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GEOLOGIC HAZARD EVALUATION AND SOILS AND FOUNDATION INVESTIGATION CLOVEN HOOF, LOTS 1 AND 2 MORGAN SUBDIVISION FILING 1 CLOVEN HOOF DRIVE EL PASO COUNTY, COLORADO

Prepared For:

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Project No. CS19720-120

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SCOPE

This report presents the results of our Geologic Hazards Evaluation and Soils and Foundation Investigation for two proposed new residences and renovations to two existing single-family residences at the Morgan Subdivision in El Paso County, Colorado (Fig. 1). We understand that development will consist of new residences on parcel number 7109002018, and addition renovations to the existing residences on parcel number 7109002019. The purpose of our investigation was to evaluate the geologic and subsurface conditions in order to provide geotechnical design and construction recommendations for the proposed residences. The report includes descriptions of the subsurface conditions encountered in our exploratory borings, and discussions of construction as influenced by geotechnical considerations. The scope was described in our proposal (CS-23-0113) dated July 6, 2023. Evaluation of the property for the presence of potentially hazardous materials (Environmental Site Assessment) was not included in our scope.

This report was prepared from data developed during field exploration, laboratory testing and engineering analysis, and from our experience with similar conditions. It includes our opinions and recommendations for design criteria and construction details for foundation and floor system alternatives, slabs-on-grade, lateral earth loads, and drainage precautions, as well as a geologic hazards evaluation. The report was prepared for the exclusive use of Joyner Construction CO, Inc. in design and construction of single-family residences on the specified lots. Other types of construction may require revision of this report and the recommended design criteria. A brief summary of our conclusions and recommendations follows. Detailed design criteria are presented within the report.

SUMMARY OF CONCLUSIONS

1. We did not identify geotechnical or geologic constraints at this site we believe preclude construction of single-family residences. The primary geotechnical concern is the presence of sporadic lenses of expansive

claystone bedrock. We believe these concerns can be mitigated with proper planning, engineering, design, and construction.

2. Strata encountered in our exploratory borings consisted of 4 to 5 feet of silty, clayey sand soils underlain by predominantly sandstone bedrock with localized layers of claystone bedrock to the maximum depths explored of 30 feet. Testing and our experience indicate the near-surface soils and sandstone are generally non-expansive to low swelling. Claystone layers are intermittently present within the bedrock and may exhibit variable swell potential.

3. Groundwater was not encountered during drilling and the borings were found to be dry 17 days after exploration was completed. Groundwater elevations can be altered by development and will vary with seasonal precipitation and landscaping irrigation.

4. The presence of expansive soils and bedrock on the site constitutes a geologic hazard. There is risk that these materials may heave and damage slabs-on-grade and foundations. We believe the risk of damage can be mitigated through typical engineering practices employed in the region. Slabs-on-grade and, in some instances, foundations, may be damaged. Where claystone is encountered within foundation excavations, sub-excavation may be appropriate.

5. We believe spread footings designed and constructed to apply a minimum deadload will be appropriate if underlain by natural sand, sandstone bedrock, or new, moisture conditioned and densely compacted fill. Claystone bedrock was encountered in one boring at a depth of 12 feet. The presence of claystone should be evaluated by excavation of test pits at the time of the excavation observation for each of the structures.

6. Control of surface drainage will be critical to the performance of foundations and slabs-on-grade. Overall surface drainage should be designed to provide rapid removal of surface runoff away from the proposed residences. Conservative irrigation practices should be followed to avoid excessive wetting.

SITE CONDITIONS

Lot 1 of Filing 1 at the Morgan Subdivision is vacant in what is generally a built-out subdivision located south of Colorado 105 and west of Cloven Hoof Drive. Lot 2 contains two single-family residences. One or both of the structures on Lot 2 were constructed in 1943. At the time of our investigation, access to TH-2 was provided by a rough graded driveway into the Lot 2. Site topography consists of gentle to moderate slopes generally with gradients less than 25 percent. Vegetation consists of pine trees, grasses and shrubs.

PROPOSED DEVELOPMENT

The project is to consist of subdividing Lots 1 and 2 into four individual lots that will be denoted as Lots 1, 1A, 2, and 2A. Two new single-family residences will be constructed on Lots 1 and 1A, and additions/renovations will be performed at Lots 2 and 2A. We assume the homes will be one to two-story, wood-frame structures with basements. The residences may have partial brick or stone exterior veneer. Foundation loads are expected to vary between 1,000 and 3,000 pounds per lineal foot of foundation wall, with individual column loads of 25 kips or less. Finish floor elevations were not available at the time of this report. We anticipate excavations of 7 to 10 feet will be required for basement construction. Final grading and landscaping may result in slightly greater depth of backfill.

PREVIOUS INVESTIGATION

A soils report was previously prepared for the project by A Better Soil Solution (A Better Soil Solution Job No. 23-0178, dated May 2, 2023). Two borings were advanced at the site. The report was reviewed as part of this investigation.

INVESTIGATION

Subsurface conditions at the site were investigated by our firm by drilling two exploratory borings to depths of 30 feet below the existing ground surface. The approximate locations of the borings are shown in Fig. 1. Our investigation was limited due to access constrains associated with the sloping terrain and dense cover of trees. Our representative observed the drilling operations, logged the subsurface conditions found in the borings, and obtained samples for laboratory testing. Graphical logs of the borings, including the results of field penetration resistance tests, and some laboratory test data are presented in Fig. 3. Soil samples obtained during drilling were visually classified and laboratory testing was assigned to representative samples. Swell-consolidation and gradation test results are presented in Appendix A. Laboratory test data are summarized in Table A-1.

SUBSURFACE CONDITIONS

Strata encountered in our exploratory borings generally consisted of a natural, silty, clayey sand underlain by predominantly sandstone bedrock interbedded with claystone to the maximum depths explored of 30 feet. Some of the pertinent engineering characteristics of the soil and bedrock are described in the following paragraphs.

Natural Soils

Natural soils were encountered at the surface in each of our borings and extended to depths of 4 to 5 feet. The natural soils consisted of silty, clayey sand. Our experience indicates the silty, clayey sand soils are low swelling when wetted. A sample of the silty, clayey sand contained 35 percent silt and clay-sized particles and exhibited a Liquid Limit of 30 and Plasticity Index of 6.

Bedrock

Bedrock was encountered in each of the borings underlying the natural soils, at depths between 4 and 5 feet below the ground surface. The predominate sandstone bedrock within the site vicinity is known to contain sporadic claystone layers. We encountered a layer of claystone in TH-1 between approximately 12 and 19 feet. The bedrock was hard to very hard and slightly cemented. Four samples of the sandstone contained 16 to 48 percent silt and clay-sized particles. The sandstone is judged to be non-expansive to low swelling. One sample compressed 2.5 percent and one sample swelled 2.0 percent when wetted under estimated overburden pressures. We attribute the compression to sample disturbance.

A sample of the claystone tested in our laboratory contained 70 percent silt and clay-sized particles. Swell testing was conducted; however, sample disturbance resulted in unreliable results.

<u>**Groundwater**</u>

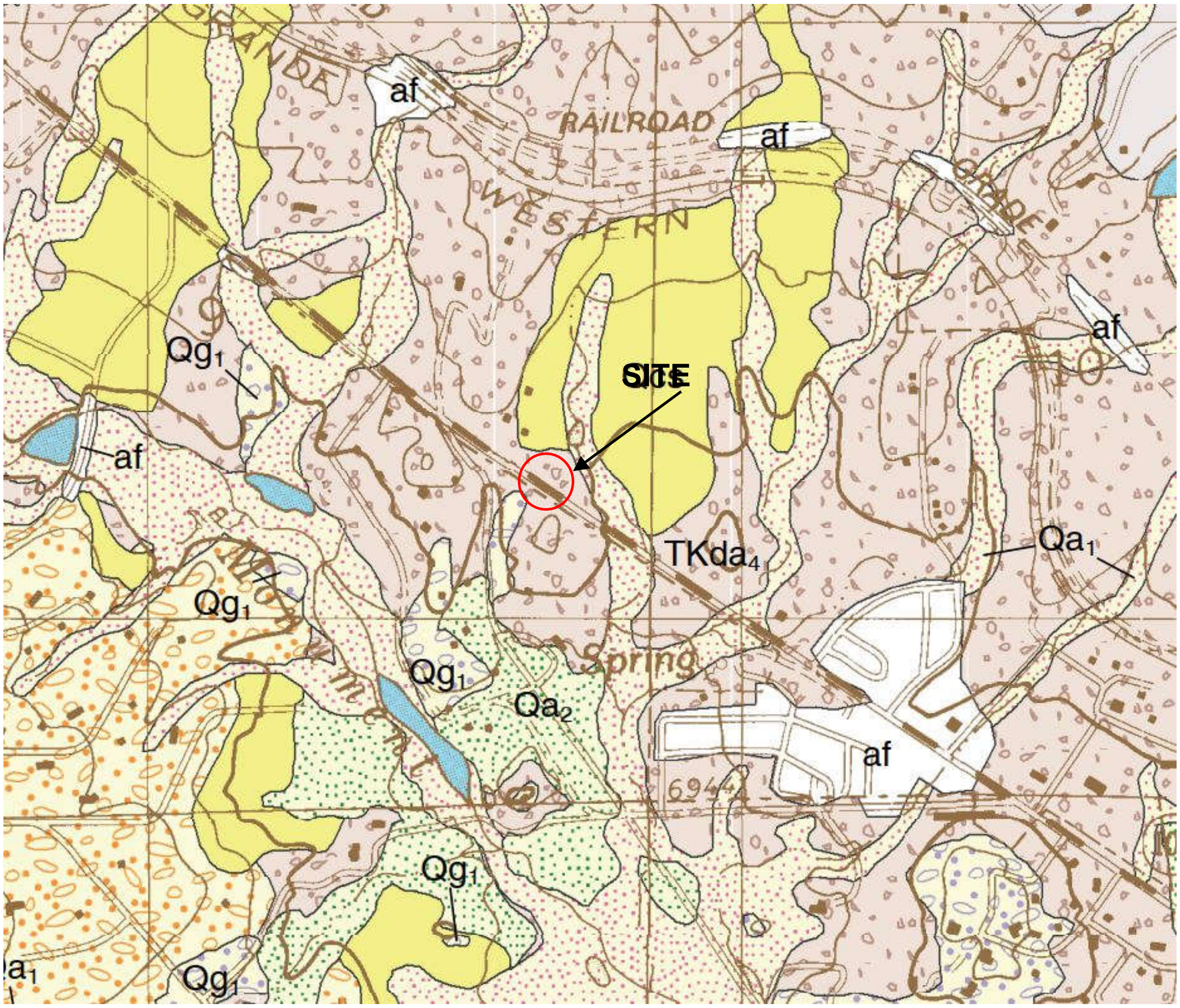
Groundwater was not encountered in our borings during drilling to the total depth explored of 30 feet. The borings were found to be dry seventeen days after exploration. Groundwater may develop and fluctuate seasonally and rise in response to development, precipitation, and landscape irrigation.

