CTL | THOMPSON
INCORPORATED

GEOTECHNICAL INVESTIGATION
FRISCO TRANSFER CENTER
1010 MEADOW DRIVE
FRISCO, COLORADO

Prepared For:

Board of County Commissioners of
Summit County
0037 Peak One Drive
Frisco, Colorado 80443

Project No. SU01150-125

November 19, 2015

1790 Airport Road, Unit 2, Breckenridge, Colorado 80424
Telephone: 970-453-2047 www.ctlthompson.com

TABLE OF CONTENTS

SCOPE 1

SITE CONDITIONS 1

PROPOSED CONSTRUCTION 2

SUBSURFACE CONDITIONS 2

GEOLOGIC HAZARDS 3

SITE EARTHWORK 3
- **Structural Fill** 4

FOUNDATIONS 5

FLOOR SYSTEM AND SLABS-ON-GRADE 5

FOUNDATION WALLS 6
- **Foundation Wall Backfill** 7

SUBSURFACE DRAINAGE 7

CONCRETE 8

PAVEMENT SECTION THICKNESS 8
- **Subgrade Preparation and Aggregate Base Course** 9
- **Asphalt Pavement** 10
- **Concrete Pavement** 10

SURFACE DRAINAGE 10
- **Building Areas** 10
- **Pavement Areas** 11

CONSTRUCTION OBSERVATIONS 11

GEOTECHNICAL RISK 12

LIMITATIONS 12

FIGURE 1 – VICINITY MAP

FIGURE 2 – LOCATIONS OF EXPLORATORY PITS/BORINGS

FIGURE 3 – SUMMARY LOGS OF EXPLORATORY PITS/BORINGS

FIGURE 4 – LEGEND AND NOTES

FIGURE 5 – SWELL CONSOLIDATION TEST RESULTS

FIGURE 6 – PROCTOR TEST RESULTS

FIGURES 7 thru 13 – GRADATION TEST RESULTS

FIGURE 14 – TYPICAL EXTERIOR FOUNDATION WALL DRAIN DETAIL

TABLE I – LABORATORY TEST RESULTS

TABLE 2 – PERCOLATION TEST DATA

SCOPE

This report presents the results of our geotechnical investigation for the proposed improvements and redevelopment to the Frisco Transfer Center in Frisco, Colorado. We conducted this investigation to evaluate subsurface conditions and provide geotechnical engineering recommendations for the proposed structures and new pavement. Our report was prepared from data developed during our field exploration, engineering analysis, and experience in the area. This report includes a description of the subsurface conditions observed in exploratory test borings/pits and presents geotechnical engineering recommendations for thickness of new pavement, building foundations and floor system, and percolation data for the proposed detention pond. The scope was described in an On-Call Service Agreement (SU-15-0108) dated March 11, 2015 and Task Order Number ST15-01-G dated September 23, 2015.

Recommendations contained in this report were developed based on our understanding of the planned construction thus far. The proposed redevelopment is in the conceptual phase at the time of this report. Once building plans are finalized, we should be informed so that we can determine whether adjustments need to be made to our recommendations and design criteria. Our conclusions are presented below.

SITE CONDITIONS

The Frisco Transfer Center consists of a Lobby building, bus lane and loading platform, paved parking, shade structures, detention pond, and greenhouses. The Lobby building is a one story 2,178 square foot structure located in the central-western portion of the site. The bus lane, shade structures, and pedestrian platforms are on the west side of the site. Pedestrian platforms consist of concrete flatwork. The bus drive lane is constructed with asphalt, and the loading platform is concrete. Paved asphalt parking is located in the center of the site with paved walkways and recreation paths traversing the site in multiple locations. The southeast side of the site is used for storm water detention and has a predominantly grassy ground covering. Partially erected greenhouse structures, surrounded by a grassy and gravelly ground surface, occupy the northern portion of the site.

Topography is mostly flat with a gentle regional slope to the east. The detention pond represents the low point of the site, and a small mound exists in the area of the Lobby building. The site is bordered to the west by new construction and a shopping plaza. Meadow Drive and the Safeway/Walmart Shopping Center boarder the site to the east. To the north is Lusher Court, and

to the south is Meadow Creek Park.

PROPOSED CONSTRUCTION

The proposed redevelopment is in the conceptual phase at the time of this report. As we understand it, the existing lobby building may be demolished and replaced or be left in place with a new enclosed structures north and east of the existing building. These structures will most likely be connected to a hard surfaced outdoor plaza. An east-west access road will be added south of the existing structure. The bus lane, loading platform, and parking lot will most likely be repaved and expanded in areas. The detention pond will be improved in its present location. The open space area on the southwest portion of the site, and the northern portion of the site will be reserved for possible future development. Proposed building elevations and design loads are not known at the time of this report. Once this information is available, we should be contacted reevaluate our recommendations.

SUBSURFACE CONDITIONS

Our field investigation consisted of drilling three exploratory borings and excavation of three test pits. Approximate locations of the exploratory borings and test pits are shown on Figure 2. The borings were advanced using a truck-mounted drill rig and 4-inch diameter, continuous-flight solid-stem auger. The pits were excavated with a track-mounted mini excavator. Our representative observed drilling/excavation operations, logged the soils encountered, and obtained samples. Summary logs of the soils encountered and results of field penetration resistance tests are shown on Figure 3.

The subsurface conditions encountered where somewhat variable. In all of the borings/pits, with the exception to the detention pond area, we encountered 3 to 5 feet of man-placed fill. The fill consisted of sandy gravel to gravelly sand with variable amounts of clay. Within the fill soil, some debris and organic materials such as wood and refuse were observed in the pits. Beneath the fill, in the northern portion of the site (TH-1 and TP-1), we encountered a very moist clay to a depth of 7 to 7.5 feet below existing grade. The clay was medium stiff and contained organic layers of decomposed topsoil. Beneath the clay we encountered natural sandy gravel. In TP-2, south of the existing lobby, we encountered natural sandy gravel at a depth of 4 feet. In the area of the detention pond (TH-3 and TP-3), we encountered 12 to 24 inches of topsoil overlying natural sandy gravel to gravelly sand. Boulders up to 2.5 feet where observed in the topsoil layer. TH-2, which was drilled in the parking area, had approximately 5 inches of asphalt overlying the sandy gravel fill.

No free water was encountered in the test holes or pits at the time of drilling/excavation. We placed hand-slotted PVC pipes in TH-1 and TH-3 after drilling to measure water levels. No free water was observed in either test holes when checked 20 days after drilling. The PVC pipes where left in place for future monitoring.

Samples obtained in the field were returned to our laboratory where field classifications were checked and samples were selected for pertinent testing. Results of swell consolidation testing conducted on the clay soils are shown on Figure 5. Proctor Test results of the Fill soil are shown on Figure 6. Results of gradation testing conducted on the fill and natural gravel/sand soils are shown on Figures 7 through 13. Laboratory test results are summarized on Table I.

A percolation (perc) test was conducted on November 1, 2015 in the detention pond area. See Figure 1 for the perc test hole location (labeled P-1). The perc hole was hand-dug 8 inches in diameter and 10 inches deep. The top of the perc hole was 2.5 feet below existing ground surface. The top of the perc hole was in natural gravelly sand soil, approximately 6 inches below the bottom of the topsoil layer. The perc hole was presoaked 24 hours prior to the perc test. The last 30 minute interval of a 4 hour test produced a perc rate of 79 minutes per inch. The results of the percolation data are presented in Table 2.

GEOLOGIC HAZARDS

We reviewed the following geologic mapping showing the site.

1. Geologic Map of the Frisco Quadrangle, Summit County, Colorado, (Map MF-2340) by Karl S. Kellogg, Paul J Bartos and Cindy L. Williams with the U.S. Geologic Survey, 2002.

Surface materials mapped at the project site location include alluvial glacial outwash of the Pinedale period consisting of sand to boulder-sized clasts. Our field investigation and observation at the site support the mapping.

SITE EARTHWORK

Due to the presence of debris and organic material in the man-placed fill and the unknown placement characteristics of the fill, the fill is not suitable to support building foundations in its present condition. The clay soil encountered in the northern portion of the site is also not suitable to support building foundations. Building foundations and floor slabs should be placed on natural sand and gravel soils or properly compacted structural fill after the removal of all existing fill and clay soils. In TH-1 and TP-1 we encountered clay soil to a depth of as much as 7.5 feet below existing

ground surface. If buildings are to be constructed in this area, the cost to remove the clay soils should be considered. Once construction plans are finalized we should be consulted to reevaluate our recommendations. We should also observe any excavations to confirm whether subsurface conditions are as anticipated.

We anticipate excavation of the soils can be accomplished using conventional, heavy duty excavating equipment. Sides of excavations need to be sloped to meet local, state and federal safety regulations. The soils will likely classify as Type C (sand and gravel) soils based on OSHA standards governing excavations. Temporary slopes deeper than 4 feet that are not retained should be no steeper than 1.5 to 1 (horizontal to vertical) in Type C soils. Excavations may encounter cobbles and boulders. Contractors should identify the soils encountered and ensure that applicable standards are met. Contractors are responsible for site safety and maintenance of the work site.

No free water was encountered during our field exploration. However, seepage may be encountered during excavation, particularly during late spring and early summer. The footing areas should be protected from the seepage through the use of shallow trenches and sumps. Excavations should be sloped to a gravity discharge or to a temporary sump where water can be removed by pumping, if necessary.

