GEOTECHNICAL INVESTIGATION

PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION

7930 INDIAN VILLAGE HEIGHTS
FOUNTAIN, COLORADO

Prepared for:

HANOVER SCHOOL DISTRICT NO. 28
17050 SOUTH PEYTON HIGHWAY
FOUNTAIN, COLORADO 80928

Attention: Mr. Mark McPherson, Superintendent

Project No. CS19910.000-125

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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 the results of our Geotechnical Investigation for the proposed Prairie Heights Elementary School building addition located at 7930 Indian Village Heights in Fountain, Colorado. The purpose of our investigation was to evaluate subsurface conditions at the site in order to develop geotechnical design criteria for the proposed addition and associated site improvements. This report summarizes the results of our field and laboratory investigation, and presents our design and construction recommendations for foundations, floor systems, pavement section alternatives, as well as other details influenced by subsurface conditions and site improvements. We believe the investigation was completed in accordance with our proposal (CTL|T Proposal No. CS-24-0203) dated October 24, 2024. Evaluation of the property for the possible presence of potentially hazardous materials (environmental site assessment) is not included in the scope.

The report was prepared based on conditions disclosed by our exploratory borings, results of laboratory tests, engineering analyses, and our experience. The design criteria presented in the report were based on our understanding of the planned construction. The following section summarizes the report. More detailed descriptions of subsurface conditions, as well as our design and construction recommendations, are presented in the report.

SUMMARY OF CONCLUSIONS

1. Subsurface conditions were explored by advancing five (5) exploratory borings within the approximate footprint of the proposed building addition. Soils encountered within the exploratory borings consisted of suspect quality sand and clay fill underlain by natural, clayey sand, silty sand, and sandy clay extending to the maximum depths explored of 20 to 30 feet. The natural sand and clay are judged to be slightly expansive or non-expansive. Bedrock was not encountered in our exploratory borings.

2. Groundwater was not encountered in our exploratory borings during our drilling operations. Groundwater levels may rise in response to seasonal precipitation and irrigation.

3. The proposed addition to the school building can be constructed using a spread footing foundation system. Footings should be underlain by properly moisture conditioned and densely compacted fill. Existing suspect quality fills cannot be relied upon as a reliable support stratum; therefore, existing fills may not remain in place below new foundations.

4. We believe a low risk of poor slab-on-grade performance will exist for a slab-on-grade floor when underlain by new, properly constructed fill. Suspect quality fills cannot be relied upon for new construction.

5. Surface drainage should be designed and maintained to provide for the rapid removal of runoff away from the proposed building addition to reduce potential subsurface wetting. Water should not be allowed to pond adjacent to the building.

6. The design and construction criteria for foundations and slabs-on-grade included in this report were compiled with the expectation that all recommendations will be incorporated into the project and that the property manager/owner will maintain the structure, use prudent irrigation practices, and maintain surface drainage. It is critical that all recommendations in this report are followed.

SITE CONDITIONS

The school property is located at 7930 Indian Village Heights in Fountain, Colorado. The overall property contains 38.5 acres of land; however, the immediate project area contains about 4 acres of land. The existing school is a single-story building with no below grade construction. Two modular buildings are located to the northeast of the school building. A dirt and gravel surface parking lot, bus lane, and access road are located east of the school building. Indian Village Heights is present adjacent to the south. Large plot residences are present to the east, and vacant lots are present in the immediate vicinity to the north and west. The Hanover Volunteer Fire Department is located immediately south of the school.

The ground surface in the vicinity of the project site and within the immediate area of the proposed building addition are generally graded flat and level. Areas to the north and west, beyond the approximate project site, are slightly to moderately sloping downward and to the north at grades of about 5 to 7 percent. Elevations at the school and proposed addition are approximately 5,420 feet above mean sea level, based on available United States Geological Survey mapping of the area. Areas to the east and south are generally flat and level to slightly sloping toward the north at grades of 1 to 3 percent. The ground surface at the project area is generally covered with weeds and native grasses. The general vicinity of the property and approximate location of the proposed building addition is presented in Fig. 1.

PROPOSED CONSTRUCTION

A building addition is planned to be constructed on the east side of the existing Prairie Heights Elementary School, at the approximate location shown on Fig. 1. The addition is planned as a single-story structure, and will likely be constructed using light gauge metal framing with metal, block veneer, composite exterior finishes, or other similar construction. The structure is planned to contain nearly 18,400 square feet of interior floor space. No below grade construction is planned. Our understanding of the proposed construction is based on discussions with the client, a Geotechnical Engineering Scope of Services prepared by HSD (dated October 17, 2024), and a conceptual site plan prepared by MOA Architecture, October 10, 2024.

INVESTIGATION

Subsurface conditions at the site were investigated by drilling five (5) exploratory borings for the proposed building addition and two (2) shallow subgrade borings in the proximity of the proposed parking lot improvements. A percolation test was performed near the existing leach field, west of the school building. The exploratory borings were drilled at the approximate locations shown on Fig. 1 and advanced to depths of 20 and 30 feet using 4-inch diameter, continuous-flight auger and a truck-mounted drill rig. Subgrade borings were advanced to depths of 4 feet.

Samples of the soil were obtained at 5 to 10-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. Subgrade samples consisted of the upper 4 feet of the borings, obtained from two exploratory borings and two subgrade borings. 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, Atterberg limits, gradation analysis, swell-consolidation testing, and water-soluble sulfate concentration. Swell-consolidation testing was performed by wetting samples under estimated overburden pressures (weight of the overlying soils). Summary logs of the exploratory borings, including results of field penetration resistance tests and a portion of the laboratory data, are presented in Fig. 2. Swell-consolidation test results are presented in Figs. 3 through 7 and gradation test results are presented in Figs. 8 through 10. The laboratory results are summarized on Table 1.

SURFACE CONDITIONS

Subsurface soils encountered in the five (5) borings advanced within the area of the addition consisted of suspect quality, sandy to very sandy clay and very clayey sand fill underlain by natural, sand and clay soils to the maximum depths explored of 25 and 30 feet. Subsurface soils encountered in the two (2) shallow parking lot subgrade borings consisted of about 4 feet of natural, very sandy clay. Bedrock and groundwater were not encountered in our borings. Pertinent engineering characteristics of the soils encountered are described in the following paragraphs.

Fill

Sandy to very sandy clay and very clayey sand fill was encountered at the ground surface in four of the five borings located within the building footprint and extended to depths of between 4 and 10 feet below existing grades. The fill is judged to be loose to medium dense (sand) and stiff to very stiff (clay) based on field penetration resistance testing. Four samples of the fill were subjected to laboratory testing and contained 38 to 75 percent silt and clay-sized particles (percent passing the No. 200 sieve). Two samples of the fill were subjected to Atterberg limits testing resulting in Liquid Limits of 33 and 36 and Plasticity Indices of 15 and 16. Based on the laboratory test results and our experience, we judge the fill to be non-expansive to slightly expansive when wetted.

Natural Soils

Natural, slightly sandy to very sandy clay as well as clayey to very clayey and silty sand were encountered at the ground surface and underlying the existing fill within the building footprint. Near surface materials encountered within the parking lot consisted of sandy and very sandy clay. The natural soils extended to depths of up to 30 feet below existing grades.

Clay soils were encountered at the site and judged to be stiff to very stiff based on field penetration resistance testing. Clay was found at the ground surface and underlying the existing fills in 5 borings. Clays were also encountered underlying the natural, clayey and silty sands at depths of between 16 and 23 feet in three of the borings. Five samples of the clay were subjected to laboratory testing and contained 64 to 92 percent silt and clay-sized particles. Five samples were subjected to swell-consolidation testing. One sample exhibited 0.2 percent measured swell. Three samples compressed between 0.1 and 1.4 percent, and one sample exhibited no movement when wetted under estimated overburden pressures.

Sand soils encountered at the site are judged to be loose to very dense, based on field penetration resistance testing. The sands were encountered underlying the existing fills and natural clays at depths ranging from 6 to 18 feet. Seven samples were tested in our laboratory and contained 15 to 48 percent silt and clay-sized particles. Three samples were subjected to swell-consolidation testing resulting in 0.8 and 0.5 percent compression and 0.2 percent swell when wetted under estimated overburden pressures. Based on the laboratory test results and our experience, we judge the natural soils to be slightly expansive or non-expansive when wetted.

Groundwater

Groundwater was not encountered in the exploratory borings during our drilling operations. The borings were drilled in the late fall season when groundwater depths typically become deeper. Water levels may rise in response to seasonal precipitation and irrigation.

Seismicity

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

The soil and bedrock at this site are not expected to respond unusually to seismic activity. The 2021 International Building Code (Section 1613.2.2) defers the estimation of Seismic Site Classification to ASCE 7-16, as outlined in the table below.

ASCE 7-16 SITE CLASSIFICATION CRITERIA

Seismic Site Class	$\bar{s}_u$, Average Undrained Shear Strength (lb/ft^2)	$\bar{N}$, Average Standard Penetration Resistance (blows/ft)	$\bar{v}_s$, Average Shear Wave Velocity (ft/s)
A. Hard Rock	N/A	N/A	>5,000
B. Rock	N/A	N/A	2,500 to 5,000
C. Very Dense Soil and Soft Rock	>2,000	>50 blows/ft	1,200 to 2,500
D. Stiff Soil	1,000 to 2,000	15 to 50 blows/ft	600 to 1,200
E. Very Loose Sand or Soft Clay Soil	<1,000	<15 blows/ft	<600
F. Soils requiring Site Response Analysis	See Section 20.3.1	See Section 20.3.1	See Section 20.3.1

Based on the results of our investigation, we judge a Seismic Site Classification of D (Stiff Soil). The subsurface conditions indicate low susceptibility to liquefaction from a materials and groundwater perspective. If desired, we can provide shear wave velocity testing to evaluate the site classification; however, we believe it is unlikely to result in an improved seismic site classification.

SITE GEOLOGY

Geology of the site generally consists of Verdos Alluvium (Qv) originating from the Pleistocene Geologic Era and includes a granular mix of silty to clayey sand with weathered gravels. The geologic unit is considered to be underlain by Pierre Shale, which generally weathers to claystone and clay. Bedrock was not encountered in the exploratory borings. Geologic conditions at the site were identified following our review of the Pueblo 1° X 2° Quadrangle, South-Central Colorado, prepared by Glen R. Scott, Richard B. Taylor, Rudy C. Epis, and Reinhard A. Wobus, dated 1976.

SITE DEVELOPMENT

The location of the proposed building addition is relatively flat and level to slightly sloping toward the northwest. Materials encountered in the vicinity of the proposed school building addition consist of suspect quality fills and natural, slightly expansive or non-expansive sandy clay and clayey sand. Based on the existing site grading, we expect cuts and fills of less than about 2 to 3 feet will be needed to establish a building pad. Grading plans have not been provided for our review.

Excavation

We believe the near-surface soils can be excavated with conventional, heavy-duty excavation equipment. Based on our investigation and Occupational Safety and Health Administration (OSHA) standards, we believe the fills, clays, and granular materials identified at the site classify as Type C soil. Type C soil requires a maximum slope inclination of 1.5:1 (horizontal to vertical) for dry conditions. Excavation slopes specified by OSHA are dependent upon the types of soil and groundwater conditions encountered. The contractor's "competent person" should identify the soils encountered in the excavation 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.

