GEOTECHNICAL ENGINEERING CONSULTATION
MIDDLE SCHOOL BUILDING DISTRESS
COLORADO SPRINGS CHARTER ACADEMY
2555 NORTH CHELTON ROAD
COLORADO SPRINGS, COLORADO

Prepared For:

COLORADO SPRINGS CHARTER ACADEMY
2577 North Chelton Road
Colorado Springs, Colorado 80909

Attention: Ms. Zoe Anne Holmes

CTL|T Project No. CS19781.000-125

Draft Date April 12, 2024

CTL|Thompson, Inc.
Denver, Fort Collins, Colorado Springs, Glenwood Springs, Pueblo, Summit County – Colorado
Cheyenne, Wyoming and Bozeman, Montana

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SCOPE

This report presents our findings, recommendations, and conclusions for repairs and/or reconstruction to the existing middle school building at the Colorado Springs Charter Academy School campus. The building has experienced distress in the form of significant slab-on-grade movement and cracking, limited exterior brick cracking, and cracking of large window panels. The purpose of our investigation was to evaluate subsurface conditions at the site in order to develop opinions as to the likely cause(s) of the distress and provide construction recommendations that include stabilizing or reconstruction of the floor slab, as well as improving existing surface drainage conditions adjacent to the school building. This report summarizes the results of our field and laboratory investigations and presents our design and construction opinions and recommendations. We believe the investigation was completed in accordance with our proposal CS-23-0204, dated December 15, 2023. Evaluation of the site for the possible presence of potentially hazardous materials (environmental site assessment) was not included in our scope of services.

The report was prepared based on conditions disclosed by several site visits, conditions found in our exploratory borings, results of laboratory tests, engineering analyses, our review of available construction plans for the existing structure, and our experience with similar projects. The following section summarizes the report. More detailed descriptions of subsurface conditions, as well as our opinions and recommendations, are presented in the report.

EXECUTIVE SUMMARY

The configuration of the facility is effectively "V" shaped, with north (uphill) and south (downslope) wings connected at the west end by a large common area pod. The damages to this structure primarily are related to a complicated combination of settlement of slab-on-grade floors around the perimeter, combined with some heave more internal to portions of the building. The north wing is two-story and has very poor surface drainage. This wing is underlain by 4 to 5 feet of fill and natural soils underlain by highly plastic claystone bedrock. Based on the subsurface conditions and very poor surface drainage, including ponding along the entire north side, we would expect this floor to heave significantly. However, visually, the ground level floor and the adjoining exterior flatwork have performed well.

The slab-on-grade floor of the single-story south wing exhibits the most significant signs of differential movement, cracking, and interior partition wall damage. Most of this wing is underlain by 4 to 7 feet of fill. At the eastern one-third of this wing, the fill is underlain by very clayey sandstone (7 feet) and high plasticity claystone (10 feet). The fill below the western two-thirds is underlain by more than 10 feet of silty sand that consolidated upon wetting. Surface drainage is also poor but does not appear to promote ponding. The interior slab around the perimeter has settled significantly enough, at some locations, to expose the double 2-by mudsills and a former foundation grade beam. At the northeast corner of the wing, the exterior sidewalks have settled significantly at the outbound edges. Subsurface conditions at this location suggest fill is about 2 feet thick and underlain by expansive bed-rock.

The performance of the north and south sides of the westerly common area pod are completely opposite of the north and south classroom wings. The north half of this pod has shown signs of significant slab-on-grade movement and possibly some foundation wall distress, while the south half appears to be comparatively stable. The northernmost section is underlain by about 4 feet of fill, then by highly expansive claystone. The central area is underlain by about 7 feet of fill and expansive clay, then by moderately expansive bedrock. The north edge of the floor settled significantly at the perimeter, and a 2-inch wide, west to east crack opened in the floor at about the north one-third mark. Exterior windows in this general area on both the east and west sides suggesting some possible foundation wall heave.

This building is heated by a hot water radiant system around the perimeter fed by a central boiler which is located on the south side between the west common area pod and the south wing. The feed lines of the system are run below the slab-on-grade floor. We suspect the heating system is a significant contributor to perimeter slab settlement due to the lines aiding in the drying of fills and natural soils. The interior sections may have heaved since they are away from the heat source. The north wing may not have significantly heaved, as data would suggest, due to the heat source and shorter distance between sources.

This facility is nearly 40 years old. Issues with the ground level floors developed about 10 years after construction and has apparently been problematic ever since. Our recommendation is to replace the ground level floors throughout the facility with structurally supported floors with a minimum separation from the soil of at least 12 inches. This will involve significant structural modifications, and likely, a major change in the HVAC system. While it appears the existing pier lengths are appropriate from an expansive soil standpoint, the reinforcement may be insufficient by today's practice. Existing void forms below the grade beams may be too thin, resulting in possible stress on grade beams causing exterior brick joint cracks and stress on exterior windowpanes.

EXISTING SITE CONDITIONS

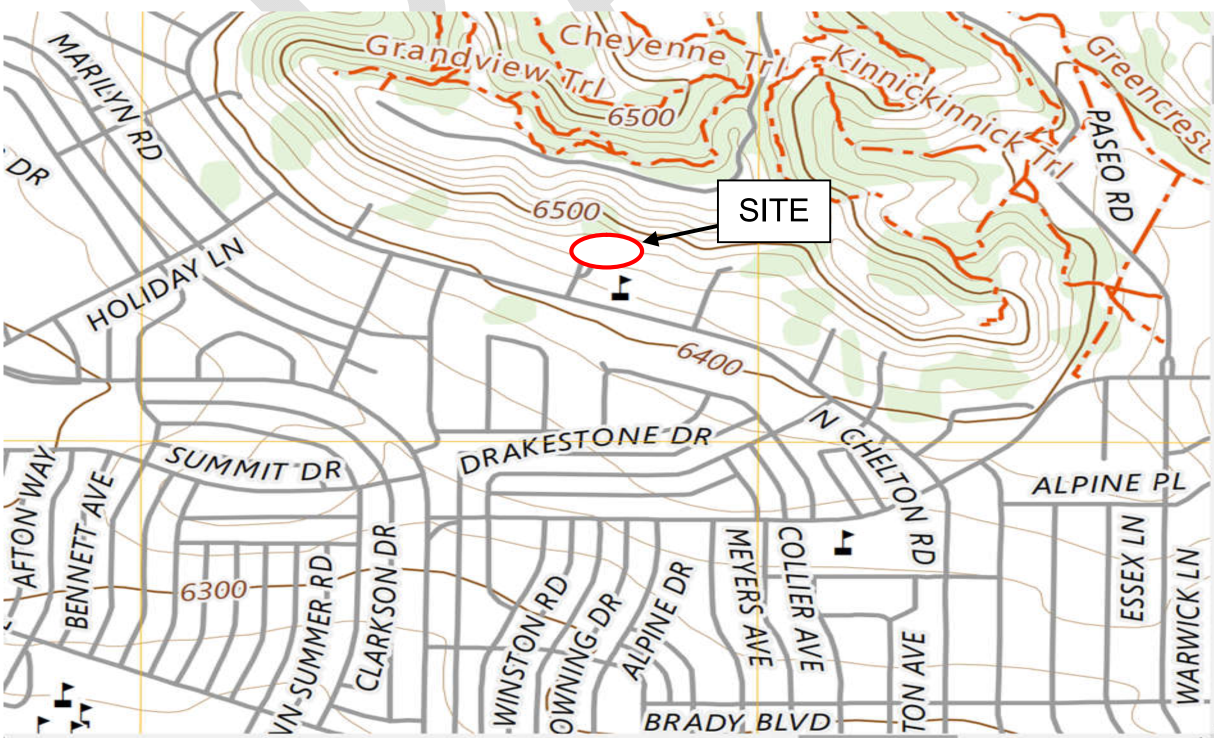
Colorado Springs Charter Academy Middle School is located at 2555 North Chelton Road in Colorado Springs, Colorado. The existing middle school building was constructed in 1986 and consists of a total footprint of about 11,000 square feet. The school building is constructed with a main common/entrance on the west end, and two easterly classroom wings (north and south). A central courtyard separates the north and south wings. Each classroom wing contains a central common/entry area providing access to classrooms and the outside. The north wing has a second story. The remainder of the building is single-story. The ground level floors are slabs-on-grade, reportedly underlain by controlled fill. We are not aware of below grade areas.

The original uses of the building included a worship area (west end of building) and living quarters (classroom wings). Our understanding of the existing foundation and building construction are based on plans supplied to us by the owner which included the original construction plans by Clifford S. Nakata & Associates, PC, titled Benet Hill Priory, and dated June 6, 1986 (Job No. 852500). The structure was renovated in 2010 to convert the interior spaces into a middle school. Our understanding of the interior renovations is based on reviewed project plans by Art C. Klien Construction, dated April 20, 2010 (Job No. 10-0105).

Topography

The middle school site is located on the south facing slope of the Palmer Park Bluff in central Colorado Springs, as indicated by the arrow in the depiction below. Some rock outcrops are present, and erosion is significant in select areas. Vegetation on the slope is sparse and includes scrub oak, some mature pine trees, grasses, and cactus. Original construction of the middle school building included grading the existing sloping terrain to establish a building pad. This resulted in the middle school being about 20+/- feet higher in elevation than the elementary school. A slope between the middle school and elementary school, sloping to the south at grades of about a 3:1, is covered with large cobbles, boulders, and some sod. A short retaining wall is present at the toe of the slope. Stairs are present on the slope, providing access up the slope, between the elementary school and middle school building. Chelton Road is situated on the opposite side (south) of the elementary school.

Overall grades at the school property and in the vicinity of the middle school building are sloped downward toward the building on the north and away from the building on the south. Areas to the north are up to about 100 feet higher in elevation and steeply sloped from the crest of the bluff, downward toward the school building at grades of about 25 to 30 percent. A small, unmaintained stormwater pond feature is present, located upgradient of the school building, about 1/3 the way up the slope, with a drainage channel leading from the pond to the north side of the school building.



Surface runoff from the north has no defined diversion around the building, either by storm water system, or surface drainage features. Rather, it is abruptly interrupted by the school building. Significant erosion of the slope to the north has occured and has resulted in sediment deposition along the north side of the school. Minor flooding has occurred on several occasions.

The centrally located courtyard is relatively flat and covered with concrete walks and irrigated sod. Drainage within the courtyard is such that ponding of stormwater runoff within the courtyard is common.

Existing Structure

We understand the building was constructed using a drilled pier foundation and slab-on-grade floor system. Plans indicate piers were to be 12-inches in diameter, have a minimum length of 25 feet and penetrate 20 feet into bedrock. They were to be continuously reinforced with two #6, grade 60 bars. The void between piers was to be at least 4-inches thick. We have not seen documentation for pier construction.

We understand a slab-on-grade floor system was constructed over a layer of granular fill. We measured fill thickness between 2 and 7 feet. A portion of the underlying fill may have been constructed as site grading. Slab-on-grade floors at the time of construction were typically designed to be separated from foundation elements to allow for free vertical movement. We have not seen documentation for the placement of fills or construction of slabs.

Original building uses included a housing facility for Benet Hill Academy staff and a worship hall. The interior layout included living quarters, shared restrooms between each residence room within each of the building wings, common areas, kitchen, and common dining areas. Access to these areas was by a common corridor, no longer present. The west end of the building was occupied with a worship hall.

Interior renovations were performed in the year 2010 and included significant changes to the interior layout. The exterior remained generally unchanged following the completed renovation. Layout and location of mechanical rooms do not appear to have changed. The renovations included removing interior partition walls, some of which were supported by a foundation (grade beam and piers), which were left in place. The completed renovation resulted in the main floor level of each wing consisting of two classrooms, a central foyer, and restrooms. The worship area at the west end of the building was renovated to establish two classrooms and a main lobby.

Observed Damages

We observed the interior and exterior of the building during our various site reconnaissance's. Several areas were observed displaying distress, including cracking of interior slab-on-grade partition drywall and slab-on-grade construction joints. Exterior distresses were minimal, in our opinion, and limited to opening of mortar joint step cracking, settlement at exterior door stoops, and the sidewalk had pulled away and separated from the building at various locations, mainly at the northwest corner of the west most classroom (science room) and the northeast corner of the south wing.

In general, drywall cracks range in width from less than 1/16 of an inch to up to about 3/8 of an inch. Floor slab cracks range in width from about less than 1/8 of an inch to about 2 inches. Floor cracks in the science room located on the west end of the north wing were observed as the most severe, having a width approaching 2 inches. Most of the floor slab cracks exhibit no differential movement to slight differential movement; however, differential movement was observed at two locations in the east most classroom of the south wing (classroom 308). Differential movement was measured at up to about 1 inch at the entry of classroom 308, at the south foyer, and within the center of the classroom. Most of the distress observed within the floor slab appears to be located along construction joints or at the edges. Cracking outside of construction joints was not common.

Previous Investigations

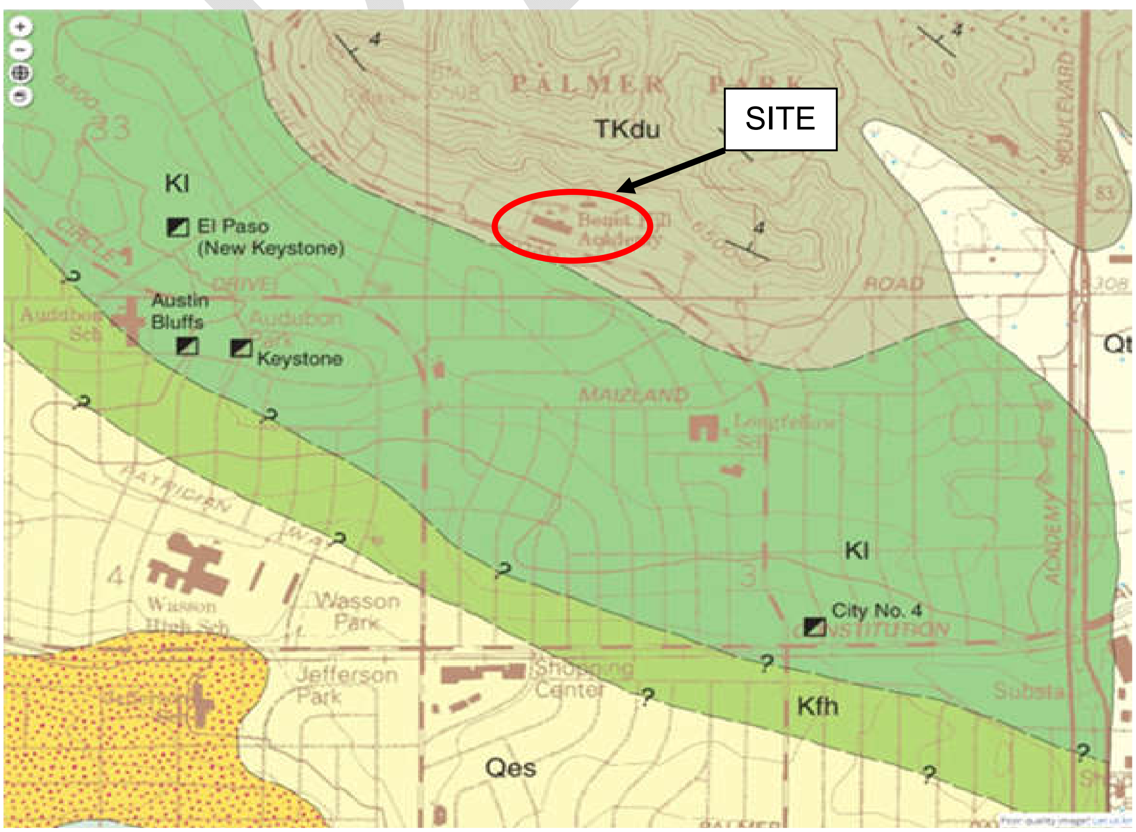
The conditions at the Colorado Springs Charter Academy Middle School have been investigated to various degrees over the past 29 years. Each investigation identified varying amounts of distress and damage within the interior and on the exterior of the building. The earliest slab movement was documented in a report by Samberson and Associates, Inc, dated April 10, 1995. Damages to dry wall were identified and refer to being the result of slip joint failure due to improper installation. Additionally, poor drainage around the building is also mentioned in the report. Recommendations included expanding the slip joints, inspecting the building for further damage, consult with a geotechnical engineer, and perform repairs to the building where necessary. We are not aware of the owner consulting with a Geotechnical Engineer as recommended in the 1995 letter. A letter prepared as meeting minutes between the owner and Art C. Klien Construction (dated April 2, 1996) contain similar discussions and recommendations.

Entech Engineering, Inc conducted an investigation of the reported slab distresses with documented observations, conclusions, and recommendations presented in a letter dated February 14, 1996 (Entech Job No. 77125). Observations included cosmetic damage, inoperable doors, and distresses to the floor slab throughout the building. Entech included a shallow subsurface exploration. It was the opinion of Entech Engineering that no damage to the exterior foundation existed due to proper isolation of the slab from the foundations. Subsurface conditions found below the floor slab were explored by hand auger at six locations. Materials found included fill, clayey sands, sandy clays, and weathered claystone bedrock. A foundation perimeter drain was not identified during the excavation of two test pits along the exterior side of the foundations. Samples were obtained and subjected to laboratory testing. Entech concluded heave of the below slab soils and bedrock were contributing factors to the observed distresses. Slab movement transferred to interior partition walls resulted in cosmetic damage. Recommendations included the replacement of below slab soils, correcting partition wall construction, installing a foundation perimeter drain, and improving surface drainage around the structure.

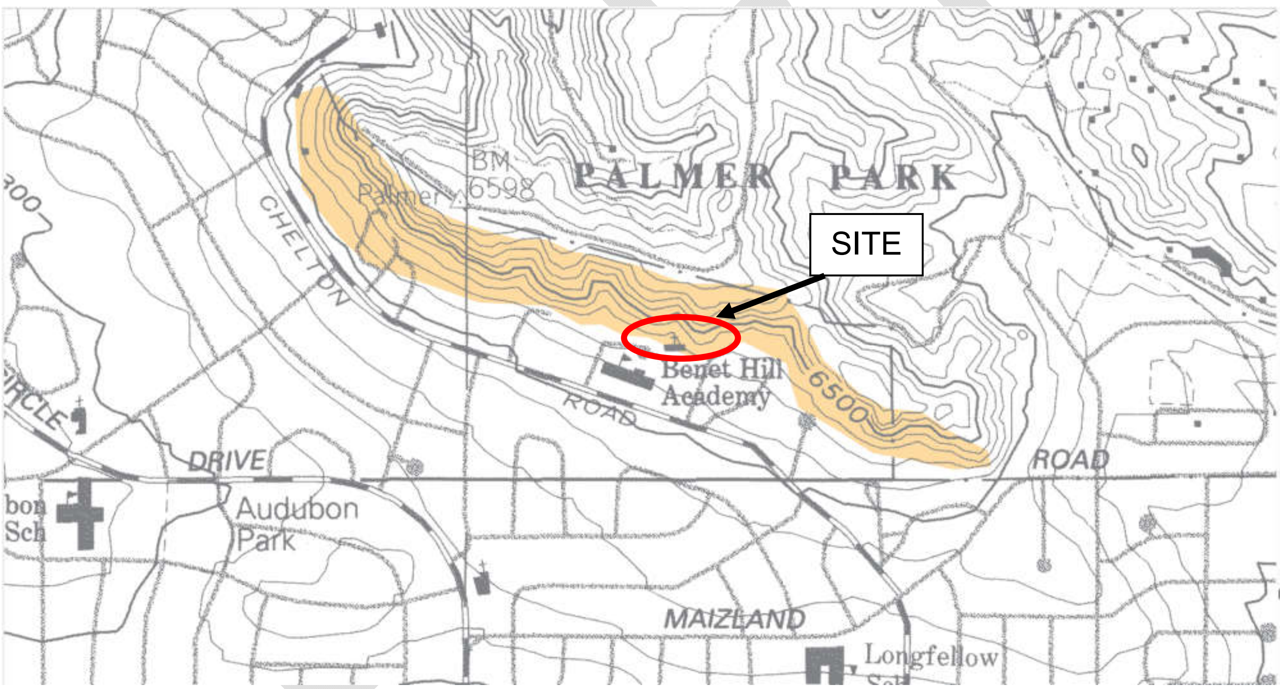
Yee Consulting Engineering, Inc, prepared two letters, dated December 18, 2008 and February 11, 2009, summarizing and providing opinions regarding an investigation of the school building. The letters outline structural observations including minor exterior brick work damage, cosmetic damage to interior partition walls, and distresses to the ground level floor slab. Distresses and settlement of the floor slab are generally described as located at control joints and edges of the slabs at foundation walls. Yee noted that foundation walls did not appear to exhibit lateral movement. Doors and windows were not reported by the owner as “sticking” at the time of Yee’s investigation. Poor surface drainage was noted in the report.

SITE GEOLOGY

The geology of the site was evaluated by reviewing geologic maps, aerial photographs, conditions found in our borings, and observing field conditions. The site was mapped by Christopher J. Carroll and Timothy A. Crawford in 2000 as part of regional mapping for the United States Geological Survey (USGS). The site is mapped and described as underlain by bedrock classified as the Dawson Formation (TKdu) undivided (Paleocene or Upper Cretaceous) described as light gray to tan arkose and thin, interbedded gray claystone. The materials were brown, reddish brown and orange-brown. High angle crossbedding, clay ripup clasts, and soft sediment deformation are common features. Contains some andesitic gravel lenses beneath arkose beds. Nearby bedrock is mapped as slightly dipping; between 4 and 5 degrees. Subsurface coal mining operations took place during the late 1800s and early 1900s in the general vicinity of the site. The following presents the mapped geology of the site and vicinity, and the location of the site is indicated by the black arrow on the following depiction.



The site is included in an area mapped as susceptible to potential landslide, according to available mapping prepared by White and Wait of the CGS for the City of Colorado Springs in 2003, as depicted by the beige color in the below figure. The proximity to areas mapped as potential landslide susceptible areas may present regulatory approval and challenges for new construction. Special design and construction requirements may need to be considered and can be outlined in a Geologic Hazards Evaluation, which may be required by the City if new construction is considered. We have extensive experience in preparing Geologic Hazards Evaluations and can prepare one if desired. The location of the site is indicated by the black arrow on the following depiction.



We believe facility ownership should be aware of two factors that include site geology and the potential geologic hazards. We evaluated the geology of the area by reviewing mapping prepared by the Colorado Gologic Survey (CGS) and Charles Robinson (Robinson, 1977 Land Use Maps prepared for El Paso County, and a mine subsidence report prepared by Dames and Moore in 1985. We have developed our discussion on site specific geology based on our observations of the site.