SITE GEOLOGY

The surficial geology at the site was evaluated by reviewing published geologic maps and our own site reconnaissance. The site was included on a Geologic Map of the Palmer Lake Quadrangle[1] published by the Colorado Geological Survey.

The site is mapped as Dawson Formation, map unit $Tkda_4$. Facies unit four of the Dawson Formation is similar to facies unit one ($Tkda_1$) in the Monument Quadrangle, but becomes finer and more clay-rich in the Palmer Lake Quadrangle. The facies in $Tkda_1$ are bright-maroon to dark red, very clayey, coarse sandstone and fine-pebble conglomerate and contain interbedded light-gray to pink, very coarse, pebbly arkose and pebble conglomerate. Facies unit four is generally permeable, well drained, and has good foundation characteristics. The arkoses are friable and easily eroded, but excavation may be difficult. Conditions at the site were found to be similar to the mapped conditions. An excerpt of the geologic map is presented below.

[1] Keller, John W., Morgan, Matthew L., Thorson, Jon, P., Lindsay, Neil R., Barkmann, Peter E., Geologic Map of the Palmer Lake Quadrangle, El Paso County, Colorado, 2007.



Excerpt of Geologic Map, Keller, et al., 2007

GEOLOGIC HAZARDS

Geologic hazards we identified at the site include expansive and hard bedrock. No geologic hazards were noted that we believe preclude the proposed construction. We believe potential hazards can be mitigated with proper engineering, design, and construction practices, as discussed in this report. Figure 2 shows our interpretation of the engineering geology modified from the system used by Charles Robinson & Associates (1977).

Expansive Soils and Bedrock

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

Covering the ground with structures, streets, driveways, patios, etc., coupled with lawn irrigation and changing drainage patterns, leads to an increase in subsurface moisture conditions. As a result, some soil movement due to heave or settlement is inevitable. Localized layers of expansive bedrock are present at this site, which constitutes a geologic hazard. There is risk that foundations and slab-on-grade floors will experience heave or settlement and damage. It is critical that precautions are taken to increase the chances that the foundations and slabs-on-grade will perform satisfactorily. It is noted that the presence of expansive materials within the Dawson Formation is highly variable and will need to be further evaluated at the time of lot specific soils and foundation investigations. Engineered planning, design and construction of grading, pavements, foundations, slabs-on-grade, and drainage can mitigate, but not eliminate, the effects of expansive and compressible soils. Sub-excavation is a ground improvement method that can be used to reduce the impacts of swelling soils.

Hard Bedrock

The sandstone and claystone of the Dawson Formation are hard to very hard and present at shallow depths within the site. The hard to very hard bedrock will require heavy duty excavation equipment. Excavations into bedrock may require rock teeth and rock buckets. The bedrock slows the rate of excavation but does not preclude basement construction.

Flooding

The site lies within Zone X or D as shown on FIRM Community Map Number 08041C0257G, revised December 7, 2018. Zone D indicates an undetermined flood hazard. Floods are possible, but not likely. Zone X is outside of the 500-year floodplain.

Seismicity

This area, like most of Colorado, is subject to a low degree of seismic risk. The soil and bedrock units are not expected to respond unusually to seismic activity. The Rampart Range Fault lies approximately 2 miles west of the site.

Erosion

The site is susceptible to the effects of wind and water erosion. Water flowing across the site in an uncontrolled manner will likely result in considerable erosion, particularly where the water flow is concentrated. The surficial sandy soils are relatively stable and resistant to wind erosion where vegetation is established. Disturbance of the vegetative cover and long-term exposure of these deposits to the erosive power of wind and water increases the potential for erosion. Maintaining vegetative cover and utilizing surface drainage collection and distribution systems will reduce the potential for erosion from wind and water.

Radon/Radioactivity

We believe no unusual hazard exists from naturally occurring sources of radioactivity on the site. However, the materials found in this area are often associated with the production of radon gas, and concentrations in excess of those currently accepted by the EPA can occur. Passive and active mitigation procedures are commonly employed in this region to effectively reduce the buildup of radon gas. Measures that can be taken after a structure is enclosed during construction include installing a blower connected to the foundation drain and sealing the joints and cracks in concrete floors and foundation walls. If the occurrence of radon is a concern, we recommend structures be tested after they are enclosed. The EPA provides guidance on construction radon resistant structures.

Recoverable Minerals

The project site is included in the Aggregate Resources of Colorado mapping from the Colorado Geological Survey. The mapping does not indicate any commercial sand or gravel pits near the project site. We observed no evidence of surface or subsurface mining at the site.

ESTIMATED POTENTIAL HEAVE

Based on the subsurface profiles, swell-consolidation test results and our experience, we calculated potential heave at the existing ground surface for each test hole. The analysis involves dividing the soil profile into layers and modeling the heave of each layer from representative swell tests. We estimate potential ground heave will generally be less than 1-inch; thicker and more expansive layers of soils and bedrock may be present between our borings. A depth of wetting of 24 feet below existing grades was considered for the analysis. This depth of wetting is typically used for irrigated residential sites. Variations from our estimates should be anticipated. It is not certain whether the estimated heave will occur.

We judge there is a relatively low risk of problems due to expansive soils and bedrock for much of the site; however, sporadic layers of expansive claystone may be present throughout the site.

Sub-Excavation

Our investigation indicates soils and bedrock with nil to low expansion potential are present at depths likely to influence the performance of shallow foundations and slabs-on-grade. We estimated total potential ground heave could be up to about 1 inch within our borings. Our experience suggests performance of structures constructed on claystone bedrock can be erratic. The foundation bearing materials should be carefully evaluated at the time of the open excavation observation. Pot holes should be excavated within each of the structure foot prints to evaluate the possible presence of claystone within 4 feet of foundations. In the event claystone is identified, we recommend it be sub-excavated to a depth of 4 feet below foundation levels or to depths that expose sandstone, whichever comes first. This excavation should extend at least 5 feet beyond the outer edges of the footings. The excavation can then be backfilled with on-site material that has been moisture conditioned to between 1 and 4 percent over optimum moisture content and compacted in thin lifts to at least 95 percent of maximum standard Proctor dry density (ASTM D 698).

EXCAVATIONS

We believe the soils and bedrock can be excavated with conventional, heavy-duty excavation equipment. Where very hard bedrock is encountered, the contractor should expect the need for rock buckets and rock teeth and increased wear and tear on equipment. The contractor should identify the soils and bedrock encountered in trench excavations and refer to Occupational Safety and Health Administration (OSHA) standards to determine appropriate slopes. We anticipate the near-surface sand soils will classify as Type C. Temporary excavations in Type C materials require a maximum slope inclination of 1.5:1 (horizontal to vertical) in the absence of groundwater, unless the excavation is shored or braced. Where excavations extend into sound bedrock, these materials will classify as Type A requiring maximum slope inclinations of 0.75:1. 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 excavations and refer to OSHA standards to determine appropriate slopes. Stockpiles of soils and equipment should not be placed within a horizontal distance equal to one-half the excavation depth, from the edge of the excavation.

FOUNDATIONS

Our investigation indicates natural sand and sandstone and possibly claystone bedrock are present at or near anticipated shallow foundation levels. In our opinion, the proposed residences can be constructed with spread footing foundations.

1. Footings should be supported by the natural sand, sandstone, and/or new compacted granular fill. If soft or loose soils are exposed in the excavations, they should be removed or densely compacted. The presence of claystone should be evaluated by excavation of test pits at the time of the excavation observation. If claystone is within 4 feet of the footing foundation excavation, it should be sub-excavated to expose sandstone or to a depth of 4 feet below footing level, whichever occurs first. The excavation should extend at least 5 feet beyond the outer edges of the footings. The excavation should be backfilled with densely compacted fill consisting of the on-site materials that have been moisture conditioned and compacted in thin lifts as specified previously.

2. Footings should be designed for a maximum allowable soil pressure of 3,000 psf and a minimum deadload pressure of 1,000 psf. If interrupted footings are necessary to maintain the recommended deadload, a 4-inch (or thicker) continuous void should be constructed below grade beams or foundation walls, between the pads.

3. Footings should have a minimum width of 16 inches. Foundations for isolated columns should have minimum dimensions of 20 inches by 20 inches. Larger sizes may be required depending on the loads and structural system used.

