site Grading

We believe grading can be accomplished using conventional heavy-duty construction equipment. The ground surface in areas to be filled should be stripped of vegetation, scarified, and moisture-conditioned between 1 and 4 percent above optimum for clay or within 2 percent of optimum for sand, and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698).

The properties of fill will affect the performance of foundations, slabs-on-grade, utilities, pavements, flatwork and other improvements. The on-site soils are suitable for use as site grading fill provided they are substantially free of debris, organics and other deleterious materials. Fill should be placed in thin loose lifts, moisture-conditioned and compacted prior to placement of the next lift using the criteria presented in the previous paragraph. The placement and compaction of site grading fill should be observed and tested by our representative during construction. Guideline Site Grading Specifications are presented in Appendix C and should be strictly followed.

Our experience indicates fill and backfill can settle, even if properly compacted to criteria provided above. Factors that influence the amount of settlement are depth of fill, material type, degree of compaction, amount of wetting and time. The degree of compression of fill under its own weight will likely range from low for granular soils (½ percent or less), to moderate for clay/sand mixtures (1 to 2 percent).

Sub-Excavation

We encountered expansive and collapsible soil at depths likely to influence performance of shallow foundations and slabs-on-grade. We estimated potential heave at the existing ground surface could range up to about 6 inches. Long and heavily-reinforced drilled piers and structurally supported basement floors are used for sites with significant potential heave unless sub-excavation is performed. Sub-excavation can be performed to reduce the impacts of expansive and collapsible soil and to provide a more uniform subgrade for shallow foundations.

Sub-excavation is recommended for all residences to a depth of at least 12 feet below existing grade, 5 feet below basement foundations, or 10 feet below non-basement foundation elements, whichever is deeper. Additional drilling, sampling, and testing may indicate that less sub-excavation is necessary. Sub-excavation should not extend deeper than about elevation 5312 as the soils at that level become softer due to groundwater influence. Sub-excavation should also extend at least 5 feet laterally outside foundations. A conceptual sub-excavation profile is presented on Fig. 2.

Sub-excavation may be limited by adjacent structures and property lines. Where sub-excavations cannot fit within the property boundaries or where they could undermine existing structures, deep foundations without sub-excavation may be merited. The feasibility of practical sub-excavation extents should be evaluated by a civil engineer. Shifting buildings to allow for sub-excavation may be a prudent choice. We should review the site civil plans including the sub-excavation grading plan when they become available.

The excavation contractor should be chosen carefully to assure they have experience with fill placement at over-optimum moisture and have the necessary compaction equipment. Sub-excavation fill (clay) should be moisture-conditioned between 1 and 4 percent above optimum moisture content. Sand fill should be placed within 2 percent of optimum. Fill should be compacted to at least 95 percent of standard Proctor maximum dry density. Guideline Sub-Excavation Specifications are provided in Appendix D.

Special precautions should be taken for compaction of fill at corners, access ramps, and along the perimeters of the sub-excavation as large compaction equipment cannot easily reach these areas. We recommend a surveyor document the actual limits of the treatment, and create "as-built" plans. These plans should be provided to the civil/surveyor so that they can verify that each building is over the treated area. The "treated area" stops at the toe of the deep sub-excavation slope.

Our representative should observe placement procedures and test compaction of the fill on a nearly full-time basis. The swell of the moisture-conditioned fill should be tested during and after the fill placement.

Sub-excavation has been used in the Denver area with satisfactory performance for the majority of the sites where this ground modification method has been completed. We have seen isolated instances where settlement of sub-excavation fill has led to damage to lots supported on footings. In most cases, the settlement was caused by wetting associated with poor surface drainage, and/or poorly compacted fill placed at the horizontal limits of the excavation. Wetting of the fill may cause softening and settlement.

Sub-excavation typically allows the use of shallow foundations at about 95 percent of the lots where it is performed. Based on the design-level Soils and Foundation Investigations, we anticipate that shallow foundations can be used on about 95 percent of the lots. For the remaining 5 percent of the lots, we suggest budgeting for additional sub-excavation or the use of deep foundations. This 5 percent has been found to occur due to (1) poorly moisture-treated and processed fill, (2) improper sub-excavation limits, or (3) discovery of unanticipated subsurface conditions below the fill.

If the fill dries excessively prior to construction, it may be necessary to rework the upper drier materials just prior to constructing foundations. We judge the fill should retain adequate moisture for about two or three years and can check moisture conditions in each excavation as construction progresses, if requested.

Stabilization

If loose or soft soils are encountered in excavations during construction, they should be removed and replaced with compacted fill as recommended above or stabilized. Stabilization can likely be accomplished by crowding 1.5-inch to 3-inch nominal size crushed rock into the soft subsoils until the base of the excavation does not deform more than about 1 inch when compactive effort (a full-sized loader with full load) is applied. Acceptable rock material includes, but is not limited to, No. 2 and No. 57 rock. Geotextile fabric or geogrid may be used to help stabilization and will likely reduce the amount of rock needed to achieve stable subgrade.

Utilities

Water and sewer lines are often constructed beneath slabs and pavements. Compaction of utility trench backfill can have a significant effect on the life and serviceability of floor slabs, exterior flatwork, and pavements. We recommend utility trench backfill be placed in thin, loose lifts, (6-inches or less) and moisture-conditioned and compacted according to the specifications presented previously. Utility installation may require street cuts, and the new pavements should match the existing sections. The placement and compaction of utility trench backfill should be observed and tested by a representative of our firm during construction.

Pavements

Pavement areas will be used as access drives, parking lots, and truck/fire lanes. Near-surface soils consist of expansive clay and sand (or fill with similar composition) with moderate plasticity. The samples classify as A-6 to A-7-6 according to the American Association of State Highway Transportation Officials (ASHTO), which is considered fair to poor subgrade support material.

Based on the swell and plasticity of the subgrade along with the City of Aurora requirements, the pavement subgrade should be sub-excavated and moisture treated to a depth of 2 ½ feet below the pavement structure. The sub-excavation should extend to the back of the curb or attached sidewalk, if present. The sub-excavation should be filled in accordance with the criteria presented in “Site Grading” except that the fill should moisture-conditioned to 4 to 6 percent above optimum moisture content, per Aurora requirements.

For highly expansive subgrade environments with swell values exceeding 5.0 percent, the City of Aurora requires the upper 1-foot of the pavement subgrade to be chemically or mechanically stabilized. Chemical treatment may consist of lime, cement, fly-ash, or a combination thereof. Mechanical treatment may consist of an additional 12 inches of aggregate with geogrid. Limited data indicates that chemical or mechanical treatment may or may not be necessary.

Based on methodology in City of Aurora specifications, the soils classify as Soil Group D or E. This material is considered to be fair to poor subgrade. We judge the City of Aurora “Default” pavement sections will likely be necessary. The following table provides pavement alternatives (Table 5.01.2.03.1, Private Pavement Default Sections, City of Aurora Roadway Design & Construction Specifications, October 2016). Using Soil Group E, a conservative approach, and assuming the project is multi-family residential with private streets, at least 6 inches of asphalt or an equivalent composite section of 4 inches of asphalt over 8 inches of aggregate base course will be needed. If the pavements will be public, it should be noted that full depth asphalt sections are not allowed. For planning purposes, thicker sections should be considered. A design-level subgrade investigation should be done prior to paving.

Table 5.01.2.03.1
PRIVATE PAVEMENT DEFAULT SECTIONS[1]
PRIVATE STREET OR DRIVE

	Single-Family Residential	Multifamily Residential	Commercial and Business	Industrial
Minimum ESAL ($X10^6$)	0.06	0.07	0.2	0.7
SOIL GROUP "A" A-1 thru A-5 (R-Value)				
Full Depth Asphalt	5.0"	5.0"	5.0"	5.0"
AC and Aggregate Base	3.5" + 6.0"	3.5" + 6.0"	3.5" + 6.0"	3.5" + 6.0"
PCC	6.0"	6.0"	6.0"	6.0"
SOIL GROUP "B" A-2 thru A-5 (CBR)				
Full Depth Asphalt	5.0"	5.0"	5.0"	5.5"
AC and Aggregate Base	3.5" + 6.0"	3.5" + 6.0"	3.5" + 6.0"	4.0" + 6.0"
PCC	6.0"	6.0"	6.0"	6.0"
SOIL GROUP "C" [2] A-2-4 & A-2-6 (Q_U)				
Full Depth Asphalt	5.0"	5.0"	5.0"	5.0"
AC and Aggregate Base	3.5" + 6.0"	3.5" + 6.0"	3.5" + 6.0"	3.5" + 6.0"
PCC	6.0"	6.0"	6.0"	6.0"
SOIL GROUP "D" [2] A-6 (Q_U)				
Full Depth Asphalt	5.0"	5.0"	5.5"	6.5"
AC and Aggregate Base	3.5" + 6.0"	3.5" + 6.0"	4.0" + 6.0"	4.0" + 8.0'
PCC	6.0"	6.0"	6.0"	6.0"
SOIL GROUP "E" [2] A-7-6 (Q_U)				
Full Depth Asphalt	5.5"	6.0"	7.0"	8.5"
AC and Aggregate Base	4.0" + 6.0"	4.0" + 8.0'	5.0" + 8.0"	5.0" + 12.5"
PCC	6.0"	6.0"	6.0"	6.0"

BUILDING CONSTRUCTION CONSIDERATIONS

The following discussions are preliminary and are not intended for design or construction. A design-level investigation should be performed after sub-excavation and overlot grading are complete.

Foundations and Slab-On-Grade Floors

Shallow foundations will likely be suitable after sub-excavation on about 95 percent of the lots where it is performed. On a preliminary basis, we prefer that shallow foundations consist of post-tensioned slabs-on-grade for structures with no basements. Footings designed to maintain minimum deadload are probable for structures with basements and may also be a foundation choice for non-basement structures; however, footings typically provide less resistance to potential heave than post-tensioned slabs-on-grade for non-basement structures. We anticipate allowable soil pressures on the order of 2,000 to 3,000 psf for foundation subgrade comprised of fills made up of on-site soils. The ranges presented above are for planning purposes only, additional borings will be necessary to provide actual design parameters. For the 5 percent of lots where sub-excavation could be unsuccessful, we foresee foundation solutions consisting of shallow foundations after additional sub-excavation or deep foundations without additional sub-excavation.

Sub-excavations may not be feasible for the buildings along the property edges because excavation slopes could propagate offsite and possibly impacting neighboring properties and residences. Deep foundations should be planned for these residences. Deep foundations could consist of helical piles, short friction piers, or very long drilled piers bottomed in bedrock. Drilled piers bottomed in bedrock may not be a viable option as bedrock was not encountered during this investigation; we suspect pier lengths of at least 35 to 45 feet. Shorter friction piers bottomed in soil may be practical at some locations; we anticipate pier lengths of 20 to 25 feet for short friction piers. Preliminary data implies that casing will likely be necessary to construct drilled pier foundations.