Structural Fill

Structural fill will likely be required to backfill excavations resulting from the removal of the existing man-placed fill and clay soils. We anticipate that most of the existing fill and the natural sand and gravel soils, free of organic matter, debris, and rocks larger than about 6 inches in diameter, can be used as structural fill. Care should be taken during fill placement so the larger rocks do not become nested (grouped together). If required, import fill should consist of a CDOT Class 6 aggregate base course or similar soil. Lean-mix concrete (flowable fill) could also be used to fill voids.

Structural fill beneath footing areas should be placed in loose lifts of 8 inches thick or less, moisture conditioned to within 3 percent of optimum moisture content, and compacted to at least 98 percent of ASTM D 698 maximum dry density. Fill beneath interior slab areas should be compacted to at least 95 percent. Moisture content and density of structural fill should be checked by a representative of our firm during placement.

FOUNDATIONS

We recommend that site structures be supported on footing foundations supported on the undisturbed, natural sand and gravel soil or properly compacted fill. Prior to concrete placement, the footing areas should be moistened and compacted to provide a flat and level subgrade. Loose and disturbed soils should be removed or compacted. Structural fill should meet the criteria in the Structural Fill section. Our representative should observe conditions exposed in the completed foundation excavations to confirm whether the exposed soils are as anticipated and suitable for support of the foundation as designed. Structural fill should be checked for proper moisture content and density during placement.

1. Structures can be supported by footing foundations supported on the undisturbed, natural sand and gravel soil or compacted fill. Soils loosened during the forming process for the footings should be removed or re-compacted prior to placing concrete.

2. Footings can be sized using a maximum allowable soil pressure of 3,000 psf.

3. Continuous wall footings should have a minimum width of at least 16 inches. Foundations for isolated columns should have minimum dimensions of 24 inches by 24 inches.

4. Grade beams and foundation walls should be well reinforced, top and bottom, to span undisclosed loose or soft soil pockets and resist lateral earth pressures. We recommend reinforcement sufficient to span an unsupported distance of at least 10 feet. Reinforcement should be designed by the structural engineer.

5. The soils under exterior footings should be protected from freezing. We recommend the bottom of footings be constructed at a depth of at least 40 inches below finished exterior grades.

FLOOR SYSTEM AND SLABS-ON-GRADE

We assume most building floors will be slab-on-grade. Based on our laboratory test data and experience, we judge slab-on-grade construction supported by the undisturbed, natural sand and gravel or properly placed granular structural fill will have a low risk of damaging differential movement. Removal of boulders from the excavation may require that a leveling course of granular material be placed to achieve a flat and level subgrade. Fill placed to attain subgrade elevations below floor slabs should be placed in accordance with the recommendations outlined in Structural Fill. We recommend the following precautions for slab-on-grade construction at this site. These precautions will not prevent movement from occurring; they tend to reduce damage if slab movement occurs.

1. Slabs should be separated from exterior walls and interior bearing members with slip joints which allow free vertical movement of the slabs.

2. Underslab plumbing should be pressure tested for leaks before the slabs are constructed. Plumbing and utilities which pass through slabs should be isolated from the slabs with sleeves and provided with flexible couplings.

3. Frequent control joints should be provided, in accordance with American Concrete Institute (ACI) recommendations, to reduce problems associated with shrinkage and curling.

4. The 2012 International Building Code states that a 4-inch base course layer consisting of clean graded sand, gravel, crushed stone or crushed blast furnace slag shall be placed beneath grade floors (unless the underlying soils are free-draining), along with a vapor retarder. We recommend a minimum 4-inch layer of clean gravel (1½ inch maximum diameter). The underslab gravel should be compacted with a vibratory plate prior to concrete placement.

   IBC states that the vapor retarder can be omitted where approved by the building official. 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 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. 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 3.2.3 of the 2006 American Concrete Institute (ACI) Committee 302, "Guide for Concrete Floor and Slab Construction (ACI 302.R-96)".

FOUNDATION WALLS

Foundation walls which extend below-grade should be designed for lateral earth pressures where backfill is not present to about the same extent on both sides of the wall. Many factors affect the values of the design lateral earth pressure. These factors include, but are not limited to, the type, compaction, slope and drainage of the backfill, and the rigidity of the wall against rotation and deflection. For a very rigid wall where negligible or very little deflection will occur, an "at-rest" lateral earth pressure should be used in design. For walls that can deflect or rotate 0.5 to 1 percent of wall height (depending upon the backfill types), lower "active" lateral earth pressures are appropriate. Our experience indicates typical below-grade walls deflect or rotate slightly under normal design loads, and that this deflection results in satisfactory wall performance. Thus, the earth pressures on the walls will likely be between the "active" and "at-rest" conditions.

If on-site sand and gravel soils are used as backfill and the backfill is not saturated, we rec-

ommend design of basement walls at this site using an equivalent fluid density of at least 55 pcf. A passive earth pressure of 300 pcf can be used to calculate resistance from sliding for permanent embedment depths. These pressures do not include allowances for sloping backfill or hydrostatic pressures. These values assume deflection; some minor cracking of walls may occur. If very little wall deflection is desired, a higher design value is appropriate. The structural engineer should also consider site-specific grade restrictions, the effects of large openings on the behavior of the walls, and the need for lateral bracing during backfill.

Foundation Wall Backfill

Proper placement and compaction of foundation backfill is important to reduce infiltration of surface water and settlement of backfill. The on-site sand and gravel soils can be used as backfill, provided the foundation walls are designed appropriately. The backfill should be free of rocks larger than about 6-inches in diameter, organics, existing building components and debris. The upper 2 feet of fill should be a relatively impervious material to limit infiltration. Backfill should be placed in loose lifts of approximately 8 inches thick or less, moisture conditioned to within 3 percent of optimum moisture content, and compacted. Thickness of lifts will likely need to be about 6 inches if there are small confined areas of backfill, which limit the size and weight of compaction equipment. The backfill which will support surface improvements should be compacted to at least 98 percent of maximum standard Proctor dry density (ASTM D 698). Backfill in landscape areas should be compacted to at least 90 percent of maximum standard Proctor dry density. Moisture content and density of the backfill should be checked during placement by a representative of our firm. Observation of the compaction procedure is necessary. Testing without observation can lead to undesirable performance.

SUBSURFACE DRAINAGE

Water from precipitation, snowmelt, and surface irrigation frequently flows through relatively permeable backfill placed adjacent to a building, and collects on the surface of less permeable soils occurring at the bottom of basement or foundation excavations. Perched groundwater levels can also enter the backfill zone. This process can cause wet or moist conditions in the below grade levels after construction. To reduce the likelihood water pressure will develop outside foundation walls and the risk of accumulation of water at the lower level, we recommend provision of a foundation drain. The drain should be installed along the entire building perimeter that is below grade. The provision of a drain will not eliminate slab movement or prevent moist conditions in on the interior of the building. The drain should consist of a 4-inch diameter, perforated or slotted pipe encased in free-draining gravel, and a geocomposite drain board or clean gravel layer extending to

within 2 feet of exterior grade, adjacent to the walls. The drain should lead to a positive gravity outlet or sump where water can be removed by pumping. Sump pumps and gravity outlet locations must be maintained. A typical foundation drain detail for basement construction is presented on Figure 14.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. Our experience in the area indicates there are no special requirements for sulfate resistance. Superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are likely relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious materials ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high water tables. Concrete should have a total air content of 6 percent ± 1.5 percent. We advocate all foundation walls and grade beams in contact with the subsoils be damp-proofed.

PAVEMENT SECTION THICKNESS

The natural gravel soils encountered in our exploratory borings/pits are judged to be a very good support for pavement. The existing fill soils are judged to be a fair support for pavement. The clay soils encountered in TH-1 and TP-1 are not judged suitable and should be removed beneath new pavements if they are encountered within 2 feet of the pavement subgrade. Additional pothole exploration will be required to determine this, if this area is to be paved in the future. Due to the extent of the clay layer (7.5 feet below existing grade) it may not be feasible or practical to remove all the clay. It may be necessary to removed the upper 2 to 3 feet, stabilize with geogrid reinforcement and place structural fill above to bridge the soft clay. The depth of the overexcavation should be determined at the time of construction based on the depth and lateral extent of the unsuitable soils. For bidding purposes, we suggest a sub-excavation depth of 3 feet and two layers of geogrid reinforcement.

Our recommendations assume a properly prepared subgrade and drained conditions. The collection and diversion of surface water away from paved areas is extremely important to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from the paved areas and prevent wetting of the subgrade soils. Frost susceptible soils (with high levels of silt and/or clay) can be problematic if there is a free water source and heaving can occur. The onsite soils encountered are predominantly sand and gravel and the frost susceptibility is generally low. Our recommendations for pavement section thickness are given below:

1. New portland cement concrete pavements for bus drive and parking lanes should have a minimum thickness of 9 inches over 6 inches of aggregate base course. New asphalt pavement for bus drive lanes should have a minimum thickness of 9 inches of asphalt over 6 inches of aggregate base course. These values are based on bus traffic data provided Summit Stage (112 bus trips per day).

2. Other areas of concentrated truck traffic and turning movements such as areas in front of dumpsters should consist of at least 6 inches of portland cement concrete over 6 inches of aggregate base course. Steel-reinforcement can be added to the pavement to lengthen design life and reduce differential movement. We believe a reasonable reinforcement section for this type of project is a single mat of No. 4 re-bar at a spacing of 24 to 36 inches each way (mid height of slab).

