NorthWest Colorado Consultants, Inc.

Geotechnical / Environmental Engineering • Materials Testing

May 7, 2024

Tim McCarthy
PO Box 773484
Steamboat Springs, CO 80487

mountwernergroup@gmail.com

Job Number: 24-13286

Subject: Subsoil and Foundation Investigation, Proposed Sundance Court Duplex, 200 Sundance Court, Steamboat Springs, Colorado.

Tim,

This report presents the results of the Subsoil and Foundation Investigation for the proposed duplex to be constructed at 200 Sundance Court, Steamboat Springs, 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, 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 the proposed duplex will consist of a multi-family duplex that will be a two-story wood framed structure with walkout basements and garages on the main levels. NWCC has assumed the lower levels of the duplex will be constructed with a concrete slab-on-grade floor systems.

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 located south of Sundance Court and east of Steamboat Boulevard in Steamboat Springs, Colorado. The subject property was vacant at the time of our investigation. Vegetation at the site appears to consist of grasses, deciduous scrubs and scrub oak. Approximately 1 to 2 feet of snow was on the ground surface at the time of the field investigation.

The topography of the site slopes moderately to steeply down to the southwest. A steep road cut exists on the north side of the lot which slopes steeply down to the north towards Sundance Court. An elevation difference of approximately 20 feet exists across the proposed building site.

Subsurface Conditions: To investigate the subsurface conditions at the site, two test pits were advanced on April 9, 2024, with a CAT 305.5E2 trackhoe. The approximate test pit locations are shown in Figure #2.

The subsurface conditions encountered generally consisted of a layer of topsoil and organic materials with roots overlying natural sands and gravels to the maximum depth investigated, 8 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.

A layer of topsoil and organic materials with roots was encountered at the ground surface and was approximately 16 to 24 inches in thickness. Natural sands and gravels were encountered beneath the layer of topsoil and organic materials in both test pits and extended to the maximum depth investigated. It should be noted that practical rig refusal was encountered in each test pit on boulders. The natural sands and gravels were slightly silty, non plastic, fine to coarse grained with cobbles and boulders, dense, moist and brown in color. Samples of the natural sands and gravels classified as a SM and GM soils in accordance with the Unified Soil Classification System (USCS). Laboratory test results are presented in Table 1.

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.

Groundwater was not encountered in the test pits at the time of excavation. 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 pits, the results of the field and laboratory investigations and our understanding of the proposed construction, we believe an economically feasible and safe type of foundation system is spread footings or individual pads with grade beams founded on the natural sands and gravels found beneath the existing topsoil and organic materials or on properly compacted structural fill materials placed over the natural sands and gravels. Foundation movement should be within tolerable limits if the following design and construction precautions are observed.

1) Footings placed on the natural sands and gravels, or properly compacted structural fill materials placed on the natural sands and gravels should be designed using an allowable soil bearing pressure of 3,000 psf. A minimum deadload pressure is not required for the footings.

2) Footings or pad sizes should be computed using the above soil pressures and placed on the undisturbed sands and gravels or on properly compacted structural fill materials placed over the sands and gravels. Spread footings placed on granular soils should have a minimum footing width of 16 inches.

3) Any existing topsoil and organic materials, existing fill materials, silts and loose sands encountered within the foundation excavations should be removed prior to structural fill or concrete placement.

4) Any fill materials placed beneath the footings should be a non-expansive granular soil approved by this office. The on-site sands and gravels will be suitable fill materials after the materials are properly moisture conditioned and larger cobbles and boulders are removed. 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.

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

6) 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.

7) 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 #4.

8) Care should be taken when excavating the foundations to avoid disturbing the supporting materials. Hand excavation or careful backhoe soil removal may be required in excavating the last few inches.

9) The client must retain NWCC to observe the foundation excavations when they are near completion to identify the bearing soils and confirm the recommendations in this report, as well as test the structural fill materials placed beneath the foundations for compaction.

Floor Slabs: NWCC has assumed the lower levels of the duplex and garages will be constructed with concrete slab-on-grade floor systems. The natural sands and gravels, exclusive of any topsoil and organic materials, 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 soils are properly moisture conditioned and larger cobbles and boulders are removed. We recommend that all of the topsoil and organic materials encountered be removed from underneath the floor slabs prior to concrete or fill placement.

Underdrain System: Any floor levels or crawl space areas constructed below the existing or finished ground surfaces and the foundations should be protected by underdrain systems 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 structures at the foundation levels. This water can be one of the primary causes of differential foundation and slab movement. Excessive moisture in crawl space areas or lower levels can also lead to rotting and mildewing of wooden structural members and the formation of mold and mold spores. 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.