Floor Systems and Slabs-on-Grade

Structurally supported floors are recommended in all first floor finished living areas for structures with or without basements. Slab-on-grade floors can be used in basements where the risk of poor performance is judged to be low and the buyer is willing to tolerate about 1 to 2 inches of slab heave and the associated damage. There will likely be low risk of poor slab-on-grade basement floor performance, provided they are constructed on sub-excavated fill. The risk of poor slab-on-grade basement floor performance will probably be moderate to high if sub-excavation is not performed. The choice of basement floor support systems should depend on the buyer's tolerance for movement. Structurally supported floors should be used in basements with high risk of poor performance and where about 1 to 2 inches of movement is not acceptable.

Slabs-on-grade can be used in garages provided that heave related damage from 1 to 2 inches of movement after sub-excavation is acceptable. If deep sub-excavation is not performed to allow use of shallow foundations, we recommend at least 5 feet of sub-excavation below garage slabs to enhance performance. Deeper sub-excavation than 5 feet is preferable where site constraints will allow for the sub-excavation slopes to be laid back safely within the property boundaries.

Below-Grade Construction

If basements or below-grade areas are used, foundation drains will be necessary around all below-grade areas, with a piped connection to sump(s) where water can be removed by pumping, or appropriate storm sewer outfall. If no below-grade areas are included, perimeter foundation drains are will only be required in crawl spaces.

Surface Drainage

Performance of foundations, concrete flatwork and pavements is influenced by the moisture conditions existing within the foundation or subgrade soils. It will be necessary to design and construct surface grades, landscaping and roof drains to avoid excessive wetting near foundations. Pavement grading and drainage should also be planned to remove water efficiently and avoid excessive wetting of subgrade soils.

RECOMMENDED FUTURE INVESTIGATIONS

We recommend the following investigations and services:

1. Additional drilling and sampling to further evaluate expansive and collapsible soil and delineate bedrock depths if drilled piers are necessary;

2. Review of sub-excavation and grading plans, once available;

3. Construction testing and observation during site development, and building and pavement construction; including compaction testing of sub-excavation fill, site grading fill, utility trench backfill, and pavements;

4. Subgrade investigation and pavement design after grading;

5. Design-level Soils and Foundation Investigations after grading/sub-excavation; and

6. Foundation installation observations.

GEOTECHNICAL RISK

The concept of risk is an important aspect with any geotechnical evaluation primarily because the methods used to develop geotechnical recommendations do not comprise an exact science. We never have complete knowledge of subsurface conditions. Our analysis must be tempered with engineering judgment and experience. Therefore, the recommendations presented in any geotechnical evaluation should not be considered risk-free. Our recommendations represent our judgment of those measures that are necessary to increase the chances that the structures will perform satisfactorily. It is critical that all recommendations in this report are followed during construction.

LIMITATIONS

Our borings were limited in number and spacing across the site. The borings provide a general indication of subsurface conditions for preliminary assessment and planning of site development and building construction. More borings would be beneficial to verify the estimated sub-excavation limits and depths below residences and pavements. The borings are representative of conditions encountered only at the exact boring locations. Variations not indicated by our borings are probable.

This report is based on the referenced concept plans provided by the client. If plans change, the contents of this report including our opinions may be invalid. We should be contacted immediately if plans change to review the plans and determine if revisions to this report are necessary.

We believe this investigation was conducted in a manner consistent with the level of care and skill ordinarily used by geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report or analysis of the influence of subsurface conditions on the project, please call.

CTL | THOMPSON, INC.

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Reviewed By:

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Senior Geotechnical Engineer, Associate

Jan 4 2022 11:04 AM

via e-mail: chase.stillman@oreadcapital.com

VICINITY MAP
NOT TO SCALE

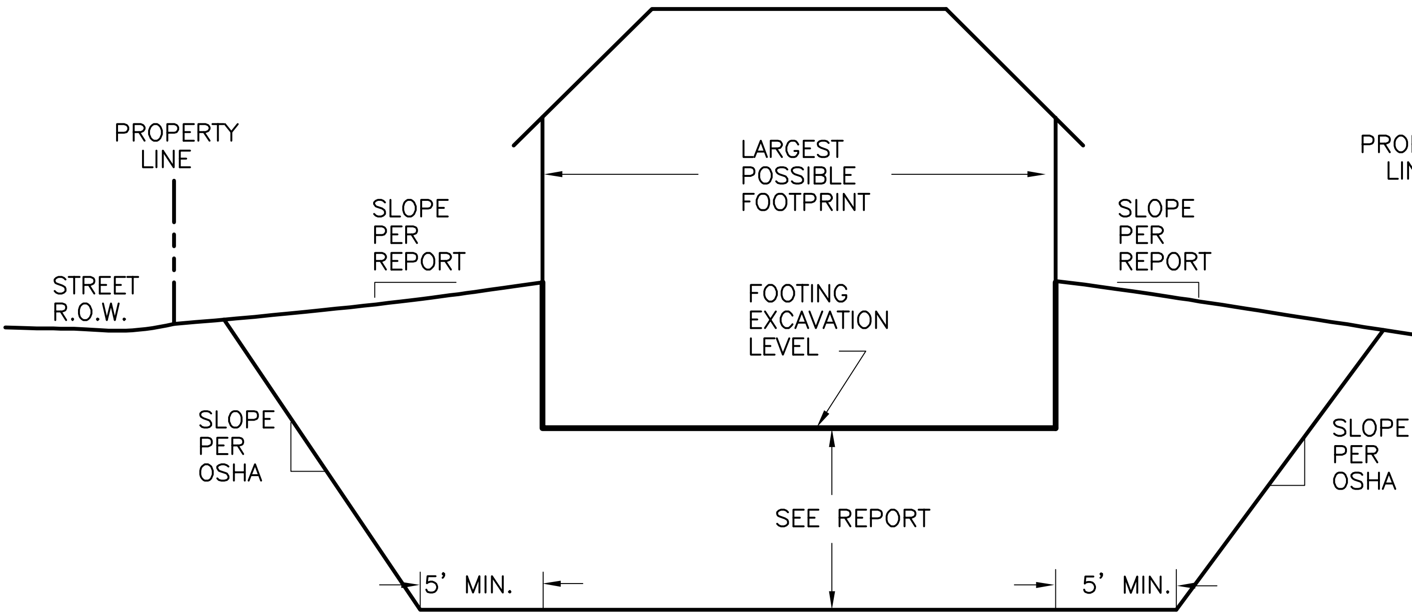
LEGEND:

TH-1 ● APPROXIMATE LOCATION OF EXPLORATORY BORING

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
CTL|T Project No. DN51,256-115-R1

Locations of Exploratory Borings

Fig. 1



NOT TO SCALE

95-SUB-EXCAVATION_01

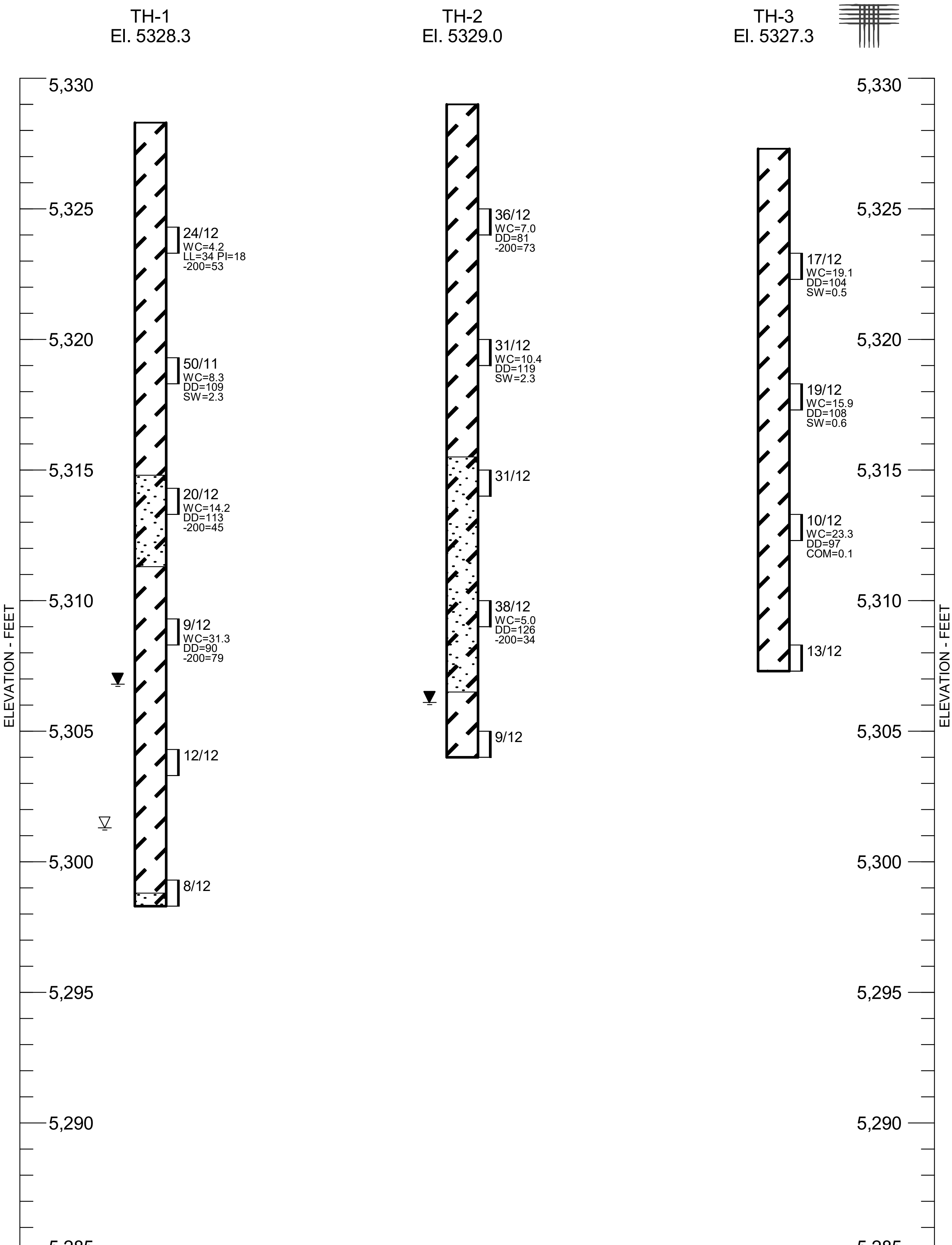
OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
CTL|T Project No. DN51,256-115-R1