3. New asphalt pavements in parking areas and access roads should have a minimum thickness of 5 inches over 6 inches of aggregate base course. This value assumes traffic will primarily consist of vehicular traffic with about 5 percent truck and bus traffic.

4. These pavement thickness recommendations do not consider construction traffic loads. Consideration should be given to staging asphalt and/or concrete placement to prevent damage by excessive construction equipment loads.

Subgrade Preparation and Aggregate Base Course

Once the existing pavement and topsoil is removed, the subgrade should be scarified to a depth of at least 8 inches and recompacted. Prior to placement of new aggregate base course, the completed pavement subgrade should be proof-rolled with a fully loaded tandem dump truck with a gross weight of at least 50,000 pounds. Areas which deform excessively should be removed and replaced with structural fill to achieve a stable subgrade prior to placing pavement materials. The depth of sub-excavations should be determined on a case by case basis at the time of construction. Normally, sub-excavations to stabilize subgrade are 1 to 3 feet in depth. In some cases, geogrid reinforcement can be used to reduce sub-excavation depths. Structural fill placed beneath pavements, such as utility trench backfill and embankment fill, should consist of the onsite sand and gravel soils devoid of vegetation, topsoil and rocks larger than 6 inches in diameter. Imported material should be a relatively well-graded granular material consisting primarily of gravel and sand with less than 15 percent passing the No. 200 Sieve and no rocks larger than 6 inches in diameter. CDOT Class 5 or 6 aggregate base course is a suitable imported structural fill.

We consider the use of the existing aggregate base course (if present) a reasonable way to be economical. However, it is important that rocks larger than 1.5 inches do not exist at the subgrade level. Larger rocks at or near the bottom of pavement can cause point loading and cracking of the pavement. We should evaluate the existing aggregate base course at the time of construction. New aggregate base course should have a minimum 'R' value of 84 and meet CDOT Class 5 or 6 gradation specifications. The subgrade and aggregate base course should be compacted to at

least 98% of the maximum Standard Proctor (ASTM D-698) dry density at a moisture content within 2% of optimum.

Asphalt Pavement

The asphalt should consist of a mixture of aggregate, filler and asphalt cement. The asphalt mixture should meet the Summit County or Colorado Department of Transportation (CDOT) grading requirements for an asphalt mix. The asphalt should be a batched hot mix, approved by the engineer, and placed and compacted to a density of 92% to 96% of the maximum theoretical density, determined according to Colorado Procedure 51. The asphalt should be placed in lifts not exceeding 3 inches thick or less than 1.5 inches thick. We recommend State Highway Grading SX.

Concrete Pavement

All concrete should be based on a mix design established by a qualified engineer. A CDOT Class P mix is acceptable. The design mix should consist of aggregate, Portland cement, water, and additives which will meet the requirements contained in this section. The concrete should have a modulus of rupture of third point loading of 630 psi. Normally, concrete with a 28-day compressive strength of 4,000 psi will meet this requirement. Concrete should contain approximately 6 percent entrained air. Maximum allowable slump should not exceed 4 inches.

The concrete should contain joints not greater than 15 feet on centers. Joints should be sawed or formed by premolded filler. The joints should be at least ¼ of the slab thickness. Expansion joints should be provided at the end of each construction sequence and between the concrete slab and adjacent structures. Expansion joints, where required, should be filled with a ½-inch thick asphalt impregnated fiber. Concrete should be cured by protecting against loss of moisture, rapid temperature changes and mechanical injury for at least three days after placement.

SURFACE DRAINAGE

Surface drainage is critical to the performance of foundations, floor slabs, concrete flatwork, and pavements. Recommendations in this report are based on effective drainage for the life of the structures/improvements and cannot be relied upon if effective drainage is not maintained. We recommend the following precautions be observed during construction and maintained at all times after construction is completed:

Building Areas

1. The ground surface surrounding the exterior of the buildings should be sloped to drain away from the buildings in all directions. We recommend providing a slope of

at least 12 inches in the first 10 feet in landscape areas. In some cases, attaining 12 inches of slope is not feasible. In these areas, we recommend a slope of 6 inches as a minimum. We recommend a slope of at least 3 inches in the first 10 feet in paved areas. A swale should be provided around the uphill side of the building to divert surface runoff.

2. Backfill around the exterior of foundation walls should be placed as described in the Foundation Wall Backfill section. Increases in the moisture content of the backfill soils after placement often results in settlement. Settlement is most common adjacent to north facing walls. Re-attaining proper slopes away from the buildings may be necessary (owner maintenance).

3. Landscaping should be carefully designed to minimize irrigation. Plants used near foundation walls should be limited to those with low moisture requirements; irrigated grass should not be located within 5 feet of the foundation. Sprinklers should not discharge within 5 feet of the foundation and should be directed away from the buildings.

4. Impervious plastic membranes should not be used to cover the ground surface immediately surrounding the enclosure. These membranes tend to trap moisture and prevent normal evaporation from occurring. Geotextile fabrics can be used to control weed growth and allow some evaporation to occur.

5. Roof downspouts and drains should discharge well beyond the limits of all backfill. Splash blocks and/or extensions should be provided at all downspouts so water discharges onto the ground beyond the backfill. Where downspout discharge is buried, solid, rigid pipe should be used and it should slope to an open gravity outlet. We recommend the buried discharge pipes are heated. Downspout extensions, splash blocks and buried outlets must be maintained by the property owners.

6. The design and construction criteria for foundations and floor systems were compiled with the expectation that all other recommendations presented in this report related to surface and subsurface drainage, landscaping irrigation, backfill compaction, etc. will be incorporated into the project. It is critical that all recommendations in this report are followed.

Pavement Areas

The collection and diversion of surface water away from paved areas is extremely important to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from the paved areas and prevent wetting of the subgrade soils.

CONSTRUCTION OBSERVATIONS

This report has been prepared for the exclusive use of The Board of County Commissioners of Summit County and the design team for the purpose of providing geotechnical design and construction criteria for the proposed project. The information, conclusions, and recommendations presented herein are based upon consideration of many factors including, but not limited to, the type of structures proposed, the geologic setting, and the subsurface conditions encountered. The conclusions and recommendations contained in the report are not valid for use by others. Stand-

ards of practice evolve in the area of geotechnical engineering. The recommendations provided in this report are appropriate for about three years. If the proposed project is not constructed within about three years, we should be contacted to determine if we should update this report.

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

GEOTECHNICAL RISK

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

LIMITATIONS

Our exploratory borings and pits were located to provide a reasonably accurate picture of subsurface conditions. Variations in the subsurface conditions not indicated by the borings and pits will occur. A representative of our firm should test structural fill during placement and observe foundation/pavement subgrade to confirm that the exposed soils are as expected and suitable for support of the footings and pavement as designed. We believe this investigation was conducted in a manner consistent with that level of care and skill ordinarily exercised by geotechnical engineers currently practicing under similar conditions in the locality of this project. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report, please call.

CTL | THOMPSON, INC.

Matthew Hopkins
Engineering Technician III

Reviewed by:

George Benecke III, P.E.
Division Manager, Summit County

11/18/15

MRH:GWB/cj (2 copies)