The site sits at the base of the Palmer Park Mesa open space. The bluff and exposed slope consists of Dawson Formation sandstone of varying degrees of cementation. The formation contains layers of claystone that are often highly explasive and highly plastic. CGS mapping indicated the Dawson Formation to be underlain by the Larame Formation that consists of interbedded sandtone, siltstone, shels and coal. The Larame Formation in the northern portion of Colorado Springs was widely mined for coal by subsurface shafts and horizontal extraction. Several abandoned mine entrances exist south and west of the school campus. A review of the mapping included in the Dames and Moore report indicate the campus is NOT underlain by abandoned mines that would present a risk of future surface subsidence.

CGS maps the slope face as having an elevated susseptibility to instability. No instances of slope failure were documented, and we did not see evidence in the slope face on the lower 10 to 20 feet. Slopes under those conditions are subject to concentrated channel waterflow that transport loose materials in a mud like river known as a debris flow. This phenominan does exist at the north side of the north wing. Prior owners and the current owner have made attempts at controlling these flows, but the measures have been ineffective based upon the occurance of sediment deposited behind sandbags around exit stoops along the north side of the north wing.

Maps prepared by the CGS indicate south of the campus, the various bedrock formations are overlain by Eolian, or windblown deposits of silty sand. These types of materials can be sensitive to changes in moisture content and consolidate (Compress or setttle) under their own weight when wetted. We do not believe we encountered these materials below the middle school but could exist below the elementary school and south of Chelton Road, the southern campus.

The Robinson mapping indicated that the bedrock formation below the middle school is overlain by Colluvium or soils deposited by the weathering of the exposed bedrock bluffs and deposited by water or wind. Colluvial deposits can also be sensitive to water and load and are typically of low density. We expect the natural soil found in our test holes are likely colluvium in nature. They may not exist below the elementary school or southern campus.

SUBSURFACE INVESTIGATION

We explored subsurface conditions at the site by drilling eight (8) exploratory borings within and adjacent to the existing middle school building. Boring locations were located where accessibility allowed. The approximate locations are shown on Fig. 1. The borings were advanced to depths of between 6 ½ and 20 feet, using 3.5-inch diameter, continuous-flight augers, and a mini hydraulic drill rig.

Samples of the soil and bedrock were obtained at continuous intervals as well as 2 to 5-foot intervals using a 2.5-inch diameter (O.D.) modified California barrel sampler driven by blows from a 140-pound hammer falling 30 inches. A representative of CTL|Thompson, Inc. was present during drilling to observe drilling operations, log the subsurface conditions encountered in the borings, and obtain samples for laboratory tests.

Samples were returned to our laboratory where they were examined by our engineer and laboratory tests were assigned. Laboratory tests included dry density, moisture content, swell-consolidation, sieve analysis (percent passing the No. 200 sieve), Atterberg limits, and water-soluble sulfate concentration. Standard Proctor tests were performed on two samples of the existing fill materials. Swell-consolidation tests were performed by wetting the samples under approximate overburden pressures (the weight of overlying soils) as well as over consolidation pressures. Summary logs of the exploratory borings including results of field penetration resistance tests and a portion of the laboratory data are presented on Fig. 2. Results of swell-consolidation and gradation tests are presented in Appendix B. The laboratory results are summarized on Table B-1.

SUBSURFACE CONDITIONS

Subsurface soils and bedrock encountered in the eight borings consisted of up to about 7 feet of silty to clayey sand fill underlain by up to about 12.5 feet of natural, silty to clayey sand. Sandy clay was encountered underlying the fill materials, extending to depths of about 4.5 and 7.5 feet in two borings. Layers of soil we interpreted to be slope wash are present within the overburden materials and identified in exploratory borings TH-2 though TH-6. The slope wash generally occurred immediately underlying the fill and extending to depths of between 4.5 and 10 feet. Claystone and sandstone bedrock was encountered underlying the fill, natural soils, and slope wash at depths of between 2 and 17 feet and extended to the maximum depths explored of 20 feet. Some pertinent engineering characteristics of the soils encountered, as well as groundwater conditions, are described in the following paragraphs.

Fill

Silty to clayey sand fill was encountered below the concrete floor slab and extended to depths of 2 to 7 feet. The fill was judged to be medium dense to very dense based on field penetration resistance testing. Six samples contained 23 to 38 percent silt and clay sized particles (passing the No. 200 sieve). Three samples were subjected to Atterberg limits testing, resulting in liquid limits of between 25 and 29 and plasticity indices of between 6 and 12. The fill did not swell when wetted under estimated overburden pressures (weight of the overlying soils); however, three samples did exhibit measured consolidation of between 0.3 and 2.5 percent. We judge the fill materials to be non-expansive.

Two Proctors were prepared using materials obtained from below the floor slab and representative of the fill. Two samples of the fill indicate maximum dry densities of between 125 pcf and 130 pcf with optimum moisture contents of 8 and 10 percent, respectively. Based on these values and laboratory test results, the fill materials supporting the floor slab have dry densities within at least 92 percent of the maximum value. Moisture contents are within a range of about 6 percent of optimum. Based on our analysis, we do not believe the fill materials are significantly loose. Loose fill materials would be expected to present a higher risk of settlement.

Natural Soils

Natural soils encountered underlying the existing fill at depths of 3 to 6 feet consisted of 2 to 12.5 feet of silty to clayey sand and sandy clay. The natural soils are judged to be loose to medium dense or stiff based on field penetration resistance testing. Five samples of the silty to clayey sand subjected to laboratory testing contained 14 to 28 percent silt and clay-sized particles. One sample of sandy clay contained 85 percent silty and clay-sized particles. Based on experience, the sand soils are judged to be non-expansive or exhibit slight expansion when wetted. The clay soils exhibit moderate expansion potential when wetted.

Bedrock

Slightly sandy to sandy claystone and clayey to very clayey sandstone bedrock was encountered underlying the natural soils at depths of 2 and 17 feet and extended to the maximum depths explored of 20 feet. The bedrock was judged to be medium hard based on field penetration resistance testing. Nine samples of the bedrock contained 22 to 91 percent silt and clay-sized particles. Five samples were subjected to Atterberg limits testing resulting in Liquid Limits of between 51 to 124 and Plasticity Indices of between 28 to 67 indicate the materials are highly plastic. Eight samples of the bedrock exhibited moderate to high measured swell values of between 3.3 and 8.7 percent when wetted under estimated overburden pressures. Swell pressures resulting from laboratory testing range from 7,200 to 30,000 psf. One sample exhibited compression prior to wetting.

Groundwater

Groundwater was not encountered in the exploratory borings during our drilling operations. Borings were advanced to depths of between 6.5 and 20 feet. Groundwater was measured in one exploratory boring (TH-6) at a depth of 17 when checked 8 days following the completion of the drilling operation. Water levels may rise in response to seasonal precipitation, precipitation runoff from the adjacent hillside, and irrigation.

FLOOR LEVEL SURVEY

We surveyed the relative levelness of the ground level floor using an optical survey instrument and a vertical rod. For the purpose of comparison, we denoted the west entrance threshold as the baseline zero point. We converted elevation measurements into 1/16-inch increments as shown in Figures 1 and 2. Figures 1 and 2 also show the general locations of significant visible vertical and horizontal distress in the slabs. We concentrated our measurements on the south wing, the west common pod where most of the significant movement was observed. For comparison, we made measurements within the north wing.

To put measurements into perspective, differences of 4/16 (1/4-inch) are considered to be normal survey variances. For construction, variances at 16/16 (1-inch) over a lateral distance of 50 feet is considered to be within normal tolerances. Simply put, the survey suggests the floor slab in the north wing is 1 to nearly 4 inches higher in elevation than the main entrance and is about 2 ½ inches higher at the east end than the west end.

The south wing shows significant variance between the west half being nearly level with the main entrance, and the east half being up to 3¾ inches higher at the northeast corner. Within classroom 308, the relative levelness difference is 3 ¾ inches from the common area entrance at the northeast exit door. One thing to note is the elevation of the exposed grade beam in the middle of the room is over 1-inch, and the vertical displacement with the adjoining slab being over 1-inch.

The slab-on-ground movements within the western common pod area are as erratic as the east half of the south wing. The elevation of the slab in the interior portions of this pod are 1 to 2 inches higher than the main entrance, and about ½ inch lower than the main entrance at the north end. The total differential, south to north, is about 2 ½ inches over 50 feet.

DISCUSSION OF ASSEMBLED DATA

We were originally contacted to evaluate the performance of the slab-on-grade interior floors and adjacent flatwork. Later during the evaluation, the scope expanded to evaluate the cause of the presence of slight exterior brick work cracking and reoccurring cracking of large windowpanes in the west pod, west and east facing areas. This section is limited to our interpretation of slab-on-grade distress.

A geotechnical consultant evaluating this site today without the background information would advise slab-on-grade floors could heave 8+ inches. The areas underlain by 10+ feet of fill or natural soil (classroom 307 and west foyer) could experience 1-inch or so movement. These projections consider an intensive, consistent wetting source such as irrigated landscaping, and a passive heating (forced air) system. The combination of covering the ground surface, preventing evaporation and a wetting source causes an increase in the moisture of the expansive soils to depths in excess of 10 feet.

At this site, the primary wetting source is the poor surface drainage and ponding of water at the exterior side of the foundation. The heat transfer from the radiant heat system may be drying the soils, reducing the wetting and actually drying the highly plastic materials causing shrinkage and the observed settlement. This drying effect may be limited to the perimeter and along feed lines. Wetting may be occurring more internal to the building causing heaving.

We evaluated the performance of the piers using current accepted methods of analysis and design criteria, along with the results of our swell testing. The specified 25-foot minimum length and specified bedrock penetration appear to be appropriate. Our calculations suggest the specified 4-inch-thick void may be too thin to accommodate the projected 8 inches of potential heave, but there is no evidence this projected amount of heaving has occurred. The two #6 reinforcing bars in the piers may also be insufficient for tension due to heaving, but again, we do not believe the full potential heave has not occurred.

RECOMMENDATIONS Repair Solution

We understand a financial decision is being evaluated requiring repairing and upgrading the existing building or constructing a new structure elsewhere on the campus. Given the past performance of the slab-on-grade floor and the future risk of heave for a replacement slab-on-grade system, we recommend any replacement floor be structurally-supported with at least 12 inches of void space between floor joists and or beams and the subsoils. When the existing slab is removed, the void beneath grade beams, between piers should be thickened to accommodate at least 8 inches of heave. We also recommend installation of an interior perimeter drain. Construction of a structurally supported floor will likely require installation of new piers. The new piers can be designed using the criteria for the existing structure but should be reinforced using at least three #6, grade 60 bars. Alternative support systems include micro-piles or auger piles. We can provide design criteria for these systems if desired.

Surface drainage around the existing building must be significantly revised to avoid ponding of water near the building. This will likely include a storm drain system along the north side of the building and with the courtyard between the wings. Construction of new retaining walls may be needed at the toe of the north slope to establish proper drainage. As plans develop, we can provide criteria for retaining walls.

LIMITATIONS

This report has been prepared for the exclusive use of Colorado Springs Charter Academy for the purpose of providing geotechnical conclusions, opinions, and recommendations for the proposed building slab repairs, stabilization, and/or reconstruction. The information, conclusions, and recommendations presented herein are based upon consideration of many factors including, but not limited to, the type of structure 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 continuously evolve in the area of geotechnical engineering. The recommendations provided are appropriate for about three years. If the project is not constructed within about three years, we should be contacted to determine if we should update this report.

Our borings were located to obtain a reasonably accurate understanding of existing subsurface and foundation conditions within the general vicinity of the building. The data are representative of conditions encountered only at the exact boring locations. Variations in the subsurface conditions not indicated by our borings are possible. Building repairs as it relates to geotechnical engineering, observations, inspection, and materials testing should be performed by a representative of our office during construction.

We believe this subsurface investigation was conducted in a manner consistent with that level of skill and care normally 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 the contents of this report or in the analysis of the influence of the subsoil conditions on design of the structure repairs, please call.

CTL|THOMPSON, INC. Reviewed by:

Patrick Foley, EI
Staff Engineer

William C. Hoffmann, Jr., P.E., FACEC
Senior Engineering Consultant

PF:WCH:cw
(1 copy via email)

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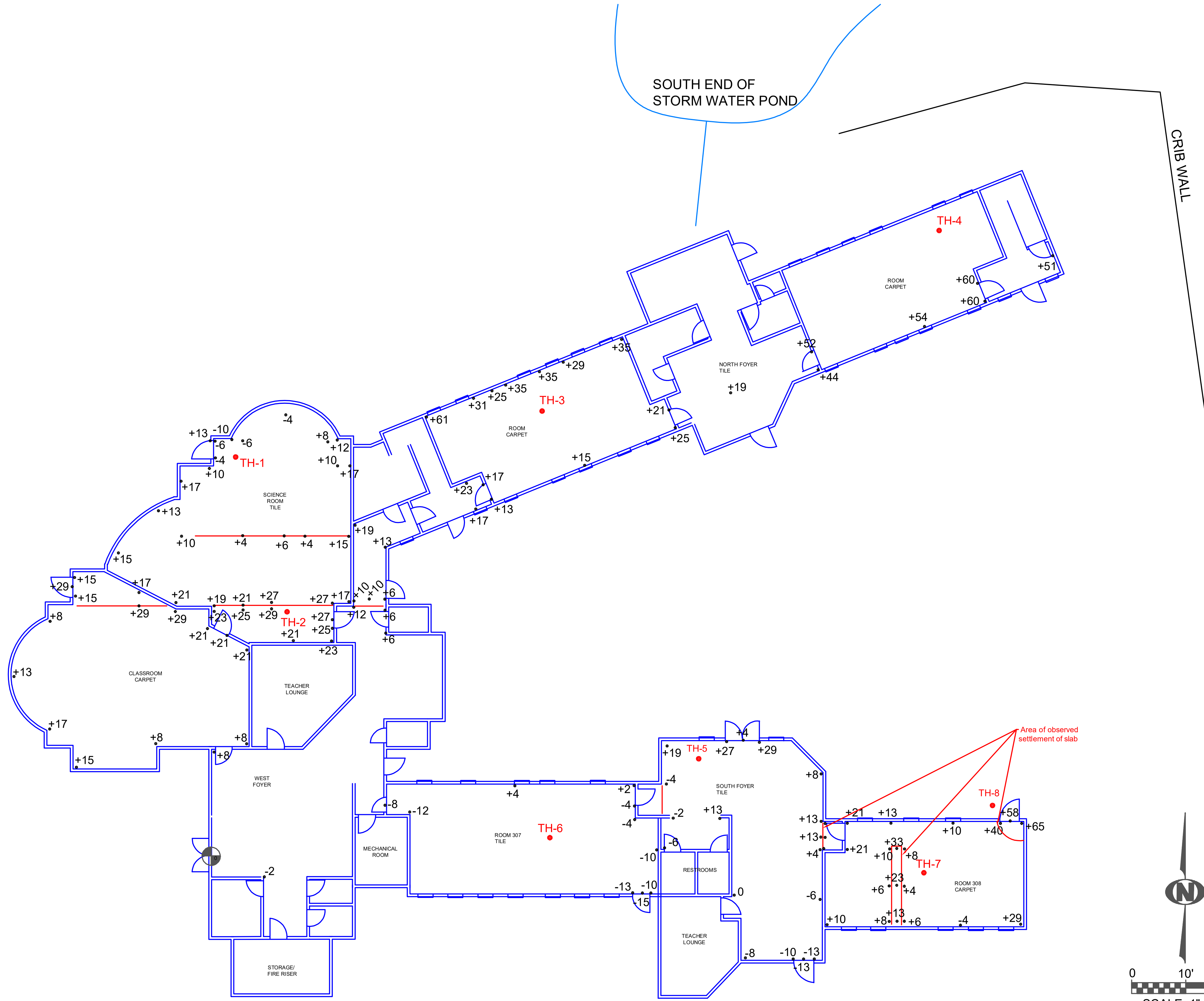
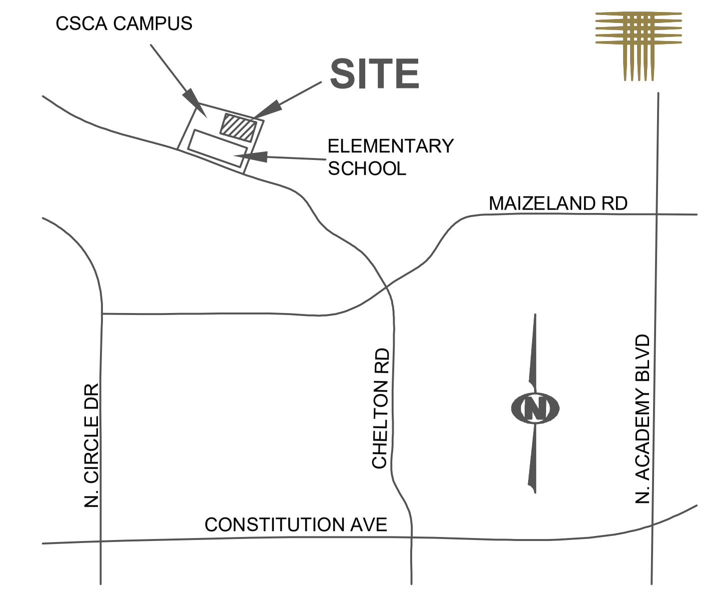




VICINITY MAP
(NOT TO SCALE)

LEGEND:

- TH-1 — APPROXIMATE LOCATION OF EXPLORATORY BORING.
- +33 — MEASURED DEVIATION OF SLAB BASED ON ESTABLISHED BENCH MARK IN $\frac{1}{16}$ OF AN INCH. VALUE INDICATES NUMBER OF 1/16TH FROM BENCH MARK.
- LOCATION OF EXISTING BUILDING FOOTPRINT.
- APPROXIMATE LOCATION OF SIGNIFICANT FLOOR CRACK/SEPARATION OF CONTROL JOINT.
- REFERENCE POINT: THE CENTER OF THE DOOR THRESHOLD OF MAIN ENTRANCE WAS USED AS THE BASE REFERENCE POINT.

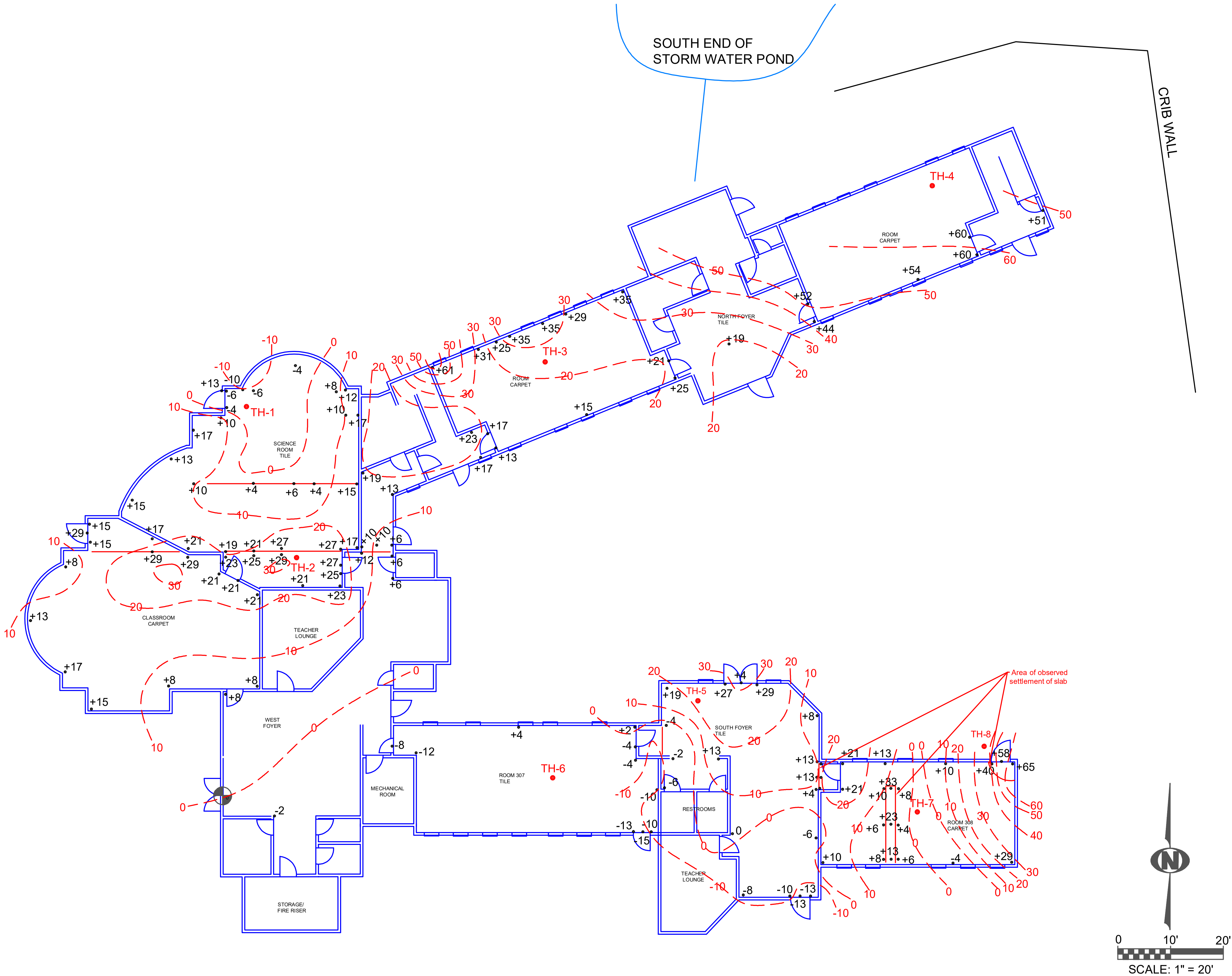
0 10' 20'
SCALE: 1" = 20'

NOTE:
BASE DRAWING WAS PROVIDED BY THE CLIENT, PREPARED BY CLIFFORD S. NAKATA, PC
(JOB NO. 852500, DATED JUNE 6, 1986).

Location of Exploratory Borings

COLORADO SPRINGS CHARTER ACADEMY
MIDDLE SCHOOL BUILDING DISTRESS
CTL|T PROJECT NO. CS19781.000-125

FIG. 1



LEGEND:

TH-1 — APPROXIMATE LOCATION OF EXPLORATORY BORING.

LOCATION OF EXISTING BUILDING FOOTPRINT.

APPROXIMATE LOCATION OF SIGNIFICANT FLOOR SLAB CRACK/SEPARATION OF CONTROL JOINT

+33 — MEASURED DEVIATION OF SLAB BASED ON ESTABLISHED BENCH MARK IN $\frac{1}{16}$ OF AN INCH. VALUE INDICATES NUMBER OF 1/16TH FROM BENCH MARK.

