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GEOLOGIC AND PRELIMINARY GEOTECHNICAL INVESTIGATION HESS RANCH – SOUTH PORTION NORTHEAST OF PRADERA PARKWAY AND NORTH CROWFOOT VALLEY ROAD DOUGLAS COUNTY, COLORADO

Prepared For:

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Project No. DN48,372-115

June 9, 2016

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SCOPE

This report presents the results of our Geologic and Preliminary Geotechnical Investigation for the south portion of Hess Ranch located northeast of the intersection of Pradera Parkway and North Crowfoot Valley Parkway in Douglas County, Colorado (Fig. 1). The purpose of our investigation was to evaluate the subsurface conditions to assist in planning of site development and residential construction. The report includes descriptions of soil and groundwater conditions found in our exploratory borings, and discussion of site development and construction as influenced by geotechnical considerations. The scope was described in a Service Agreement dated April 28, 2016 (DN 16-0191).

This report is based on subsurface conditions found in our exploratory borings, results of field and laboratory tests, engineering analysis of field and laboratory data, previous investigation and our experience with similar projects. The report contains discussions of geologic conditions and hazards, recommendations for site development, and preliminary estimates for pavements, potential foundation and floor support alternatives, and surface and subsurface drainage. Additional investigations will be necessary to evaluate the extent of over-excavation, if used. The preliminary discussions of foundation and floor system alternatives are intended for planning purposes only. Site (lot) specific investigations will be necessary to design residences. A brief summary of our conclusions and recommendations follows, with more detailed discussion in the report.

SUMMARY OF CONCLUSIONS

1. The site is judged suitable for residential development. The primary geotechnical concern is expansive soil and bedrock. We believe this concern can be mitigated with proper planning, engineering, design, construction and monitoring for settlement. There are no geotechnical constraints that preclude development.

2. Strata encountered in our borings generally consisted of 1 to 30 feet of sandy clay and/or clean to clayey sand. Weathered and comparatively unweathered claystone and sandstone bedrock was encountered below the soil in 20 borings. The clay and claystone are expansive.

3. Groundwater was encountered in three borings during drilling at depths of 11.5 to 29 feet. When the holes were checked several days later, water was measured in nine holes at depths of 6.5 to 28 feet. Most groundwater measurements were at levels of 10 feet or greater. The 6.5-foot measurement may be due to surface water from a precipitation event. Groundwater levels will likely fluctuate seasonally and may rise in response to precipitation and landscape irrigation.

4. We estimate total potential ground heave could range up to 5 inches at the existing ground surface considering a depth of wetting of 24 feet. Footing foundations may be considered where the underlying soil and bedrock is low swelling or non-expansive, or if sub-excavation of expansive material is performed. Additional investigation is recommended to delineate areas that would benefit from sub-excavation.

5. Preliminary data suggests that local residential streets will require at least 3 inches of asphalt and 6 inches of aggregate base course. If expansive clay is present immediately below pavements, mitigation will be merited with an additional 12 inches of base course. A design-level subgrade investigation should be done prior to paving.

6. Control of surface and subsurface drainage will be critical to the performance of foundations, slabs-on-grade and pavements. Surface drainage should be designed to provide rapid run-off of surface water away from structures, and off of pavements and flatwork.

SITE CONDITIONS

The southern portion of Hess Ranch is located northeast of the intersection of Pradera Parkway and North Crowfoot Valley Parkway in Douglas County, Colorado (Fig. 1 and Photo 1). Vacant land is present to the west and occupied residences are present north, east, and south of the site. Cherry Creek is about ¼ mile east. Ground cover consists of grass, weeds, and sparse trees. The ground slopes gently to moderately to both the east and west from a high point in the center of the site.

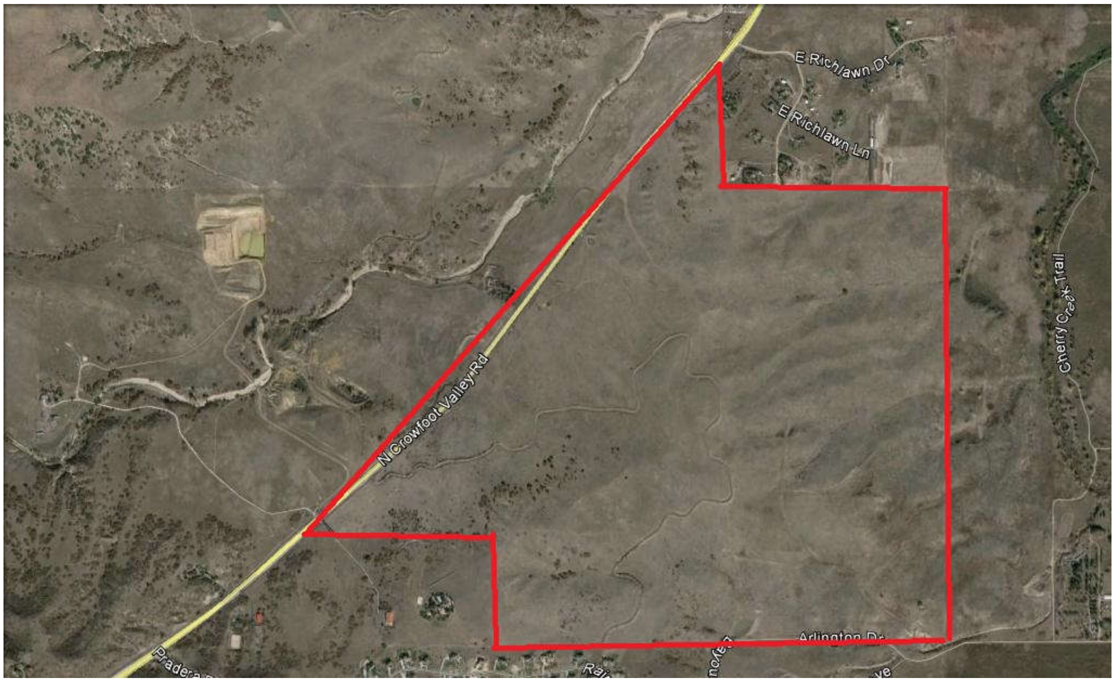

Photo 1. Google Earth© Aerial Site Photo 11/2015

SITE GEOLOGY AND GEOLOGIC HAZARDS

The geology and existence of geologic hazards on this site were evaluated through review of subsurface data, available literature and brief site reconnaissance. According to the Geologic Map of the Castle Rock North Quadrangle, Douglas County, Colorado (Thorson, Jon P.: Colorado Geological Survey Open File Report 05-2, 2005), the site is predominantly underlain by alluvium deposited in the late Pleistocene as well as sheetwash colluvium from the Holocene and late Pleistocene. Bedrock from the Dawson formation underlies the overburden soils.

Geologic hazards at the site include expansive soil and bedrock, and the regional geologic hazards of seismicity and naturally occurring radioactive materials. No geologic hazards that would preclude the proposed development were noted. We believe potential hazards can be mitigated with proper engineering, design, and construction practices, as discussed in this report.

Expansive Clay and Claystone

The clay and claystone are expansive. There is risk that ground heave will damage pavements, slabs-on-grade and foundations. Engineered design of grading, pavements, foundations, slabs-on-grade, and surface drainage can mitigate, but not eliminate, the effects of expansive soil.

Seismicity

Based on available mapping, we found no active faults within or near the site. The soil and bedrock units are not expected to respond unusually to seismic activity. The 2012 International Building Code (IBC) considers the area to be in Seismic Design Category B for a Site Class C or D. Only minor damage to new, properly designed and constructed buildings would be expected. Wind loads, not seismic considerations, generally govern dynamic structural design in this area.

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) 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. Radon rarely accumulates to significant levels in above-grade living spaces. We recommend provision for ventilation of foundation drain systems if a radon problem is discovered.

Other Considerations

Erosion potential on the site is considered low to moderate due to site topography. 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

We did not identify significant economically recoverable, high quality aggregate in our borings. We believe there are no economic aggregate or energy resources on the property.

PROPOSED DEVELOPMENT

We were provided with a conceptual site plan indicating the site will include thirteen planning areas (Planning Areas 34 through 47) that will be developed for construction of single-family homes. We anticipate the residences will be one or two-story, wood-framed structures with basements and/or crawl spaces and attached multi-car garages. The residences may have partial brick or stone veneer exterior wall treatments. Paved streets will provide access throughout the development. Grading plans were not available during this investigation.

INVESTIGATION

We investigated subsurface conditions by drilling 25 exploratory borings at the locations shown on Fig. 1. The boring locations were surveyed by CVL Consultants of Colorado, Inc. Prior to drilling, we contacted the Utility Notification Center of Colorado and local sewer and water districts to clear boring locations for conflicts with buried utilities. The borings were advanced to depths of 25 to 30 feet using solid stem, continuous-flight auger and a truck-mounted drill rig.

Samples of the soil and bedrock were obtained at 5-foot intervals using 2.5-inch diameter (O.D.) modified California barrel samplers driven by a 140-pound hammer falling 30 inches. Representatives of CTL | Thompson, Inc. were present during drilling to observe drilling operations, log the soil and bedrock, and obtain samples. Summary logs of the exploratory borings with results of field penetration resistance tests and a portion of the laboratory data are presented in Appendix A, including previous borings.

Samples were returned to our laboratory where they were examined by our engineers. Laboratory tests included dry density, moisture content, percent silt and clay-sized particles (passing the No. 200 sieve), Atterberg limits, gradation, swell-consolidation, and water-soluble sulfate concentration. Swell-consolidation tests were performed by wetting the samples under approximate existing overburden pressures (the weight of the overlying soil after grading). Results of laboratory tests are presented in Appendix B and are summarized in Table B-I. Laboratory test results for previous borings are presented in Appendix C.

SUBSURFACE CONDITIONS

Strata encountered in our borings generally consisted of 1 to 30 feet of sandy clay and/or clean to clayey sand. Weathered and comparatively unweathered claystone and sandstone bedrock was encountered below the soil in 20 borings. Some pertinent engineering characteristics of the soil and bedrock are presented in the following paragraphs.

Clay and Sand

Sandy clay and/or clean to clayey sand were encountered in all borings. The clay was medium stiff to very stiff and the sand was loose to dense based on field penetration resistance tests. Four clay samples compressed 0.1 to 1.5 percent, one sample did not swell, and eighteen samples swelled 0.2 o 6.0 percent when wetted. Four clay samples contained 50 to 99 percent fines (passing the No. 200 sieve) and exhibited moderate to high plasticity. Thirteen samples of sand contained 7 to 38 percent fines and exhibited moderate plasticity. We judge the sand to be non-expansive or low swelling.

Bedrock

Claystone and sandstone bedrock was encountered below the soil in 20 borings at depths ranging from 1 to 19 feet. Bedrock was weathered to very hard. Twenty-eight claystone samples swelled 0.2 to 5.3 percent. Six claystone samples contained 50 to 95 percent fines and exhibited moderate to high plasticity. Ten sandstone samples contained 7 to 42 percent fines and exhibited moderate plasticity. We judge the sandstone to be non-expansive or low swelling. An estimated bedrock surface elevation contour map is presented on Fig. 2.

Groundwater

Groundwater was encountered in three borings during drilling at depths of 11.5 to 29 feet. When the holes were checked several days later, water was measured in nine holes at depths of 6.5 to 28 feet. Most groundwater measurements were at levels of 10 feet or greater. The 6.5-foot measurement may be due to surface water from a precipitation event. Depth to groundwater will be affected by proposed grading. Groundwater levels will likely fluctuate seasonally and may rise in response to precipitation and landscape irrigation.

ESTIMATED POTENTIAL HEAVE

We used the results of swell tests to evaluate potential heave of the soils below the site. The analysis involves dividing the soil profile into layers and modeling the heave of each layer from representative swell tests. Based on the swell-consolidation test results and our experience, we estimate potential heave at the existing ground surface may range up to 5.0 inches based on a 24-foot depth of wetting. Heave estimates for each boring are shown below. These estimates neglect potential compression of non-expansive soils due to wetting, and are thus conservative.

TABLE 1
Potential Heave at Existing Ground Surface

Boring	Estimated Heave (in.)
TH-1	1.8
TH-2	<0.5
TH-3	0.9
TH-4	1.4
TH-5	1.3
TH-6	4.8
TH-7	<0.5
TH-8	3.1
TH-9	3.1
TH-10	2.8
TH-11	4.1
TH-12	3.6
TH-13	0.5
TH-14	4.4
TH-15	<0.5
TH-16	1.6
TH-17	1.7
TH-18	4.2
TH-19	<0.5
TH-20	1.4
TH-21	1.3
TH-22	5.0
TH-23	<0.5
TH-24	<0.5
TH-25	3.1

SITE DEVELOPMENT

The primary geotechnical concern that we believe will influence development and building performance is the presence of expansive clay and claystone. This concern can be mitigated with proper planning, engineering, design and construction. We believe there are no geologic or geotechnical constraints that would preclude development. The following sections provide site development recommendations.

Site Grading

The ground surface in areas to be filled should be stripped of vegetation, scarified, and moisture conditioned to between optimum and 4 percent above optimum moisture content for clay and within 2 percent of optimum for sand, and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). We anticipate stripping may require cuts of 3 to 6 inches for the majority of the site.

The properties of fill will affect the performance of foundations, slabs-on-grade, utilities, pavements, flatwork and other improvements. If imported soil is needed to achieve site grades, the material should be tested and approved by our firm prior to importing to the site. The on-site soils are suitable for use as site grading fill provided they are substantially free of debris, organics and other deleterious materials. There are some highly plastic clays which will be excavated as part of site grading and potential sub-excavation. It would be prudent to mix these clays with sand during grading, which will likely occur to the variable soils which will be encountered during scraper operations. 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 density tested by our representative during construction. Guideline grading specifications are presented in Appendix C.

Our experience indicates fill and backfill can settle, even if properly compacted to criteria provide 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), too high for highly plastic clay and claystone (2 percent or more). We anticipate the mixing of soils during grading and utility installation should result in tolerable long-term fill settlement provided fill and backfill are compacted in accordance with recommendations in this report.

Excavation

We believe the soils penetrated by our exploratory borings can be excavated with typical heavy-duty equipment. We recommend the owner and contractor become familiar with applicable local, state and federal safety regulations, including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Based on our investigation and OSHA standards, we anticipate the clay will classify as Type B or C soil and the sand will classify as Type C soil based on OSHA Standards governing excavations are published in 29 CFR, Part 1926. Type B soils require 1:1 slopes and Type C requires 1½:1 for temporary excavations in dry conditions. Excavation slopes specified by OSHA are dependent upon soil types and groundwater conditions encountered. The contractor's "competent person" should identify the soils encountered in the excavations and refer to OSHA standards to determine appropriate slopes. Stockpiles of soils and equipment should not be placed within a horizontal distance equal to one-half the excavation depth from the edge of the excavation. A professional engineer should design excavations deeper than 20 feet.

Sub-Excavation

Our investigation indicates expansive clay and claystone are present at depths likely to influence the performance of shallow foundations and slabs-on-grade. We calculated ground heave at the existing ground surface could range up to about 5.0 inches for an assumed depth of wetting of 24 feet. Deep foundations and structurally supported floor systems are commonly used on sites where moderate to high swell clay or bedrock are found at depths likely to influence foundations; their use has diminished greatly because most sites are sub-excavated. Many local builder-developers choose to perform sub-excavation to reduce potential heave and provide a relatively uniform fill layer that is likely suitable for footings and slab-on-grade basement floors. We believe sub-excavation can be used to mitigate the moderate to highly expansive soils.

The site soils are erratic and our borings were widely spaced. Proposed grades were not available at the time of this investigation. Figure 3 presents our interpretation of the risk due to expansive soils at the existing ground surface. Moderate to high risk conditions were assessed in 40 percent of the borings, implying sub-excavation could be mentioned on about half of the site. Additional borings will be necessary to further define areas that would benefit from sub-excavation. Conceptual sub-excavation templates are shown on Figs. 4 and 5. The excavation slopes should meet OSHA, state, and local safety standards. The bottom of sub-excavation areas should extend laterally at least 5 feet outside the largest possible foundation footprint to ensure foundations are constructed over moisture-conditioned fill. The sub-excavation areas should be staked by a surveyor, and we recommend periodic surveying verification of the "as-built" bottom of the excavations. An "as-built" sub-excavation plan should be prepared and provided to construction and sales staff to ensure foundations and decks are located within the sub-excavated area.

Sub-excavation can also be used to mitigate potential movements of pavements as part of pavement design and construction. If highly plastic soils are found in pavement areas, they could be excavated and replaced with on-site sands. Douglas County will require swell mitigation (see Pavements).

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

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. In order for the sub-excavation procedure to be performed properly, close control of fill placement to specifications is required. Special precautions should be taken for compaction of fill at corners, access ramps, and edges of the sub-excavation trenches due to equipment access constraints. The contractor should have the appropriate equipment to reach and compact these areas. Clay fill should be moisture treated between 1 and 4 percent above optimum moisture content. Sand fill should have a moisture content within 2 percent of optimum. Fill should be compacted to at least 95 percent of maximum standard proctor dry density (ASTM D 698). Guideline specifications are provided in Appendix D. Our representative should observe and test compaction of the fill. The fill should be tested after the fill placement to evaluate swell and whether footing or pad-type foundations can be used.

If the fill dries excessively prior to construction, it may be necessary to rework the upper drier materials prior to constructing foundations. We judge the fill should retain adequate moisture for about two years. Moisture conditions can be assessed in excavations as construction progresses.

<u>Underdrain</u>

With long-term development and subsequent irrigation, groundwater may develop. We believe this water should be controlled. The water could lead to expansive soil related problems and frequent pumping of basement foundation drains. Where feasible, we advocate use of an underdrain system incorporated into the design of sanitary sewer systems to provide a means to control water and allow gravity discharge from basement foundation drains. It may not be practical to install underdrains at this site if a gravity discharge is not available. It is possible a pumped system could be used, which would require long-term maintenance. If an underdrain system is not installed, individual house foundation drains would discharge into sumps with pumps. Sump discharge can result in ponding and recycling if slopes between lots are not adequately graded. Problems with chronic ice or algae formation on sidewalks have also been attributed to sump discharge. Conceptual sewer underdrain details are provided on Figs. 6 and 7. If used, the underdrain should be provided with clean-outs and be maintained. Drain outfalls should be designed with a concrete headwall large enough to protect the pipe from damage. We are available to assist in design of the underdrain system if one is chosen.

Where feasible, the underdrain services should be installed deep enough so that the lowest point of the basement foundation drain can be connected to the underdrain service as a gravity outlet. For non-walkout basements, the low point of the basement foundation drain may be about 2 to 3 feet deeper than the foundation excavation. For buildings with walkout basements, the low point or sump pit of the basement foundation drain will be below the frost stem wall in the rear portion of the basement. The foundation drain in a walkout basement would require a deeper underdrain service for a gravity discharge and may not be practical. For these conditions, we suggest the front portion of the foundation drain be connected to the underdrain and a sump pit used for the rear portion.

<u>Utilities</u>

Water and sewer lines are usually constructed beneath paved roads. Compaction of trench backfill can have a significant effect on the life and serviceability of pavements. Douglas County requires trench backfill be placed in thin (8 inches or less) loose lifts and moisture conditioned to between optimum to 4 percent above optimum moisture content for clay and claystone, and compacted to at least 95 percent of maximum dry density (ASTM D 698). Sand fill should be moisture conditioned to within 2 percent of optimum moisture content and compacted to 100 percent of maximum dry density.

The placement and compaction of utility trench backfill should be observed and tested by a representative of our firm during construction.

Our experience indicates use of a self-propelled compactor results in more reliable performance compared to backfill “compacted” by a sheepsfoot wheel attachment on a backhoe or trackhoe. The upper portion of the trenches should be widened to allow the use of a self-propelled compactor. Special attention should be paid to backfill placed adjacent to manholes as we have seen instances where settlement in excess of 2 percent has occurred. Any improvements placed over backfill should be designed to accommodate movement.

BUILDING CONSTRUCTION CONSIDERATIONS

The following discussions are preliminary and are not intended for design or construction. After grading is completed, design-level investigations should be performed on a lot-specific basis.

Foundations

Our investigation indicates non-expansive sand and low to high swelling clay and claystone are present at depths likely to influence the performance of shallow foundations and slabs-on-grade. We judge footing foundations may be appropriate for about half the site, and piers for about half. Footing foundations can likely be used on nearly all if sub-excavation of expansive material is performed. Additional investigation of each lot should be conducted after grading is completed.

Slab-On-Grade Construction

Slab-on-grade basement floors may be considered on low and some moderate risk sites where potential heave is acceptable to builders and home buyers. Structurally supported basement floors should be used on all sites with high or very high risk of poor basement slab performance. Sub-excavation should reduce potential heave to about 2 inches or less on lots where high swell soils are sub-excavated and should allow wider use of slab-on-grade floors.

The performance of garage floors, driveways, sidewalks, and other surface flat-work will likely be poor where high swell materials are shallow, unless sub-excavation is performed. The following precautions will be required to reduce the potential for damage due to movement of slabs-on-grade for this site.

1. Isolation of the slabs from foundation walls, columns and other slab penetrations;
2. Voiding of interior partition walls to allow for slab movement without transferring movement to the structure;
3. Flexible water and gas connections to allow for slab movement. A flexible plenum above furnaces will be required; and
4. Proper surface grading and foundation drain installation to reduce water availability to sub-slab and foundation soils

Below-Grade Areas

Surface water can penetrate relatively permeable loose backfill soils located adjacent to residences and collect at the bottom of relatively impermeable basement excavations causing wet or moist conditions. Basement foundation walls should be designed for lateral earth pressures. Foundation drains should be constructed around the lowest excavation levels and ideally should be connected to an underdrain system (if constructed) to provide a gravity outlet. The drains can be connected to a sump pit where water can be removed by pumping if an underdrain is not provided. We believe underdrain systems are a good way to discharge water that may accumulate in foundation drains.

Surface Drainage

The performance of improvements will be influenced by surface drainage. When developing an overall drainage scheme, consideration should be given to drainage around each residence. The ground surface around the residences should be sloped to provide positive drainage away from the foundations. We recommend a slope of at least 10 percent for the first 10 feet surrounding each residence, where practical. If the distance between houses is less than 20 feet, the slope in this area should be 10 percent to the swale between houses. Where possible, drainage swales should slope at least 2 percent. Variation from these criteria is acceptable in some areas. For examples, for lots graded to direct drainage from the rear yard to the front, it is difficult to achieve the recommended slope at the high point behind a house. We believe it is acceptable to use a slope of about 6 inches in the first 10 feet (5 percent) in this instance and others when achieving 10 percent is not practical. Roof downspouts and other water collection systems should discharge beyond the limits of backfill around structures.

Proper control of surface runoff is also important to control the erosion of surface soils. Sheet flow should not be directed over unprotected slopes. Water should not be allowed to pond at the crest of slopes. Permanent slopes should be prepared in such a way to reduce erosion.

Attention should be paid to compact the soils behind curb and gutter adjacent to streets and in utility trenches during the development. If surface drainage between preliminary development and construction phases is neglected, performance of the roadways, flatwork and foundations may be poor.

Concrete

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentrations of less than 0.01 to 0.06 percent in five samples from this site. For this level of sulfate concentration, ACI 332-08 *Code Requirements for Residential Concrete* indicates there are no special requirements for sulfate resistance.

Superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious materials ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high water tables. Concrete should have a total air content of 6 percent ± 1.5 percent. We advocate all foundation walls and grade beams in contact with the subsoils (including the inside and outside faces of garage and crawl space grade beams) be damp-proofed.

Pavements

Pavement subgrade soils will likely consist of sandy clay and non-expansive sand or fill of similar composition. Clay soil is considered relatively poor pavement subgrade. Sand is considered better subgrade. Douglas County requires the following minimum pavement sections. Where clay or clayey sand subgrade soils are present, thicker pavements will be necessary. Douglas County also requires mitigation of expansive soils which often includes placement of 12 inches of additional base course. A design-level subgrade investigation should be done prior to paving.

Roadway Classification	Hot Mix Asphalt Concrete (HMAC) + Aggregate Base Course (ABC)	Portland Cement Concrete (PCC)
Local Residential	3” HMAC + 6” ABC	5” PCC
Minor Collectors	3” HMAC + 6” ABC	6” PCC

RECOMMENDED FUTURE INVESTIGATIONS

We recommend the following investigations and services:

1. Additional drilling, sampling, and testing to better determine the extents of expansive soil and bedrock, and delineate potential sub-excavation areas;

2. Construction testing and observation during site grading, utility installation and pavement construction.

3. Subgrade investigation and pavement design(s) after grading;

4. Design-level Soils and Foundation Investigation(s) after grading; and

5. Foundation installation observations.

CONSTRUCTION OBSERVATIONS

This report has been prepared for the exclusive use of E5X Management and your design and construction team to provide geotechnical design and construction criteria for development. The information, conclusions, and recommendations presented herein are based upon consideration of many factors including, but not limited to, the type of structures proposed, the geologic setting, and the subsurface conditions encountered. The conclusions and recommendations contained in the report are not valid for use by others. Standards of practice evolve in the area of geotechnical engineering. The recommendations provided are appropriate for about three years. If the site is not developed within about three years, we should be contacted to determine if we should update this report.

We recommend that CTL | Thompson, Inc. provide construction observation services to allow us the opportunity to verify whether soil conditions are consistent with those found during this investigation. If others perform these observations, they must accept responsibility to judge whether the recommendations in this report remain appropriate.

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. Home owners must assume responsibility for maintaining the structures and use appropriate practices regarding drainage and landscaping.

LIMITATIONS

Our borings were widely spaced to provide a general picture of subsurface conditions for planning of development and residence construction for this site. Variations in the subsoil conditions not indicated by our borings are likely. We believe this investigation was conducted in a manner consistent with that level of care and skill ordinarily used by geotechnical engineers practicing in this area at this time. No warranty, express or implied, is made.

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

CTL | THOMPSON, INC.

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Staff Engineer

Reviewed by:

Ronald

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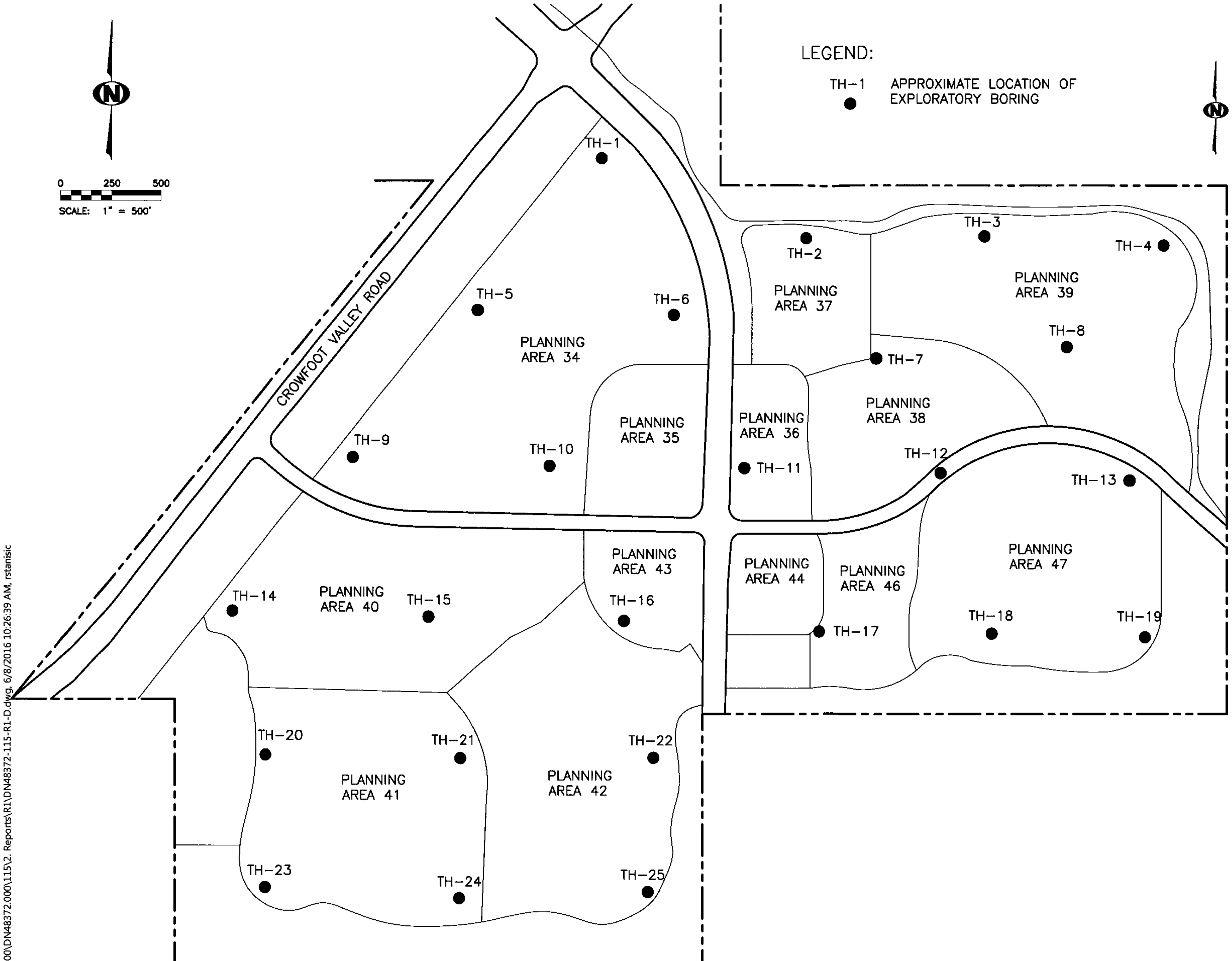
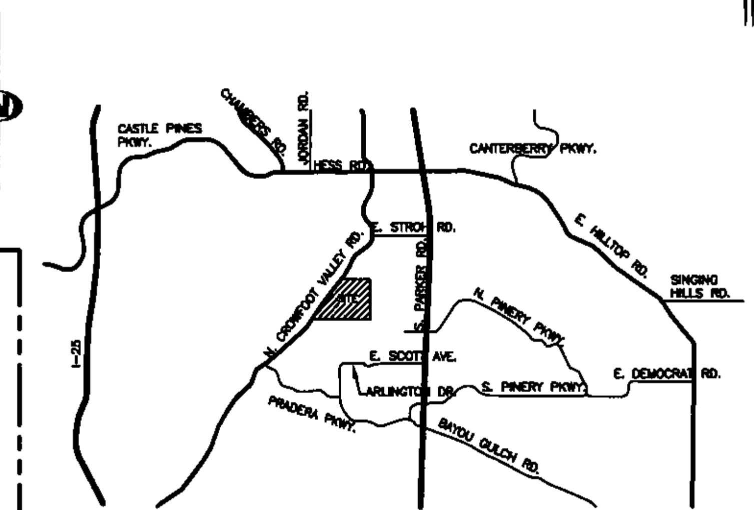


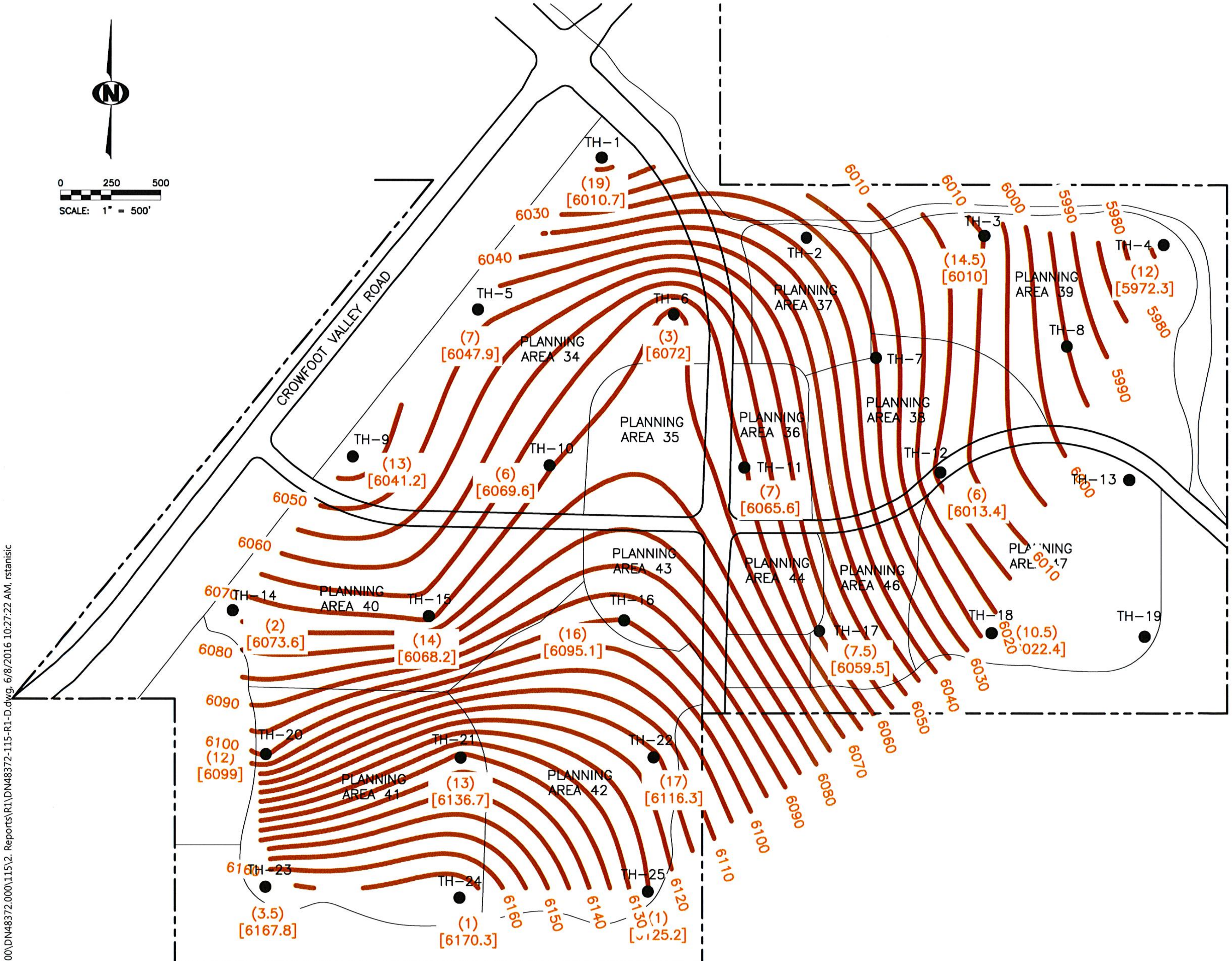


VICINITY MAP
NOT TO SCALE

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
Project No. DN48,372-115

Locations of Exploratory Borings

Fig. 1



LEGEND:

TH-1 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING
(19)	INDICATES DEPTH TO BEDROCK (FEET)
(6010.7)	INDICATES BEDROCK ELEVATION AT BORING LOCATION (FEET)
6000	INDICATES ESTIMATE BEDROCK SURFACE ELEVATION (FEET)

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF DRILL HOLE DATA AND MAY NOT REFLECT LOCAL VARIATIONS.

