NorthWest Colorado Consultants, Inc.

Geotechnical / Environmental Engineering • Materials Testing

July 31, 2023

Beth Herbert
PO Box 273
Yampa, CO 50433
happytraveler23@yahoo.com

Job Number: 23-13059

Subject: Subsoil and Foundation Investigation, Proposed Herbert Residence, 18195 Highway 131, Routt County, Colorado.

Beth,

This report presents the results of the Subsoil and Foundation Investigation for the proposed Herbert Residence to be constructed at 18195 Highway 131 in Routt County, Colorado. The approximate location of the project site is shown in Figure #1.

NWCC, Inc. (NWCC) scope of our work included obtaining data from observations made at the site, the logging of two test pits, sampling of the probable foundation soils, and 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: NWCC understands that a new single-family residence will be constructed at the site. The structure will consist of a one to two-story modular structure. We understand the lower level will consist of a structural floor over a crawlspace.

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, NWCC should be notified to reevaluate the recommendations in this report.

Site Conditions: The proposed building site is situated west of Highway 131 in Routt County, Colorado. The proposed building site was vacant at the time of our field investigation. Some existing cabins were located in the south and west sides of the property, as well as a garage on the south side. The vegetation at the proposed building site consists of grasses, tress along the west and south side, willows and sagebrush along the north and northwest corner of the building site. The topography of the site is fairly flat and generally slopes gently down to the west with a change in elevation of approximately 1 foot. The Yampa River runs along the west side of the property and is approximately 130 feet from the proposed residence.

Subsurface Conditions: To investigate the subsurface conditions at the site, two test pits were advanced on June 22, 2023, with a CAT 305E trackhoe. A site plan showing existing features along with the approximate test pit locations is presented in Figure #2.

The subsurface conditions encountered consisted of a layer of topsoil and organic materials overlying natural sands and gravels that extended to the maximum depth investigated, 5 ½ feet below the existing ground surface (bgs). Graphic logs of the exploratory test pits, along with the associated Legend and Notes, are presented in Figure #3.

Topsoil and organic materials were encountered at the ground surface and extended to a depth of 2 feet bgs. Natural sands and gravels were encountered below the topsoil and organic materials and extended to the maximum depths investigated. The sands and gravels were clean to silty, non plastic, medium to coarse grained with cobbles, medium dense to dense, dry to wet and brown in color. A sample of the natural sands and gravels classified as a GW soils in accordance with the Unified Soil Classification System. The laboratory test results are presented in Table 1.

Groundwater was encountered at the time of excavation at 3 feet bgs in Test Pit 1 and 1 ½ feet in Test Pit 2. 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 subsurface conditions encountered in the test pits, the results of the field and laboratory investigations and our assumptions regarding the proposed construction, NWCC believes an economically feasible type of foundation system is spread footings or individual pads with grade beams founded on the natural sands and gravels or on properly compacted structural fill materials placed over the natural gravels.

1) Footings placed on the natural sands and gravels or properly compacted structural fill materials placed over the natural sands and gravels may be designed using an allowable soil bearing pressure of 3,000 psf. Based on anticipated geologic site conditions, NWCC recommends a **Site Class C** designation be used in structural design calculations in accordance with Table 20.3-1 in Chapter 20 of ASCE 7-10.

2) Footings or pad sizes should be computed using the above soil pressure and placed on the natural undisturbed sands and gravels found below the topsoil and organic materials layer and any existing fill materials and any, or on properly compacted structural fill materials placed over the natural sands and gravels. Spread footings placed on granular soils should have a minimum footing width of 16 inches. Temporary cuts for foundation construction should be constructed to OSHA standards for temporary excavations. Difficult excavating conditions, due to the presence of cobbles and possibly boulders and a relatively shallow groundwater table, should be anticipated.