ESTIMATED FLOOR SLAB ELEVATION CONTOUR

REFERENCE POINT: THE CENTER OF THE DOOR THRESHOLD OF MAIN ENTRANCE WAS USED AS THE BASE REFERENCE POINT.

NOTES:

1. BASE DRAWING WAS PREPARED BY CLIFFORD S. NAKATA (JOB NO. 852500, DATED JUNE 6, 1986).
2. ALL BOUNDARIES SHOWN SHOULD BE CONSIDERED APPROXIMATE. THEY ARE BASED UPON A SUBJECTIVE INTERPRETATION OF OUR SURVEY OF FLOOR ELEVATIONS AND AN A FIELD RECONNAISSANCE.

COLORADO SPRINGS CHARTER ACADEMY
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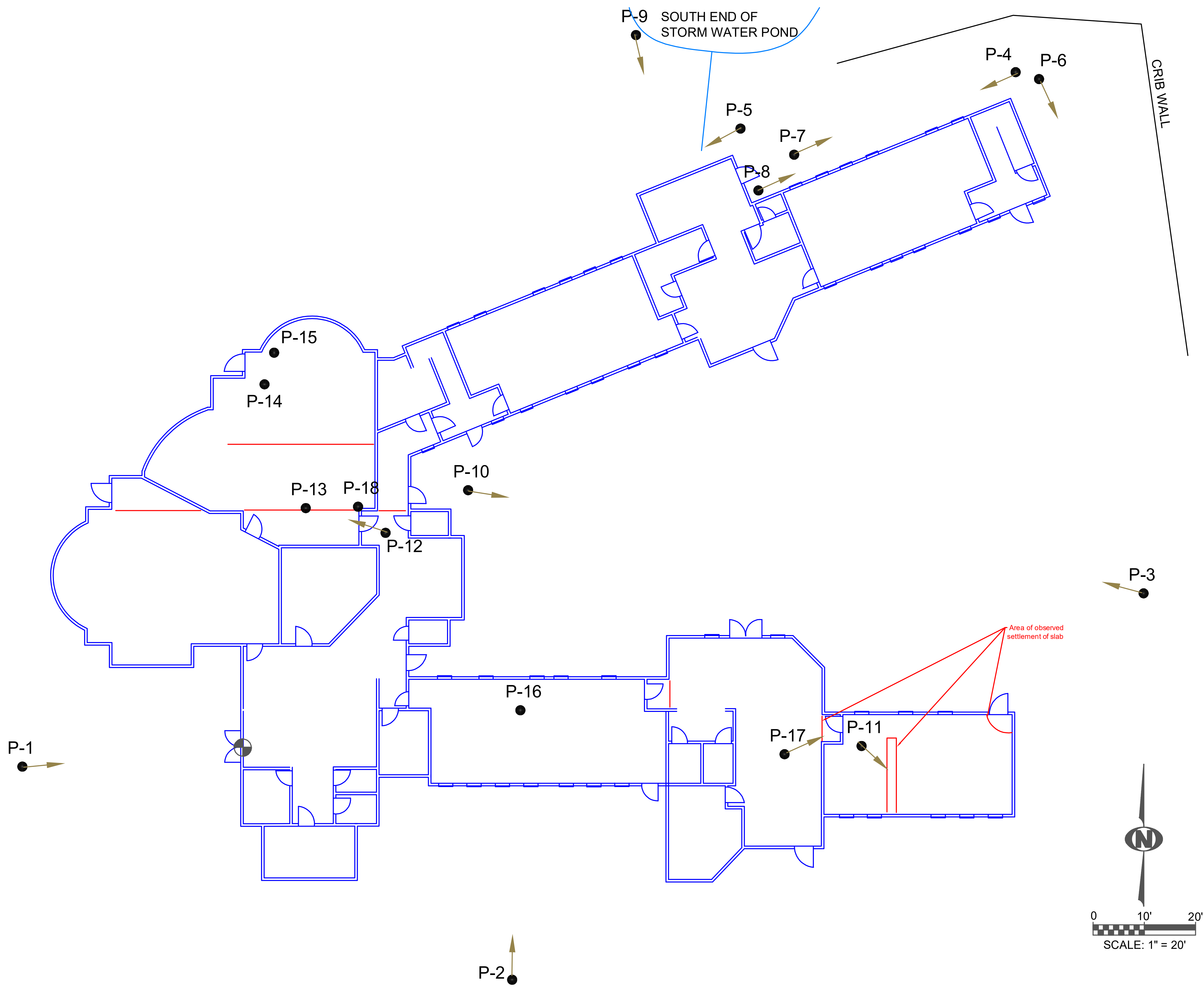
Floor Elevation Survey
Contour Map

FIG. 2



LEGEND:

P-1 ● APPROXIMATE LOCATION OF PHOTOGRAPH. ARROW INDICATES DIRECTION OF PHOTOGRAPH.

(blue line) LOCATION OF EXISTING BUILDING FOOTPRINT.

(red line) LOCATION OF OBSERVED CRACK OF FLOOR SLAB-ON-GRADE.

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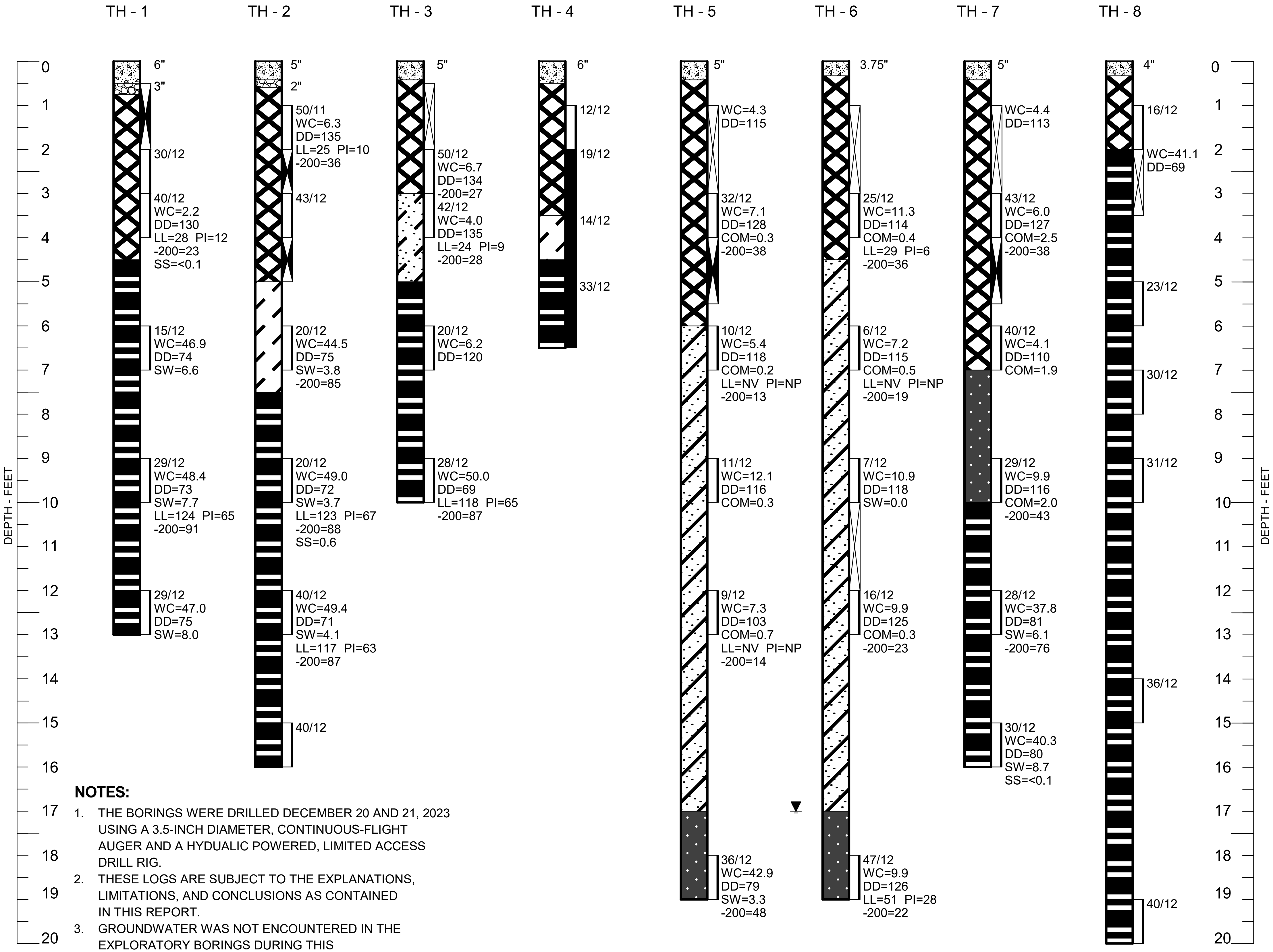
Location of Photographs

FIG. 3

APPENDIX A

SUMMARY LOGS OF EXPLORATORY BORINGS



NOTES:

1. THE BORINGS WERE DRILLED DECEMBER 20 AND 21, 2023 USING A 3.5-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A HYDUALIC POWERED, LIMITED ACCESS DRILL RIG.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.
3. GROUNDWATER WAS NOT ENCOUNTERED IN THE EXPLORATORY BORINGS DURING THIS INVESTIGATION.

LEGEND:

- CONCRETE. SLAB-ON-GRADE FLOOR. 6" REPRESENTS THICKNESS (INCHES).
- FILL, SAND, SILTY TO VERY SILTY OR CLAYEY TO VERY CLAYEY, MEDIUM DENSE TO VERY DENSE, SLIGHTLY MOIST TO MOIST, LIGHT BROWN TO BROWN, LIGHT RED BROWN TO RED BROWN.
- CLAY, SANDY, VERY STIFF, MOIST TO VERY MOIST, LIGHT GRAY BROWN, OLIVE BROWN (CL).
- SAND, SILTY TO CLAYEY, LOOSE TO MEDIUM DENSE, SLIGHTLY MOIST TO MOIST, LIGHT BROWN TO BROWN (CL).
- WEATHERED BEDROCK, CLAYSTONE, SLIGHTLY SANDY TO SANDY, MEDIUM HARD, MOIST TO VERY MOIST, OLIVE BROWN TO DARK OLIVE BROWN.
- WEATHERED BEDROCK, SANDSTONE, SILTY OR CLAYEY TO VERY CLAYEY, MEDIUM HARD, MOIST TO VERY MOIST, OLIVE BROWN.
- INDICATES BULK SAMPLE OBTAINED FROM AUGER CUTTINGS.
- DRIVE SAMPLE. THE SYMBOL 30/12 INDICATES 30 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.
- DRIVE SAMPLE. THE SYMBOL 30/12 INDICATES 30 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.0-INCH O.D. SAMPLER 12 INCHES.
- INDICATES SHELBY TUBE SAMPLER DRIVEN 12 TO 18 INCHES.
- GROUNDWATER LEVEL MEASURED 8 DAYS AFTER DRILLING.

NOTES:

- WC - INDICATES MOISTURE CONTENT. (%)
- DD - INDICATES DRY DENSITY. (PCF)
- SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
- COM - INDICATES COMPRESSION WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
- LL - INDICATES LIQUID LIMIT. (NV : NO VALUE)
- PI - INDICATES PLASTICITY INDEX. (NP : NON-PLASTIC)
- -200 - INDICATES PASSING NO. 200 SIEVE. (%)
- SS - INDICATES WATER-SOLUBLE SULFATE CONTENT. (%)

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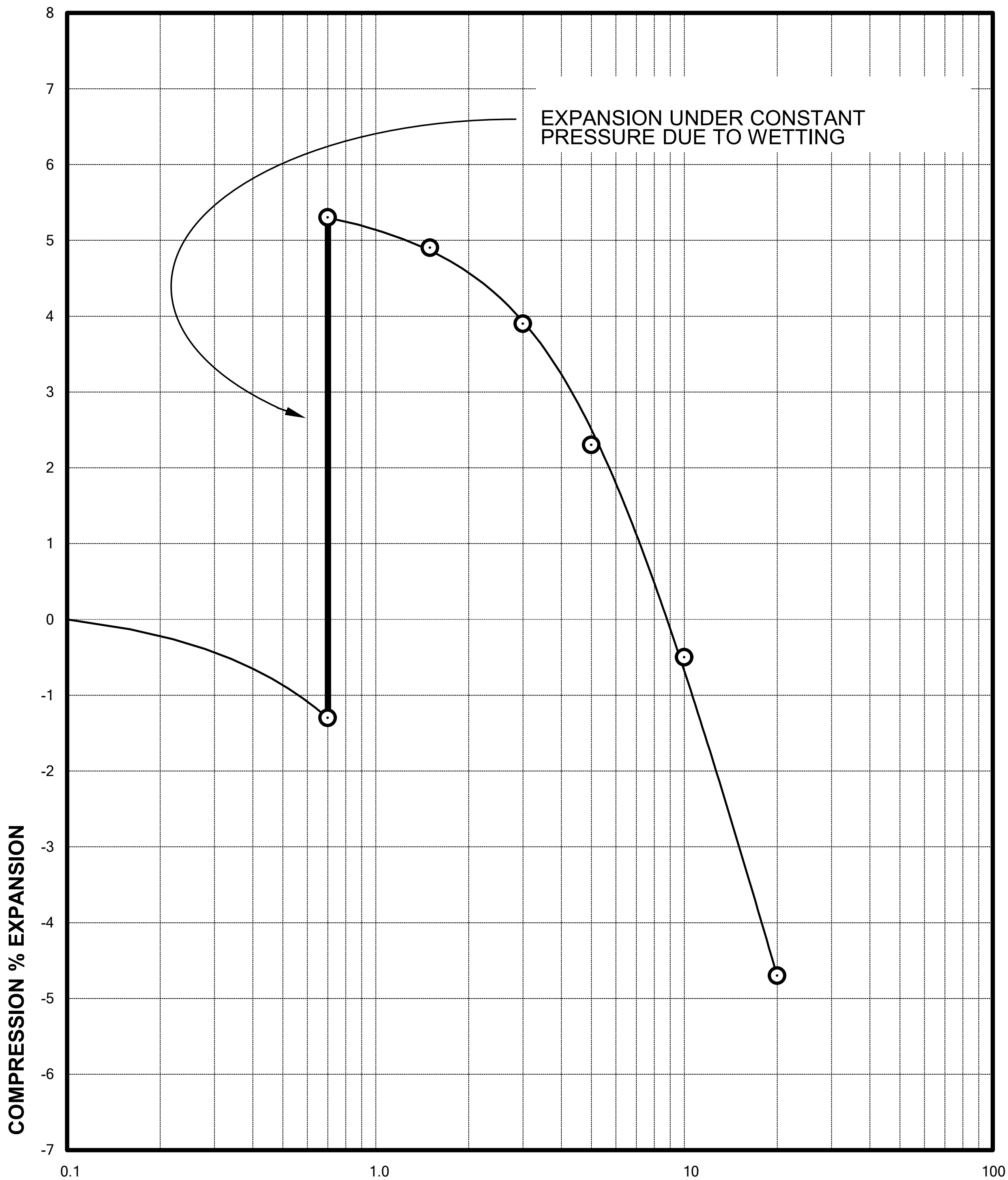
Summary Logs of Exploratory Borings

FIG. A-1

APPENDIX B

LABORATORY TEST RESULTS

TABLE B-1 – SUMMARY OF LABORATORY TESTING



Sample of WEATHERED CLAYSTONE, SANDY

From TH-1 AT 6 FEET

DRY UNIT WEIGHT= 74 PCF

MOISTURE CONTENT= 46.9 %

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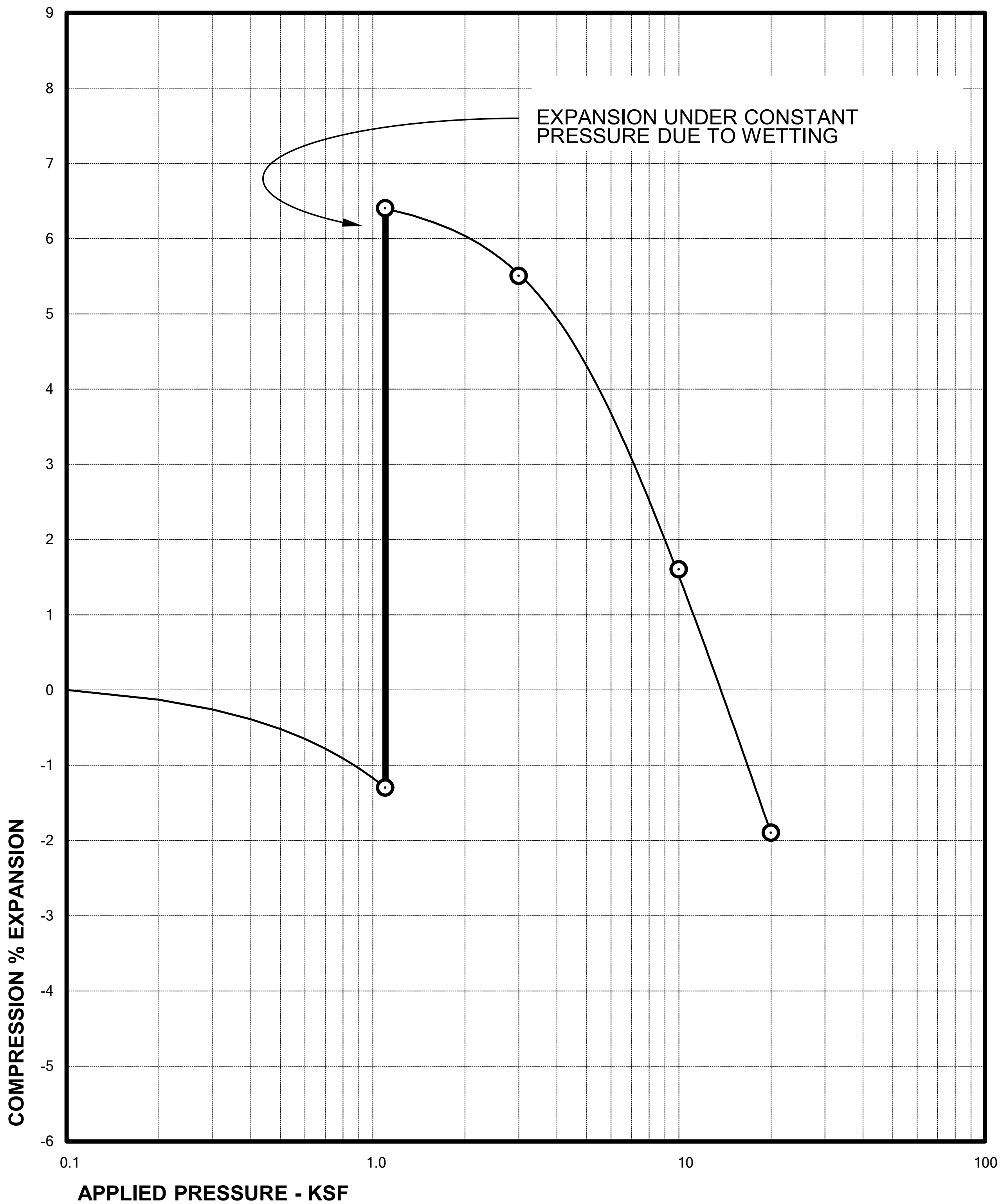
Swell Consolidation Test Results

FIG. B-1



Sample of	WEATHERED CLAYSTONE, SLIGHTLY SANDY	DRY UNIT WEIGHT=	73	PCF
From	TH-1 AT 9 FEET	MOISTURE CONTENT=	48.4	%

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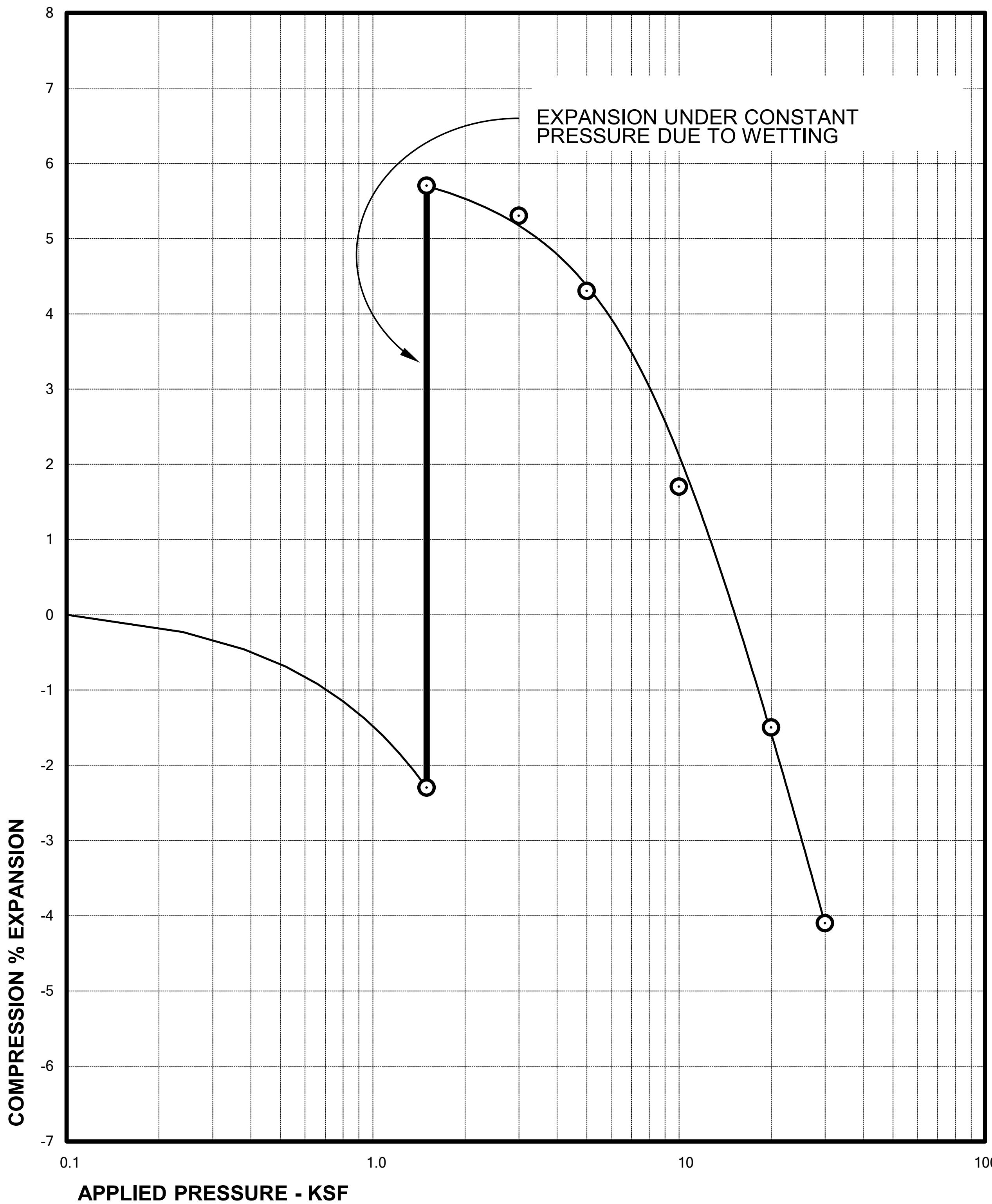
Swell Consolidation Test Results