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Estimated Bedrock Surface Elevation

Fig. 2

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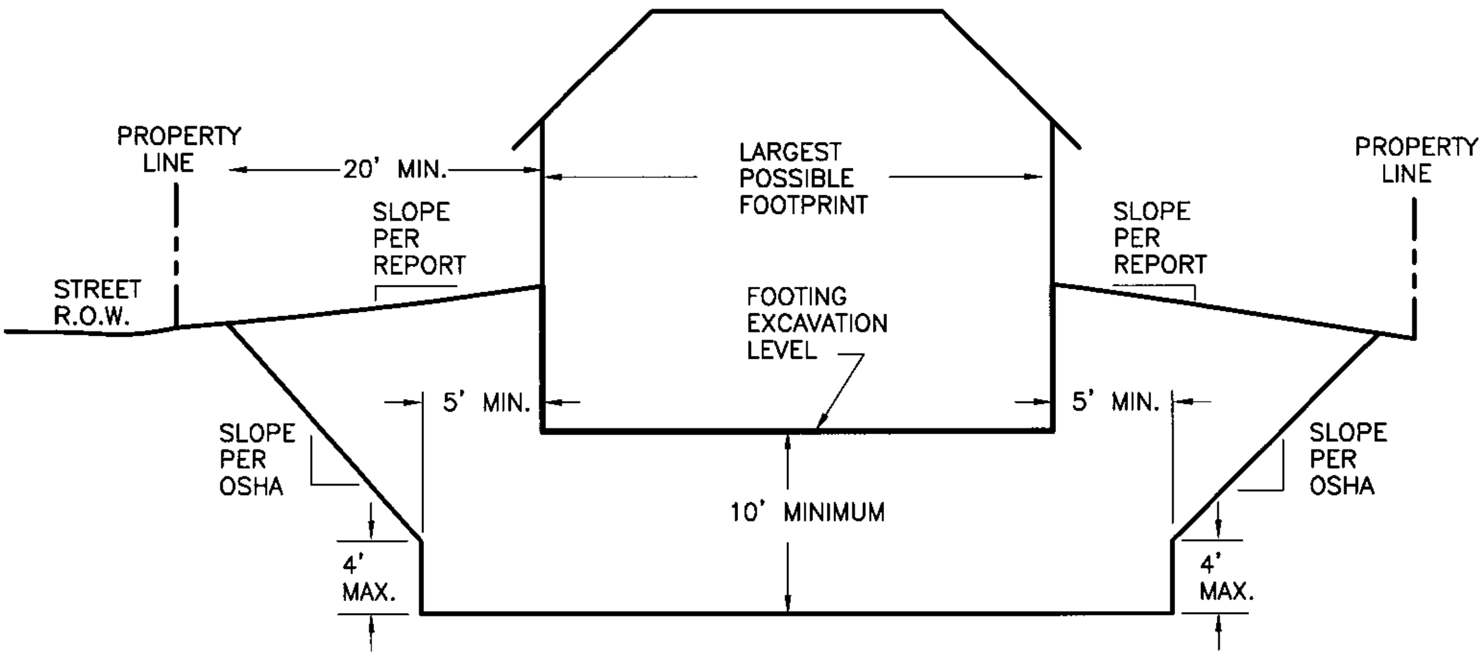
Preliminary Risk Assessment Due to Expansive Soil and Bedrock

Fig. 3

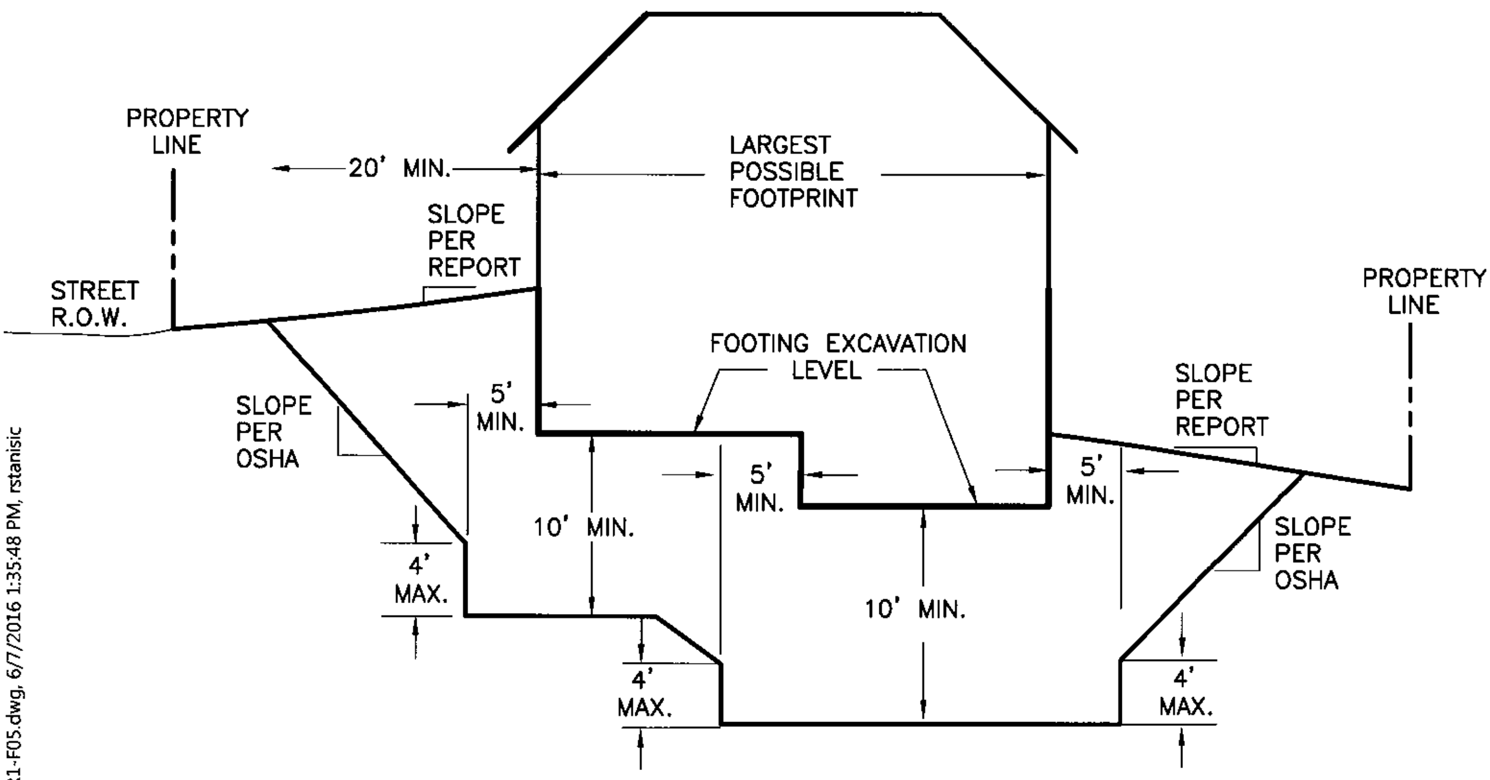


NOT TO SCALE

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
Project No. DN48,372-115

Conceptual Sub-excavation Profile

Fig. 4

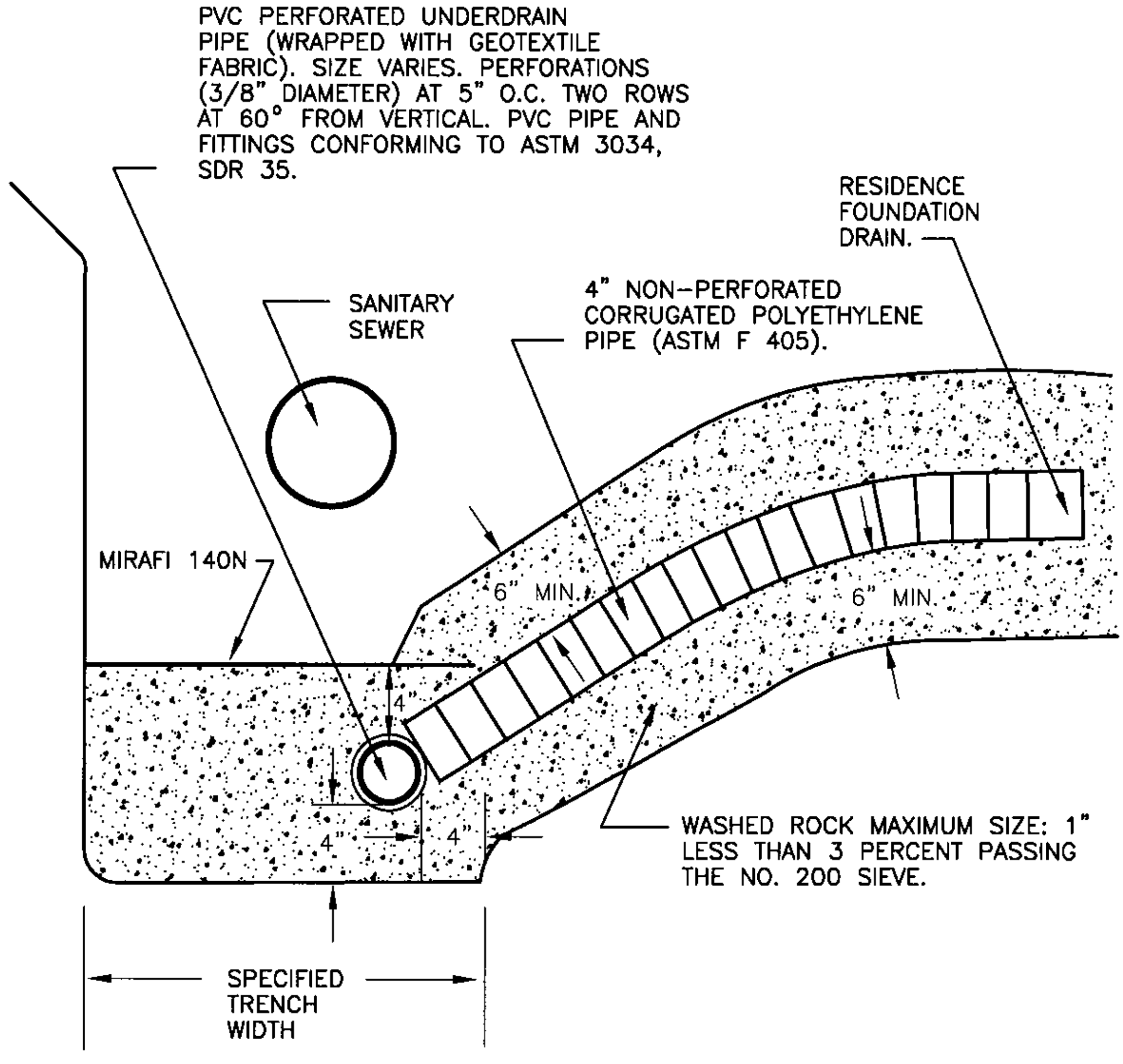


NOT TO SCALE

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
Project No. DN48,372-115

Conceptual Sub-excavation Profile
(Walk-out Basement)

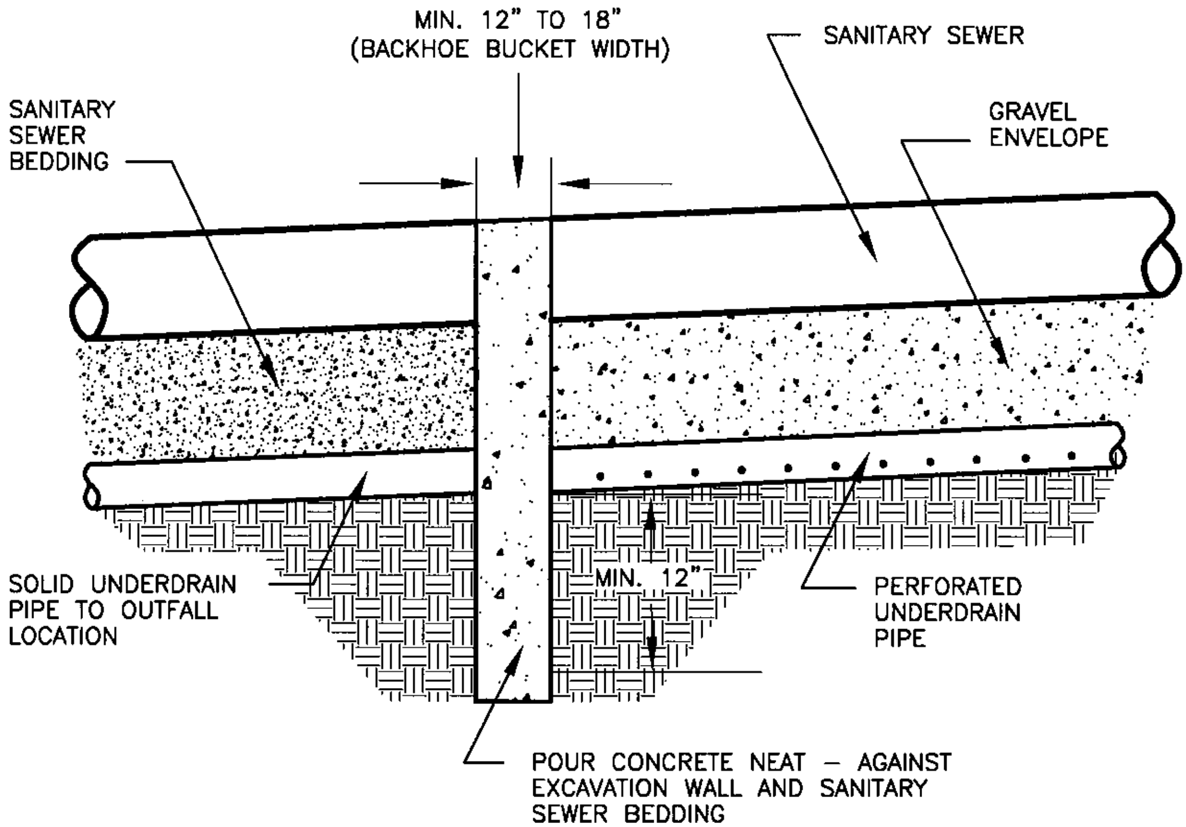
Fig. 5



NOTE: NOT TO SCALE.

Sewer Underdrain Detail

Fig. 6

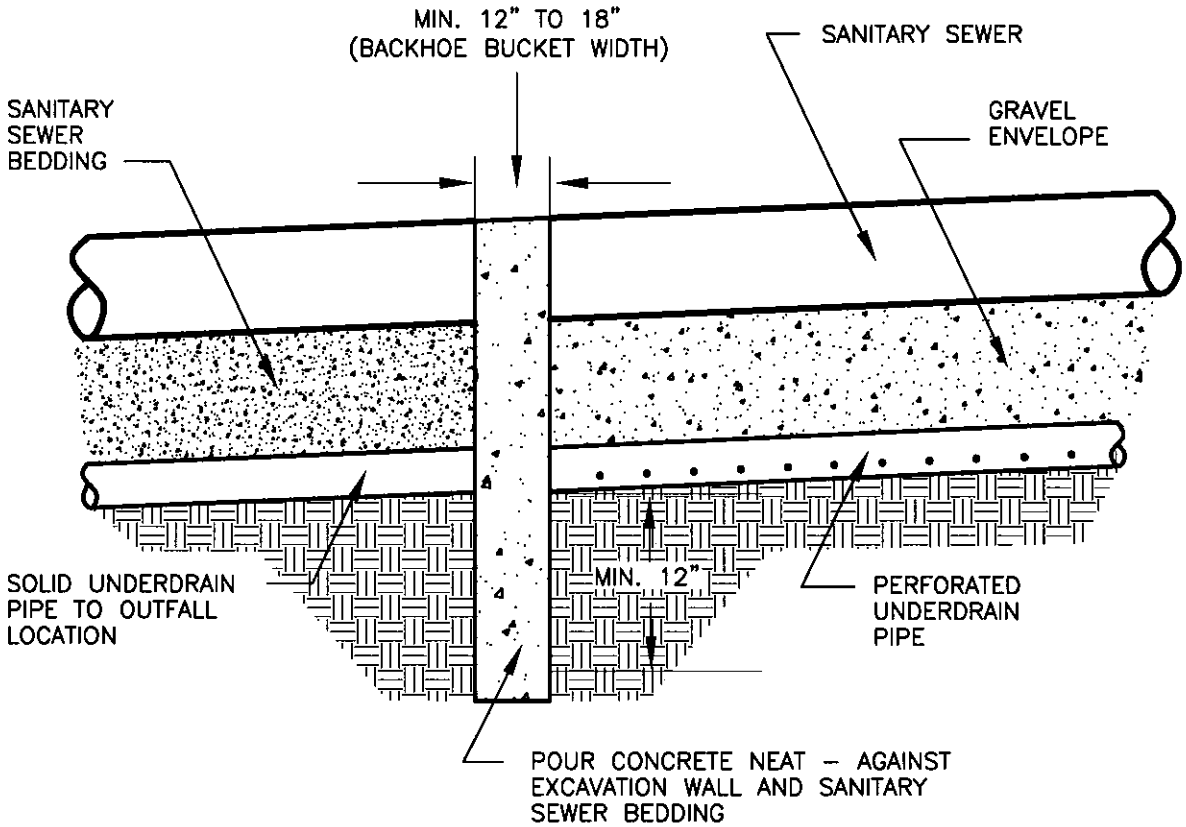


NOTE:
THE CONCRETE CUTOFF WALL SHOULD EXTEND INTO THE UNDISTURBED SOILS OUTSIDE THE UNDERDRAIN AND SANITARY SEWER TRENCH A MINIMUM DISTANCE OF 12 INCHES.

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
Project No. DN48,372-115

Underdrain Cutoff Wall Detail

Fig. 7



NOTE:
THE CONCRETE CUTOFF WALL SHOULD EXTEND INTO THE UNDISTURBED SOILS OUTSIDE THE UNDERDRAIN AND SANITARY SEWER TRENCH A MINIMUM DISTANCE OF 12 INCHES.

50-UNDERDRAIN_05

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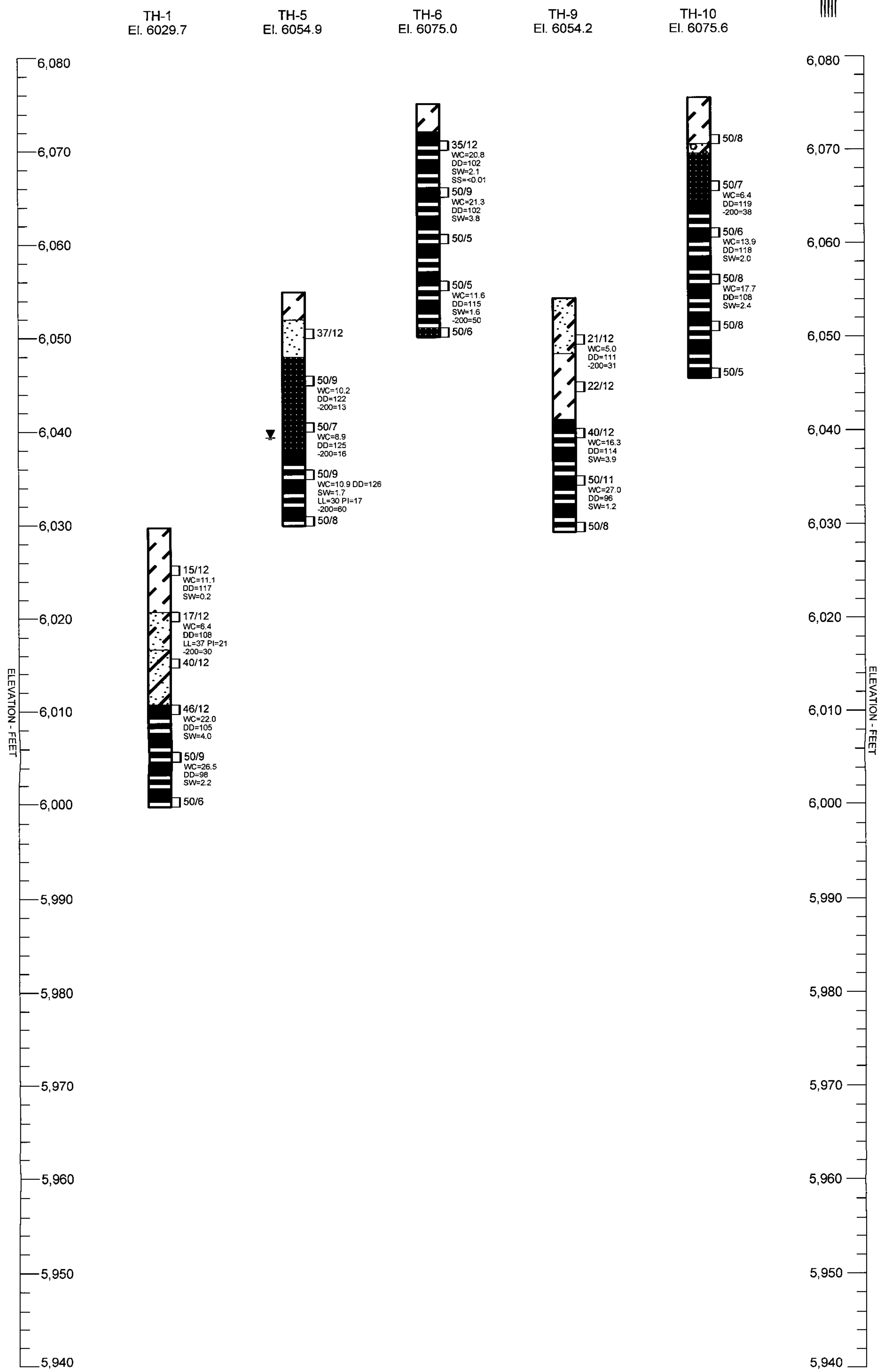
E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
Project No. DN48,372-115

Underdrain Cutoff Wall Detail

Fig. 8

APPENDIX A

SUMMARY LOGS OF EXPLORATORY BORINGS



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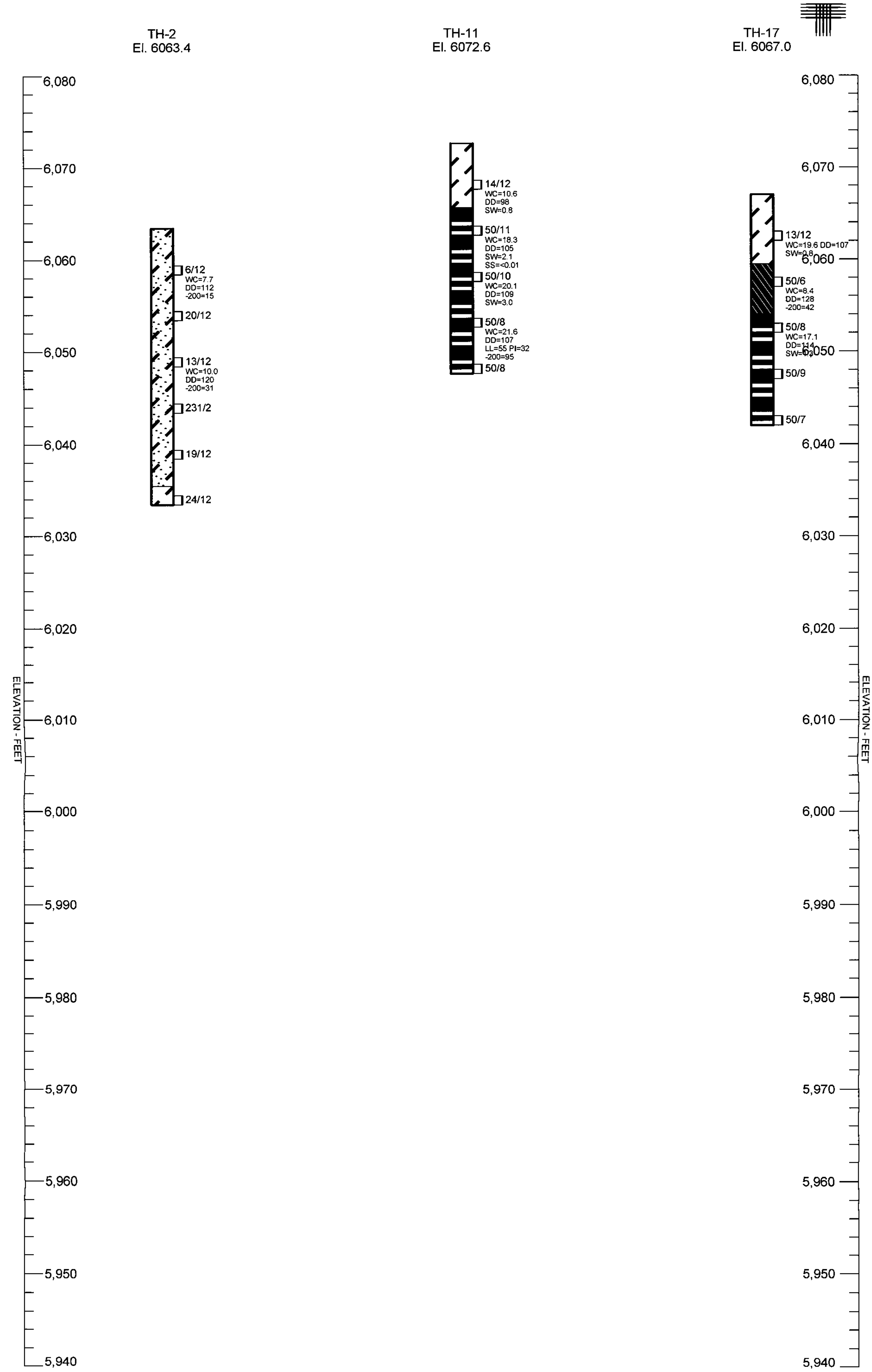
SUMMARY LOGS OF EXPLORATORY BORINGS

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115

FIG. A-1



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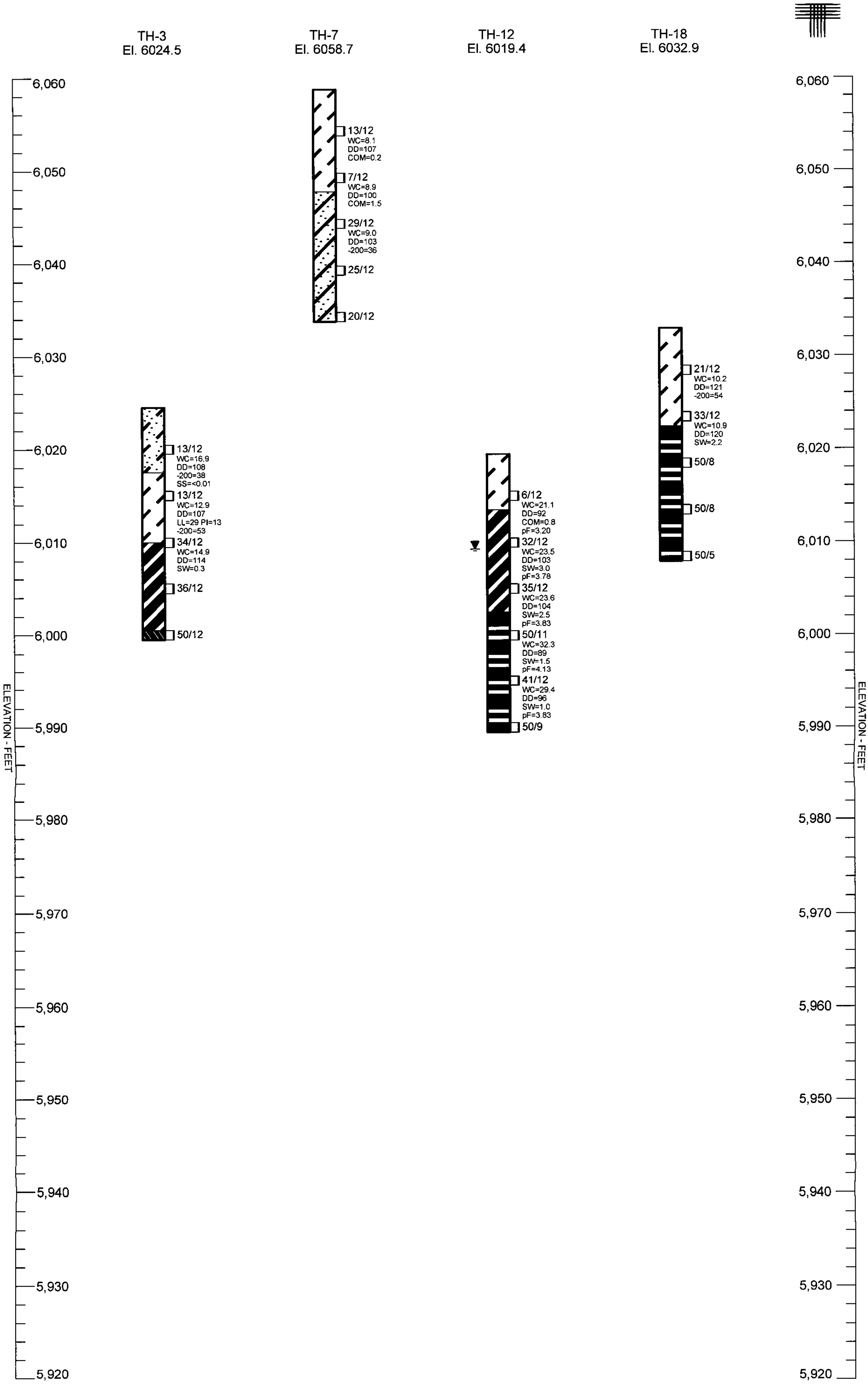
SUMMARY LOGS OF EXPLORATORY BORINGS

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115

FIG. A-2



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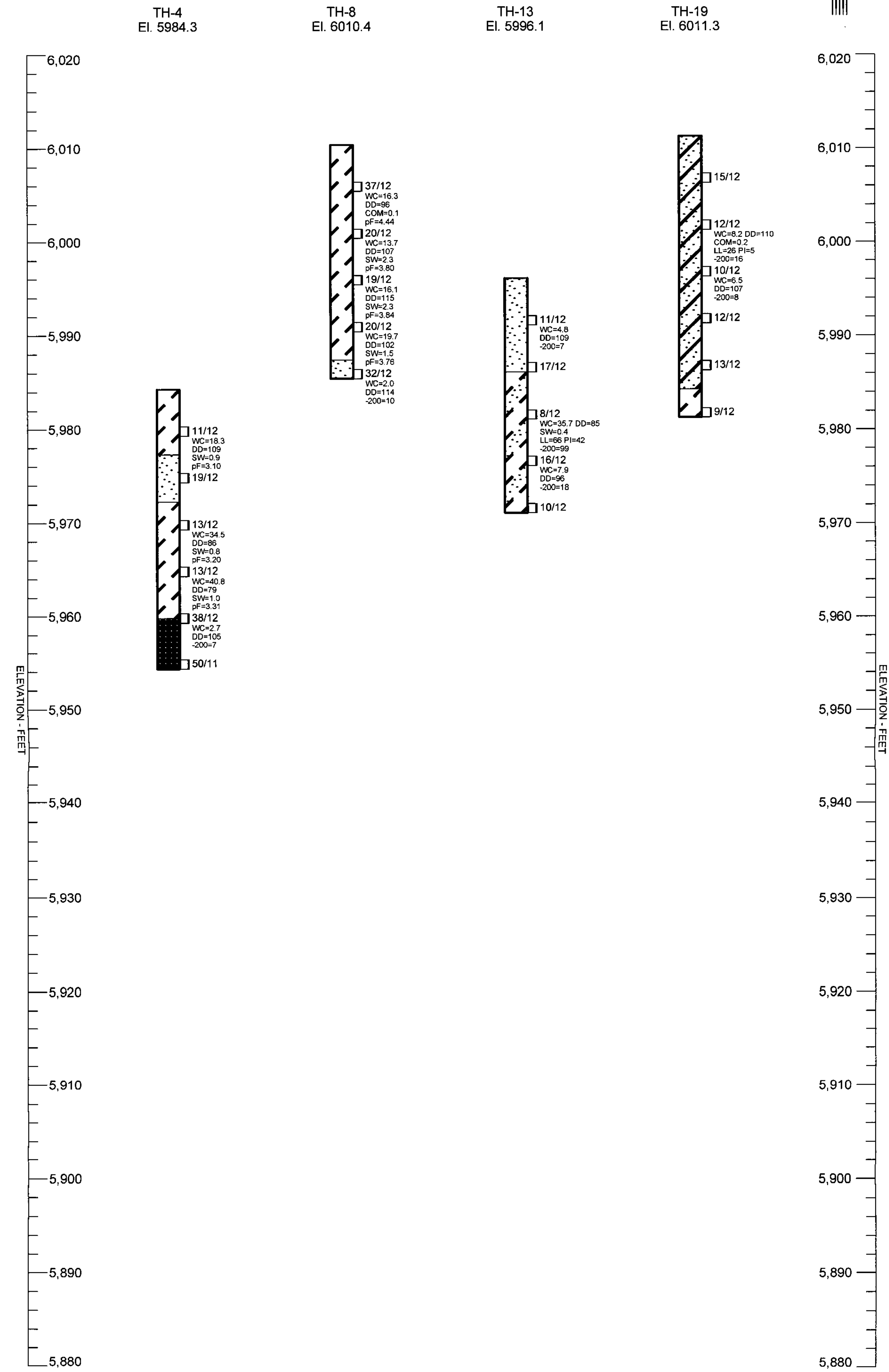
SUMMARY LOGS OF EXPLORATORY BORINGS

