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Geotechnical / Environmental Engineering • Materials Testing

Reviewed for Code Compliance

06/06/2022

March 24, 2009

Darin Heiter
395 E. Bayaud Avenue
Denver, CO 80209

Job Number: 09-8295

Subject: Subsoil and Foundation Investigation, Proposed Heiter Residence, 29550 County Road 14D, Routt County, Colorado.

Ladies and Gentlemen:

This report presents the results of the Subsoil and Foundation Investigation for the proposed Heiter Residence to be constructed at 29550 County Road 14D in Routt County, Colorado. The approximate location of the project site is shown in Figure #1.

The scope of our work included obtaining data from cursory observations made at the site, the logging of three test holes, the sampling of the probable foundation soils and the laboratory testing of the samples obtained. This report presents recommendations for economically feasible and safe type foundations, as well as allowable soil pressures and other design and construction considerations that are advisable, but not necessarily routine to quality design and building practices.

Proposed Construction: The building plans were not available at the time of our investigation. We have assumed that the proposed residence will consist of a one to two-story log or wood-framed structure constructed over a full-depth walkout basement and with an attached garage. We have also assumed that the lower levels of the residence and attached garage will be constructed utilizing concrete slab-on-grade floor systems placed from 0 to 8 feet below the existing ground surface.

For design purposes, we have assumed that the building loads will be light to moderate typical of this type of residential construction. If loadings or conditions are significantly different from those above, we should be notified to reevaluate the recommendations in this report.

Site Conditions: The proposed building site is situated at the north of County Road 14D in Routt County, Colorado. The site was occupied by an existing residence at the time of our investigation and was covered by two to three feet of snow. It appears that the vegetation at the site consists of grasses and weeds.

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The topography of the site is variable and generally slopes moderately to strongly down to the north, northwest and southwest on the order of 10 to 15 percent. It appears that an elevation difference of approximately 6 to 8 feet exists across the building site.

Subsurface Conditions: To investigate the subsurface conditions at the site, three test holes were drilled on March 12, 2009 with an all-terrain mounted drill rig using 4-inch diameter continuous flight augers. The approximate test hole locations are shown in Figure #2.

The subsurface conditions encountered were fairly consistent and generally consisted of a layer of topsoil and organic materials overlying natural sands and sandstone bedrock to the maximum depth investigated, 25 feet. Graphic logs of the exploratory test holes are presented in Figure #3, and the associated Legend and Notes are presented in Figure #4.

A layer of natural topsoil and organic materials was encountered at the ground surface in all of the test holes and was approximately 12 inches thick. Natural sands were encountered below the layer of topsoil and organic materials in all of the test holes and extended to depths ranging from 3 to 7 feet beneath the existing ground surface. The natural sands were clayey to very clayey, fine to coarse grained, low to moderately plastic, medium dense, slightly moist and brown in color. A sample of the natural sands classified as a SC soil in accordance with the Unified Soil Classification System.

Sandstone bedrock materials were encountered below the sands in test holes 1 and 2, and extended to the maximum depth investigated in each test hole. The sandstone bedrock materials were silty to clayey, fine to coarse grained, slightly conglomeratic, low to non-plastic, hard to very hard, slightly moist to moist and brown to light brown in color. A sample of the sandstone bedrock classified as a SM soil in accordance with the Unified Soil Classification System.

Swell-consolidation tests conducted on samples of the natural sands and sandstone bedrock indicate that the materials tested exhibited a very low to low swell potential when wetted under a constant load. The swell-consolidation test results are presented in Figures #5 and #6, and all of the other laboratory test results are summarized in the attached Table 1.

Groundwater seepage was not encountered in the test holes at the time of drilling. It should be noted that the groundwater conditions at the site can be expected to fluctuate with changes in precipitation and runoff.

Foundation Recommendations: Based on the soils encountered in the test holes, the results of the field and laboratory investigations and our understanding of the proposed construction, we believe an economically feasible type of foundation system is spread footings or individual pads with grade beams founded on the undisturbed natural sands or sandstone bedrock.

1) The footings placed on the undisturbed, sands and/or sandstone bedrock should be designed using an allowable soil bearing pressure of 3,000 psf. The footings should also be designed for a minimum dead load pressure of at least 600 psf.

2) The footings or pad sizes should be computed using the above soil pressures and placed on the natural undisturbed sands and/or sandstone bedrock. Any topsoil and organic materials encountered within the foundation excavations should be removed and the excavations extended to competent sands or bedrock materials prior concrete placement. The footings may have to be narrow or interrupted to maintain the minimum dead load. The foundation design should be closely checked to assure that it distributes the loads per the allowable pressures given.

3) The foundation walls should be designed and reinforced to span an unsupported distance of 10 feet or the length between pads, whichever is greater.

4) The footings or pads should be placed well enough below final backfill grades to protect them from frost heave. Forty-eight (48) inches is typical for this location considering normal snow cover and other winter factors.

5) Based on experience, we estimate the total settlement for footings and pads designed and constructed as discussed in this section will be approximately 1 inch. Additional bearing capacity values along with the associated settlements are presented in Figure #7.

6) We strongly recommend that the client retain our firm to observe the foundation excavations when they are near completion to identify the bearing soils and confirm the recommendations in this report.

<u>Floor Slabs:</u> The on-site soils, with the exception of the topsoil and organic materials, are capable of supporting slab-on-grade construction. However, floor slabs present a difficult problem where swelling materials are present near floor slab elevation because sufficient dead load cannot be imposed on them to resist the uplift pressure generated when the materials are wetted and expand. Based on the moisture-volume change characteristics of the natural sands and sandstone bedrock encountered at this site, we believe slab-on-grade construction may be used, provided the risk of distress resulting from slab movement is recognized and special design precautions are followed.

The following measures should be taken to reduce the damage, which could result from movement should the underslab clays be subjected to moisture changes.

1) The floor slabs should be separated from all bearing walls, columns and their foundation supports with a positive slip joint. We recommend the use of ½-inch thick cellotex or impregnated felt.

2) Interior non-bearing partition walls resting on the floor slabs should be provided with a slip joint, preferably at the bottom, so that in the event the floor slab moves, this movement is not transmitted to the upper structure. This detail is also important for wallboard and doorframes and is shown in Figure #8.

3) A minimum 6-inch gravel layer should be provided beneath all floor slabs to act as a capillary break and to help distribute pressures. Prior to placing the gravel, the excavation should be shaped

so that if water does get under the slab, it will flow to the low point of the excavation. In addition, all of the topsoil and organic materials and any soft or disturbed sands should be removed prior to placement of the underslab gravels or new fill materials.