Conceptual Sub-excavation Profile

Fig. 2

APPENDIX A

SUMMARY LOGS OF EXPLORATORY BORINGS



SUMMARY LOGS OF EXPLORATORY BORINGS

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
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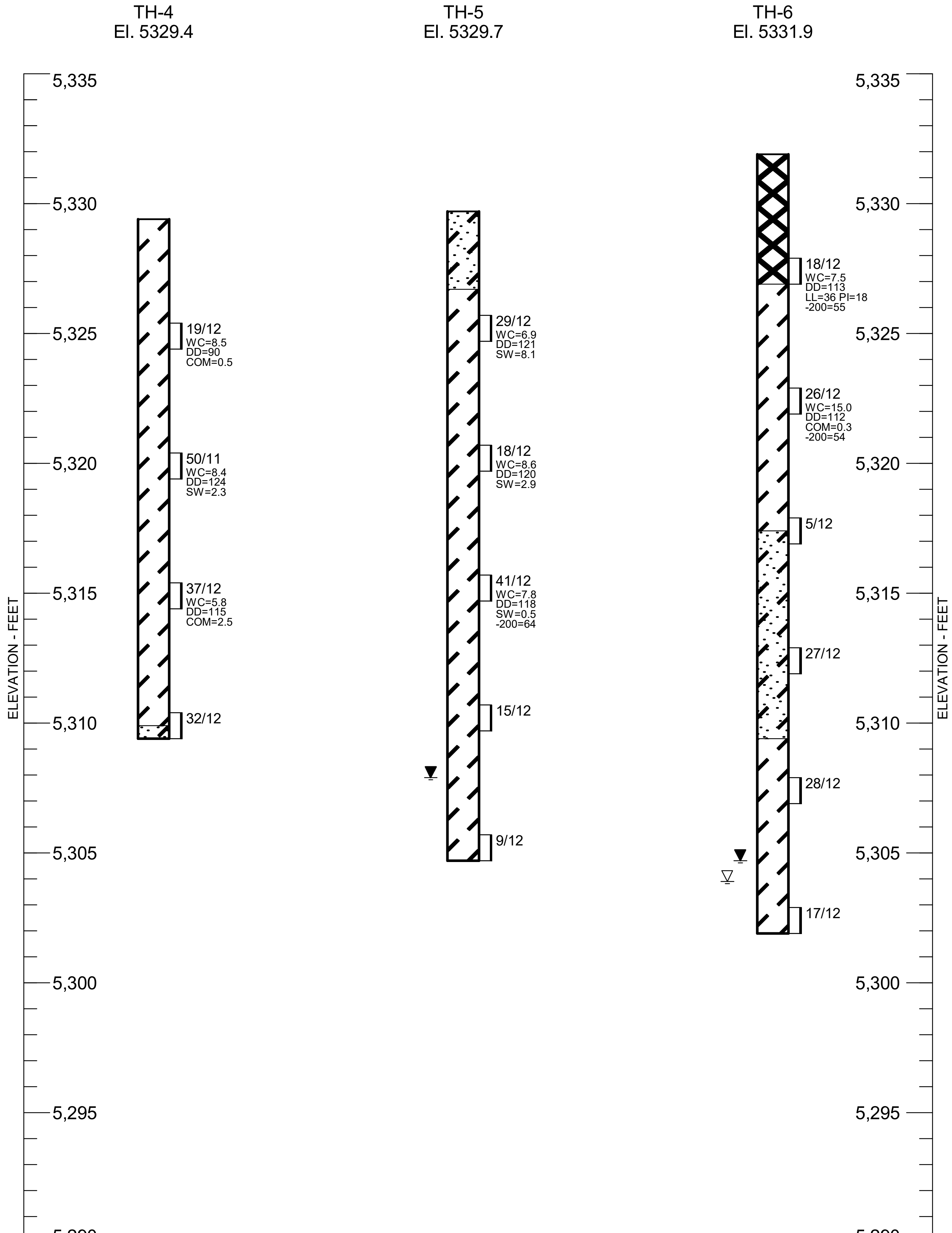
FIG. A- 1



SUMMARY LOGS OF EXPLORATORY BORINGS

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
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LEGEND:

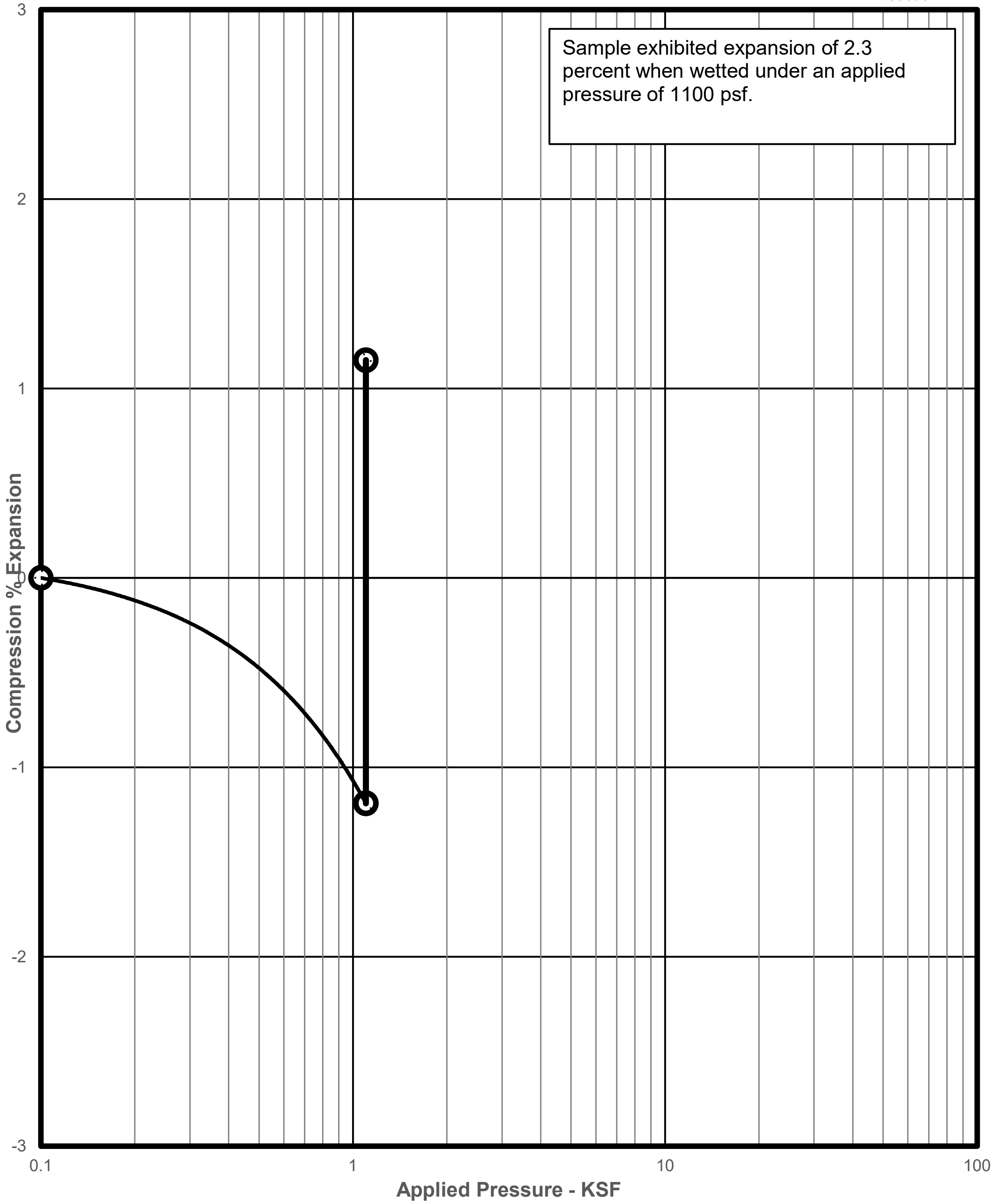
- FILL, CLAY, SANDY, VARIABLE GRAVEL CONTENT, STIFF, BROWN, DARK BROWN, GRAY.
- CLAY, SANDY, SILTY, GRAVELLY, SAND LAYERS, CALCAREOUS, STIFF TO VERY STIFF, SLIGHTLY MOIST TO WET, BROWN, GRAY, WHITE (CL).
- SAND, CLAYEY, CLAY LAYERS, GRAVELLY, MEDIUM DENSE, SLIGHTLY MOIST TO WET, BROWN, GRAY, OLIVE, TAN (SC, SM).
- DRIVE SAMPLE. THE SYMBOL 24/12 INDICATES 24 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.
- ▽ WATER LEVEL MEASURED AT TIME OF DRILLING.
- ▼ WATER LEVEL MEASURED AFTER DRILLING ON SEPTEMBER 7, 2021.

NOTES:

1. THE BORINGS WERE DRILLED ON SEPTEMBER 2, 2021 USING 4-INCH DIAMETER, CONTINUOUS-FLIGHT SOLID-STEM AUGER AND TRUCK-MOUNTED CME-45 DRILL RIG.
2. BORING LOCATIONS AND ELEVATIONS ARE APPROXIMATE AND WERE DETERMINED BY A REPRESENTATIVE OF OUR FIRM USING A LEICA GS18 GPS UNIT REFERENCING THE NORTH AMERICAN DATUM OF 1983 (NAD 83).
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.
   PI - INDICATES PLASTICITY INDEX.
   -200 - INDICATES PASSING NO. 200 SIEVE (%).
4. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS CONTAINED IN THIS REPORT.