Not to scale

VICINITY MAP

Project No. SU01150-125

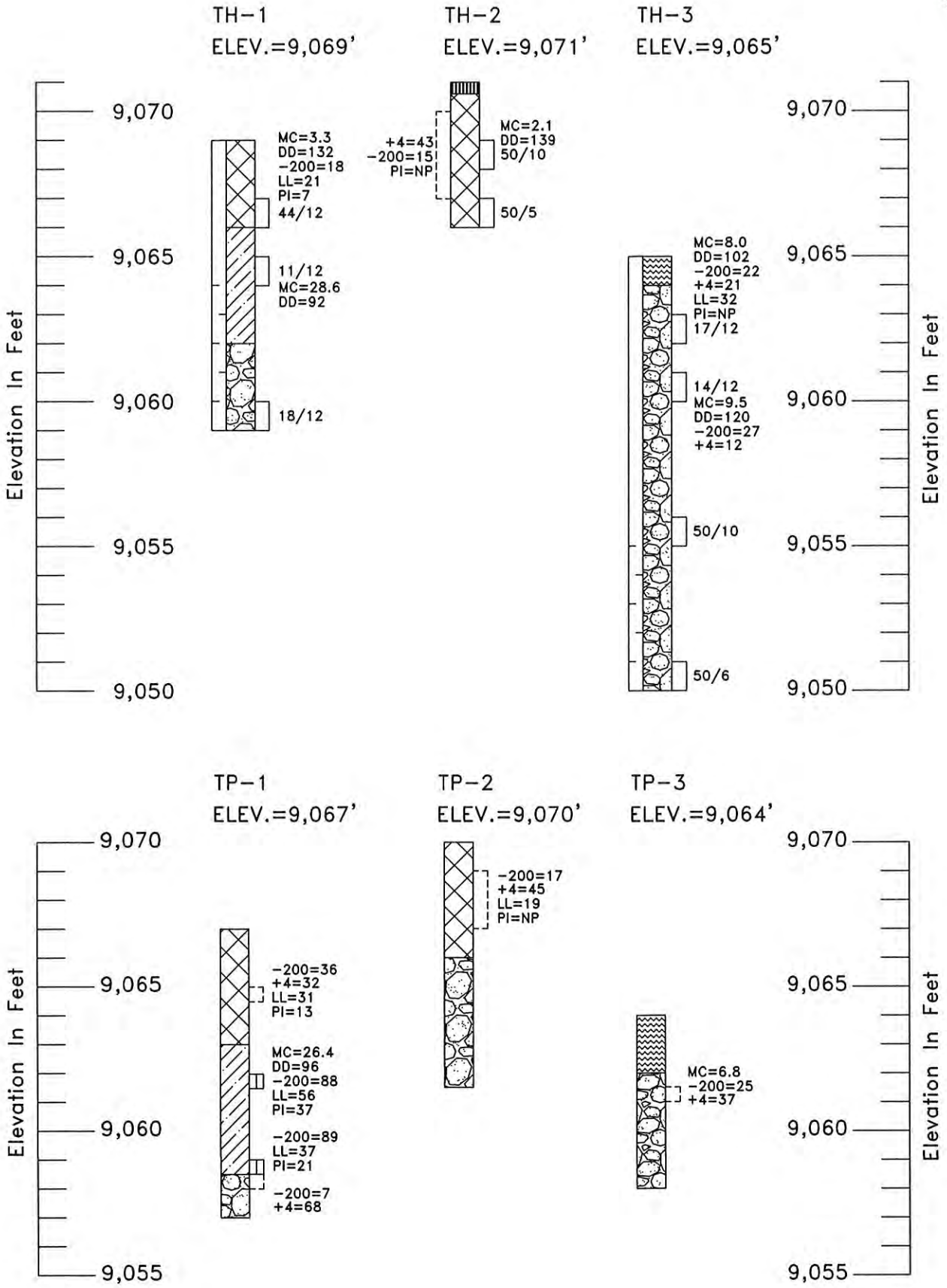
Figure 1

Scale: 1 inch = 140 feet

LOCATIONS OF EXPLORATORY PITS/BORINGS

Project No. SU01150-125

Figure 2



SUMMARY LOGS OF EXPLORATORY PITS/BORINGS

Project No. SU01150-125

Figure 3

LEGEND:

TOPSOIL; silty sand, with boulders up to 2.5 feet, moist, dark brown to dark grey.

Asphalt pavement, 5 inches in thickness.

FILL; GRAVEL; very sandy to gravelly sand, slightly silty to clayey, with subrounded to subangular cobbles, debris, and organic materials, medium dense to dense, slightly moist to moist, medium brown. (GM-GC)

CLAY; slightly sandy, with roots and organics, medium stiff, very moist, gray to bluish gray. (CL)

GRAVEL; very sandy to gravelly sand, silty, with scattered cobbles (subrounded to subangular), medium dense to very dense, brown to orange-brown. (GM-SW)

Relatively undisturbed hand drive sample

Drive Sample; The symbol 50/12 indicates 50 blows of a 140-pound hammer falling 30 inches were required to drive a 2-inch I.D. sampler 12 inches.

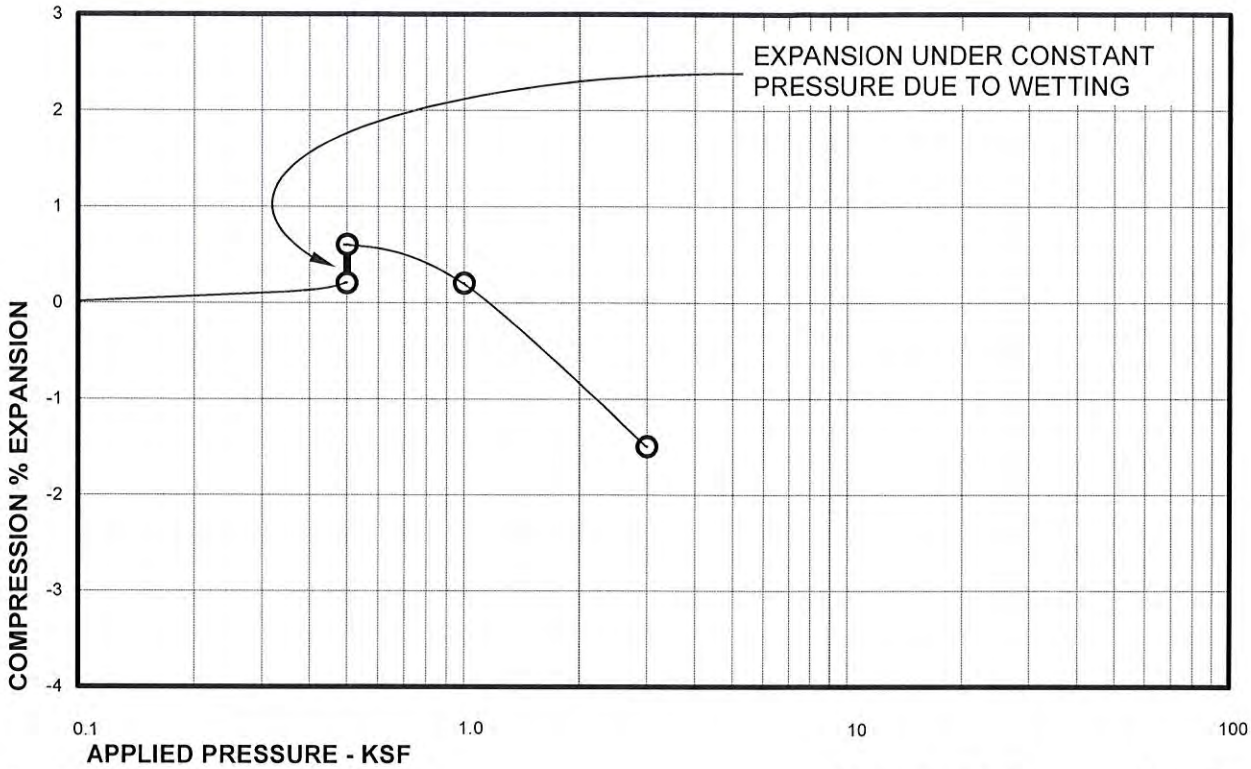
Disturbed bulk sample.

1½-inch diameter PVC pipe, hand slotted as shown, installed in boring to measure water level.

NOTES:

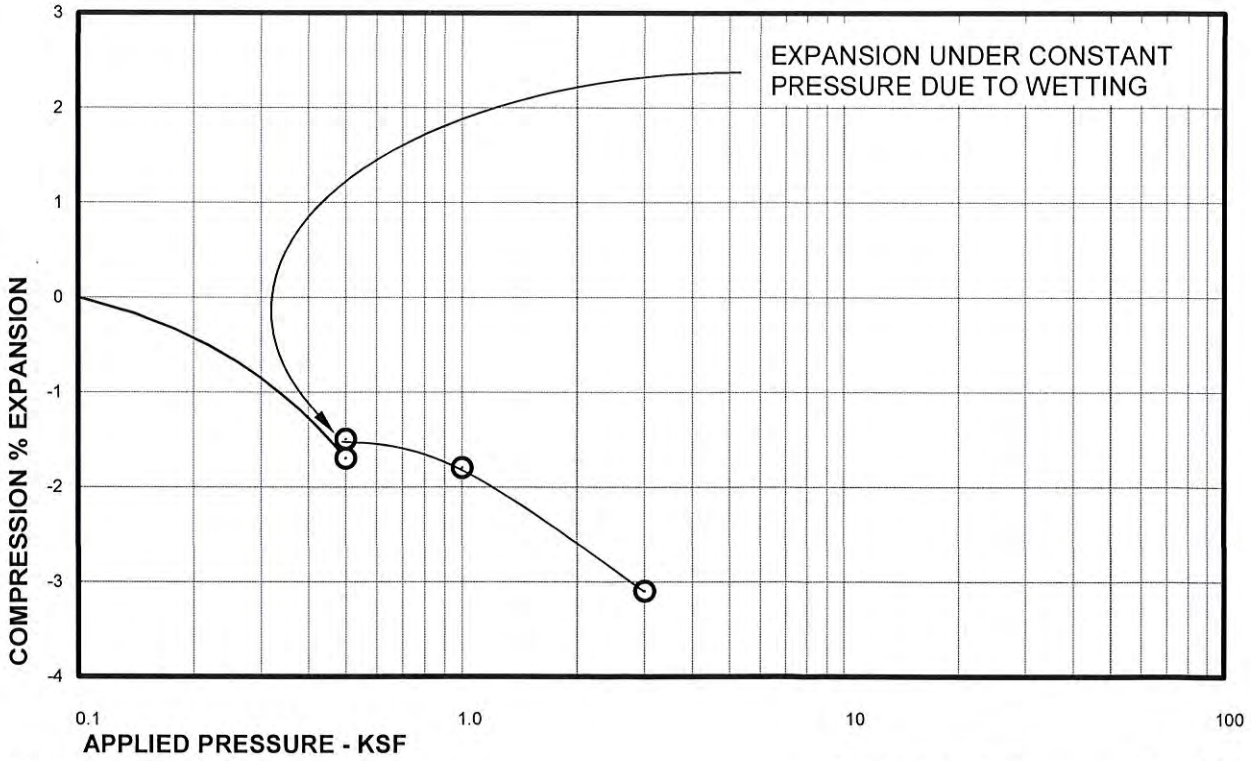
1. Exploratory pits were excavated with a track-mounted mini-excavator on October 9, 2015. Exploratory borings were drilled with a truck-mounted drill rig on October 12, 2015
2. No free water was observed in the exploratory pits at the time of excavation. No free water was observed in the exploratory borings at the time of drilling or 20 days subsequent to drilling.
3. Location of the exploratory pits and borings shown on Figure 2 are approximate. Elevations were surveyed by CTL and should be considered approximate.
4. These exploratory pits and borings are subject to the explanations, limitations and conclusions as contained in this report.