3) Any topsoil and organic materials, existing fill materials or loose and soft natural soils encountered within the foundation excavations, should be removed and the excavations extended to competent natural sands and gravels prior to structural fill or concrete placement. If groundwater is encountered in the excavations, dewatering of the excavations may be required. We also recommend that a minimum of 6 inches of free draining gravels be placed over the natural sands and gravels to limit disturbance of these soils, where groundwater is encountered. The free draining gravels should be placed in uniform lifts not exceeding 6 inches in thickness and be compacted to at least 80% of the maximum relative density determined in accordance with ASTM D4253/4254.Any fill materials placed beneath the footings should be a non-expansive granular soil approved by this office. Fill materials placed under the footings should be uniformly placed in 6 to 8 inch loose lifts and compacted to at least 100% of the maximum standard Proctor density and within 2% of the optimum moisture content determined in accordance with ASTM D-698. Structural fill materials should extend out from the edge of the footings on a 1(horizontal) to 1(vertical) or flatter slope.

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

5) 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.

6) Based on experience, NWCC estimates 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 #4.

Floor Slabs: NWCC understands the lower level of the residence will be constructed over a crawlspace. However, we have included the following floor slab recommendations in the event that a future slab is constructed. The natural sands and gravels are capable of supporting lightly to moderately loaded slab-on-grade construction. The floor slabs should be provided with control joints placed a maximum of 10 to 12 feet on center in each direction, depending on slab configuration, 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 the thickness of the slab.

Any fill materials placed beneath the floor slabs should be a non-expansive granular soil approved by NWCC prior to placement. The fill should be placed in 6 to 8 inch loose lifts and be compacted to at least 95% of the maximum standard Proctor density and within 2% of the optimum moisture content. The on-site sands and gravels should be suitable for use as fill materials beneath the floor slabs after the cobbles and boulders are removed and the soils are properly moisture conditioned. We recommend that any topsoil and organic materials encountered within the excavations be removed from underneath the floor slabs prior to concrete or fill placement.

Perimeter Drainage System Recommendation: To enhance site drainage and improve foundation and slab-on-grade performance, NWCC recommends shallow perimeter drainage system be installed around the building perimeter. Localized perched water or runoff can infiltrate the structures at the foundation level. This water can be one of the primary causes of differential foundation and slab movement.

The drainage systems should be located around each building perimeter and be placed and at least 12 inches below interior building grades and a minimum of 24 inches below final grades to provide frost protection. Ideally, the drainage systems should be centered along roof drip-line locations. In locations where roof driplines are not present, the drainage systems may be located within 24 inches of foundation walls. Drains should be insulated using 2-inches of rigid polystyrene insulation board in locations higher than 48 inches below final grade to provide protection against freezing.

Perimeter drainage system piping should be constructed using perforated PVC pipe that meets or exceeds ASTM D-3034/SDR 35 requirements to provide satisfactory long-term function and rapid runoff of water. The holes in the drainpipes should be oriented down between 4 o'clock and 8 o'clock to promote rapid runoff of the water. The drainpipes should be covered with at least 12 inches of free draining gravel and be protected from contamination by a geotextile filter fabric covering of Mirafi 140N subsurface drainage fabric or an equivalent product. The drainpipes should have a minimum slope of 1 percent and be daylighted at positive outfalls that are protected from freezing. If the drainpipes cannot be daylighted, the drains should be led to sumps where the water can be pumped. Multiple daylights or sumps may be required for the proposed structures. A typical perimeter drain section is provided in Figure #5.

If crawlspaces are constructed below the building structures, we recommend that interior perimeter drainage systems be installed within the crawlspace areas. We also recommend that the interior of the crawlspaces be backfilled with the on-site clays that are compacted to at least 95% of the SPD. Our firm can provide assistance with the design of the interior drainage systems after the plans are completed.

Caution should be taken when backfilling so as not to damage or disturb the installed drains. NWCC recommends the drainage piping include cleanouts provided at minimum 100-foot intervals, be protected against intrusion by animals at the outfalls and be tested prior to backfilling. NWCC should be retained to provide periodic observations of underdrain construction to verify installation has been accomplished in general accordance with these recommendations. Flow testing of the systems is also recommended.

Foundation Walls and Retaining Structures: 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 the on-site soils.

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 the on-site soils.

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.

NWCC recommends imported granular soils for backfilling foundation walls and retaining structures because their use results in lower lateral earth pressures. Imported granular materials should be placed to within 2 to 3 feet of the ground surface, be free draining and have less than 5 percent passing the No. 200 sieve. 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. Upper 2 to 3 feet of fill should be a relatively impervious soil or pavement structure to prevent surface water infiltration into the backfill.