4) The floor slabs should be provided with control joints placed a maximum of 12 feet on center in each direction to help control shrinkage cracking. The location of the joints should be carefully checked to assure that the natural, unavoidable cracking will be controlled. The depth of the control joints should be a minimum of ¼ of the thickness of the slab.

5) The underslab soils should be kept as close as possible to their in-situ moisture content. Excessive wetting or drying of these soils prior to placement of the floor slab could result in differential movement after the slabs are constructed.

6) If fills are required to bring the underslab soils to the desired grade, the fill should consist of non-expansive, granular materials. The fill should be uniformly placed and compacted in 6 to 8 inch loose lifts to at least 95% of the maximum standard Proctor density at or near the optimum moisture content, as determined by ASTM D-698/AASHTO T-99.

The above precautions and recommendations will not prevent floor slab movement in the event the sands or bedrock materials beneath the floor slabs undergo moisture changes. However, they should reduce the amount of damage if such movement occurs. The only way to eliminate the risk of all floor slab movement is to construct a structural floor over a well-vented crawl space.

Underdrain System: Any lower levels or crawl space areas constructed below the existing or finished ground surfaces should be protected by an underdrain system to help reduce the problems associated with surface and subsurface drainage during high runoff periods. Localized perched water or runoff can infiltrate the lower levels of the structure at the foundation level. This water can be one of the primary causes of differential foundation and slab movement. Especially, when expansive soils are encountered. Excessive moisture in crawl space areas or lower level can also lead to rotting and mildewing of wooden structural members and the formation of mold and mold spores. The formation of mold and mold spores could have detrimental effects on the air quality in these areas, which in turn can lead to potential adverse health effects.

The drains should be located around the entire perimeter of the lower levels and be placed and at least 12 inches below any floor slab or crawl space level and at least 6 inches below the foundation voids and bottom of the footings. We recommend the use of perforated PVC pipe for the drainpipe, which meets ASTM D-2729 requirements, to minimize the potential for crushing the pipe during backfill operations. The holes in the drainpipe should be oriented down between 4 o'clock and 8 o'clock to promote rapid runoff of the water. The drainpipe should be surrounded with at least 12 inches of free draining gravel and should be protected from contamination by a filter covering of Mirafi 140N subsurface drainage fabric or an equivalent product. The drains should have a minimum slope of 1/8 inch per foot and should be day lighted at a positive outfall protected from freezing, or be led to a sump from which the water can be pumped. Caution should be taken when backfilling so as not to damage or disturb the installed underdrain. We recommend the drainage system include at least one cleanout, be protected against intrusion by animals at the outfall and be tested prior to backfilling. We also recommend that the client retain this firm to observe the underdrain system during construction to verify that it is being installed in accordance with our recommendations and observe a flow test prior to backfilling the system.

In addition, we recommend that an impervious barrier be constructed to keep water from infiltrating through the voided areas and/or under the footings. The barrier should be constructed of an impervious material, which is approved by this office and placed below the perimeter drain and up against the sides of the foundation walls. A typical perimeter/underdrain detail is shown in Figure #9. The placement of the impervious membrane and properly compacted clays in the crawl space areas to the top of the footings or at least 12 inches above the top of the foundation voids or bottom of the foundation walls will help reduce the moisture problems in these areas.

<u>Foundation Walls and Retaining Structures:</u> Foundation walls and retaining structures, which are laterally supported and can be expected to undergo only a moderate amount of deflection, may be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 45 pcf for imported, free draining granular backfill and 55 pcf for the on-site materials.

Cantilevered retaining structures on the site can be expected to deflect sufficiently to mobilize the full active earth pressure condition. Therefore, cantilevered structures may be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 35 pcf for imported, free draining granular backfill and 45 pcf for the on-site materials.

The foundation walls and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent buildings, traffic and construction materials. An upward sloping backfill and/or natural slope will also significantly increase the earth pressures on foundation walls and retaining structures and the structural engineer should carefully evaluate these additional lateral loads when designing the foundation and retaining walls.

The lateral resistance of retaining wall foundations placed on undisturbed natural soils at the site will be a combination of the sliding resistance of the footings on the foundation materials and the passive pressure against the sides of the footings. Sliding friction can be taken as 0.4 times the vertical dead load. Passive pressure against the sides of the footing can be calculated using an equivalent fluid pressure of 250 pcf. The fill placed against the sides of the footings to resist lateral loads should be compacted to at least 100% of the maximum standard Proctor density and near the optimum moisture content.

We recommend imported granular soils for backfilling foundation walls and retaining structures because their use results in lower lateral earth pressures. The imported granular materials should be placed to within 2 to 3 feet of the ground surface. Imported granular soils should be free draining and have less than 7 percent passing the No. 200 sieve. The granular soils behind foundation and retaining walls should be sloped from the base of the wall at an angle of at least 45 degrees from the vertical. The upper 2 to 3 feet of fill should be a relatively impervious soil or pavement structure to prevent surface water infiltration into the backfill.

The wall backfill should be carefully placed in uniform lifts and compacted to at least 95 percent of the maximum standard Proctor density and near the optimum moisture content. Care should be taken not to overcompact the backfill since this could cause excessive lateral pressure on the walls. Some settlement of deep foundation wall backfill materials will occur even if the material is placed correctly.

Surface Drainage: Proper surface drainage at this site is of paramount importance for minimizing the infiltration of surface drainage into the wall backfill and bearing soils, which could result in increased wall pressures, differential foundation and slab movement. The following drainage precautions should be observed during construction and at all times after the structure has been completed:

1) The ground surface surrounding the structure should be sloped (minimum of 1.0 inch per foot) to drain away from the structure in all directions to a minimum of 10 feet. Ponding must be avoided. If necessary, raising the top of foundation walls to achieve a better surface grade is advisable.

2) Non-structural backfill placed around the structure should be compacted to at least 95% of the maximum standard Proctor density at or near the optimum moisture content in order to minimize future settlement of the fill. The backfill should be placed immediately after the braced foundation walls are able to structurally support the fill. Puddling or sluicing must be avoided.

3) The top 2 to 3 feet of soil placed within 10 feet of the foundation should be impervious in nature to minimize infiltration of surface water into the wall backfill.

4) Roof downspouts and drains should discharge well beyond the limits of all backfill. Roof overhangs, which project two to three feet beyond the foundation, should be considered if gutters are not used.

5) Landscaping, which requires excessive watering and lawn sprinkler heads, should be located a minimum of 10 feet from the foundation walls of the structure.

6) Plastic membranes should not be used to cover the ground surface adjacent to foundation walls.

Site Grading: The slopes on which the proposed structure and driveway are proposed could become unstable as a result of the proposed construction. Design and construction considerations must be addressed to avoid and/or limit the potential for slope instability at the site and adjacent sites. Although a detailed slope stability analysis is beyond the scope of this report, some general guidelines are provided below for initial planning and design. Our office should review the construction plans as they are being prepared so that we can verify that our recommendations are being properly incorporated into the plans. Additional recommendations and/or investigations may be warranted at that time.