LEGEND AND NOTES



Sample of CLAY; slightly sandy
From TP-1 5'

DRY UNIT WEIGHT= 96 PCF
MOISTURE CONTENT= 26.4 %



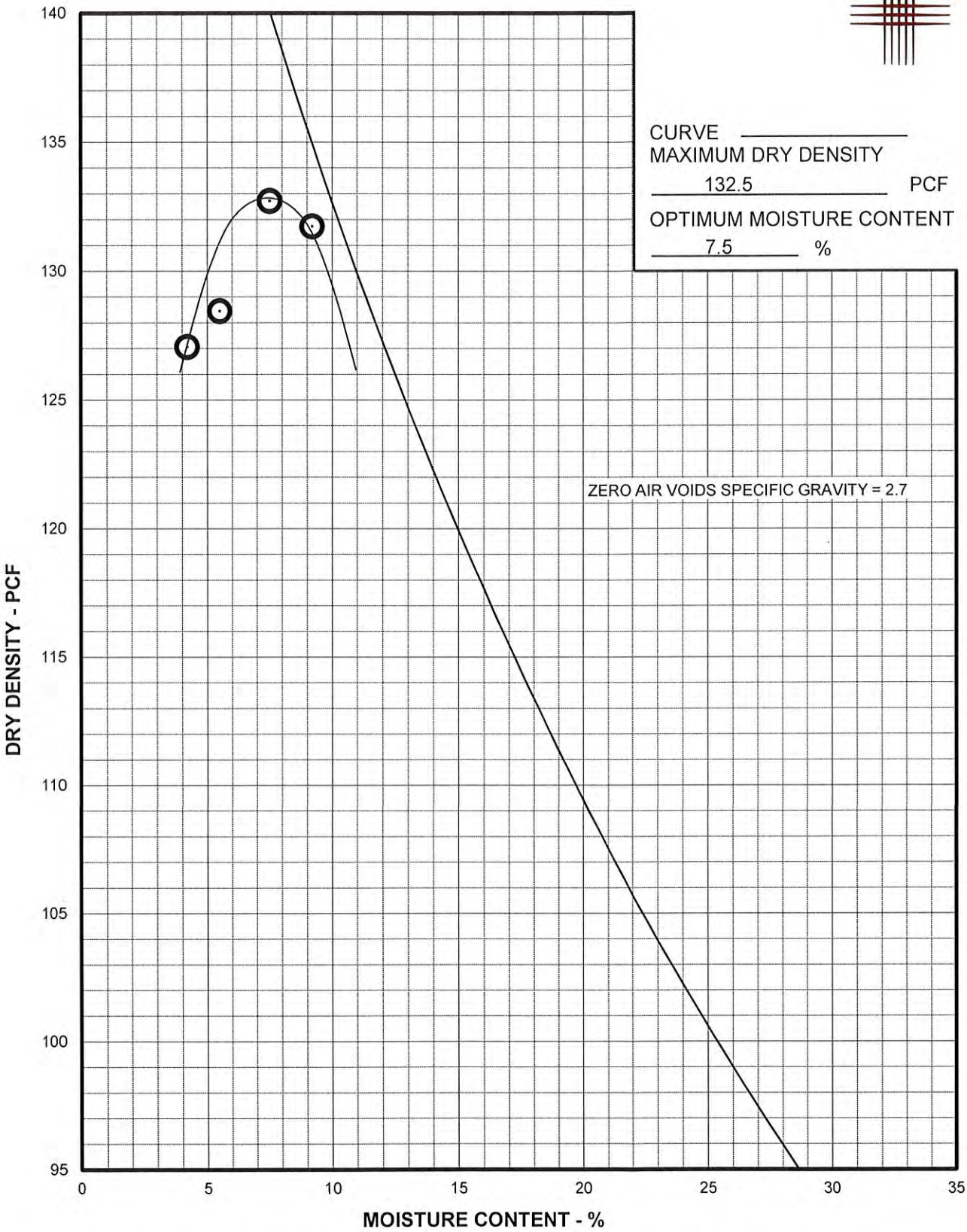
Sample of CLAY; slightly sandy
From TH-1 4'

DRY UNIT WEIGHT= 92 PCF
MOISTURE CONTENT= 28.6 %

Swell Consolidation Test Results

CTL|T PROJECT NO. SU01150-125

Figure 5



Unified Soil Classification System(USCS) FILL; GRAVEL, very sandy, silty

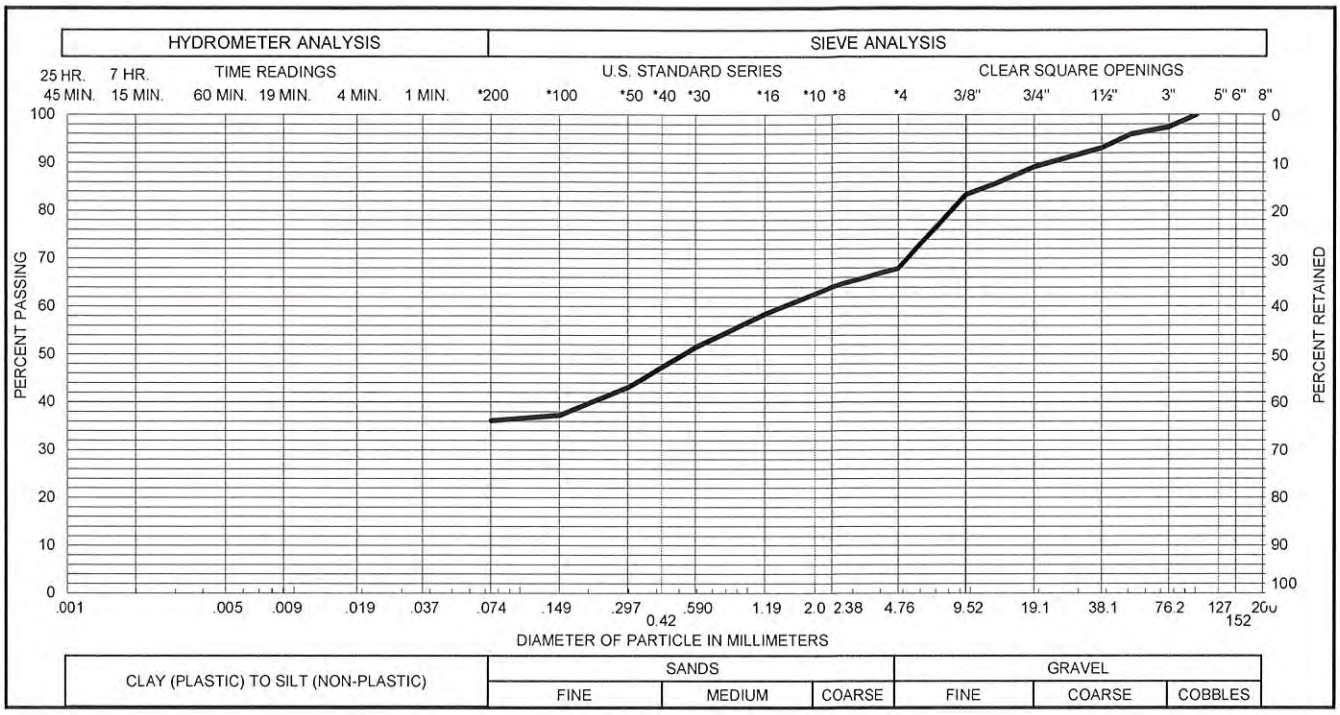
AASHTO Soil Classification

Location TP-2 1-3'

Compaction Test Procedure ASTM D 698-91 METHOD C

LIQUID LIMIT	19	%
PLASTICITY INDEX	NP	%
GRAVEL (USCS)	45	%
SAND (USCS)	38	%
SILT AND CLAY	17	%

Proctor Test Results



Sieve Size	% Passing
4 in.	100
3 in.	97
2 in.	96
1.5 in.	93
3/4 in.	89
1/2 in.	86
3/8 in.	83
No. 4	68
No. 8	64
No. 16	58
No. 30	52
No. 50	43
No. 100	37
No. 200	36