FIG. B-2



Sample of WEATHERED CLAYSTONE, SANDY
From TH-1 AT 12 FEET

DRY UNIT WEIGHT= 75 PCF
MOISTURE CONTENT= 47.0 %

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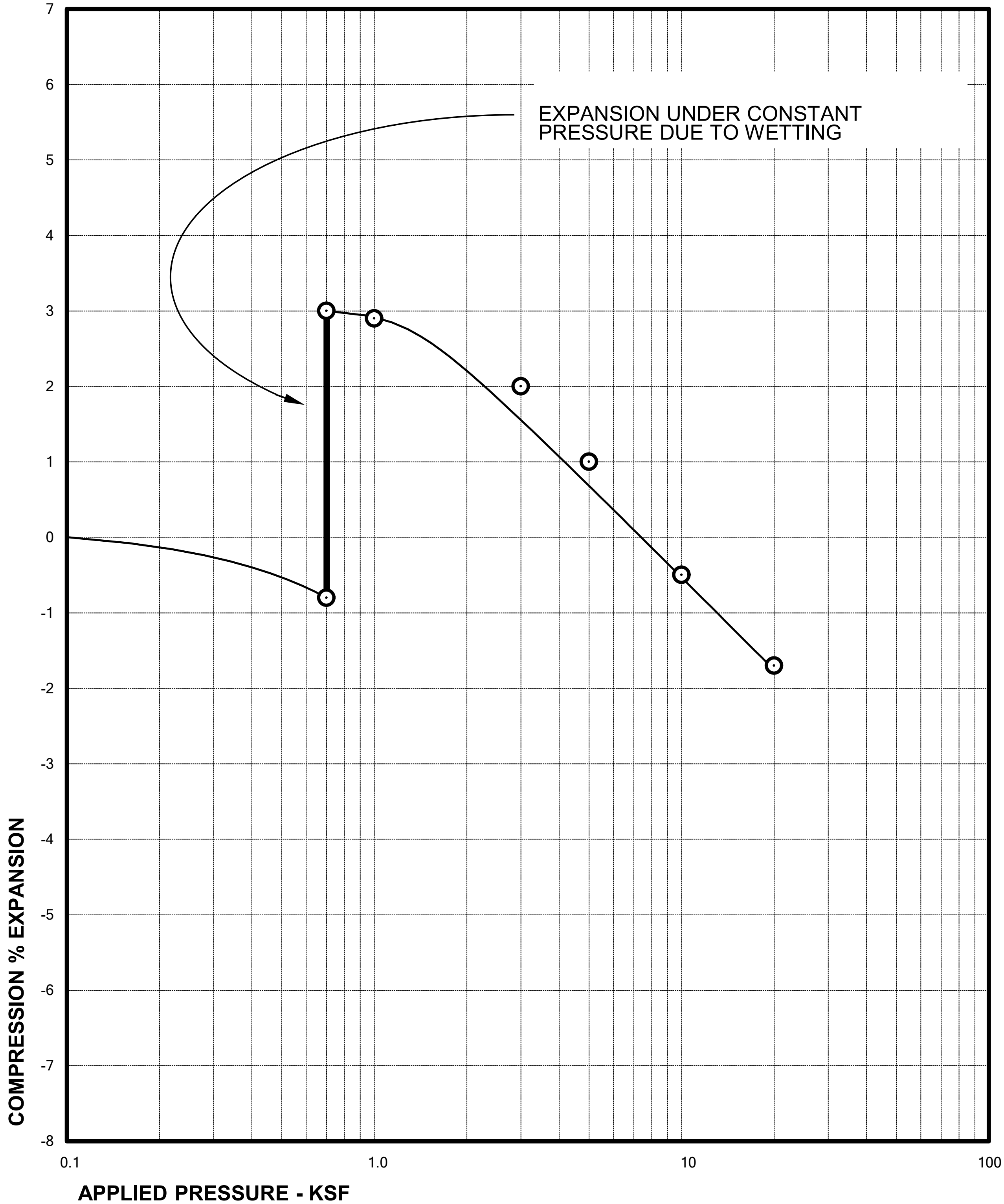
Swell Consolidation Test Results

FIG. B-3



Sample of CLAY, SANDY (CL)
From TH-2 AT 6 FEET

DRY UNIT WEIGHT= 75 PCF
MOISTURE CONTENT= 44.5 %

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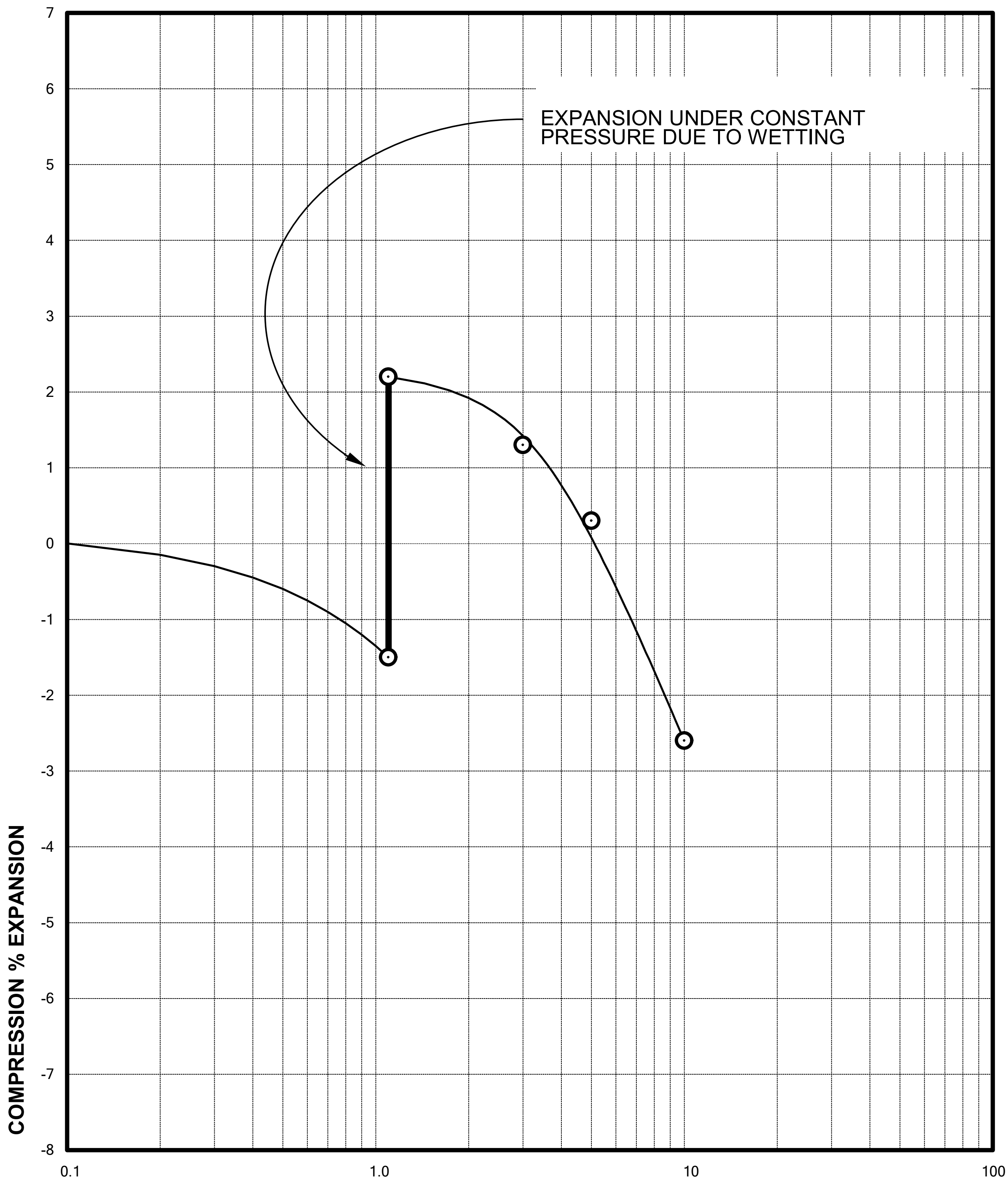
Swell Consolidation Test Results

FIG. B-4



Sample of	WEATHERED CLAYSTONE, SLIGHTLY SANDY	DRY UNIT WEIGHT=	72	PCF
From	TH-2 AT 9 FEET	MOISTURE CONTENT=	49.0	%

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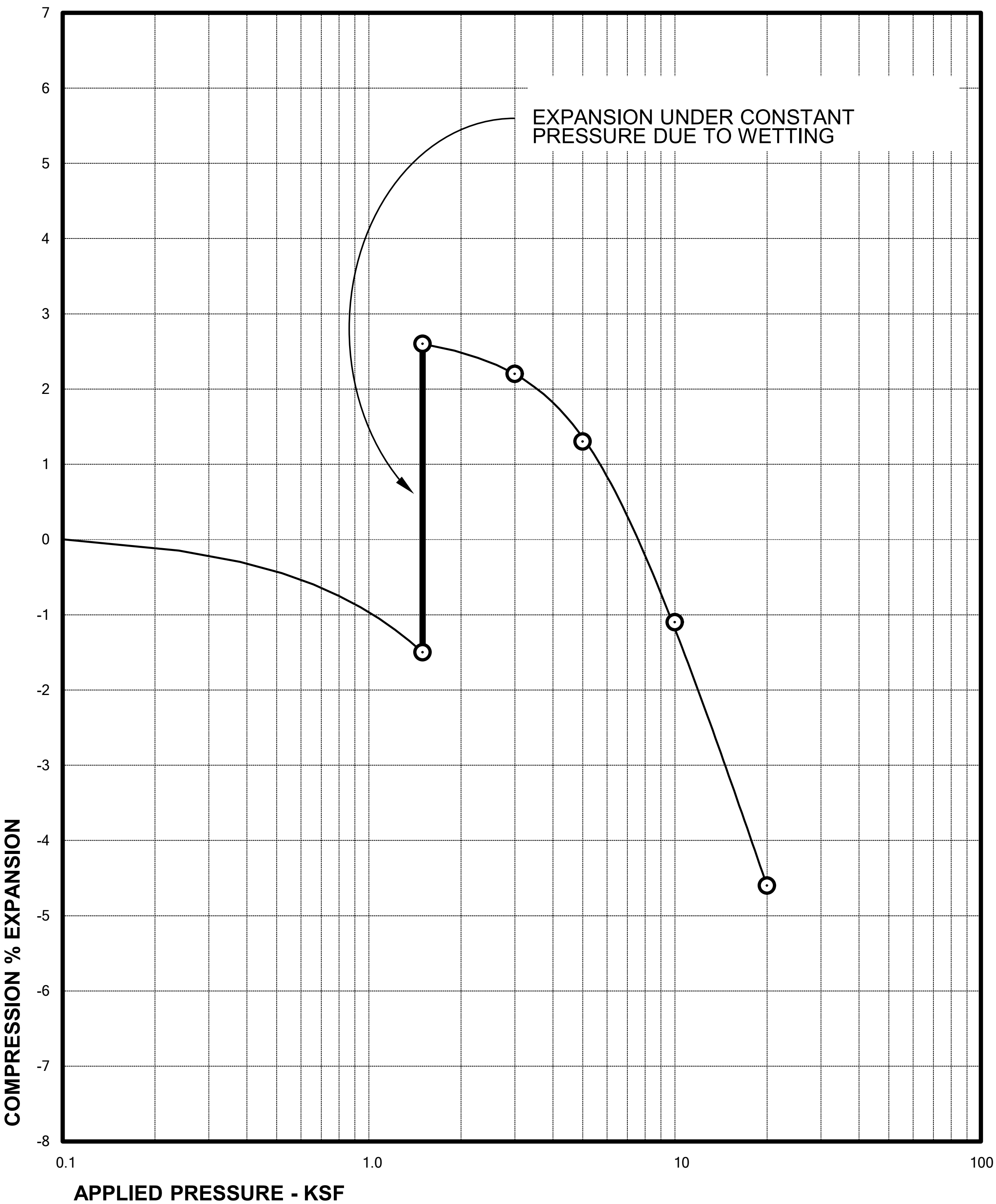
Swell Consolidation Test Results

FIG. B-5



Sample of	WEATHERED CLAYSTONE, SLIGHTLY SANDY	DRY UNIT WEIGHT=	71	PCF
From	TH-2 AT 12 FEET	MOISTURE CONTENT=	49.4	%

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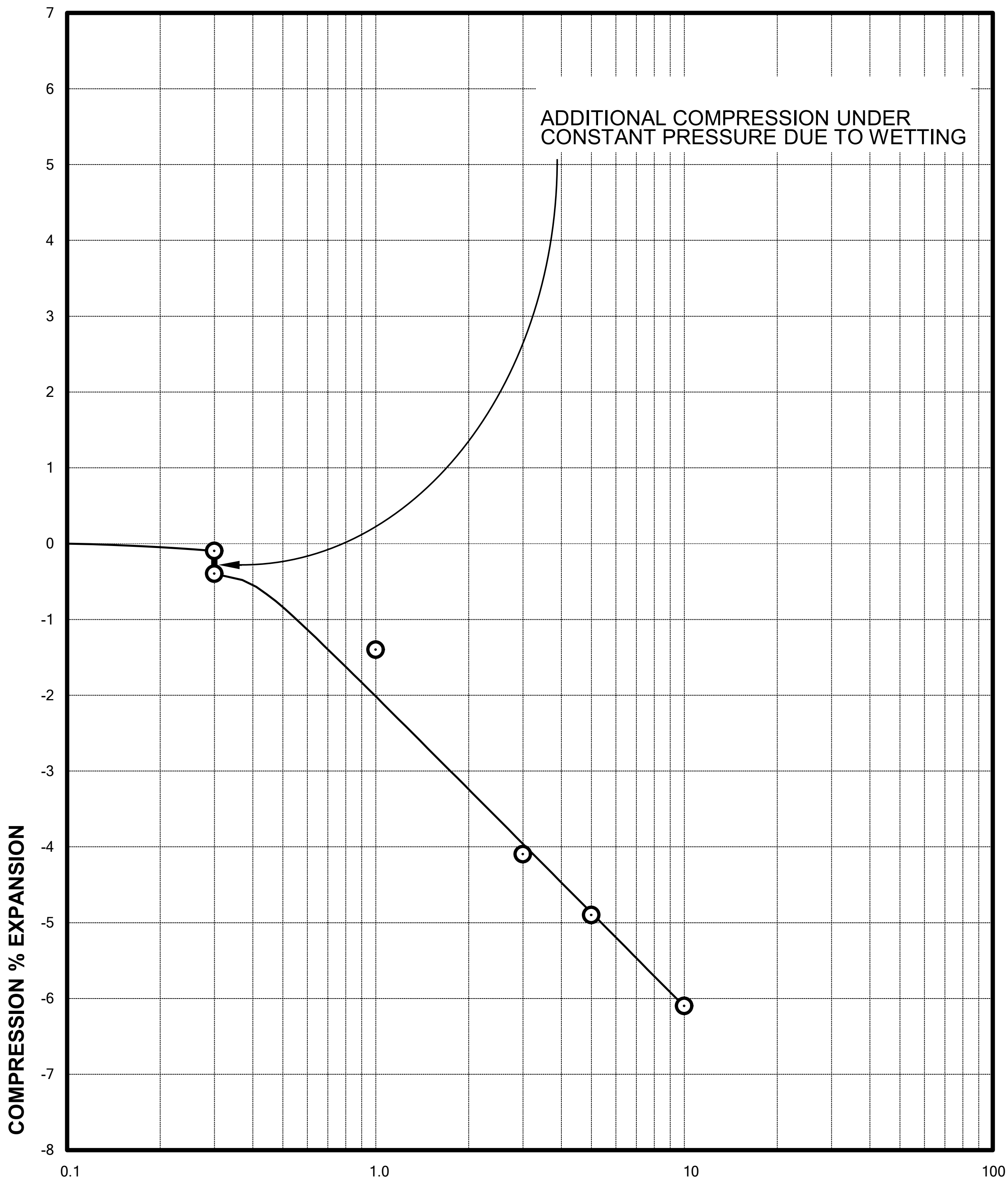
Swell Consolidation Test Results

FIG. B-6



Sample of FILL, SAND, VERY SILTY
From TH-5 AT 3 FEET

DRY UNIT WEIGHT= 128 PCF
MOISTURE CONTENT= 7.1 %

COLORADO SPRINGS CHARTER ACADEMY
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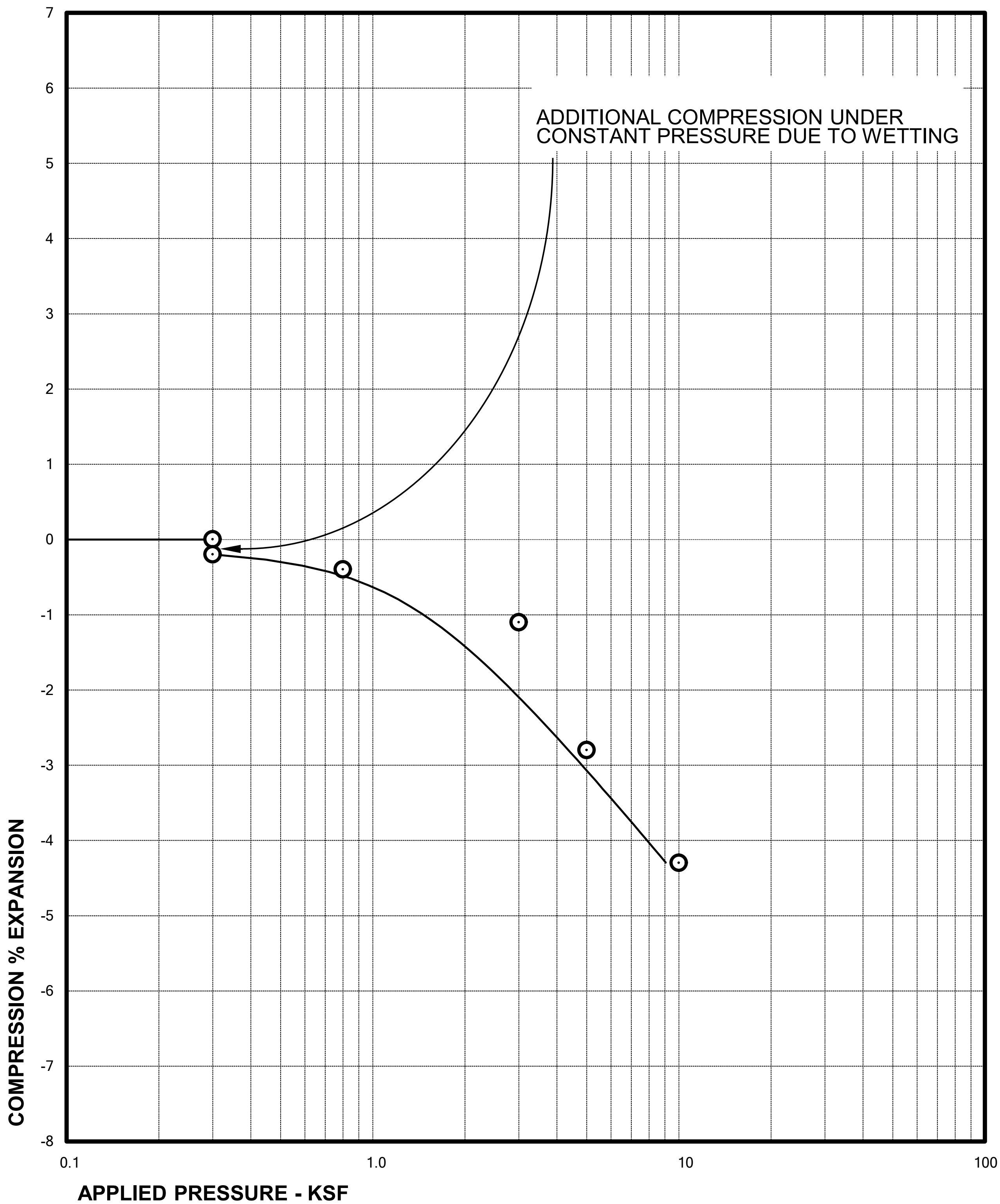
Swell Consolidation Test Results