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 structures have been completed:

1) Ground surface surrounding the structures should be sloped (minimum of 1.0 inch per foot) to drain away from the structures 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 structures 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) Top 2 to 3 feet of soil placed within 10 feet of the foundations 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 structures.

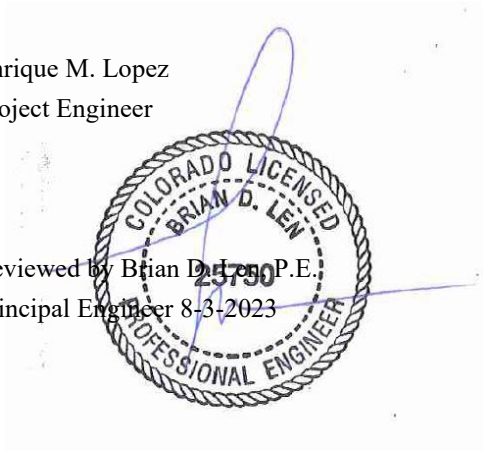
6) Plastic membranes should not be used to cover the ground surface adjacent to foundation walls.

Limitations: The recommendations provided in this report are based on the subsurface conditions encountered at this site and NWCC's 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 soils profiles beneath those or adjacent to those observed. No warranties expressed or implied are given on the content of this report.

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, NWCC strongly recommends 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 their representative to ensure 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.



Enrique M. Lopez
Project Engineer

Reviewed by Brian D. Len, P.E.
Principal Engineer 8-3-2023

NWCC, Inc.

N

NOT TO SCALE

Title: VICINITY MAP		**Date:** 7/13/23	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing
Job Name: Proposed Herbert Residence		**Job No.** 23-13059	(970)879-7888 • Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 18195 Highway 131, Routt County, Colorado		**Figure** #1	