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 levels and at least 6 inches below the bottom of the grade beams or footings. NWCC recommends the use of perforated PVC pipe for the drainpipe, which meets or exceeds ASTM D-3034/SDR 35 requirements, to minimize potential for pipe crushing during backfill operations. Holes in the drainpipe should be oriented down between 4 o'clock and 8 o'clock to promote rapid runoff of water. 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. Drains should have a minimum slope of 1/8 inch per foot and be daylighted at positive outfalls protected from freezing or be led to sumps from which water can be pumped. The use of interior laterals, multiple daylights or sumps may be required for the proposed structure. Caution should be taken when backfilling so as not to damage or disturb the installed underdrain. NWCC recommends the drainage system include a cleanout every 100 feet, be protected against intrusion by animals at outfalls and be tested prior to backfilling. NWCC also recommends the client retain our firm to observe the underdrain systems during construction to verify that they are being installed in accordance with recommendations provided in this report and observe a flow test prior to backfilling the system.

In addition, NWCC recommends an impervious barrier be constructed to keep water from infiltrating under the footings and/or foundation walls. 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 #5.

Placement of and impervious membrane and/or properly compacted clays in crawlspace 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 should help reduce the moisture problems in these areas.

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 55 pcf for 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 45 pcf for 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 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 the 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 over compact 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.

Site Grading: 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. 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.

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 3(Horizontal) to 1(Vertical) configuration for the topsoil and organic materials and a 2(Horizontal) to 1(Vertical) configuration for the sands and gravels. We recommend these cuts be limited to 15 feet in height or less unless stable bedrock is encountered or retaining walls are constructed. The risk of slope instability will be significantly increased if groundwater seepage is encountered in the cuts. NWCC 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 15 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 existing fill materials and 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. 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. NWCC recommends that a maximum of 4 inches of topsoil be placed over the new cut and fill slopes. It should be noted that the newly placed topsoil materials may slough/slide off the slopes during the spring runoff seasons until the root zone in the vegetated cover establishes.

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 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 structures; 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.

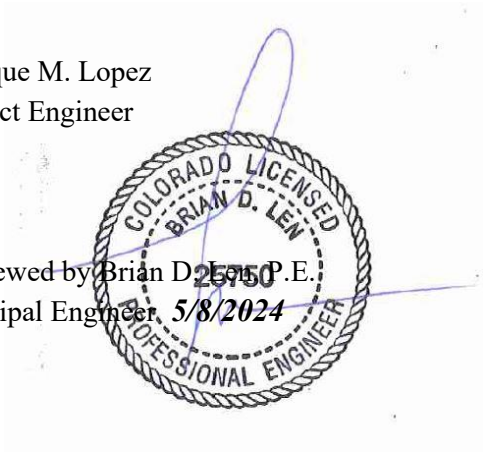
Man-made or natural changes in the conditions of a property can also occur over a period of time. In addition, changes in requirements due to state of the art knowledge and/or legislation do from time to time occur. As a result, the findings of this report may become invalid due to these changes. Therefore, 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 and any future owners 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