FIG. B-7



Sample of FILL, SAND, SILTY
From TH-5 AT 6 FEET

DRY UNIT WEIGHT= 118 PCF
MOISTURE CONTENT= 5.4 %

COLORADO SPRINGS CHARTER ACADEMY
MIDDLE SCHOOL BUILDING DISTRESS
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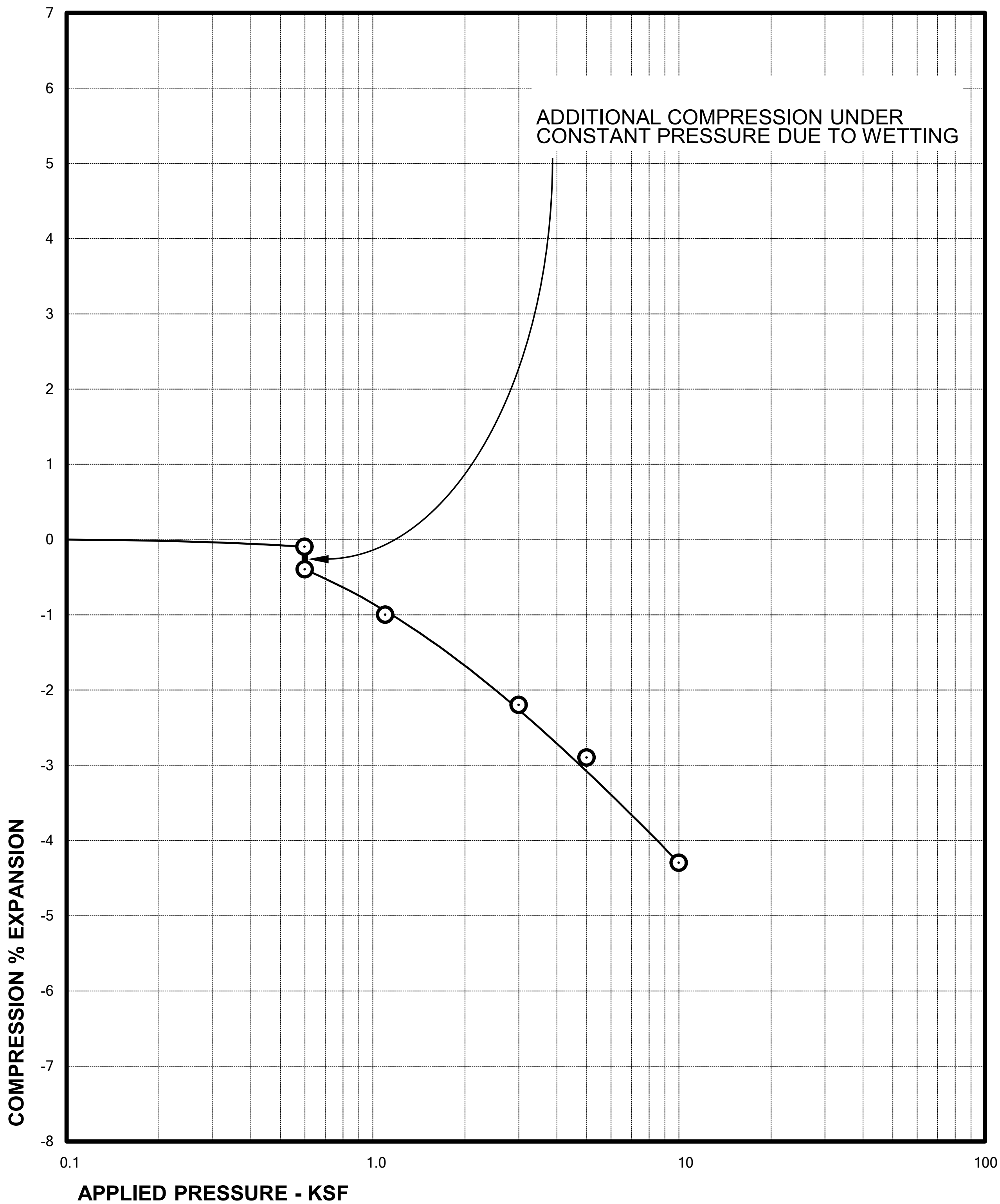
Swell Consolidation Test Results

FIG. B-8



Sample of	SAND, SILTY (SM)	DRY UNIT WEIGHT=	116	PCF
From	TH-5 AT 9 FEET	MOISTURE CONTENT=	12.1	%

COLORADO SPRINGS CHARTER ACADEMY
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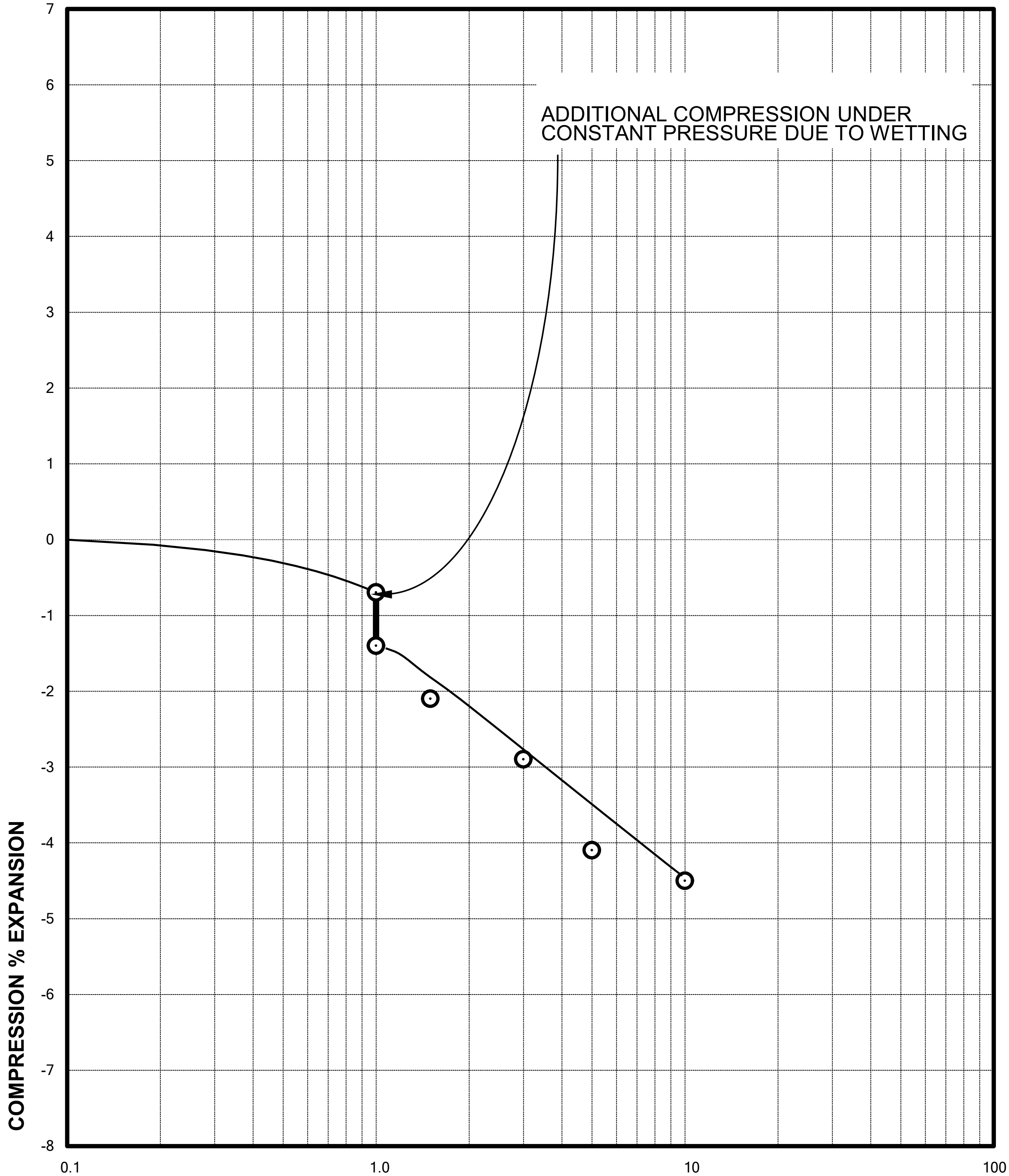
Swell Consolidation Test Results

FIG. B-9



Sample of SAND, SILTY (SM)
From TH-5 AT 12 FEET

DRY UNIT WEIGHT= 103 PCF
MOISTURE CONTENT= 7.3 %

COLORADO SPRINGS CHARTER ACADEMY
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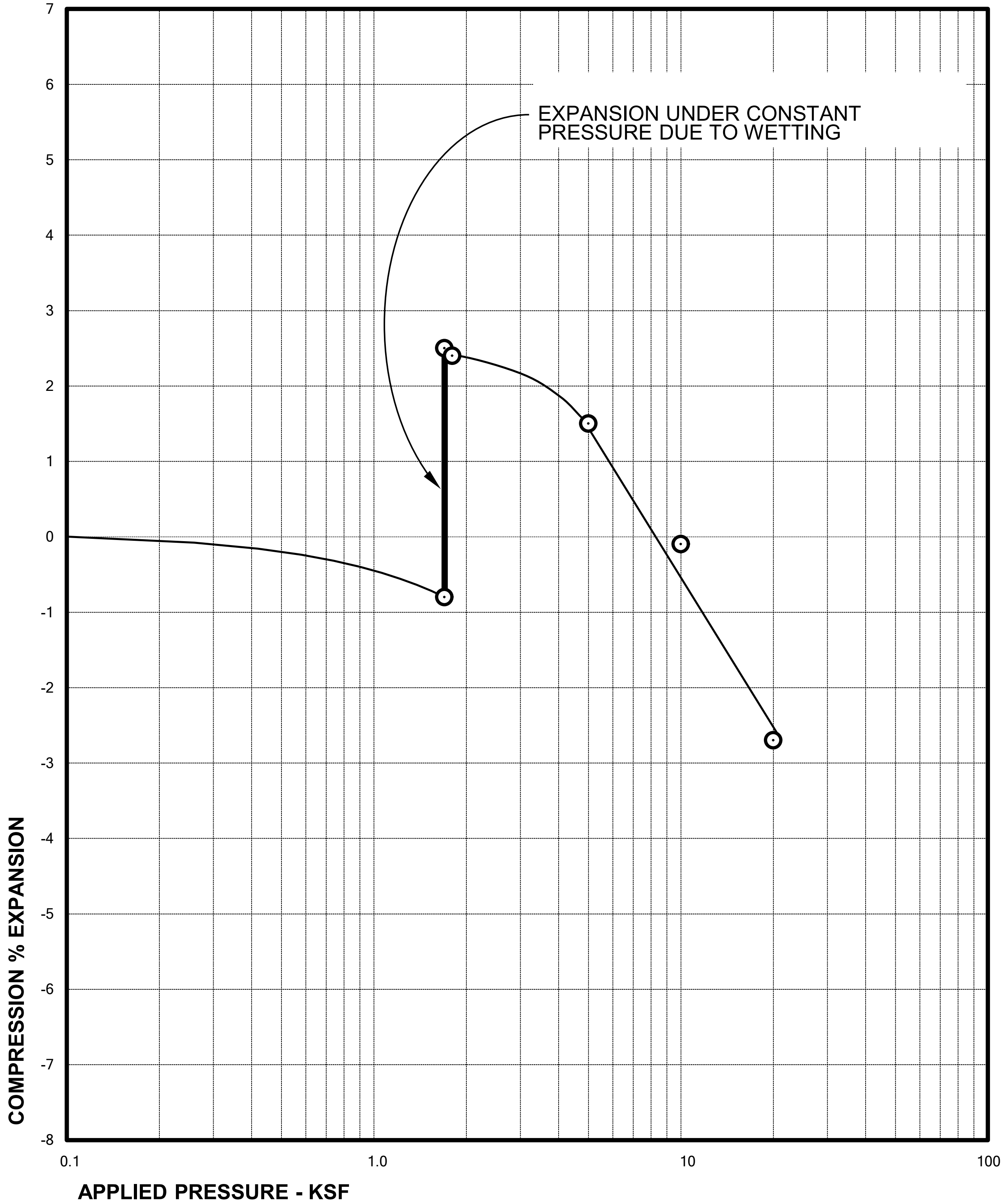
Swell Consolidation Test Results

FIG. B-10



Sample of WEATHERED SANDSTONE, VERY CLAYEY
From TH-5 AT 18 FEET

DRY UNIT WEIGHT= 79 PCF
MOISTURE CONTENT= 42.9 %

COLORADO SPRINGS CHARTER ACADEMY
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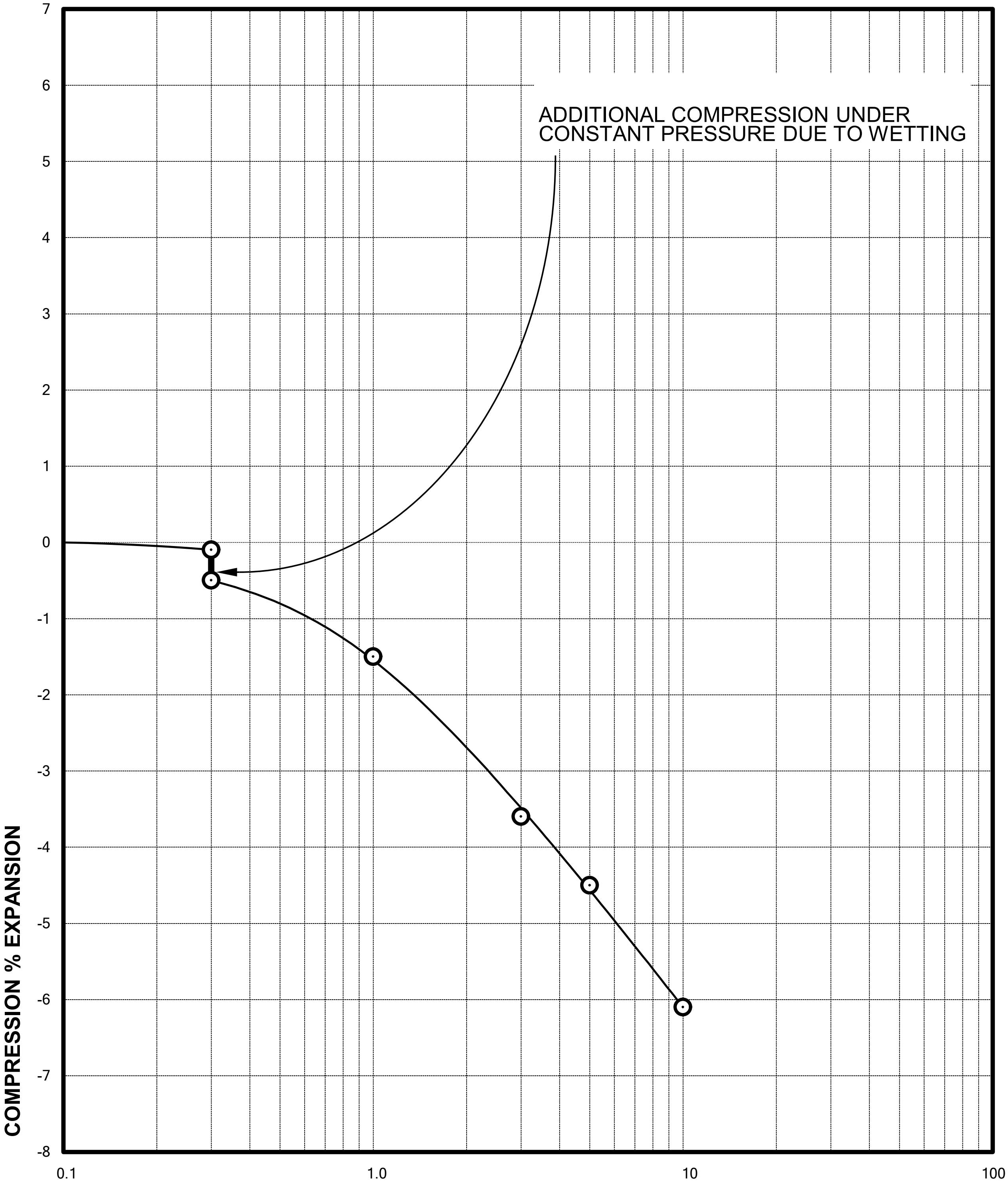
Swell Consolidation Test Results

FIG. B-11



Sample of FILL, SAND, VERY SILTY

From TH-6 AT 3 FEET

DRY UNIT WEIGHT= 114 PCF

MOISTURE CONTENT= 11.3 %

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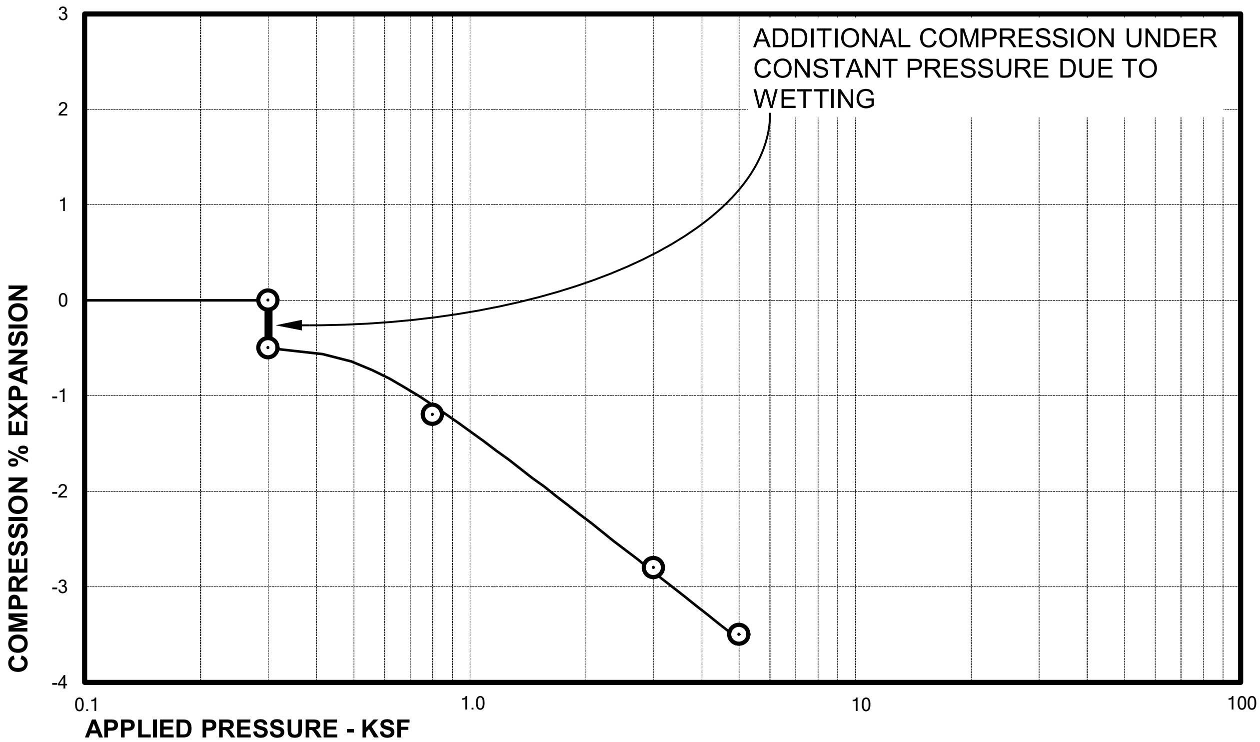
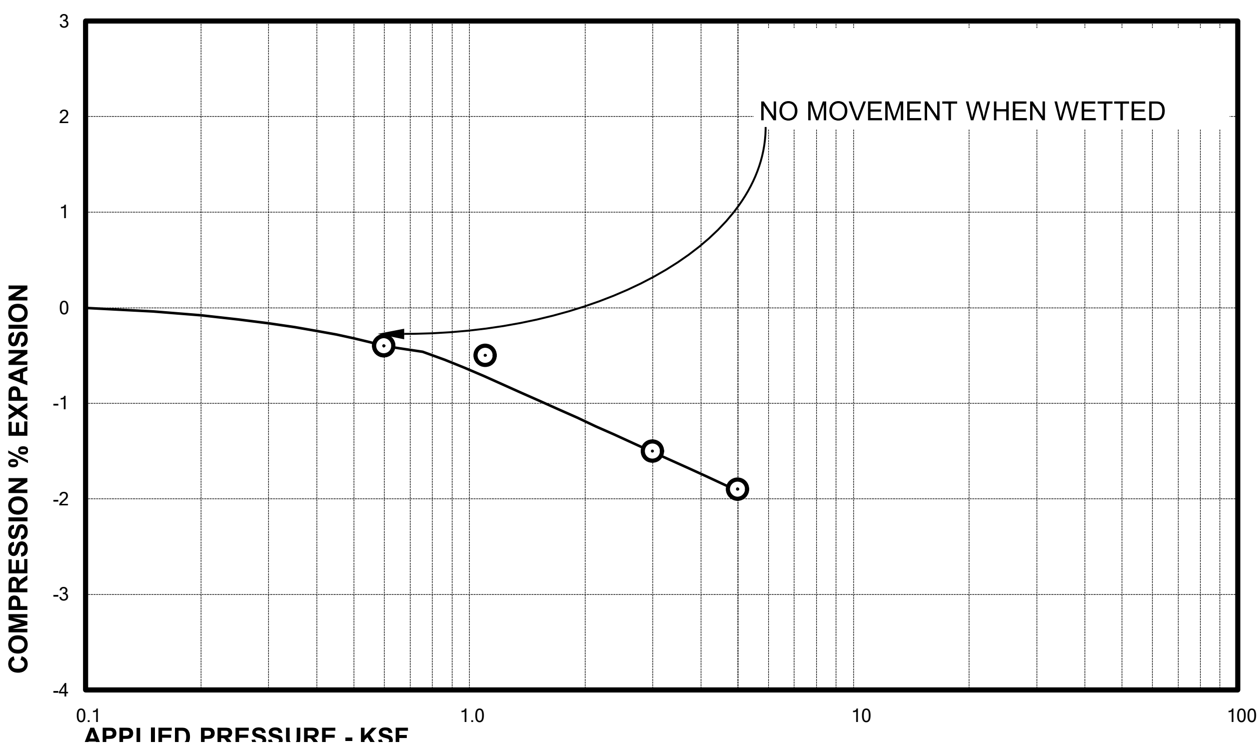
Swell Consolidation Test Results

FIG. B-12



Sample of SAND, SILTY (SM)
From TH-6 AT 6 FEET

DRY UNIT WEIGHT= 115 PCF
MOISTURE CONTENT= 7.2 %



Sample of SAND, SILTY (SM)
From TH-6 AT 9 FEET

DRY UNIT WEIGHT= 118 PCF
MOISTURE CONTENT= 10.9 %

COLORADO SPRINGS CHARTER ACADEMY
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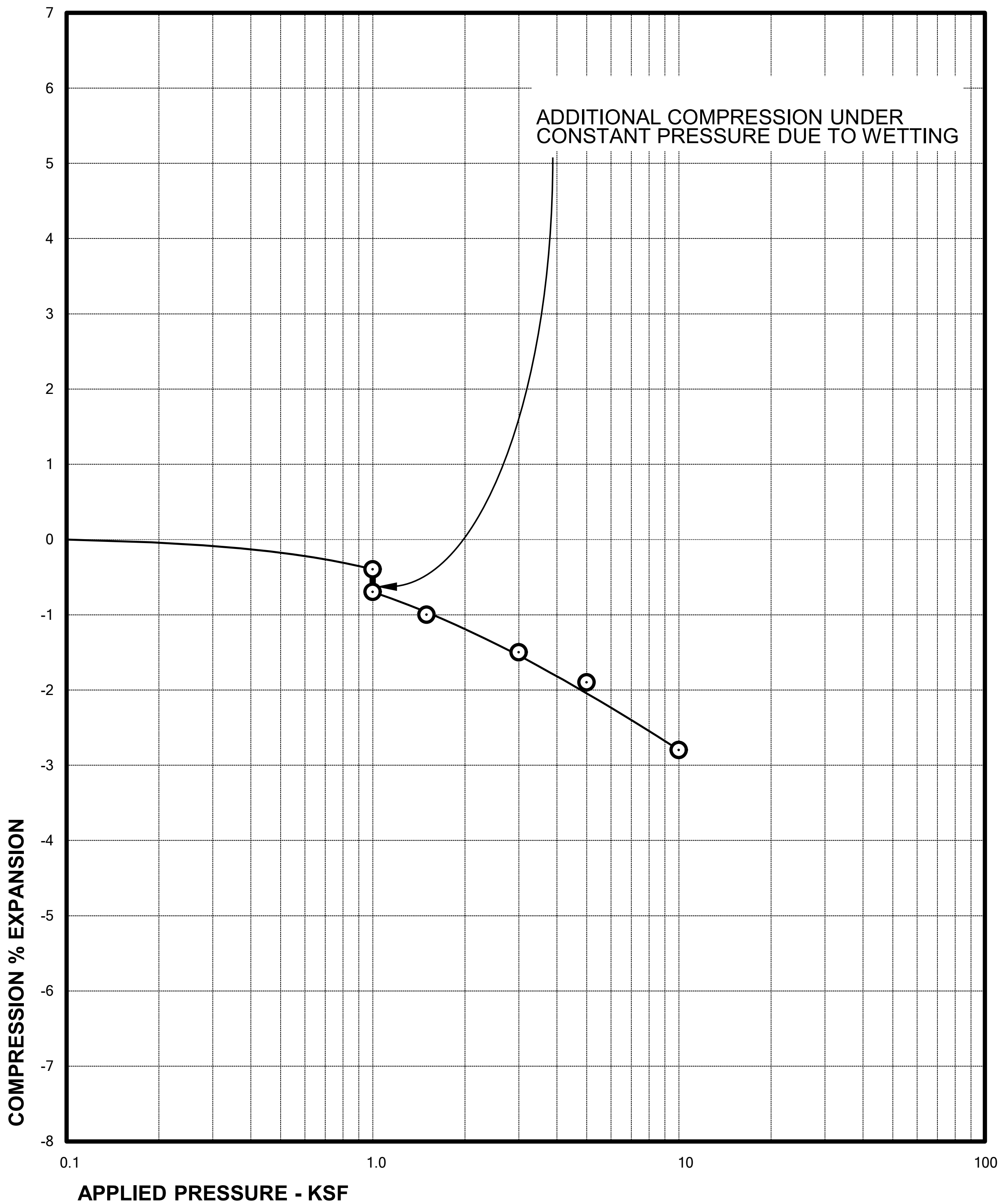
Swell Consolidation