Over-Excavation and Building Pad Improvement

Existing fill was identified in 4 of the 5 borings located within the building addition footprint. The fill extended to depths of 4 to 10 feet below existing ground surface elevations. Documentation for the placement of the existing fill was not available for review and zones of loose materials and relatively low densities were identified in our boring logs. These conditions pose a risk of differential movement and associated damages to foundations and the structure. A reliable approach to reduce the risk of differential movement associated with variations of the existing fill includes removal of the fills within the building footprint; however, this may not be feasible adjacent to existing structures. We recommend over-excavation of the existing soils, fill and native, to a depth of at least 4 feet below the lowest bottom of footing elevation and throughout the building footprint. Excavations should extend 5 feet laterally beyond the outside edges of the footings. Over-excavation will improve bearing capacity and establish a more uniform layer of support for shallow foundations. Where existing fills extend deeper than 4 feet below bottom of foundations, our personnel should evaluate the exposed materials within the excavations at the time of construction to determine if removal to more competent materials is necessary. Evaluation may include visual observation, probing, potholing, and field density testing.

Excavations immediately adjacent to the existing building should be sloped away from the foundations at a 1:1 slope. Care should be taken not to undermine existing foundations and excavations should not remain open as long as necessary to complete the excavation and backfill process, especially adjacent to existing foundations.

Over-excavated soils can be reused given they are free of organics and debris. The materials should be reconstructed as moisture conditioned and densely compacted fill. The materials placed as over-excavation backfill should be moisture conditioned and densely compacted as discussed in the following Fill Placement Section.

Fill Placement

New fill placed at the site will be required to establish a building pad for the building addition and as over-excavation backfill. The properties of the fill will affect the performance of foundations and slabs-on-grade. The near surface soils including the existing suspect quality fills are expected to be suitable to re-use as fill and over-excavation backfill material given the materials are free from vegetation and organics, topsoil, debris, building remnants, and other deleterious materials.

Our experience suggests shrinkage factors of about 10 to 15 percent will exist for the on-site materials. Many variables affect the actual shrinkage-swelling factors of soils and include sample disturbance actual percent compaction of the fill, subsoil profile, compression of the natural soils below the new fill, compression of the deeper fill, rebound of materials cut during site grading, swell after excavated materials are moisture conditioned, etc. The effects of these variables on the shrinkage-swelling factor are difficult to quantify. The actual shrinkage-swelling factor will vary from the estimated percentages.

If imported fill is necessary, it should ideally consist of granular material with 100 percent passing the 2-inch sieve and less than 40 percent passing the No. 200 sieve. The import soil should exhibit low plasticity with a Liquid Limit less than 30 and a Plasticity Index less than 10. Import soils similar to the on-site natural soils may be suitable. A sample of the import material should be submitted to our office for approval before stockpiling at the site.

Prior to fill placement, vegetation, topsoil, and other deleterious material should be removed. Areas to receive fill should be scarified to a depth of 8 inches, moisture conditioned to near optimum moisture content and compacted to high densities.

Fill and backfill should be placed in thin, loose lifts of 8 inches or less. Cohesive materials placed as fill should be moisture conditioned to within 2 percent of optimum moisture contents and compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D

698). Granular materials placed as fill should be moisture conditioned to within 2 percent of optimum moisture contents and compacted to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557). We estimate maximum dry densities for the on-site clay soils to range from 105 to 120 pcf with estimated optimum moisture contents of 12 to 18 percent. A Proctor should be conducted by our laboratory at the time of construction to determine the actual maximum Proctor dry density and optimum moisture content for materials placed as fill. Compaction of backfill should be observed and tested by a representative of our firm during construction.

Water and sewer lines are often constructed beneath slabs and pavements. Compaction of utility trench backfill can have a significant effect on the life and serviceability of floor slabs, pavements, and exterior flatwork. We recommend utility trench backfill in non-building areas be moisture conditioned to within 2 percent of optimum moisture content and compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D 698). Our experience indicates the use of a self-propelled compactor results in more reliable performance compared to trench 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. The placement and compaction of utility trench backfill should be observed and tested by a representative of our firm during construction.

Fill should not be placed when frozen and should not be placed over top of frozen soils. Once fill is placed, it is important that measures be planned to reduce drying of the near-surface materials. If the fill dries excessively prior to building construction, it may be necessary to rework (scarify, moisture condition, and compact) the upper, drier materials prior to the placement of concrete and forms for the new foundations or floor slabs.

FOUNDATIONS

We understand the desired foundations for the building addition includes the use of spread footings. Based on our exploratory borings and understanding of the proposed construction, we anticipate suspect quality fill and natural, slightly expansive and non-expansive clays and sands are present at elevations that will influence the performance of shallow foundations. Existing fills are considered suspect in quality, as no records of the placement are available for review and zones of loose soils were identified during drilling. New foundations cannot be underlain by suspect quality fill. Additionally, the natural materials present across the building addition footprint exhibit variability such as loose soils, slight expansion and consolidation when wetted, resulting in risk of movement and potential structure damage. To reduce risk and establish a layer of reliable foundation support, new foundations should be underlain by new over-excavation backfill as described in the Over-Excavation and Building Pad Improvement section. Design and construction criteria for the spread footing foundations are presented in the following section.

Spread Footing Foundations

The following presents our design and construction recommendations for the spread footing foundation option.

1. Existing fill cannot be relied upon and must be over-excavated and reconstructed as moisture conditioned and densely compacted fill per the Fill Placement section of this report. Spread footings for the proposed building addition should be underlain by a minimum 4-foot-thick layer of properly constructed over-excavation fill.

2. Spread footings can be designed for a maximum allowable soil bearing pressure of 3,000 psf when underlain by a layer of properly constructed over-excavation fills.

3. We recommend footings beneath continuous foundation walls be at least 16 inches wide. Footings beneath isolated column pads should be at least 24 inches square. Larger footing sizes may be required to accommodate the anticipated foundation loads.

4. Foundation walls should be well-reinforced. We recommend reinforcement sufficient to span an unsupported distance of at least 10 feet.

5. We recommend designs consider total movement of 1-inch and differential movement of 1/2-inch.

6. Foundations subject to lateral loading may be designed using a coefficient of friction of 0.3.

7. Exterior footings must be protected from frost action. Normally, 30 inches of frost cover is required in the area, according to the Pikes Peak Regional Building Department.

8. A representative of our firm should observe the completed foundation excavation prior to the placement of over-excavation backfill to confirm the exposed conditions are similar to those encountered in our exploratory borings. The placement and compaction of below-footing fill and footing subgrade preparation should be observed and tested by a representative of our firm during construction.

9. Excessive wetting of foundation soils during and after construction can cause softening and settlement of foundation soils and result in footing and slab movements. Proper surface drainage around the building is critical to control wetting.

FLOOR SYSTEMS

We understand a slab-on-grade floor is the preferred floor system of the proposed school building addition. The anticipated building addition finished floor elevation will likely match the elevation of the existing building floor slab-on-grade. We estimate less than about 2 to 3 feet of new fill may be required to establish a finished floor slab-on-grade elevation. Based on our understanding of the proposed construction and near surface materials encountered in our exploratory borings, we anticipate suspect quality fill will impact the proposed slabs. We believe an undefined risk of differential settlement exists due to the presence of suspect quality fill, loose sands, and inconsistent material types (clay and sand) found within the borings at or near anticipated floor slab-on-grade elevations. We recommend mitigation efforts be performed to reduce risk of settlement as described in the Site Development section and the following section. Design and construction recommendations for slabs-on-grade are presented below.

Slab-on-Grade

Where conventional slabs-on-grade are used and the owner accepts the risks, we recommend the following design and construction criteria. These recommendations will not prevent movement. Rather, they tend to reduce damage if movement occurs.

1. Slabs should be separated from exterior walls and interior bearing members with a slip joint that allows free vertical movement of the slabs. This detail can reduce cracking when movement occurs.

2. Use of slab-supported partition walls should be minimized. Slip-joints in slab-bearing partitions should allow for at least 1-1/2 inches of free vertical movement. If the “float” is provided at the tops of partitions, the connection between interior, slab-supported partitions and exterior, foundation-supported walls should be detailed to allow differential movement. These architectural connections are critical to help reduce cosmetic damage when foundations and floor slabs move relative to each other. We have seen instances where these architectural connections were not designed and constructed properly and resulted in moderate cosmetic damage, even though the movement experienced was well within the anticipated range. The architect should pay special attention to these issues and detail the connections accordingly.

3. Underslab plumbing should be eliminated where feasible. Where such plumbing is unavoidable, it should be pressure tested for leaks prior to slab construction

and provided with flexible couplings. Pressurized water supply lines should be brought above the floors as quickly as possible.

4. Plumbing and utilities that pass through the slabs should be isolated from the slabs and constructed with flexible couplings. Utilities, as well as electrical and mechanical equipment, should be constructed with sufficient flexibility to allow for movement.

5. HVAC or other mechanical systems supported by the slabs (if any) should be provided with flexible connections capable of withstanding at least 1-inch of movement.

6. Slabs should be placed directly on properly moisture conditioned, well-compacted fill. The 2021 International Building Code (IBC) requires a vapor retarder between the base course or subgrade soils and the concrete slab-on-grade floor. The merits of installation of a vapor retarder below floor slabs depend on the sensitivity of floor coverings and building use to moisture. A properly installed vapor retarder (6 mil minimum) is more beneficial below concrete slab-on-grade floors where floor coverings, painted floor surfaces or products stored on the floor will be sensitive to moisture. The vapor retarder is most effective when concrete is placed directly on top of it, rather than placing a sand or gravel leveling course between the vapor retarder and the floor slab. The placement of concrete on the vapor retarder may increase the risk of shrinkage cracking and curling. Use of concrete with reduced shrinkage characteristics including minimized water content, maximized coarse aggregate content, and reasonably low slump will reduce the risk of shrinkage cracking and curling. Considerations and recommendations for the installation of vapor retarders below concrete slabs are outlined in Section 5.2.3.2 of the 2015 report of American Concrete Institute (ACI) Committee 302, "Guide for Concrete Floor and Slab Construction (ACI 302.1R-15)".

7. Slab-on-grade floors can be designed considering a modulus of subgrade reaction of 100 pci for slabs supported on at least 4 feet of new fill.

8. The American Concrete Institute (ACI) recommends frequent control joints be provided in slabs to reduce problems associated with shrinkage cracking and curling. To reduce curling, the concrete mix should have a high aggregate content and a low slump. If desired, a shrinkage compensating admixture could be added to the concrete to reduce the risk of shrinkage cracking. We can perform a mix design or assist the design team in selecting a pre-existing mix.

Exterior Flatwork

We recommend exterior flatwork and sidewalks be isolated from the foundations to reduce the risk of transferring heave, settlement, or freeze-thaw movement to the structures. One alternative would be to construct the inner edges of the flatwork on haunches or steel angles bolted to the foundation walls and detail the connections such that movement will cause less distress to the building, rather than tying the slabs directly into the building foundation. Construction on haunches or steel angles and reinforcing the sidewalks and other exterior flatwork will reduce the potential for differential settlement and better allow them to span across wall backfill. Frequent control joints should be provided to reduce problems associated with shrinkage cracking. Panels that are approximately square perform better than rectangular areas.

BELOW-GRADE CONSTRUCTION

It is our understanding that no below-grade construction (habitable or mechanical such as elevator pits) is planned for the proposed school building addition. If plans change and habitable or mechanical, below-grade areas will be included in the structure, our office should be contacted to assess our shallow foundation recommendations as well as provide design criteria for lateral earth pressures and subsurface drain systems.