4. Foundation walls should be well-reinforced. We recommend reinforcement sufficient to span an unsupported distance of at least 10 feet or the distance between pads, whichever is greater. Reinforcement should be designed by the structural engineer considering lateral earth pressure and the effects of large openings on wall performance.

5. We anticipate footings designed using the soil pressure recommended above could experience 1-inch of movement. Differential settlement of 1/2-inch should be considered in the design.

6. Exterior footings must be protected from frost action per local building codes. Normally, 36 inches of frost cover is used in this area.

7. The completed foundation excavation should be observed by a representative of our firm prior to placing the forms to verify subsurface conditions are as anticipated from our borings. Our representative should observe and test the placement and compaction of foundation subgrade fill (if merited) and excavation backfill during placement.

8. Excessive wetting of the foundation soils during and after construction can cause heave or softening and settlement of foundation soils and result in footing and slab movements. Proper surface drainage around the residence and between lots is critical to control wetting. The foundation drain and utility service trench should be braced or installed away from the footings to reduce the risk of undermining the footings. Sump pit and sewer service excavations should avoid undermining the footings or compromising the soil support below and adjacent to footings. The voids around the sump pit excavation should be backfilled with squeegee or “flow fill” to reduce settlement.

SLAB PERFORMANCE RISK

Laboratory test results, subsoil profiles, and our experience with residential construction and performance were used to provide an evaluation of basement slab performance risk. Slab performance risk evaluation is an engineering judgment that is used as a predictor of the general magnitude of potential slab-on-grade movement and the risk of poor slab-on-grade performance. We believe a low risk of poor slab performance will exist for floor slabs underlain by the natural sand, sandstone or dense fill.

FLOOR SYSTEMS AND SLABS-ON-GRADE

Basement Floor Systems and Slabs-on-Grade

Full-depth, garden-level, or a walk-out basement may be constructed at the proposed residences. Our experience indicates basement slab performance has generally been satisfactory on low risk sites. The builder may use a slab-on-grade floor for basement construction. More heavily loaded foundation walls underlain by granular soils can settle relative to lightly loaded slab-on-grade floors. The settlement can result in cosmetic cracking of drywall partitions in stairwells and in finished basements. We recommend slab-on-grade floors be separated from exterior walls and interior bearing members with joints that allow for independent vertical movements of the slab relative to the foundation. Slab bearing partitions should be minimized. Where such partitions are necessary, a slip joint (or float) allowing at least 1-1/2 inches of free vertical slab movement should be used to reduce the risk of cracking the drywall. Doorways should also be designed to allow vertical movement of slabs. To limit damage in the event of movement, sheetrock should not extend to the floor.

Underslab plumbing should be avoided as much as possible. If underslab plumbing is necessary, service lines should be pressure tested for leaks during construction and be provided with flexible couplings. Any utility lines that penetrate the slabs should be isolated from the slabs with joints to allow for free vertical movement. Gas and water lines leading to slab-supported appliances should be constructed with flexibility. Heating and air conditioning systems constructed on slabs should be provided with flexible connections capable of at least 1-1/2 inches of vertical movement so that slab movement is not transmitted to the ductwork.

The 2021 International Residential Code (IRC R506) 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 below-grade floors (unless the underlying soils are free-draining), along with a vapor retarder. The granular soils found on this site are comparatively free-draining. Some building codes state that a 4-inch base course layer consisting of clean graded sand, gravel, crushed stone, or crushed blast furnace slag shall be placed beneath below-grade floors (unless the underlying soils are free-draining), along with a vapor retarder. The granular soils found on this site are comparatively free-draining.

The IRC 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)".

Frequent control joints should be provided in the floor slabs to reduce the effects of curling and to help control shrinkage cracking. Panels that are approximately square generally perform better than rectangular areas.

Structurally Supported Floors

Structural floors should be installed in non-basement, finished living areas. A structural floor is supported by the foundation system. Design and construction issues associated with structural floors include ventilation and lateral loads. Where structurally supported floors are installed in basements or over a crawl space, the required air space depends on the materials used to construct the floor and the potential expansion of the underlying soils. Building codes require a clear space of 18 inches between exposed earth and untreated wood floor components. For non-organic floor systems, we recommend a minimum clear space of 8 inches. This minimum clear space should be maintained between any point on the underside of the floor system (including beams and floor drain traps) and the soils.

Where structurally supported floors are used, utility connections, including water, gas, airduct, and exhaust stack connections to floor supported appliances, should be capable of absorbing some deflection of the floor. Plumbing that passes through the floor should ideally be hung from the underside of the structural floor and not placed on the bottom of the excavation. This configuration may not be achievable for some parts of the installation. It is prudent to maintain the minimum clear space below all plumbing lines. If trenching below the lines is necessary, we recommend sloping these trenches so they discharge to the foundation drain.

Control of humidity in crawl spaces is important for indoor air quality and performance of wood floor systems. We believe the best current practices to control humidity involve the use of a vapor retarder or vapor barrier (10 mil minimum) placed on the soils below accessible sub-floor areas. The vapor retarder/barrier should be sealed at joints and attached to concrete foundation elements. If desired, we can provide designs for ventilation systems that can be installed in association with a vapor retarder/barrier to improve control of humidity in crawl space areas. The Moisture Management Task Force of Metro Denver[2] has compiled additional discussion and recommendations regarding current best practices for the control of humidity in below-grade, under-floor spaces.

Porches, Decks and Patios

Porches and decks with roofs that are integral with a residence should be constructed with the same foundation type as the house when porch or deck foundation movement would damage the structure. Deck foundations should be designed by a structural engineer. For simple decks that are not integral with the residence and can tolerate some movement, the use of short pier or footing foundations bottomed at least 36 inches below grade can be considered, as long as the foundations are located outside foundation wall backfill. Deck foundations should be bottomed

[2] "Guidelines for Design and Construction of New Homes with Below-Grade Under-Floor Spaces," Moisture Management Task Force, October 30, 2003.

below foundation wall backfill to reduce risk of settlement; longer (8 to 10 feet or more) deck piers may be necessary to provide adequate support. The inner edge of a deck may be constructed on haunches or steel angles bolted to the foundation walls and detailed such that movement of the deck foundation will not cause distress to the residence. We suggest use of adjustable bracket-type connections or other details between foundations and deck posts so the posts can be adjusted if movement occurs.

Porches, patio slabs, and other exterior flatwork should be isolated from the structure. Porch slabs can be constructed to reduce the likelihood that settlement or heave will affect the slab. One approach (for smaller porches located over basement backfill zones) is to place loose backfill under a structurally supported slab. This fill will more likely settle than swell, and can thus accommodate some heave of the underlying soils. A lower risk approach is to construct the structural porch slab over void-forming materials. Conditions should allow the void-forming materials to be quickly broken down after construction to reduce the risk of transmitting ground heave to the porch slab. Wax or plastic-coated void boxes should not be used unless provisions are made to allow water vapor to penetrate into the boxes.

Garage Floors and Exterior Flatwork

Garage floors, driveways and sidewalks are normally constructed as slabs-on-grade. Performance of conventional slabs on expansive soils is erratic. Various properties of the soils and environmental conditions influence magnitude of movement and other performance. Increases in the moisture content of these soils will cause heaving and may result in cracking of slabs-on-grade. Backfill below slabs should be moisture conditioned and compacted to reduce settlement, as discussed in BACKFILL COMPACTION. Driveways and exterior slabs founded on the backfill may settle and crack if the backfill is not properly moisture treated and compacted. Where slabs-on-grade are used, we recommend adherence to the precautions for slab-on-grade construction that are included in Exhibit A.

Design criteria for spread footing foundations developed from analysis of field and laboratory data and our experience are presented below. The builder and structural engineer should also consider design and construction details established by the structural warrantor (if any) that may impose additional design and installation requirements. The footings should be constructed on moisture conditioned, densely compacted fill and/or the natural sands.

BELOW-GRADE WALLS

Basement and/or foundation walls and grade beams that extend below grade should be designed to resist lateral earth pressures where backfill is not present to about the same extent on both sides of the wall. Many factors affect the value of the design lateral earth pressure. These factors include, but are not limited to, the wall type, backfill compaction and composition, 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 the wall height (depending upon the backfill types), lower “active” lateral earth pressures are appropriate. Our experience indicates basement walls can deflect or rotate slightly under normal design loads, and that this deflection typically does not affect the structural integrity of the walls. Thus, the earth pressure on the walls will likely be between the “active” and “at-rest” conditions.

If on-site soils are used as backfill and the backfill is not saturated, we recommend design of basement walls at this site using an equivalent fluid density of at least 50 pcf. This value assumes 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 and the effects of large openings on the behavior of the walls.

BACKFILL COMPACTION

Settlement of foundation wall and utility trench backfill can cause damage to concrete flatwork and/or result in poor drainage conditions. Compaction of backfill can reduce settlement. Attempts to compact backfill near foundations to a high degree can cause damage to foundation walls and window wells and may increase lateral pressures on the foundation walls. The potential for cracking of a foundation wall can vary widely based on many factors including the degree of compaction achieved, the weight and type of compaction equipment utilized, the structural design of the wall, the strength of the concrete at the time of backfill compaction, and the presence of temporary or permanent bracing.

Proper moisture conditioning of backfill is as important as compaction, because settlement commonly occurs in response to wetting. The addition of water complicates the backfill process, especially during cold weather. Frozen soils are considered unsuitable for use as backfill because excessive settlement can result when the frozen materials thaw. Exhibit C describes four alternative methods to place, moisture condition, and compact backfill along with a range of possible settlements, and advantages and disadvantages of each approach, all based on our experience. These are just a few of the possible techniques, and represent a range for your evaluation. We recommend Alternatives C or D if you wish to control potential settlement.