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115

FIG. A-3



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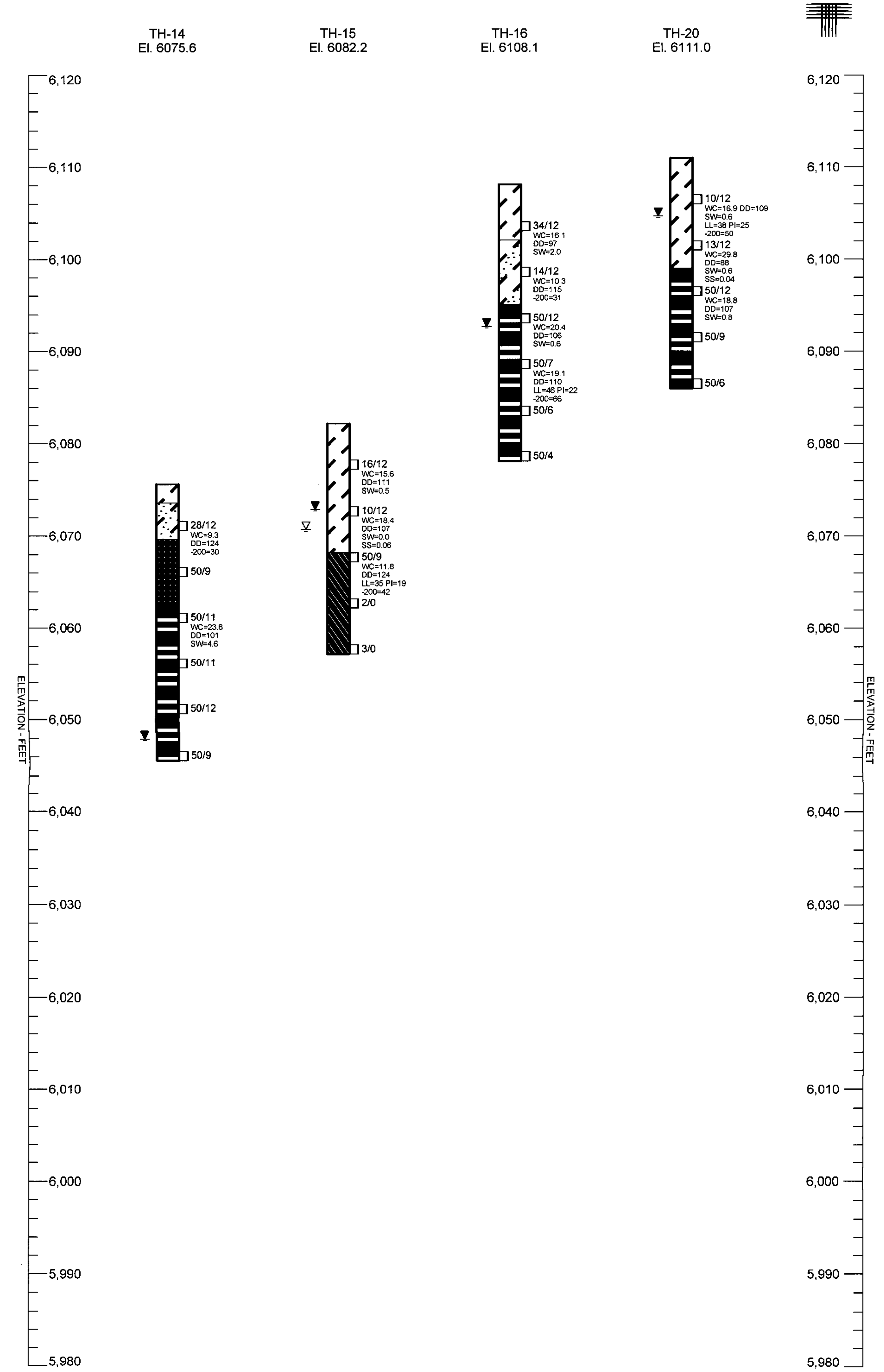
SUMMARY LOGS OF EXPLORATORY BORINGS

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115

FIG. A-4



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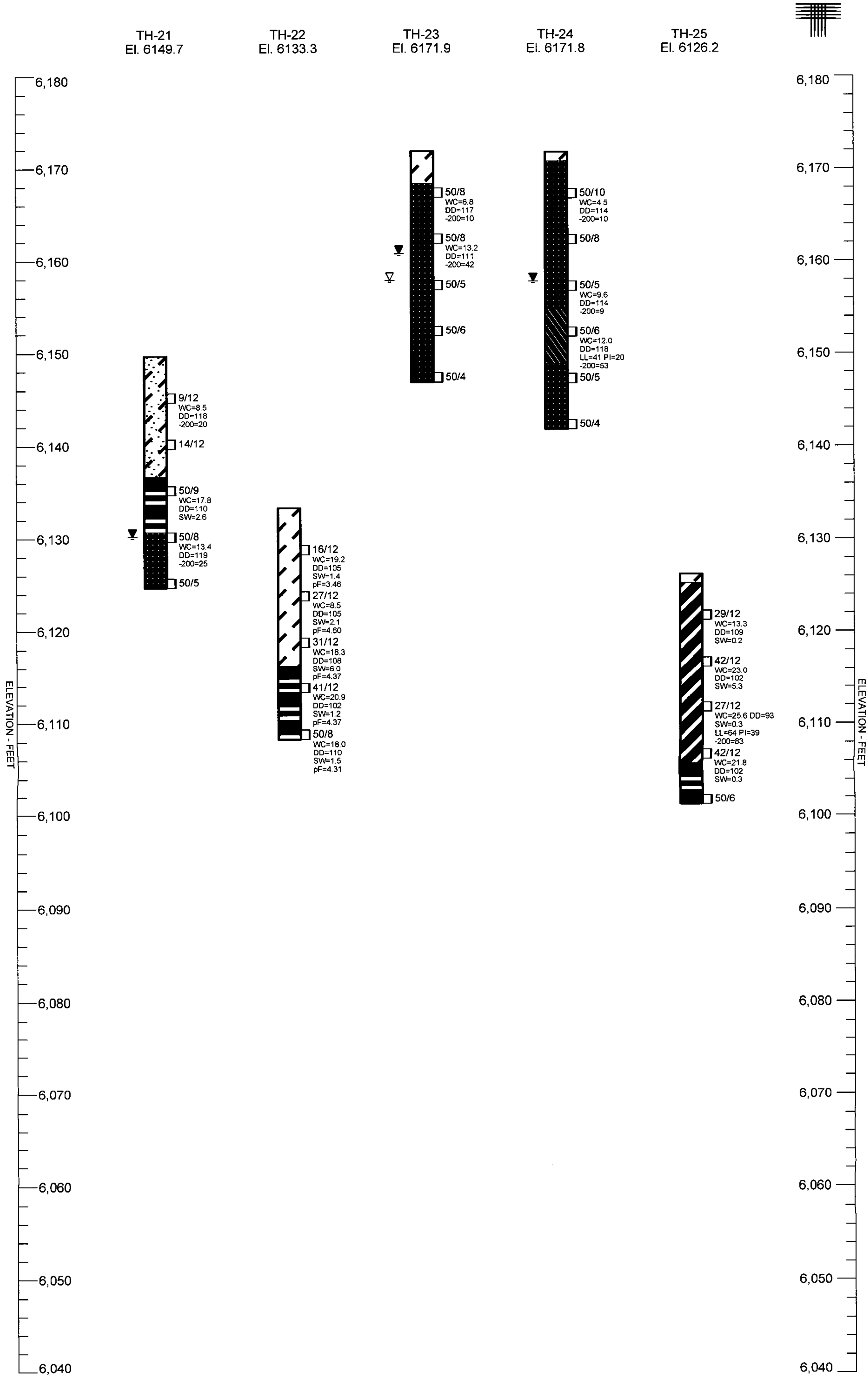
SUMMARY LOGS OF EXPLORATORY BORINGS

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115

FIG. A-5



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SUMMARY LOGS OF EXPLORATORY BORINGS

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115

FIG. A-6

LEGEND:

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

SAND, CLAYEY, LOOSE TO MEDIUM DENSE, SLIGHTLY MOIST, BROWN, PINK, WHITE, RUST (SC).

SAND, CLEAN TO SLIGHTLY SILTY, MEDIUM DENSE, SLIGHTLY MOIST, BROWN, WHITE (SP, SP-SM).

GRAVEL, SILTY TO CLAYEY, VERY DENSE, MOIST, BROWN, WHITE, BLACK (GM).

WEATHERED CLAYSTONE, MOIST, BROWN, RUST.

BEDROCK, CLAYSTONE, MEDIUM HARD TO HARD, MOIST, TAN, RUST, GRAY, BLUE-GRAY.

BEDROCK, INTERBEDDED CLAYSTONE/SANDSTONE, HARD, MOIST, BROWN, OLIVE.

BEDROCK, SANDSTONE, MEDIUM HARD TO HARD, MOIST, BROWN, WHITE.

DRIVE SAMPLE. THE SYMBOL 15/12 INDICATES 15 BLOWS OF AN AUTOMATIC 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.

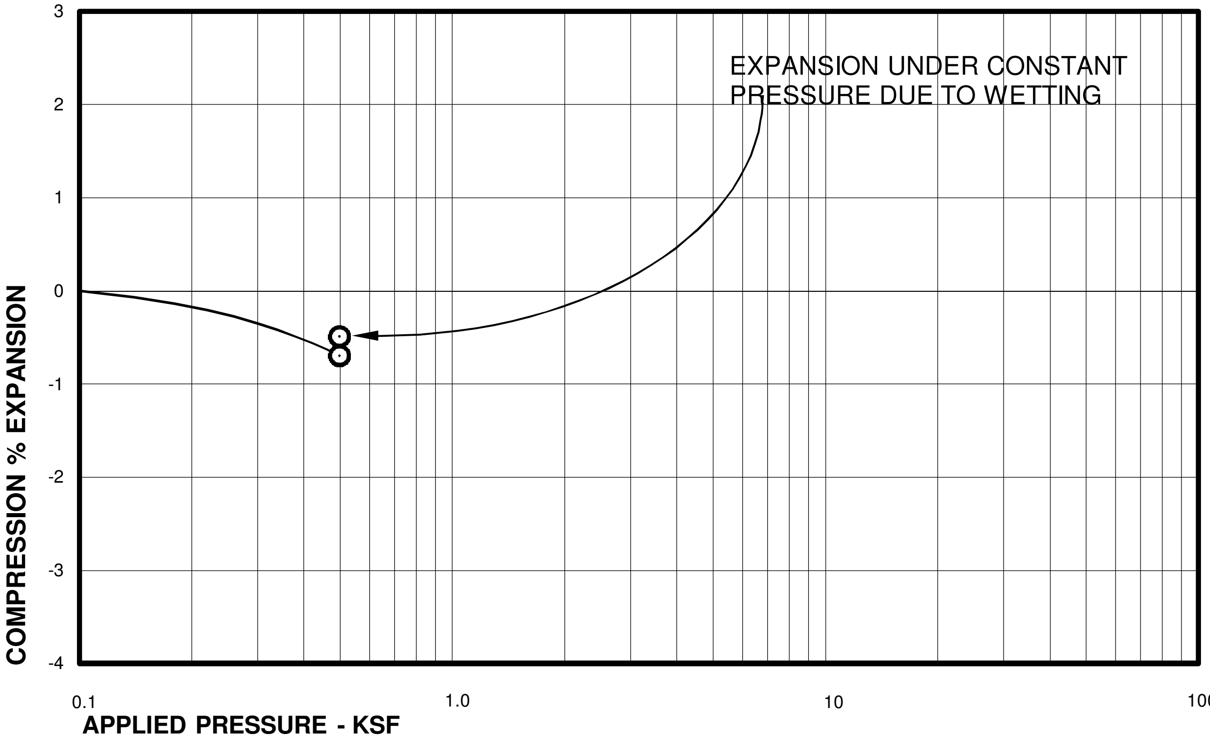
▼ WATER LEVEL MEASURED SEVERAL DAYS AFTER DRILLING.

NOTES:

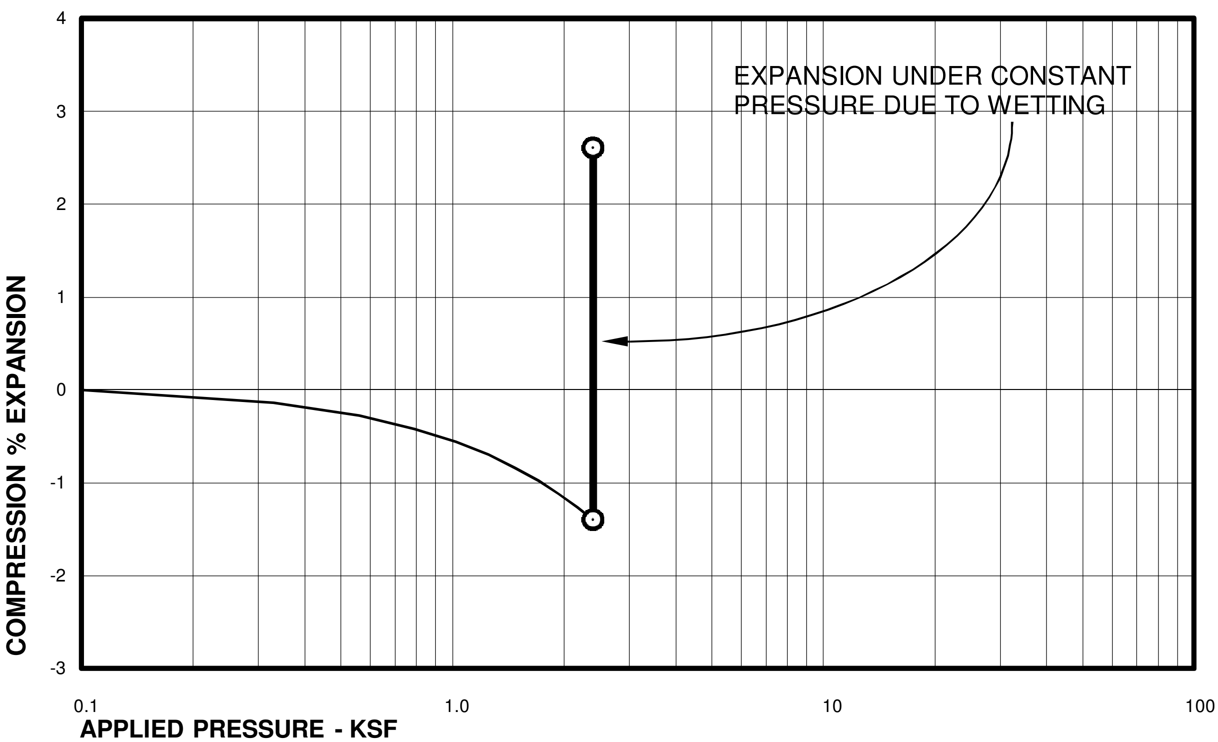
1. THE BORINGS WERE DRILLED BETWEEN MAY 16 AND 18, 2016 USING 4-INCH DIAMETER, CONTINUOUS-FLIGHT SOLID-STEM AUGER AND A TRUCK-MOUNTED CME-45 DRILL RIG.
2. BORING LOCATIONS AND ELEVATIONS WERE DETERMINED BY A REPRESENTATIVE OF OUR FIRM REFERENCING THE TEMPORARY BENCHMARK SHOWN ON FIG. 1.
3. WC INDICATES MOISTURE CONTENT (%).
   DD - INDICATES DRY DENSITY (PCF).
   SW - INDICATES SWELL WHEN WETTED UNDER APPLIED PRESSURE (%).
   COM- INDICATES COMPRESSION WHEN WETTED UNDER APPLIED PRESSURE (%).
   LL - INDICATES LIQUID LIMIT.
   PI - INDICATES PLASTICITY INDEX.
   -200 - INDICATES PASSING NO. 200 SIEVE (%).
   UC - INDICATES UNCONFINED COMPRESSIVE STRENGTH (psf).
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT (%).
   pF - INDICATES SOIL SUCTION VALUE (pF).
4. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS CONTAINED IN THIS REPORT.

APPENDIX B

LABORATORY TEST RESULTS



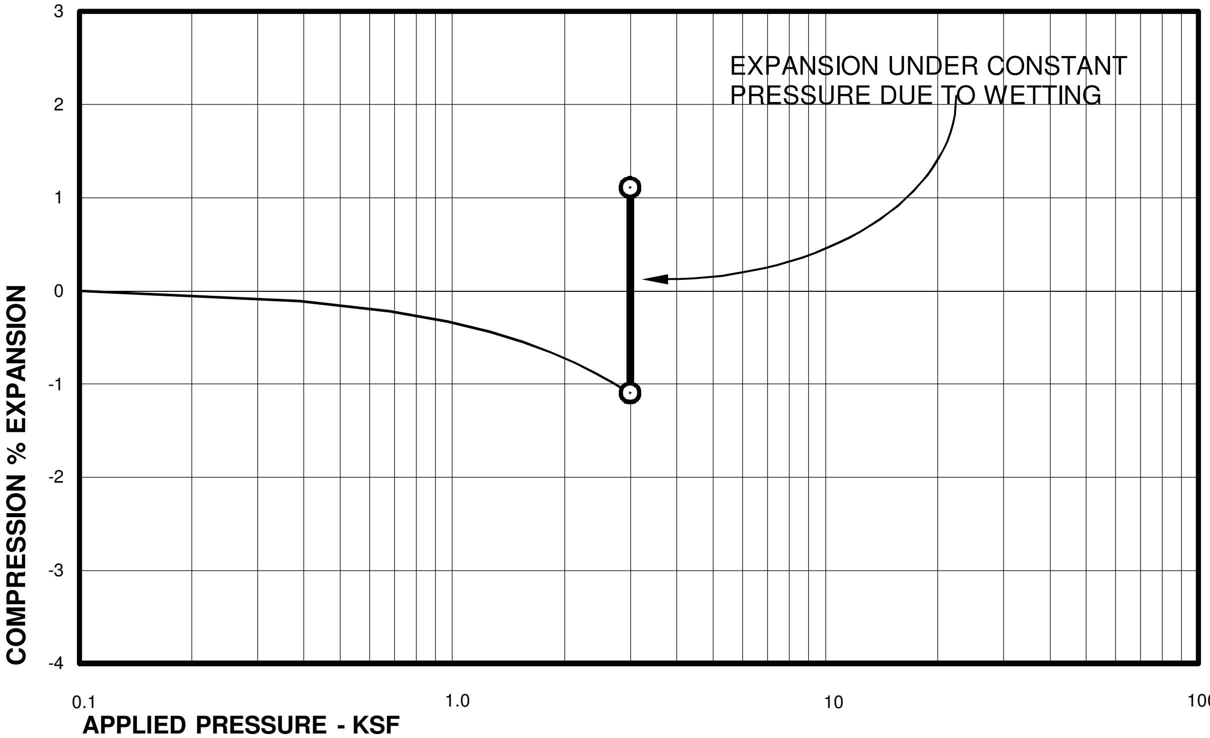
Sample of	FILL, CLAY, SANDY	DRY UNIT WEIGHT=	117	PCF
From	TH-1 AT 4 FEET	MOISTURE CONTENT=	11.1	%



Sample of	CLAYSTONE	DRY UNIT WEIGHT=	105	PCF
From	TH-1 AT 19 FEET	MOISTURE CONTENT=	22.0	%

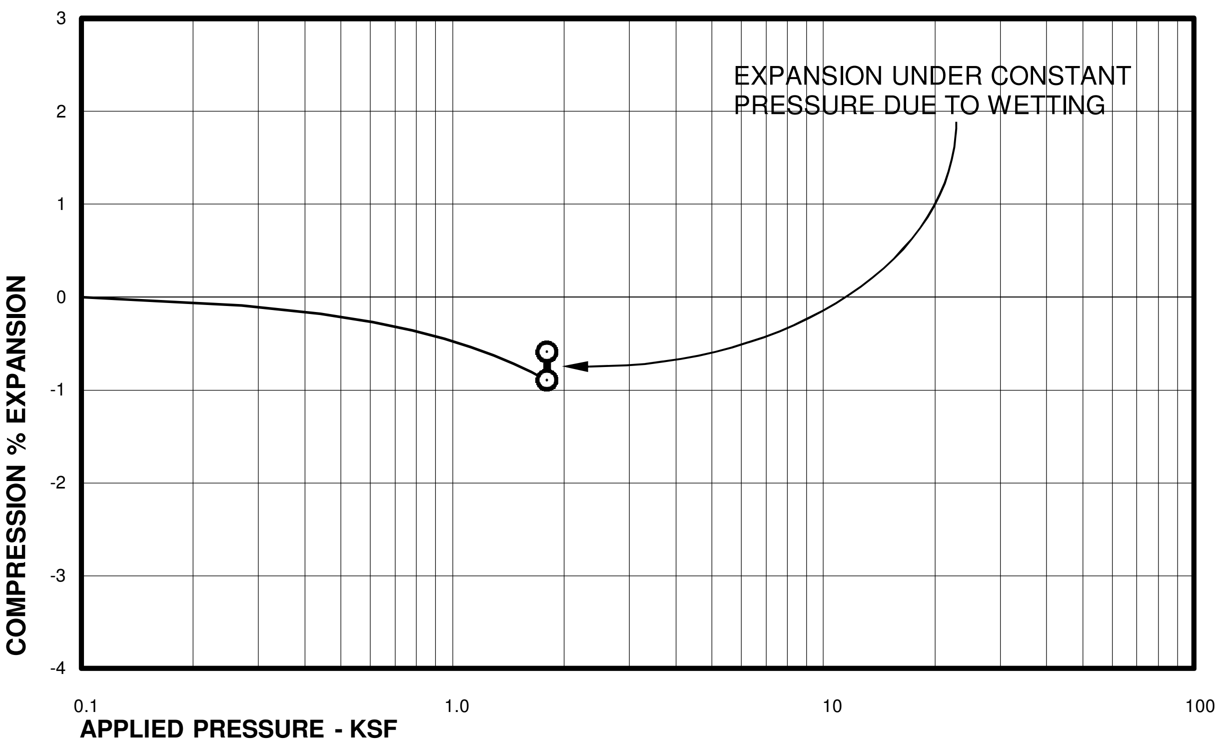
Swell Consolidation Test Results

FIG. B-1



Sample of CLAYSTONE
From TH-1 AT 24 FEET

DRY UNIT WEIGHT= 98 PCF
MOISTURE CONTENT= 26.5 %

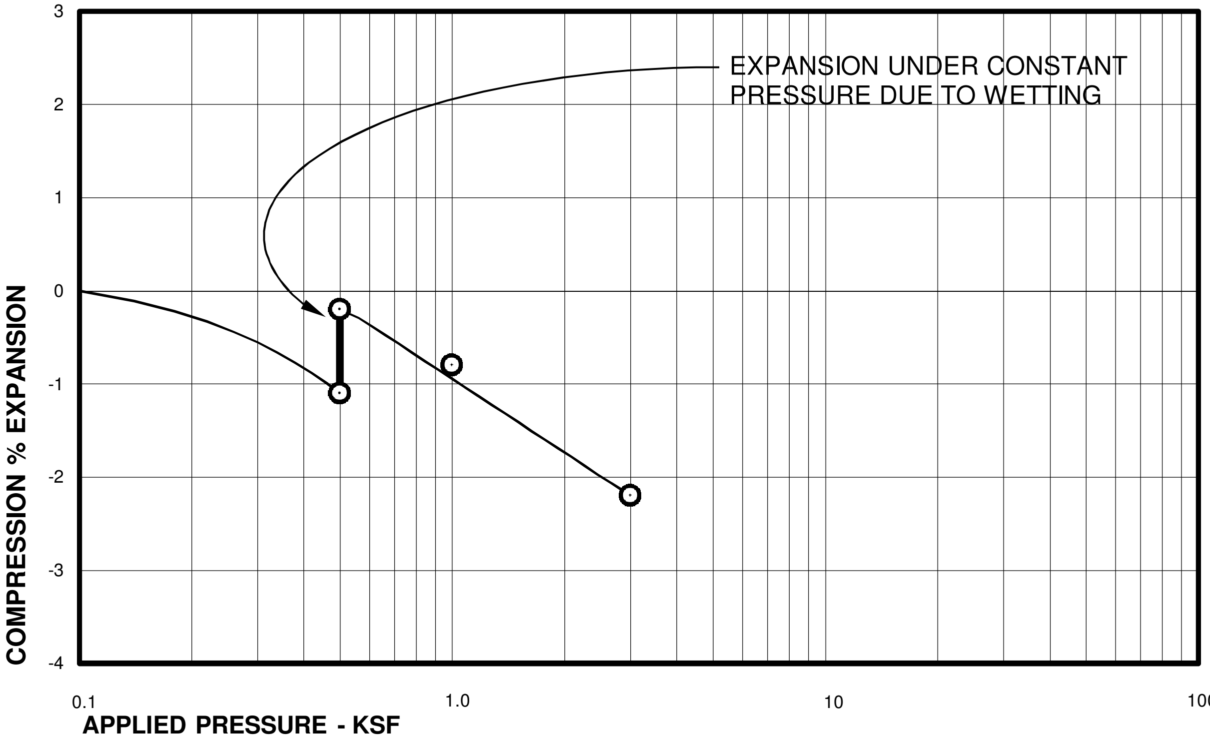


Sample of WEATHERED CLAYSTONE
From TH-3 AT 14 FEET

DRY UNIT WEIGHT= 114 PCF
MOISTURE CONTENT= 14.9 %

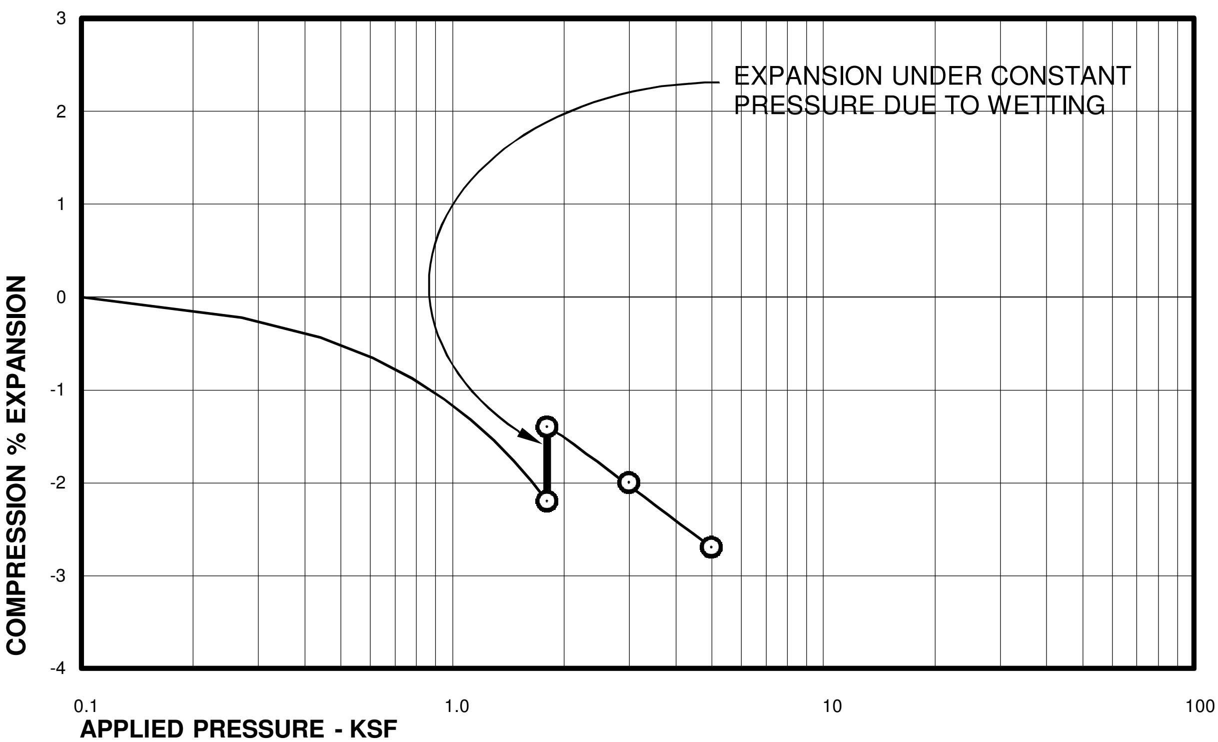
Swell Consolidation Test Results

FIG. B-2



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

DRY UNIT WEIGHT= 109 PCF
MOISTURE CONTENT= 18.3 %



Sample of CLAY, SANDY (CL)
From TH-4 AT 14 FEET

DRY UNIT WEIGHT= 86 PCF
MOISTURE CONTENT= 34.5 %

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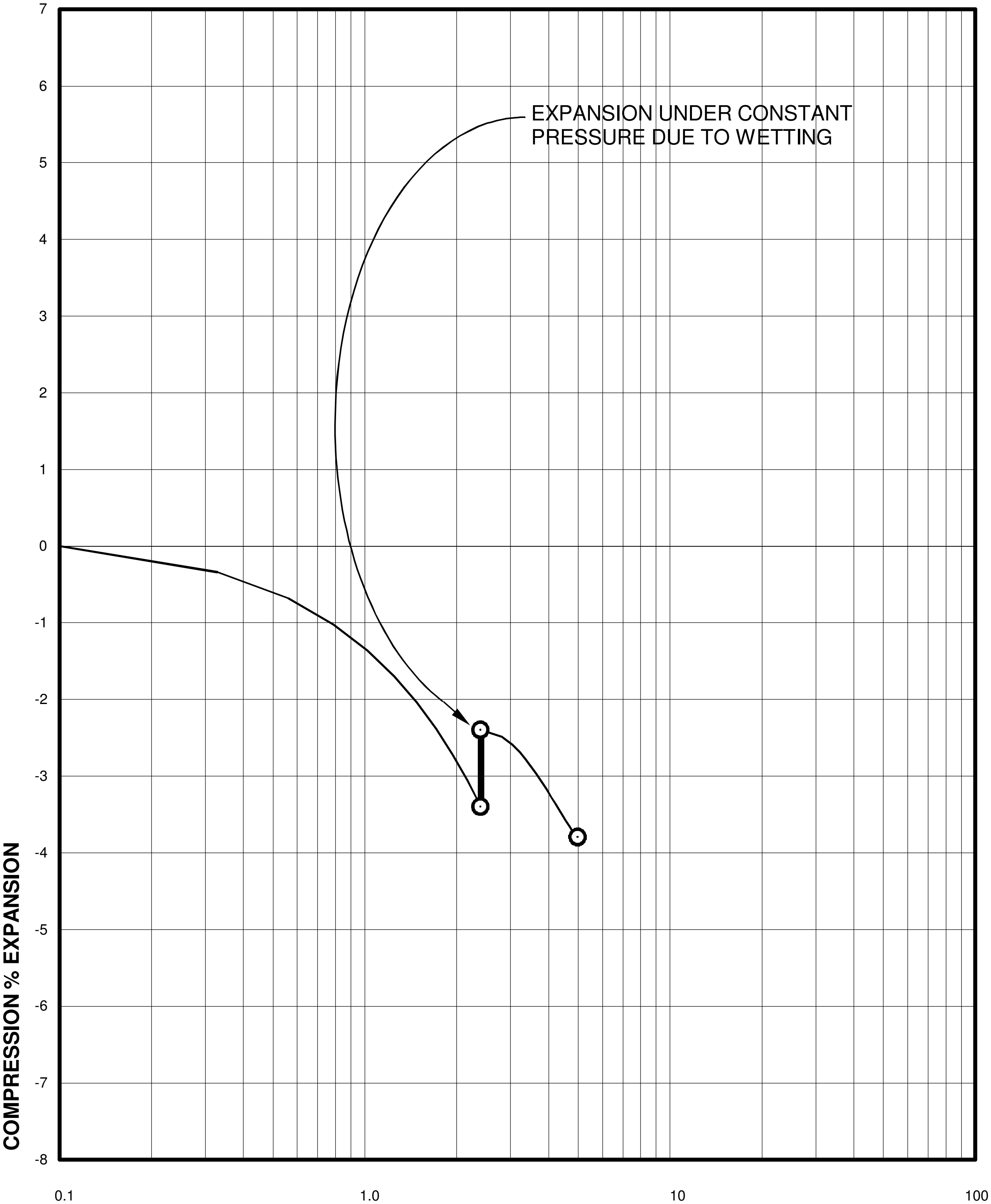
Swell Consolidation Test Results

FIG. B-3



Sample of CLAY, SANDY (CL)

