NorthWest Colorado Consultants, Inc.
Geotechnical / Environmental Engineering • Materials Testing

April 22, 2022

Luke Berlet
PO Box 774000 #81
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Job Number: 22-12594

Subject: Subsoil and Foundation Investigation, Proposed Berlet Residence, 23570 Frayser Lane, Routt County, Colorado.

Luke,

This report presents the results of the Subsoil and Foundation Investigation for the proposed residence to be constructed within Lot 2 of the Ski View Estates Subdivision (23570 Frayser Lane) in Routt County, Colorado. The approximate location of the project site is shown in Figure #1.

NWCC, Inc.'s (NWCC) scope of work included obtaining data from cursory observations made at the site, logging of three 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 a single-family residence will be constructed at the site. NWCC assumes that the lower levels of the residence and garage will be constructed with concrete slab-on-grade floor systems constructed from 0 to 10 feet below the existing ground surface (bgs).

For design purposes, NWCC has assumed that 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 recommendations in this report.

Site Conditions: The proposed building site is located south of County Road 16 and at the north end of Frayser Lane in Routt County, Colorado. The building site was vacant at the time of our investigation, and there was approximately 2 to 3 feet of snow on the ground surface. Vegetation at the proposed building site consisted primarily of grasses and weeds with sagebrush and deciduous bushes.

Topography of the site is variable and the proposed building site sits on a ridge that generally slopes gently to moderately down to the north/northeast in the building envelope. Outside of the proposed building site, the topography is considerably steeper.

Subsurface Conditions: To investigate the subsurface conditions at the site, three test pits were advanced at the site on March 15, 2022, using a Cat trackhoe. A site plan showing existing features, along with the approximate test pit location, is presented in Figure #2. Graphic logs of the exploratory test pits, along with associated legend and notes, are presented in Figure #3.

Subsurface conditions encountered were variable and generally consisted of a layer of topsoil and organic materials, approximately 6 to 12 inches in thickness, overlying highly weathered bedrock consisting of clays and sands, which were underlain by siltstone-sandstone bedrock of the Browns Park Formation.

The clays and sands encountered beneath the topsoil and organic materials extended to depths ranging from 1 ½ to 3 feet bgs. The clays and sands were low to moderately plastic, fine grained, very stiff to weathered, moist and brown to light brown in color. A sample of the clays and sands classified as a CL soil in accordance with the Unified Soil Classification System.

Siltstone-sandstone bedrock was encountered below the clays and sands and extended to the maximum depth investigated, 5 feet bgs. It should be noted that practical rig refusal was encountered in the bedrock in all three test pits. The siltstone-sandstone bedrock materials were clayey, non to very low plastic, fine to coarse grained, hard, moist and light brown to tan in color. Samples of the bedrock materials classified as ML soils in accordance with the Unified Soil Classification System.

Swell-consolidation testing was not conducted on samples of the bedrock materials due to hardness of the bedrock. However, a swell consolidation test conducted on s sample of the clays indicates the materials tested had a low swell potential when wetted under a constant load. Swell-consolidation test results are shown in Figure #4 and all of the other laboratory test results are presented in the attached 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 7.

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 seasonal 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 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 clays and sands and/or siltstone-sandstone bedrock materials.

1) Footings placed on the natural soils and/or bedrock materials should be designed using an allowable soil bearing pressure of 3,000 psf. A minimum dead load pressure of at least 800 psf is recommended for footings constructed on the clays and/or bedrock materials.

2) Footings or pad sizes should be computed using the above soil pressures and placed on the natural undisturbed soils and/or bedrock materials found below the layer of topsoil and organic materials.

3) Any topsoil and organic materials, as well as any loose or soft natural soils or bedrock materials encountered within the foundation excavations should be removed and the excavations extended to competent natural soils or bedrock materials prior to concrete placement.

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 recognized by the local building authority.

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 #5.

7) NWCC recommends 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.

Floor Slabs: NWCC has assumed the lower levels of the residence and garage will be constructed with concrete slab-on-grade floor systems. On-site soils, apart from topsoil and organic materials, are capable of supporting slab-on-grade construction. However, floor slabs present a very 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 soils and bedrock materials encountered at this site, NWCC believes 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 must be taken to reduce damage, which could result from movement should the underslab soils and bedrock materials be subjected to moisture changes.

1) Floor slabs must be separated from all bearing walls; columns and their foundation supports with a positive slip joint. NWCC recommends the use of ½-inch thick cellotex or impregnated felt.

2) Interior non-bearing partition walls resting on the floor slabs must be provided with a slip joint, preferably at the bottom, so 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 #6.

3) A minimum 6-inch gravel layer must be provided beneath all floor slabs to act as a capillary break and to help distribute pressures. Prior to placing the gravel, 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, any topsoil and organic materials should be removed prior to placement of the underslab gravels or new structural fill materials.