Precautions should be taken when backfilling against a basement wall. Temporary bracing of comparatively long, straight sections of foundation walls should be used to limit damage to walls during the compaction process. Waiting at least seven days (or longer during cold weather months) after the walls are placed to allow the concrete to gain strength can also reduce the risk of damage. Compaction of fill placed beneath and next to window wells, counterforts, and grade beams may be difficult to achieve without damaging these building elements. Proper moisture conditioning of the fill prior to placement in these areas will help reduce potential settlement.

Ideally, drainage swales should not be located over the backfill zone (including excavation ramps), as this can increase the amount of water infiltration into the backfill and cause excessive settlement. Swales should be designed to be a minimum of at least 5 feet from the foundation to help reduce water infiltration. Irrigated vegetation, sump pump discharge pipes, sprinkler valve boxes, and roof downspout terminations should also be at least 5 feet from the foundation.

SUBSURFACE DRAINS AND SURFACE DRAINAGE

Water from surface irrigation of lawns and landscaping frequently flows through relatively permeable backfill placed adjacent to a residence, and collects on the surface of less permeable soils occurring at the bottom of basement or foundation excavations. This process can cause wet or moist basement conditions after construction. To reduce the likelihood water pressure will develop outside foundation walls and the risk of accumulation of water at the basement level, we recommend provision of a foundation drain around the entire basement perimeter. The provision of a drain will not eliminate slab movement or prevent moist conditions in crawl spaces. The drain should consist of a 4-inch diameter, perforated or slotted pipe encased in free-draining gravel. The drain should lead to a positive gravity outlet, such as a subdrain located beneath the sewer, or to a sump where water can be removed by pumping. Sump pumps must be maintained by homeowners. A typical foundation drain detail for basement construction is presented in Fig. 4.

Our experience indicates moist conditions can develop in non-basement crawl space areas, resulting in isolated instances of damp soils, musty smells and, in rare cases, standing water. These crawl space areas should be well ventilated, depending on the use of a vapor retarder/barrier and the floor material selected. Some builders install drain systems around non-basement crawl space areas as a precaution; we regard these installations as optional. However, if no basement level is planned within a proposed residence, we recommend a drain be installed in crawl spaces. We can provide recommendations for crawl space drain systems, if desired.

Proper design, construction, and maintenance of surface drainage are critical to the satisfactory performance of foundations, slabs-on-grade, and other improvements. Landscaping and irrigation practices will also affect performance. Exhibit B contains our recommendations for surface drainage, irrigation, and maintenance.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentrations in one sample at less than 0.1 percent. As indicated in our tests and ACI 332-20, the sulfate exposure class is *Not Applicable* or *RS0.*

SULFATE EXPOSURE CLASSES PER ACI 332-20

Exposure Classes		Water-Soluble Sulfate (SO_4) in Soil [A] (%)
Not Applicable	RS0	< 0.10
Moderate	RS1	0.10 to 0.20
Severe	RS2	0.20 to 2.00
Very Severe	RS3	> 2.00

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

For this level of sulfate concentration, ACI 332-20 *Code Requirements for Residential 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 332-20

Exposure Class	Maximum Water/ Cement Ratio	Minimum Compressive Strength [A] (psi)	Cementitious Material Types [B]			Calcium Chloride Admixtures
			ASTM C150/ C150M	ASTM C595/ C595M	ASTM C1157/ C1157M	
RS0	N/A	2500	No Type Restrictions	No Type Restrictions	No Type Restrictions	No Restrictions
RS1	0.50	2500	II	Type with (MS) Designation	MS	No Restrictions
RS2	0.45	3000	V [C]	Type with (HS) Designation	HS	Not Permitted
RS3	0.45	3000	V + Pozzolan or Slag Cement [D]	Type with (HS) Designation plus Pozzolan or Slag Cement [E]	HS + Pozzolan or Slag Cement [E]	Not Permitted

A) Concrete compressive strength specified shall be based on 28-day tests per ASTM C39/C39M
B) Alternate combinations of cementitious materials of those listed in ACI 332-20 Table 5.4.2 shall be permitted when tested for sulfate resistance meeting the criteria in section 5.5.
C) Other available types of cement such as Type III or Type I are permitted in Exposure Classes RS1 or RS2 if the C3A contents are less than 8 or 5 percent, respectively.
D) 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/C1012M and meeting the criteria in section 5.5.1 of ACI 332-20.
E) Water-soluble chloride ion content that is contributed from the ingredients including water aggregates, cementitious materials, and admixtures shall be determined on the concrete mixture ASTM C1218/C1218M between 29 and 42 days.

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 (including the inside and outside faces of garage and crawl space grade beams).

CONSTRUCTION OBSERVATIONS

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

GEOTECHNICAL RISK

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

LIMITATIONS

This report has been prepared for the exclusive use of Joyner Construction CO, Inc. 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 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 evolve in the area of geotechnical engineering. The recommendations provided are appropriate for about three years. If the proposed residences are not constructed within about three years, we should be contacted to determine if we should update this report.

One boring was drilled on each of the investigated lots to obtain a reasonably accurate indication of foundation soil conditions. Variations in the subsoil conditions not indicated by our borings are possible. A representative of our firm should observe the foundation excavation to verify the exposed subsoils are as anticipated.

We believe this investigation was conducted with that level of skill and care ordinarily used by geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.

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

CTL|THOMPSON, INC.

Dennis Pelham

Dennis E. Pelham, E.I.
Staff Engineer

Reviewed by

COLORADO LICENSED
JEFFREY MARK JONES
47539
8/30/23
PROFESSIONAL ENGINEER

Jeffrey M. Jones, P.E.
Associate Engineer

DEP:JMJ:cw
(2 copies sent)

Via e-mail: joynercon@msn.com

EXHIBIT A

SLAB PERFORMANCE RISK EVALUATION, INSTALLATION AND MAINTENANCE

As part of our evaluation of the subsoils and bedrock, samples were tested in the laboratory using a swell test. In the test procedure, a relatively undisturbed sample obtained during drilling is first loaded and then flooded with water and allowed to swell. The pressure applied prior to wetting can approximate the weight of soil above the sample depth or be some standard load. The measured percent swell is not the sole criteria in assessing potential movement of slabs-on-grade and the risk of poor slab performance. The results of a swell test on an individual lot are tempered with data from surrounding lots, depth of tests, depth of excavation, soil profile, and other tests. This judgment has been described by the Colorado Association of Geotechnical Engineers[3] (CAGE, 1996) as it relates to basement slab-on-grade floors. It can also be used to help judge performance risk for other slabs-on-grade such as garage floors, driveways, and sidewalks. The risk evaluation is considered when we evaluate appropriate foundation systems for a given site. In general, more conservative foundation designs are used for higher risk sites to control the likelihood of excessive foundation movement.

As a result of the Slab Performance Risk Evaluation, sites are categorized as low, moderate, high, or very high risk. This is a judgment of the swelling characteristics of the soils and bedrock likely to influence slab performance.

REPRESENTATIVE MEASURED SWELL
AND CORRESPONDING SLAB
PERFORMANCE RISK CATEGORIES

Slab Performance Risk Category	Representative Percent Swell* (500 psf Surcharge)	Representative Percent Swell* (1000 psf Surcharge)
Low	0 to <3	0 to <2
Moderate	3 to <5	2 to <4
High	5 to <8	4 to <6
Very High	≥ 8	≥ 6

*Note: The representative percent swell values presented are not necessarily measured values; rather, they are a judgment of the swelling characteristics of the soil and bedrock likely to influence slab performance.

[3] **"Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations", Colorado Association of Geotechnical Engineers, December 1996.**

The rating of slab performance risk on a site as low or high is not absolute. Rather, this rating represents a judgment. Movement of slabs may occur with time in low, moderate, high, and very high risk areas as the expansive soils respond to increases in moisture content. Overall, the severity and frequency of slab damage usually is greater in high and very high rated areas. Heave of slabs-on-grade of 3 to 5 inches is not uncommon in areas rated as high or very high risk. On low and moderate risk sites, slab heave of 1 to 3 inches is considered normal and we believe in most instances, movements of this magnitude constitute reasonable slab performance. Slabs can be affected on all sites. On lots rated as high or very high risk, there is more likelihood of need to repair, maintain or replace basement and garage floors and exterior flatwork.

CTL|Thompson, Inc. recommends use of structurally-supported basement floors, known as "structural floors," for lots rated as high and very high risk. We also recommend use of structural basement floors on walkout and garden-level lots rated as moderate, high or very high risk. Sub-excavation is an appropriate option to reduce slab performance risk, as discussed in the report. We believe the risk of movement and damage for slabs underlain by properly moisture conditioned and compacted fill will be low. If home buyers cannot tolerate movement of a slab-on-grade basement floor, they should select a lot where a structurally-supported floor will be constructed or request that a structurally-supported floor be installed.

The home buyer should be advised the floor slab in the basement may move and crack due to heave or settlement and that there may be maintenance costs associated during and after the builder warranty period. A buyer who chooses to finish a basement area must accept the risk of slab heave, cracking and consequential damages. Heave or settlement may require maintenance of finish details to control damage. Our experience suggests that soil moisture increases below residence sites due to covering the ground with the house and exterior flatwork, coupled with the introduction of landscape irrigation. In most cases, slab movements (if any) resulting from this change occur within three to five years. We suggest delaying finish in basements with slab-on-grade floors until at least three years after start of irrigation. It is possible basement floor slab and finish work performance will be satisfactory if a basement is finished earlier, particularly on low risk sites.

For portions of the houses where conventional slabs-on-grade are used, we recommend the following precautions. These measures will not keep slabs-on-grade from heaving; they tend to mitigate damages due to slab heave.

1. Slab-on-grade floor construction should be limited to areas such as garages and basements where slab movement and cracking are acceptable to the builder and home buyer.