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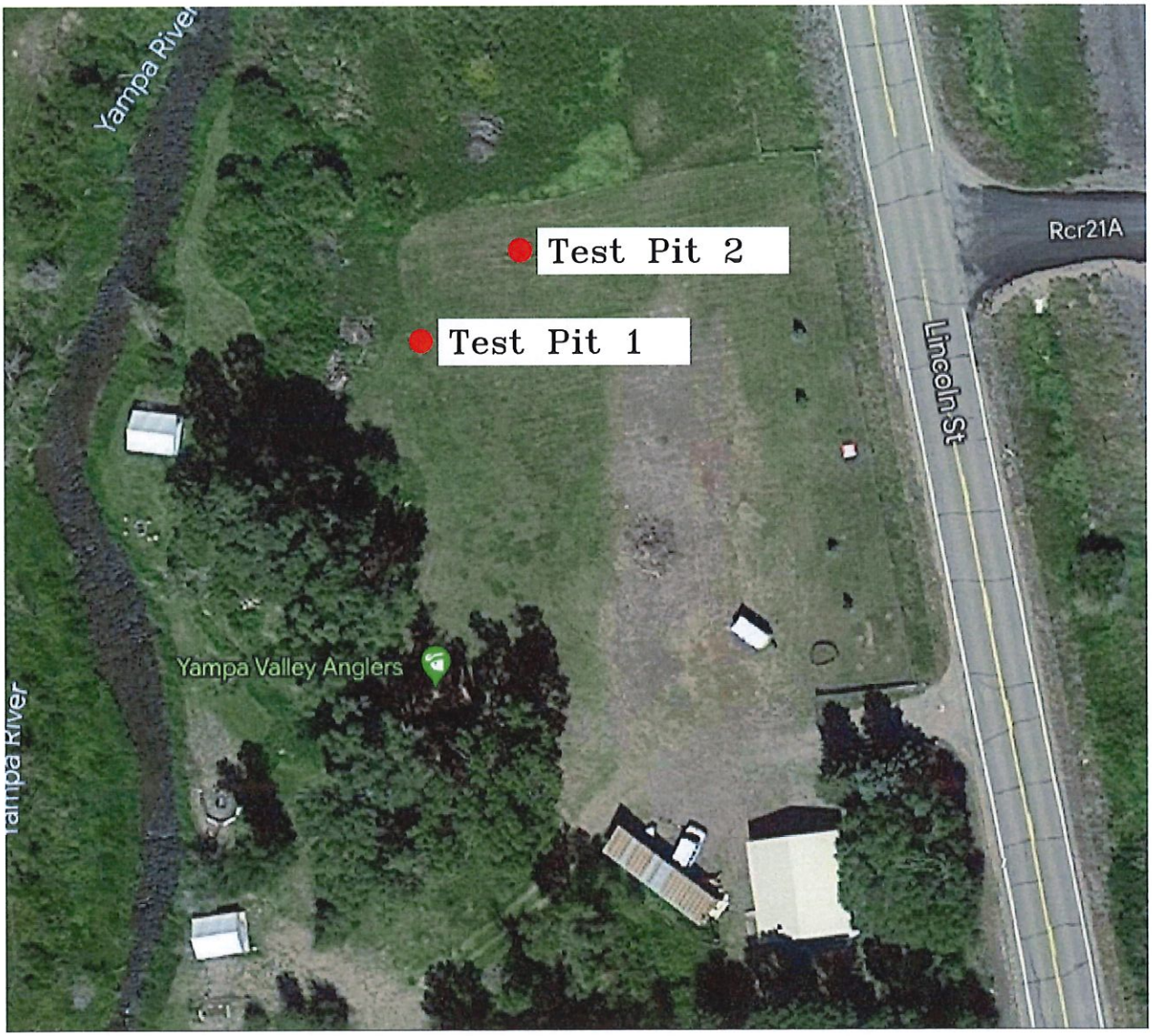
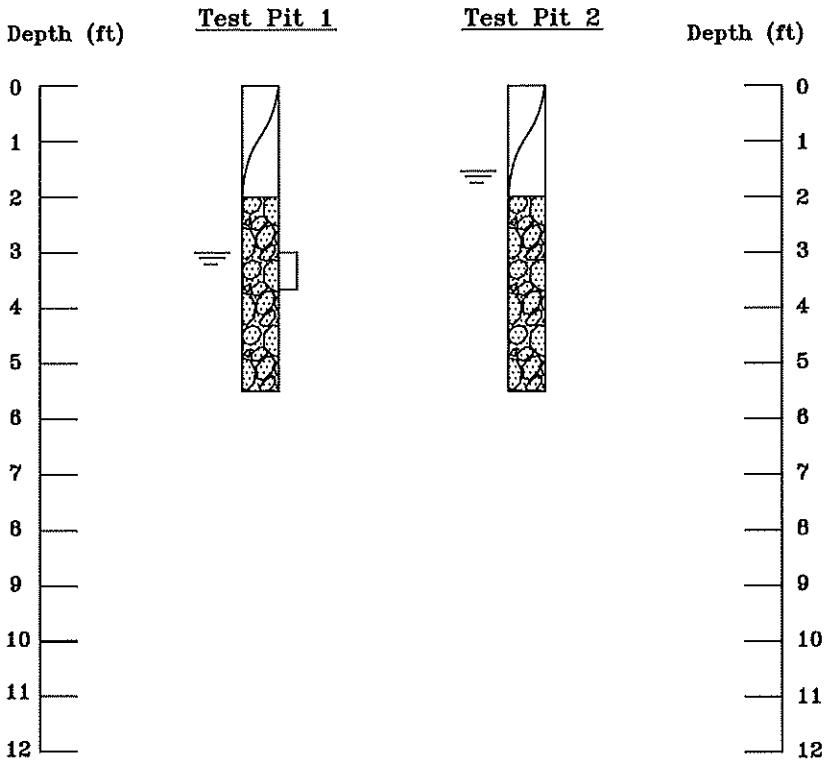
NOT TO SCALE



Title: SITE PLAN–LOCATION OF TEST PITS		**Date:** 7/13/23	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing
Job Name: Proposed Herbert Residence		**Job No.** 23-13059	(970)879-7888 • Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 18195 Highway 131, Routt County, Colorado		**Figure** #2	



LEGEND:

Topsoil and Organics.

SANDS AND GRAVELS: Silty, non plastic, medium to clean to coarse grained with cobbles, dense to very dense, dry to wet and brown.