FIG. A- 2

APPENDIX B
LABORATORY TEST RESULTS AND TABLE B-I



SAMPLE OF: CLAY, SANDY (CL)

FROM: TH-1 AT 9 FEET

DRY UNIT WEIGHT: 109 pcf

MOISTURE CONTENT: 8.3 %

OREAD CAPITAL AND DEVELOPMENT

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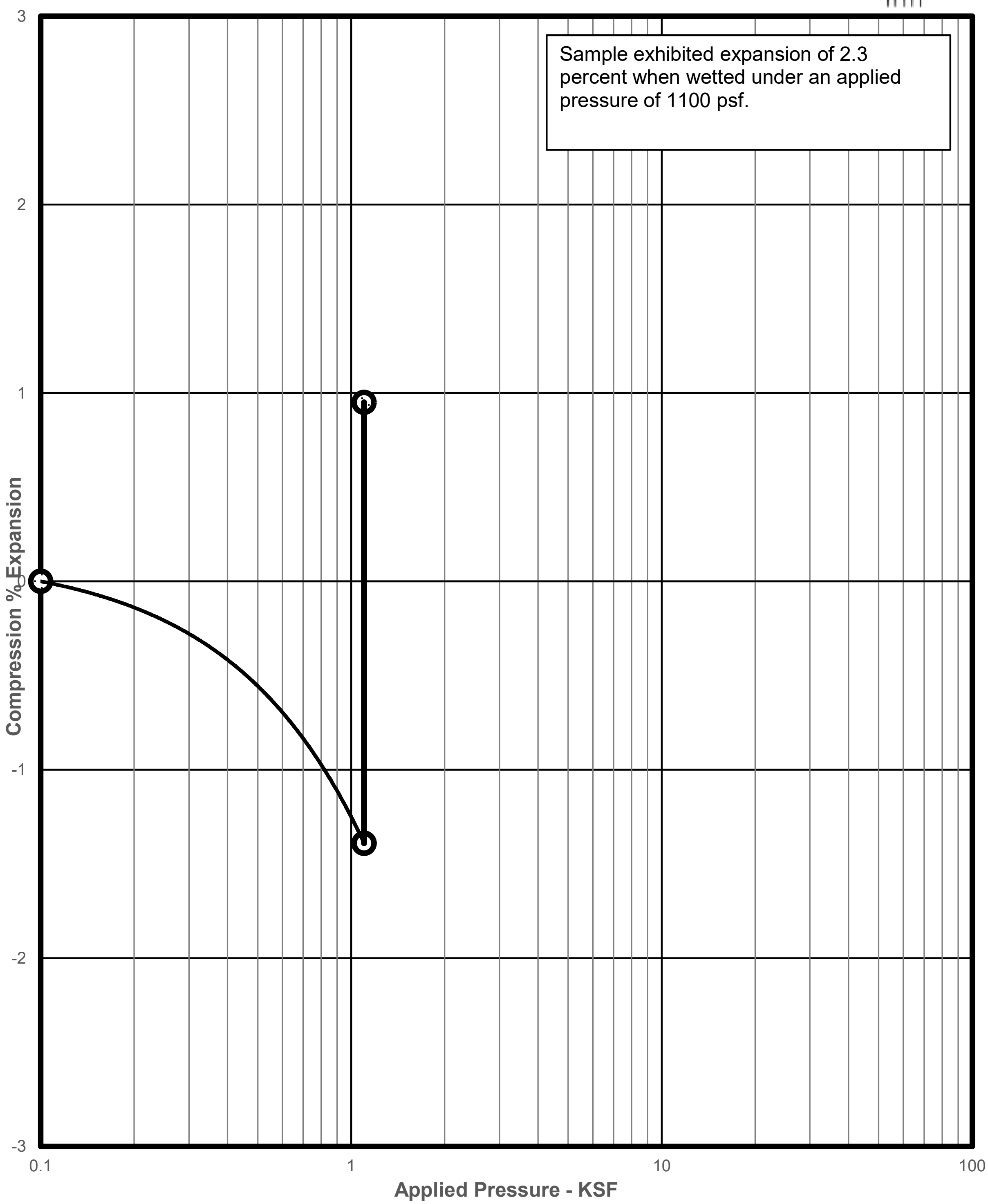
Swell Consolidation Test Results FIG. B- 1



SAMPLE OF: CLAY, SANDY (CL)

FROM: TH-2 AT 9 FEET

DRY UNIT WEIGHT: 119 pcf

MOISTURE CONTENT: 10.4 %

OREAD CAPITAL AND DEVELOPMENT

STANLEY SITE

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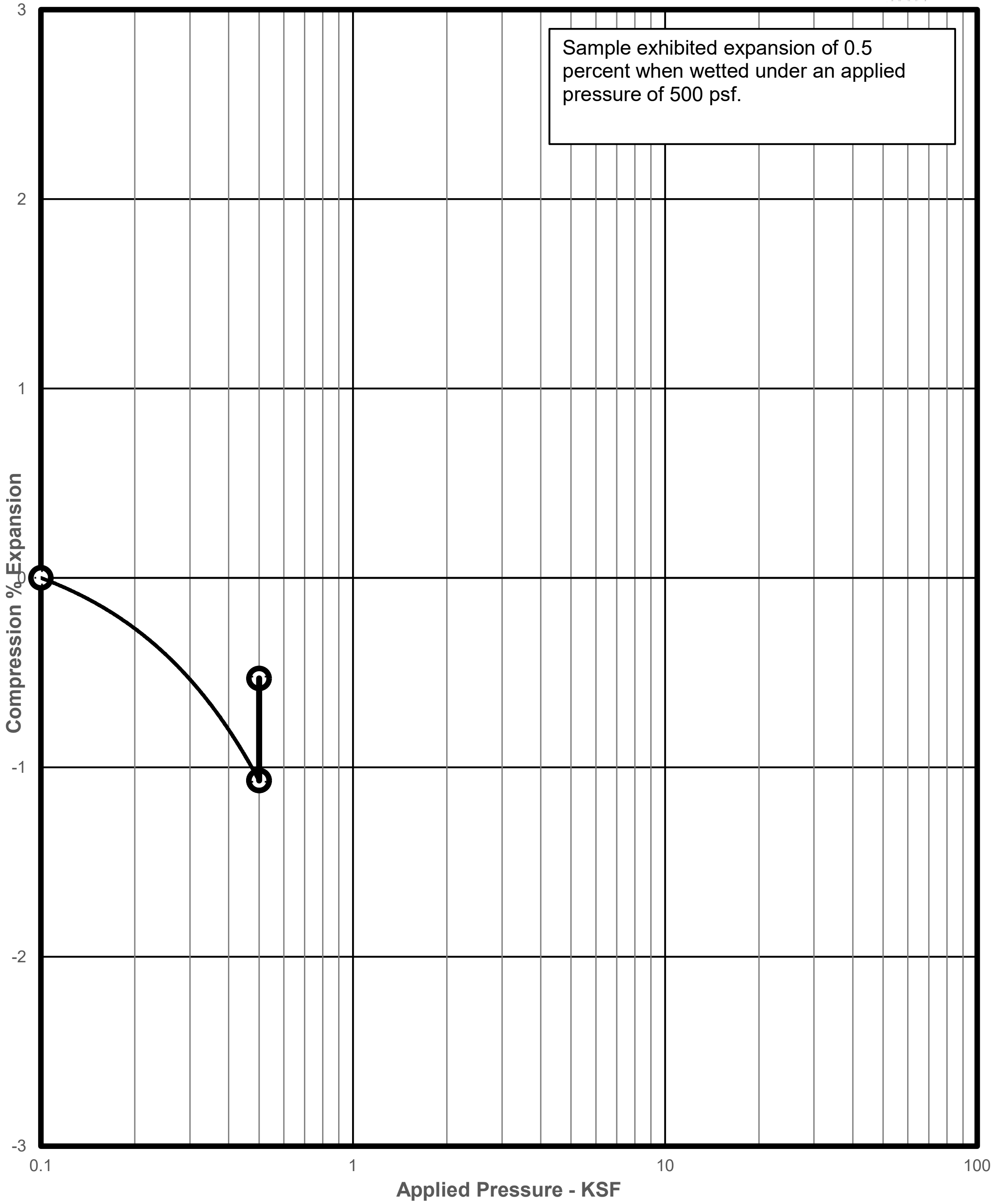
Swell Consolidation Test Results FIG. B- 2



SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-3 AT 4 FEET

DRY UNIT WEIGHT: 104 pcf
MOISTURE CONTENT: 19.1 %

OREAD CAPITAL AND DEVELOPMENT
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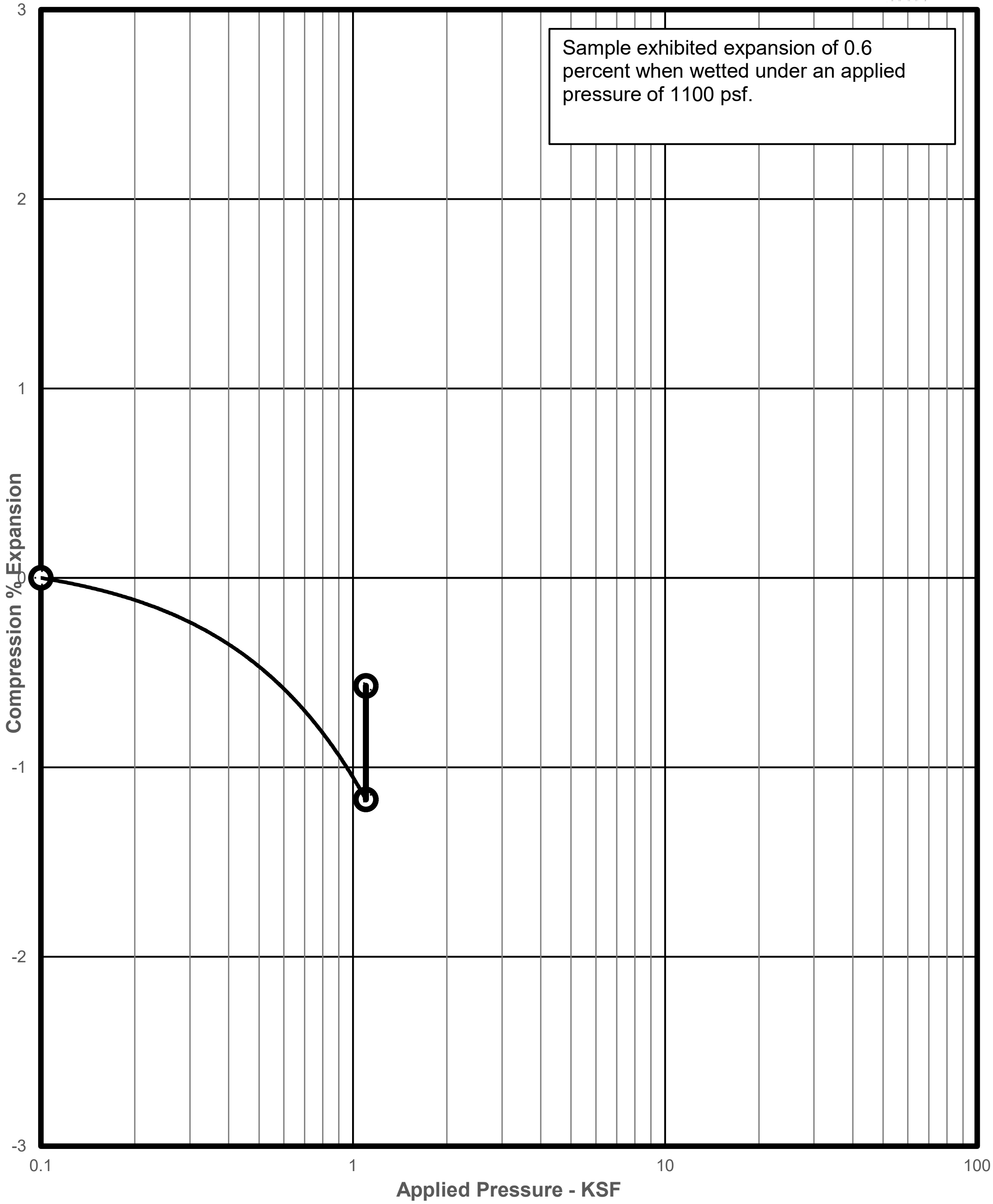
Swell Consolidation Test Results FIG. B- 3



SAMPLE OF: CLAY, SANDY (CL)