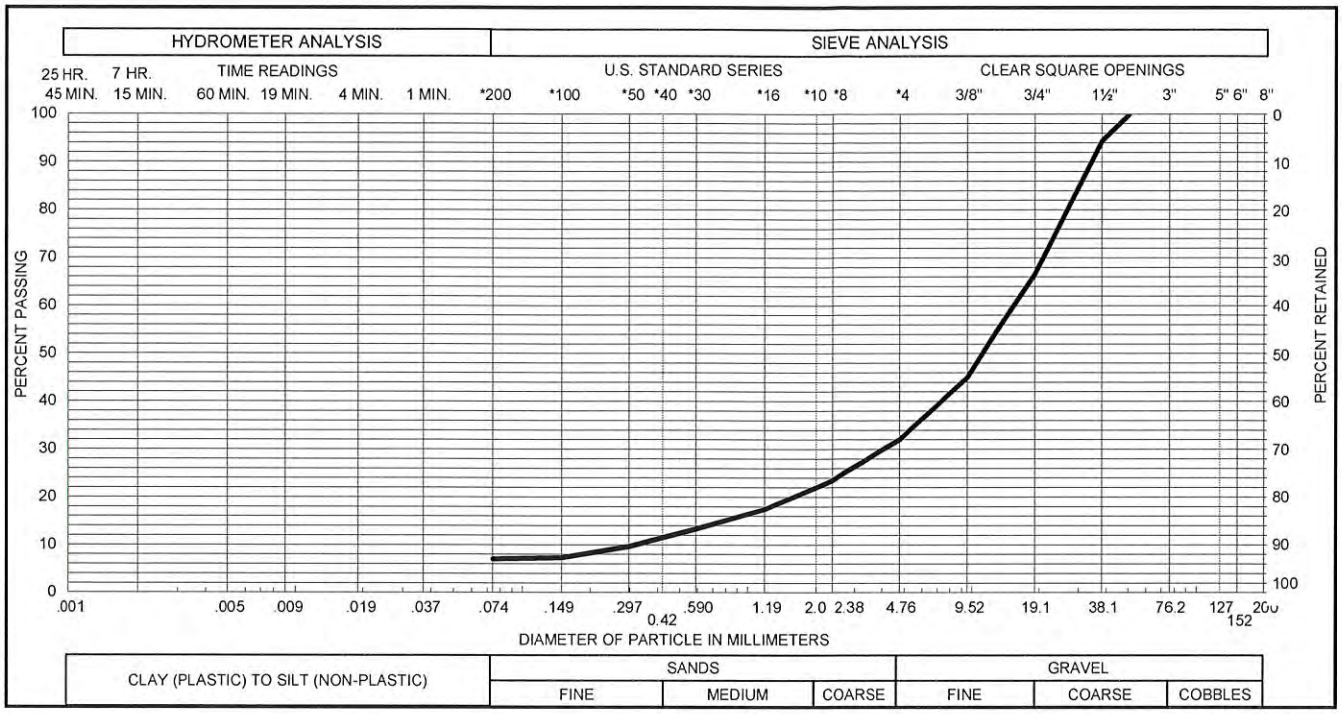
Curve No. 1

Sample of FILL; GRAVEL; sandy, clayey

From TP-1 2'

GRAVEL(USCS)	32 %	SAND(USCS)	32 %
SILT & CLAY	36 %	LIQUID LIMIT	31 %
PLASTICITY INDEX			13 %

Gradation Test Results



Sieve Size	% Passing
2 in.	100
1.5 in.	94
3/4 in.	67
1/2 in.	54
3/8 in.	45
No. 4	32
No. 8	24
No. 16	17
No. 30	13
No. 50	10
No. 100	7
No. 200	7

Curve No. 1

Sample of GRAVEL; sandy, slightly silty

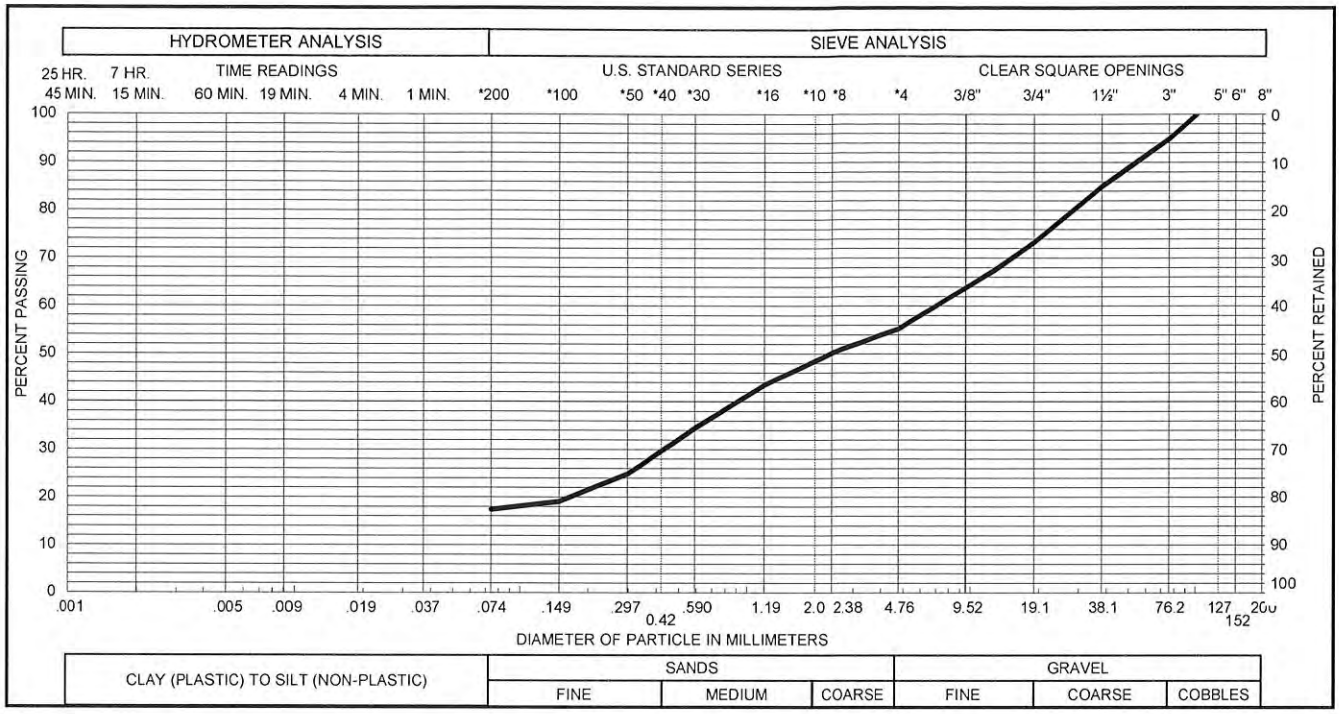
From TP-1 8.5-9'

GRAVEL(USCS) 68 % SAND(USCS) 25 %

SILT & CLAY 7 % LIQUID LIMIT %

PLASTICITY INDEX %

Gradation Test Results



Sieve Size	% Passing
4 in.	100
3 in.	95
2 in.	89
1.5 in.	85
3/4 in.	73
1/2 in.	67
3/8 in.	64
No. 4	55
No. 8	50
No. 16	44
No. 30	35
No. 50	25
No. 100	19
No. 200	17

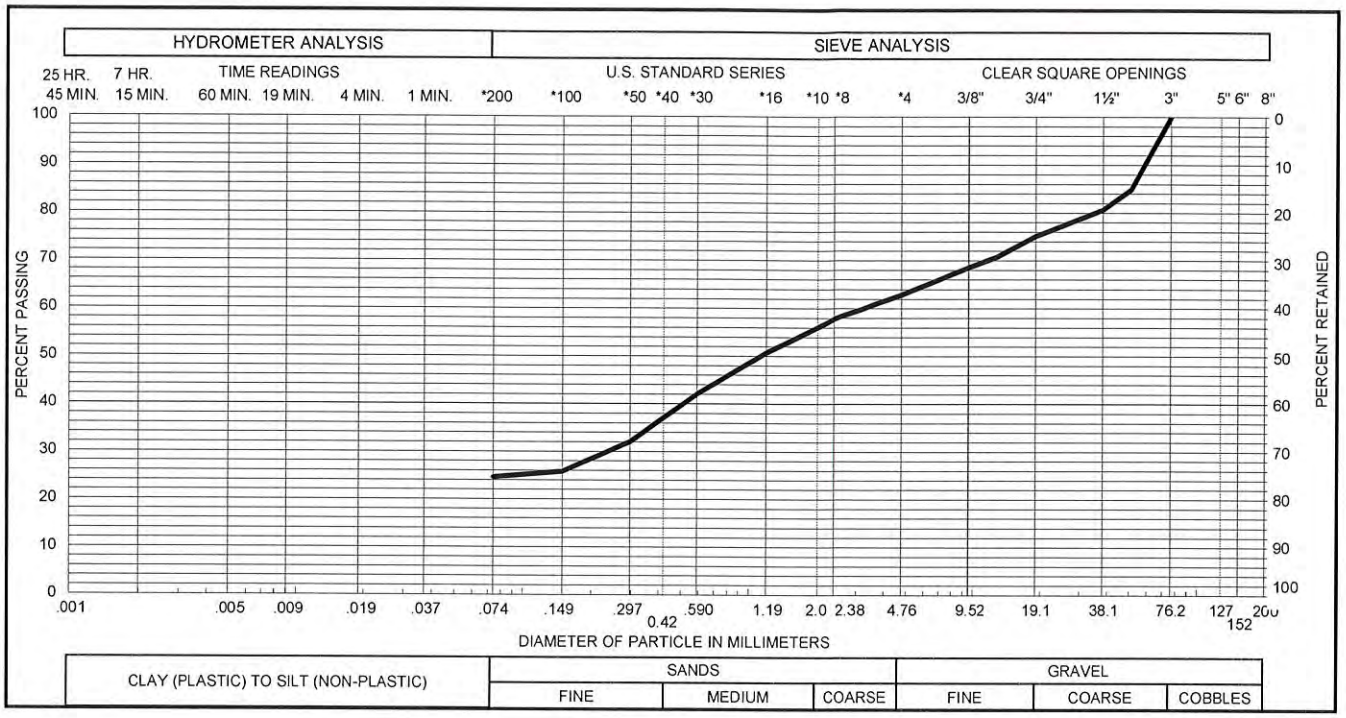
Curve No. 1

Sample of FILL; GRAVEL; very sandy, silty

From TP-2 1-3'