1) Slopes greater than 25 percent should be avoided whenever possible for construction of permanent roads and structures.

2) Temporary cuts for foundation construction should be constructed to OSHA standards for temporary excavations. Permanent, unretained cuts for driveways or building sites should be kept as shallow as possible and should not exceed a 2(Horizontal) to 1(Vertical) configuration. We recommend these cuts be limited to 10 feet in height or less unless stable bedrock is encountered. The risk of slope instability will be significantly increased if groundwater seepage is encountered in the cuts. This office should be notified immediately to evaluate the site, if seepage is encountered or deeper cuts are planned and determine if additional investigations and/or stabilization measures are warranted.

3) Excavating during periods of low runoff at the site can reduce potential slope instability during excavation. Excavations should not be attempted during the spring or early summer when seasonal runoff and groundwater levels are typically high.

4) Fills up to 10 feet in height can be constructed at the site and should be constructed to a 2(Horizontal) to 1(Vertical) or flatter configuration. The fill areas should be prepared by stripping any topsoil and organics, scarification and compaction to at least 95% of the maximum standard Proctor density and within 2% of optimum moisture content as determined by ASTM D698/AASHTO T99. The fills should be properly benched/keyed into the natural hillsides after the topsoil and organic materials have been removed. The fill materials should consist of the on-site soils (exclusive of topsoil, organics or silts) and be uniformly placed and compacted in 6 to 8 inch loose lifts to the minimum density value and moisture content range indicated above.

5) Proper surface drainage features should be provided around all permanent cuts and fills and steep natural slopes to direct surface runoff away from these areas. Cuts, fills and other stripped areas should be protected against erosion by revegetation or other methods. Areas of concentrated drainage should be avoided and may require the use of riprap for erosion control.

6) A qualified engineer experienced in this area should prepare site grading and drainage plans. The contractor must provide a construction sequencing plan for excavation, wall construction and bracing and backfilling for the steeper and more sensitive portions of the site prior to starting the excavations or construction.

Limitations: The recommendations given in this report are based on the soils and bedrock materials encountered at this site and our understanding of the proposed construction. We believe that this information gives a high degree of reliability for anticipating the behavior of the proposed structure; however, our recommendations are professional opinions and cannot control nature, nor can they assure the soil profiles beneath those or adjacent to those observed. No warranties expressed or implied are given on the content of this report.

Swelling soils and bedrock materials were encountered at this site. These soils and bedrock materials are stable at their natural moisture content but can shrink or swell with changes in moisture. The behavior of swelling soils/bedrock is not fully understood. The swell potential of any particular site can change erratically both in lateral and vertical extent. Moisture changes also occur erratically, resulting in conditions, which cannot always be predicted. The recommendations presented in this report are based on the current state of the art for foundations and floor slabs on swelling soils/bedrock. The owner should be aware that there is a risk in construction on these types of soil/bedrock. Performance of the structure will depend on following the recommendations and in proper maintenance after construction is complete. As water is the main cause for volume change in the soils/bedrock, it is necessary that the changes in moisture content be kept to a minimum. This requires judicious irrigation and providing positive surface drainage away from the structure. Any distress noted in the structure should be brought to the attention of a professional engineer.

This report is based on the investigation at the described site and on the specific anticipated construction as stated herein. If either of these conditions is changed, the results would also most likely change. Therefore, we strongly recommend that our firm be contacted prior to finalizing the construction plans so that we can verify that our recommendations are being properly incorporated into the construction plans. Man-made or natural changes in the conditions of a property can also occur over a period of time. In addition, changes in requirements due to state of the art knowledge and/or legislation do from time to time occur. As a result, the findings of this report may become invalid due to these changes. Therefore, this report is subject to review and not considered valid after a period of 3 years or if conditions as stated above are altered.

It is the responsibility of the owner or his representative to insure that the information in this report is incorporated into the plans and/or specifications and construction of the project. It is advisable that a contractor familiar with construction details typically used to dealing with the local subsoils and climatic conditions be retained to build the structure. If you have any questions regarding this report or if we may be of further service, please do not hesitate to contact us.

Sincerely,
NWCC, INC.

Josh P. Frappart, E.I.T.

COLORADO REGISTERED
BRIAN D. LEN
25750
3/25/09
PROFESSIONAL ENGINEER

Reviewed by Brian D. Len, P.E.