FROM: TH-3 AT 9 FEET

DRY UNIT WEIGHT: 108 pcf

MOISTURE CONTENT: 15.9 %

OREAD CAPITAL AND DEVELOPMENT

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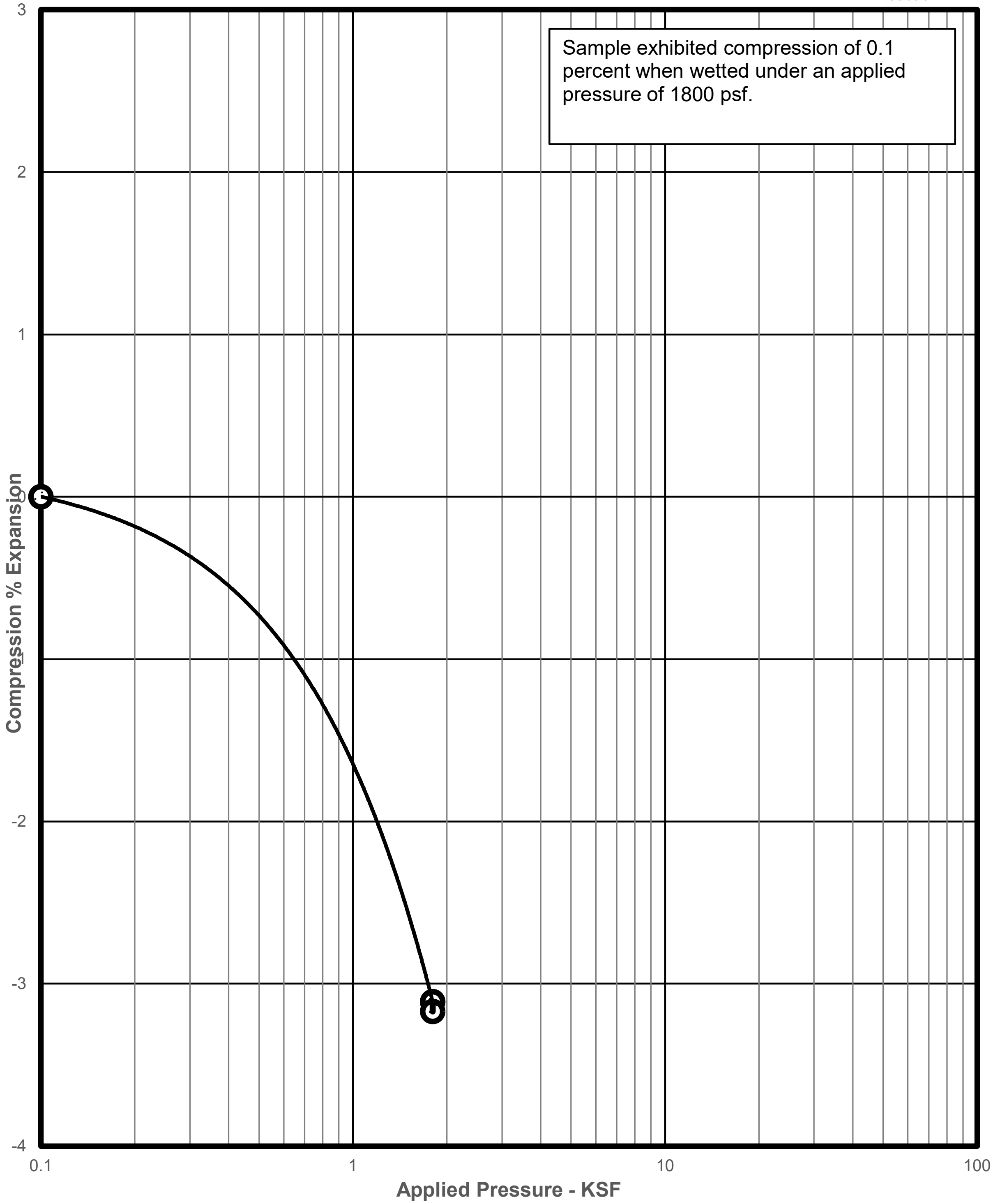
Swell Consolidation Test Results FIG. B- 4



SAMPLE OF: CLAY, SANDY (CL) DRY UNIT WEIGHT: 97 pcf
FROM: TH-3 AT 14 FEET MOISTURE CONTENT: 23.3 %

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
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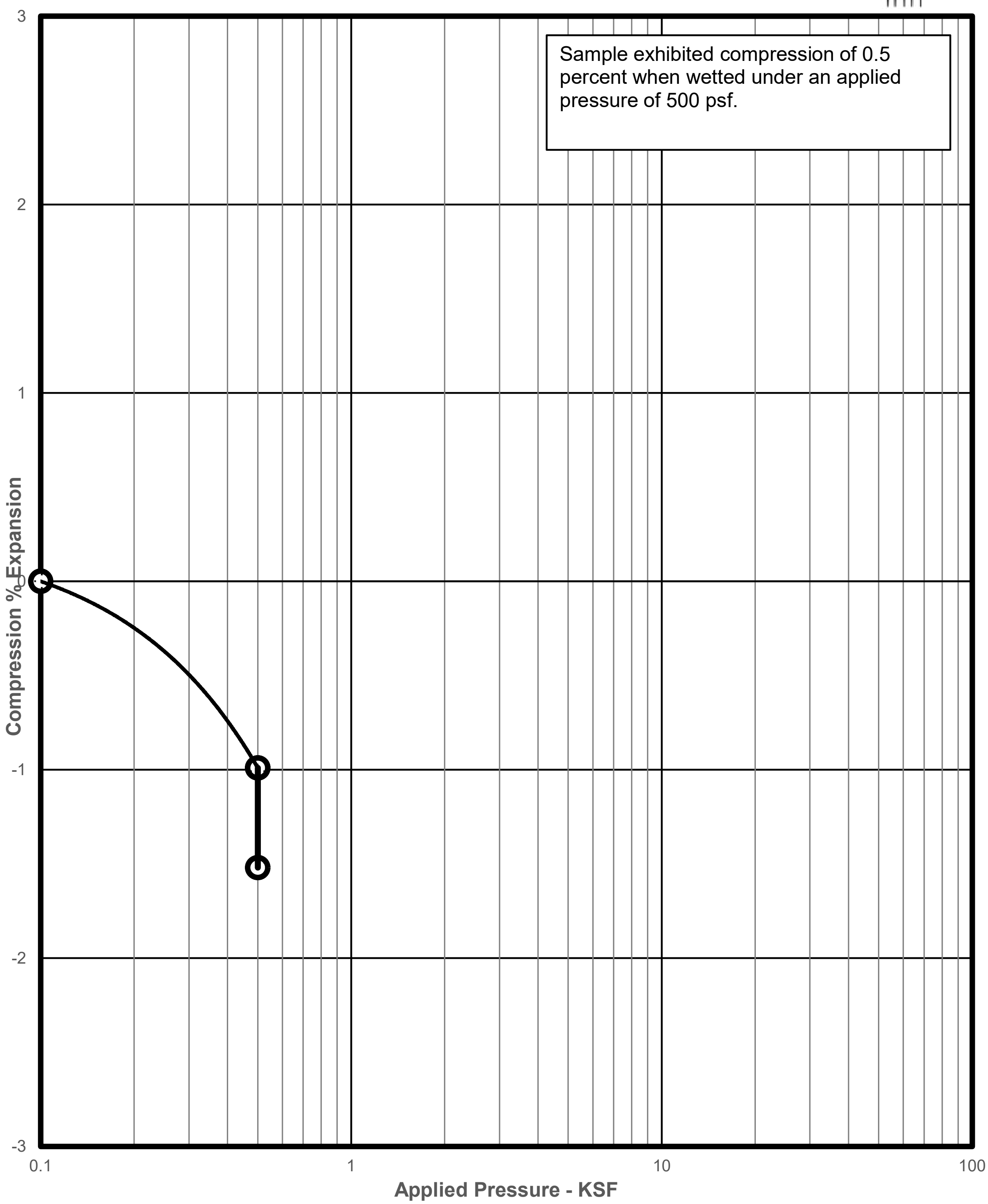
Swell Consolidation Test Results FIG. B- 5



SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-4 AT 4 FEET

DRY UNIT WEIGHT: 90 pcf
MOISTURE CONTENT: 8.5 %

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
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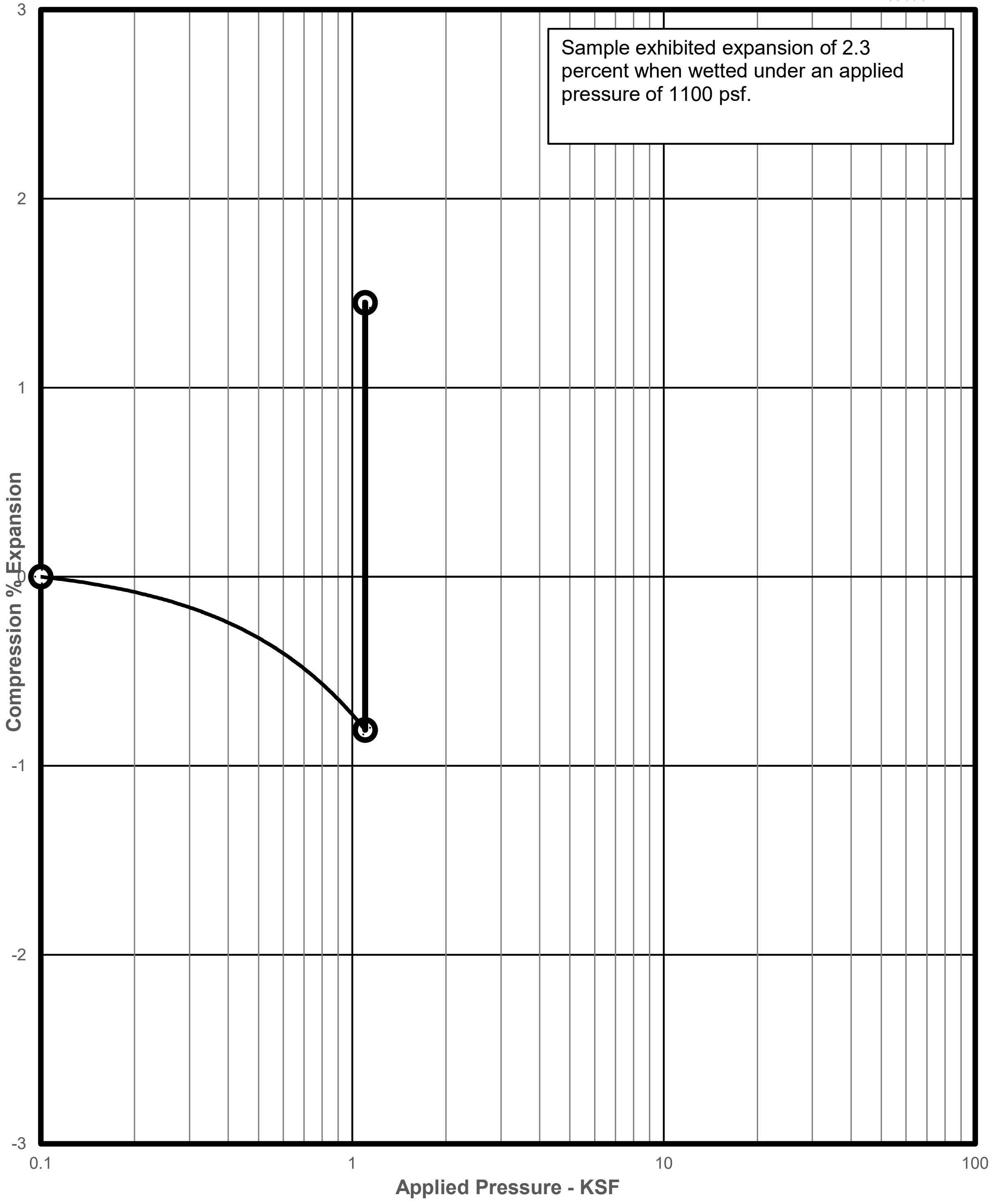
Swell Consolidation Test Results FIG. B- 6