From TH-4 AT 19 FEET

DRY UNIT WEIGHT= 79 PCF

MOISTURE CONTENT= 40.8 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
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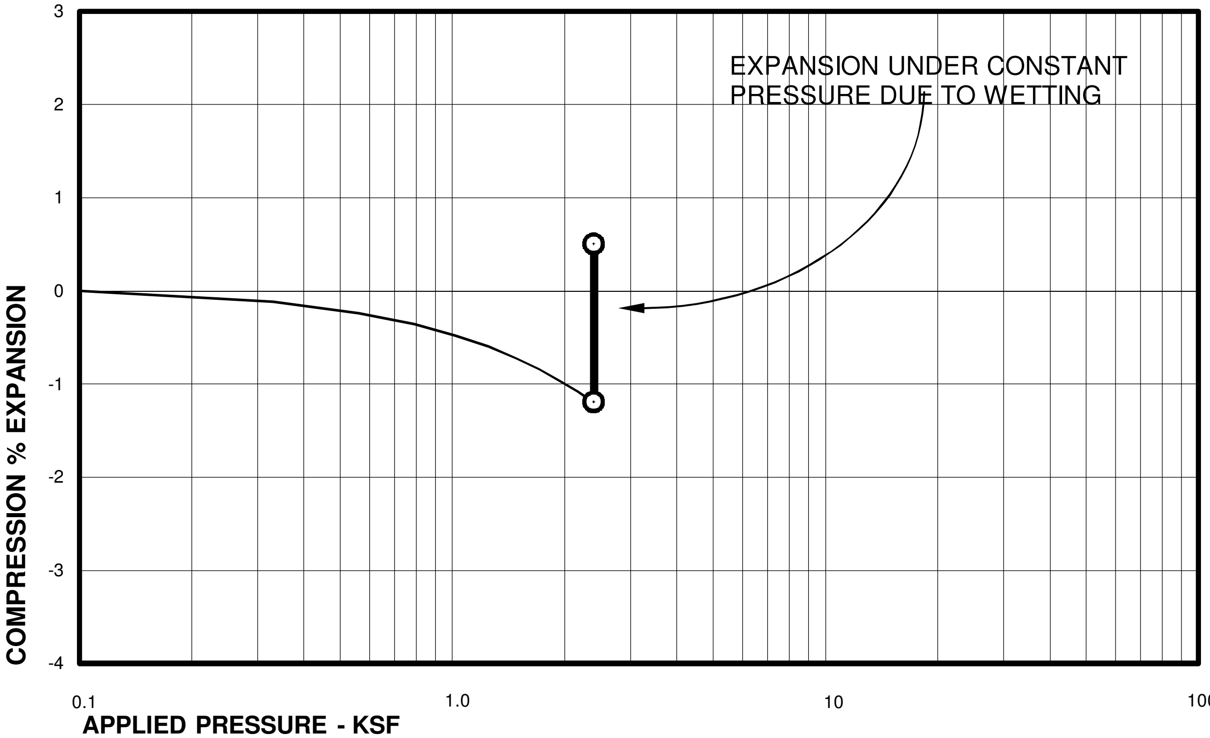
Swell Consolidation Test Results

FIG. B-4

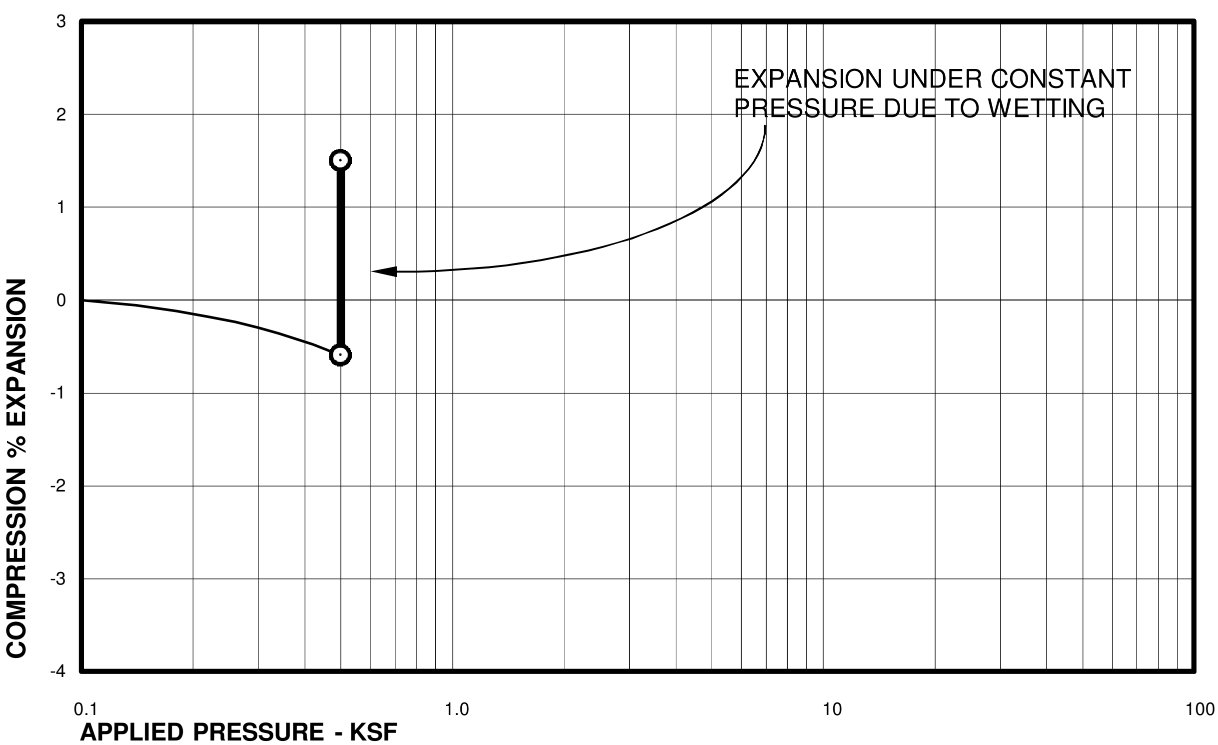


Sample of CLAYSTONE

From TH-5 AT 19 FEET

DRY UNIT WEIGHT= 126 PCF

MOISTURE CONTENT= 10.9 %



Sample of CLAYSTONE

From TH-6 AT 4 FEET

DRY UNIT WEIGHT= 102 PCF

MOISTURE CONTENT= 20.8 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
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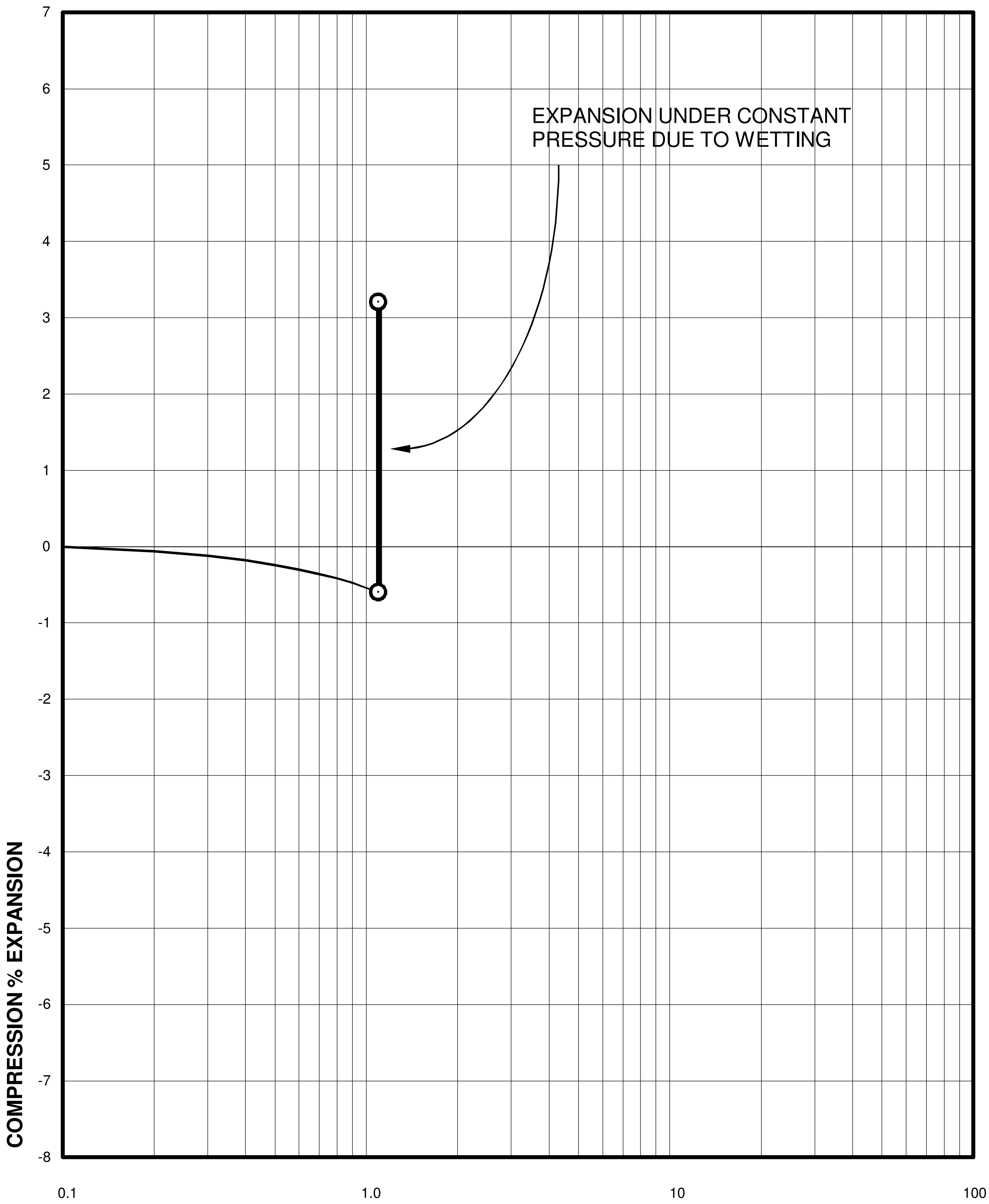
Swell Consolidation Test Results

FIG. B-5



Sample of CLAYSTONE

From TH-6 AT 9 FEET

DRY UNIT WEIGHT= 102 PCF

MOISTURE CONTENT= 21.3 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
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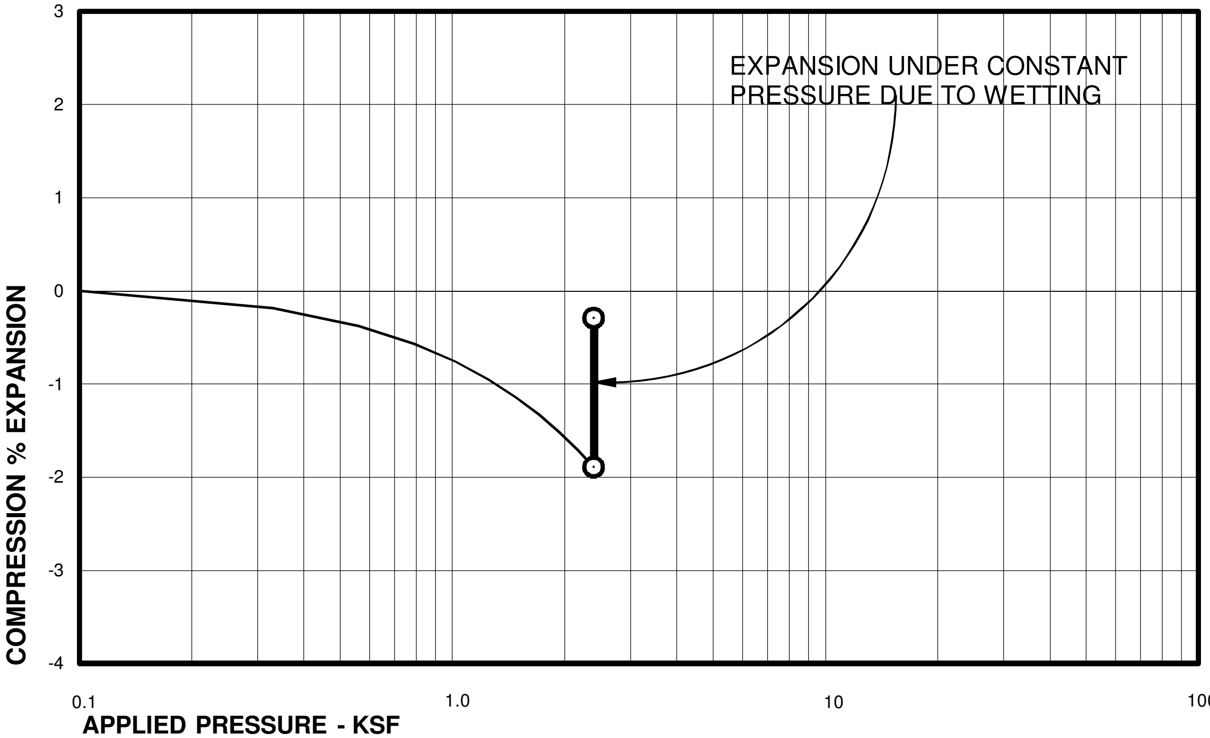
Swell Consolidation Test Results

FIG. B-6

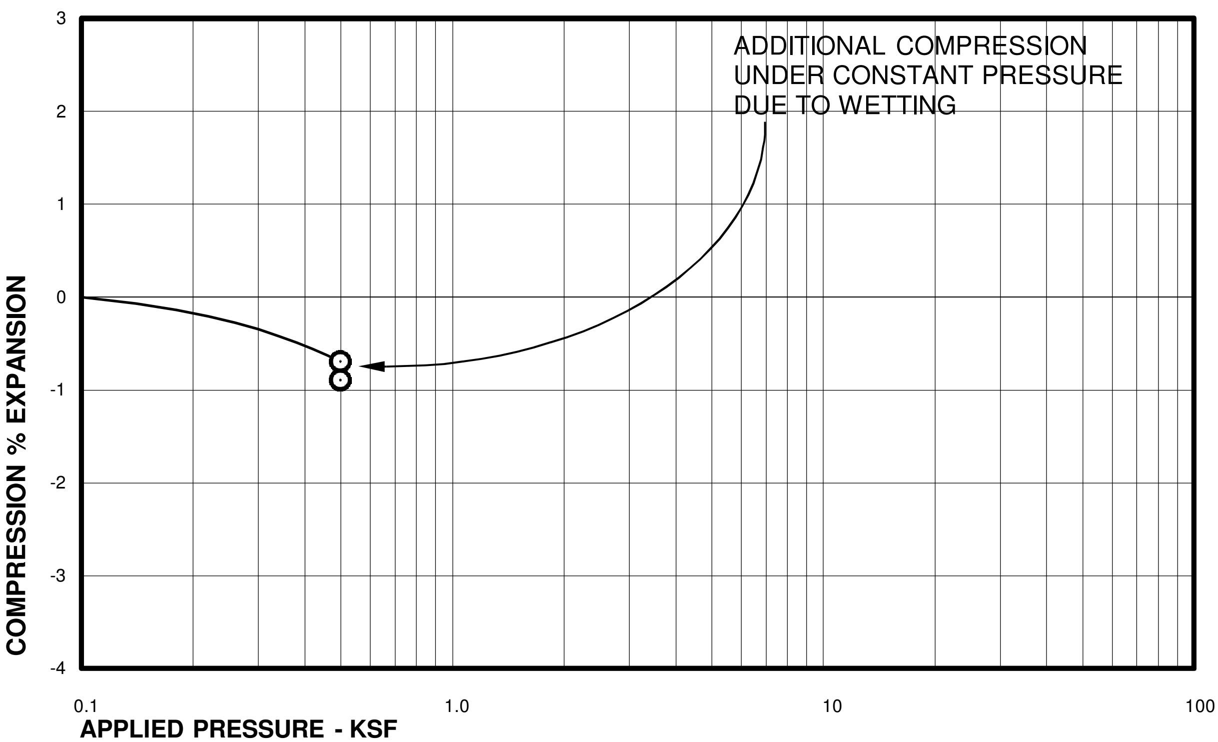


Sample of CLAYSTONE

From TH-6 AT 19 FEET

DRY UNIT WEIGHT= 115 PCF

MOISTURE CONTENT= 11.6 %



Sample of CLAY, SANDY (CL)

From TH-7 AT 4 FEET

DRY UNIT WEIGHT= 107 PCF

MOISTURE CONTENT= 8.1 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
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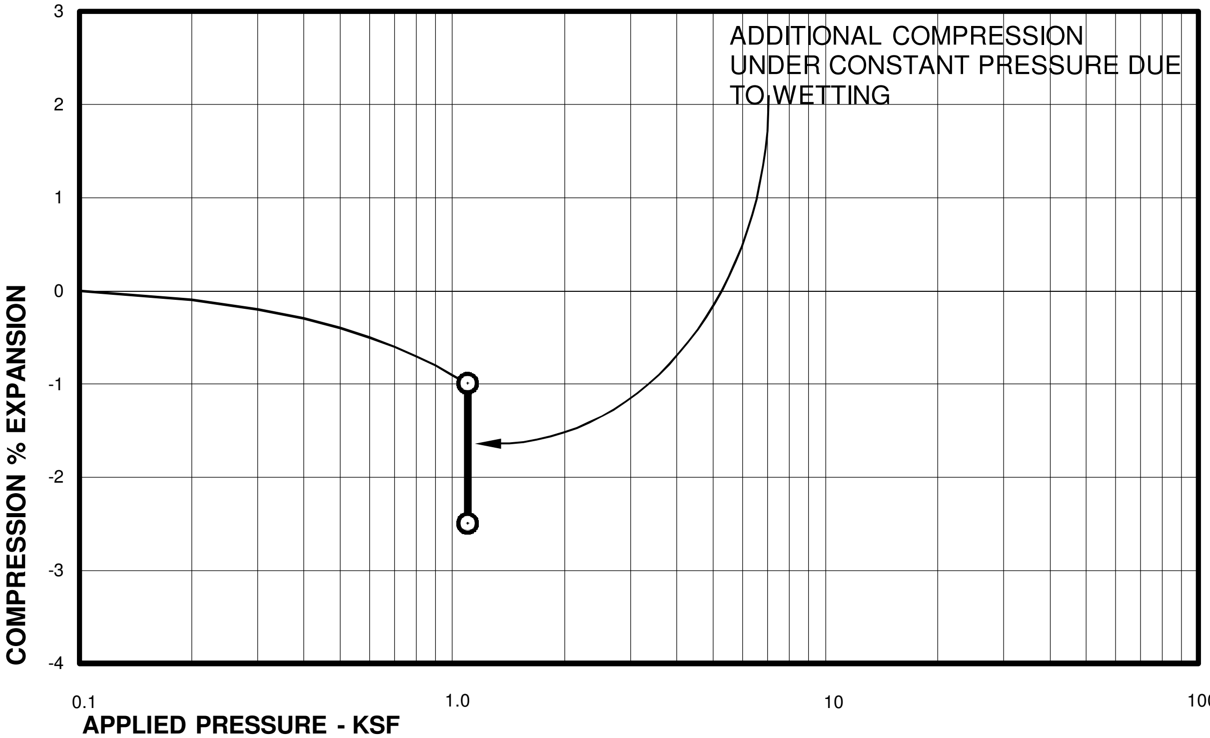
Swell Consolidation Test Results

FIG. B-7

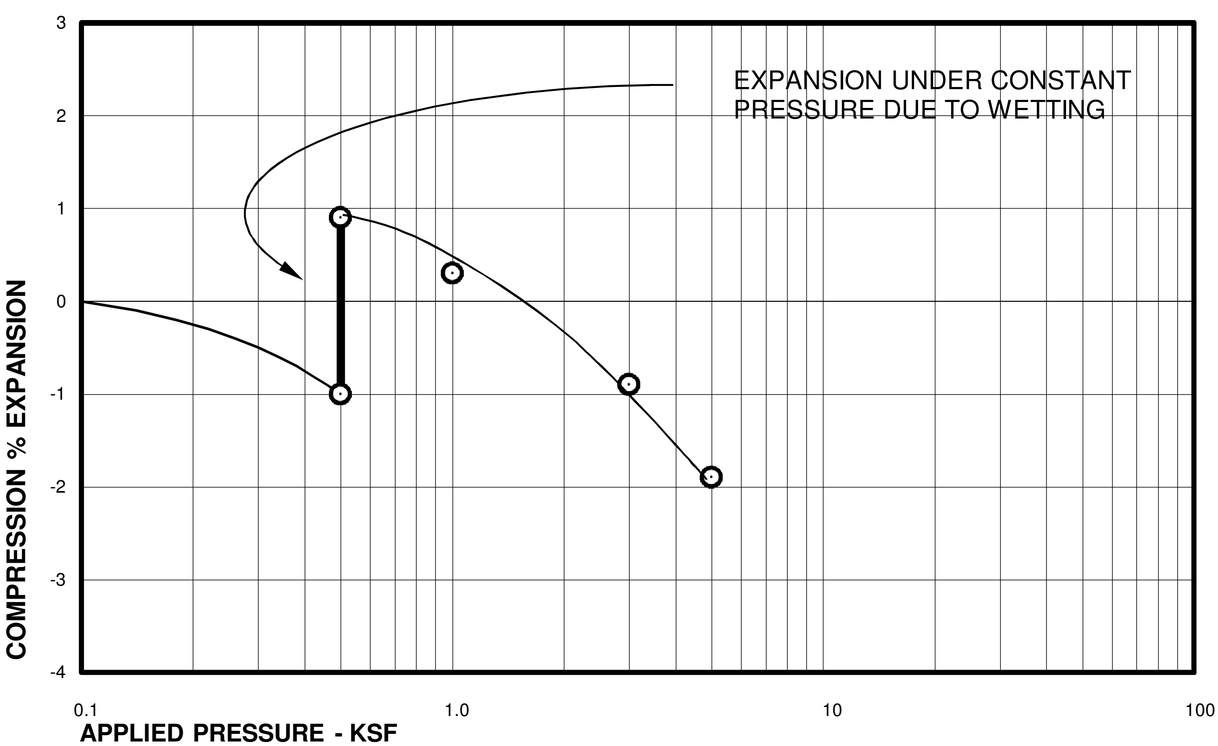


Sample of CLAY, SANDY (CL)

From TH-7 AT 9 FEET

DRY UNIT WEIGHT= 100 PCF

MOISTURE CONTENT= 8.9 %



Sample of CLAY, SANDY (CL)

From TH-8 AT 4 FEET

DRY UNIT WEIGHT= 96 PCF

MOISTURE CONTENT= 16.3 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
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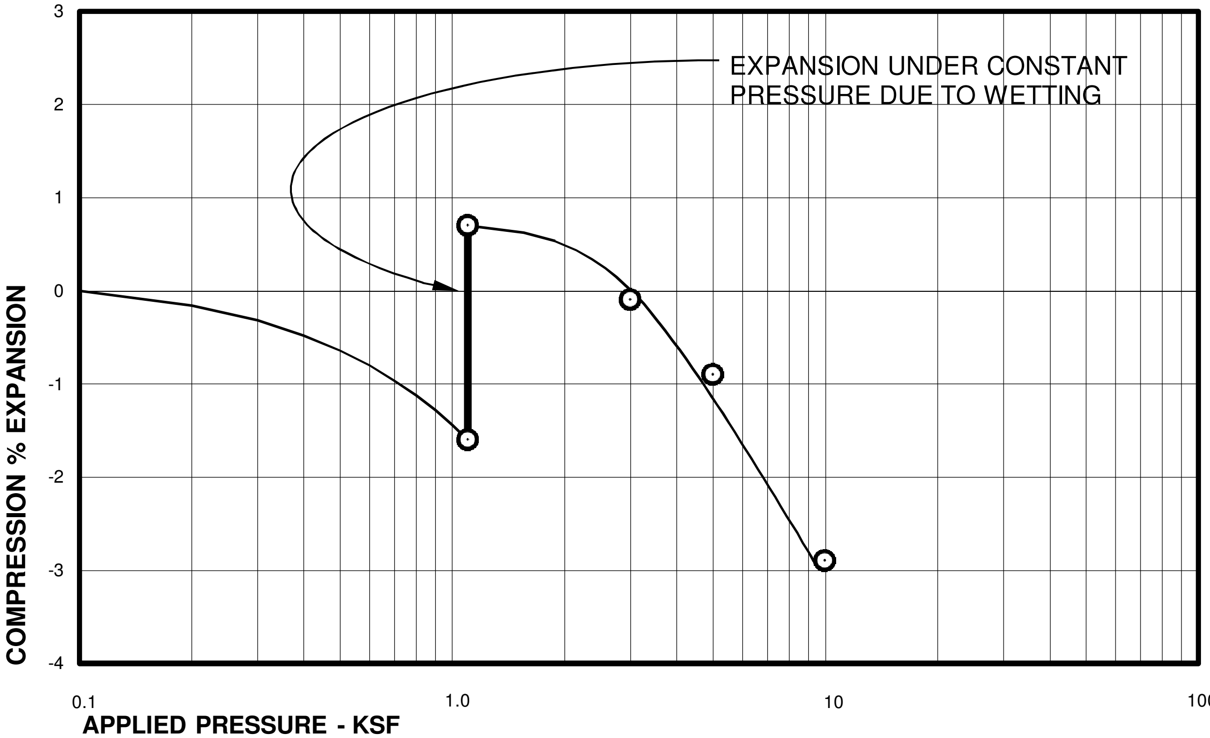
Swell Consolidation Test Results

FIG. B-8

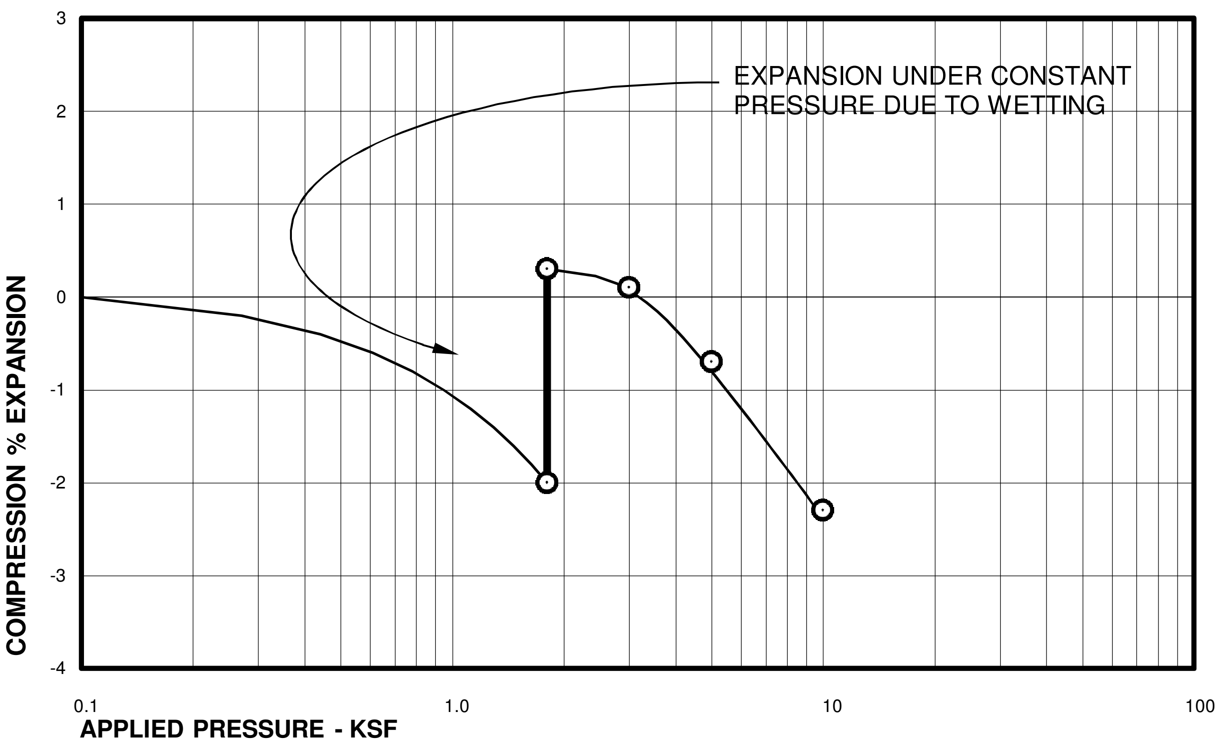


Sample of CLAY, SANDY (CL)

From TH-8 AT 9 FEET

DRY UNIT WEIGHT= 107 PCF

MOISTURE CONTENT= 13.7 %



Sample of CLAY, SANDY (CL)

From TH-8 AT 14 FEET

DRY UNIT WEIGHT= 115 PCF

MOISTURE CONTENT= 16.1 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
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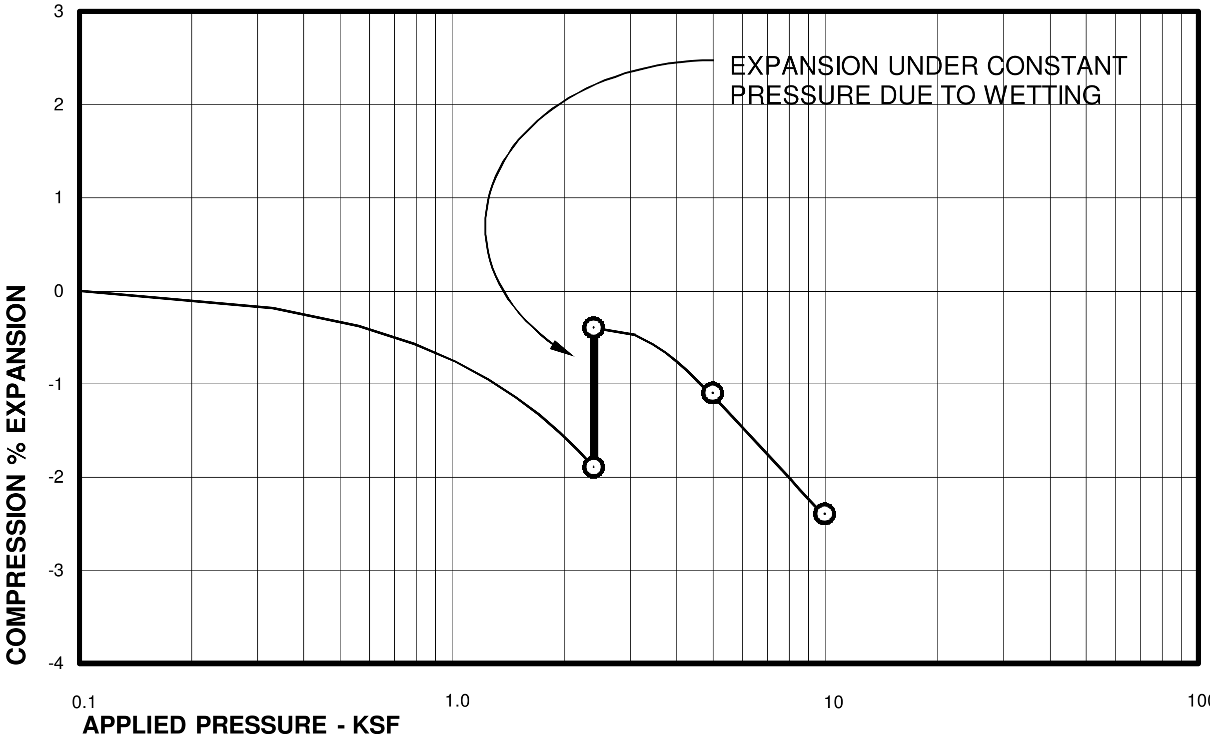
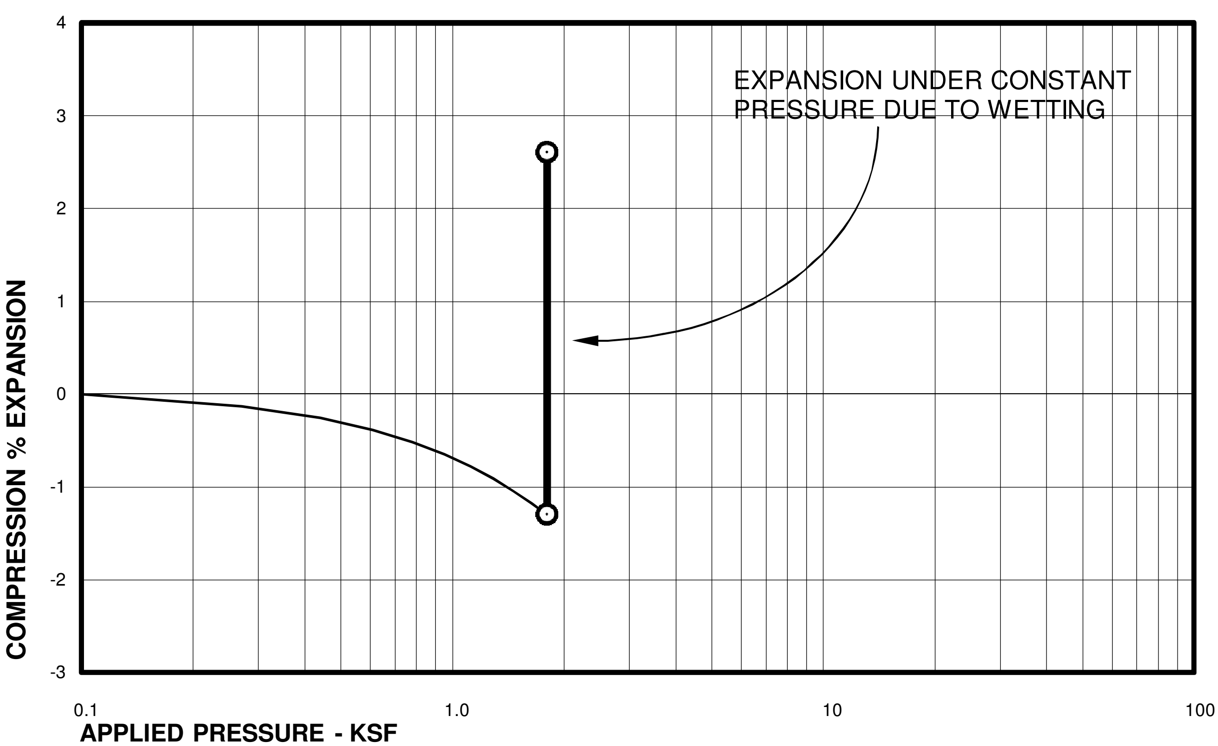
Swell Consolidation Test Results