PAVEMENTS

We understand the proposed building addition will include the construction of new asphalt and/or concrete paved drive lanes and parking lots. The new parking lot will be located east of the school building and will contain about 21 parking stalls. A pickup and drop-off drive lane as well as a bus lane will be located along the west side of the parking lot. An access drive lane will be constructed to the south, providing access to the parking lot from Indian Village Heights.

Our exploratory borings and understanding of the proposed construction suggest the subgrade soils in the vicinity of the proposed parking lot and access drive consist of sandy to very sandy clay fill and natural sandy to very sandy clay. Subgrade samples of the near surface soils were obtained from two exploratory borings (TH-4 and TH-5) and two subgrade borings (S-1 and S-2) during drilling. The subgrade samples were returned to our laboratory, combined, and assigned laboratory classification testing. Classification testing included gradation analysis and Atterberg Limits. Samples contained 50 to 55 percent silt and clay-sized particles (passing the No. 200 sieve). Atterberg limits testing resulting was performed, resulting in a Liquid Limit of 33 and a Plasticity Index of 15. The pavement subgrade sample classified as CL soils using the Unified Soil Classification System (USCS). According to the American Association of State Highway Transportation Officials (AASHTO) classification system, the subgrade soils present within the proposed parking lots and drive lanes classify as A-6 soils. These types of materials generally exhibit fair to poor pavement support characteristics. For design purposes, an estimated Hveem Stabilometer ("R") value of 20 was assigned for the existing subgrade materials, based on our laboratory classification testing.

We anticipate the parking lot will be subjected to passenger pick-up trucks, automobiles, school busses, and occasional delivery trucks. We considered a daily traffic number (DTN) of 2 for the automobile parking stalls which correspond to an 18-kip Equivalent Single-Axle Loads (ESAL) of 14,600 for a 20-year flexible pavement design life (asphalt pavement). We considered a DTN of 10 for the drive lanes and access road which corresponds to an 18-kip ESAL of 73,000 for a 20-year flexible pavement design life. We calculated an 18-kip ESAL for rigid pavement (concrete), considering a 50-year design life of 36,500 and 182,500 for the parking stalls and drive lanes, respectively. Parking lot pavement alternatives are presented in the following table. If the estimated DTN values are significantly different, we should be contacted to revise our calculations to reflect the different values.

RECOMMENDED PAVEMENT DESIGN SECTION ALTERNATIVES

Street/Parking Lot	ESAL Asphalt/Concrete	Asphalt Section (AC) Inches	Asphalt Pavement + Aggregate Base Course (AC + ABC) Inches	Plain Portand Cement Concrete (PCC) Inches
Automobile Parking Stalls	14,600 / 36,500	4.5	3 + 6	6
Drive Lanes/Access Drive	73,000 / 182,500	5.5	4 + 6	6

We recommend a concrete pad be provided at the trash dumpster site, if included in the proposed construction. The pad should be at least 8 inches thick and long enough to support the entire length of the trash truck and dumpster. Joints between concrete and asphalt pavements should be sealed with a flexible compound.

Our design considers pavement construction will be completed in accordance with the City Fountain or El Paso County Specifications. The specifications contain requirements for the pavement materials (asphalt, base course, and concrete) as well as the construction practices used (compaction, materials sampling, and proof-rolling). Of particular importance are those recommendations directed toward subgrade and basecourse compaction and proof-rolling. During proof-rolling, attention should be directed toward the areas of confined backfill compaction such as utility trenches. Soft or loose subgrade or areas that pump excessively should be stabilized prior to pavement construction. Subgrade areas that pass the proof-roll should be stable enough to pave. A representative of our office should be present at the site during placement of fill and construction of pavements to perform density testing.

PEROLATION TESTING

We understand the existing leach field may be expanded to accommodate a larger on-site wastewater system. The location of the existing on-site wastewater system is located west of the existing school building. Our office performed field percolation testing at the site to assess the percolation rate of the near surface soils in the vicinity of the proposed leach field expansion. A profile hole was advanced to a depth of 10 feet near the center of the test location and samples were obtained for classification. A total of three, six-inch diameter holes were advanced to depths of about 3 feet below existing grades using a truck mounted drill rig and continuous flight auger at the location indicated on Fig. 1. Slotted PVC pipe was installed into the three holes and the holes were presoaked. We returned on the following day to perform the percolation test by taking measurements of the water depth on a periodic basis. Measurements were taken and recorded in the field. A design infiltration rate of 10 minutes per inch was determined for percolation test location P-1. Test results are summarized in the table presented in Fig. 11 of this report.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentration of less than 0.1 percent in a sample obtained from the site. As indicated in our tests and ACI 318-19, the sulfate exposure class is *not applicable* or S0.

SULFATE EXPOSURE CLASSES PER ACI 318-19

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

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

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

CONCRETE DESIGN REQUIREMENTS FOR SULFATE EXPOSURE PER ACI 318-19

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

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

Superficial damage may occur to the exposed surfaces of highly permeable concrete. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious materials ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high-water tables. Concrete should have a total air content of 6 percent ± 1.5 percent. We advocate damp-proofing of all foundation walls and grade beams in contact with the subsoils.

SURFACE DRAINAGE

Performance of the foundation system, floor slabs, pavements, and concrete flatwork to be constructed at this site will be influenced by the moisture conditions existing within the near-surface soils. Overall surface drainage patterns must be planned to provide for the rapid removal of storm runoff. Water should not be allowed to pond adjacent to foundations or over pavements or concrete flatwork. We recommend the following precautions be observed during construction and maintained at all times after the building is completed.

1. Excessive wetting or drying of the open foundation excavation should be avoided.

2. Foundation wall backfill should be graded to provide for the rapid removal of runoff. We recommend a slope equivalent to at least 6 inches in the first 10 feet. In flatwork areas adjacent to the structure, the slope may be reduced to comply with ADA requirements.

3. Backfill around foundations should be moistened and compacted to 95 percent of standard Proctor dry density, according to criteria presented in <u>Fill Placement</u>.

4. Roof downspouts and drains should discharge well away from the building. Downspout extensions and/or splash blocks should be provided to help reduce infiltration into the backfill adjacent to the structure.

5. Landscaping concepts should concentrate on use of plantings that require little or no supplemental irrigation after the vegetation is established. Irrigated sod, if it is included in the landscaping plan, should not be located within 6 feet of the foundation walls. Irrigation should be limited to the minimum amount sufficient to maintain vegetation. Application of more water will increase likelihood of slab and foundation movements.

6. Backfill around foundations should be moistened and compacted according to criteria presented in <u>Fill Placement</u>.

CONSTRUCTION OBSERVATIONS

We recommend that CTL|Thompson, Inc. provide construction observation services to allow us the opportunity to confirm subsurface 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. The owner must assume responsibility for maintaining the structure and use appropriate practices regarding drainage.

LIMITATIONS

This report has been prepared for the exclusive use of the Hanover School District No. 28 and NV5 for the purpose of providing geotechnical design and construction criteria for the proposed Prairie Heights Elementary School building addition and associated site improvements located at 7930 Indian Village Heights in Fountain, Colorado. 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 spaced to obtain a reasonably accurate picture of foundation conditions below the proposed building addition area. 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. Representatives of our firm should periodically visit the site during construction to perform observation and testing services.

We believe this 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 building, please call.

CTL|THOMPSON, INC.

Patrick Foley, E.I.
Staff Engineer

Reviewed by:

COLORADO LICENSED
JEFFREY MARK JONES
47539
1/28/25
PROFESSIONAL ENGINEER

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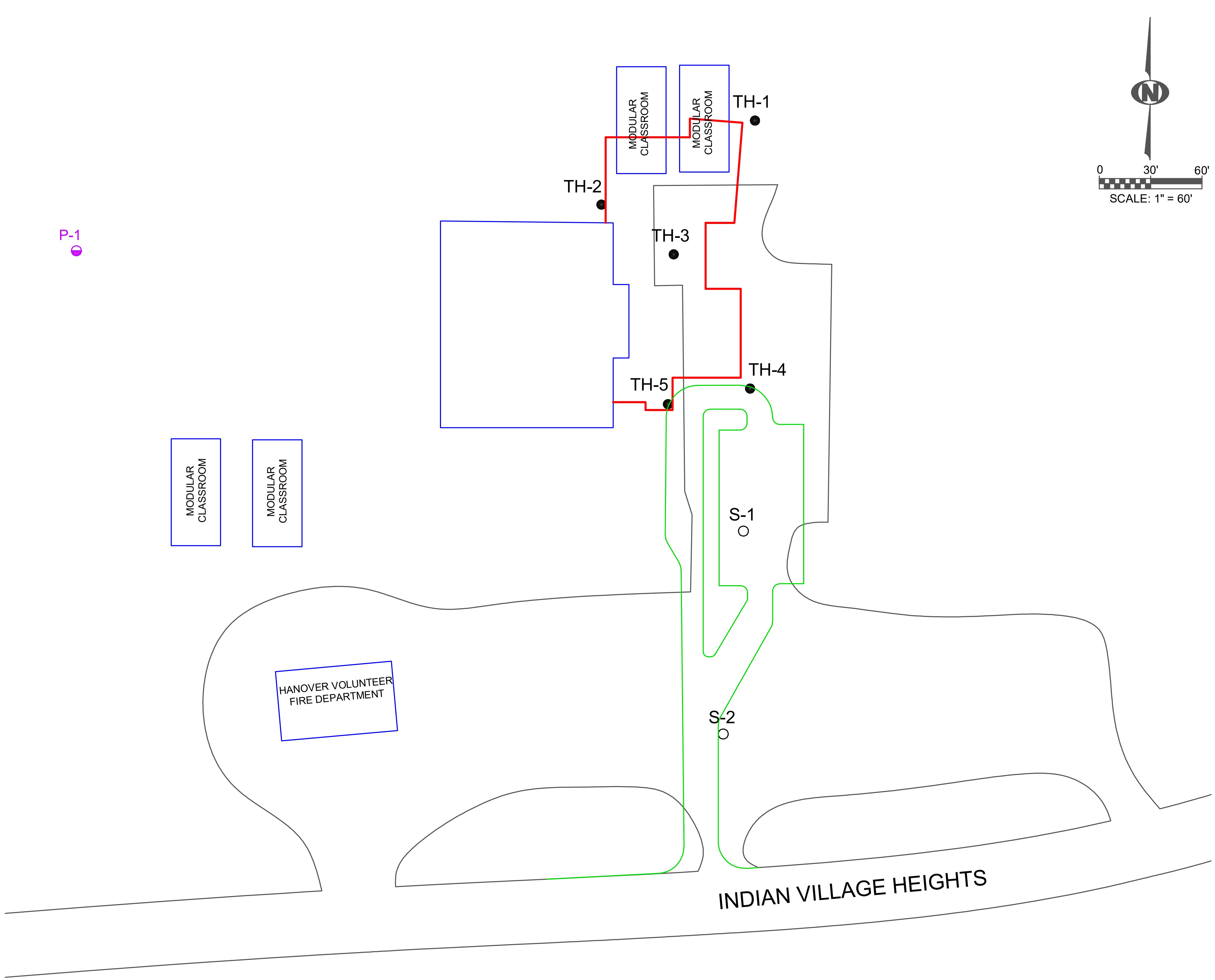
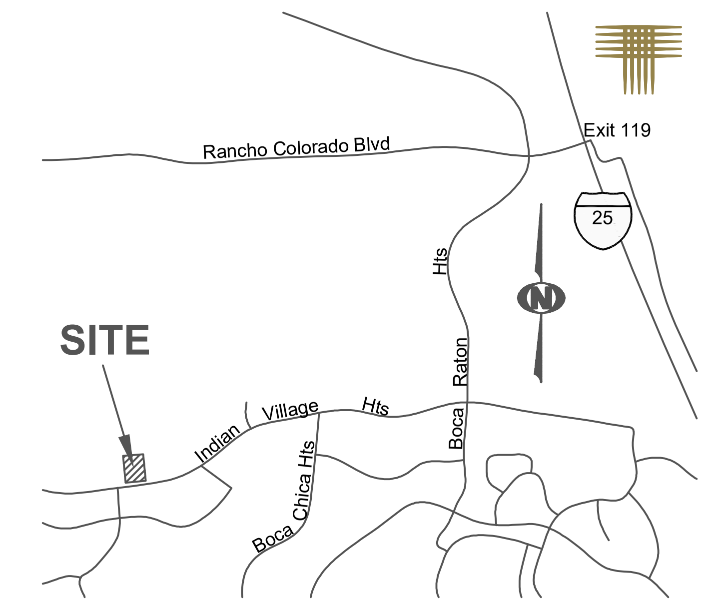