xc: Todd Young

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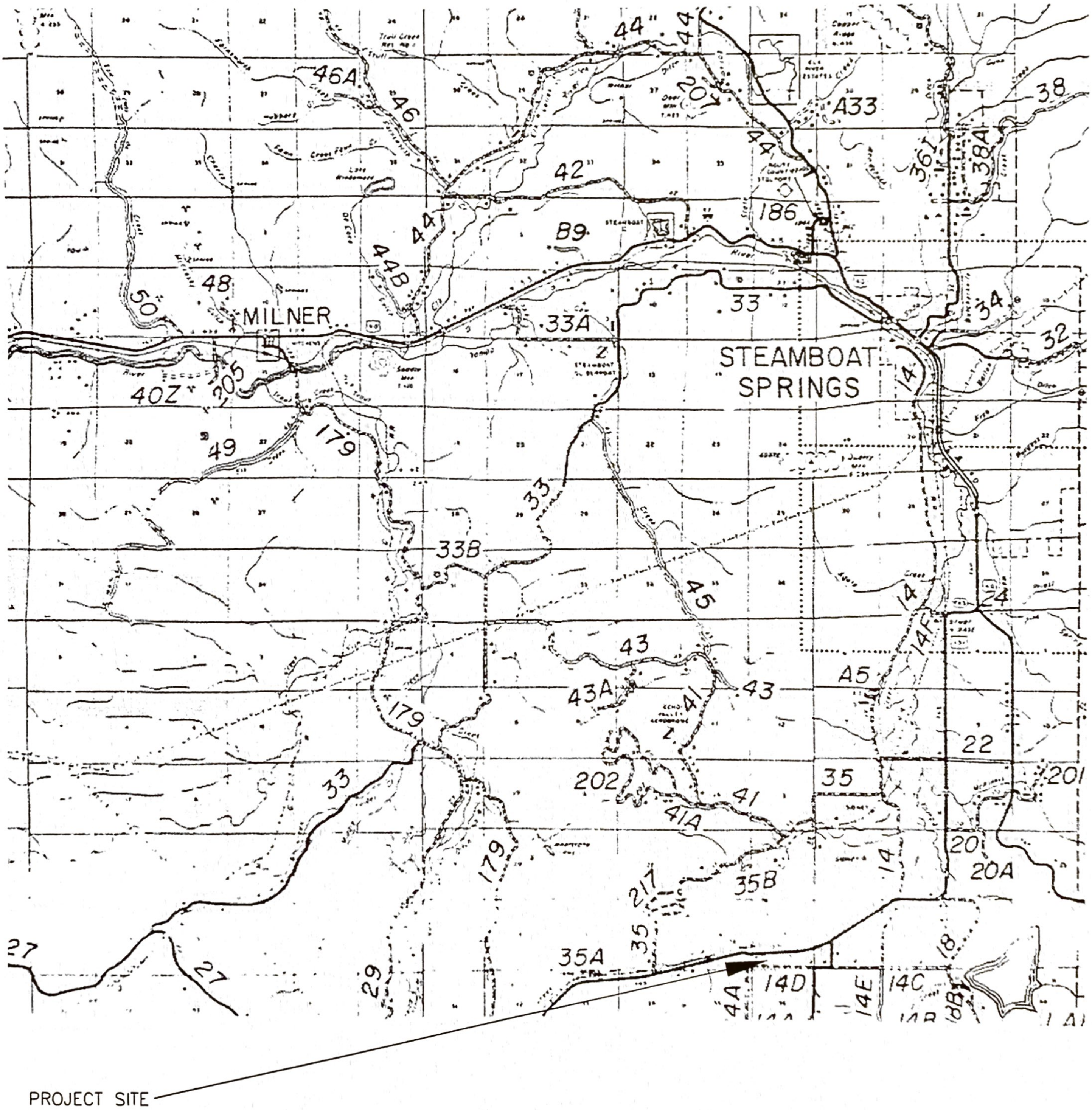
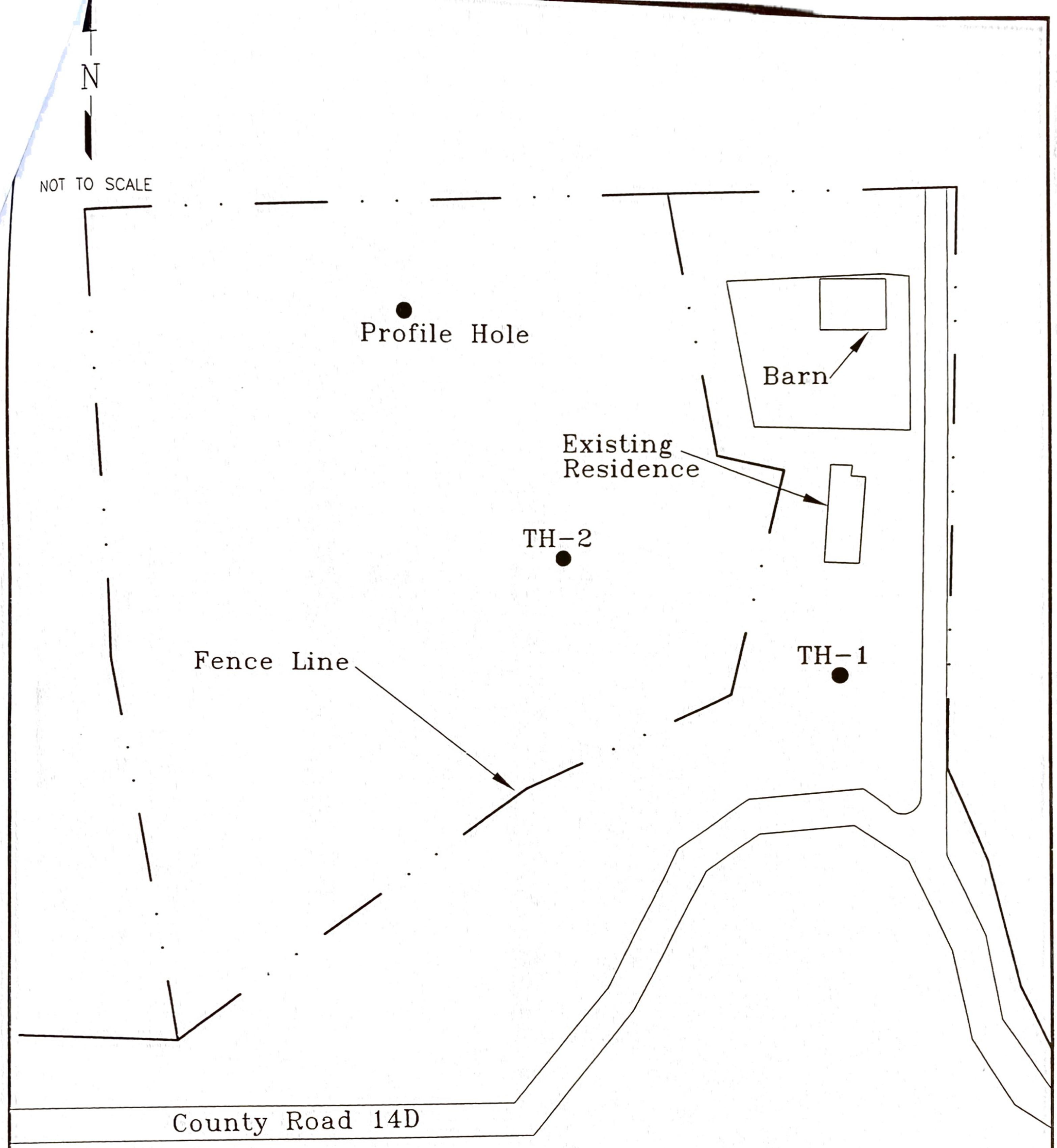


Title: VICINITY MAP	Date: 3/23/09	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing (970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Proposed Heiter Residence	Job No. 09-8295	
Location: 29550 County Road 14D, Routt County, CO	Figure #1	