FIG. B-9



Sample of CLAY, SANDY (CL)
From TH-8 AT 19 FEET

DRY UNIT WEIGHT= 102 PCF
MOISTURE CONTENT= 19.7 %



Sample of CLAYSTONE
From TH-9 AT 14 FEET

DRY UNIT WEIGHT= 114 PCF
MOISTURE CONTENT= 16.3 %

E5X MANAGMENT
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PROJECT NO. DN48,372-115
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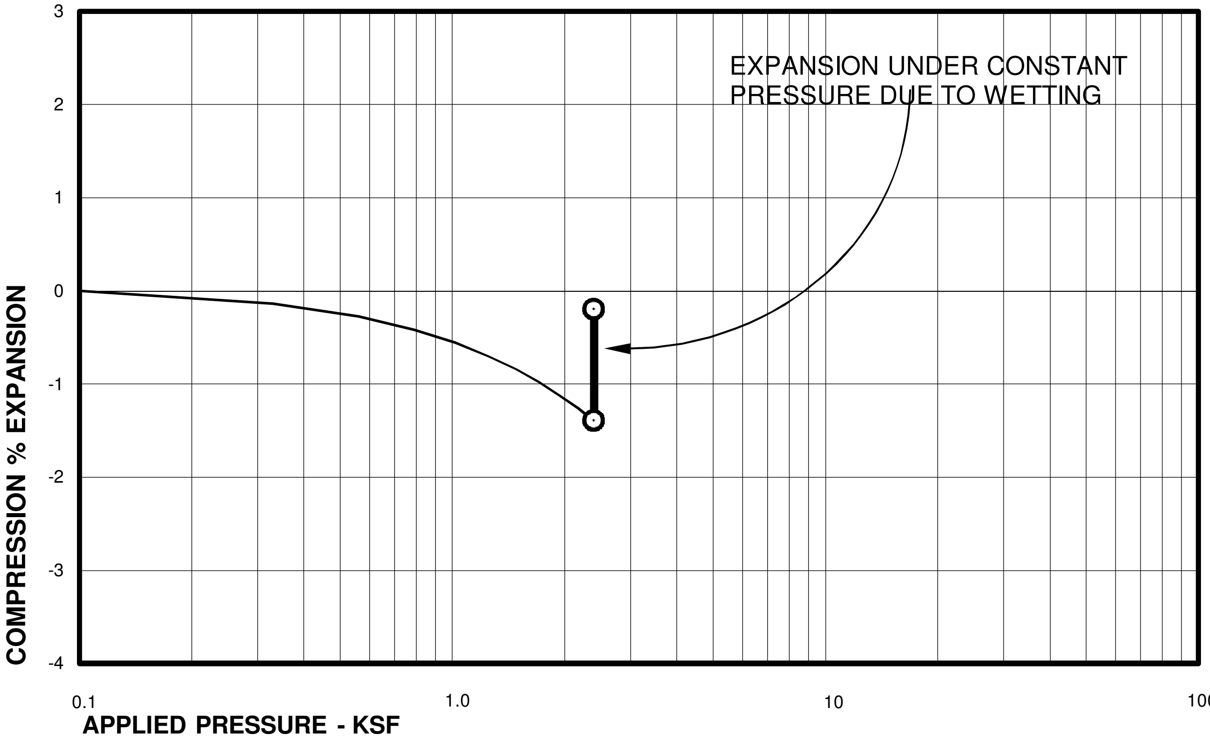
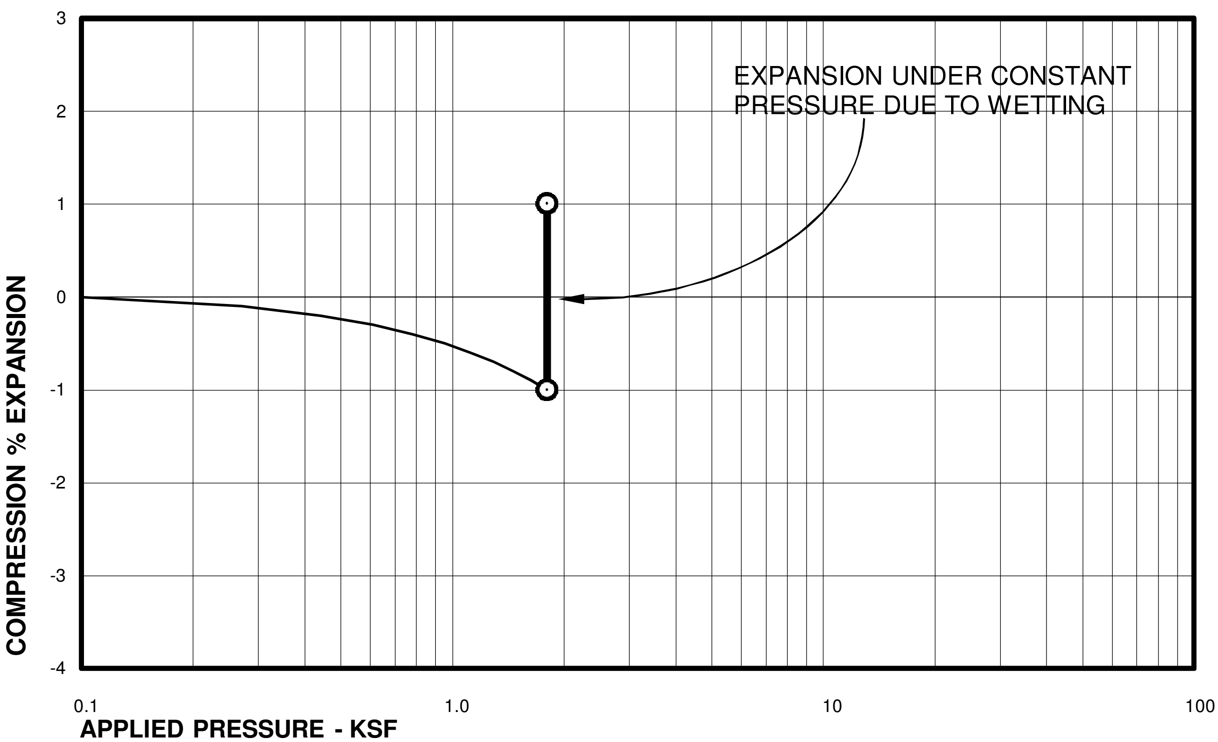
Swell Consolidation Test Results

FIG. B-10



Sample of CLAYSTONE
From TH-9 AT 19 FEET

DRY UNIT WEIGHT= 96 PCF
MOISTURE CONTENT= 27.0 %

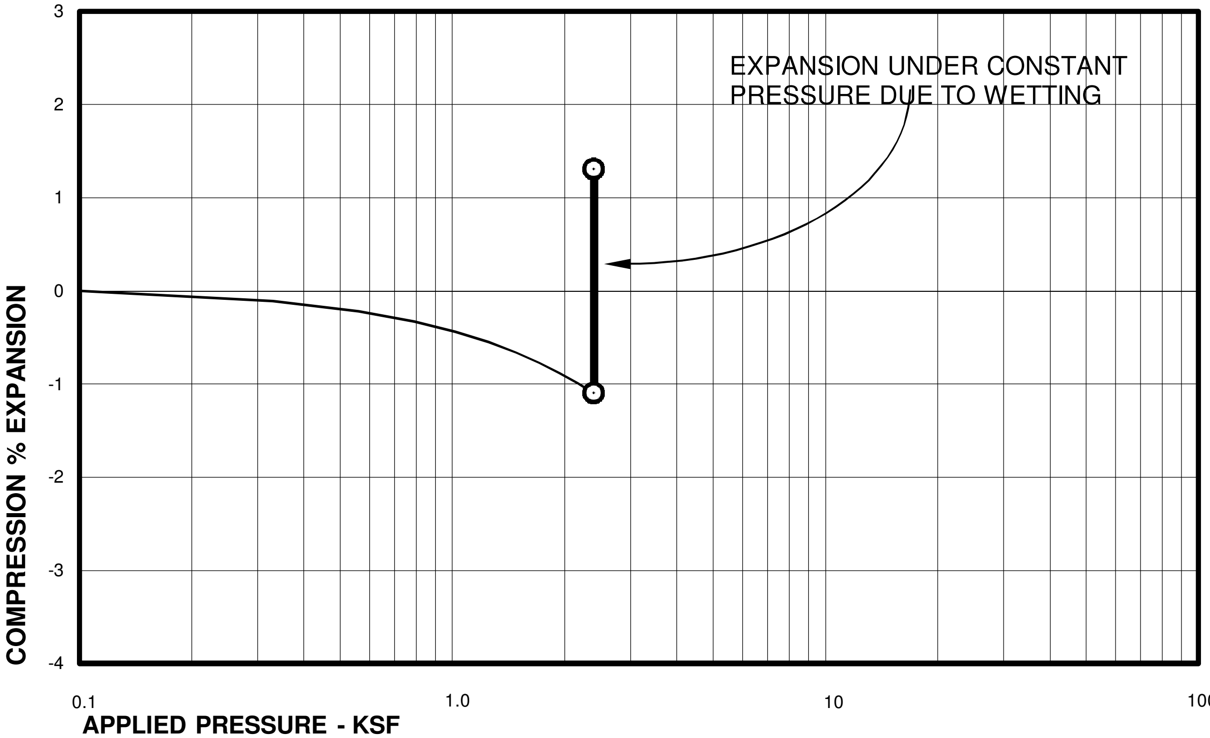


Sample of CLAYSTONE
From TH-10 AT 14 FEET

DRY UNIT WEIGHT= 118 PCF
MOISTURE CONTENT= 13.9 %

Swell Consolidation Test Results

FIG. B-11

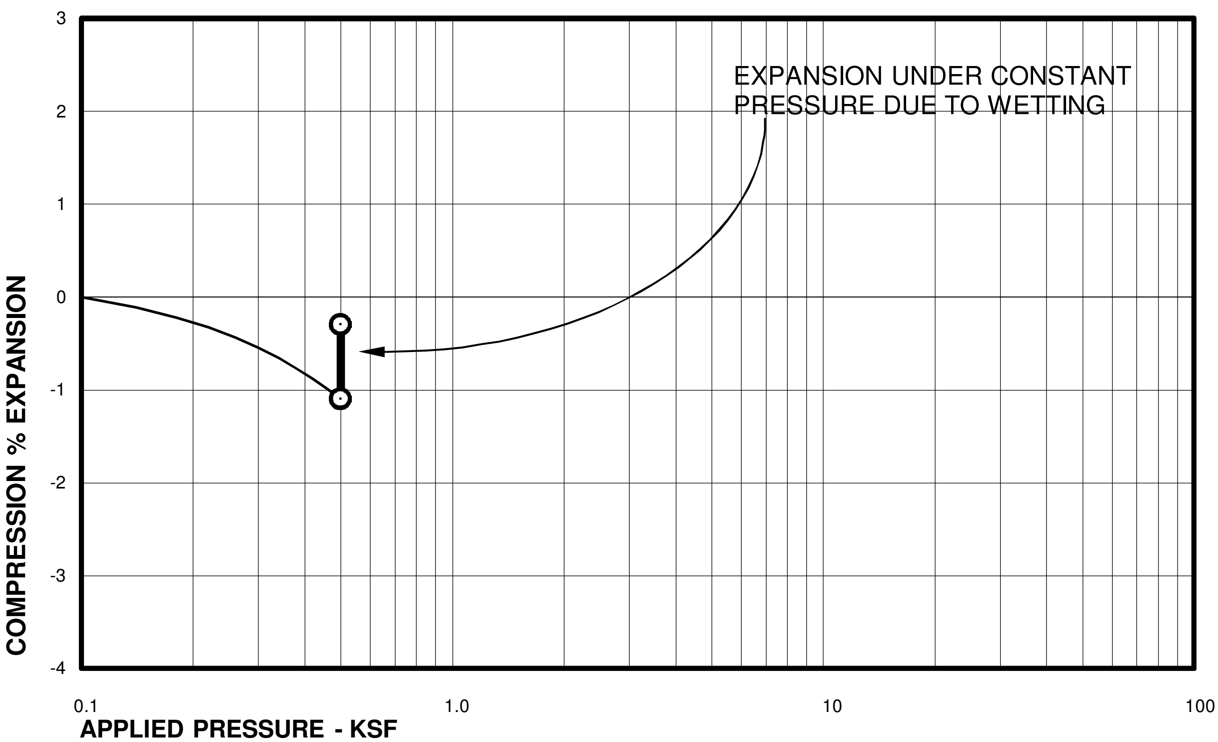


Sample of CLAYSTONE

From TH-10 AT 19 FEET

DRY UNIT WEIGHT= 108 PCF

MOISTURE CONTENT= 17.7 %



Sample of CLAY, SANDY (CL)

From TH-11 AT 4 FEET

DRY UNIT WEIGHT= 98 PCF

MOISTURE CONTENT= 10.6 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
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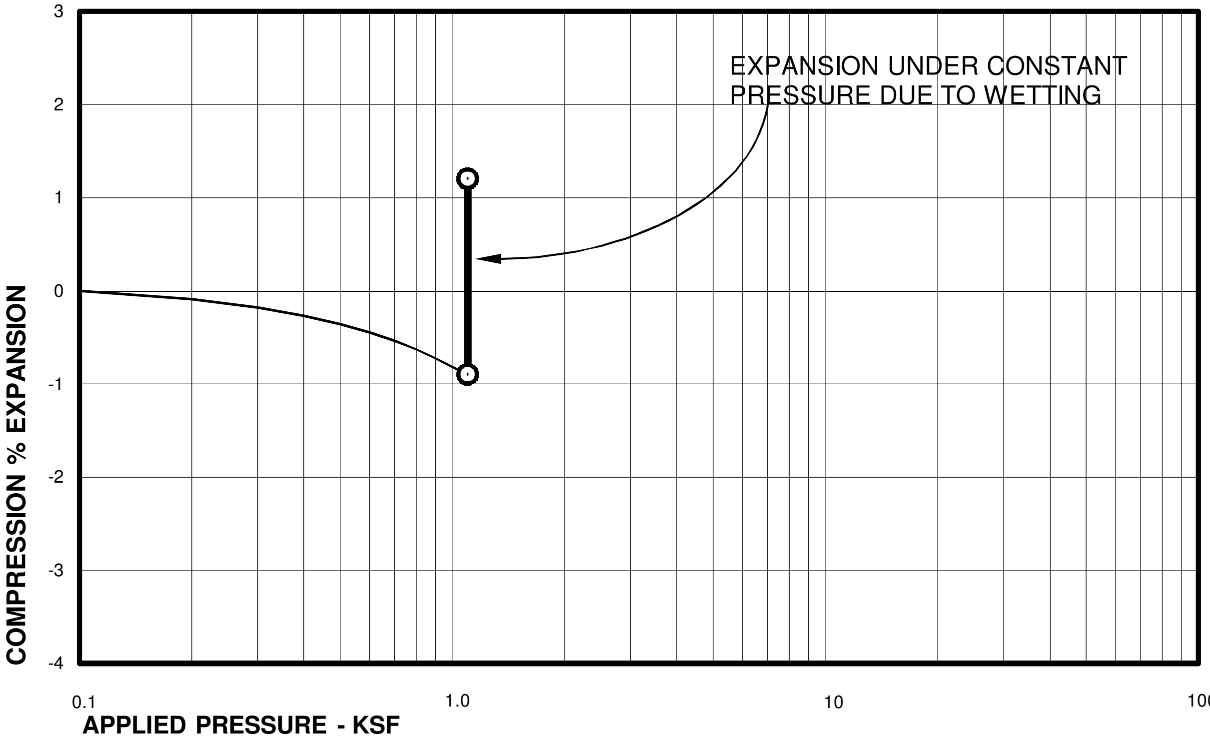
Swell Consolidation Test Results

FIG. B-12

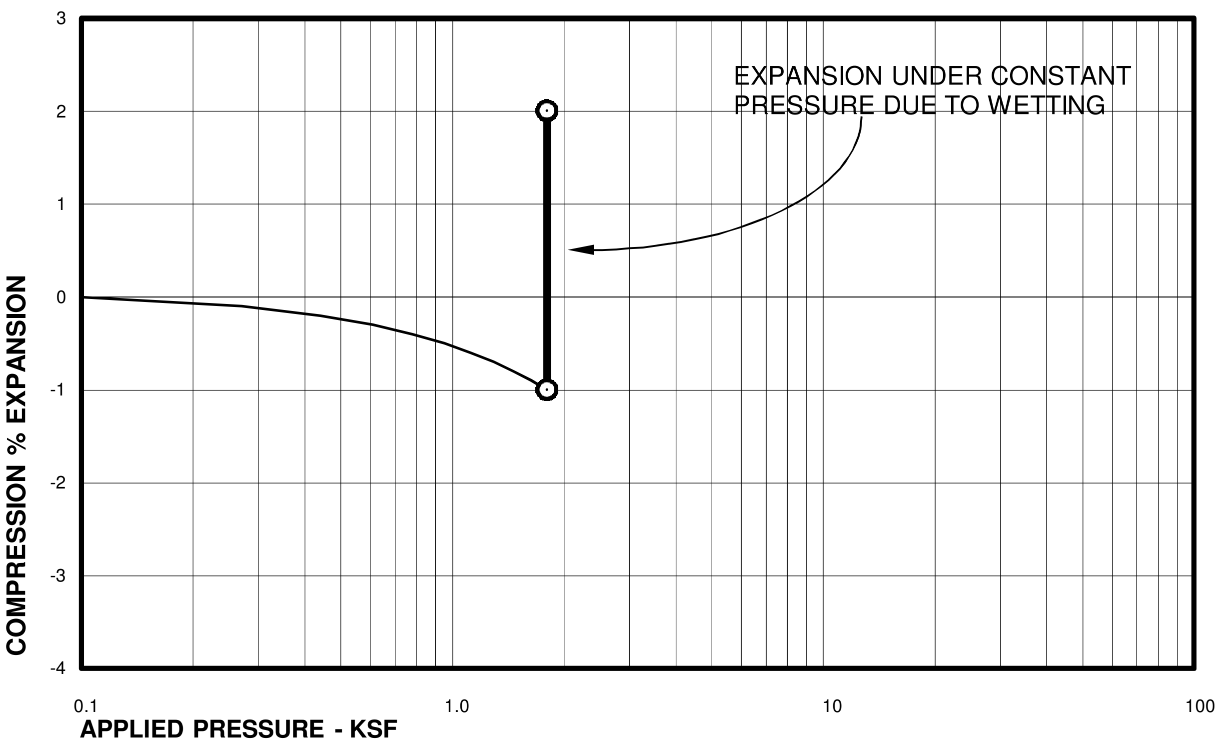


Sample of CLAYSTONE

From TH-11 AT 9 FEET

DRY UNIT WEIGHT= 105 PCF

MOISTURE CONTENT= 18.3 %



Sample of CLAYSTONE

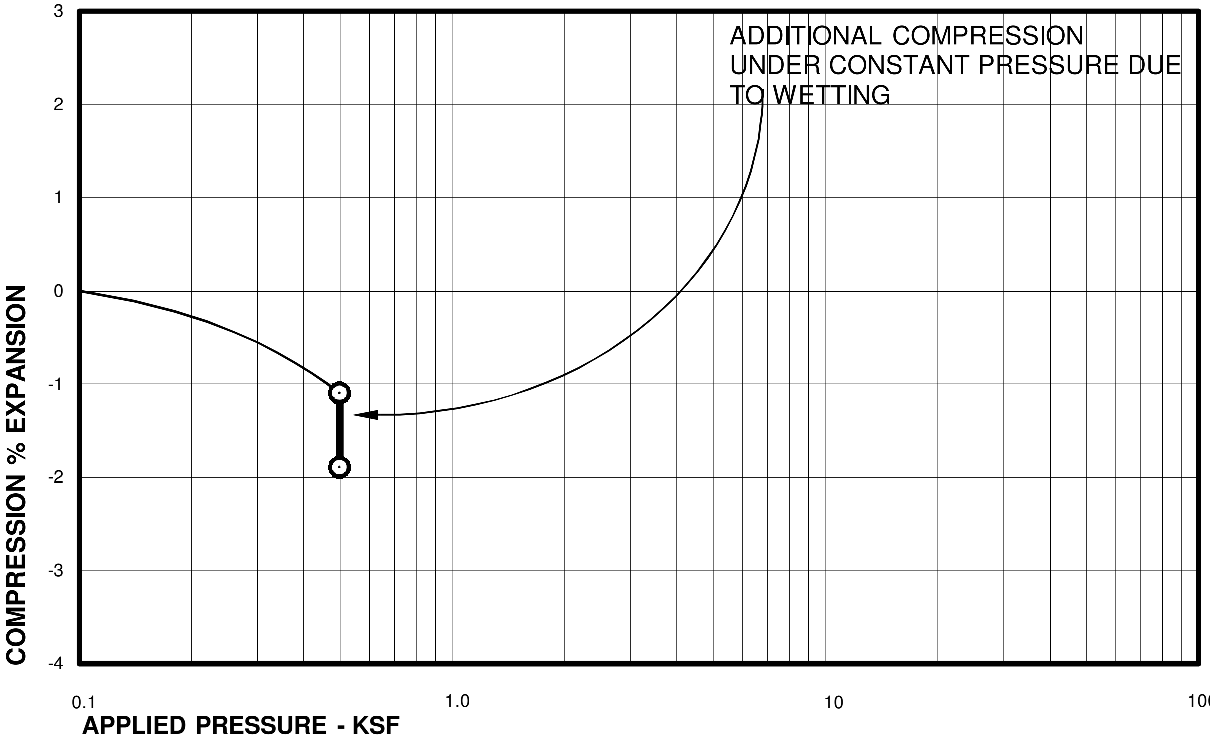
From TH-11 AT 14 FEET

DRY UNIT WEIGHT= 109 PCF

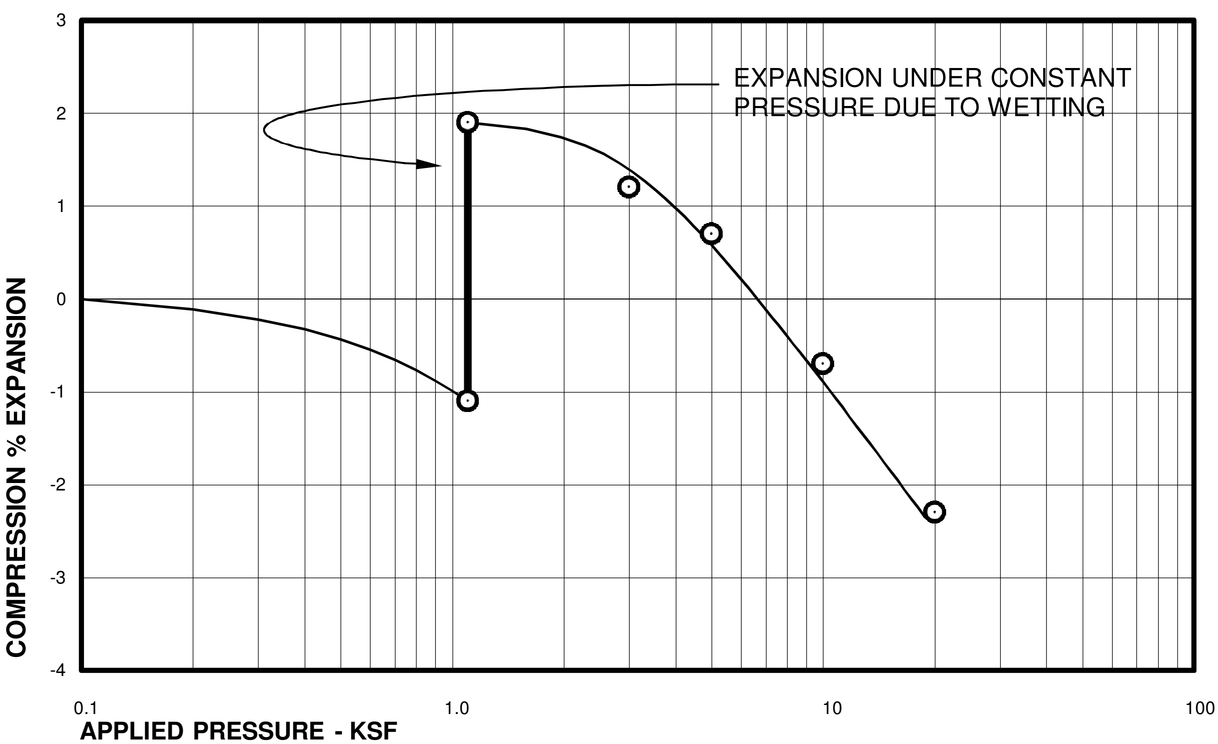
MOISTURE CONTENT= 20.1 %

Swell Consolidation Test Results

FIG. B-13



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	92	PCF
From	TH-12 AT 4 FEET	MOISTURE CONTENT=	21.1	%



Sample of	WEATHERED CLAYSTONE	DRY UNIT WEIGHT=	103	PCF
From	TH-12 AT 9 FEET	MOISTURE CONTENT=	23.5	%

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
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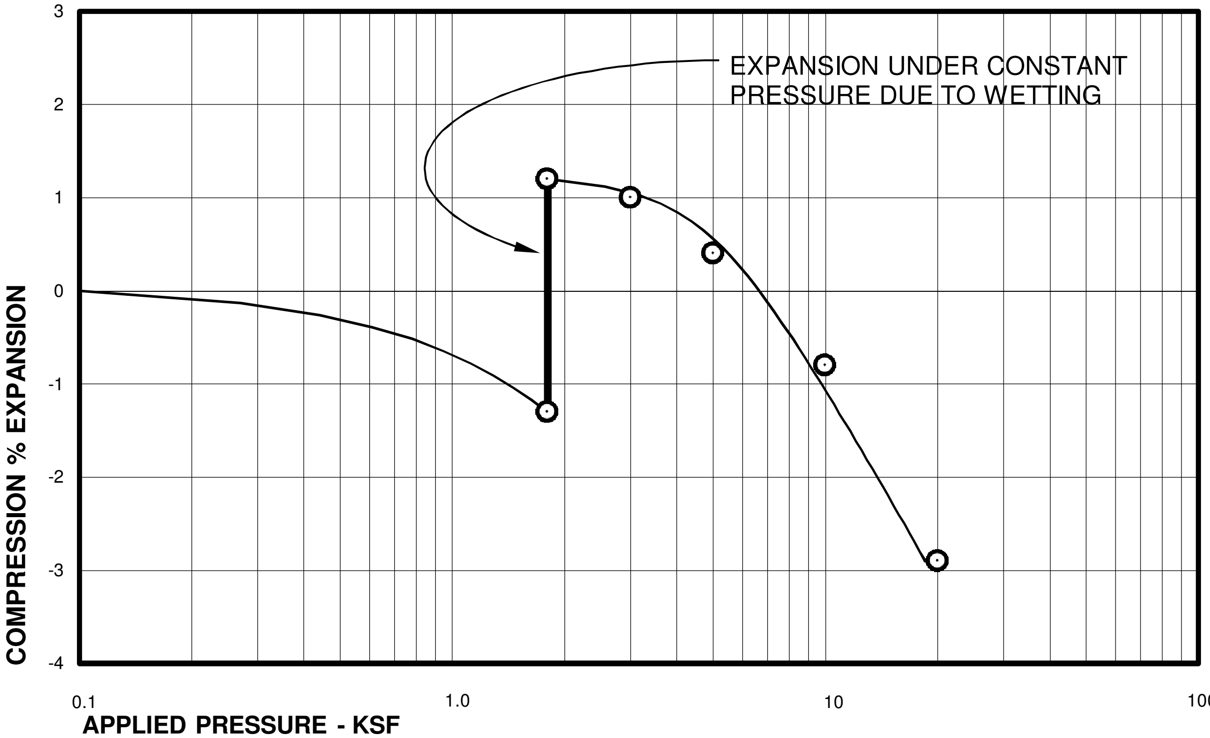
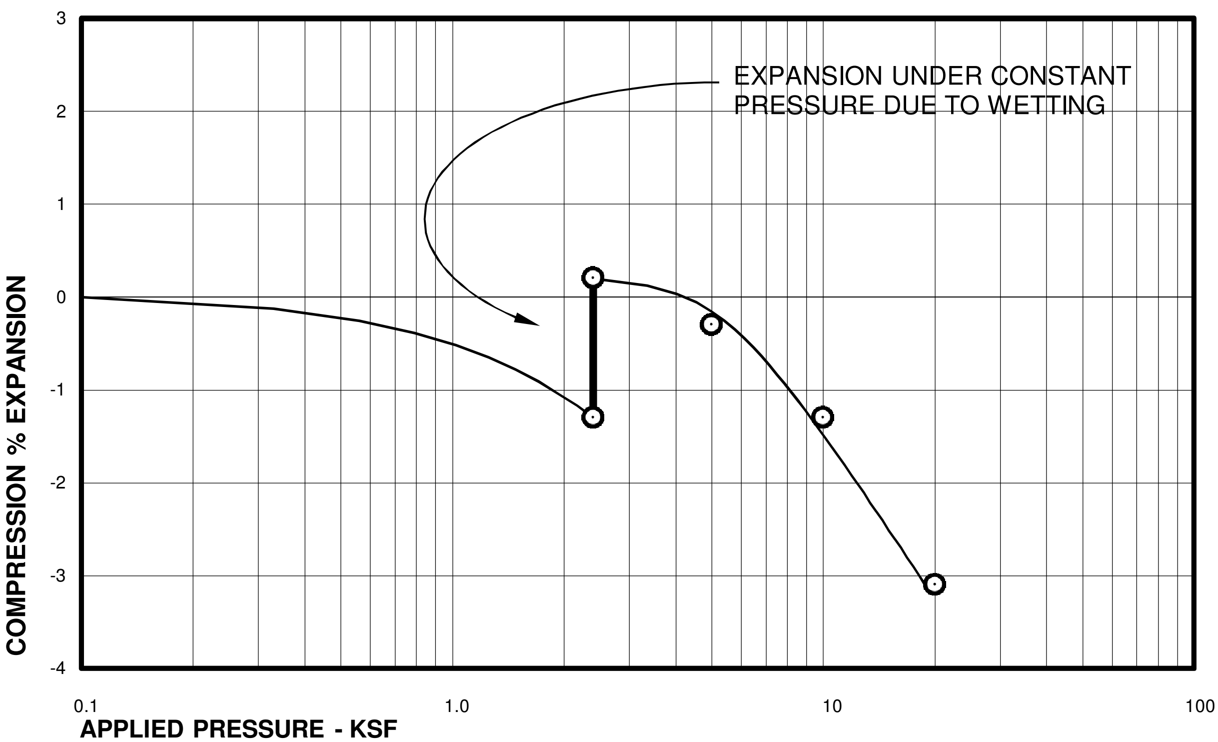
Swell Consolidation Test Results

FIG. B-14



Sample of	WEATHERED CLAYSTONE	DRY UNIT WEIGHT=	104	PCF
From	TH-12 AT 14 FEET	MOISTURE CONTENT=	23.6	%



Sample of	CLAYSTONE	DRY UNIT WEIGHT=	89	PCF
From	TH-12 AT 19 FEET	MOISTURE CONTENT=	32.3	%

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
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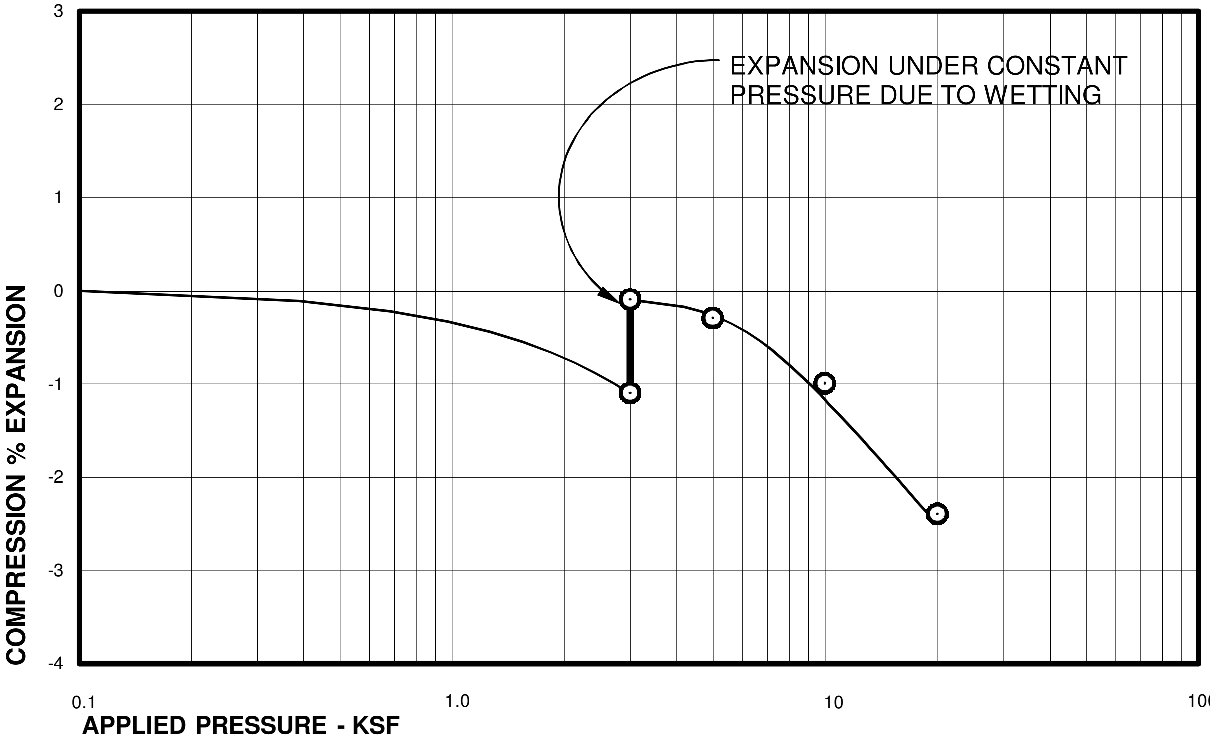
Swell Consolidation Test Results