VICINITY MAP

(NOT TO SCALE)

LEGEND:

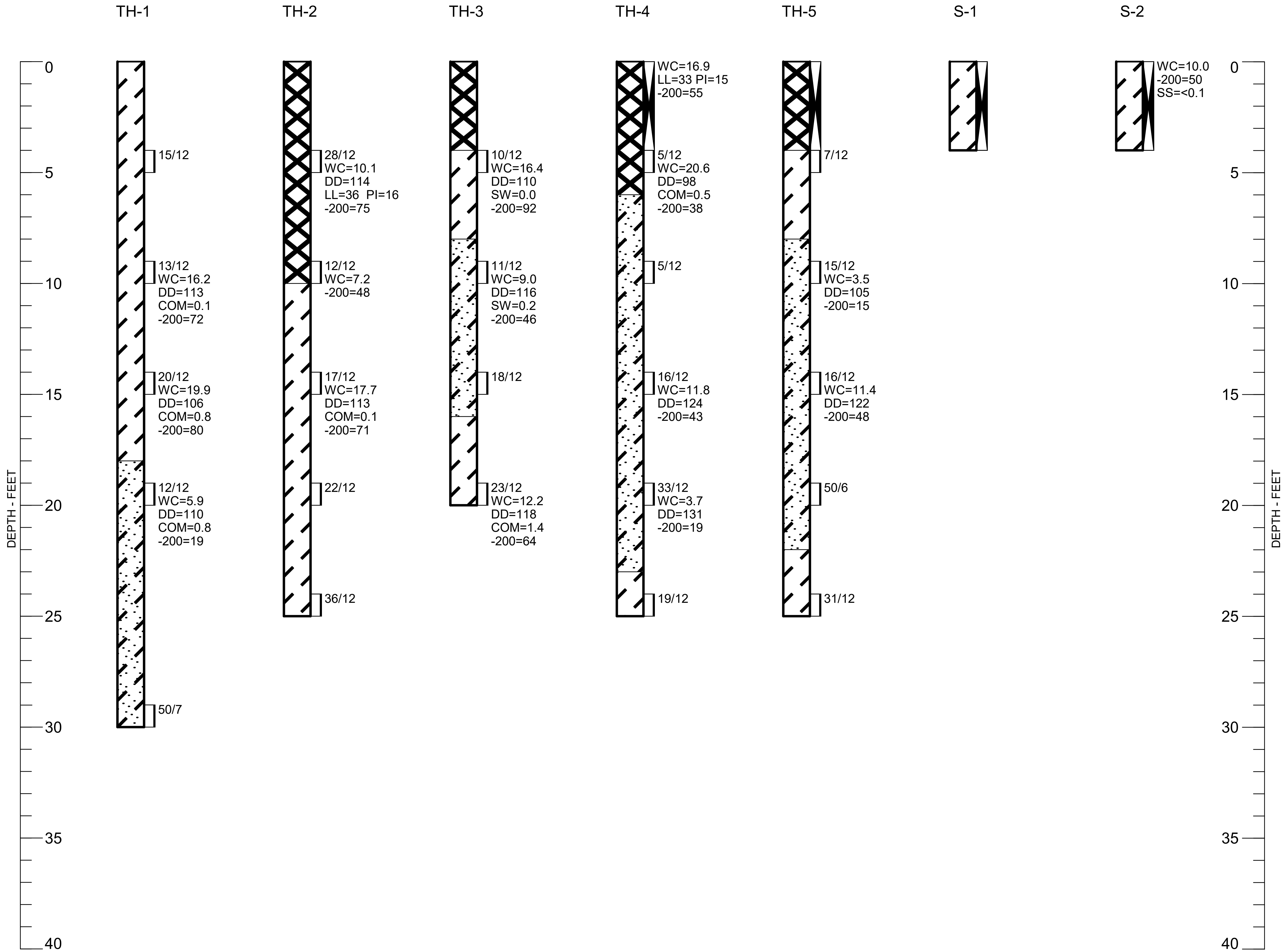
TH-1 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
S-1 ○	APPROXIMATE LOCATION OF SUBGRADE SAMPLE.
P-1 ◐	APPROXIMATE LOCATION OF PERCOLATION TEST.
(blue line)	LOCATION OF EXISTING BUILDING FOOTPRINT.
(red line)	LOCATION OF PROPOSED BUILDING ADDITION FOOTPRINT.
(gray line)	LOCATION OF EXISTING STREETS, PARKING LOT, AND DRIVE LANES.
(green line)	LOCATION OF PROPOSED PARKING LOT AND DRIVE LANES.

NOTE:
BASE DRAWING WAS PROVIDED BY NV5 (PREPARED BY MOA ARCHITECTURE, DATED OCTOBER 10, 2024).

HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
CTL|T PROJECT NO. CS19910.000-125

Location of Exploratory Borings

FIG. 1



LEGEND:

FILL, CLAY, SANDY TO VERY SANDY AND SAND, VERY CLAYEY, VERY STIFF (CLAY), SLIGHTLY GRAVELLY, MEDIUM DENSE (SAND), MOIST, BROWN.

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

SAND, CLAYEY TO VERY CLAYEY AND SILTY, SLIGHTLY GRAVELLY TO GRAVELLY, LOOSE TO VERY DENSE, LIGHT BROWN TO BROWN (SC, SM).

DRIVE SAMPLE. THE SYMBOL 15/12 INDICATES 15 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

INDICATES BULK SAMPLE OBTAINED FROM AUGER CUTTINGS.

NOTES:

1. THE BORINGS WERE DRILLED NOVEMBER 18, 2024 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-55, TRUCK-MOUNTED 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.
4. 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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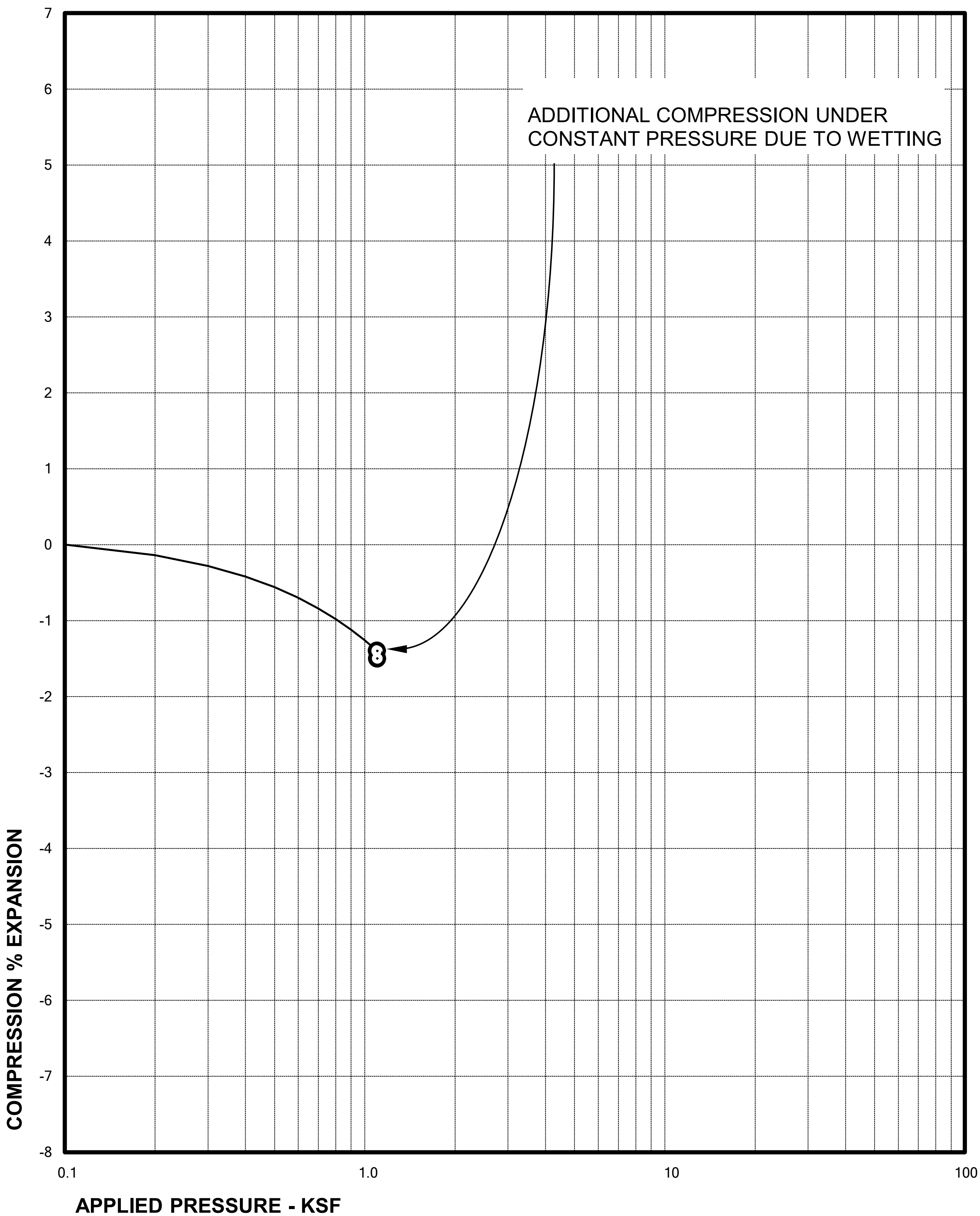
Summary Logs of Exploratory Borings