SAMPLE OF: CLAY, SANDY (CL) DRY UNIT WEIGHT: 124 pcf

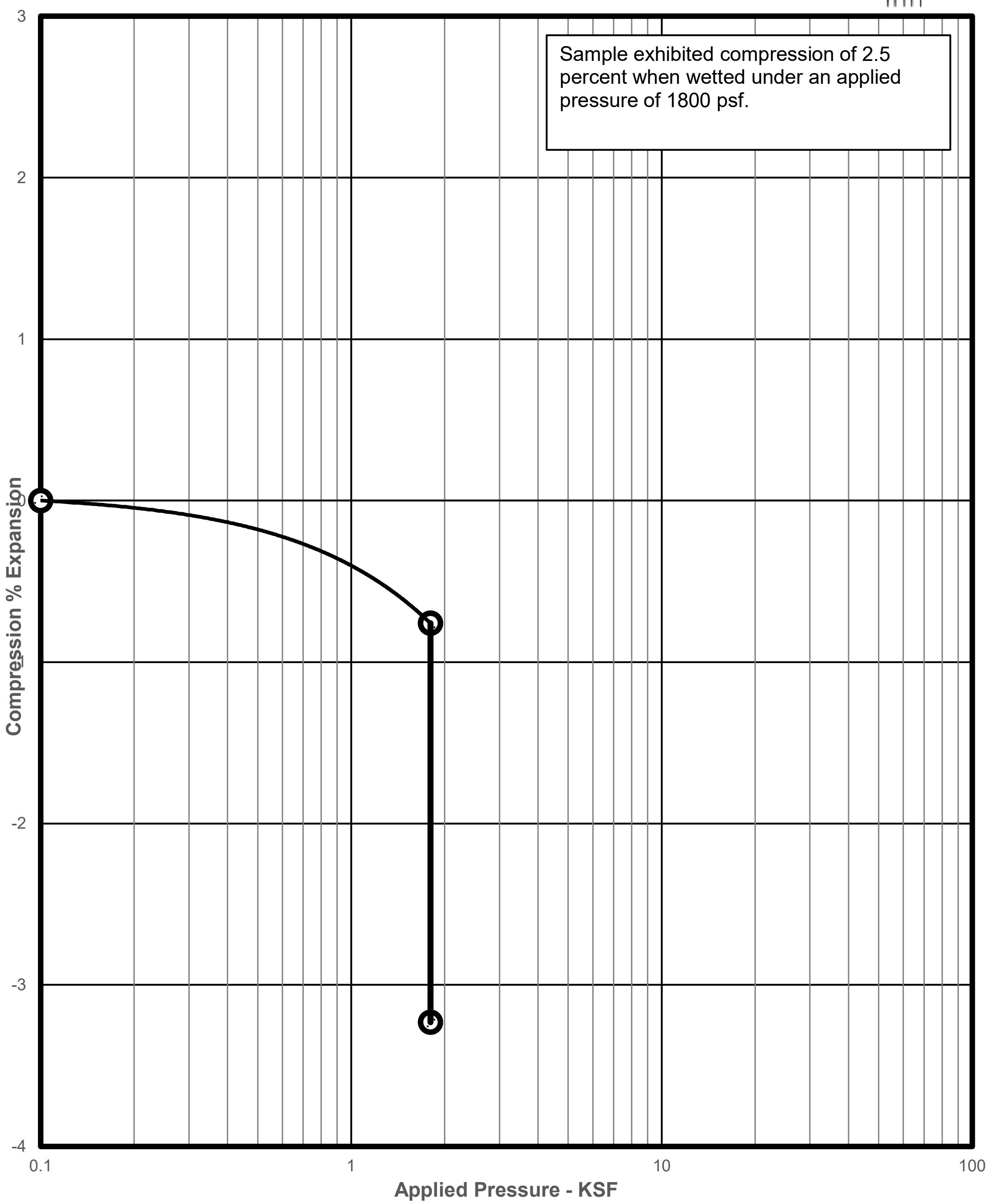
FROM: TH-4 AT 9 FEET MOISTURE CONTENT: 8.4 %

OREAD CAPITAL AND DEVELOPMENT

STANLEY SITE

CTL|T PROJECT NO. DN51,256-115-R1

Swell Consolidation Test Results FIG. B- 7



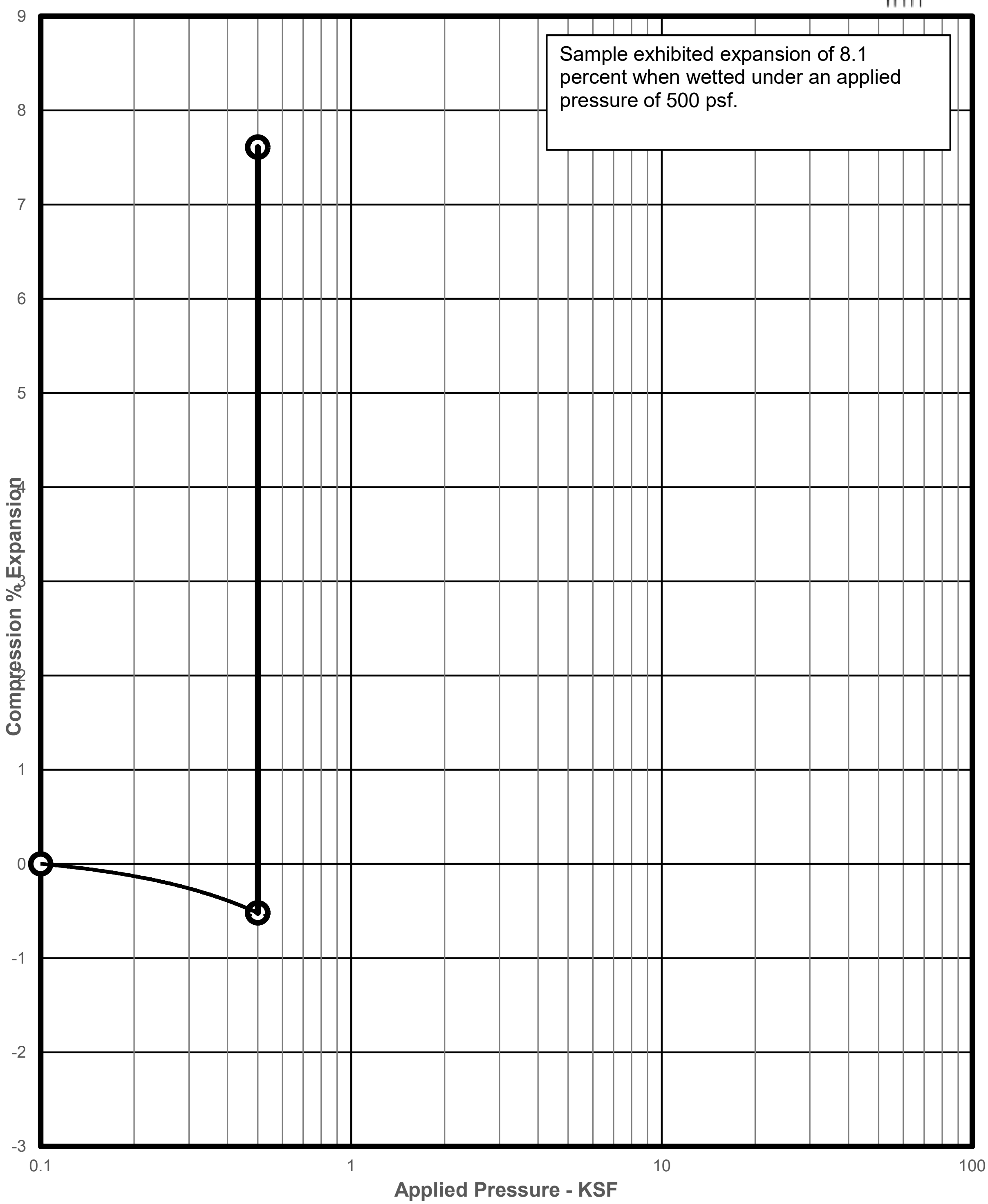
SAMPLE OF:	CLAY, SANDY (CL)	DRY UNIT WEIGHT:	115	pcf
FROM:	TH-4 AT 14 FEET	MOISTURE CONTENT:	5.8	%