2. Some building codes state that a 4-inch base course layer consisting of clean graded sand, gravel, crushed stone, or crushed blast furnace slag shall be placed beneath below-grade floors (unless the underlying soils

are free-draining), along with a vapor retarder. Installation of the base course and vapor retarder is not common in this area. Historically, there has been some concern that installation of clean base course could allow wetting of expansive soils to spread from an isolated source.

The codes state 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)".

3. Conventional slabs should be separated from exterior walls and interior bearing members with a slip joint that allows free vertical movement of the slabs. These joints must be maintained by the home buyer to avoid transfer of movement.

4. Underslab plumbing should be thoroughly pressure tested during construction for leaks and be provided with flexible couplings. Gas and waterlines leading to slab-supported appliances should be constructed with flexibility. The home buyer must maintain these connections.

5. Use of slab bearing partitions should be minimized. Where such partitions are necessary, a slip joint (or float) allowing at least 2 inches of free vertical slab movement should be used. Doorways should also be designed to allow vertical movement of slabs. To limit damage in the event of movement, sheetrock should not extend to the floor. The home buyer should monitor partition voids and other connections and re-establish the voids before they close to less than 1/2-inch.

6. Plumbing and utilities that pass through slabs should be isolated from the slabs. Heating and air conditioning systems constructed on slabs should be provided with flexible connections capable of at least 2 inches of vertical movement so slab movement is not transmitted to the ductwork. These connections must be maintained by the home buyer.

7. Roofs that overhang a patio or porch should be constructed on the same foundation as the residence. Isolated piers or pads may be installed beneath a roof overhang provided the slab is independent of the foundation elements. Patio or porch roof columns may be positioned on the slab, directly above the foundation system, provided the slab is supported by the foundation system. Structural porch or patio slabs should be constructed to reduce the likelihood that settlement or heave will affect the slab by placing loose backfill under the structurally-supported slab or constructing the slab over void-forming materials.

8. Patio and porch slabs without roofs and other exterior flatwork should be isolated from the foundation. Movements of slabs should not be transmitted to the foundation. Decks are more flexible and more easily adjusted in the event of movement.

9. Frequent control joints should be provided in conventional slabs-on-grade to reduce problems associated with shrinkage cracking and curling. Panels that are approximately square generally perform better than rectangular areas.

EXHIBIT B

SURFACE DRAINAGE,
IRRIGATION AND MAINTENANCE

Performance of foundations and concrete flatwork is influenced by the moisture conditions existing within the foundation soils. Surface drainage should be designed to provide rapid runoff of surface water away from proposed residences. Proper surface drainage and irrigation practices can help control the amount of surface water that penetrates to foundation levels and contributes to settlement or heave of soils and bedrock that support foundations and slabs-on-grade. Positive drainage away from the foundation and avoidance of irrigation near the foundation also help to avoid excessive wetting of backfill soils, which can lead to increased backfill settlement and possibly to higher lateral earth pressures, due to increased weight and reduced strength of the backfill. CTL|Thompson, Inc. recommends the following precautions. The home buyer should maintain surface drainage and, if an irrigation system is installed, it should substantially conform to these recommendations.

1. Wetting or drying of the open foundation excavations should be avoided.

2. Excessive wetting of foundation soils before, during and after construction can cause heave or softening of fill and foundation soils and result in foundation and slab movements. Proper surface drainage around the residences and between lots is critical to control wetting.

3. The ground surface surrounding the exterior of each residence should be sloped to drain away from the building in all directions. We recommend a minimum constructed slope of at least 12 inches in the first 10 feet (10 percent) in landscaped areas around each residence, where practical. The recommended slope is for the soil surface slope, not the surface of the landscaping rock.

   We do not view the recommendation to provide a 10 percent slope away from the foundation as an absolute. It is desirable to create this slope where practical, because we know that backfill will likely settle to some degree. By starting with sufficient slope, positive drainage can be maintained for most settlement conditions. There are many situations around a residence where a 10 percent slope cannot be achieved practically, such as around patios, at inside foundation corners, and between a house and nearby sidewalk. In these areas, we believe it is desirable to establish as much slope as practical and to avoid irrigation. We believe it is acceptable to use a slope on the order of 5 percent perpendicular to the foundation in these limited areas.

For lots graded to direct drainage from the rear yard to the front, it is difficult to achieve 10 percent slope at the high point behind the house. We believe it is acceptable to use a slope of about 6 inches in the first 10 feet (5 percent) at this location.

Between houses that are separated by less than 20 feet, the constructed slope should generally be at least 10 percent to the swale used to convey water out of this area. For lots that are graded to drain to the front and back, we believe it is acceptable to install a slope of 5 to 8 percent at the high point (aka “break point”) between houses.

Construction of retaining walls and decks adjacent to the residence should not alter the recommended slopes and surface drainage around the residence. The ground surface under the deck should be compacted and slope away from the residence. A 10-mil plastic sheeting and landscaping rock are recommended above the ground under the decks to reduce water dripping from the deck causing soil erosion and/or forming depressions under the deck. The plastic sheeting should direct water away from the residence. Retaining walls should not flatten the ground surface around the residence and block or impede the surface runoff.

4. Swales used to convey water across yards and between houses should be sloped so that water moves quickly and does not pond for extended periods of time. We suggest minimum slopes of about 2 to 2.5 percent in grassed areas and about 2 percent where landscaping rock or other materials are present. If slopes less than about 2 percent are necessary, concrete-lined channels or plastic pipe should be used. Fence posts, trees, and retaining walls should not impede the runoff in the swale.

5. Backfill around the foundation walls should be moistened and compacted, as discussed previously in the BACKFILL COMPACTION section of the report.

6. 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. We generally recommend against burial of downspout discharge. Where it is necessary to bury downspout discharge, solid, rigid pipe should be used and it should slope to an open gravity outlet. Downspout extensions, splash blocks and buried outlets must be maintained by the homeowner.

7. The importance of proper homeowner irrigation practices cannot be over-emphasized. Irrigation should be limited to the minimum amount sufficient to maintain vegetation; application of more water will increase likelihood of slab and foundation movements. Landscaping should be

carefully designed and maintained to minimize irrigation. Plants placed close to foundation walls should be limited to those with low moisture requirements and utilize only subsurface irrigation such as standard, low-volume drip emitters or in-line drip irrigation. Irrigated grass, irrigation mainlines, above-surface spray heads, rotors, and other above-surface irrigation spray devices should not be located or discharge within 5 feet of the foundation.

Homeowners should periodically check and maintain landscaping and irrigation systems to control introduction of surface water. This maintenance should include, but not be limited to:

- Assure proper ground surface slope (not landscape rock) away from the foundation (yearly).
- Orient downspout extensions and splash blocks away from the foundation (monthly). Keep downspout tip-ups in the down position.
- Clean roof gutters (yearly).
- Check and, if necessary, repair the irrigation system (backflow preventer, sprinkler heads, drip system heads, and pipe) to assure the system components are intact, do not leak, and that spray is directed away from foundations (twice per year).

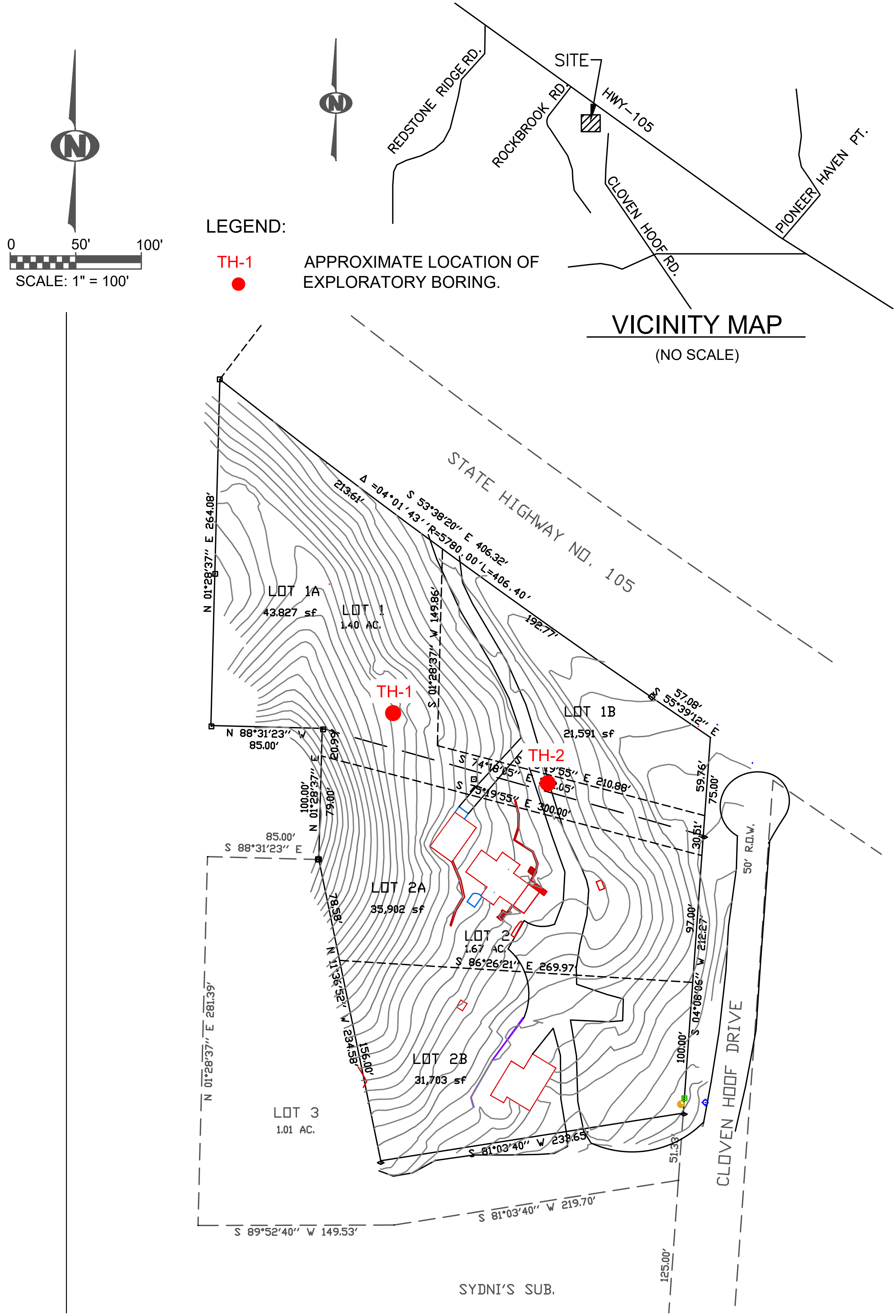
8. Plastic sheeting should not be placed beneath landscaped areas adjacent to foundation walls or grade beams. Geotextile fabric will inhibit weed growth yet still allow natural evaporation to occur.