FIG. 2



Sample of CLAY, SANDY (CL)
From TH-1 AT 9 FEET

DRY UNIT WEIGHT= 113 PCF
MOISTURE CONTENT= 16.2 %

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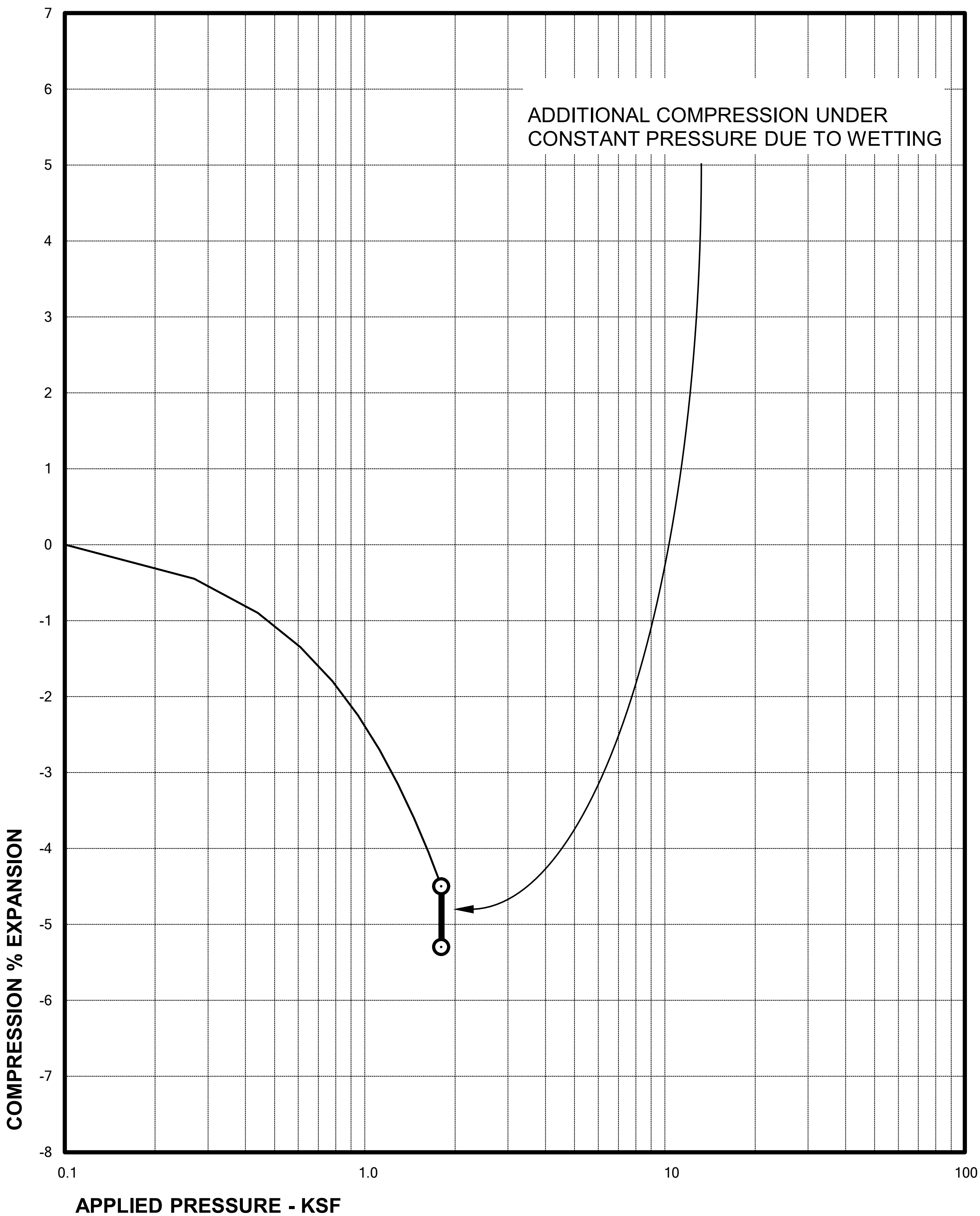
Swell Consolidation Test Results

FIG. 3



Sample of CLAY, SANDY (CL)
From TH-1 AT 14 FEET

DRY UNIT WEIGHT= 106 PCF
MOISTURE CONTENT= 19.9 %

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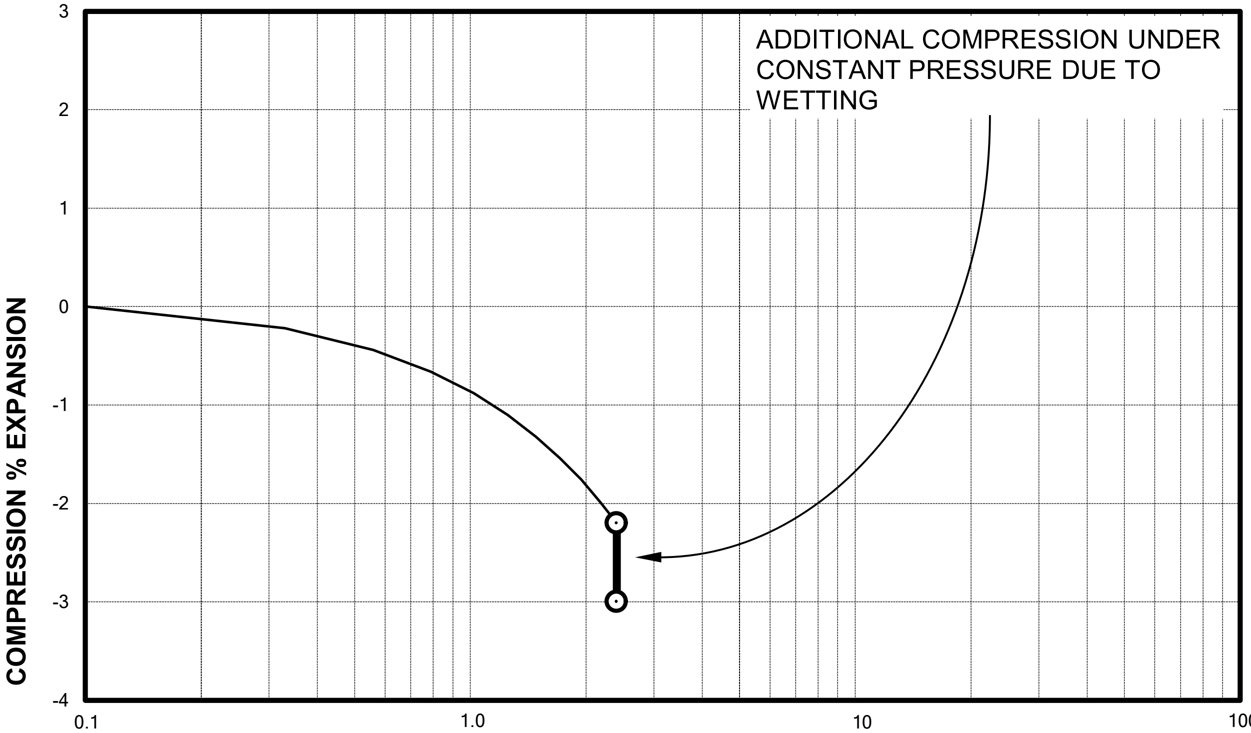
Swell Consolidation Test Results