Title: SITE PLAN-LOCATION OF TEST HOLES		Date: 3/23/09	NWCC North West Colorado Consultants, Inc.
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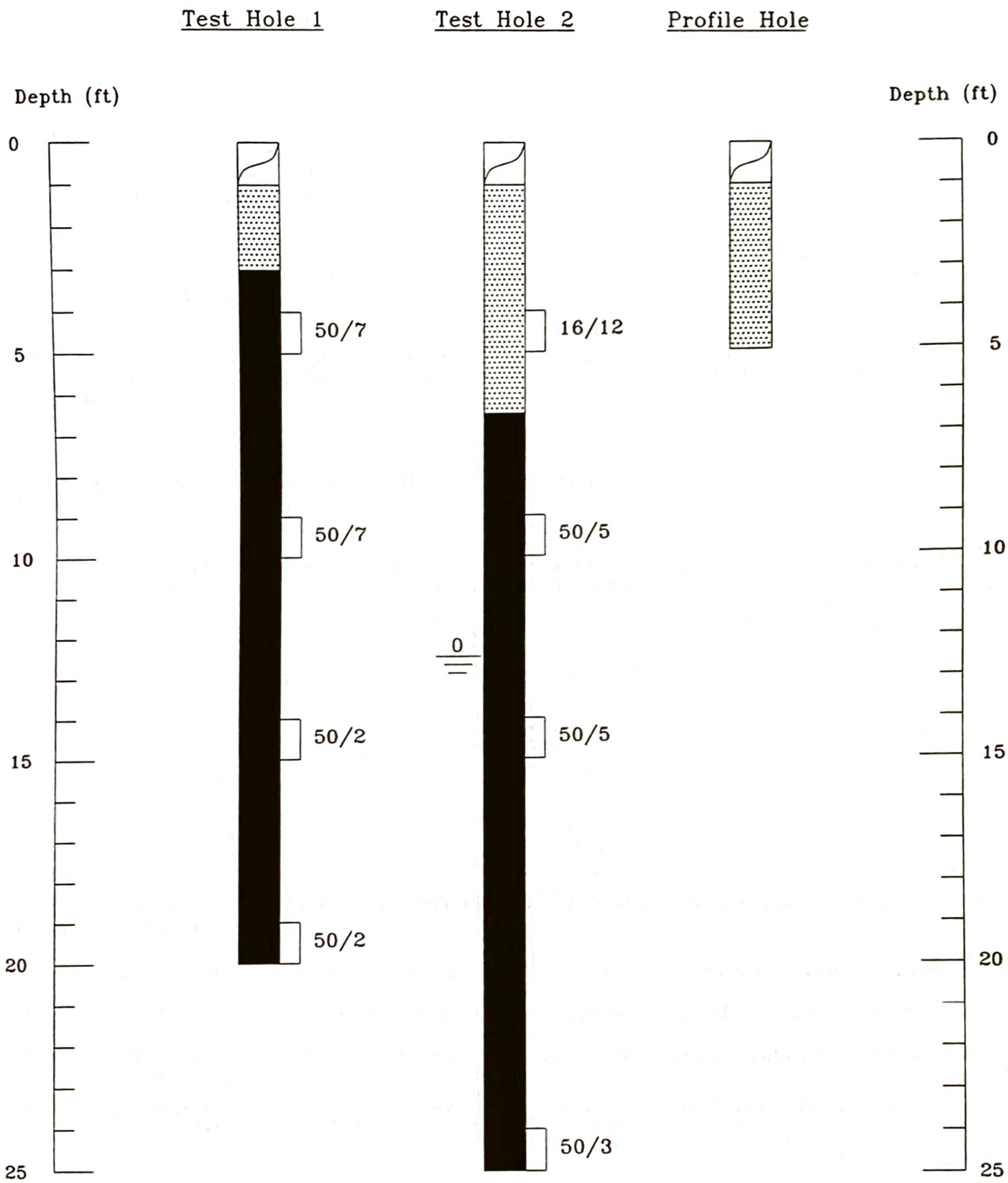

Title: LOGS OF EXPLORATORY TEST HOLES	Date: 3/23/09	NWCC North West Colorado Consultants, Inc.
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LEGEND:

TOPSOIL AND ORGANICS:

SAND: Clayey to very clayey, fine to coarse grained, low to moderately plastic, medium dense, slightly moist and brown in color.

SANDSTONE BEDROCK: Silty to clayey, fine to coarse grained, slightly conglomeratic, low to non-plastic, hard to very hard, slightly moist to moist and brown to light brown in color.

Drive Sample, 2-inch I.D. California Liner Sampler.

50/7 Drive Sample Blow Count, indicates 50 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 7 inches.

NOTES:

1) The test holes were drilled on March 12, 2009 with an all terrain drill rig using 4-inch diameter continuous flight power augers.

2) Locations of the test holes were determined in the field by pacing from topographic features at the site.

3) Elevations of the test holes were not measured and logs are drawn to the depths investigated.

4) The lines between materials shown on the logs represent the approximate boundaries between material types and transitions may be gradual.

5) The water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water levels will probably occur with time.