9. The design and construction criteria for foundations and floor system alternatives 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.

EXHIBIT C

EXAMPLE BACKFILL COMPACTION ALTERNATIVES

Alt.	Description	Possible Settlement	Pros (+) / Cons (-)
A	Place in 18 to 24-inch lifts, without moisture conditioning. Compact lift surface to about 85 percent of maximum standard Proctor (ASTM D698) dry density. (Not recommended)	5 to 15 percent of depth (for 8 feet of backfill, 5 to 15 inches)	+ Fast + Water not required - Excessive settlement - Highest water penetration - Highest probability of warranty repair
B	Moisture condition within 2 percent of optimum, place in 12 to 18-inch lifts. Compact lift surface to about 85 to 90 percent.	5 to 10 percent of depth	+ Relatively Fast - Moderate water penetration - Excessive settlement - Need for water - Warranty repairs probable
C	Moisture condition to within 2 percent of optimum and place in 8 to 12-inch lifts. Compact lift surface to 90 to 95 percent.	2 to 5 percent of depth	+ Reduced warranty + Reduced water infiltration + Reduced settlement - Possible higher lateral pressure - Slower - Need for water - Potential damage to walls
D	Moisture condition and place as in C. Compact lift surface to at least 95 percent.	1 to 2 percent of depth	+ Reduced warranty + Reduced water infiltration + Lowest comparative settlement - Possible higher lateral pressure - Slower - Need for water - Potential damage to walls



Location of Exploratory Borings

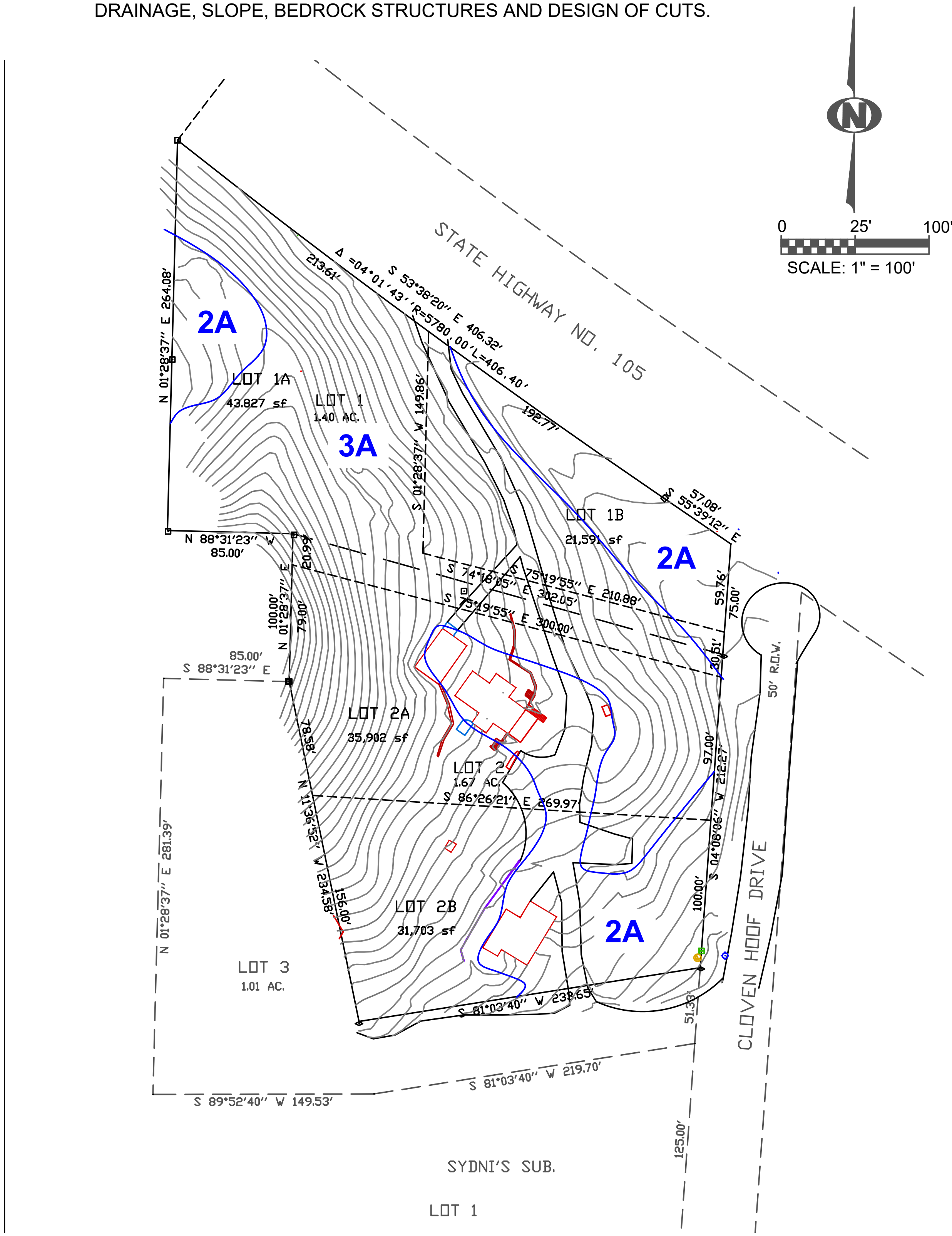
FIG. 1

JOYNER CONSTRUCTION CO, INC.
CLOVEN HOOF, LOTS 1 AND 2, MORGAN SUBDIVISION, FILING 1
CTL|T PROJECT NO. CS19720-120

LEGEND:

2A STABLE ALLUVIUM, COLLUVIUM AND BEDROCK ON GENTLE TO MODERATE SLOPES (5%-12%). EMPHASIS ON SURFACE AND SUBSURFACE DRAINAGE.

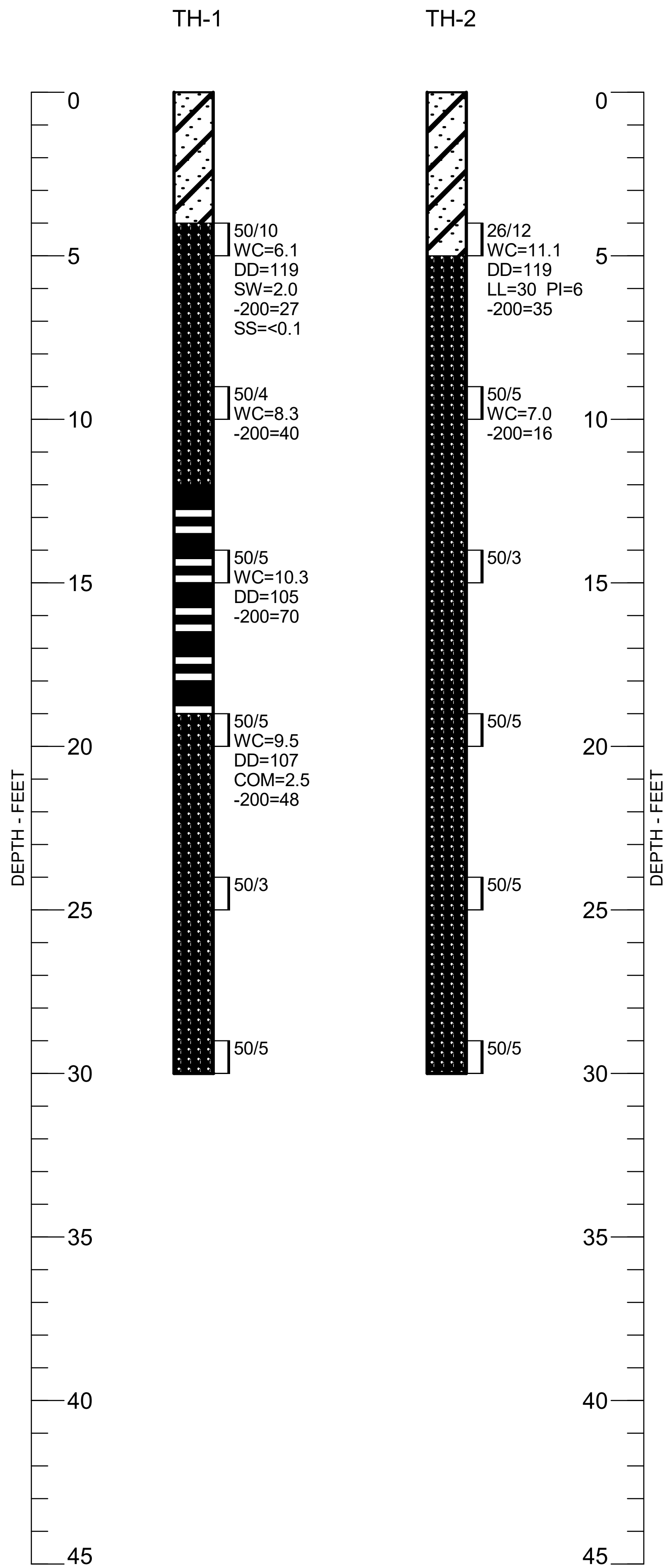
3A STABLE ALLUVIUM, COLLUVIUM AND BEDROCK ON MODERATE TO STEEP SLOPES (12%-24%). INCLUDES SOME OLD ALLUVIAL FANS ALONG MOUNTAIN FRONT THAT HAVE BEEN DISSECTED BY MODERN STREAMS. EMPHASIS ON DRAINAGE, SLOPE, BEDROCK STRUCTURES AND DESIGN OF CUTS.