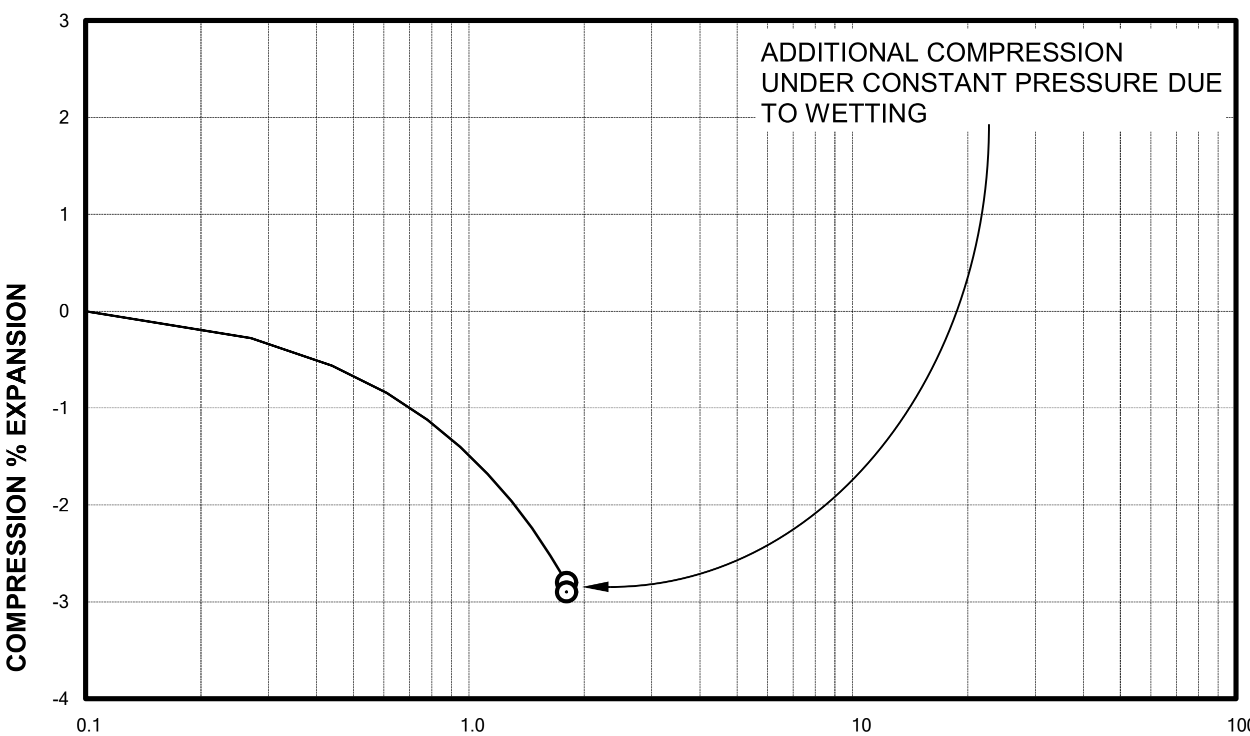
FIG. 4



APPLIED PRESSURE - KSF

Sample of SAND, SILTY (SM)
From TH-1 AT 19 FEET

DRY UNIT WEIGHT= 110 PCF
MOISTURE CONTENT= 5.9 %



APPLIED PRESSURE - KSF

Sample of CLAY, SANDY (CL)
From TH-2 AT 14 FEET

DRY UNIT WEIGHT= 113 PCF
MOISTURE CONTENT= 17.7 %

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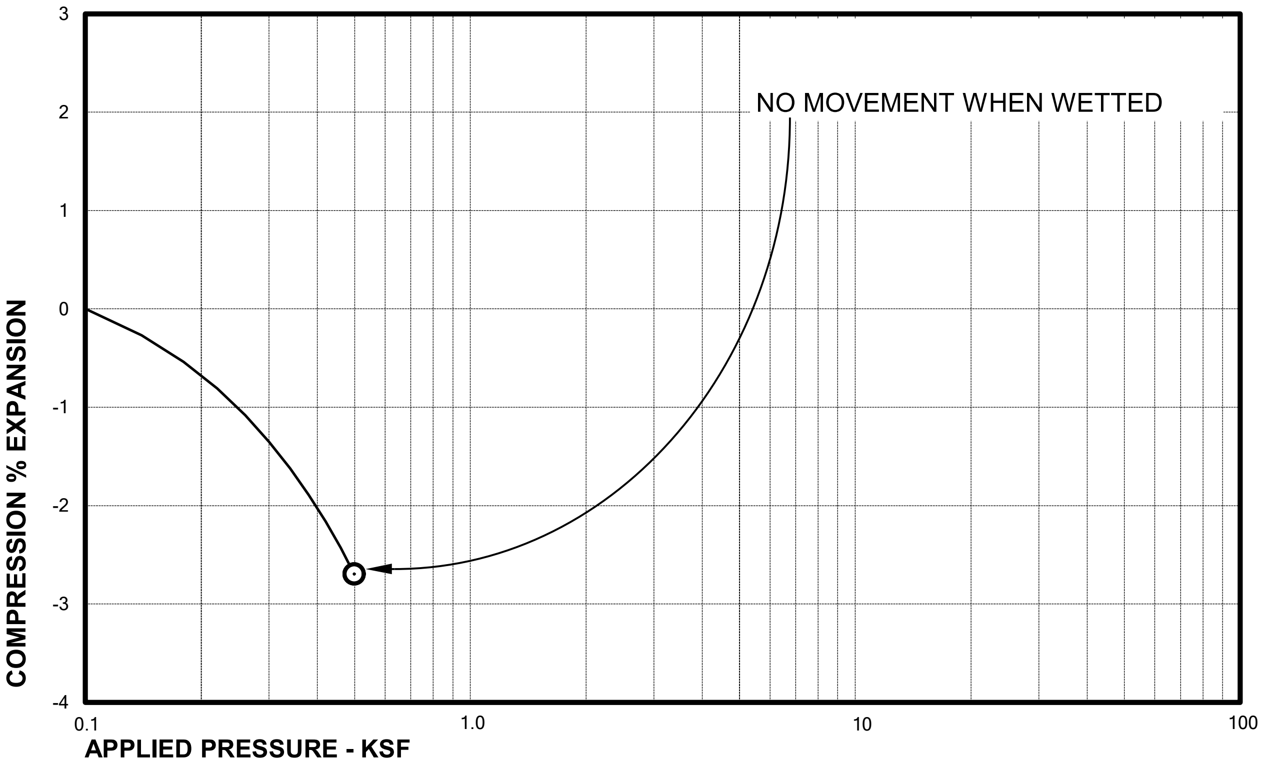
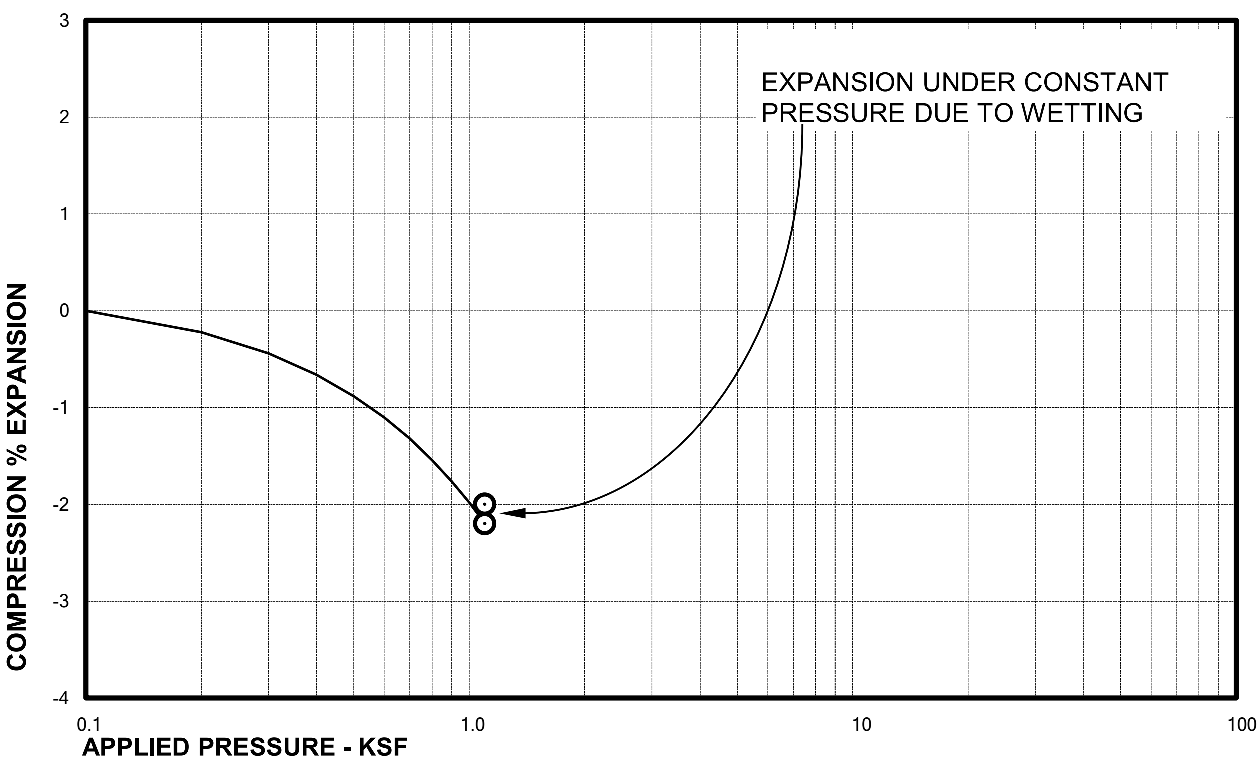
Swell Consolidation Test Results



Sample of	CLAY, SLIGHTLY SANDY (CL)	DRY UNIT WEIGHT=	110	PCF
From	TH-3 AT 4 FEET	MOISTURE CONTENT=	16.4	%



Sample of	SAND, VERY CLAYEY (SC)	DRY UNIT WEIGHT=	116	PCF
From	TH-3 AT 9 FEET	MOISTURE CONTENT=	9.0	%

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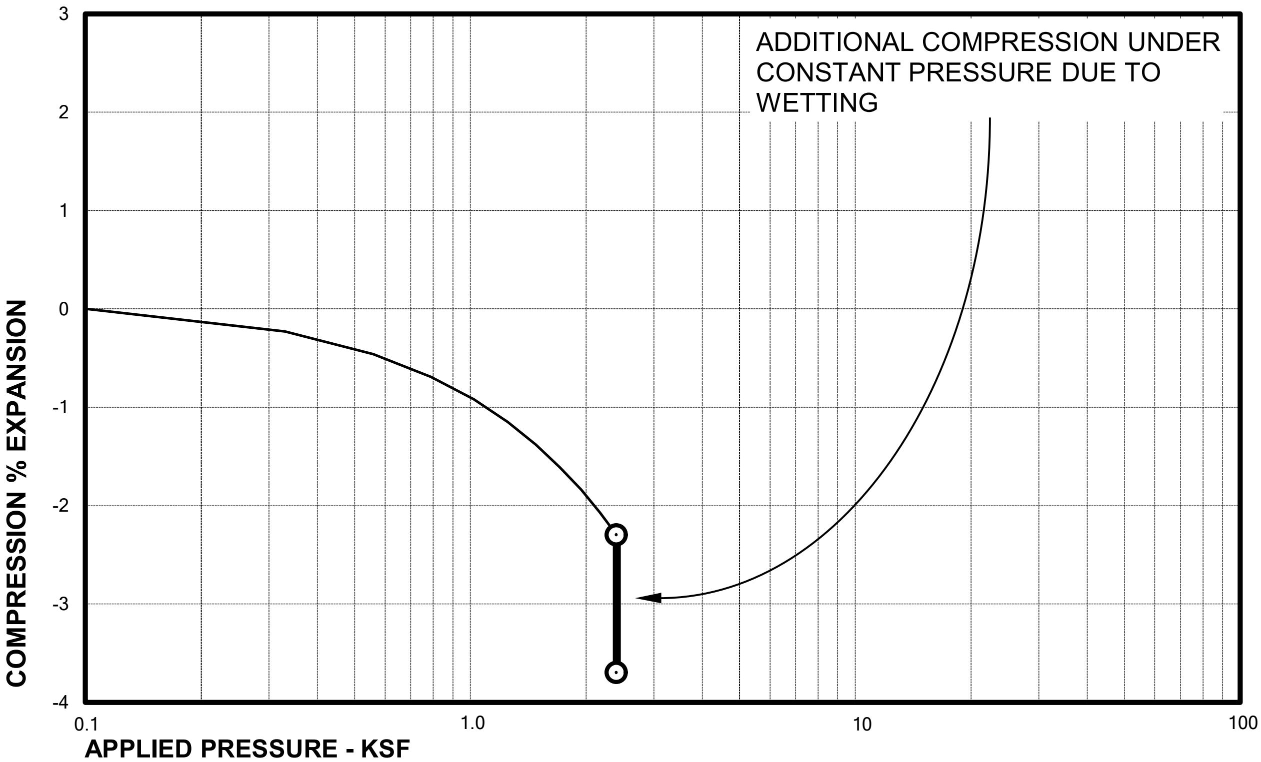
Swell Consolidation Test Results

FIG. 6

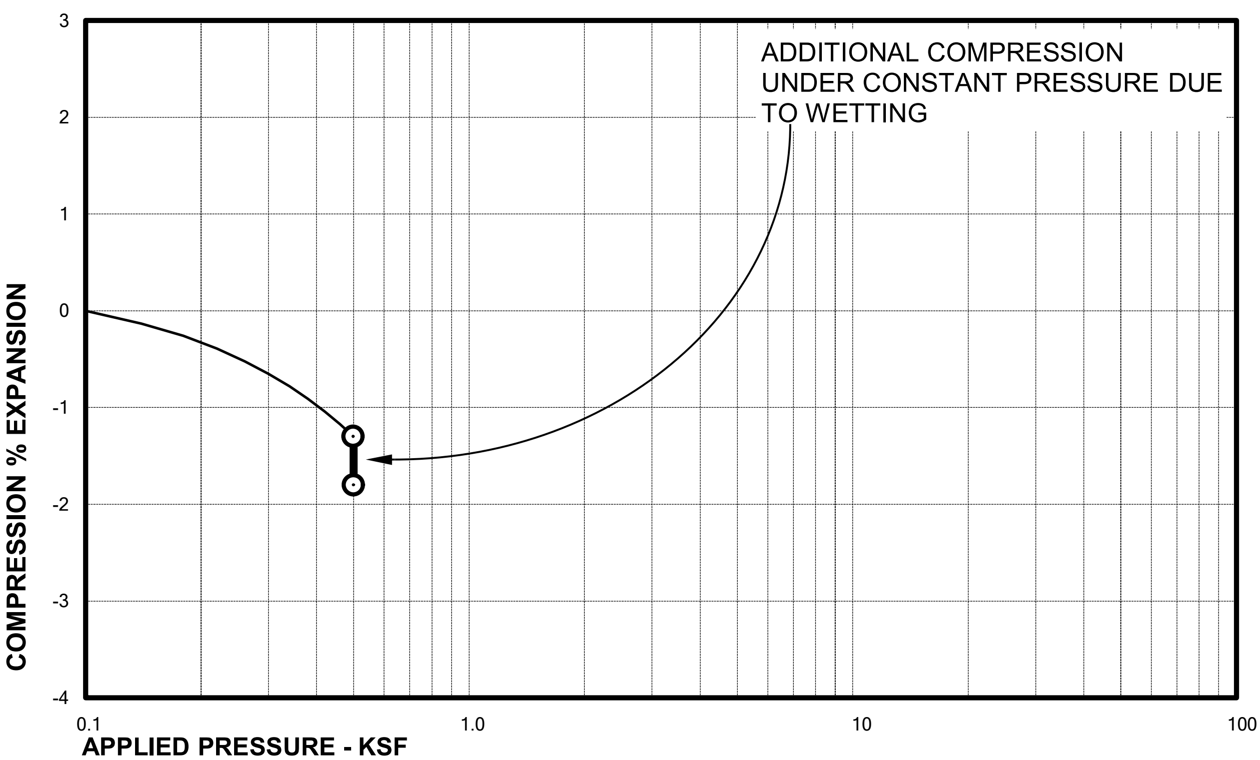


Sample of CLAY, VERY SANDY (CL)

From TH-3 AT 19 FEET

DRY UNIT WEIGHT= 118 PCF

MOISTURE CONTENT= 12.2 %



Sample of SAND, VERY CLAYEY (SC)