FIG. B-13



Sample of SAND, SILTY (SM)
From TH-6 AT 12 FEET

DRY UNIT WEIGHT= 125 PCF
MOISTURE CONTENT= 9.9 %

COLORADO SPRINGS CHARTER ACADEMY
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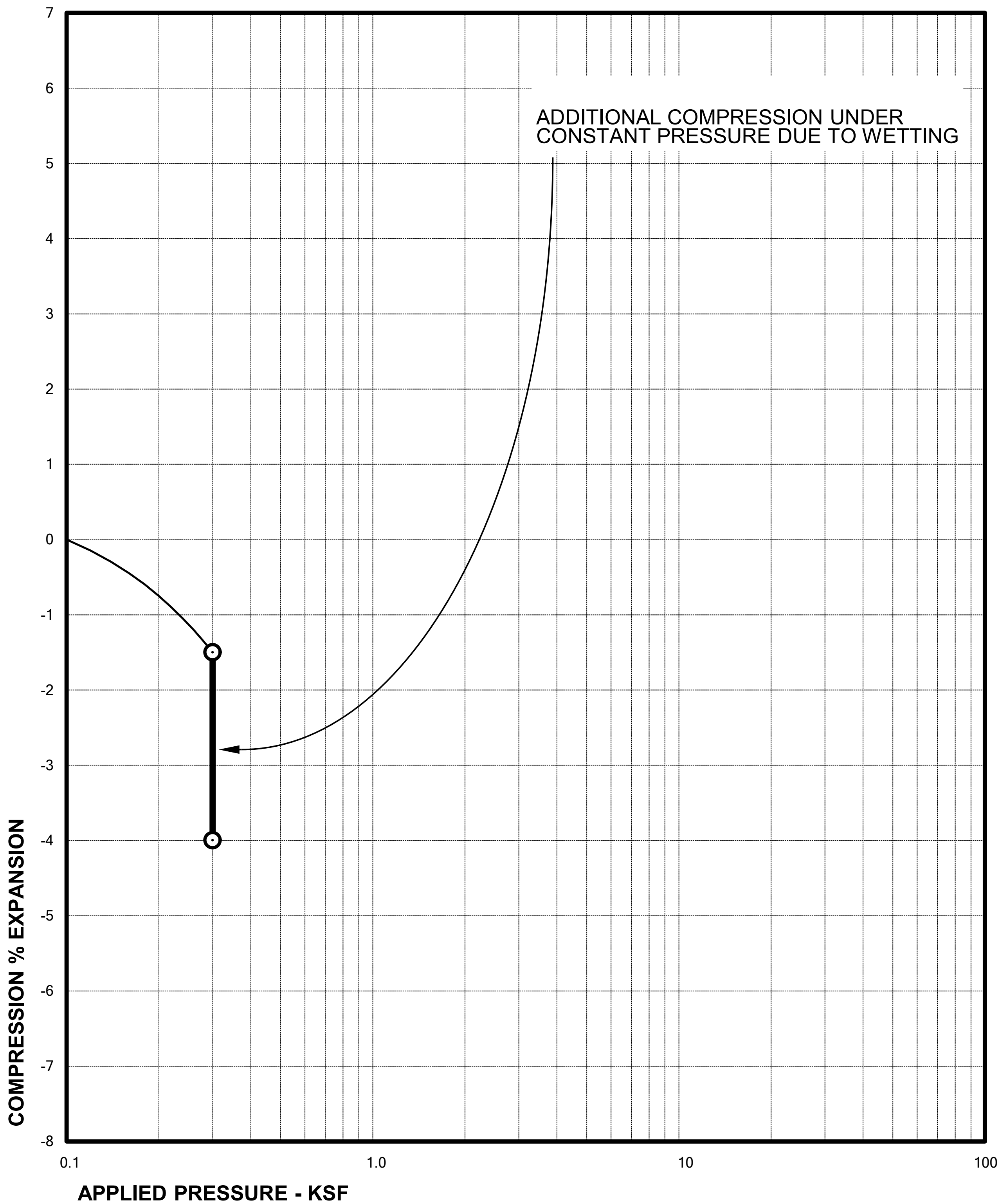
Swell Consolidation Test Results

FIG. B-14



Sample of FILL, SAND, VERY SILTY
From TH-7 AT 3 FEET

DRY UNIT WEIGHT= 127 PCF
MOISTURE CONTENT= 6.0 %

COLORADO SPRINGS CHARTER ACADEMY
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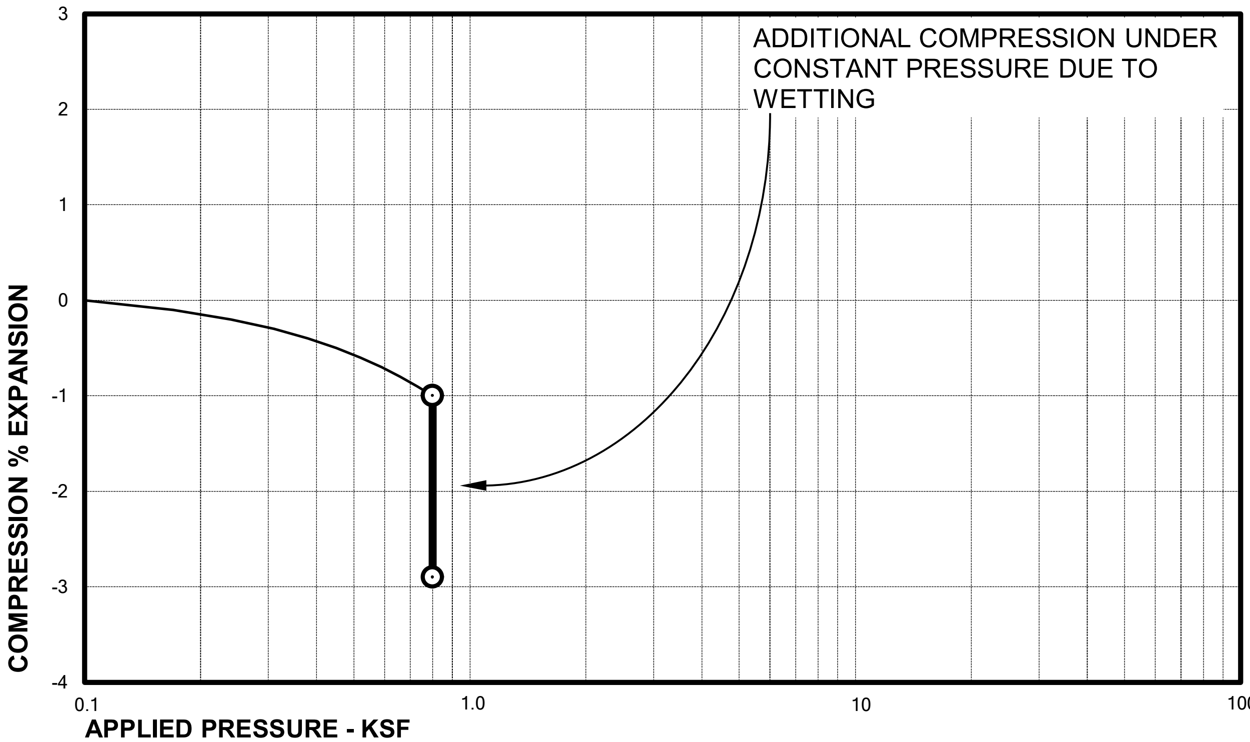
Swell Consolidation Test Results

FIG. B-15

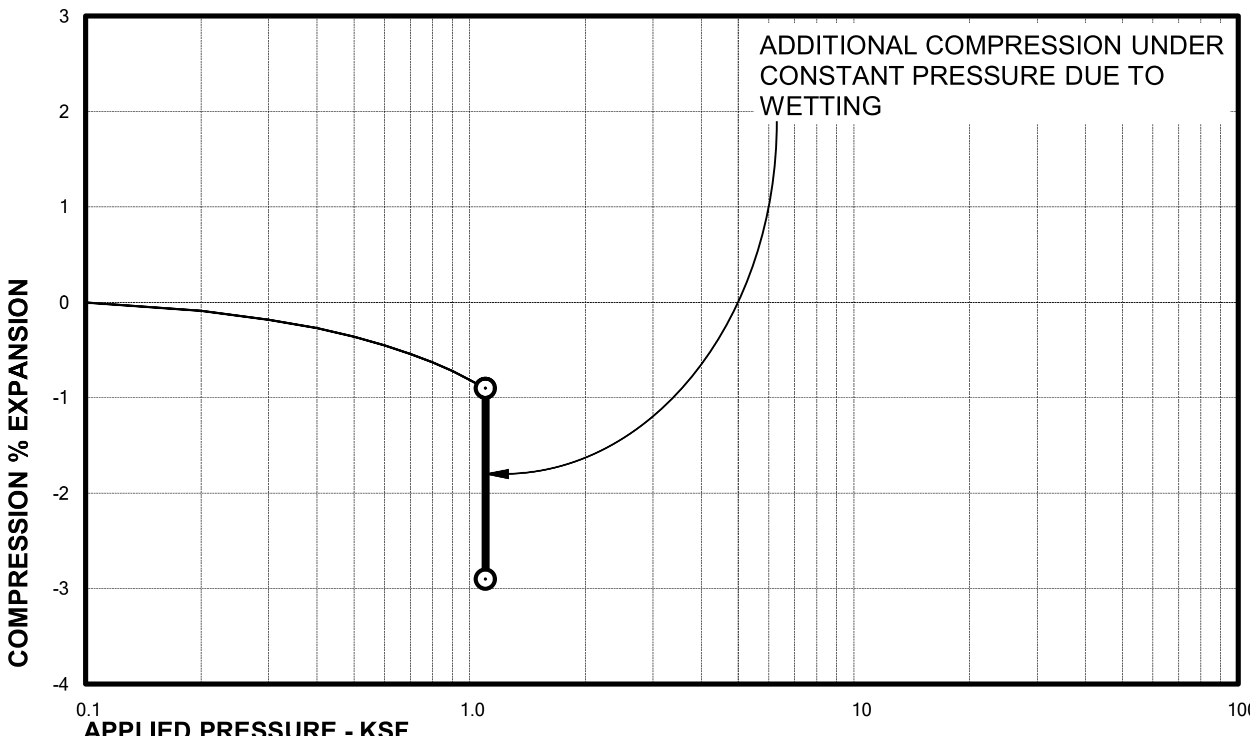


Sample of FILL, SAND, SILTY

From TH-7 AT 6 FEET

DRY UNIT WEIGHT= 110 PCF

MOISTURE CONTENT= 4.1 %



Sample of WEATHERED SANDSTONE, SILTY

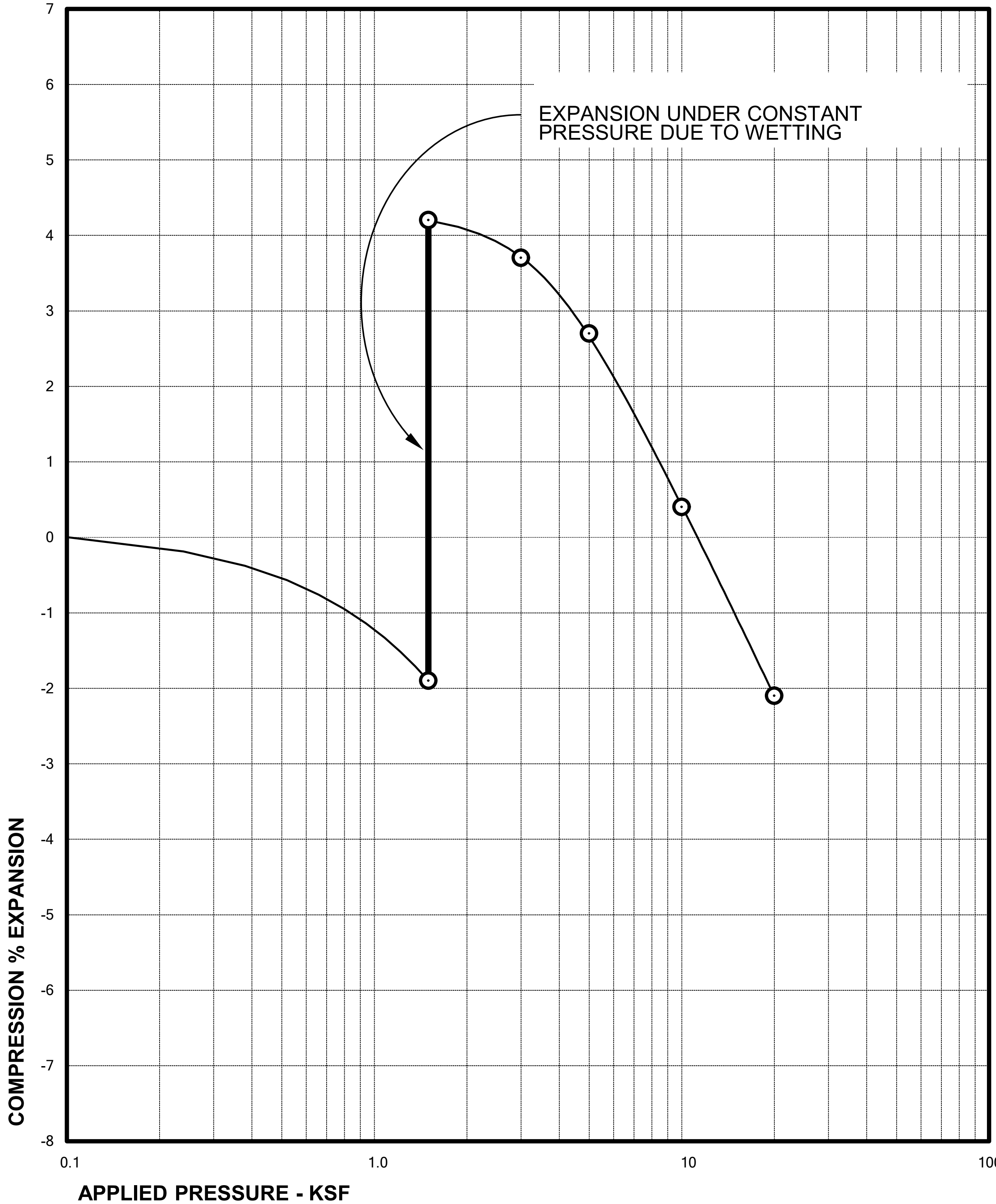
From TH-7 AT 9 FEET

DRY UNIT WEIGHT= 116 PCF

MOISTURE CONTENT= 9.9 %

Swell Consolidation

FIG. B-16



Sample of	WEATHERED CLAYSTONE, SANDY	DRY UNIT WEIGHT=	81	PCF
From	TH-7 AT 12 FEET	MOISTURE CONTENT=	37.8	%

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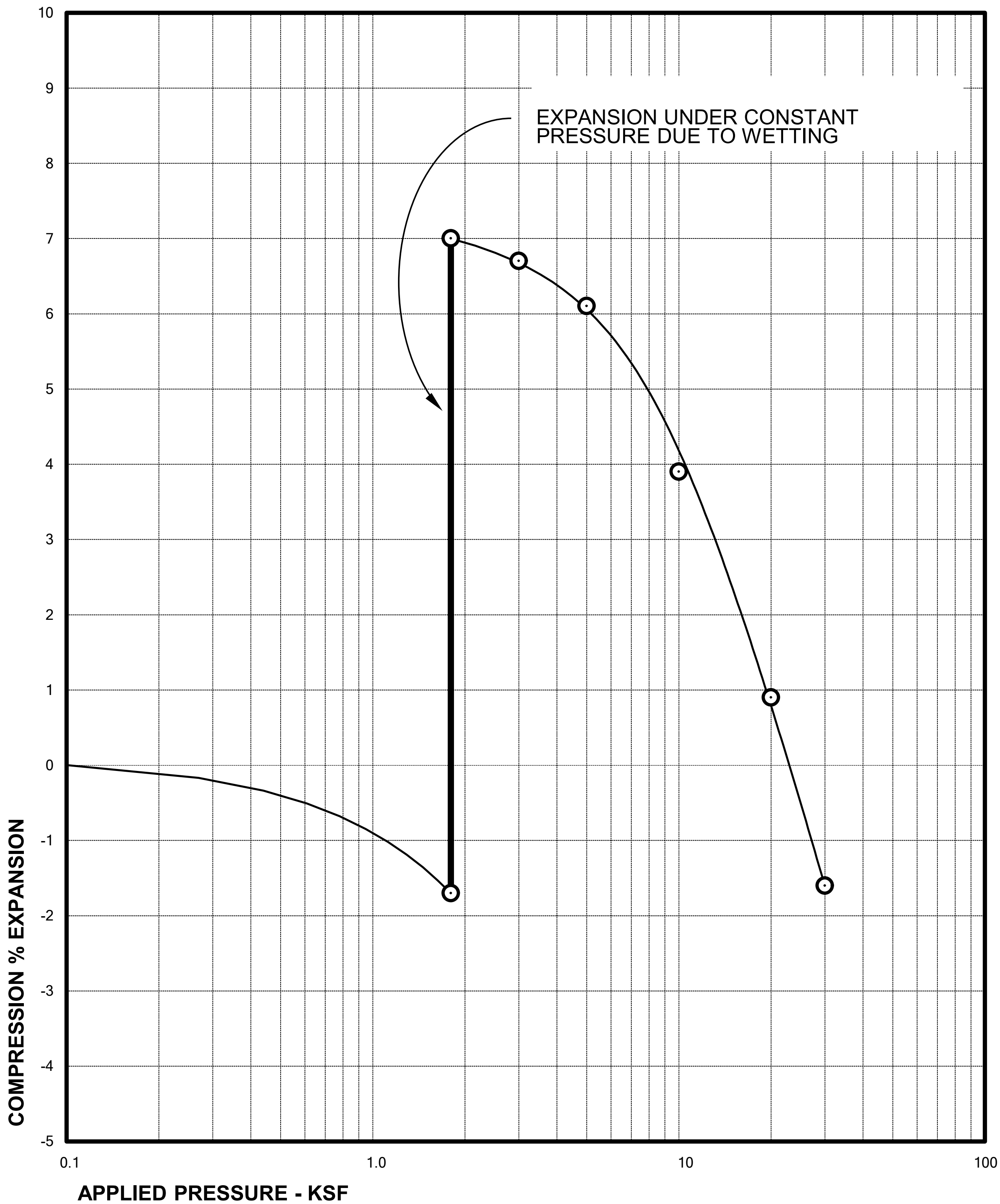
Swell Consolidation Test Results