GRAVEL(USCS)	45 %	SAND(USCS)	38 %
SILT & CLAY	17 %	LIQUID LIMIT	19 %
PLASTICITY INDEX			NP %

Gradation Test Results



Sieve Size	% Passing
3 in.	100
2 in.	85
1.5 in.	81
3/4 in.	75
1/2 in.	71
3/8 in.	69
No. 4	63
No. 8	58
No. 16	51
No. 30	42
No. 50	32
No. 100	26
No. 200	25

Curve No. 1

Sample of SAND; gravelly, silty

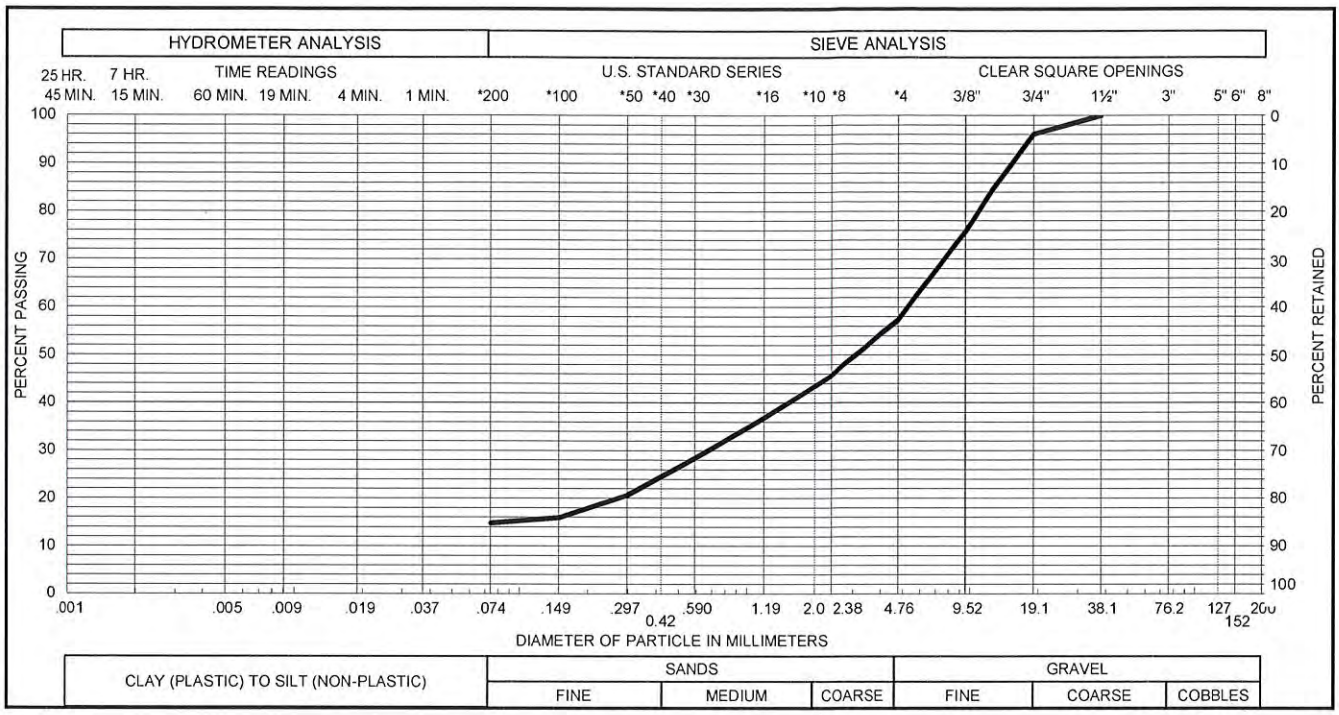
From TP-3 2.5'

GRAVEL(USCS) 37 % SAND(USCS) 38 %

SILT & CLAY 25 % LIQUID LIMIT %

PLASTICITY INDEX %

Gradation Test Results



Sieve Size	% Passing
1.5 in.	100
3/4 in.	96
1/2 in.	85
3/8 in.	76
No. 4	57
No. 8	46
No. 16	37
No. 30	28
No. 50	21
No. 100	16
No. 200	15

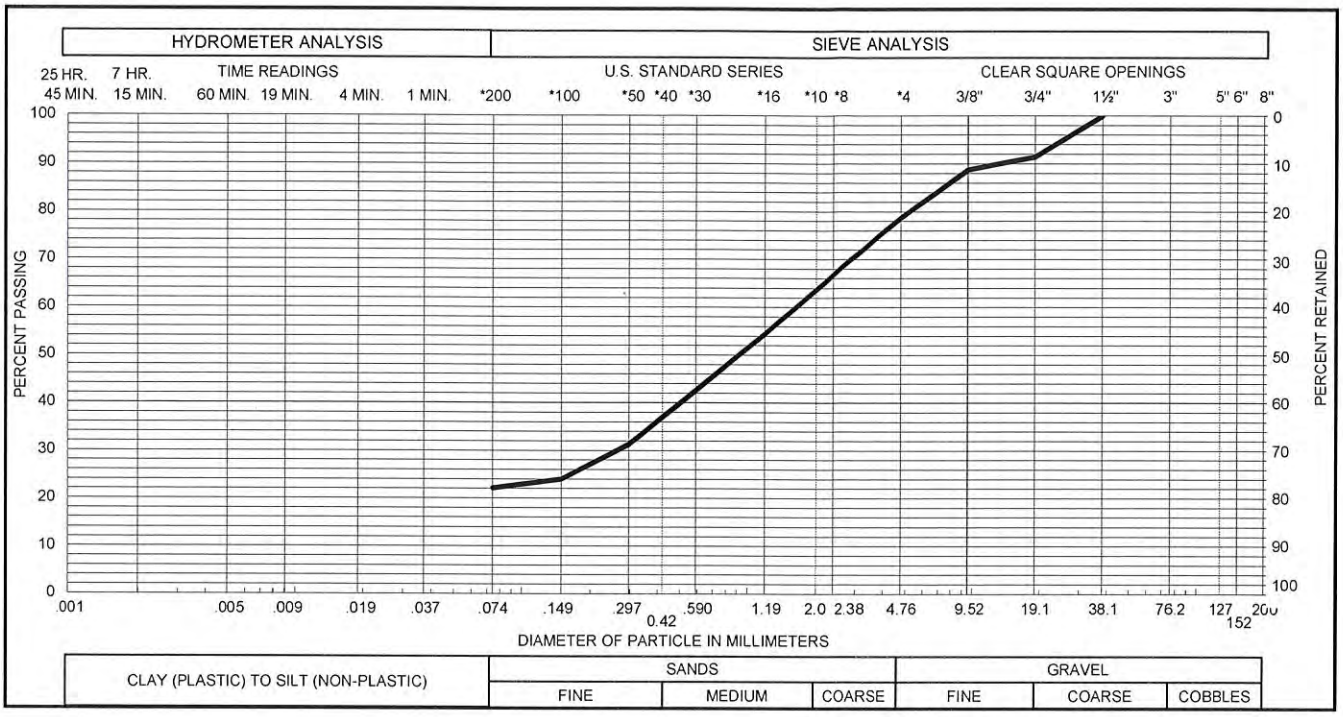
Curve No. 1

Sample of FILL; GRAVEL; very sandy, silty

From TH-2 1-4'

GRAVEL(USCS)	43 %	SAND(USCS)	42 %
SILT & CLAY	15 %	LIQUID LIMIT	NP %
PLASTICITY INDEX			NP %

Gradation Test Results



Sieve Size	% Passing
1.5 in.	100
3/4 in.	91
1/2 in.	90
3/8 in.	89
No. 4	79
No. 8	67
No. 16	54
No. 30	43
No. 50	31
No. 100	24
No. 200	22

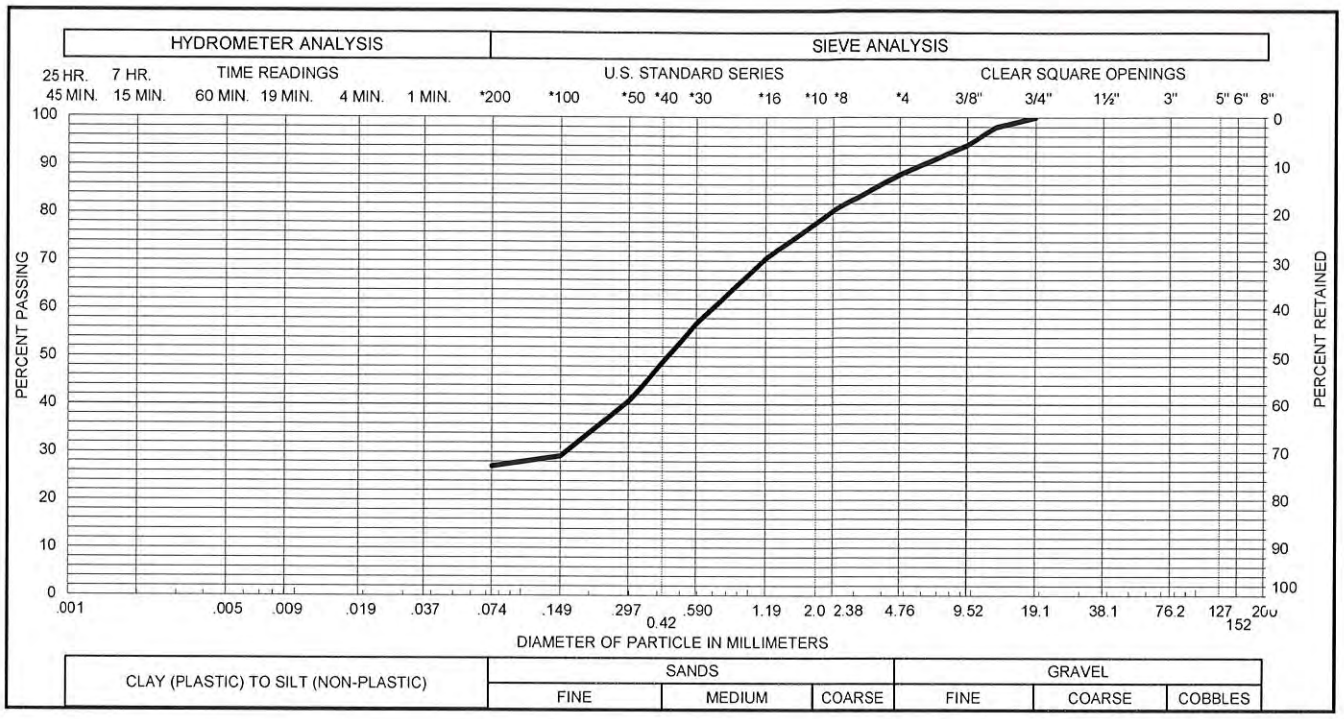
Curve No. 1

Sample of SAND; gravelly, silty

From TH-3 2'