From TH-4 AT 4 FEET

DRY UNIT WEIGHT= 98 PCF

MOISTURE CONTENT= 20.6 %

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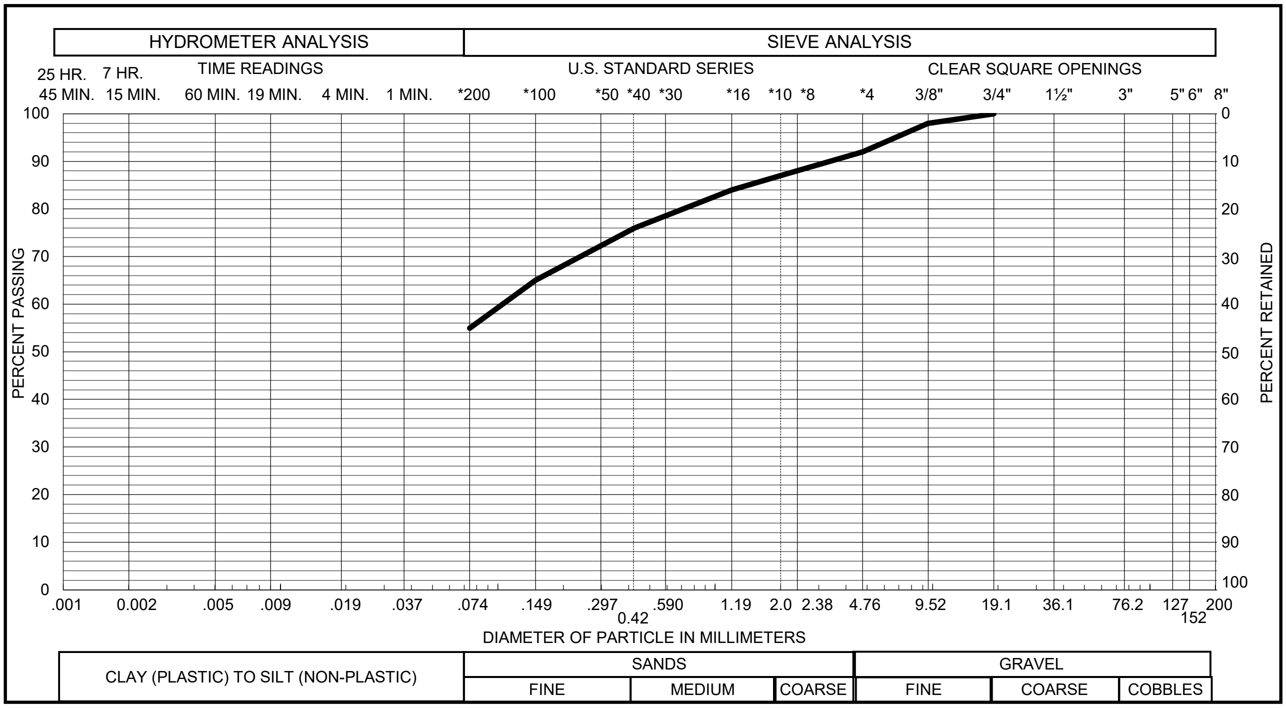
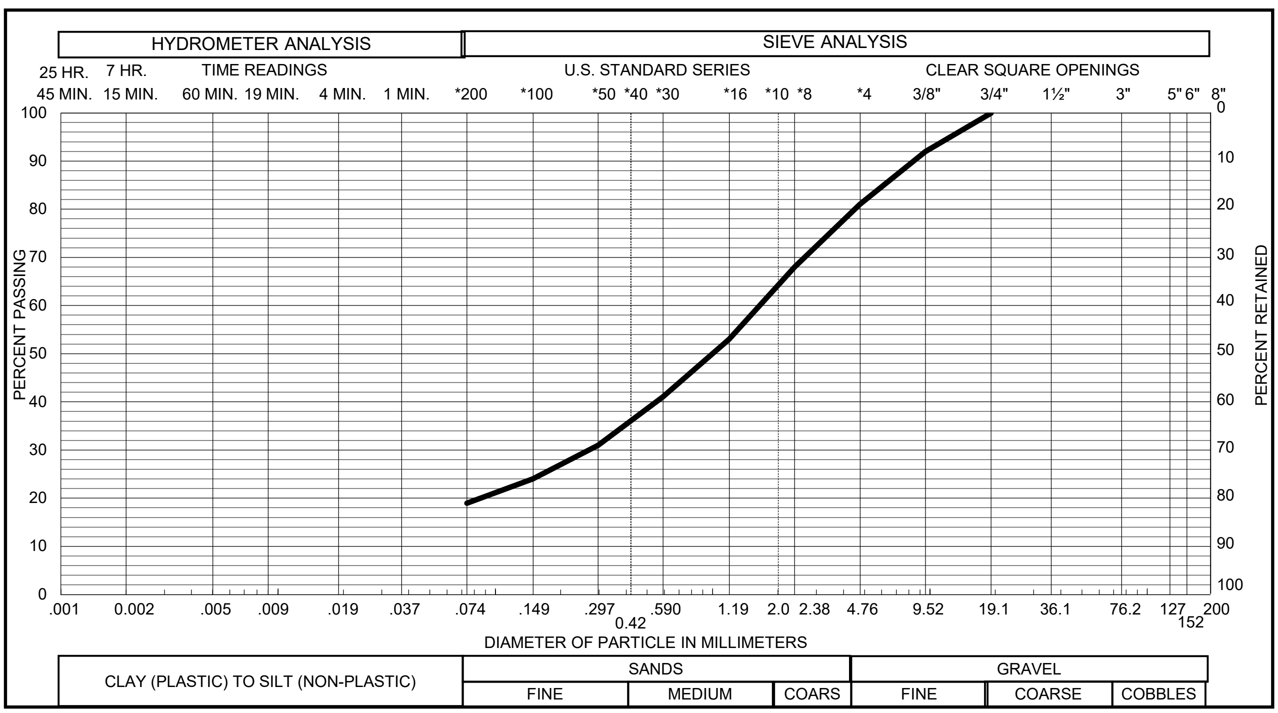
Swell Consolidation Test Results

FIG. 7



Sample of FILL, SAND, SILTY		GRAVEL 8 %	SAND 37 %
From TH - 4 AT 0 FEET		SILT & CLAY 55 %	LIQUID LIMIT 33
		PLASTICITY INDEX	15



Sample of SAND, SILTY (SM)		GRAVEL 19 %	SAND 62 %
From TH - 4 AT 19 FEET		SILT & CLAY 19 %	LIQUID LIMIT
		PLASTICITY INDEX	

HANOVER SCHOOL DISTRICT NO. 28
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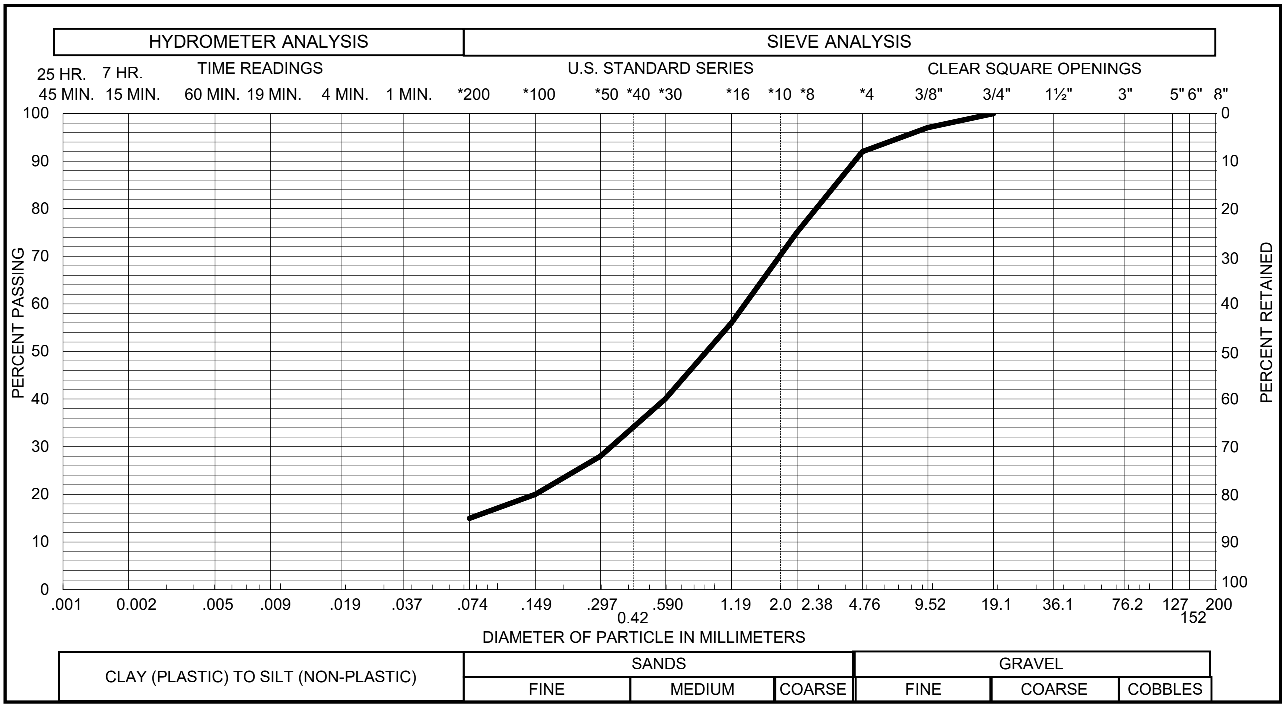
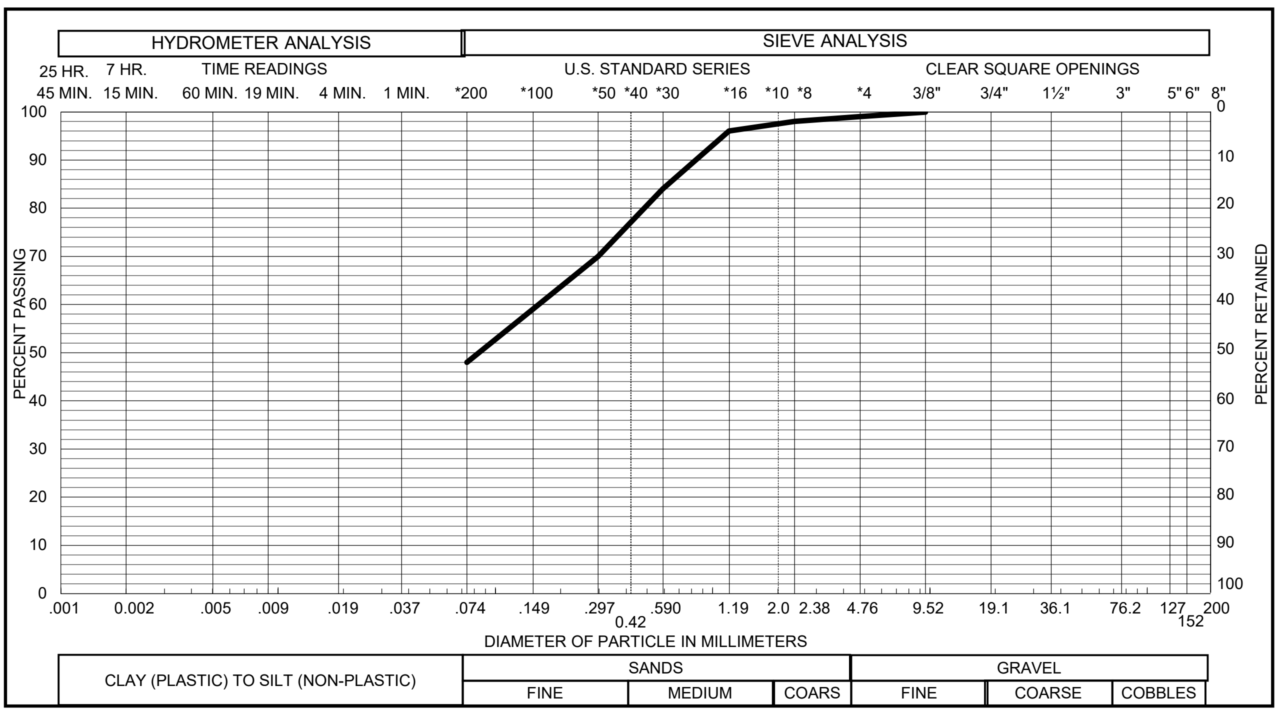
Gradation Test Results