Small Disturbed Sample.

Indicates depth of groundwater when measured during excavation.

NOTES:

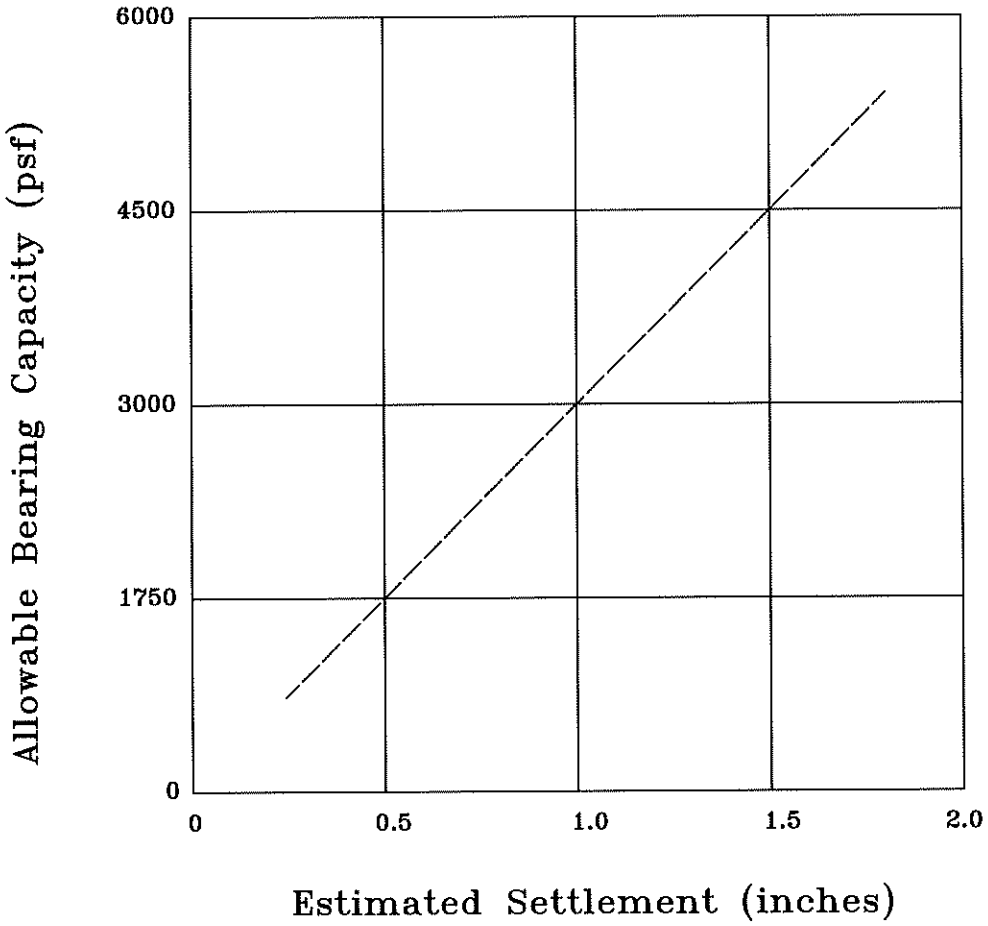
1) Test pits were excavated on June 22, 2023 with a CAT 305E trackhoe.

2) Test pit locations were located in the field by pacing from existing features.