FIG. B-17



Sample of	WEATHERED CLAYSTONE, SANDY	DRY UNIT WEIGHT=	80	PCF
From	TH-7 AT 15 FEET	MOISTURE CONTENT=	40.3	%

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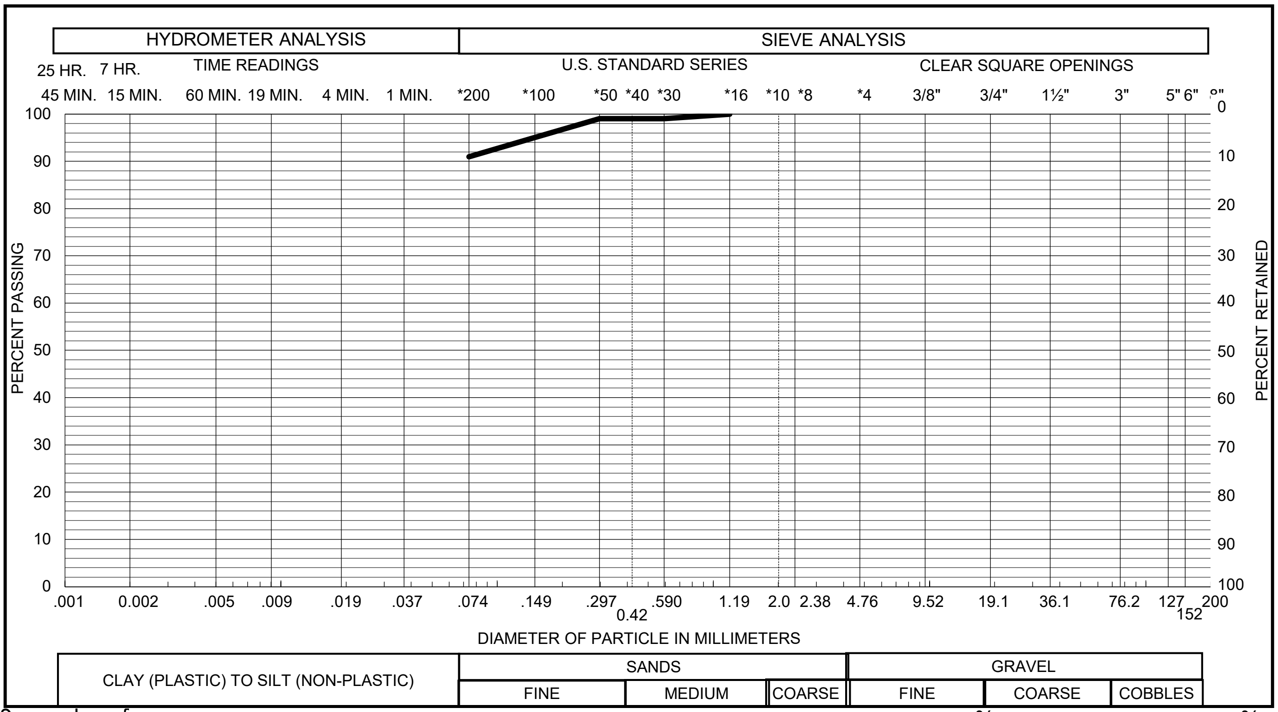
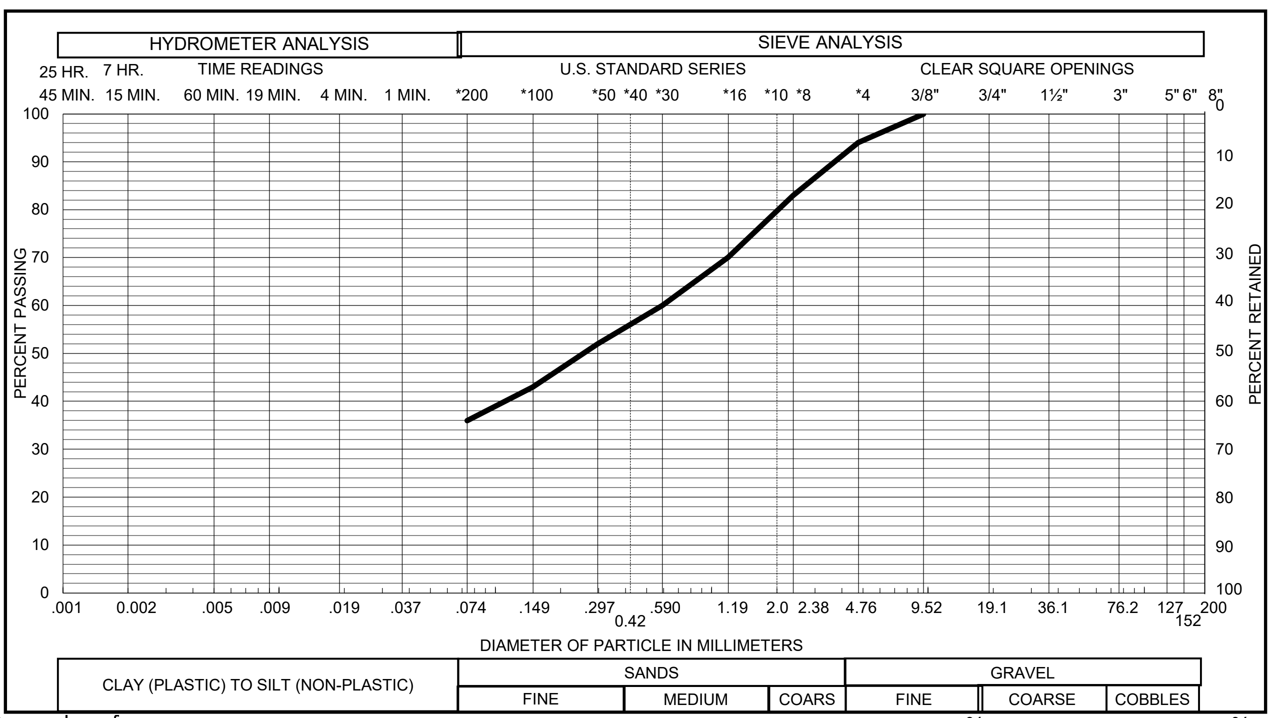
Swell Consolidation Test Results

FIG. B-18



Sample of	WEATHERED CLAYSTONE, SLIGHTLY SANDY	GRAVEL	0 %	SAND	9 %
From	TH - 1 AT 9 FEET	SILT & CLAY	91 %	LIQUID LIMIT	124
		PLASTICITY INDEX			65



Sample of	FILL, SAND, VERY CLAYEY	GRAVEL	6 %	SAND	58 %
From	TH - 2 AT 1 FEET	SILT & CLAY	36 %	LIQUID LIMIT	25
		PLASTICITY INDEX			10

COLORADO SPRINGS CHARTER ACADEMY
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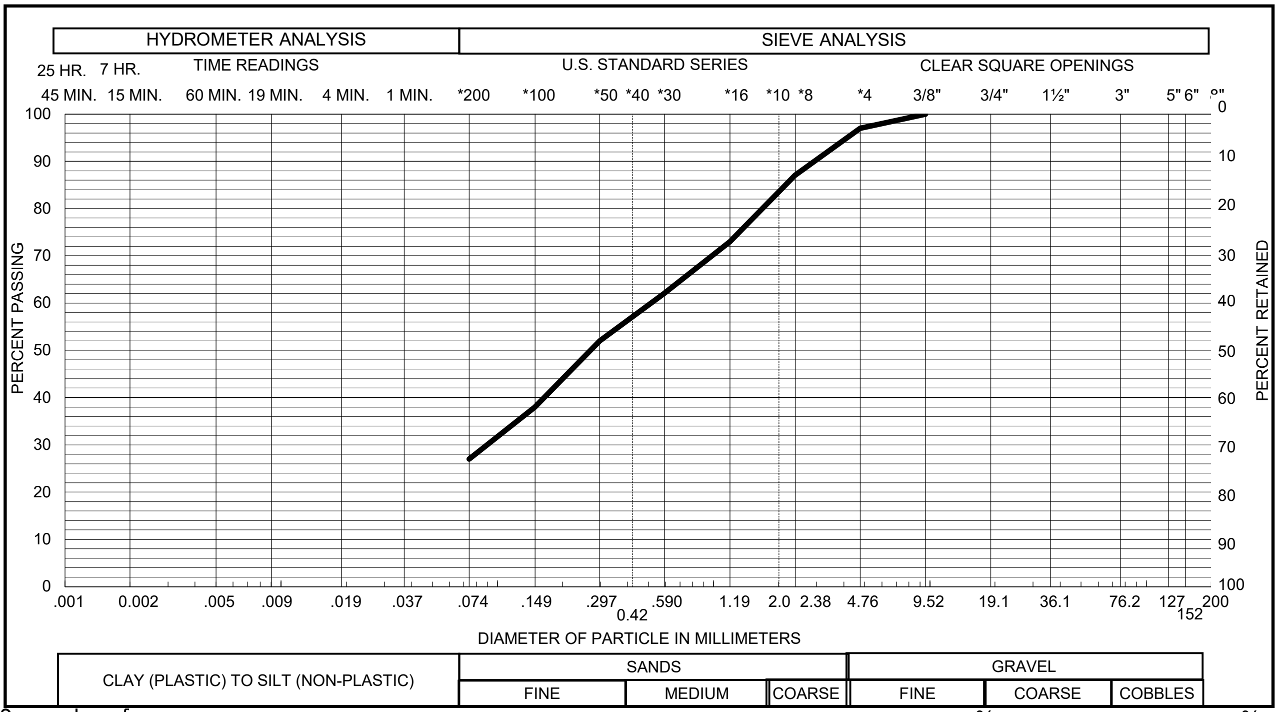
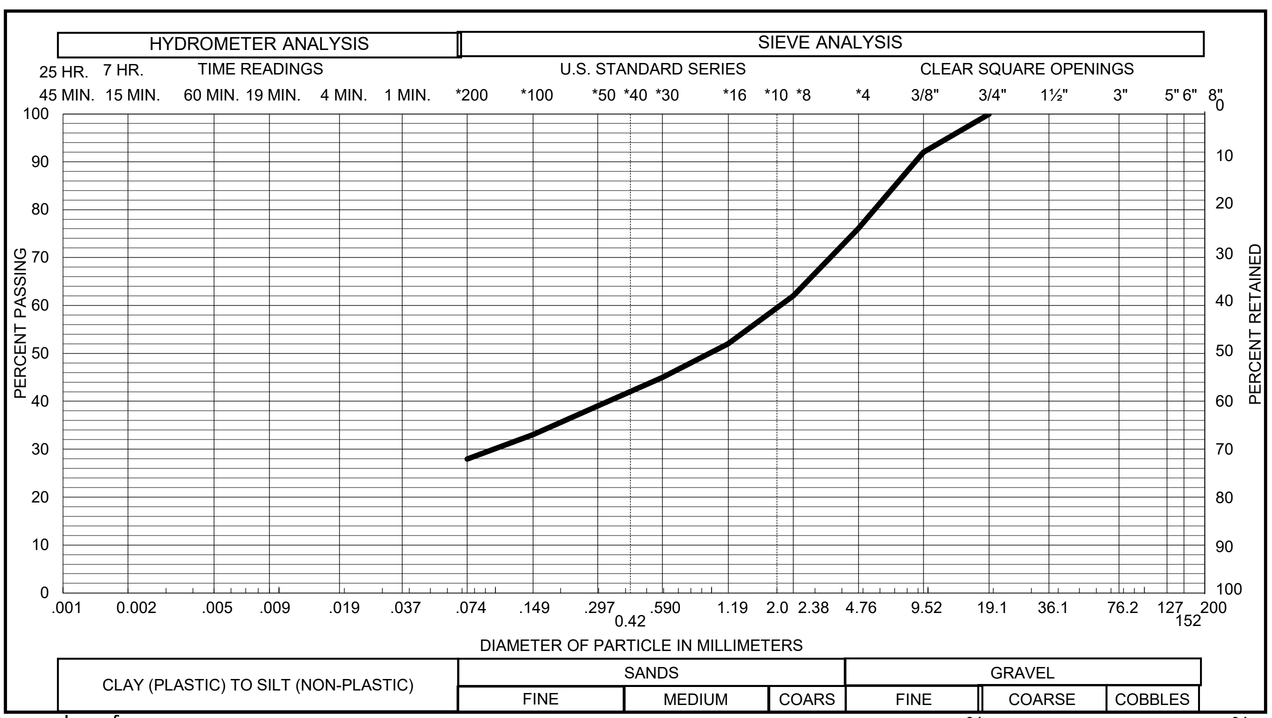
Gradation Test Results

FIG. B-19



Sample of	FILL, SAND, SILTY	GRAVEL	3 %	SAND	70 %
From	TH - 3 AT 2 FEET	SILT & CLAY	27 %	LIQUID LIMIT	
		PLASTICITY INDEX			



Sample of	SAND, CLAYEY (SC)	GRAVEL	24 %	SAND	48 %
From	TH - 3 AT 3 FEET	SILT & CLAY	28 %	LIQUID LIMIT	24
		PLASTICITY INDEX	9		

COLORADO SPRINGS CHARTER ACADEMY
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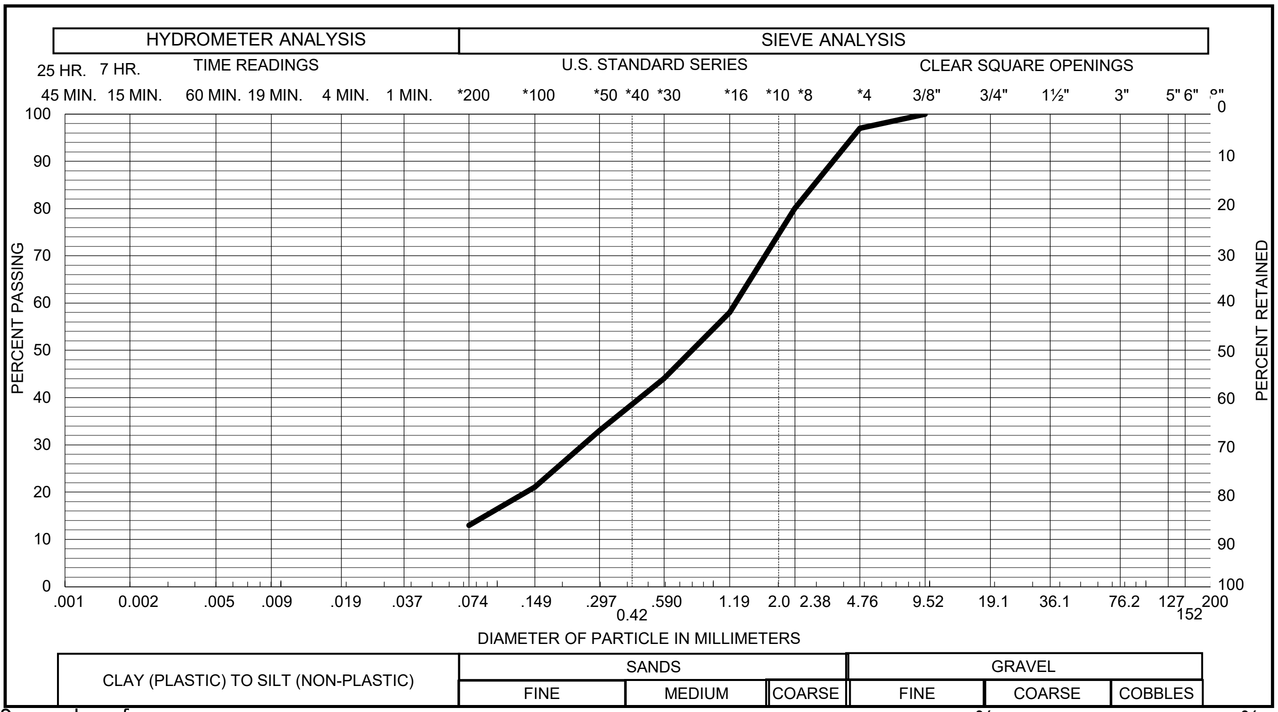
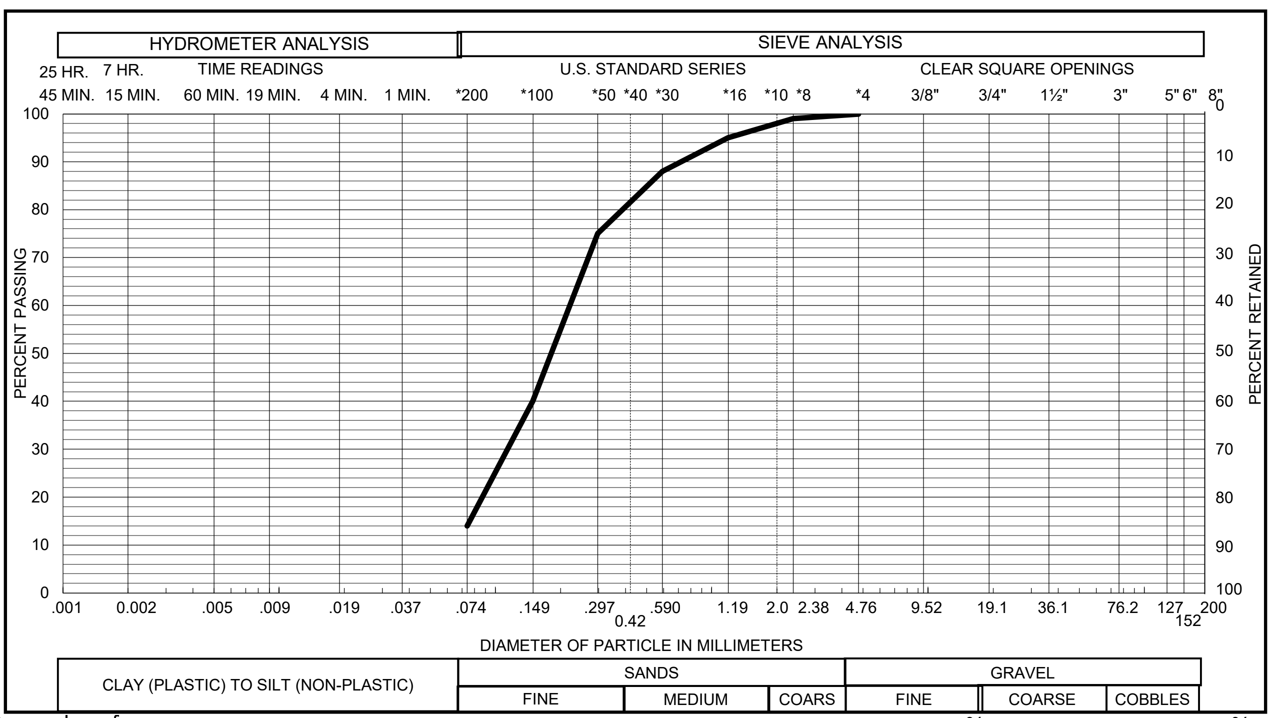
Gradation Test Results

FIG. B-20



Sample of FILL, SAND, SILTY
From TH - 5 AT 6 FEET

GRAVEL 3 % SAND 84 %
SILT & CLAY 13 % LIQUID LIMIT NL
PLASTICITY INDEX NP



Sample of SAND, SILTY (SM)
From TH - 5 AT 12 FEET

GRAVEL 0 % SAND 86 %
SILT & CLAY 14 % LIQUID LIMIT NL
PLASTICITY INDEX NP

COLORADO SPRINGS CHARTER ACADEMY
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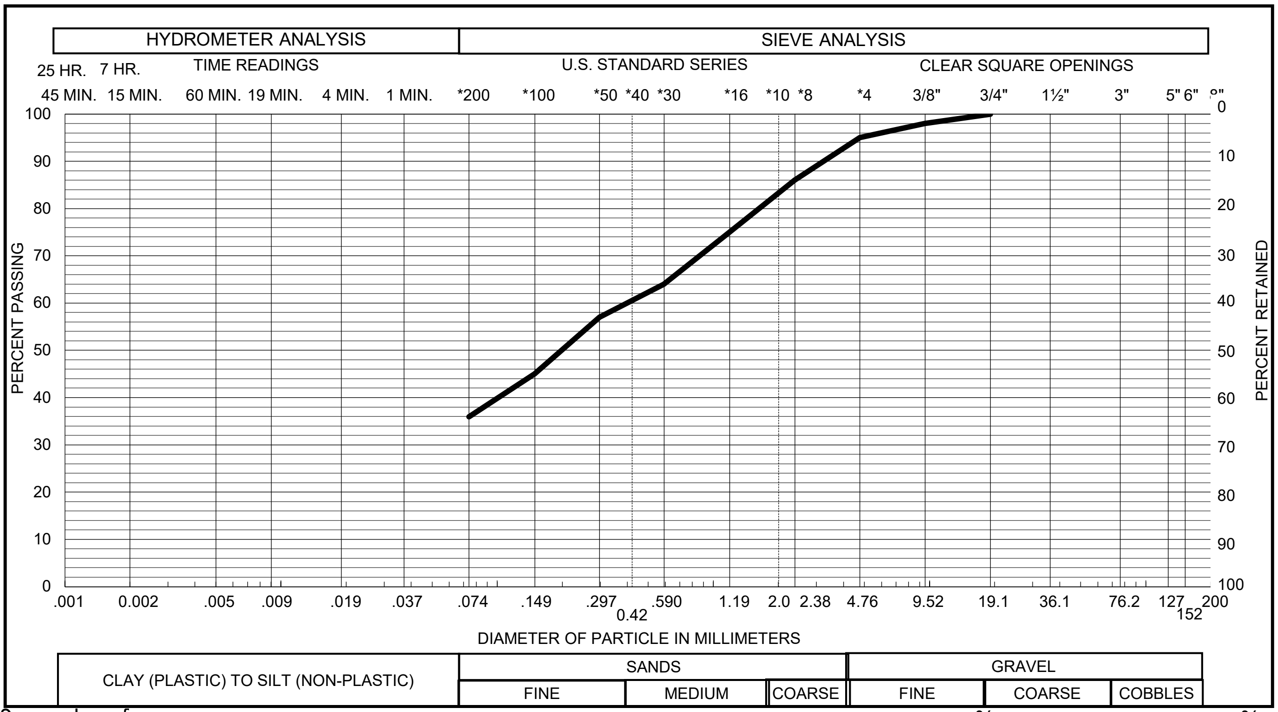
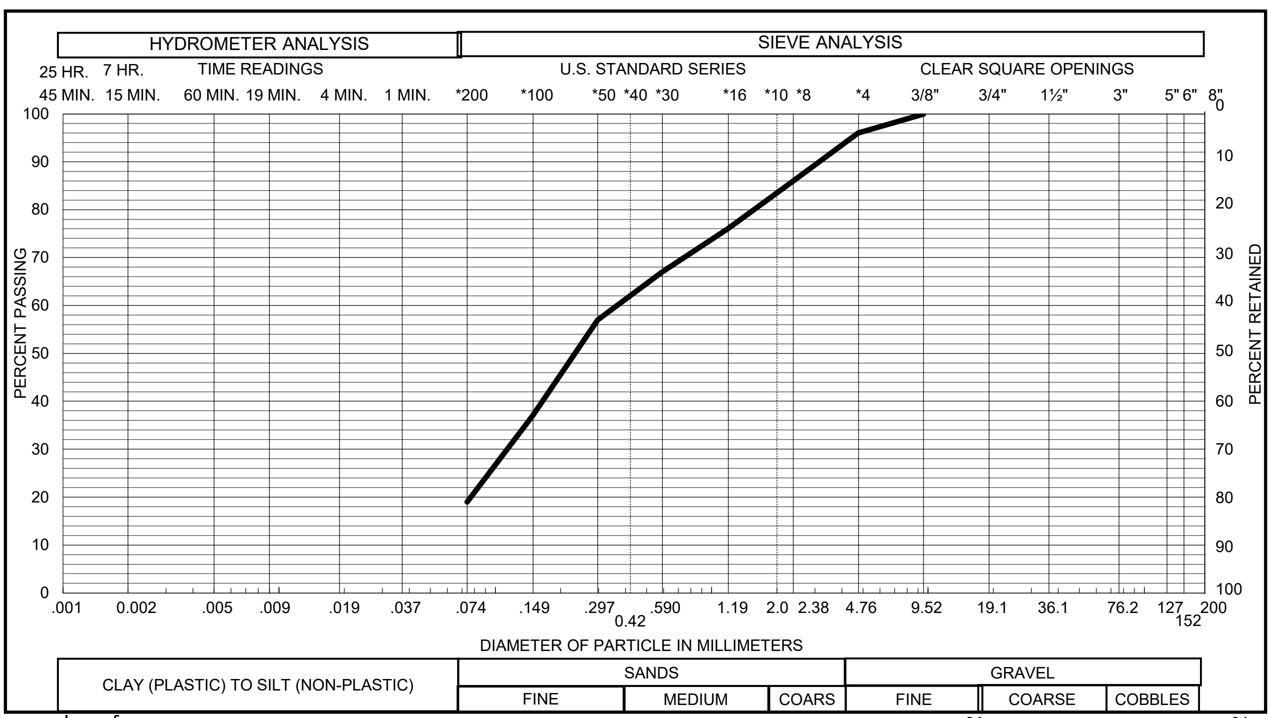
Gradation Test Results