FIG. B-15

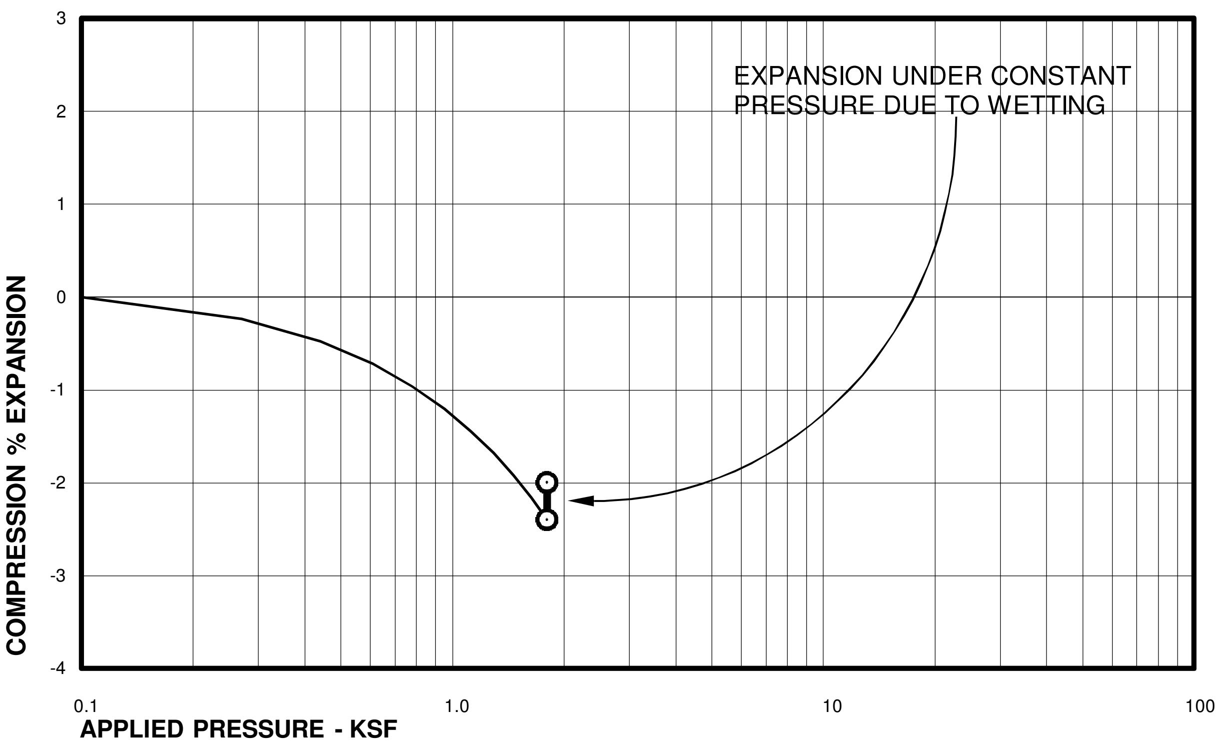


Sample of CLAYSTONE

From TH-12 AT 24 FEET

DRY UNIT WEIGHT= 96 PCF

MOISTURE CONTENT= 29.4 %



Sample of INTERLAYERED CLAY/SAND

From TH-13 AT 14 FEET

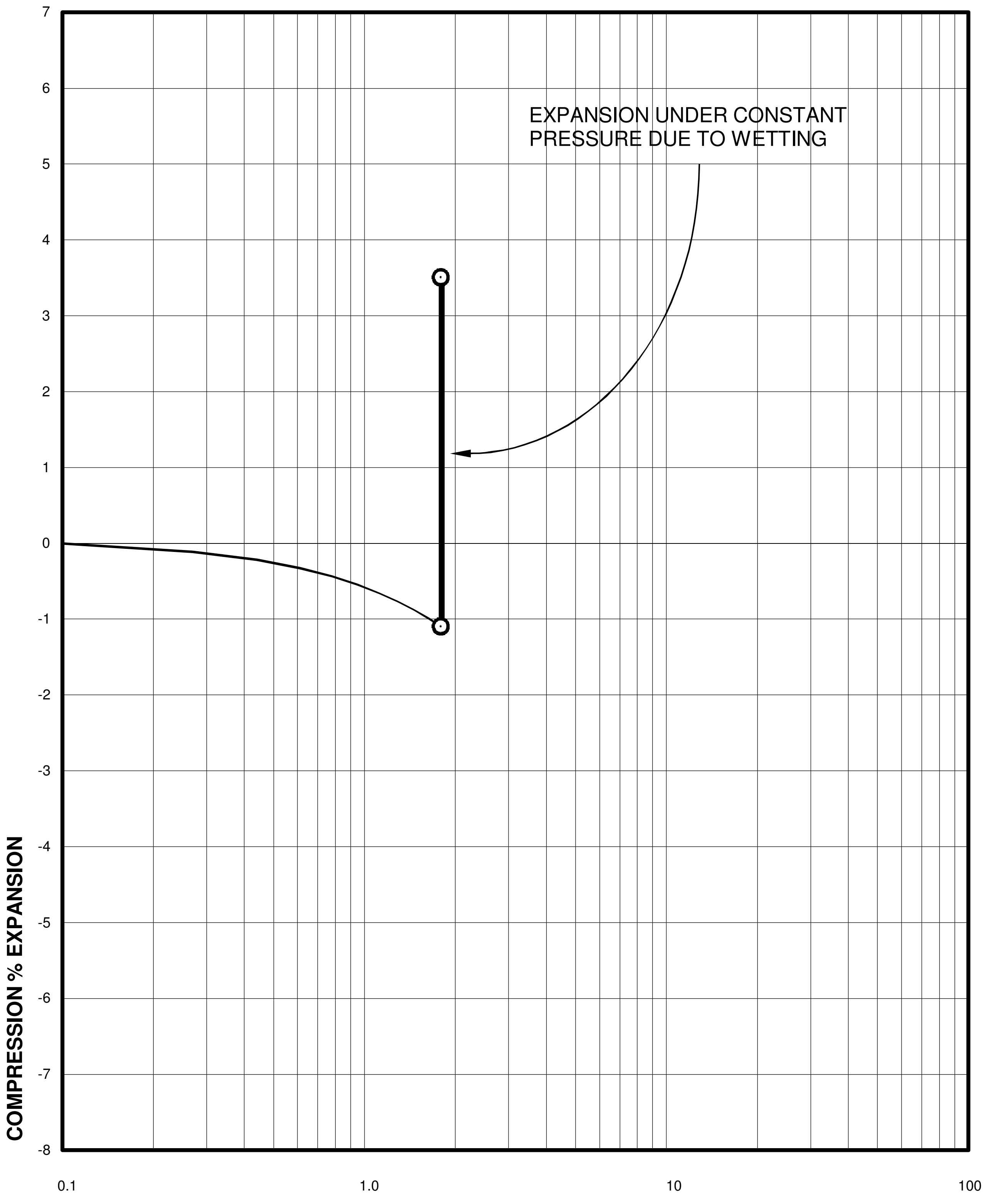
DRY UNIT WEIGHT= 85 PCF

MOISTURE CONTENT= 35.7 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

Swell Consolidation Test Results

FIG. B-16



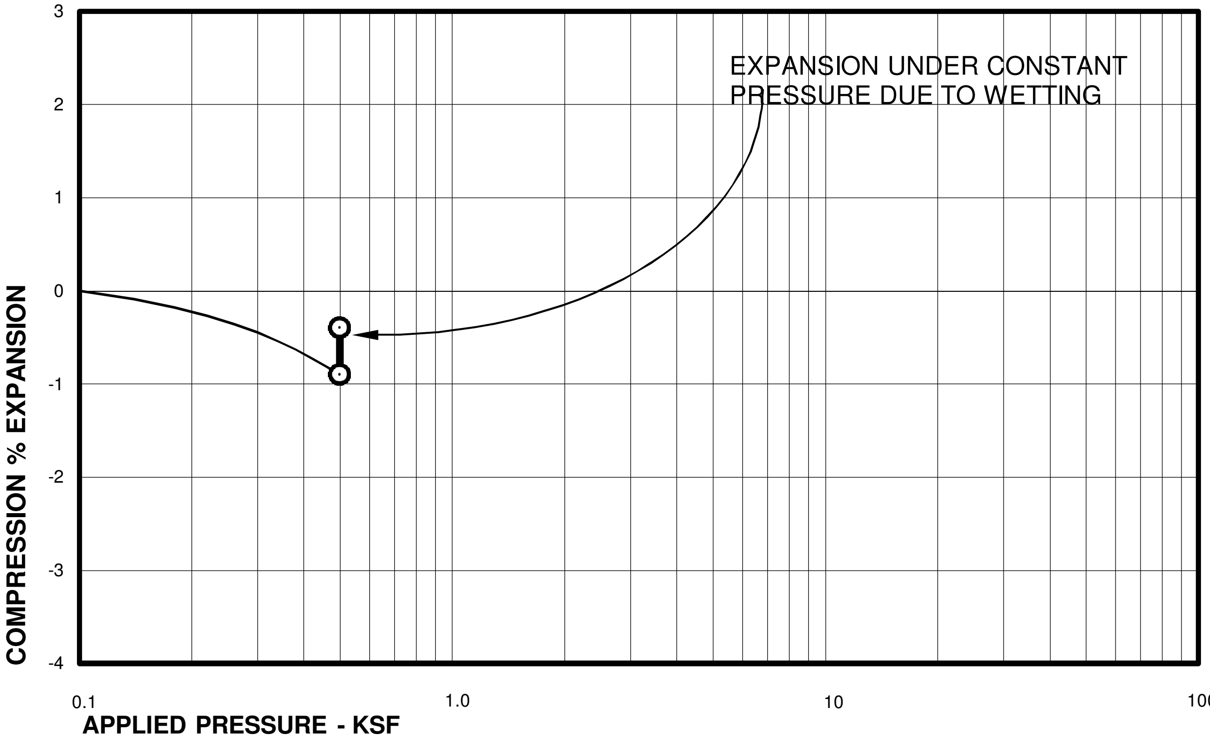
Sample of CLAYSTONE
From TH-14 AT 14 FEET

DRY UNIT WEIGHT= 101 PCF
MOISTURE CONTENT= 23.6 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

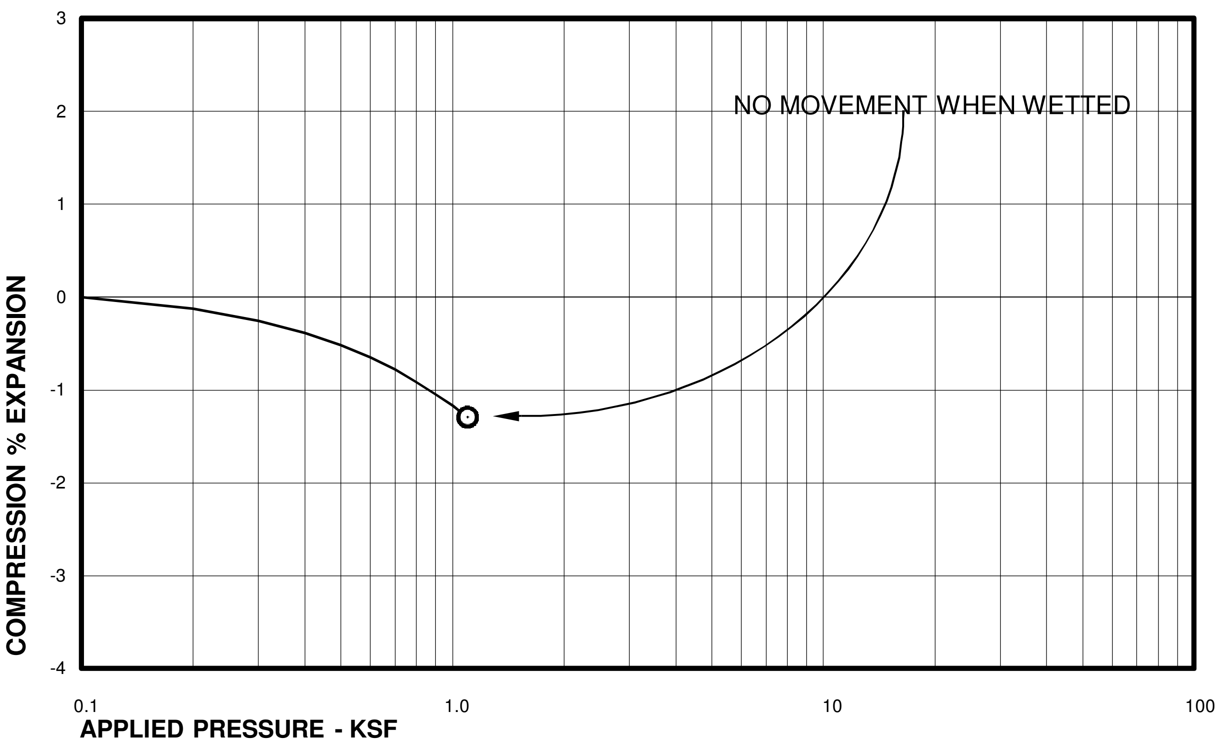
Swell Consolidation Test Results

FIG. B-17



Sample of CLAY, SANDY (CL)
From TH-15 AT 4 FEET

DRY UNIT WEIGHT= 111 PCF
MOISTURE CONTENT= 15.6 %



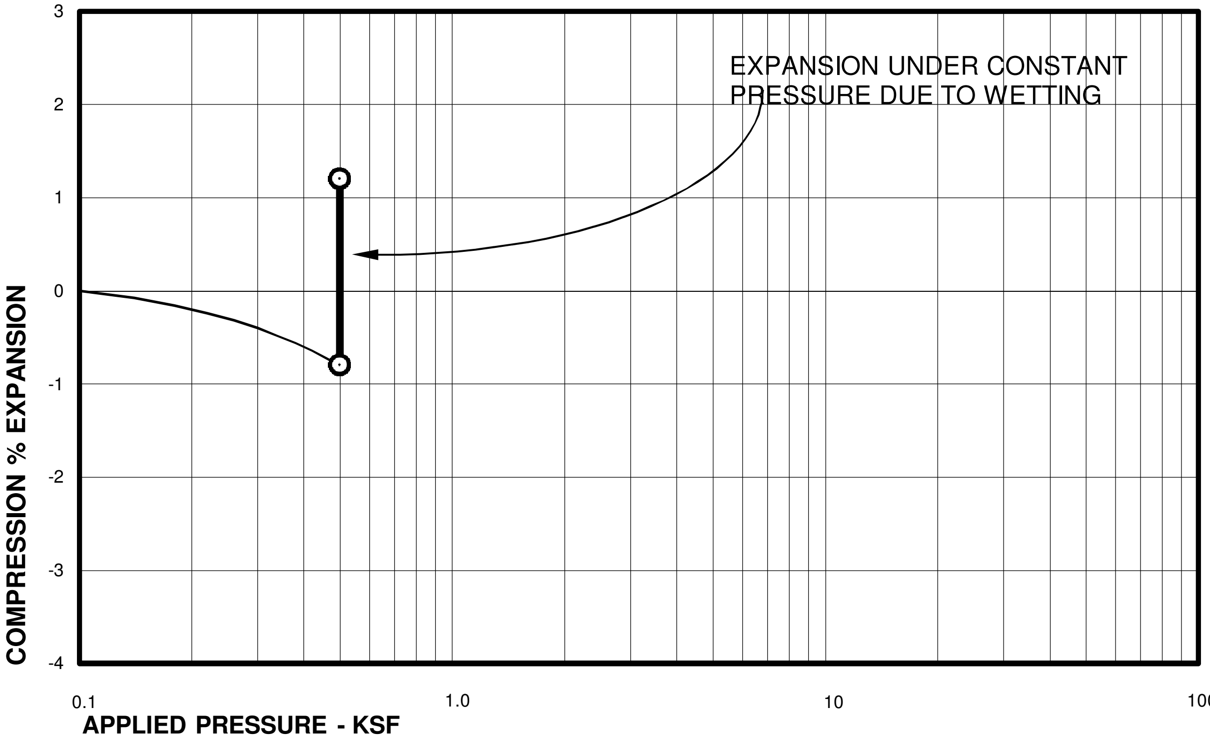
Sample of CLAY, SANDY (CL)
From TH-15 AT 9 FEET

DRY UNIT WEIGHT= 107 PCF
MOISTURE CONTENT= 18.4 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

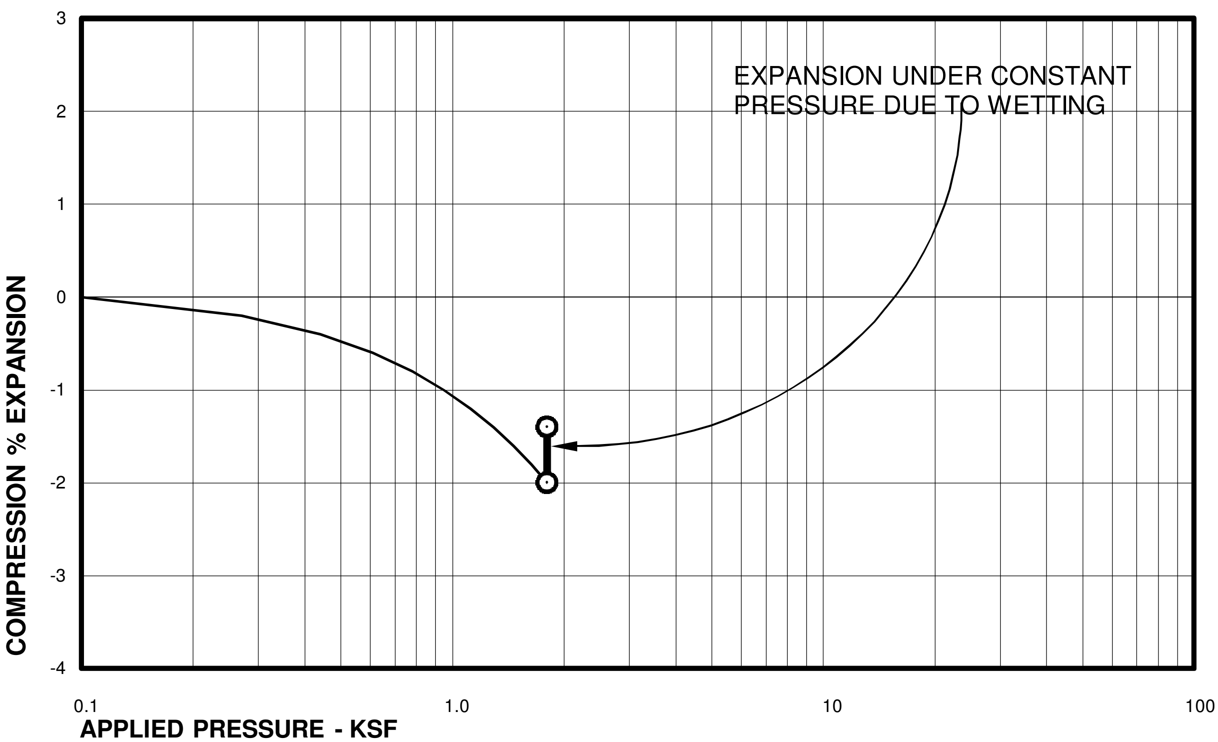
Swell Consolidation Test Results

FIG. B-18



Sample of CLAY, SANDY (CL) DRY UNIT WEIGHT= 97 PCF

From TH-16 AT 4 FEET MOISTURE CONTENT= 16.1 %



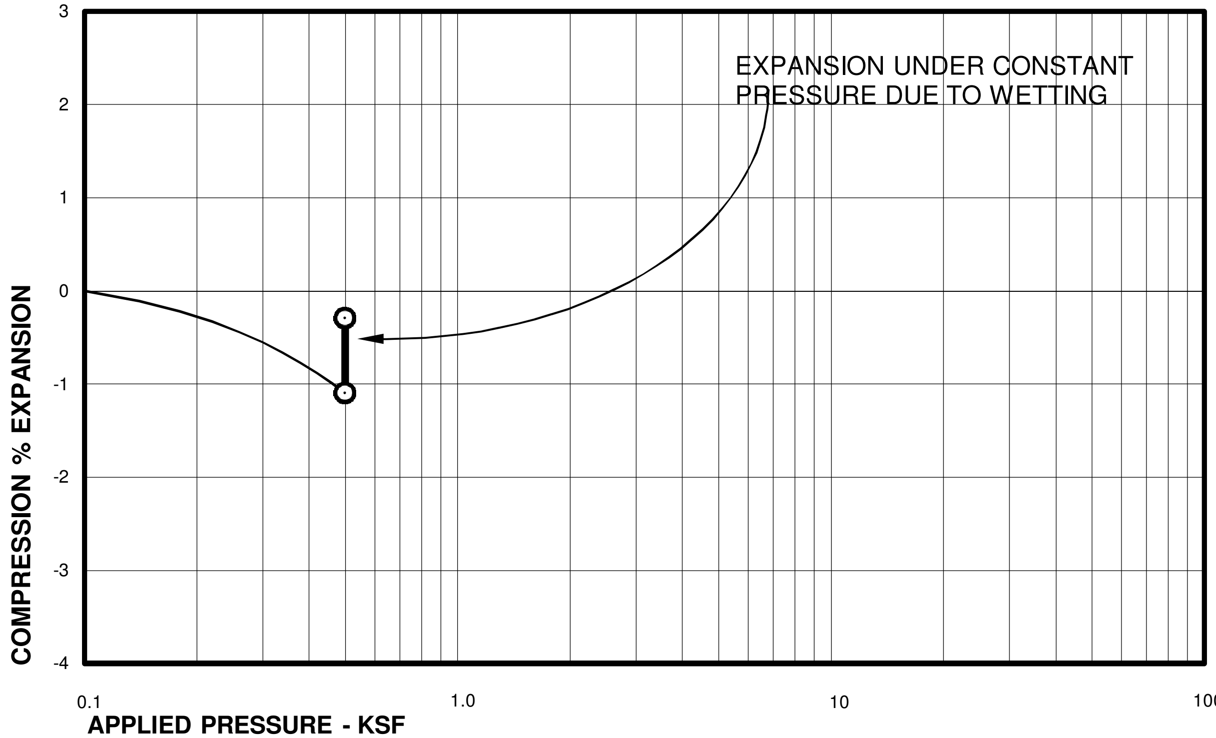
Sample of CLAYSTONE DRY UNIT WEIGHT= 106 PCF

From TH-16 AT 14 FEET MOISTURE CONTENT= 20.4 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

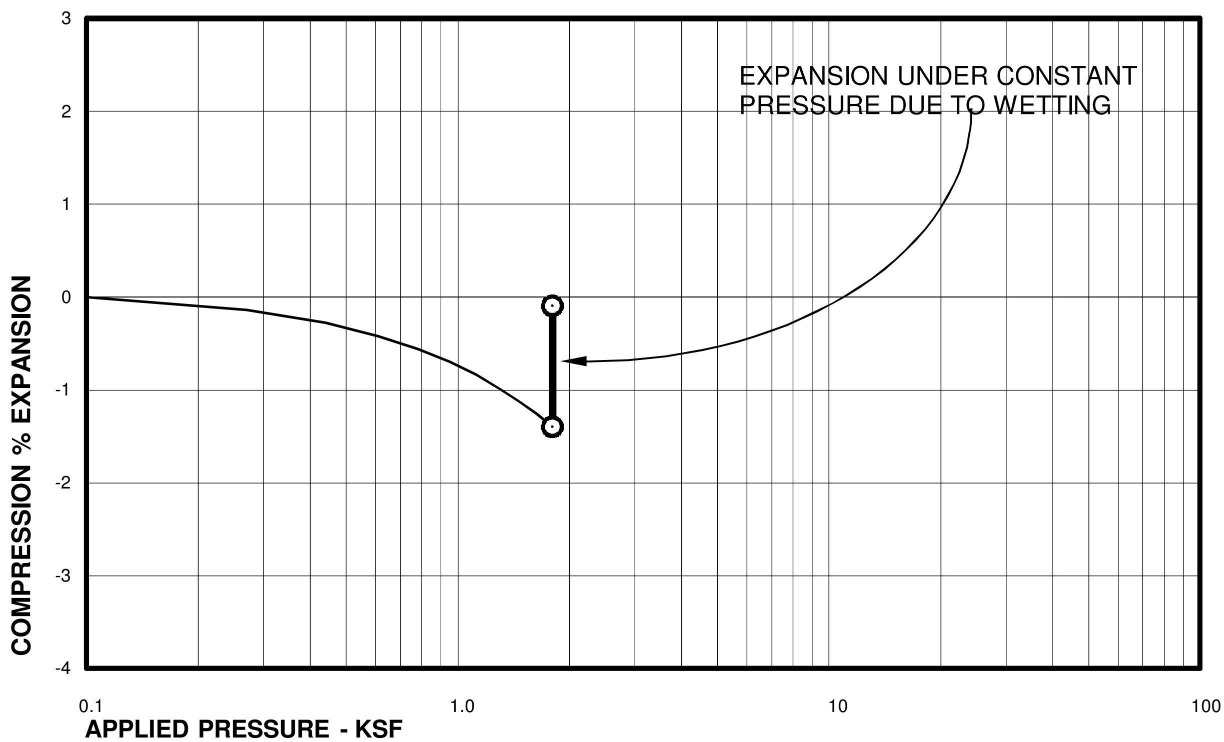
Swell Consolidation Test Results

FIG. B-19



Sample of CLAY, SANDY (CL)
From TH-17 AT 4 FEET

DRY UNIT WEIGHT= 107 PCF
MOISTURE CONTENT= 19.6 %



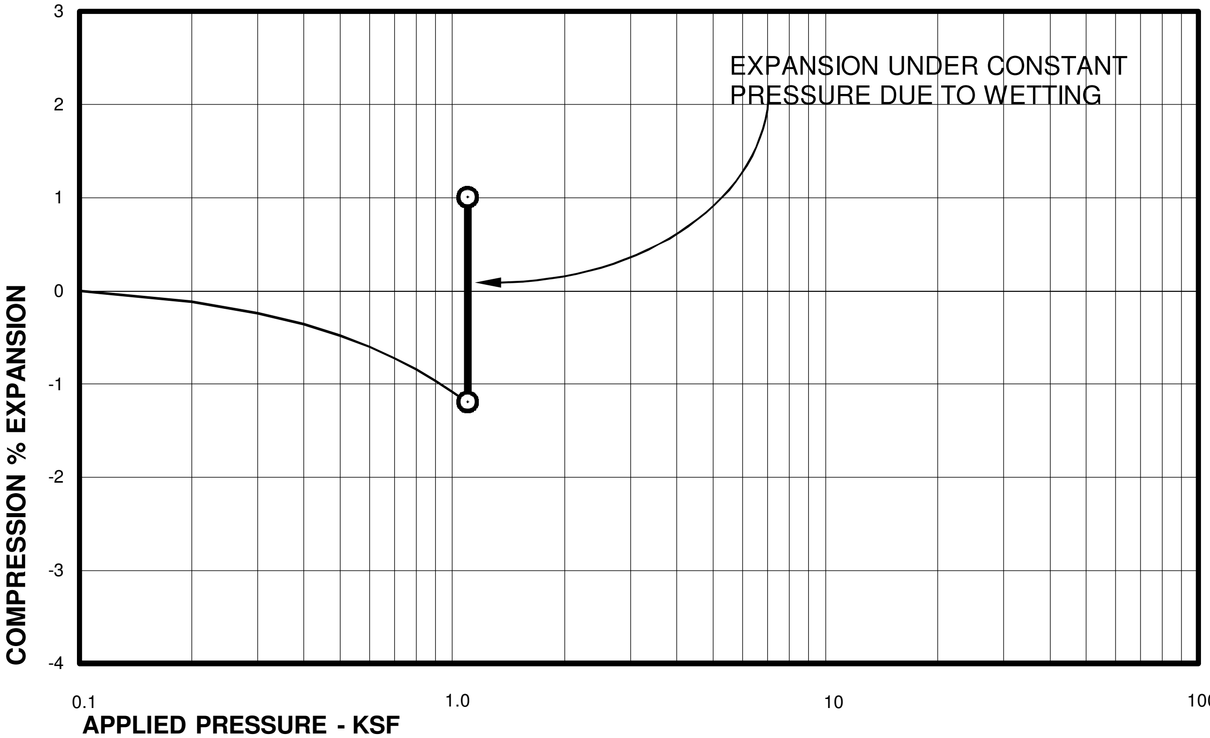
Sample of CLAYSTONE
From TH-17 AT 14 FEET

DRY UNIT WEIGHT= 114 PCF
MOISTURE CONTENT= 17.1 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

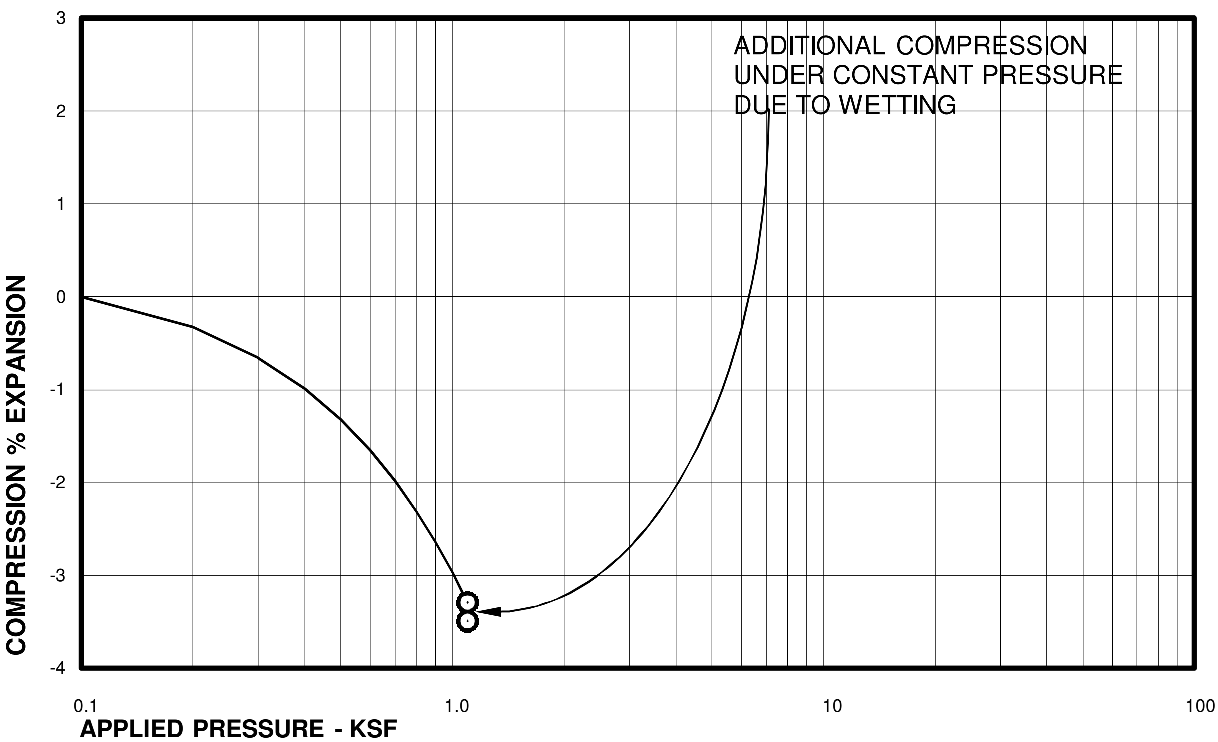
Swell Consolidation Test Results

FIG. B-20



Sample of CLAY, SANDY (CL)
From TH-18 AT 9 FEET

DRY UNIT WEIGHT= 120 PCF
MOISTURE CONTENT= 10.9 %



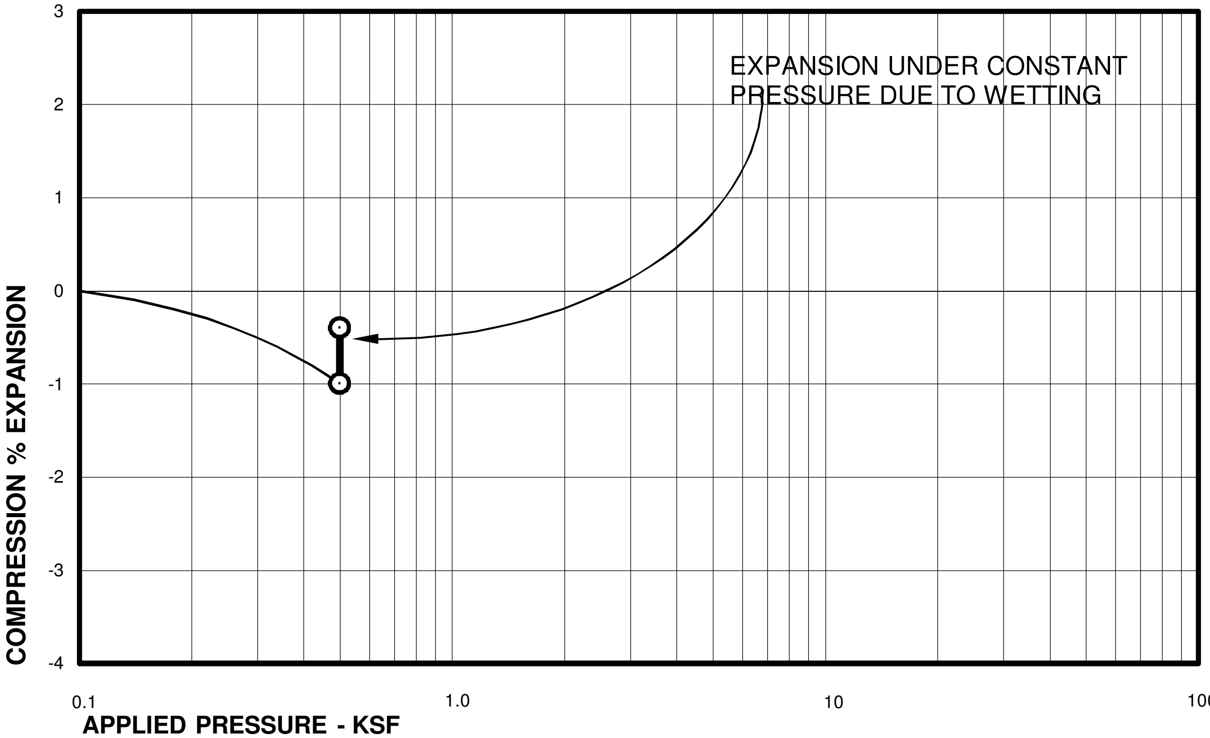
Sample of SAND, SILTY (SM)
From TH-19 AT 9 FEET