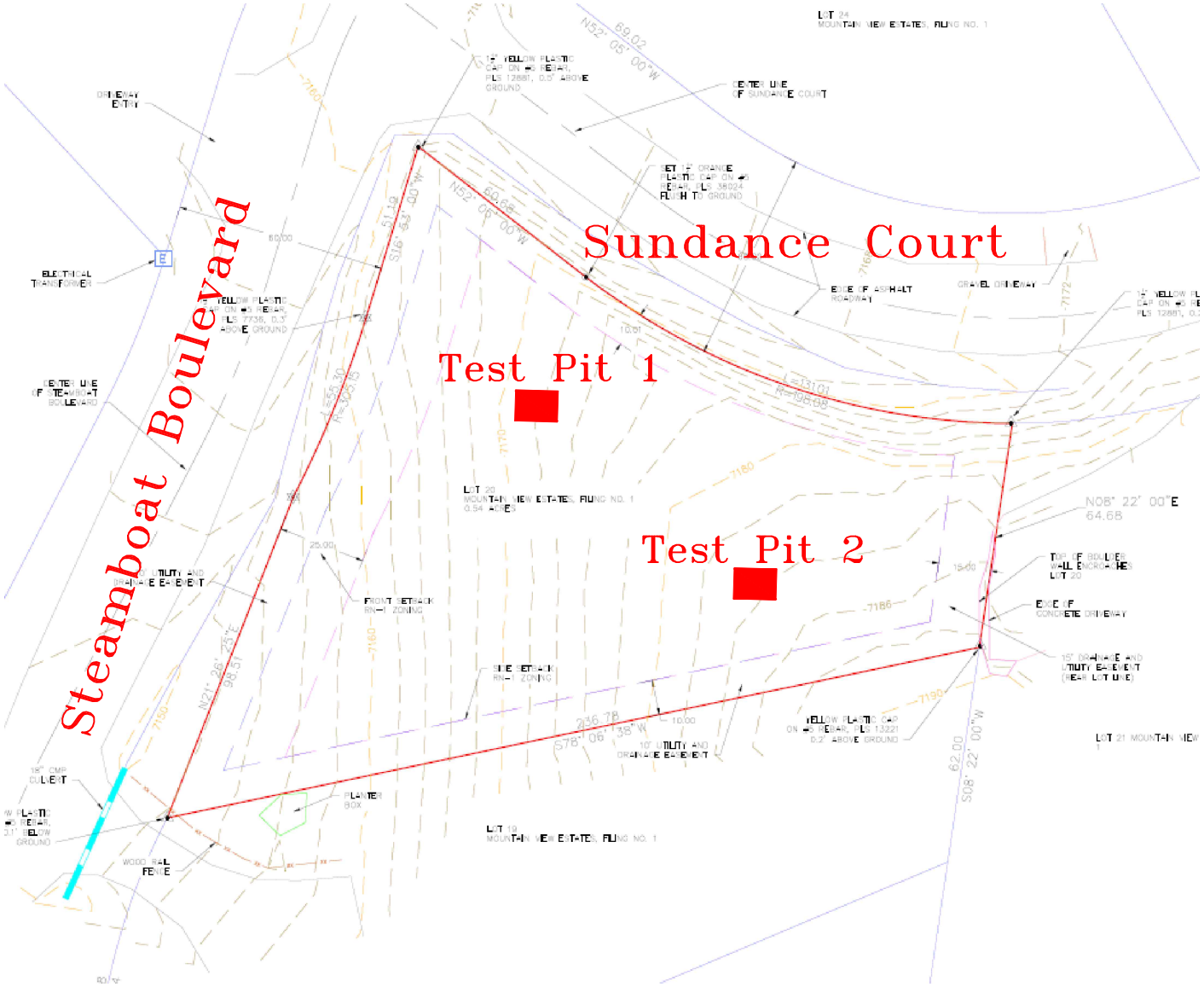


Reviewed by Brian D. Len, P.E.
Principal Engineer *5/8/2024*

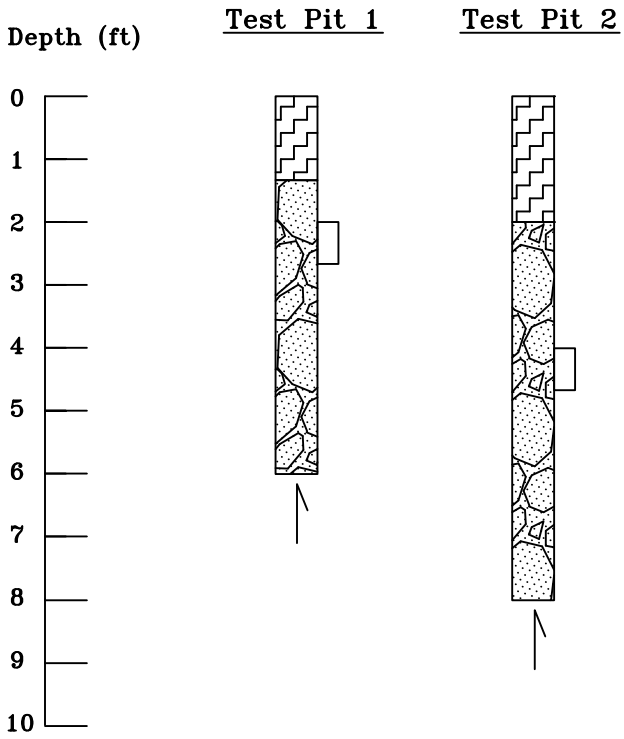
N

NOT TO SCALE

Title: VICINITY MAP		**Date:** 5/3/24	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing
Job Name: Proposed Sundance Court Duplex		**Job No.** 24-13286	(970)879-7888 • Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 200 Sundance Court, Steamboat Springs, Colorado		**Figure** #1	



Title: SITE PLAN–LOCATION OF TEST PITS		**Date:** 5/3/24	NWCC Northwest 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 Sundance Court Duplex		**Job No.** 24-13286	
Location: 200 Sundance Court, Steamboat Springs, Colorado		**Figure** #2	



LEGEND:

TOPSOIL AND ORGANIC MATERIALS.