FIG. B-21



Sample of	FILL, SAND, VERY SILTY	GRAVEL	5 %	SAND	59 %
From	TH - 6 AT 3 FEET	SILT & CLAY	36 %	LIQUID LIMIT	29
		PLASTICITY INDEX			6



Sample of	SAND, SILTY (SM)	GRAVEL	4 %	SAND	77 %
From	TH - 6 AT 6 FEET	SILT & CLAY	19 %	LIQUID LIMIT	NL
		PLASTICITY INDEX			NP

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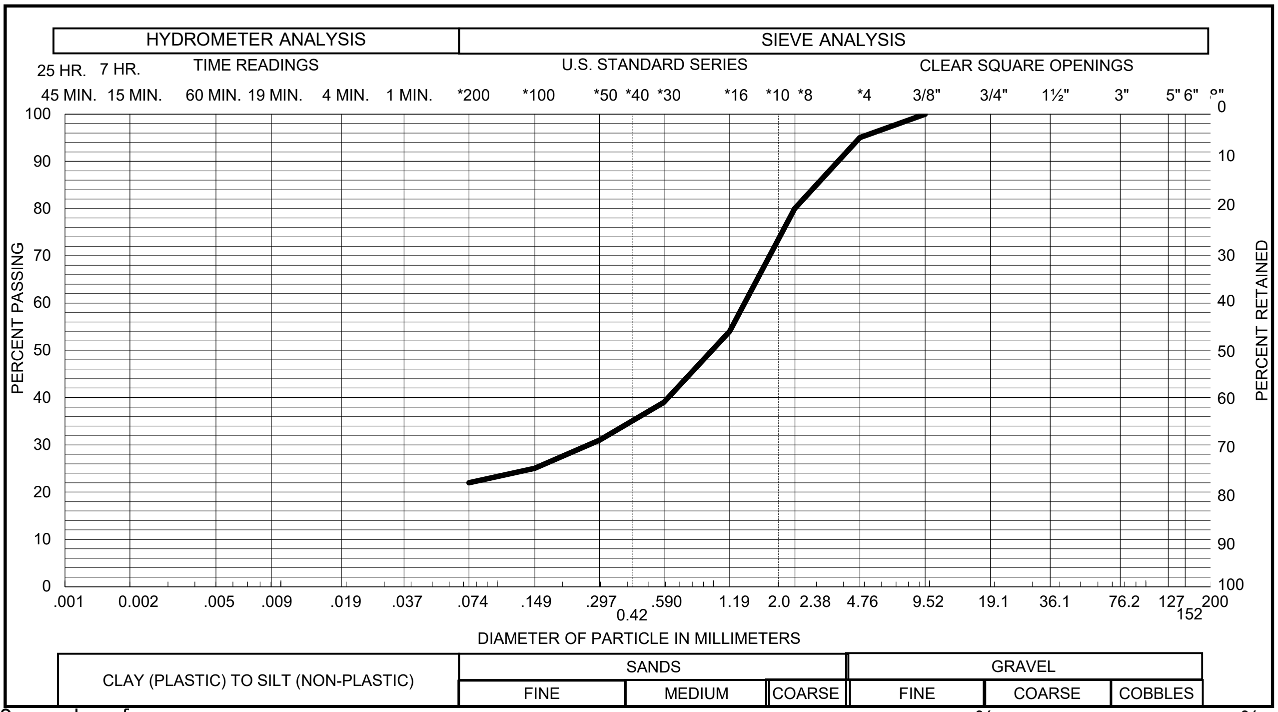
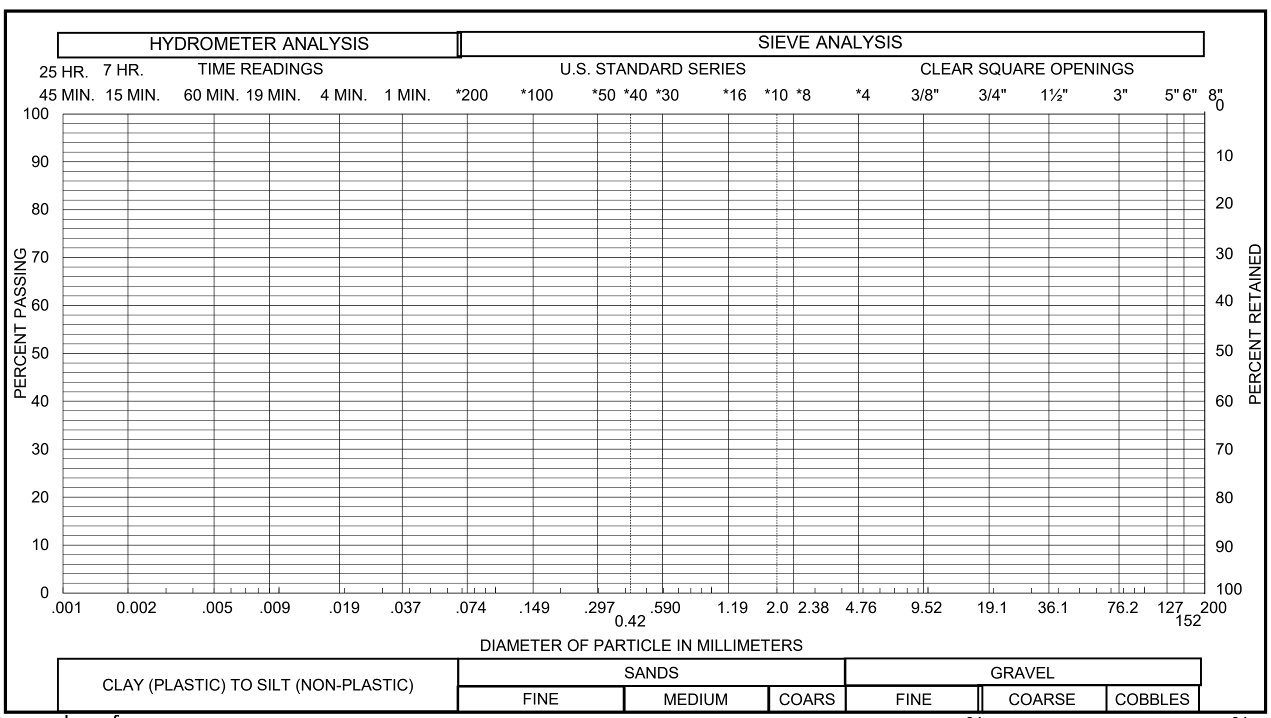
Gradation Test Results

FIG. B-22



Sample of	WEATHERED SANDSTONE, CLAYEY	GRAVEL	5 %	SAND	73 %
From	TH - 6 AT 18 FEET	SILT & CLAY	22 %	LIQUID LIMIT	51
		PLASTICITY INDEX			28



Sample of		GRAVEL	%	SAND	%
From		SILT & CLAY	%	LIQUID LIMIT	
		PLASTICITY INDEX			

COLORADO SPRINGS CHARTER ACADEMY
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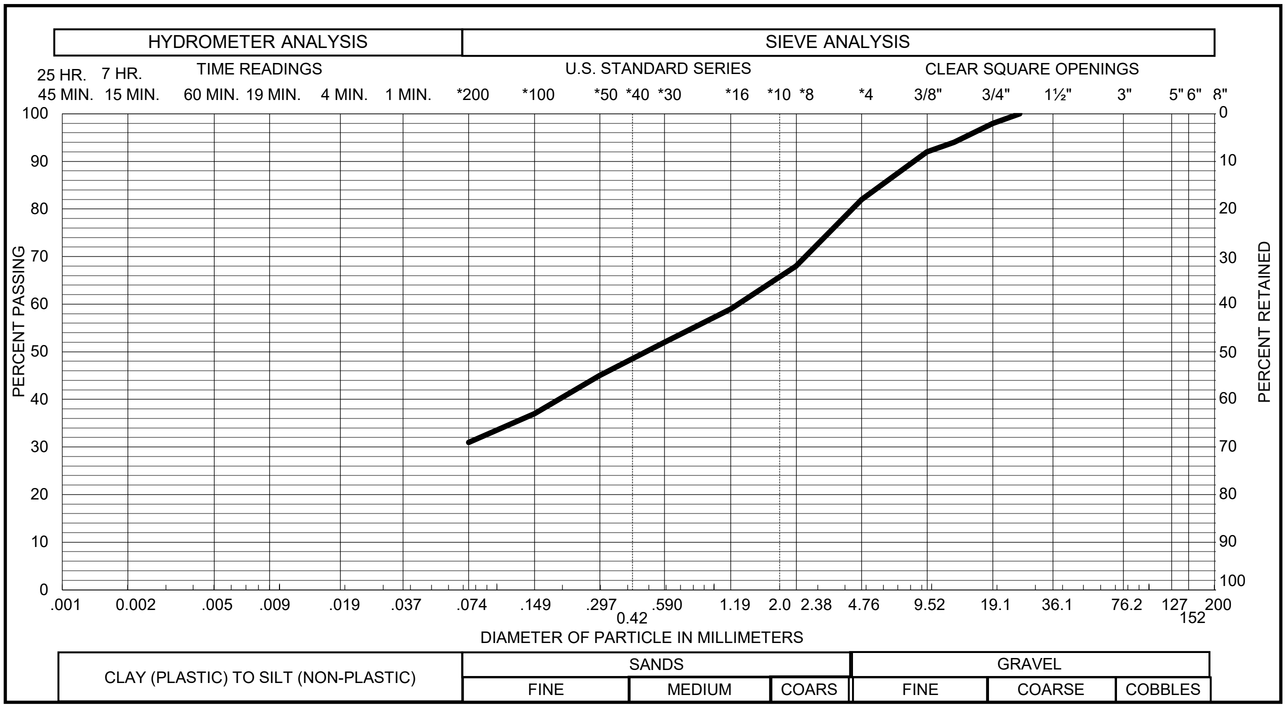
Gradation Test Results

FIG. B-23



Sample of	FILL, SAND, SILTY, GRAVELLY	GRAVEL	18 %	SAND	51 %
From	C - 1 AT 0 FEET	SILT & CLAY	31 %	LIQUID LIMIT	
		PLASTICITY INDEX			

Sample of	FILL, SAND, SILTY, GRAVELLY	GRAVEL	13 %	SAND	59 %
From	C - 2 AT 0 FEET	SILT & CLAY	28 %	LIQUID LIMIT	
		PLASTICITY INDEX			

Gradation Test Results

FIG. B-24

TABLE B-I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19781.000-125

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT	PLASTICITY INDEX	SWELL TEST RESULTS* SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
TH-1	3	2.2	130	28	12				23	<0.1	FILL, SAND, CLAYEY
TH-1	6	46.9	74			6.6	700	11,000			WEATHERED CLAYSTONE, SANDY
TH-1	9	48.4	73	124	65	7.7	1100	18,000	91		WEATHERED CLAYSTONE, SL. SANDY
TH-1	12	47.0	75			8.0	1500	21,000			WEATHERED CLAYSTONE, SANDY
TH-2	1	6.3	135	25	10				36		FILL, SAND, V. CLAYEY
TH-2	6	44.5	75			3.8	700	11,000	85		CLAY, SANDY (CL)
TH-2	9	49.0	72	123	67	3.7	1100	7,200	88	0.550	WEATHERED CLAYSTONE, SL. SANDY
TH-2	12	49.4	71	117	63	4.1	1500	11,000	87		WEATHERED CLAYSTONE, SANDY
TH-3	6"	6.2	120								FILL, SAND, SILTY
TH-3	2	6.7	134						27		FILL, SAND, SILTY
TH-3	3	4.0	135	24	9				28		SAND, CLAYEY (SC)
TH-3	6	50.0	72	113	59				88	<0.1	WEATHERED CLAYSTONE, SL. SANDY
TH-3	9	50.0	69	118	65				87		WEATHERED CLAYSTONE, SANDY
TH-5	1	4.3	115								FILL, SAND, SILTY
TH-5	3	7.1	128			-0.3	300		38		FILL, SAND, V. SILTY
TH-5	6	5.4	118	NV	NP	-0.2	300		13		FILL, SAND, SILTY
TH-5	9	12.1	116			-0.3	600				SAND, SILTY (SM)
TH-5	12	7.3	103	NV	NP	-0.7	1500		14		SAND, SILTY (SM)
TH-5	18	42.9	79			3.3	1700	12,000	48		WEATHERED SANDSTONE, V. CLAYEY
TH-6	3	11.3	114	29	6	-0.4	300		36		FILL, SAND, V. SILTY
TH-6	6	7.2	115	NV	NP	-0.5	300		19		SAND, VERY SILTY (SM)
TH-6	9	10.9	118			0.0	600				SAND, SILTY (SM)
TH-6	12	9.9	125			-0.3	1000		23		SAND, SILTY (SM)
TH-6	18	10.0	126	51	28				22		WEATHERED SANDSTONE, CLAYEY
TH-7	1	4.4	113								FILL, SAND, SILTY
TH-7	3	6.0	127			-2.5	300		38		FILL, SAND, V. SILTY
TH-7	6	4.1	110			-1.9	800				FILL, SAND, SILTY
TH-7	9	9.9	116			-2.0	1100		43		WEATHERED SANDSTONE, SILTY
TH-7	12	37.8	81			6.1	1500	19,000	76		WEATHERED CLAYSTONE, SANDY
TH-7	15	40.3	80			8.7	1800	30,000		<0.1	WEATHERED CLAYSTONE, SANDY
TH-8	2	41.1	69								FILL, CLAY SANDY

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

APPENDIX C

SITE PHTOGRAPHS

1. West side of school building, main entrance to school as viewed from the cul-da-sac.

2. South side of Middle School viewed from the Elementary School.

3. Patio/courtyard of Middle School as viewed from near the east property boundary. Courtyard is generally flat and level. The ground surface is covered with irrigated sod.

4. View of the north side of the building from near the northeast corner. Concrete crib retiaing wall present on the right. Poor drainage conditions throughout.

5. North side of the building viewed from outside of the north wing foyer. Existing poor drainage conditions throughout the area.

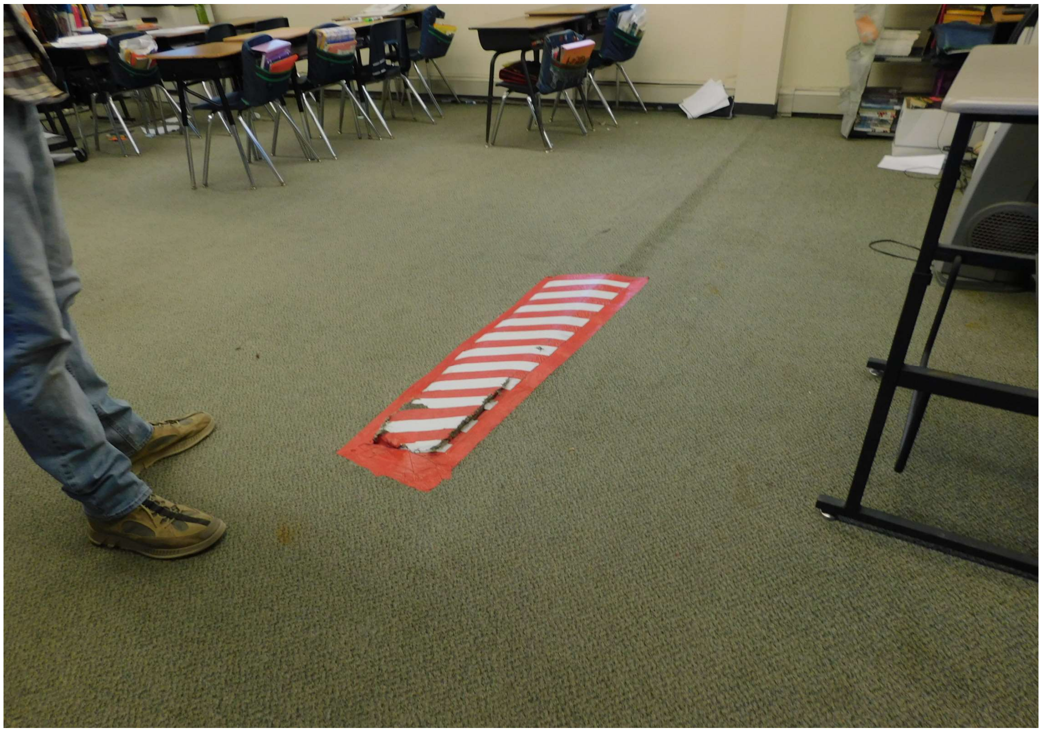
6. East side of the school building viewed from near the northeast side of the school. Crib retaining wall present on the left. East end of the patio/courtyard in the distance.

7. Northeast corner of the building. Crib retaining wall and poor drainage conditions.

8. Poor drainage patterns along north side of the school.

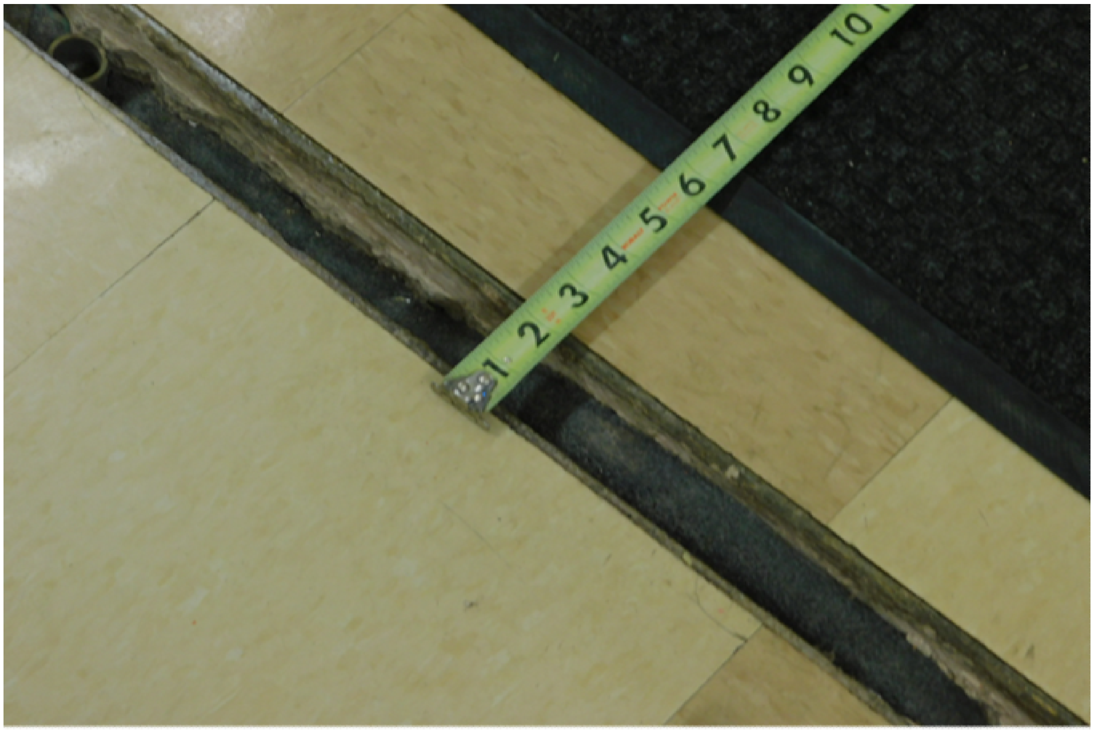
9. Stormwater pond on slope of Palmer Park. Erosion channel forming from uncontrolled stormwater runoff from the slope and out of pond toward school building.

10. Poor drainage within the patio/courtyard.



11. Vertical displacement of floor slab at grade beam in classroom 308.

12. Floor seperation at control joint in science room.

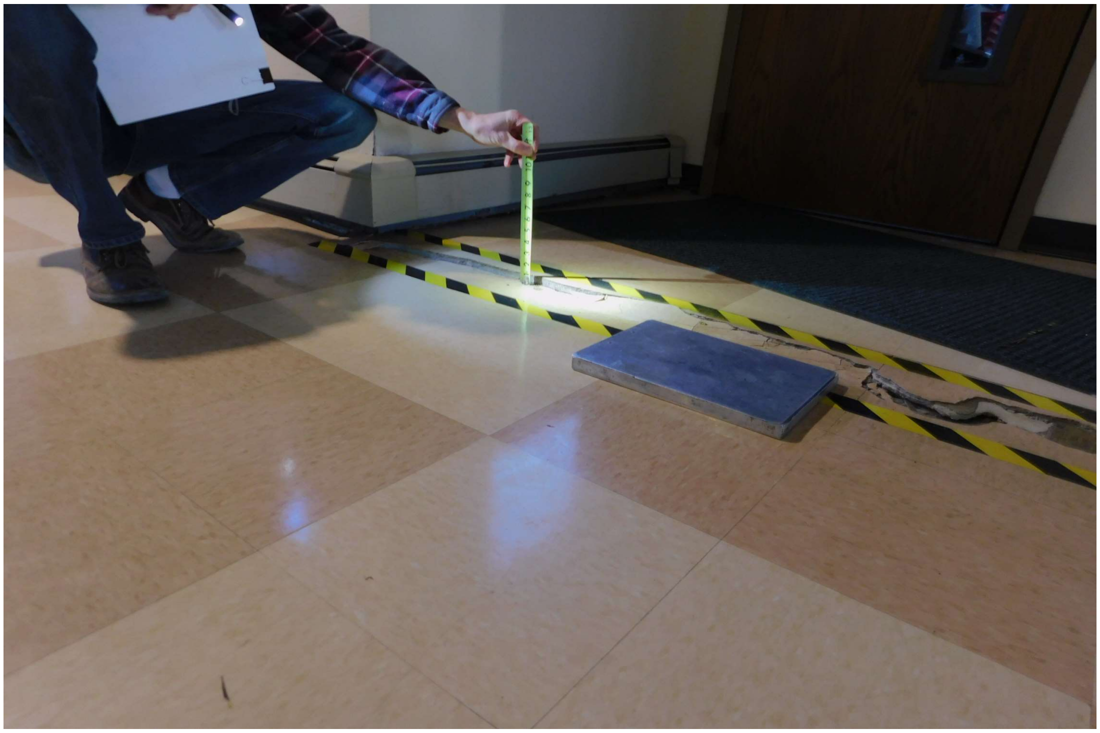


13. Floor slab seperation in science room.

14. Slab damage at slab edge located at the northwest door of the science room.

15. Slab settlement at northwest corner of the science room.

16. Slab settlement at slab edge.



17. Vertical seperation at slab control joint located at the door to classroom 308.

18. Drywall joint crack at door to science room.