JOYNER CONSTRUCTION CO, INC.
CLOVEN HOOF, LOTS 1 AND 2, MORGAN SUBDIVISION, FILING 1
CTL|T PROJECT NO. CS19720-120

Engineering Conditions

FIG. 2



LEGEND:

SAND, SILTY, CLAYEY, MEDIUM DENSE, SLIGHTLY MOIST, BROWN (SC-SM).

BEDROCK, SANDSTONE, CLAYEY, SLIGHTLY SILTY TO VERY SILTY, HARD TO VERY HARD, MOIST, BROWN, WHITE.

BEDROCK, CLAYSTONE, SANDY, VERY HARD, SLIGHTLY MOIST, BROWN, GRAY.

DRIVE SAMPLE. THE SYMBOL 50/10 INDICATES 50 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 10 INCHES.

NOTES:

1. THE BORINGS WERE DRILLED JULY 24, 2023 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-45, 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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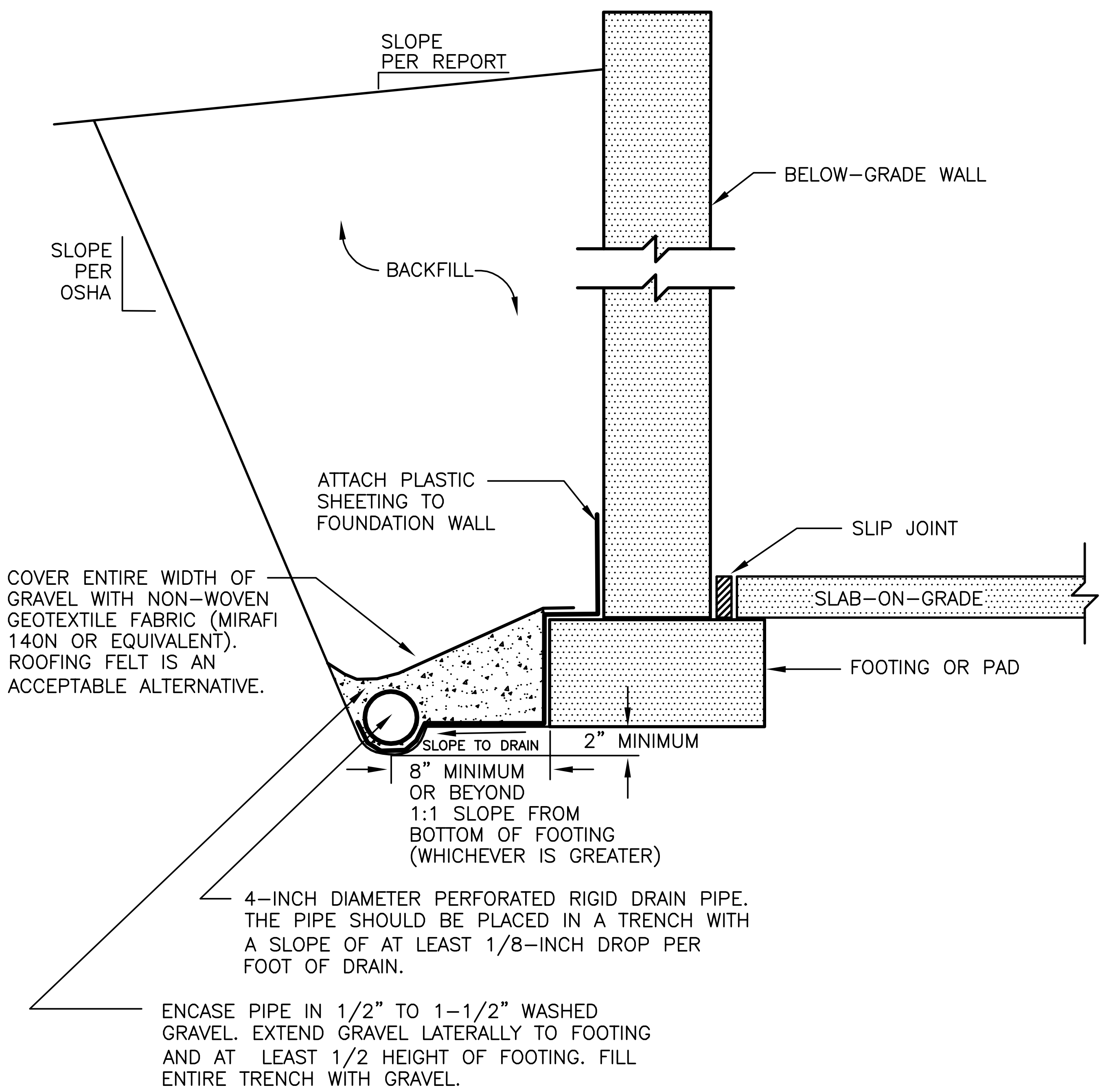
CLOVEN HOOF, LOTS 1 AND 2, MORGAN SUBDIVISION, FILING 1
CTL|T PROJECT NO. CS19720-120

Summary Logs of Exploratory Borings

FIG. 3

00-FTG-XTR-SOG-01



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

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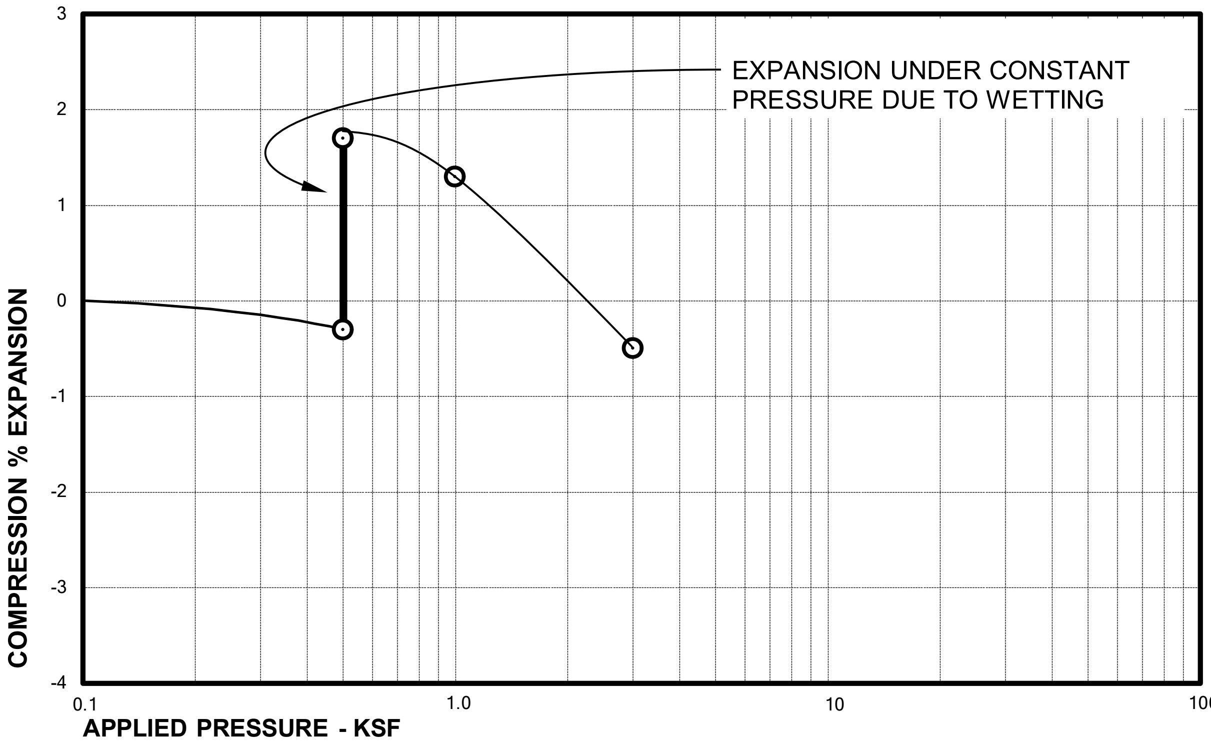
CTL|T PROJECT NO. CS19720-120