SANDS AND GRAVELS: Slightly silty, non plastic, fine to coarse grained with cobbles and boulders, dense, moist and brown.

Small Disturbed Sample.

Indicates refusal on boulder.

NOTES:

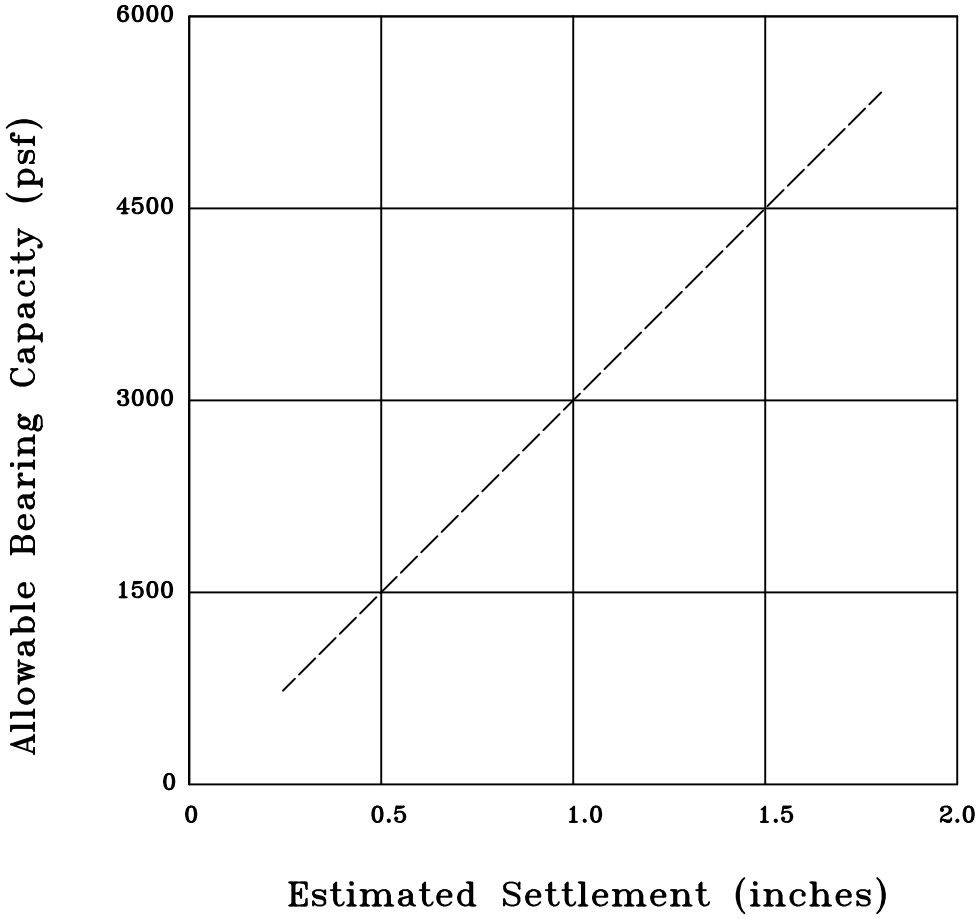
1) Test pits were excavated on April 9, 2024 with a CAT 305.5E2 backhoe.

2) The locations of the test pits were determined in the field by pacing from topographic features by NWCC.

3) The elevations of the test pits were not determined and the logs are drawn to the depth investigated.