OREAD CAPITAL AND DEVELOPMENT

STANLEY SITE

CTL|T PROJECT NO. DN51,256-115-R1

Swell Consolidation Test Results FIG. B- 8

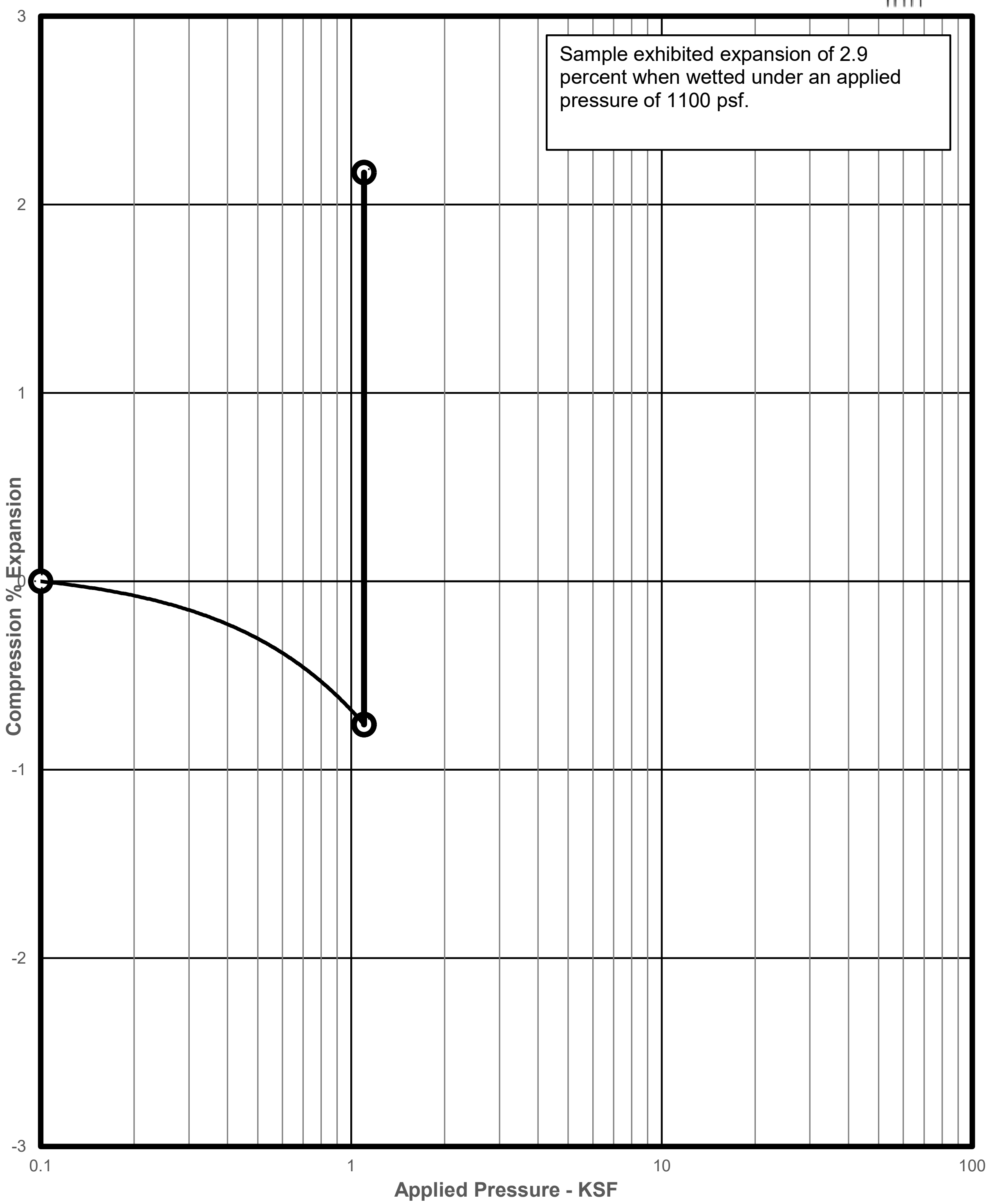


SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-5 AT 4 FEET

DRY UNIT WEIGHT: 121 pcf
MOISTURE CONTENT: 6.9 %

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
CTL|T PROJECT NO. DN51,256-115-R1

Swell Consolidation Test Results FIG. B- 9



SAMPLE OF:	CLAY, SANDY (CL)	DRY UNIT WEIGHT:	120	pcf
FROM:	TH-5 AT 9 FEET	MOISTURE CONTENT:	8.6	%

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
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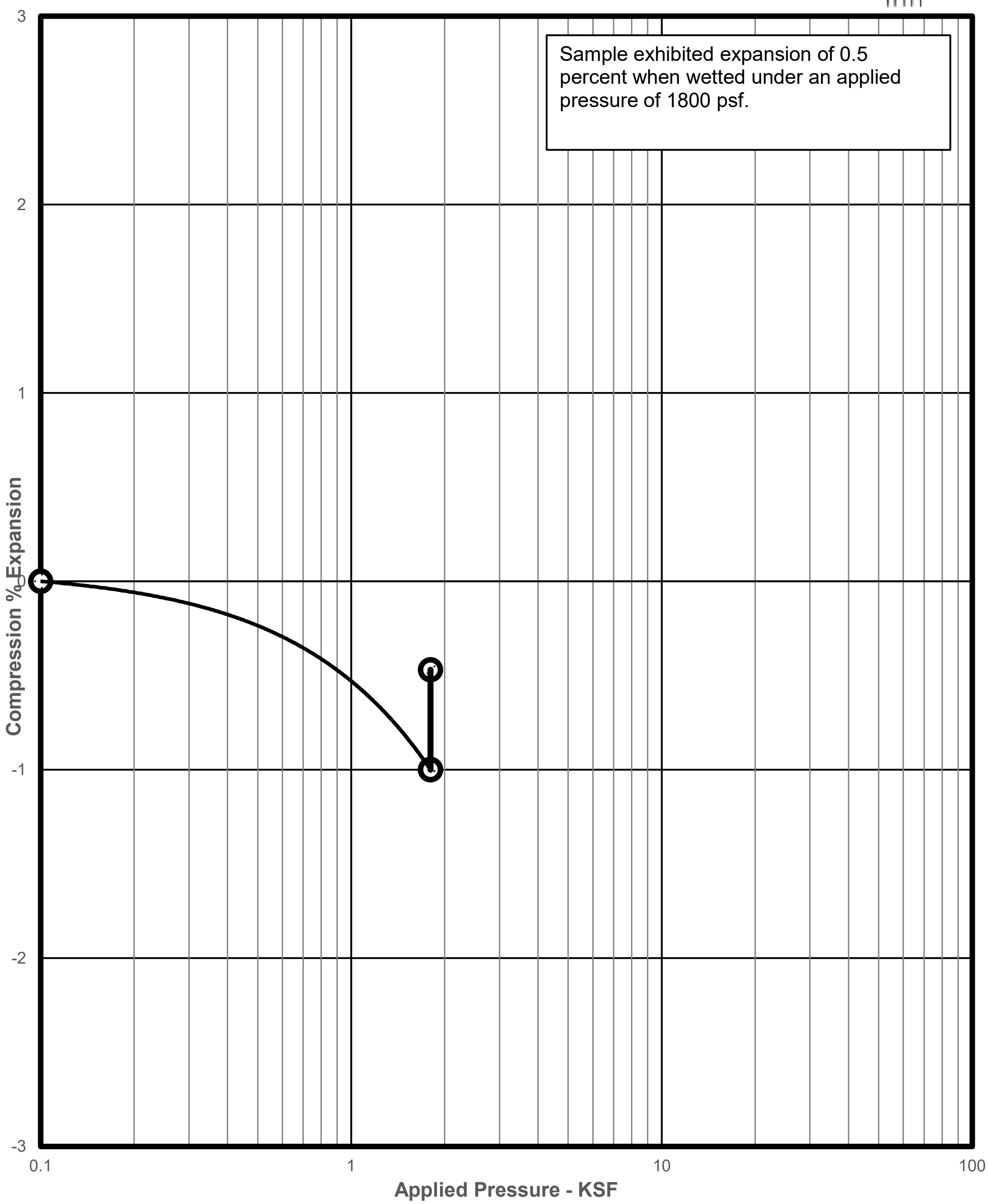
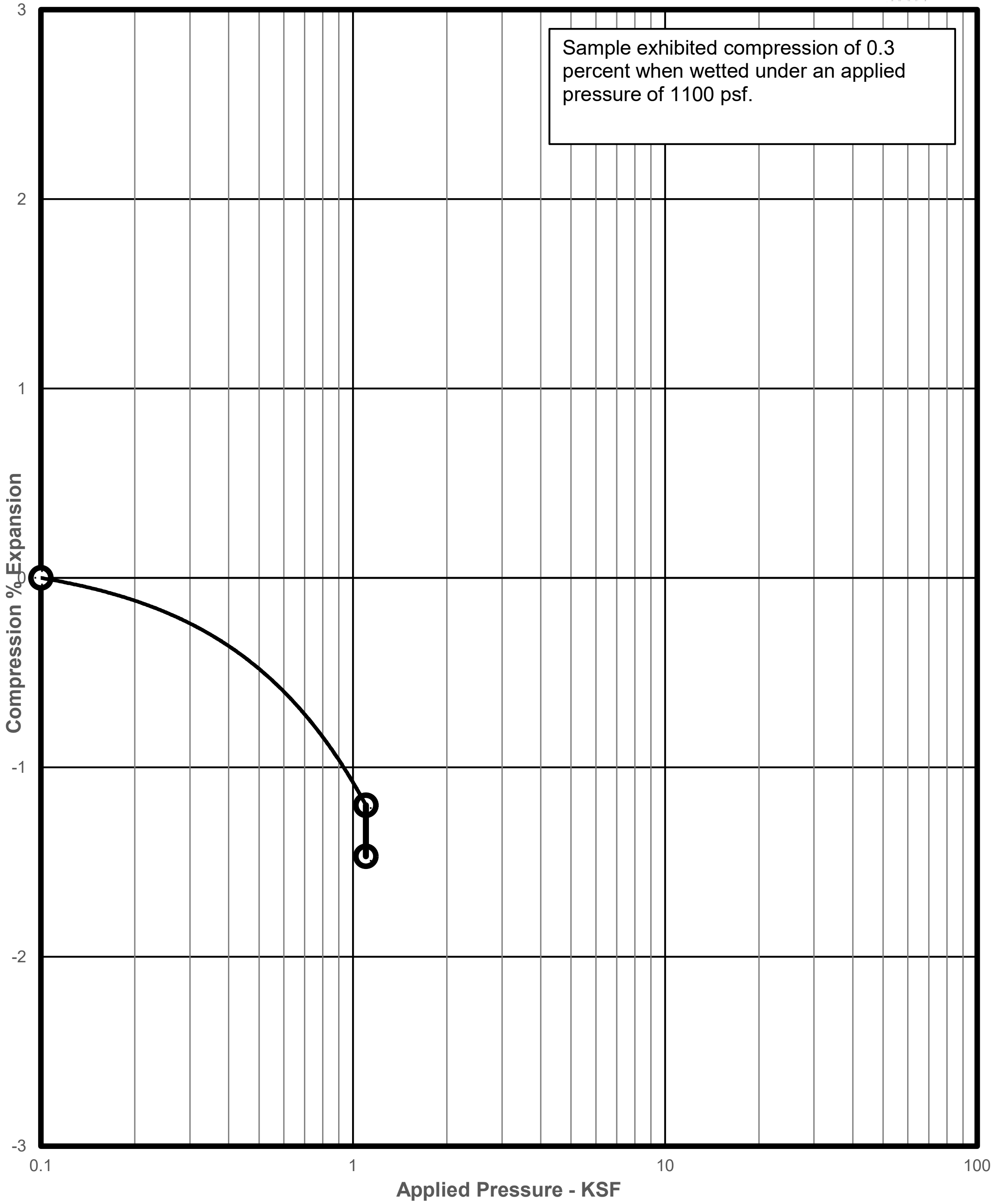
Swell Consolidation Test Results FIG. B- 10