GRAVEL(USCS)	21 %	SAND(USCS)	57 %
SILT & CLAY	22 %	LIQUID LIMIT	32 %
PLASTICITY INDEX			NP %

Gradation Test Results



Sieve Size	% Passing
3/4 in.	100
1/2 in.	98
3/8 in.	94
No. 4	88
No. 8	81
No. 16	71
No. 30	57
No. 50	41
No. 100	29
No. 200	27

Curve No. 1

Sample of SAND; gravelly, silty

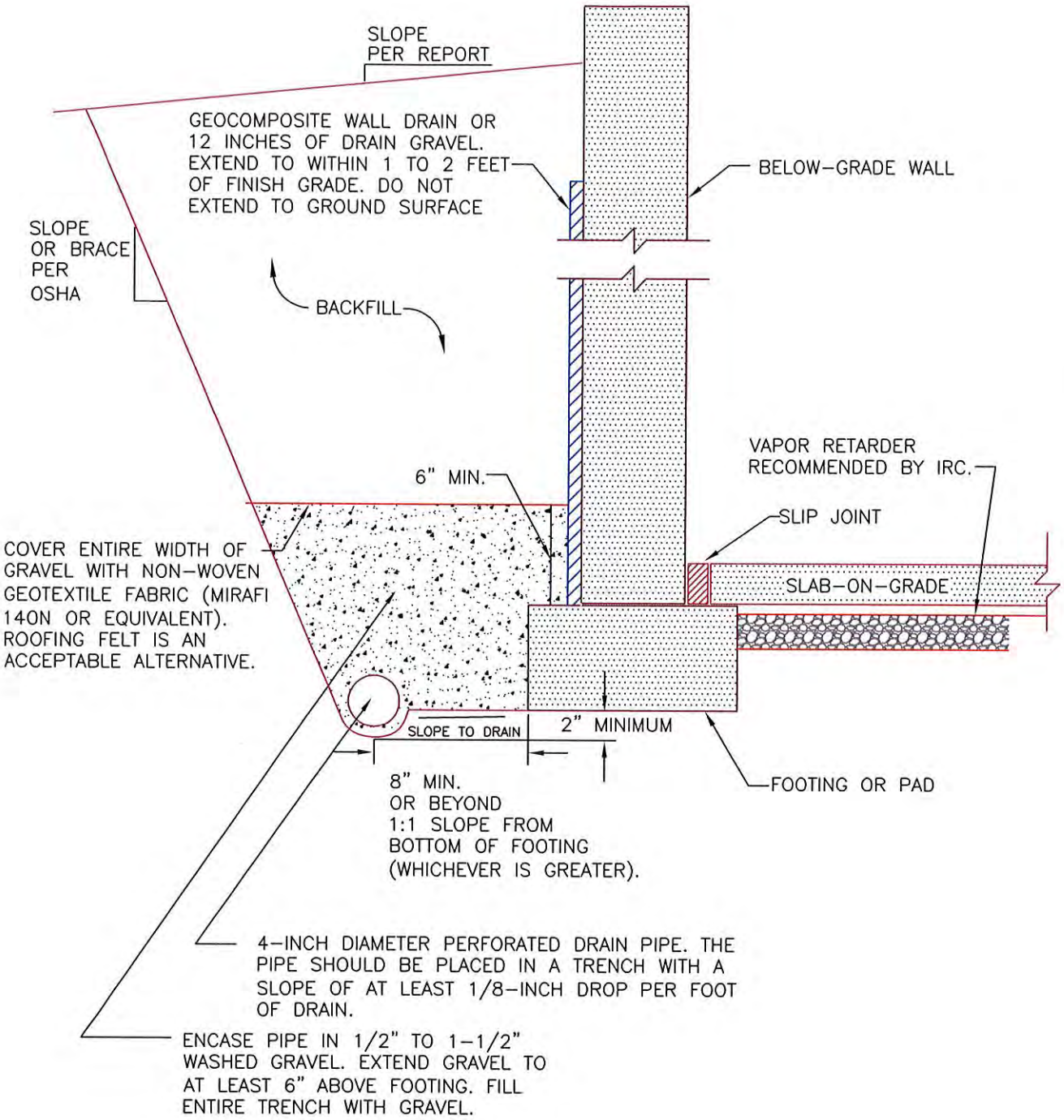
From TH-3 4'

GRAVEL(USCS) 12 % SAND(USCS) 61 %

SILT & CLAY 27 % LIQUID LIMIT %

PLASTICITY INDEX %

Gradation Test Results



NOTE:
THE BOTTOM OF THE DRAIN SHOULD BE AT LEAST 2 INCHES BELOW BOTTOM OF FOOTING (AND 12 INCHES BELOW TOP OF ADJACENT SLAB OR CRAWLSPACE GRADE) AT THE HIGHEST POINT AND SLOPE DOWNWARD TO A POSITIVE GRAVITY OUTLET OR TO A SUMP WHERE WATER CAN BE REMOVED BY PUMPING.

TYPICAL EXTERIOR FOUNDATION WALL DRAIN

TABLE I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. SU01150-125

EXPLORATORY PIT	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	SWELL TEST RESULTS* SWELL (%)	SWELL TEST RESULTS* APPLIED PRESSURE (PSF)	SWELL TEST RESULTS* SWELL PRESSURE (PSF)	PERCENT GRAVEL (%)	SULFATE CONC. (%)	PASSING NO. 200 SIEVE (%)	DESCRIPTION
TP-1	2			31	13				32		36	FILL; GRAVEL; sandy, clayey
TP-1	5	26.4	96	56	37	0.4	500	1,000			88	CLAY; slightly sandy
TP-1	8			37	21						89	CLAY; slightly sandy
TP-1	8.5-9								68		7	GRAVEL; sandy
TP-2	1-3			19	NP				45		17	FILL; GRAVEL; very sandy
TP-3	2.5	6.8							37		25	SAND; gravelly, silty
TH-1	2	3.3	132	21	7						18	FILL; GRAVEL; sandy, slightly silty
TH-1	4	28.6	92			0.2	500	850				CLAY; slightly sandy
TH-2	2	2.1	139									FILL; GRAVEL; very sandy, slighlty silty
TH-2	1-4			NP	NP				43		15	FILL; GRAVEL; very sandy, slighlty silty
TH-3	2	8.0	102	32	NP				21		22	SAND; gravelly, silty
TH-3	4	9.5	120						12		27	SAND; gravelly, silty

CTL | THOMPSON

PERCOLATION TEST DATA

Client: Summit County | Location: Frisco Transfer Ctr. | Job No.: SU01150-125

Date excavated: 10/9/2015 | Date Presoaked: 11/1/2015 | Date of Tests: 11/2/2015

Diameter of Holes: 8 inches | Scraped? Yes No | Sleeved? Yes No

Water level in Profile: None | Bottom of Profile Hole (ft): 6 | Technician: MH

Site Description: 2 feet of topsoil with boulders overlying silty sand

Depth to top of perc hole is 2.5 feet in silty sand. Perc hole is 10 inches deep

Time Interval From To	Time Interval (Min.)	Water Reading Start (in.)	Water Reading End (in.)	Change in Depth (in.)	Perc Rate (mpi)
Hole No. P-1	Water remaining from Presoak?		Yes No	Depth of Hole at Start: 2.5'	
10:14 - 10:44	30	3.25	4.13	0.88	34.1
10:44 - 11:14	30	4.13	4.75	0.62	48.4
11:14 - 11:44	30	4.75	5.25	0.5	60.0
11:44 - 12:14	30	5.25	5.75	0.5	60.0
12:14 - 12:44	30	5.75	6.19	0.44	68.2
12:44 - 13:14	30	6.19	6.63	0.44	68.2
13:14 - 13:44	30	6.63	7.06	0.43	69.8
13:44 - 14:14	30	7.06	7.44	0.38	78.9
Hole No._____	Water remaining from Presoak?		Yes No	Depth of Hole at Start:_____	
Hole No._____	Water remaining from Presoak?		Yes No	Depth of Hole at Start:_____	
Hole No._____	Water remaining from Presoak?		Yes No	Depth of Hole at Start:_____	

Table 2