DRY UNIT WEIGHT= 110 PCF
MOISTURE CONTENT= 8.2 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

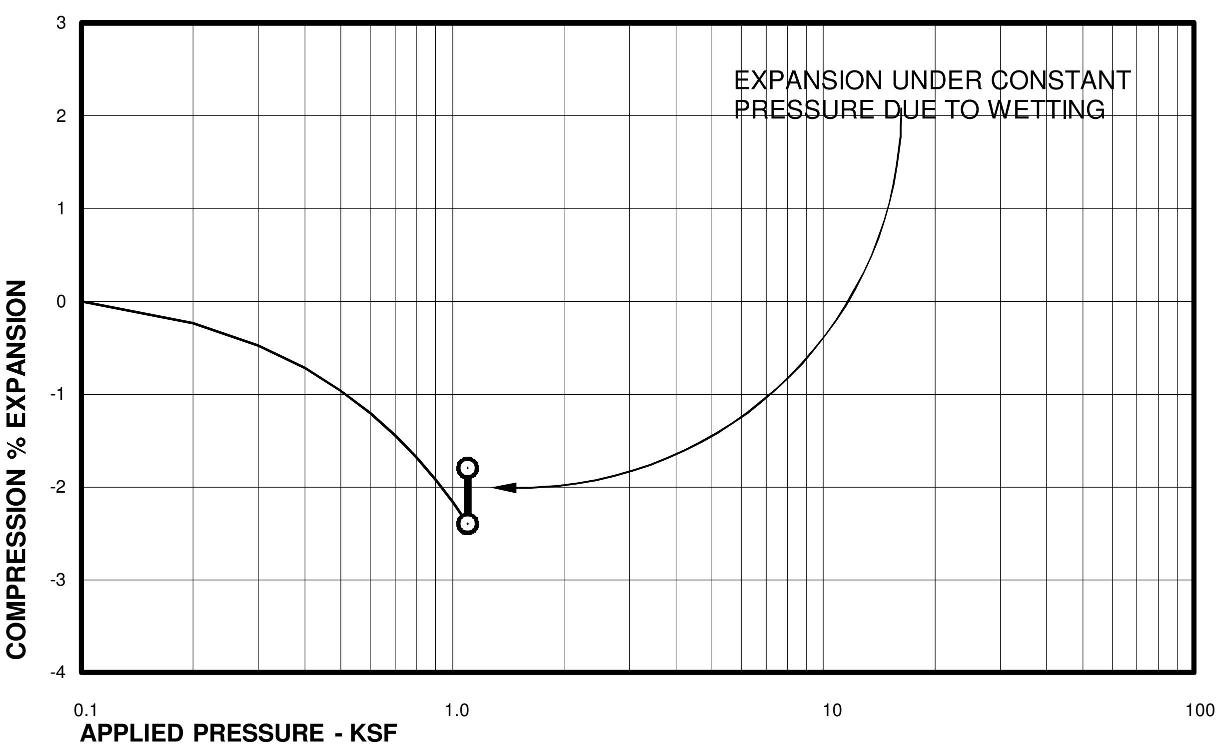
Swell Consolidation Test Results

FIG. B-21



Sample of CLAY, SANDY (CL)
From TH-20 AT 4 FEET

DRY UNIT WEIGHT= 109 PCF
MOISTURE CONTENT= 16.9 %



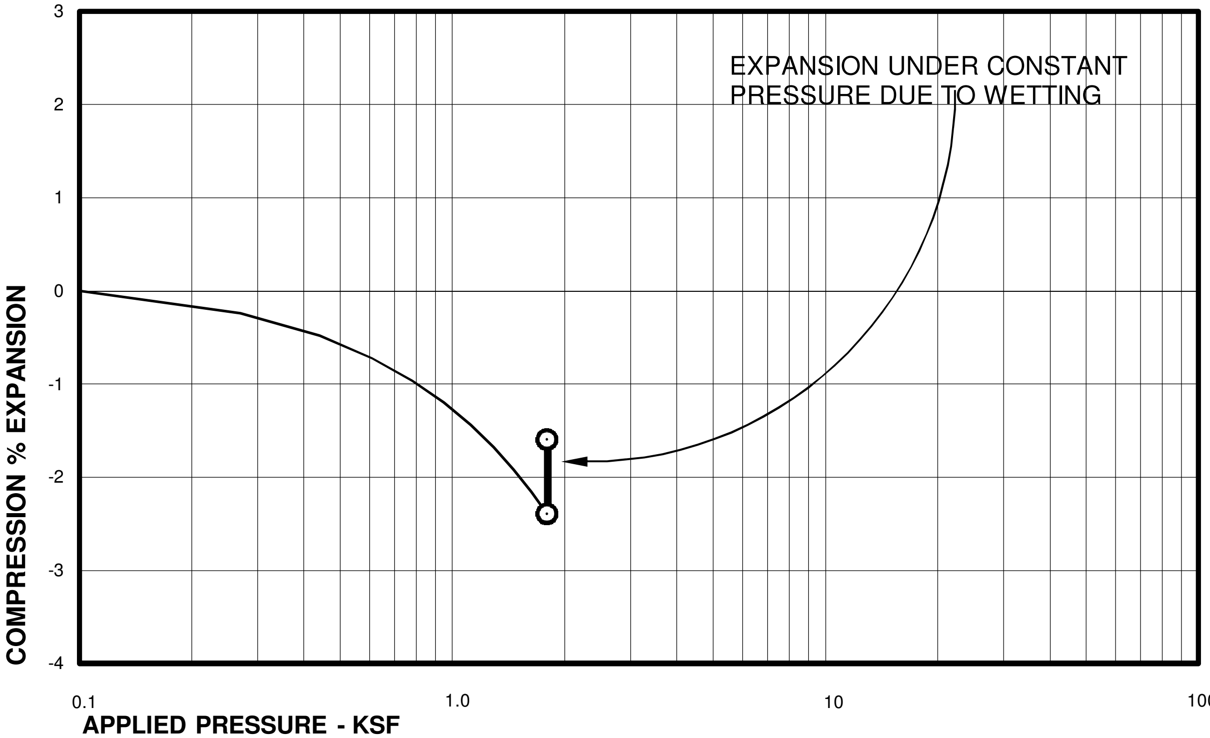
Sample of CLAY, SANDY (CL)
From TH-20 AT 9 FEET

DRY UNIT WEIGHT= 88 PCF
MOISTURE CONTENT= 29.8 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

Swell Consolidation Test Results

FIG. B-22

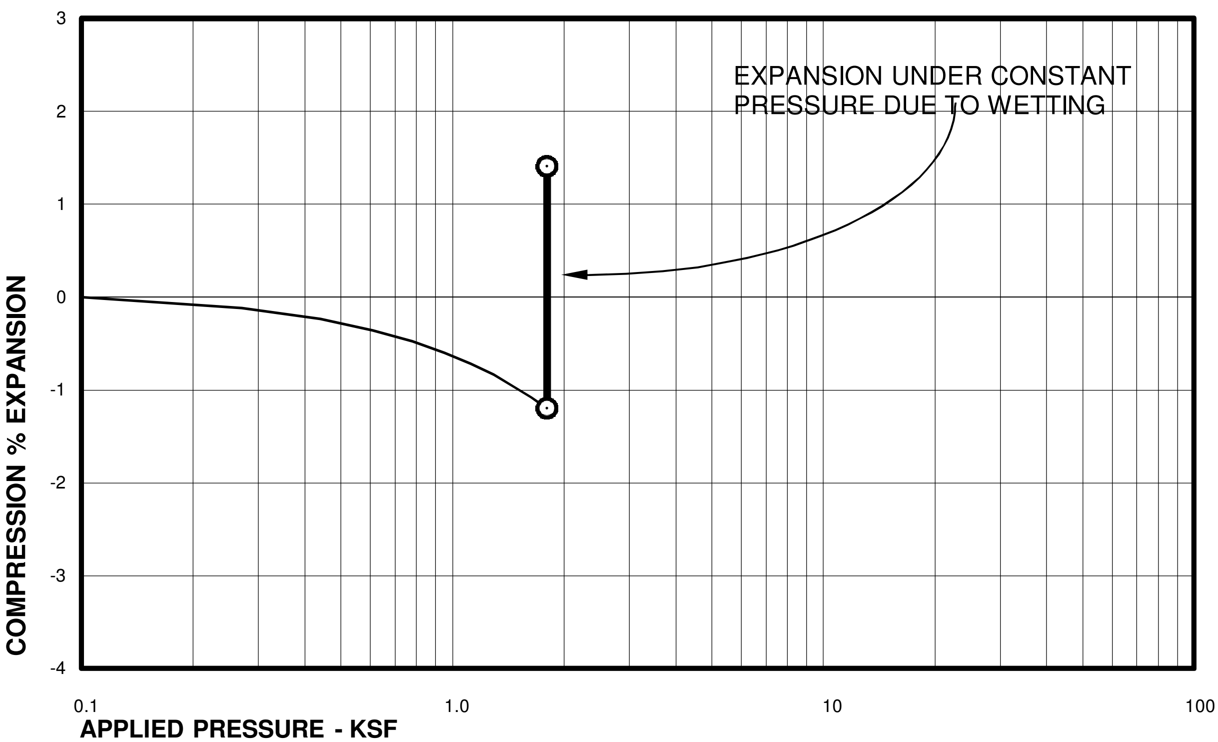


Sample of CLAYSTONE

From TH-20 AT 14 FEET

DRY UNIT WEIGHT= 107 PCF

MOISTURE CONTENT= 18.8 %



Sample of CLAYSTONE

From TH-21 AT 14 FEET

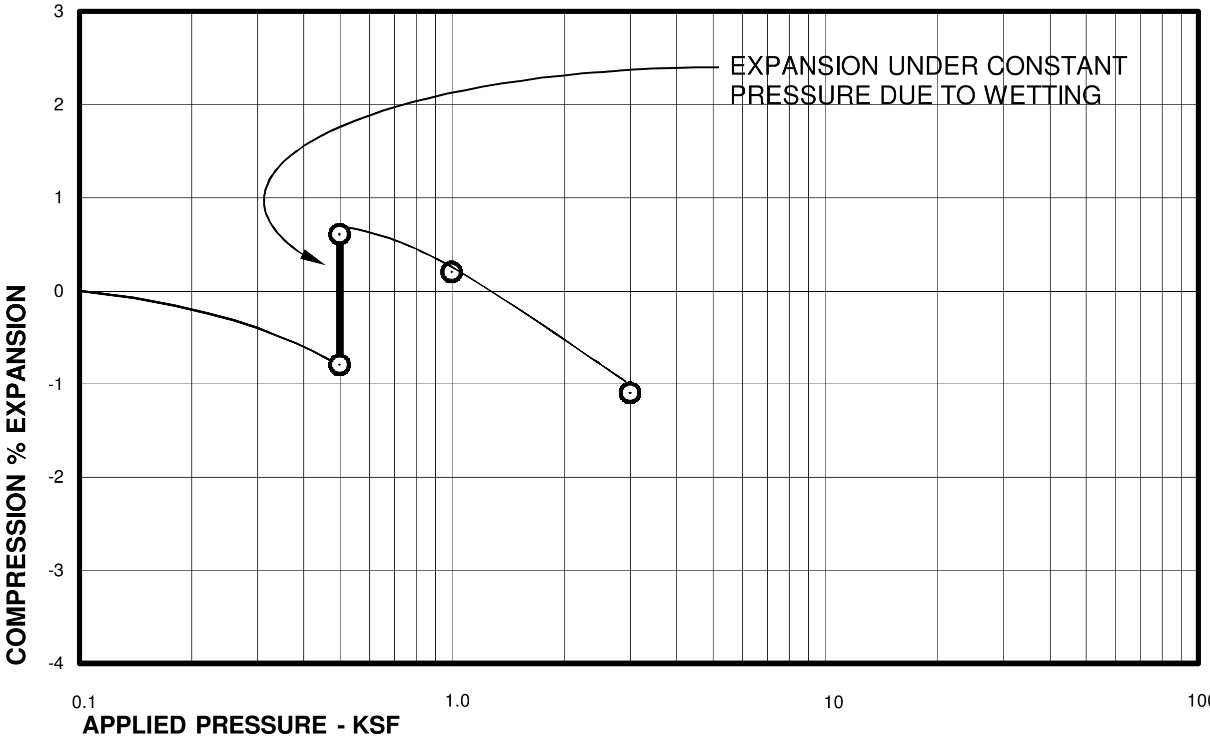
DRY UNIT WEIGHT= 110 PCF

MOISTURE CONTENT= 17.8 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

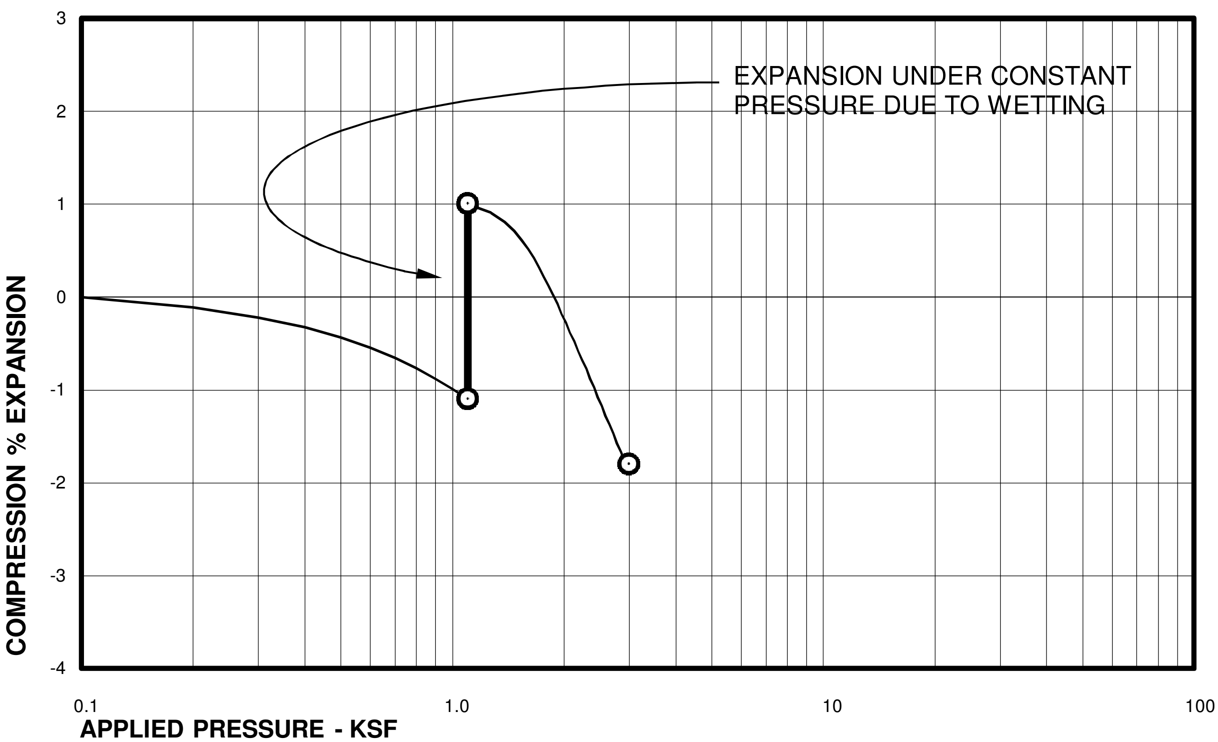
Swell Consolidation Test Results

FIG. B-23



Sample of CLAY, SANDY (CL)
From TH-22 AT 4 FEET

DRY UNIT WEIGHT= 105 PCF
MOISTURE CONTENT= 19.2 %



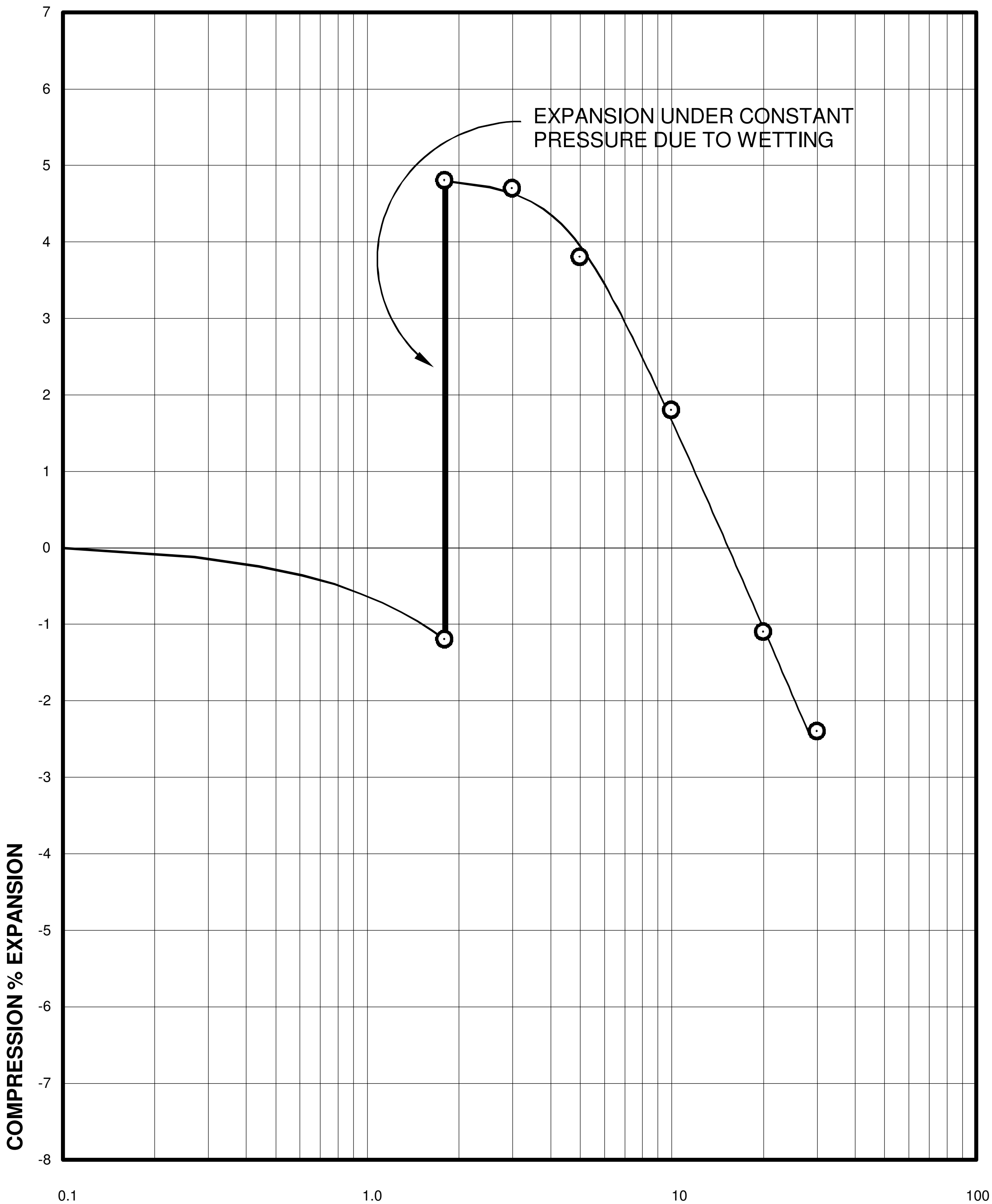
Sample of CLAY, SANDY (CL)
From TH-22 AT 9 FEET

DRY UNIT WEIGHT= 105 PCF
MOISTURE CONTENT= 8.5 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

Swell Consolidation Test Results

FIG. B-24

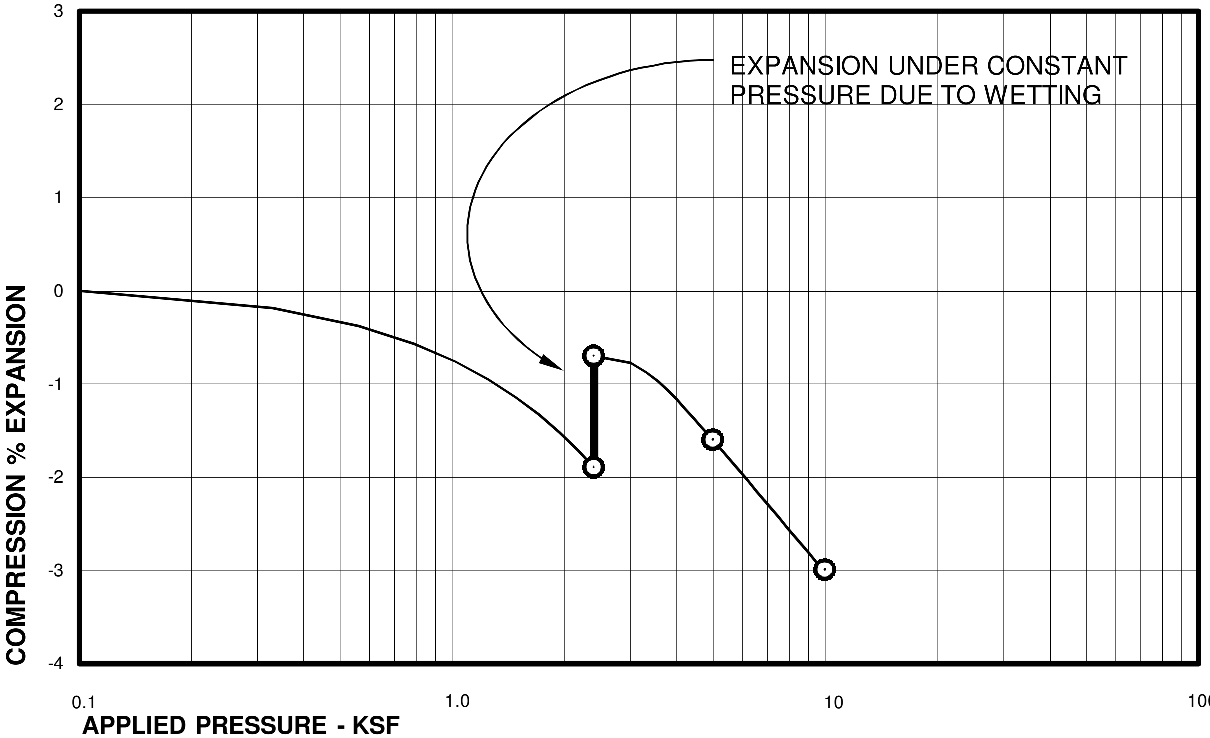


Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	108	PCF
From	TH-22 AT 14 FEET	MOISTURE CONTENT=	18.3	%