Title: LEGEND AND NOTES	Date: 3/23/09	North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing
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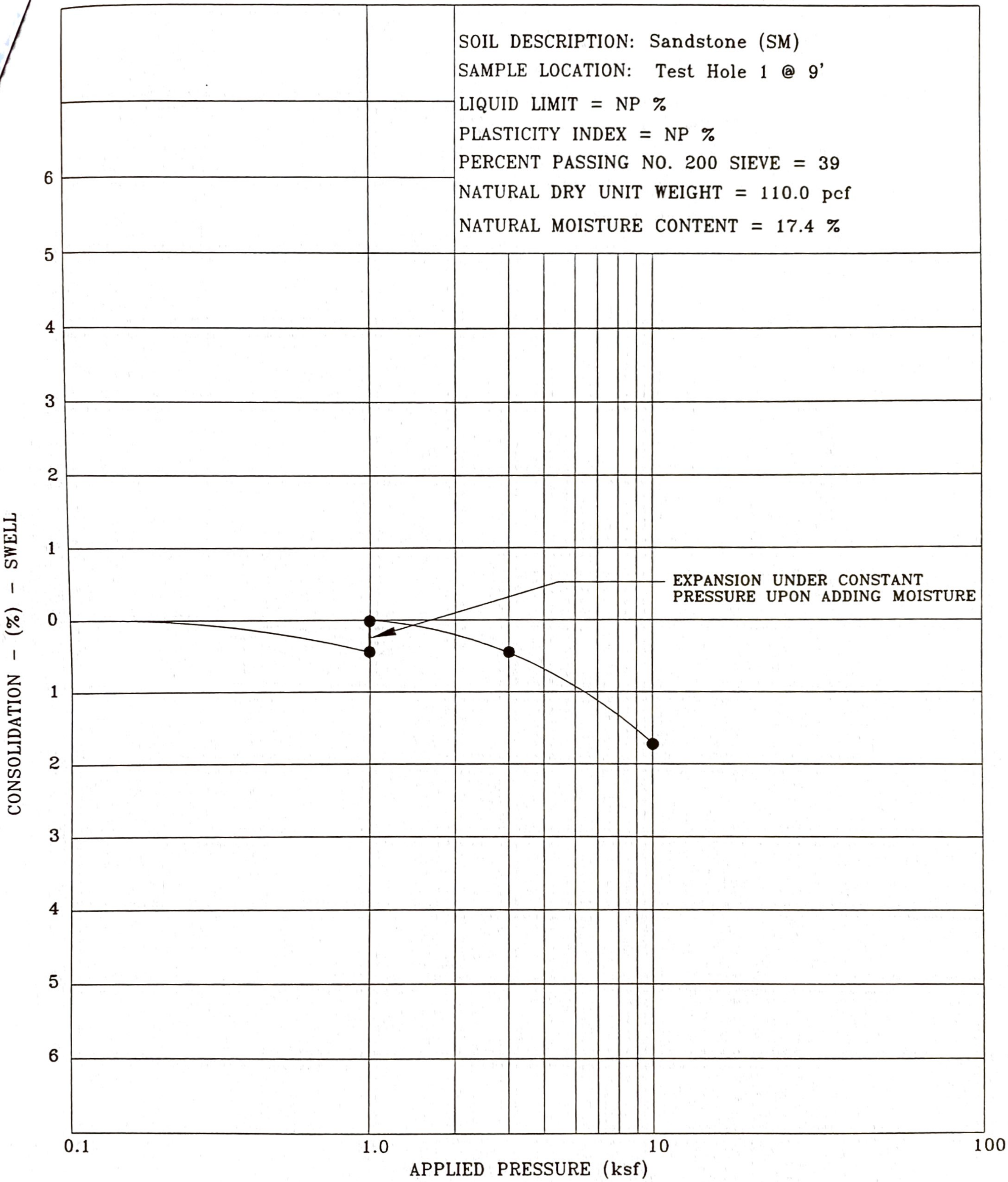
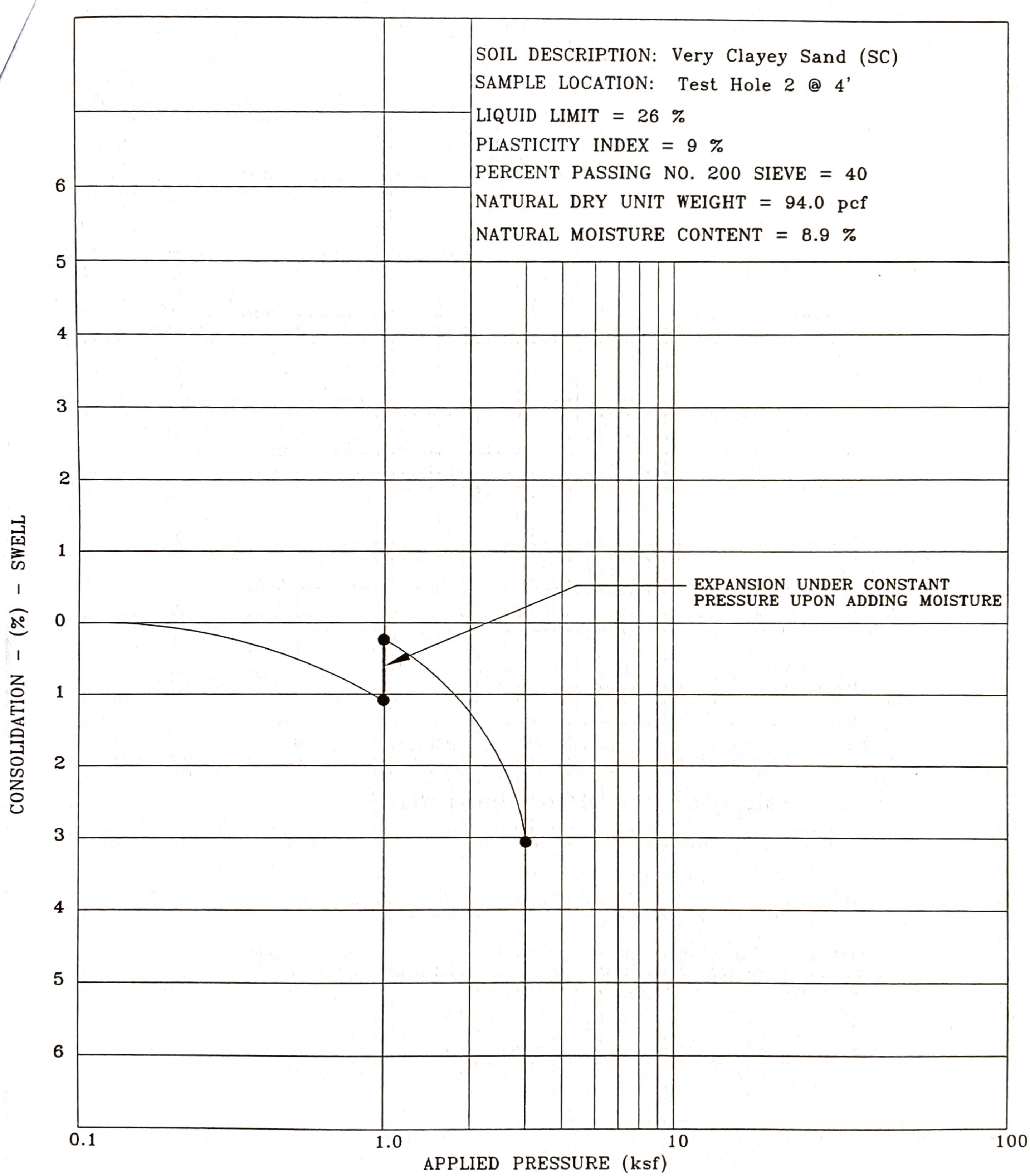
Location: 29550 County Road 14D, Routt County, CO	Figure #4	



Title: SWELL-CONSOLIDATION TEST RESULTS	Date: 3/23/09	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing (970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Proposed Heiter Residence	Job No. 09-8295	
Location: 29550 County Road 14D, Routt County, CO	Figure #5	



Title: SWELL-CONSOLIDATION TEST RESULTS	Date: 3/23/09
Job Name: Proposed Heiter Residence	Job No. 09-8295
Location: 29550 County Road 14D, Routt County, CO	Figure #6