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

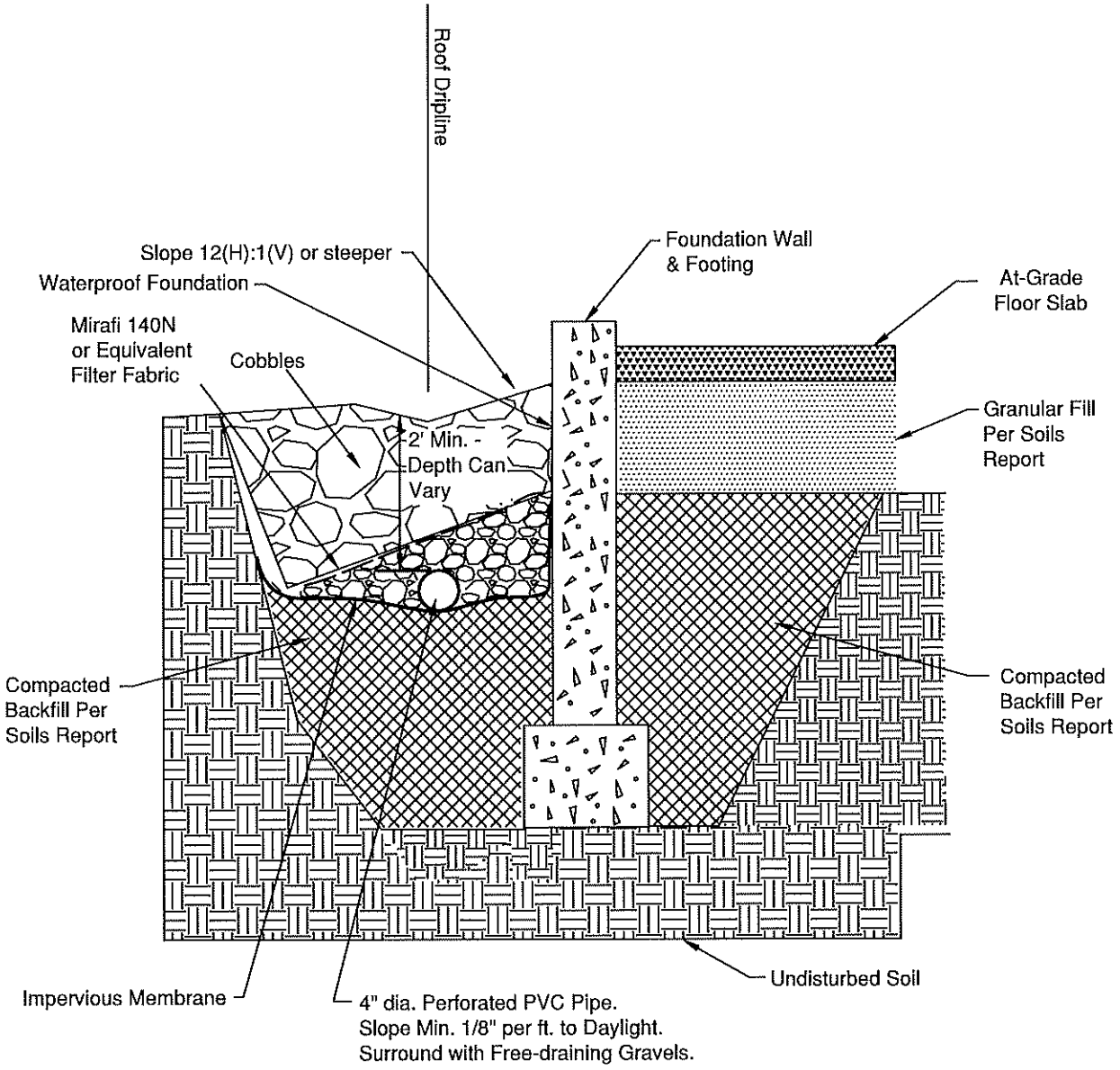
4) The lines between materials shown on the test pits log represent the approximate boundaries between material types and transitions may be gradual.

Title: LOGS, LEGEND AND NOTES	Date: 7/13/23	NWCC Northwest Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing (970)879-7688 • Fax (970)879-7691 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Proposed Herbert Residence	Job No. 23-13059	
Location: 18195 Highway 131, Routt County, Colorado	Figure #3	



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: 7/13/23	NWCC Northwest Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing (970)879-7688 • Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Proposed Herbert Residence	Job No. 23-13059	
Location: 18195 Highway 131, Routt Colorado, Colorado	Figure #4	



Title: SHALLOW PERIMETER DRAIN DETAIL		Date: 7/13/23	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 80477
Job Name: Proposed Herbert Residence		Job No. 23-13059	
Location: 18195 Highway 131, Routt County, Colorado		Figure #5	

NWCC, Inc.

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 PIT	DEPTH (feet)			LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAVEL (%)	SAND (%)				
1	3	3.3		nv	np	78	20	2		Sandy Gravel	GW

JOB NUMBER: 23-13059