SAMPLE OF:	CLAY, SANDY (CL)	DRY UNIT WEIGHT:	118	pcf
FROM:	TH-5 AT 14 FEET	MOISTURE CONTENT:	7.8	%

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
CTL|T PROJECT NO. DN51,256-115-R1

Swell Consolidation Test Results FIG. B- 11



SAMPLE OF: CLAY, SANDY (CL) DRY UNIT WEIGHT: 112 pcf
FROM: TH-6 AT 9 FEET MOISTURE CONTENT: 15.0 %

OREAD CAPITAL AND DEVELOPMENT
STANLEY SITE
CTL|T PROJECT NO. DN51,256-115-R1

Swell Consolidation Test Results FIG. B- 12

TABLE B - I

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	SWELL TEST DATA SWELL (%)	COMPRESSION (%)	APPLIED PRESSURE (psf)	ATTERBERG LIMITS LIQUID LIMIT	PLASTICITY INDEX	PASSING NO. 200 SIEVE (%)	SOIL TYPE
TH-1	4	4.2					34	18	53	CLAY, SANDY (CL)
TH-1	9	8.3	109	2.3		1,100				CLAY, SANDY (CL)
TH-1	14	14.2	113						45	SAND, CLAYEY (SC)
TH-1	19	31.3	90						79	CLAY, SANDY (CL)
TH-2	4	7.0	81						73	CLAY, SANDY (CL)
TH-2	9	10.4	119	2.3		1,100				CLAY, SANDY (CL)
TH-2	19	5.0	126						34	SAND, CLAYEY (SC)
TH-3	4	19.1	104	0.5		500				CLAY, SANDY (CL)
TH-3	9	15.9	108	0.6		1,100				CLAY, SANDY (CL)
TH-3	14	23.3	97		0.1	1,800				CLAY, SANDY (CL)
TH-4	4	8.5	90		0.5	500				CLAY, SANDY (CL)
TH-4	9	8.4	124	2.3		1,100				CLAY, SANDY (CL)
TH-4	14	5.8	115		2.5	1,800				CLAY, SANDY (CL)
TH-5	4	6.9	121	8.1		500				CLAY, SANDY (CL)
TH-5	9	8.6	120	2.9		1,100				CLAY, SANDY (CL)
TH-5	14	7.8	118	0.5		1,800			64	CLAY, SANDY (CL)
TH-6	4	7.5	113				36	18	55	FILL, CLAY, SANDY
TH-6	9	15.0	112		0.3	1,100			54	CLAY, SANDY (CL)

APPENDIX C

GUIDELINE SITE GRADING SPECIFICATIONS

GUIDELINE SITE GRADING SPECIFICATIONS

1. DESCRIPTION

This item shall consist of the excavation, transportation, placement and compaction of materials from locations indicated on the plans, or staked by the Engineer, as necessary to achieve preliminary street and overlot elevations. These specifications shall also apply to compaction of excess cut materials that may be placed outside of the subdivision and/or filing boundaries.

2. GENERAL

The Soils Representative shall be the Owner's representative. The Soils Representative shall approve fill materials, method of placement, moisture contents and percent compaction, and shall give written approval of the completed fill.

3. CLEARING JOB SITE

The Contractor shall remove all vegetation, trees, brush and rubbish before excavation or fill placement begins. 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

Topsoil and vegetable matter shall be substantially removed from the ground surface upon which fill is to be placed. The surface shall then be plowed or scarified to a depth of 8 inches, moisture treated and compacted until the surface is free from ruts, hummocks or other uneven features, which would prevent uniform compaction by the equipment to be used.

5. COMPACTING AREA TO BE FILLED

After the foundation for the fill has been cleared and scarified, it shall be disked or bladed until it is free from large clods to a depth of 8 to 12 inches, brought to the proper moisture content (between optimum and 4 percent above optimum for clay and within 2 percent of optimum for sand) and compacted to not less than 95 percent of maximum density as determined in accordance with ASTM D 698. The foundation materials shall be worked, stabilized, or removed and replaced if necessary in accordance with the soils representative's recommendations in preparation for fill.

6. FILL MATERIALS

Fill soils shall be substantially free from vegetable matter or other deleterious substances, and shall not contain rocks having a diameter greater than six (6) inches and claystone pieces larger than three (3) inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer.

On-site materials classifying as CL, CH, SC, SM, SW, SP, GP, GC and GM are acceptable. Concrete, asphalt, organic matter and other deleterious materials or debris shall not be used as fill.

7. MOISTURE CONTENT

For fill material classifying as CH, CL or SC, the fill shall be moisture treated to between 1 and 4 percent above optimum moisture content. Soils classifying as SM, SW, SP, GP, GC and GM shall be moisture treated to within 2 percent of optimum moisture content as determined from Proctor compaction tests. 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 Soils Representative, 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 through the soils.

The application of water to embankment materials shall be made with any type of watering equipment approved by the Soils Representative, 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 from being obtained, rolling and 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.

8. 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. Fill shall be compacted to at least 95 percent of the maximum density as determined in accordance with ASTM D 698. At the option of the Soils Representative, soils classifying as SW, GP, GC, or GM may be compacted to 95 percent of maximum density as determined in accordance with ASTM D 1557 or 70 percent relative density for cohesionless sand soils. Fill materials shall be placed such that the thickness of loose materials does not exceed 8 inches and the compacted lift thickness does not exceed 6 inches.

Compaction as specified above shall be obtained by the use of sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved for soils classifying as CL, CH, or SC. Granular fill shall be compacted using vibratory equipment or other approved equipment. 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 passes to ensure that the required density is obtained.

9. 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 not an appreciable amount of loose soils on the slopes. Compaction of slopes may be done progressively in increments of three to five feet (3' to 5') in height or after the fill is brought to its total height. Permanent fill slopes shall not exceed 3:1 (horizontal to vertical).

10. PLACEMENT OF FILL ON NATURAL SLOPES

Where natural slopes are steeper than 20 percent in grade and the placement of fill is required, cut benches shall be provided at the rate of one bench for each 5 feet in height (minimum of two benches). Benches shall be at least 10 feet in width. Larger bench widths may be required by the Engineer. Fill shall be placed on completed benches as outlined within this specification.

11. DENSITY TESTS

Field density tests shall be made by the Soils Representative at locations and depths of his choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests shall be taken in compacted material below the disturbed surface. When density tests indicate that 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.

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 Soils Representative indicates that 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 Soils Representative 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 3 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 Soils Representative, as specified under "Density Tests" above, shall be submitted progressively to the Owner. Dry density, moisture content, and percentage compaction shall be reported for each test taken.

15. DECLARATION REGARDING COMPLETED FILL

The Soils Engineer shall provide a written declaration stating that the site was filled with acceptable materials, and was placed in general accordance with the specifications.

APPENDIX D

GUIDELINE SITE GRADING SPECIFICATIONS
(SUB-EXCAVATION)

GUIDELINE SITE GRADING SPECIFICATIONS
(SUB-EXCAVATION)

1. DESCRIPTION

This item shall consist of the excavation, transportation, placement and compaction of materials from locations indicated on the plans, or staked by the Engineer, as necessary to achieve preliminary street and overlot elevations. These specifications shall also apply to compaction of materials that may be placed outside of the development boundaries.

2. GENERAL

The Soils Engineer shall be the Owner's representative. The Soils Engineer shall observe fill materials, method of placement, moisture content and percent compaction, and shall provide written opinions of the completed fill.

3. CLEARING JOB SITE

The Contractor shall remove all vegetation and debris 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 where the material will support structures of any kind.

4. SCARIFYING AREA TO BE FILLED

All topsoil and vegetable matter shall be removed from the ground surface where 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.

5. COMPACTING AREA TO BE FILLED

After the foundation for the fill has been cleared and scarified, it shall be disked or bladed until it is free from large clods, brought to the proper moisture content, (1 to 4 percent above optimum) and compacted to not less than 95 percent of maximum density as determined in accordance with ASTM D 698.

6. FILL MATERIALS

Fill soils shall be free from vegetable matter or other deleterious substances, and shall not contain clay and claystone having a diameter greater than three (3) inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer.

On-site materials classifying as CL, CH, SC, SM, SP, GP, GC and GM are acceptable. Concrete, asphalt, and other deleterious materials or debris shall not be used as fill.

7. MOISTURE CONTENT

Fill materials shall be moisture-conditioned to within limits of optimum moisture content specified in “Moisture Content and Density Criteria”. Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas or imported to the site.

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

The application of water to embankment materials shall be made with any type of watering equipment that will give the desire 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 from being obtained, rolling and 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.

8. COMPACTION OF FILL MATERIALS

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 given in “Moisture Content and Density Criteria”. Fill materials shall be placed such that the thickness of loose material does not exceed 8 inches and the compacted lift thickness does not exceed 6 inches.

Compaction, as specified above, shall be obtained by the use of suitable equipment. 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.

9. MOISTURE CONTENT AND DENSITY CRITERIA

Fill material shall be substantially compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698, AASHTO T 99) dry density at 1 to 4 percent above optimum moisture content. Additional criteria for acceptance are presented in DENSITY TESTS.

10. DENSITY TESTS

Field density tests shall be made by the Soils Engineer at locations and depths of his choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests shall 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 not within specifications, the particular layer or portion shall be reworked until the required density or moisture content has been achieved.

Allowable ranges of moisture content and density given in MOISTURE CONTENT AND DENSITY CRITERIA 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 Soils Engineer, shall be within the limits given. The Soils Engineer will inform the Contractor when the placement moisture is less than or exceeds the limits specified and the Contractor shall immediately make adjustments in procedures as necessary to maintain placement moisture content within the specified limits, to satisfy the following requirements.

A. Moisture

1. The average moisture content of material tested each day shall not be less than 1.5 percent over optimum moisture content.
2. Material represented by samples tested having moisture lower than 1 percent over optimum will be rejected. Such rejected materials shall be reworked until moisture equal to or greater than 1 percent above optimum is achieved.

B. Density

1. The average dry density of material tested each day shall not be less than 95 percent of standard Proctor maximum dry density (ASTM D 698).
2. No more than 10 percent of the material represented by the samples tested shall be at dry densities less than 95 percent of standard Proctor maximum dry density (ASTM D 698).
3. Material represented by samples tested having dry density less than 93 percent of standard Proctor maximum dry density (ASTM D 698) will be rejected. Such rejected materials shall be reworked until a dry density equal to or greater than 95 percent of standard Proctor maximum dry density (ASTM D 698) is obtained.

11. OBSERVATION AND TESTING OF FILL

Observation by the Soils Engineer shall be sufficient during the placement of fill and compaction operations so that they can declare the fill was placed in general conformance with specifications. All observations necessary to test the placement of fill and observe compaction operations will be at the expense of the Owner.

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 Soils Engineer indicates the moisture content and density of previously placed materials are as specified.

13. REPORTING OF FIELD DENSITY TESTS

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