FIG. 8



Sample of	SAND, SILTY (SM)	GRAVEL	8 %	SAND	77 %
From	TH - 5 AT 9 FEET	SILT & CLAY	15 %	LIQUID LIMIT	
		PLASTICITY INDEX			



Sample of	SAND, VERY CLAYEY (SC)	GRAVEL	1 %	SAND	51 %
From	TH - 5 AT 14 FEET	SILT & CLAY	48 %	LIQUID LIMIT	
		PLASTICITY INDEX			

HANOVER SCHOOL DISTRICT NO. 28
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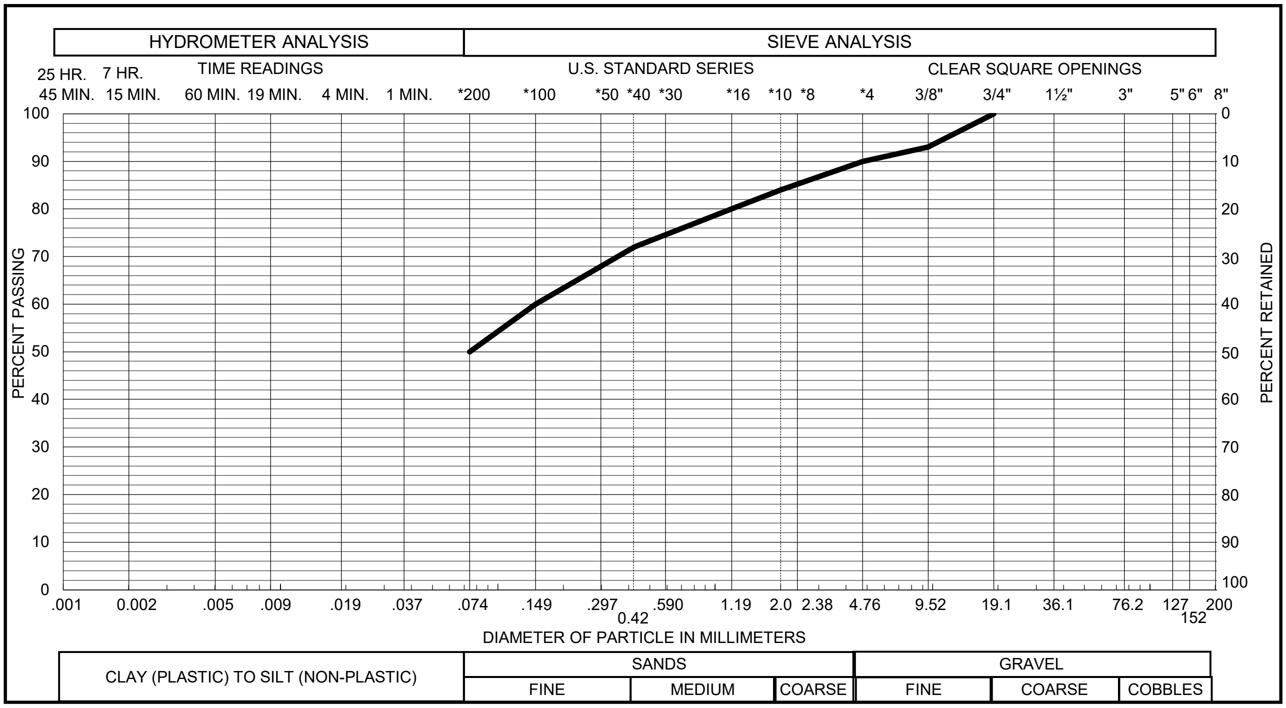
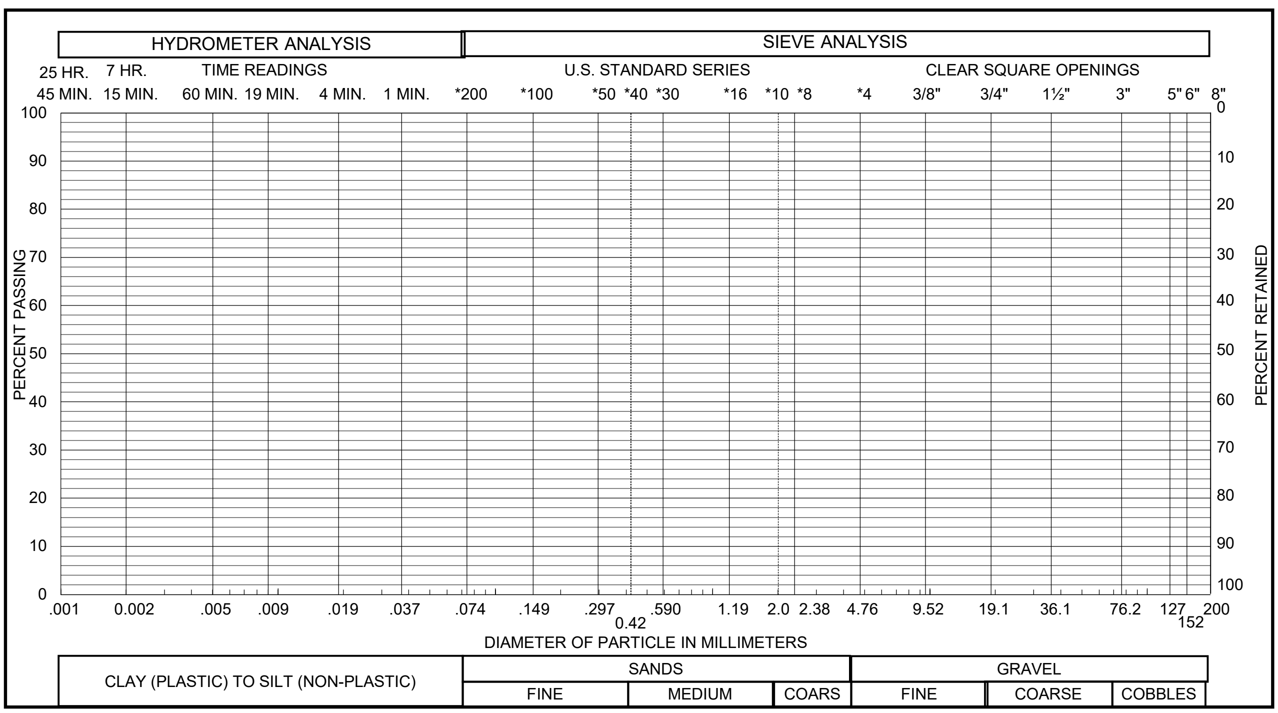
Gradation Test Results

FIG. 9



Sample of CLAY, VERY SANDY (CL)
From S - 2 AT 0 FEET

GRAVEL 10 % SAND 40 %
SILT & CLAY 50 % LIQUID LIMIT
PLASTICITY INDEX



Sample of
From

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

HANOVER SCHOOL DISTRICT NO. 28
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Gradation Test Results

FIG. 10

CTL | THOMPSON

PERCOLATION TEST DATA

Project: Prairie Heights Elementary School Addition
Location: 7930 Indina Village Heights
Pre-Soaked Date: November 18, 2024 **Time:** 1 PM

Project #: CS19910.000-125
Technician/Engineer: KD
Date of Test: November 19, 2024

Percolation Test Hole: 1
Depth of Hole: 36 inches **Pipe Length: 60 inches**

Time (hrs:min)	Time Interval (hrs:min)	Depth to Water* (in)	Change in Water Depth (in)	Perc. Rate (min/in)
10:28 AM	-------	28		
10:38 AM	0:10	29 1/2	1 1/2	7
10:48 AM	0:10	31	1 1/2	7
10:58 AM	0:10	32 1/8	1 1/8	9
11:08 AM	0:10	32 7/8	3/4	13
11:18 AM	0:10	33 5/8	3/4	13
11:28 AM	0:10	34 3/8	3/4	13

Rate = 10

Percolation Test Hole: 2
Depth of Hole: 36 inches **Pipe Length: 61 inches**

Time (hrs:min)	Time Interval (hrs:min)	Depth to Water* (in.)	Change in Water Depth (in)	Perc. Rate (min/in)
10:38 AM	-------	26 1/2		
10:48 AM	0:10	27 1/2	1	10
10:58 AM	0:10	28 3/8	7/8	11
11:08 AM	0:10	29 1/8	3/4	13
11:18 AM	0:10	29 7/8	3/4	13
11:28 AM	0:10	30 5/8	3/4	13

Rate = 12

Percolation Test Hole: 3
Depth of Hole: 36 inches **Pipe Length:59 inches**

Time (hrs:min)	Time Interval (hrs:min)	Depth to Water* (in.)	Change in Water Depth (in)	Perc. Rate (min/in)
12:12 PM	---------	26		
12:22 PM	0:10	27 3/4	1 3/4	6
12:32 PM	0:10	29 1/2	1 3/4	6
12:42 PM	0:10	31	1 1/2	7
12:52 PM	0:10	32 1/2	1 1/2	7
1:02 PM	0:10	34	1 1/2	7

Rate = 6

Average Calculated Percolation Rate = 10 min/in

*Note: The depth to water was measured from the top of pipe.

Fig. 11

TABLE I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19910.000-125

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT	PLASTICITY INDEX	SWELL TEST RESULTS* SWELL (%)	SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
TH-1	9	16.2	113			-0.1		72		CLAY, SANDY (CL)
TH-1	14	19.9	106			-0.8		80		CLAY, SANDY (CL)
TH-1	19	5.9	110			-0.8		19		SAND, SILTY (SM)
TH-2	4	10.1	114	36	16			75		FILL, CLAY, SANDY
TH-2	9	7.2						48		FILL, SAND, VERY CLAYEY
TH-2	14	17.7	113			-0.1		71		CLAY, SANDY (CL)
TH-3	4	16.4	110			0.0		92		CLAY, SLIGHTLY SANDY (CL)
TH-3	9	9.0	116			0.2		46		SAND, VERY CLAYEY (SC)
TH-3	19	12.2	118			-1.4		64		CLAY, VERY SANDY (CL)
TH-4	0	16.9		33	15			55		FILL, CLAY, VERY SANDY
TH-4	4	20.6	98			-0.5		38		SAND, VERY CLAYEY (SC)
TH-4	14	11.8	124					43		SAND, VERY CLAYEY (SC)
TH-4	19	3.7	131					19		SAND, SILTY (SM)
TH-5	9	3.5	105					15		SAND, SILTY (SM)
TH-5	14	11.4	122					48		SAND, VERY CLAYEY (SC)
S-2	0	10.0						50	<0.1	CLAY, VERY SANDY (CL)
P-1	4	7.7	106	27	11			64		CLAY, VERY SANDY (CL)

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