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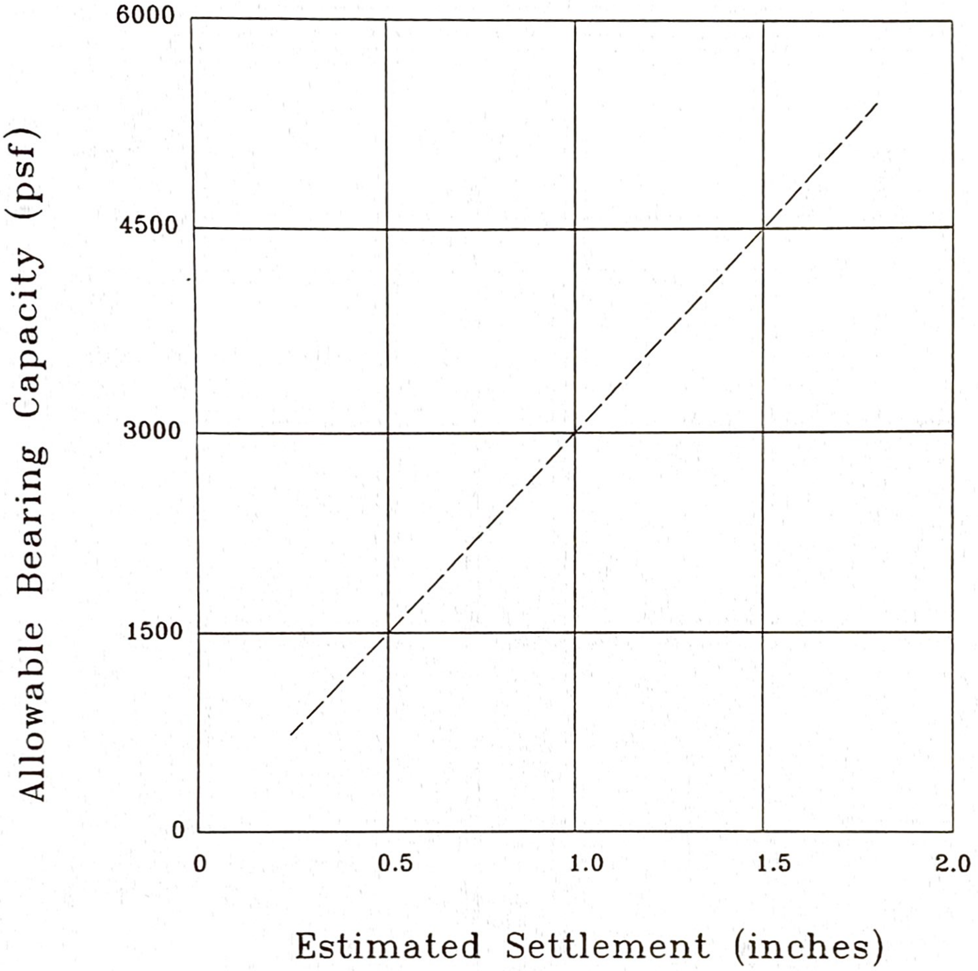
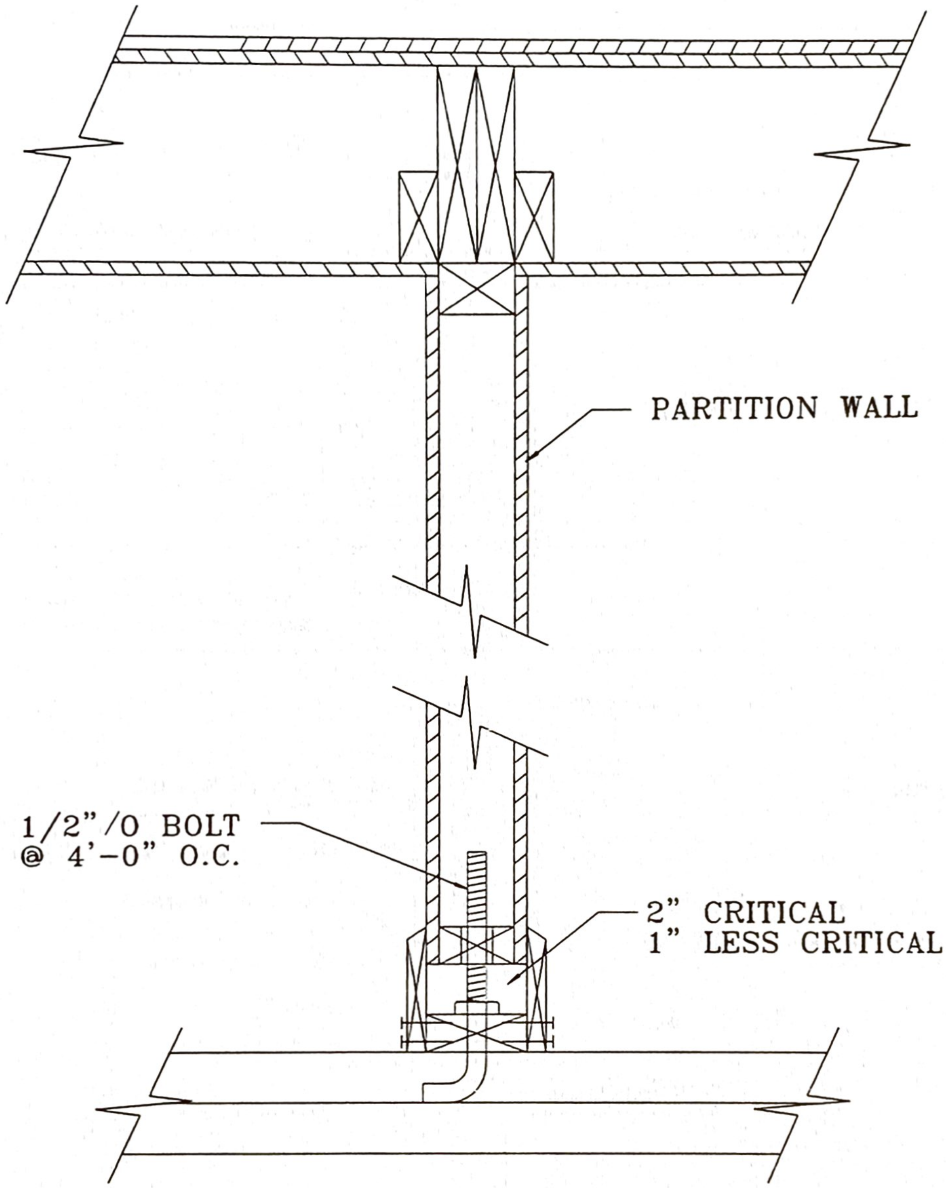


Note: These values are based on footing widths of 1 to 4 feet. If the footing width is to be greater than 4 feet in width, then we should be notified to re-evaluate these recommendations.