Exterior Foundation Wall Drain

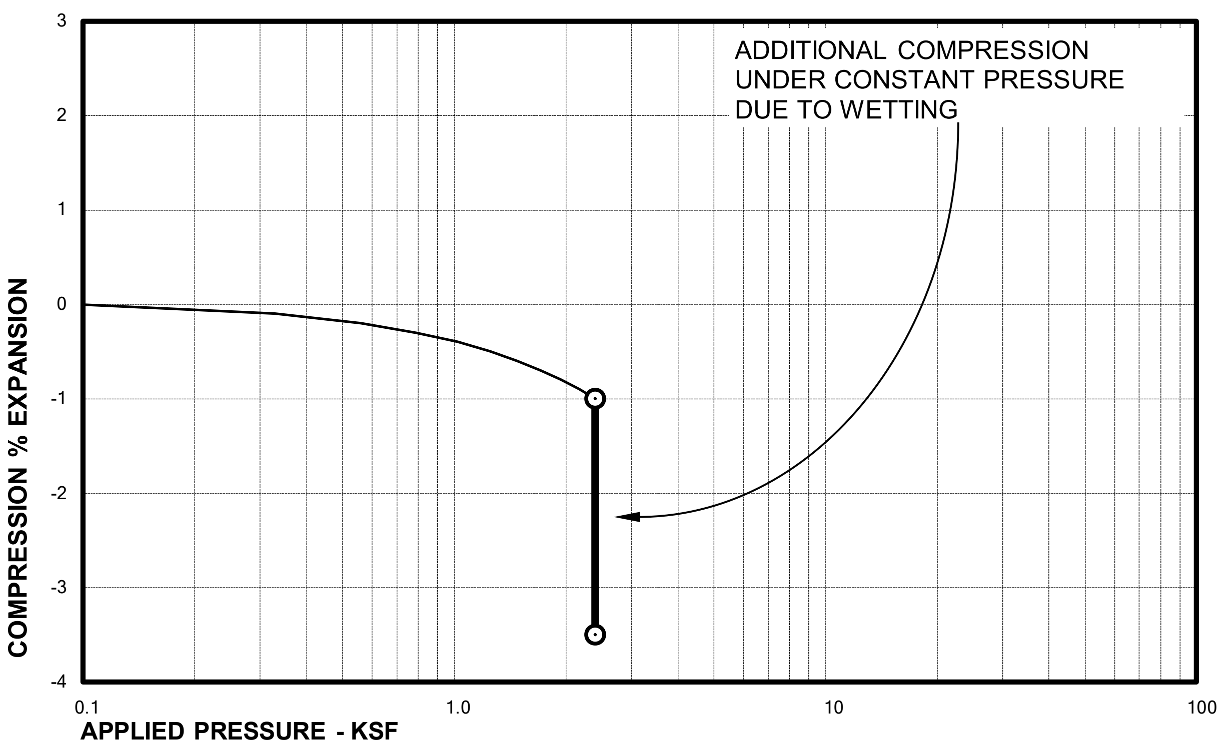
Fig. 4

APPENDIX A

LABORATORY TEST RESULTS
TABLE A-I – SUMMARY OF LABORATORY TEST RESULTS



Sample of	SANDSTONE, CLAYEY	DRY UNIT WEIGHT=	119	PCF
From	TH-1 AT 4 FEET	MOISTURE CONTENT=	6.1	%



Sample of	SANDSTONE	DRY UNIT WEIGHT=	107	PCF
From	TH-1 AT 19 FEET	MOISTURE CONTENT=	9.5	%

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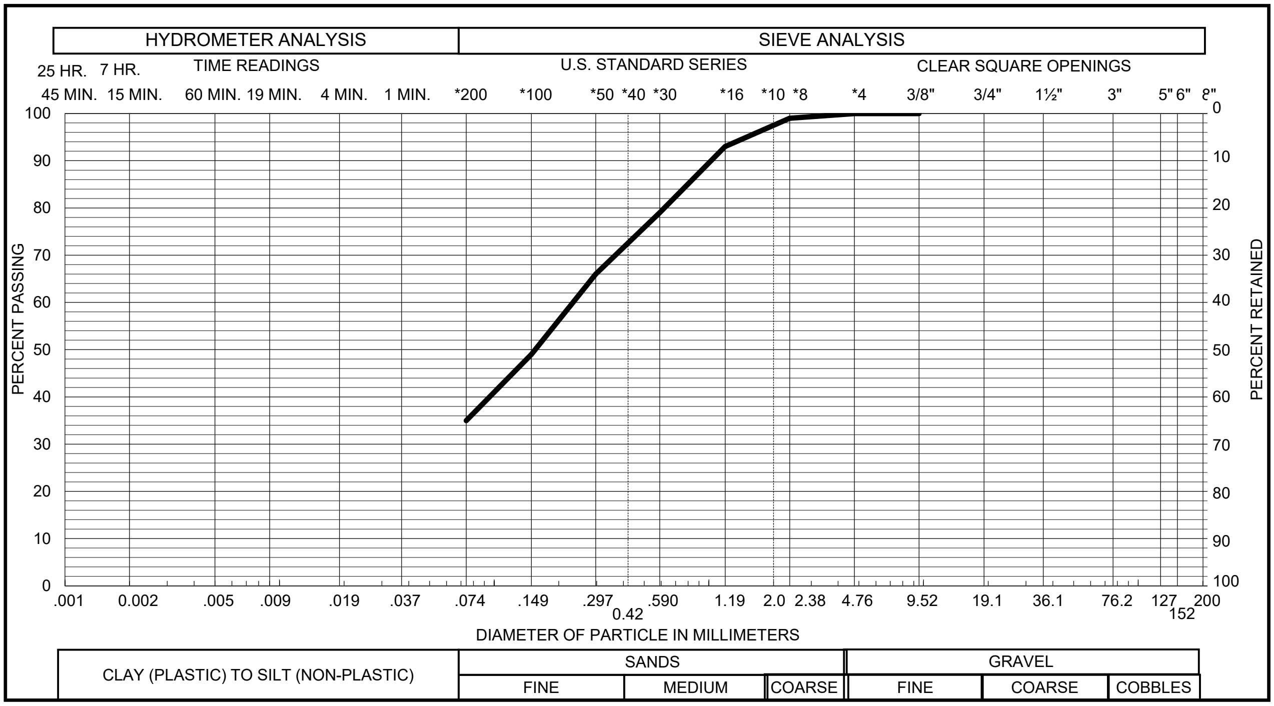
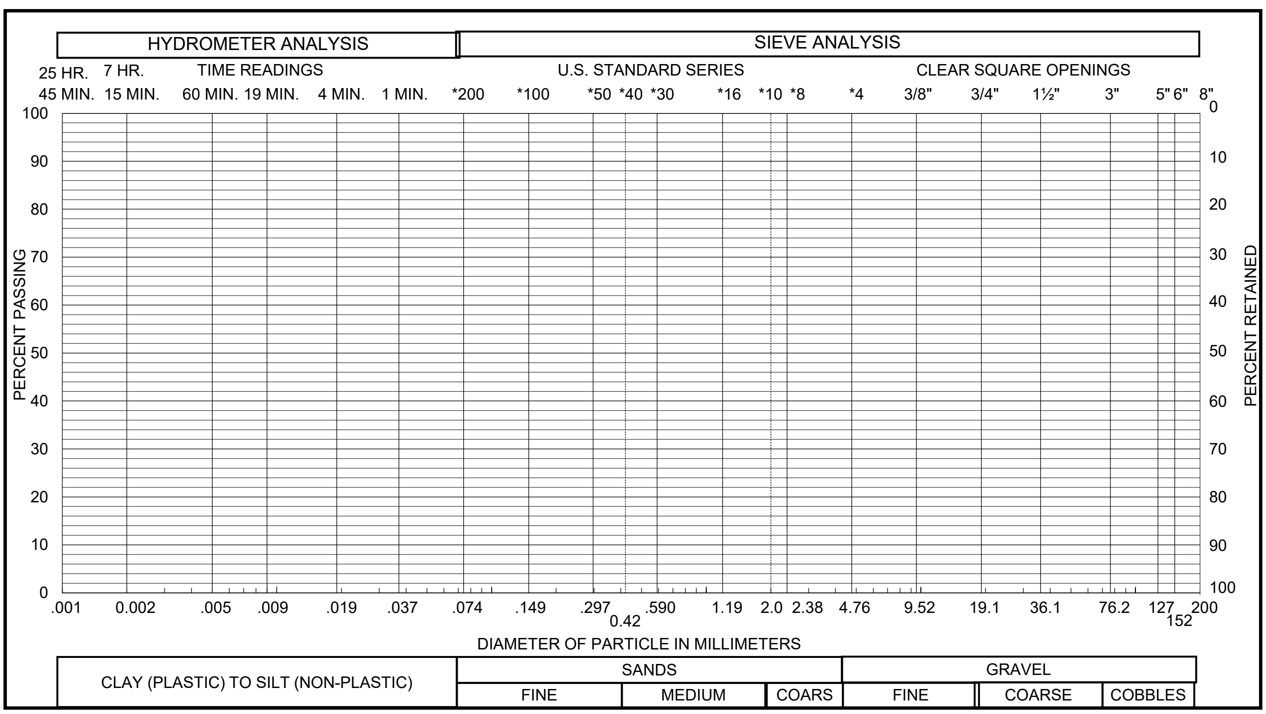
Swell Consolidation Test Results

FIG. A-1



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

GRAVEL 0 % SAND 65 %
SILT & CLAY 35 % LIQUID LIMIT 30
PLASTICITY INDEX 6



Sample of
From

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

JOYNER CONSTRUCTION CO, INC.
COVEN HOOF, LOTS 1 AND 2, MORGAN SUBDIVSION, FILING 1
CTL|T PROJECT NO. CS19720-120

Gradation Test Results

FIG. A-2

TABLE A-1

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19720-120

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS		SWELL TEST RESULTS*			PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
				LIQUID LIMIT	PLASTICITY INDEX	SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)			
TH-1	4	6.1	119			2.0	500	2000	27	<0.1	SANDSTONE, SILTY
TH-1	9	8.3							40		SANDSTONE, VERY SILTY
TH-1	14	10.3	105						70		CLAYSTONE, SANDY
TH-1	19	9.5	107			-2.5	2400		48		SANDSTONE, VERY SILTY
TH-2	4	11.1	119	30	6				35		SAND, SILTY, CLAYEY (SC-SM)
TH-2	9	7.0							16		SANDSTONE, SILTY

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