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

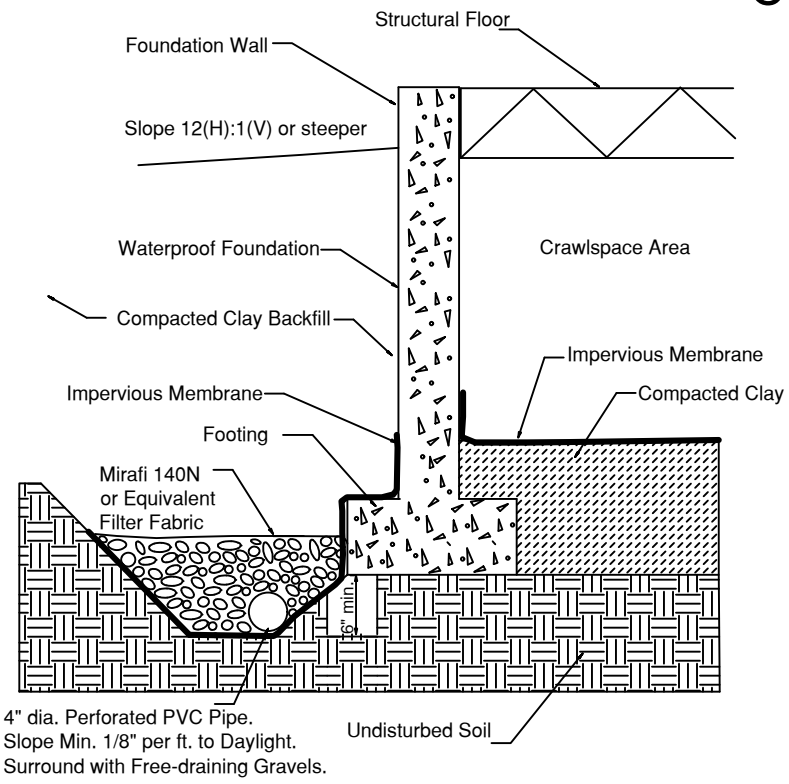
Title: LOGS, LEGEND AND NOTES	Date: 5/3/24	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Proposed Sundance Court Duplex	Job No. 24-13286	(970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 200 Sundance Court, Steamboat Springs, Colorado	Figure #3	



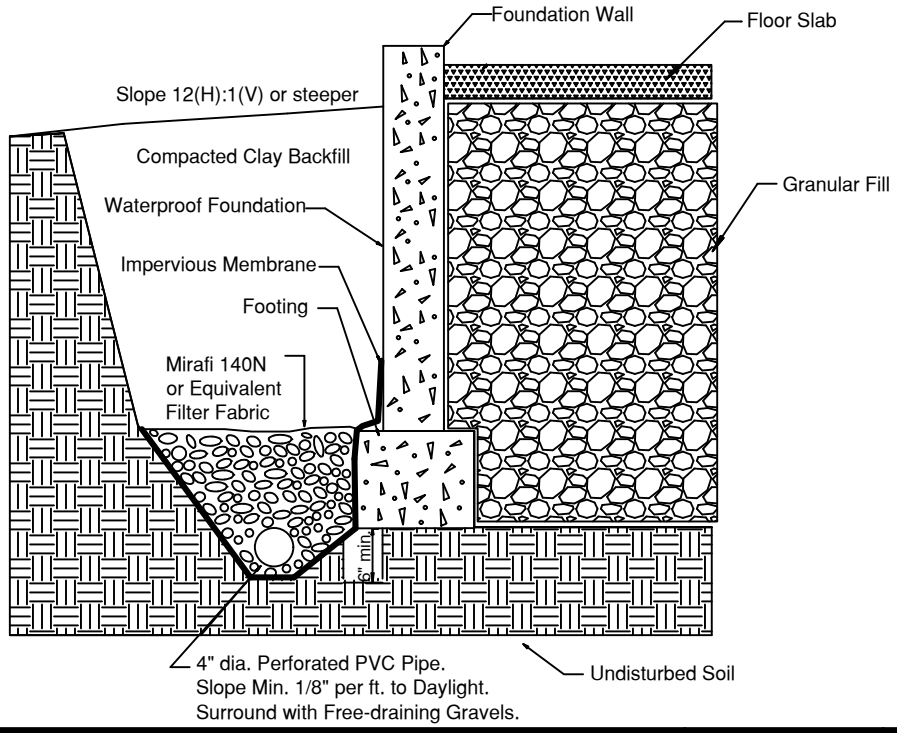
Note: These values are based on footing widths of 1 to 4 feet. If the footing width is to be greater than 4 feet in width, then we should be notified to re-evaluate these recommendations.

Title: BEARING CAPACITY CHART-BEDROCK		**Date:** 5/3/24	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing
Job Name:	Proposed Sundance Court Duplex	**Job No.** 24-13286	(970)879-7888 • Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location:	200 Sundance Court, Steamboat Springs, Colorado	**Figure** #4	

Crawlspace Area



Floor Slab



Title: PERIMETER/UNDERDRAIN DETAIL		**Date:** 5/3/24	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing
Job Name:	Proposed Sundance Court Duplex	**Job No.** 24-13286	(970)879-7888 • Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location:	200 Sundance Court, Steamboat Springs, 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	2	4.5		NV	NP	32	63	5		Slightly Silty Gravelly Sand	SM
2	4	6.8		NV	NP	61	28	11		Slightly Silty Sandy Gravels	GM

JOB NUMBER: 24-13286