Title: BEARING CAPACITY CHART	Date: 3/23/09	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing (970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Proposed Heiter Residence	Job No. 09-8295	
Location: 29550 County Road 14D, Routt County, CO	Figure #7	



Title: HUNG PARTITION WALL DETAIL	Date: 3/23/09	NWCC North West Colorado Consultants, Inc.
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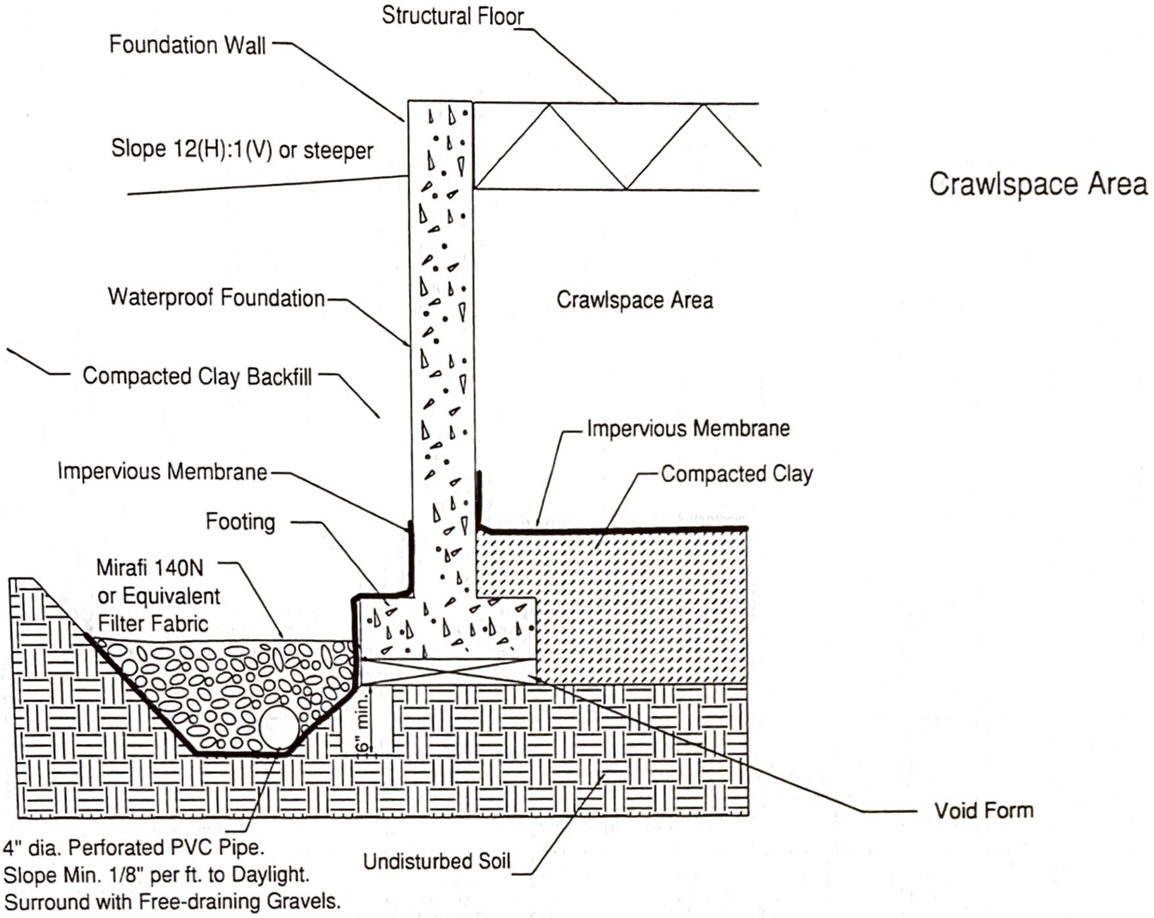
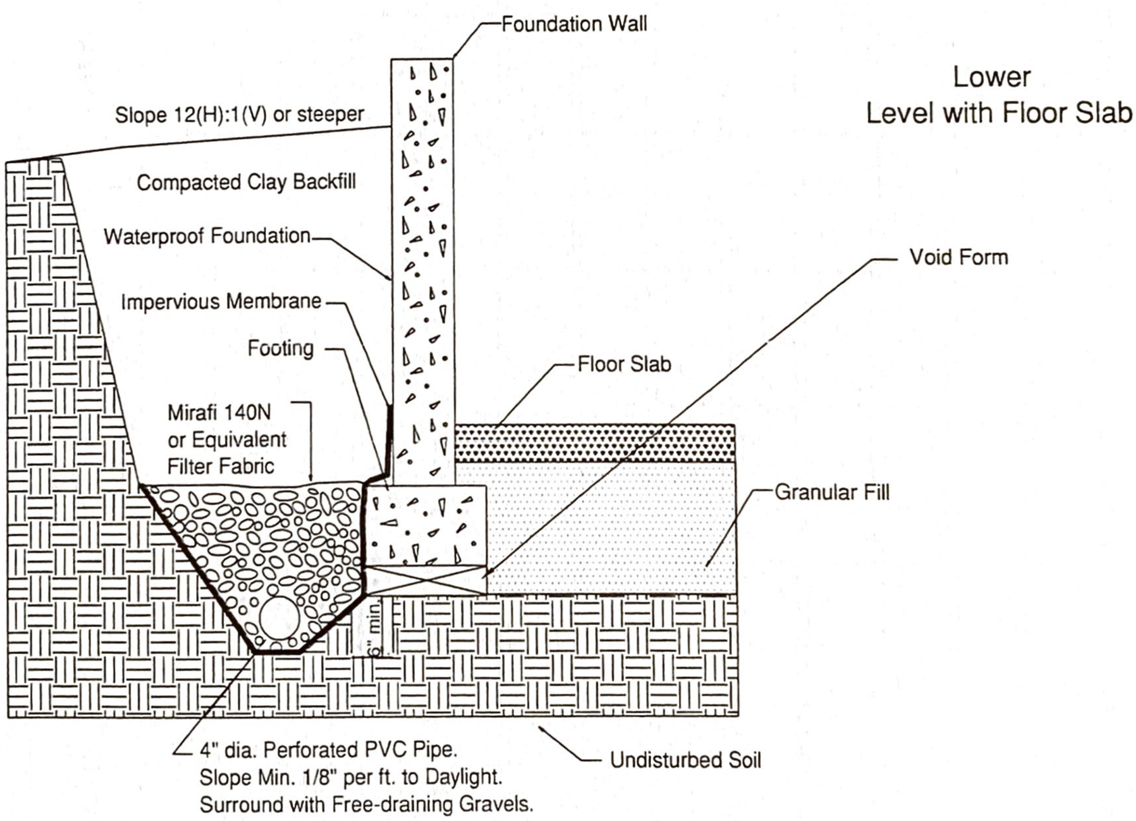
Location: 29550 County Road 14D, Routt County, CO	Figure #8	(970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487





Title: PERIMETER/UNDERDRAIN DETAIL	Date: 3/23/09	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing (970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Proposed Heiter Residence	Job No. 09-8295	
Location: 29550 County Road 14D, Routt County, CO	Figure #9	

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TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	ATTERBERG LIMITS		GRADATION		PERCENT PASSING No. 200 SIEVE	UNCONFINED COMPRESSIVE STRENGTH (psf)	SOIL or BEDROCK DESCRIPTION	UNIFIED SOIL CLASS.
TEST HOLE	DEPTH (feet)			LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAVEL (%)	SAND (%)				
1	9	17.4	110.0	NP	NP	0	61	39		Sandstone	SM
2	4	8.9	94.0	26	9	1	59	40		Very Clayey Sand	SC