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

Swell Consolidation Test Results

FIG. B-25

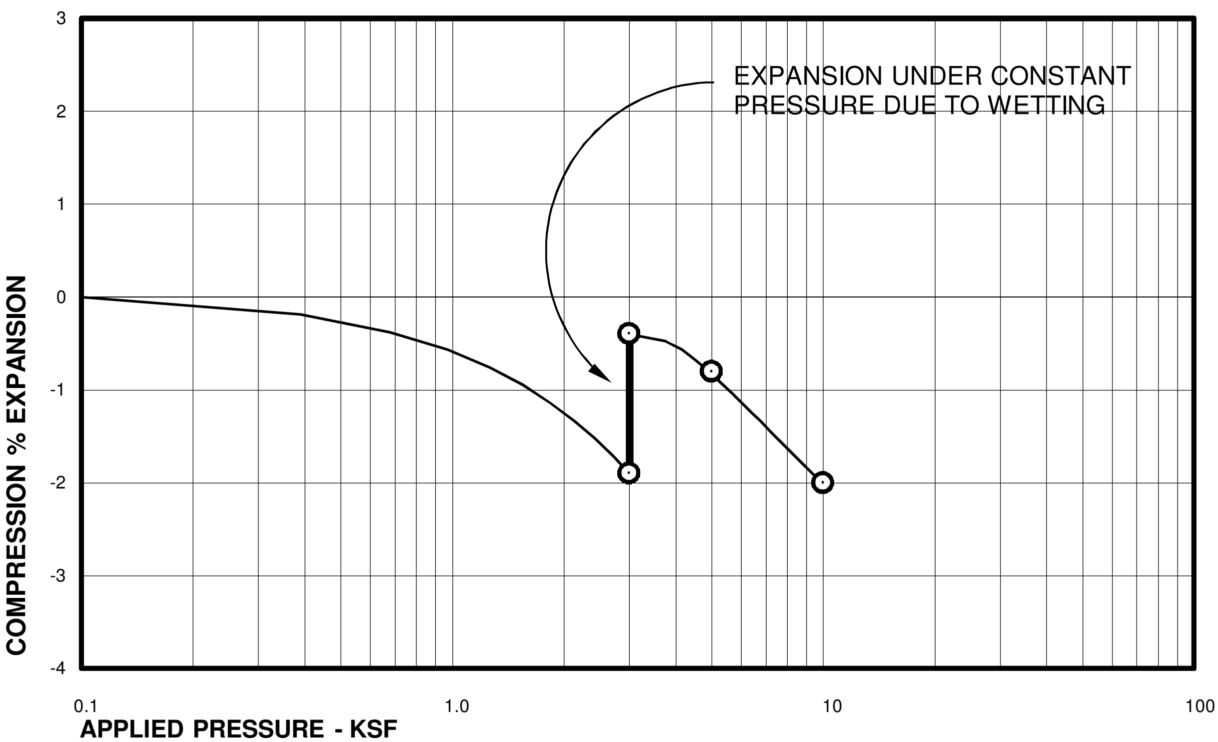


Sample of CLAYSTONE

From TH-22 AT 19 FEET

DRY UNIT WEIGHT= 102 PCF

MOISTURE CONTENT= 20.9 %



Sample of CLAYSTONE

From TH-22 AT 24 FEET

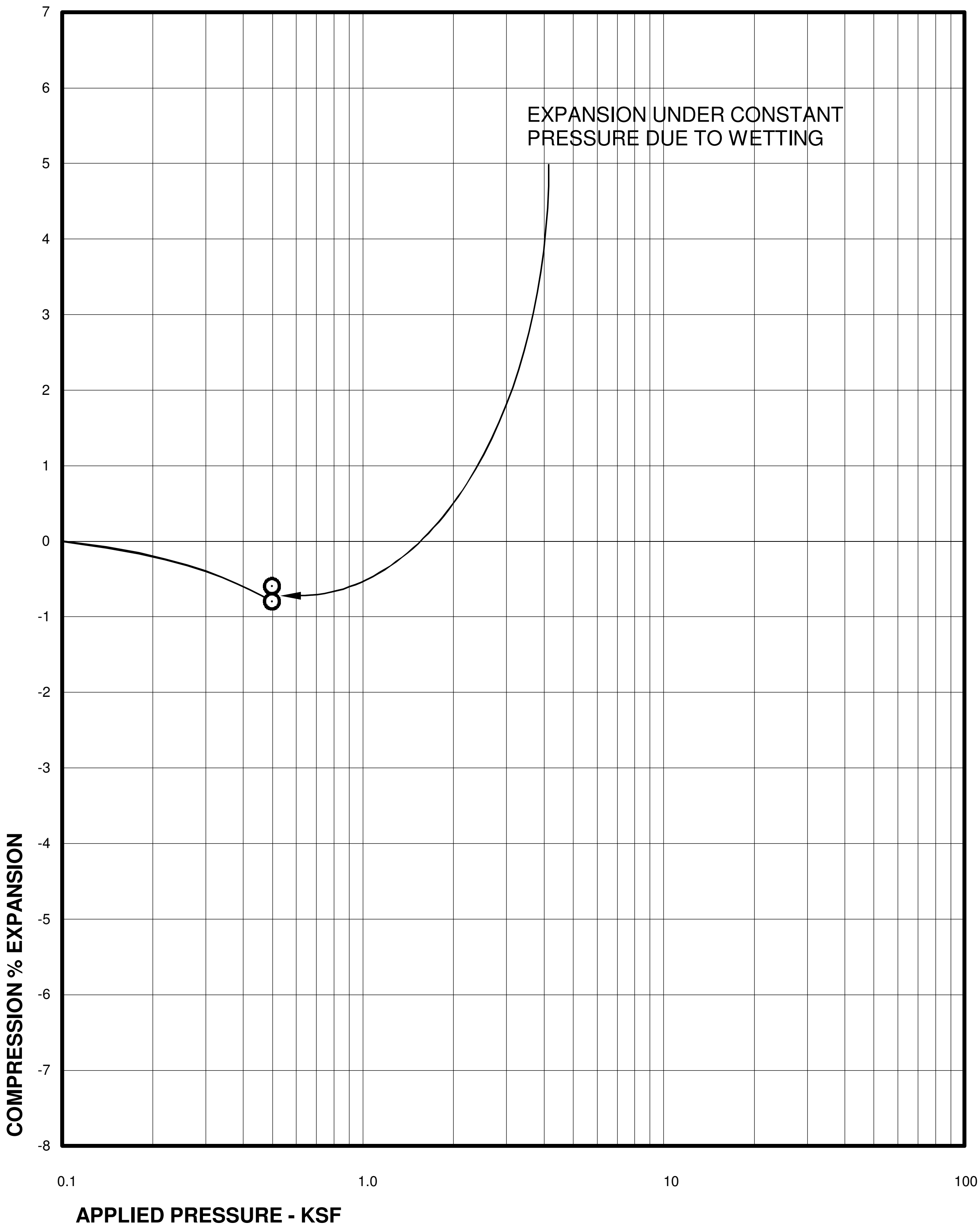
DRY UNIT WEIGHT= 110 PCF

MOISTURE CONTENT= 18.0 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

Swell Consolidation Test Results

FIG. B-26



Sample of WEATHERED CLAYSTONE

From TH-25 AT 4 FEET

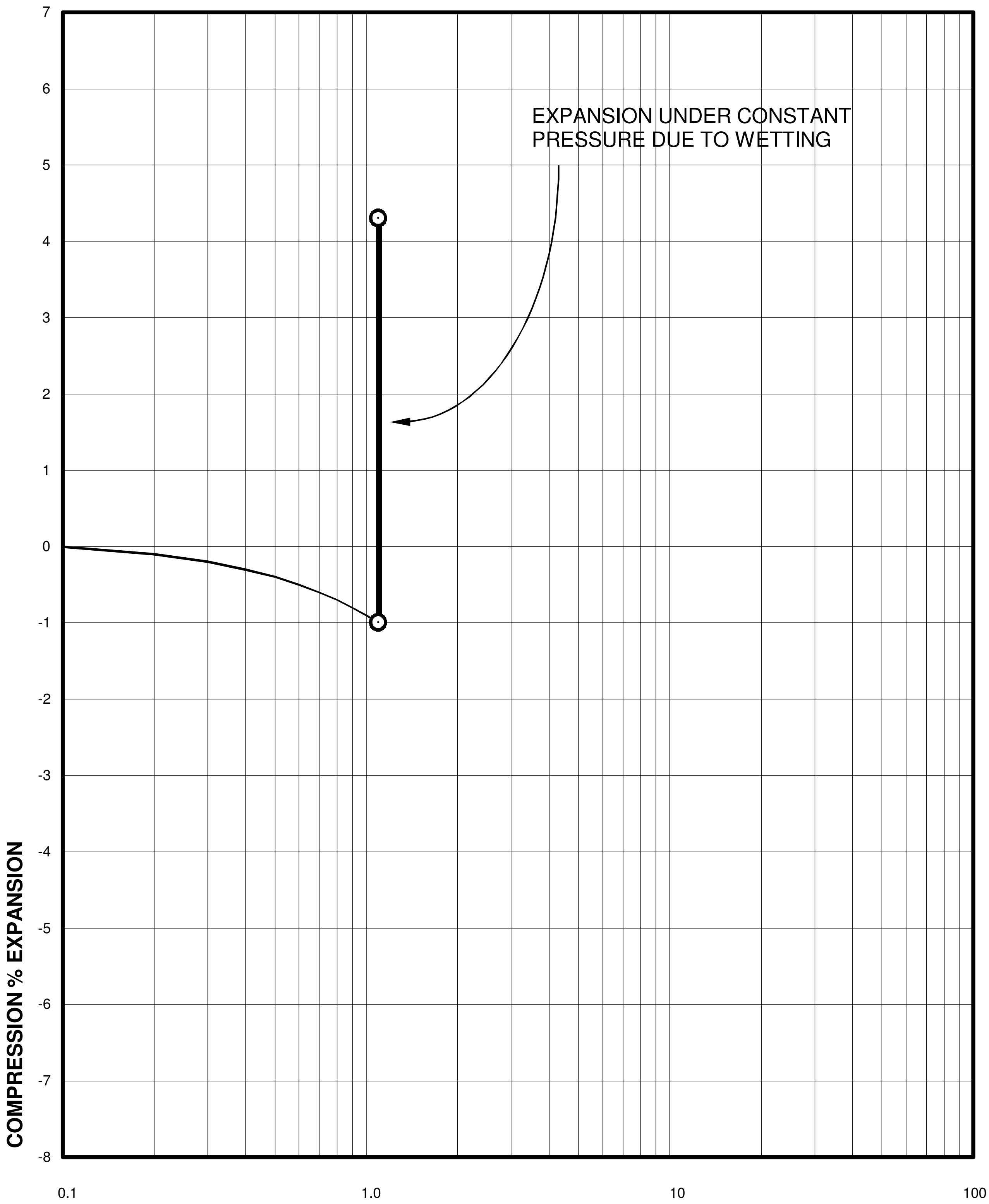
DRY UNIT WEIGHT= 109 PCF

MOISTURE CONTENT= 13.3 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

Swell Consolidation Test Results

FIG. B-27



Sample of WEATHERED CLAYSTONE

From TH-25 AT 9 FEET

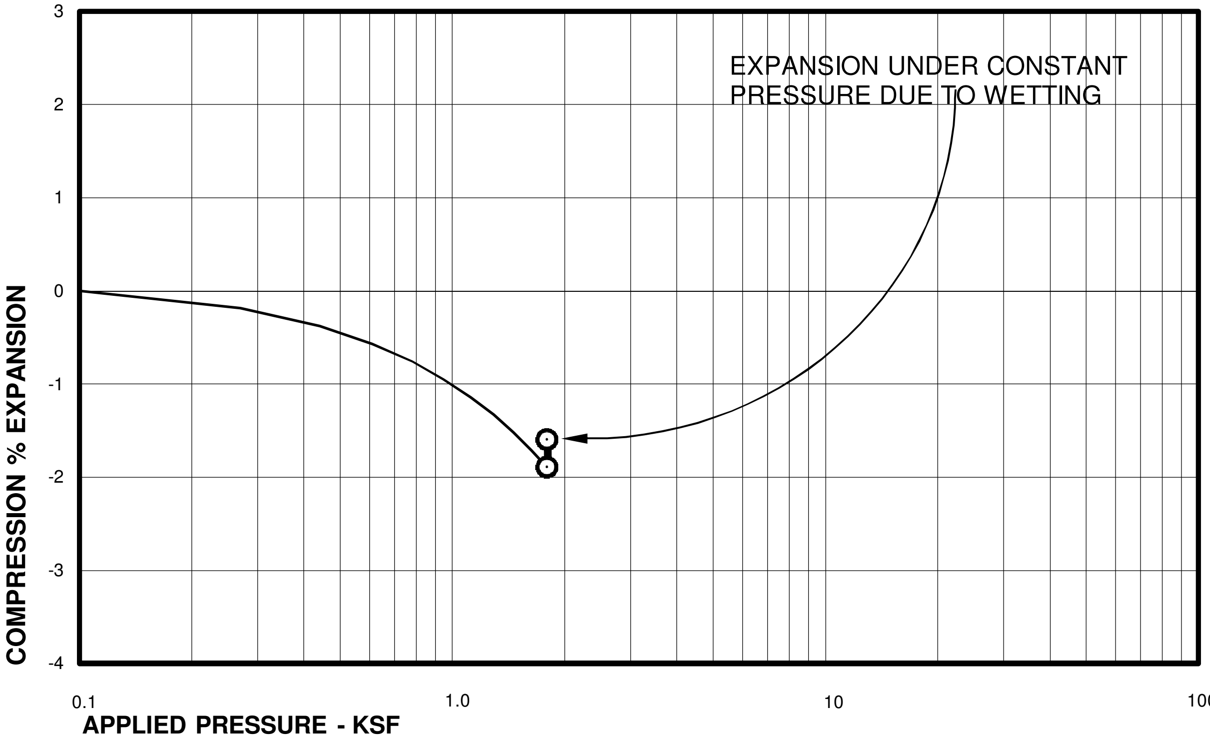
DRY UNIT WEIGHT= 102 PCF

MOISTURE CONTENT= 23.0 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

Swell Consolidation Test Results

FIG. B-28

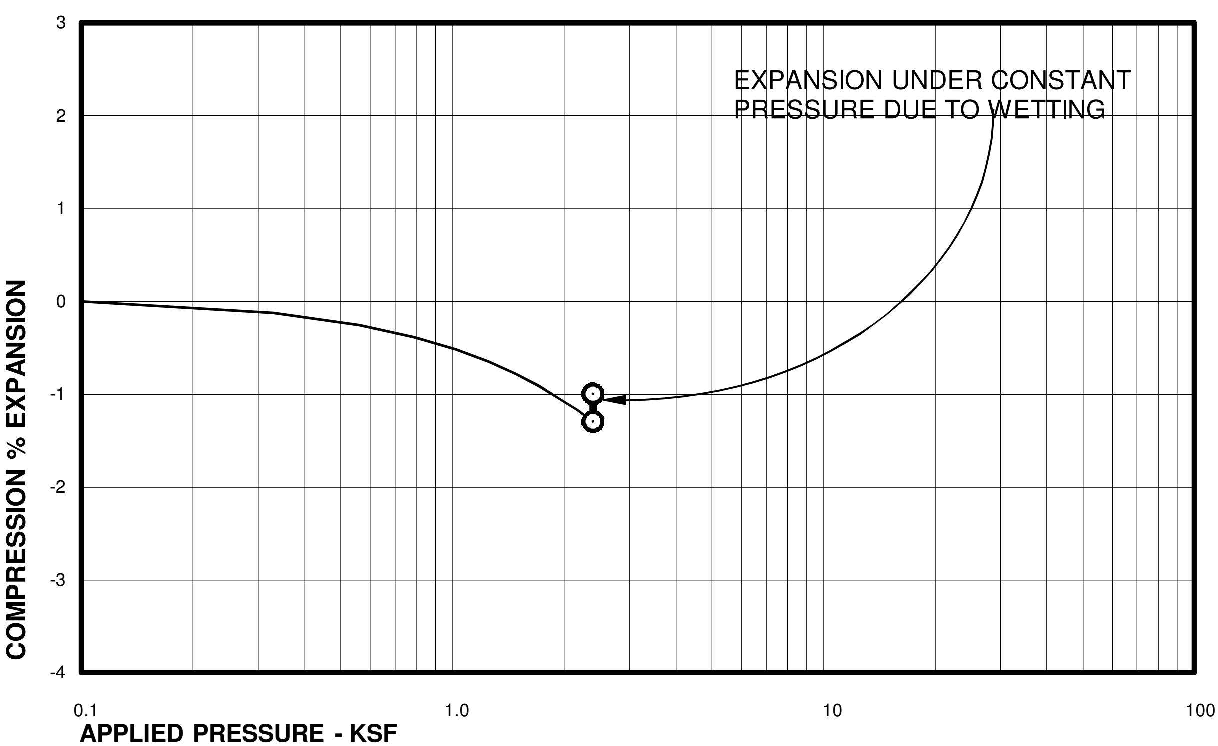


Sample of WEATHERED CLAYSTONE

From TH-25 AT 14 FEET

DRY UNIT WEIGHT= 93 PCF

MOISTURE CONTENT= 25.6 %



Sample of WEATHERED CLAYSTONE

From TH-25 AT 19 FEET

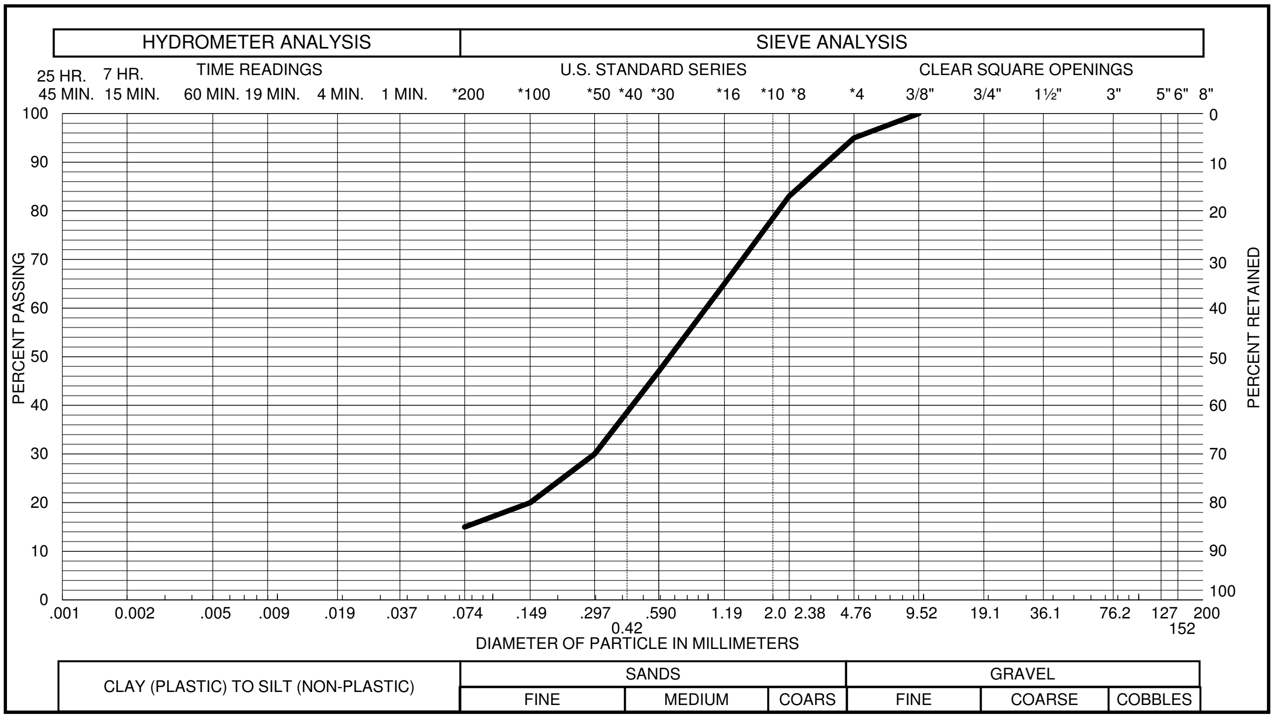
DRY UNIT WEIGHT= 102 PCF

MOISTURE CONTENT= 21.8 %

E5X MANAGMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X1(SWELL).xlsm

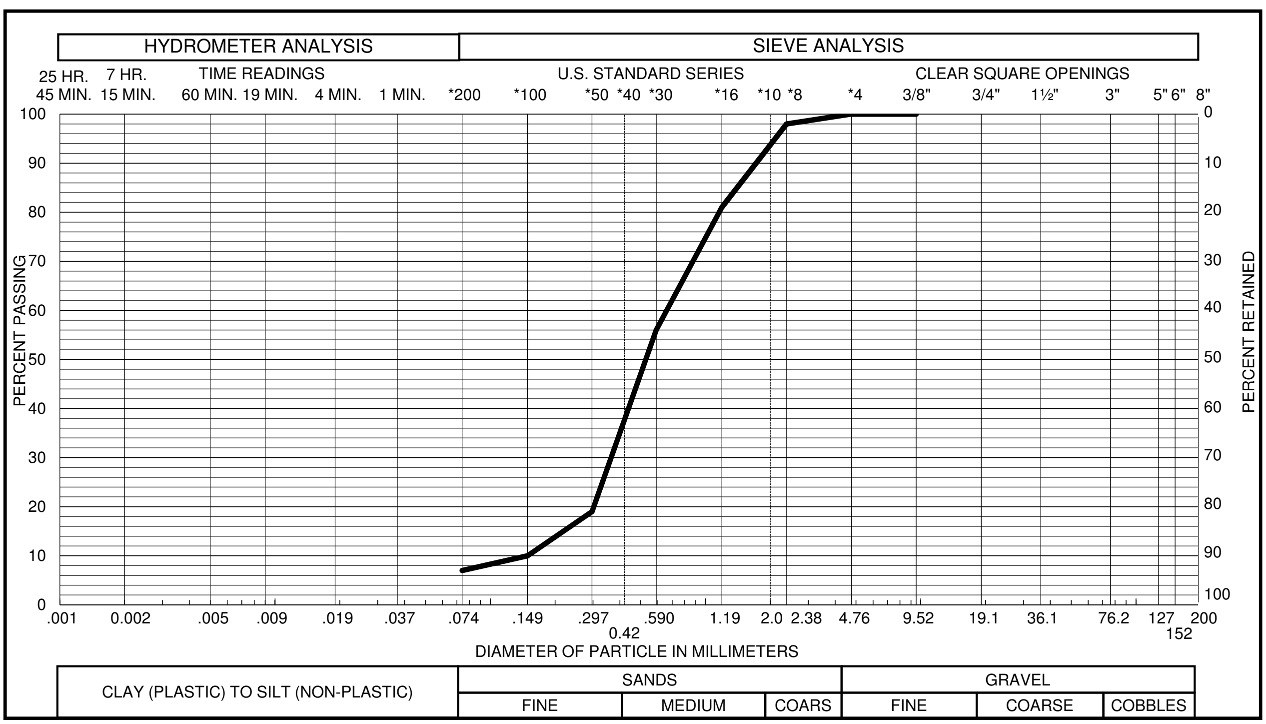
Swell Consolidation Test Results

FIG. B-29



Sample of SAND, CLAYEY (SC)
From TH - 2 AT 4 FEET

GRAVEL 5 % SAND 80 %
SILT & CLAY 15 % LIQUID LIMIT
PLASTICITY INDEX



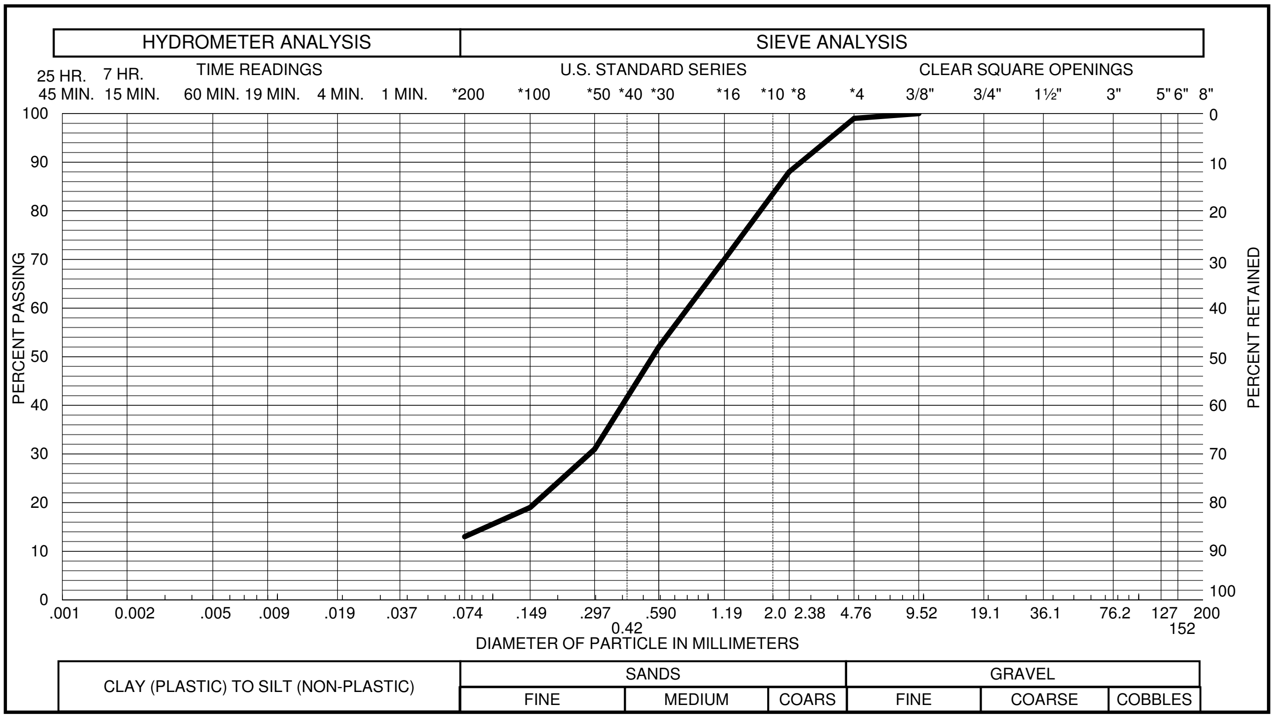
Sample of SANDSTONE
From TH - 4 AT 24 FEET

GRAVEL 0 % SAND 93 %
SILT & CLAY 7 % LIQUID LIMIT
PLASTICITY INDEX

Gradation Test Results

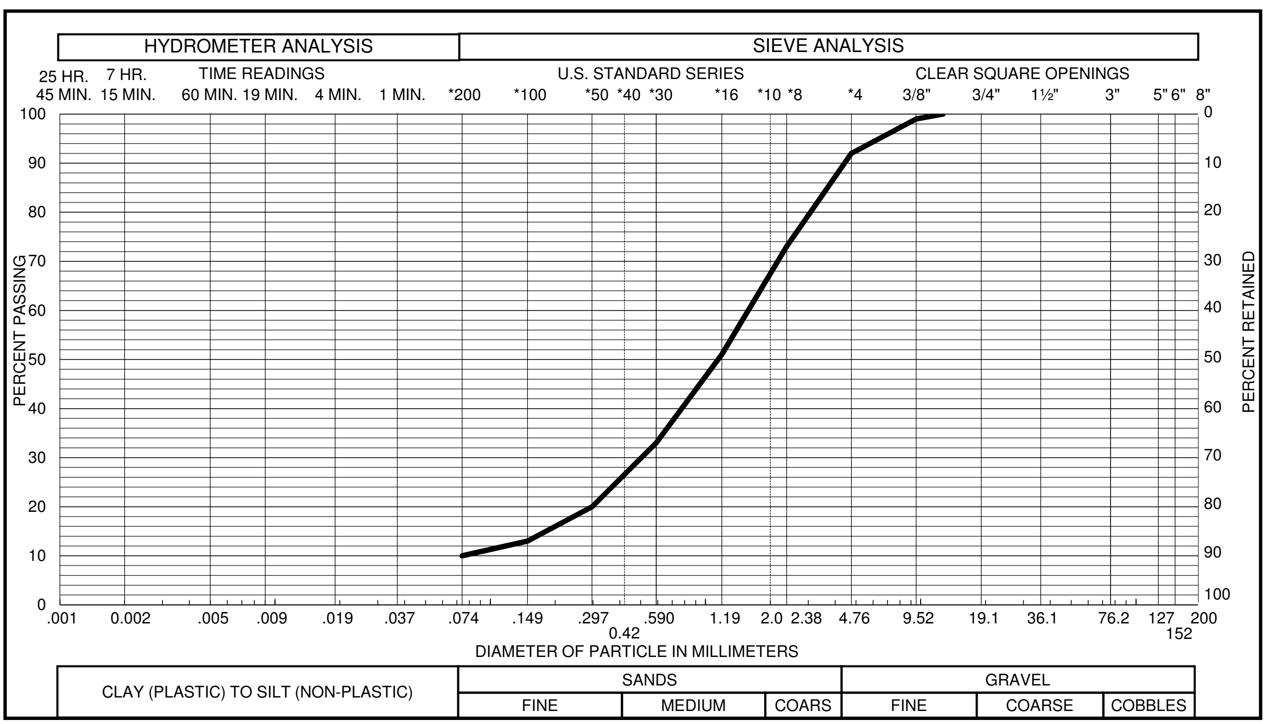
FIG. B-30

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X3(GRAD).xlsm



Sample of SANDSTONE
From TH - 5 AT 9 FEET

GRAVEL 1 % SAND 86 %
SILT & CLAY 13 % LIQUID LIMIT
PLASTICITY INDEX

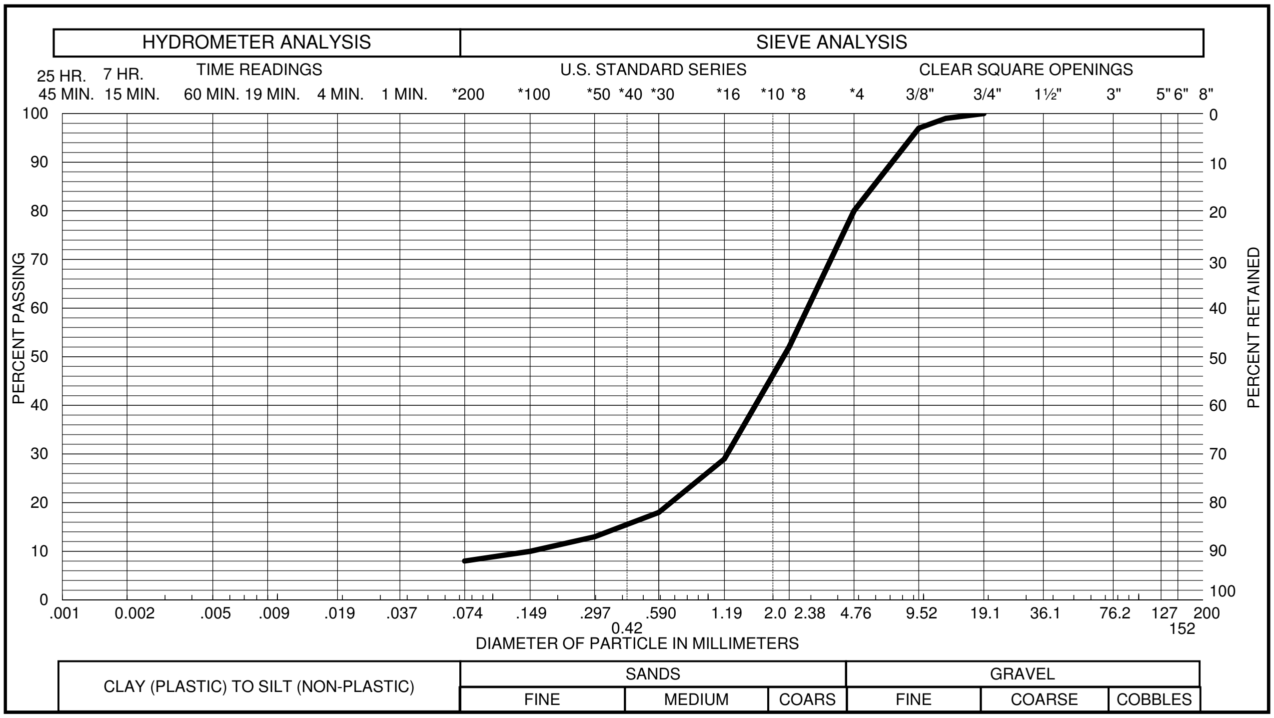


Sample of SAND, SLIGHTLY SILTY (SP-SM)
From TH - 8 AT 24 FEET

GRAVEL 8 % SAND 82 %
SILT & CLAY 10 % LIQUID LIMIT
PLASTICITY INDEX

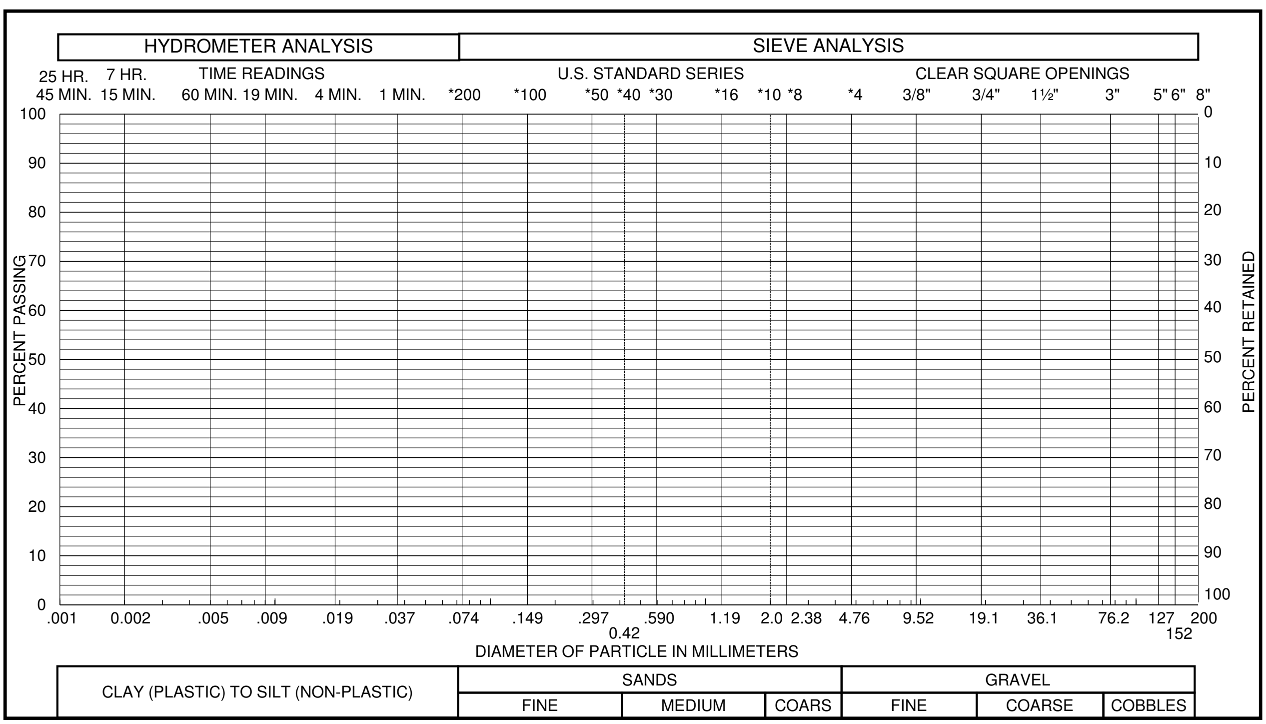
Gradation Test Results

FIG. B-31



Sample of SAND, SILTY (SM)
From TH - 19 AT 14 FEET

GRAVEL 20 % SAND 72 %
SILT & CLAY 8 % LIQUID LIMIT
PLASTICITY INDEX



Sample of
From

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

Gradation Test Results

FIG. B-32

E5X MANAGEMENT
HESS RANCH - SOUTH PORTION
PROJECT NO. DN48,372-115
S:\PROJECTS\48300\DN48372.000\115\2. Reports\R1\DN48372-115-R1-X3(GRAD).xlsm

TABLE B - I

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	SWELL TEST DATA SWELL (%)	COMPRESSION (%)	APPLIED PRESSURE (psf)	SOIL SUCTION VALUE (pF)	ATTERBERG LIMITS LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SOLUBLE SULFATE CONTENT (%)	PASSING NO. 200 SIEVE (%)	SOIL TYPE
TH-1	4	11.1	117	0.2		500						CLAY, SANDY (CL)
TH-1	9	6.4	108					37	21		30	SAND, CLAYEY (SC)
TH-1	19	22.0	105	4.0		2,400						CLAYSTONE
TH-1	24	26.5	98	2.2		3,000						CLAYSTONE
TH-2	4	7.7	112								15	SAND, CLAYEY (SC)
TH-2	14	10.0	120								31	SAND, CLAYEY (SC)
TH-3	4	16.9	108							<0.01	38	SAND, CLAYEY (SC)
TH-3	9	12.9	107					29	13		53	CLAY, SANDY (CL)
TH-3	14	14.9	114	0.3		1,800						WEATHERED CLAYSTONE
TH-4	4	18.3	109	0.9		500	3.10					CLAY, SANDY (CL)
TH-4	14	34.5	86	0.8		1,800	3.20					CLAY, SANDY (CL)
TH-4	19	40.8	79	1.0		2,400	3.31					CLAY, SANDY (CL)
TH-4	24	2.7	105								7	SANDSTONE
TH-5	9	10.2	122								13	SANDSTONE
TH-5	14	8.9	125								16	SANDSTONE
TH-5	19	10.9	126	1.7		2,400		30	17		60	CLAYSTONE
TH-6	4	20.8	102	2.1		500				<0.01		CLAYSTONE
TH-6	9	21.3	102	3.8		1,100						CLAYSTONE
TH-6	19	11.6	115	1.6		2,400					50	CLAYSTONE
TH-7	4	8.1	107		0.2	500						CLAY, SANDY (CL)
TH-7	9	8.9	100		1.5	1,100						CLAY, SANDY (CL)
TH-7	14	9.0	103								36	SAND, SILTY (SM)
TH-8	4	16.3	96		0.1	500	4.44					CLAY, SANDY (CL)
TH-8	9	13.7	107	2.3		1,100	3.80					CLAY, SANDY (CL)
TH-8	14	16.1	115	2.3		1,800	3.84					CLAY, SANDY (CL)
TH-8	19	19.7	102	1.5		2,400	3.76					CLAY, SANDY (CL)
TH-8	24	2.0	114								10	SAND, SLIGHTLY SILTY (SP-SM)
TH-9	4	5.0	111								31	SAND, CLAYEY (SC)
TH-9	14	16.3	114	3.9		1,800						CLAYSTONE
TH-9	19	27.0	96	1.2		2,400						CLAYSTONE
TH-10	9	6.4	119								38	SANDSTONE
TH-10	14	13.9	118	2.0		1,800						CLAYSTONE
TH-10	19	17.7	108	2.4		2,400						CLAYSTONE
TH-11	4	10.6	98	0.8		500						CLAY, SANDY (CL)
TH-11	9	18.3	105	2.1		1,100				<0.01		CLAYSTONE
TH-11	14	20.1	109	3.0		1,800						CLAYSTONE
TH-11	19	21.6	107					55	32		95	CLAYSTONE
TH-12	4	21.1	92		0.8	500	3.20					CLAY, SANDY (CL)
TH-12	9	23.5	103	3.0		1,100	3.78					WEATHERED CLAYSTONE
TH-12	14	23.6	104	2.5		1,800	3.83					WEATHERED CLAYSTONE
TH-12	19	32.3	89	1.5		2,400	4.13					CLAYSTONE
TH-12	24	29.4	96	1.0		3,000	3.83					CLAYSTONE
TH-13	4	4.8	109								7	SAND, SLIGHTLY SILTY (SP-SM)
TH-13	14	35.7	85	0.4		1,800		66	42		99	INTERLAYERED CLAY/SAND
TH-13	19	7.9	96								18	INTERLAYERED CLAY/SAND
TH-14	4	9.3	124								30	SAND, CLAYEY (SC)

TABLE B - I

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	SWELL TEST DATA			SOIL SUCTION VALUE (pF)	ATTERBERG LIMITS		SOLUBLE SULFATE CONTENT (%)	PASSING NO. 200 SIEVE (%)	SOIL TYPE
				SWELL (%)	COMPRESSION (%)	APPLIED PRESSURE (psf)		LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
TH-14	14	23.6	101	4.6		1,800						CLAYSTONE
TH-15	4	15.6	111	0.5		500						CLAY, SANDY (CL)
TH-15	9	18.4	107	0.0		1,100				0.06		CLAY, SANDY (CL)
TH-15	14	11.8	124					35	19		42	CLAYSTONE/SANDSTONE
TH-16	4	16.1	97	2.0		500						CLAY, SANDY (CL)
TH-16	9	10.3	115								31	INTERLAYERED CLAY/SAND
TH-16	14	20.4	106	0.6		1,800						CLAYSTONE
TH-16	19	19.1	110					46	22		66	CLAYSTONE
TH-17	4	19.6	107	0.8		500						CLAY, SANDY (CL)
TH-17	9	8.4	128								42	CLAYSTONE/SANDSTONE
TH-17	14	17.1	114	1.3		1,800						CLAYSTONE
TH-18	4	10.2	121								54	CLAY, SANDY (CL)
TH-18	9	10.9	120	2.2		1,100						CLAY, SANDY (CL)
TH-19	9	8.2	110		0.2	1,100		26	5		16	SAND, SILTY (SM)
TH-19	14	6.5	107								8	SAND, SILTY (SM)
TH-20	4	16.9	109	0.6		500		38	25		50	CLAY, SANDY (CL)
TH-20	9	29.8	88	0.6		1,100				0.04		CLAY, SANDY (CL)
TH-20	14	18.8	107	0.8		1,800						CLAYSTONE
TH-21	4	8.5	118								20	SAND, CLAYEY (SC)
TH-21	14	17.8	110	2.6		1,800						CLAYSTONE
TH-21	19	13.4	119								25	SANDSTONE
TH-22	4	19.2	105	1.4		500	3.46					CLAY, SANDY (CL)
TH-22	9	8.5	105	2.1		1,100	4.60					CLAY, SANDY (CL)
TH-22	14	18.3	108	6.0		1,800	4.37					CLAY, SANDY (CL)
TH-22	19	20.9	102	1.2		2,400	4.37					CLAYSTONE
TH-22	24	18.0	110	1.5		3,000	4.31					CLAYSTONE
TH-23	4	6.8	117								10	SANDSTONE
TH-23	9	13.2	111								42	SANDSTONE
TH-24	4	4.5	114								10	SANDSTONE
TH-24	14	9.6	114								9	SANDSTONE
TH-24	19	12.0	118					41	20		53	CLAYSTONE/SANDSTONE
TH-25	4	13.3	109	0.2		500						WEATHERED CLAYSTONE
TH-25	9	23.0	102	5.3		1,100						WEATHERED CLAYSTONE
TH-25	14	25.6	93	0.3		1,800		64	39		83	WEATHERED CLAYSTONE
TH-25	19	21.8	102	0.3		2,400						WEATHERED CLAYSTONE

APPENDIX C

GUIDELINE SITE GRADING SPECIFICATIONS

GUIDELINE SITE GRADING SPECIFICATIONS

HESS RANCH- SOUTH PORTION
Douglas County, Colorado

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 to above optimum moisture content, 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 optimum 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)

HESS RANCH – SOUTH PORTION
Douglas County, Colorado

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, (optimum 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 optimum 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.