4) Floor slabs must be provided with control joints placed a maximum of 10 to 12 feet on center in each direction, depending on slab configurations, to help control shrinkage cracking. Locations of the joints should be carefully checked to assure that natural, unavoidable cracking will be controlled. Depth of the control joints should be a minimum of ¼ the thickness of the slab.

5) Underslab soils and bedrock materials must be kept as close as possible to their in-situ moisture content. Excessive wetting or drying of these soils prior to placement of floor slab could result in differential movement after slabs are constructed.

6) It has been NWCC's experience that the risk of floor slab movement can be reduced by removing at least 2 feet of the expansive materials and replacing them with a well compacted, non-expansive fill. If this is done or if fills are required to bring underslab areas to the desired grade, the fill should consist of non-expansive, granular materials. Fill should be uniformly placed and compacted in 6-to-8-inch lifts to at least 95% of the maximum standard Proctor density at or near the optimum moisture content, as determined by ASTM D-698.

Following the above precautions and recommendations will not prevent floor slab movement in the event the soils/bedrock 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 or void form materials.

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, especially when expansive soils and bedrock materials are encountered. 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 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 foundation voids and bottom of the foundation walls 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 through the voided areas and/or under 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 #7.

Placement of an impervious membrane and/or properly compacted clays in 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 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 based on an equivalent fluid unit weight of 45 pcf for imported, free draining granular backfill and 55 pcf for on-site soils and bedrock materials.

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

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 earth pressures on foundation walls and retaining structures and the structural engineer should carefully evaluate these additional lateral loads when designing foundation and retaining walls.

Lateral resistance of retaining wall foundations placed on undisturbed natural soils and bedrock materials at the site will be a combination of sliding resistance of the footings on the foundation materials and passive pressure against the sides of 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. Fill placed against the sides of 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. Imported granular soils should be free draining and have less than 5 percent

passing the No. 200 sieve. Granular soils placed 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.

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 backfill since this could cause excessive lateral pressure on the walls. Some settlement of deep foundation wall backfill materials will occur even if the backfill materials are placed correctly.

Surface Drainage: Proper surface drainage at this site is of paramount importance for minimizing infiltration of surface drainage into wall backfill and bearing materials, 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) The ground surface surrounding structures should be sloped (minimum of 1.0 inch per foot) to drain away from structures in all directions to a minimum of 10 feet from structures. Ponding must be avoided. If necessary, raising top of foundation walls to achieve a better surface grade is advisable.

2) Non-structural backfill placed around 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. 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 foundations should be impervious in nature to minimize infiltration of surface water into 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 foundation walls, 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 ground surface adjacent to foundation walls.

Site Grading: Slopes on which the 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, on-site wastewater treatment systems and building 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 existing fill materials and a 2(Horizontal) to 1(Vertical) configuration for the bedrock materials. We recommend these cuts be limited to 10 feet in height. 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 natural topsoil and organic materials have been removed. The fill materials should consist of the on-site soils/bedrock materials (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 soils and bedrock materials encountered at this site and NWCC's understanding of the proposed construction. NWCC believes this information gives a high degree of reliability for anticipating behavior of the proposed structures; however, NWCC's recommendations are professional opinions and cannot control nature, nor can they assure the soils

and bedrock material profiles beneath those or adjacent to those observed. No warranties expressed or implied are given on the content of this report.

Expansive soils and bedrock materials were encountered at this site. These materials are stable at their natural moisture content but can shrink or swell with changes in moisture. The behavior of expansive soils/bedrock materials is not fully understood. The swell or consolidation potential of any site can change erratically both in lateral and vertical extent. Moisture changes also occur erratically, resulting in conditions, which cannot always be predicted. Recommendations presented in this report are based on the current state of the art practices for foundations and floor slabs constructed on expansive soils/bedrock materials. As noted previously, the owner must be made aware there is a risk in construction on these types of soil. Performance of the structures 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 materials, 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 structures. Any distress noted in the structures should be brought to the attention of NWCC.

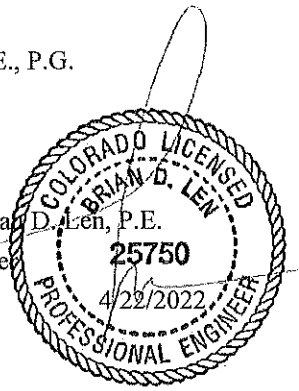
This report is based on the investigation at the described site and on specific anticipated construction as stated herein. If either of these conditions is changed, the results would also most likely change. Therefore, NWCC strongly recommends that our firm be contacted prior to finalizing the construction plans so that we can verify 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 time. In addition, changes in requirements due to state-of-the-art knowledge and/or legislation do 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 ensure that the information in this report is incorporated into the plans and/or specifications and construction of the project.

If you have any questions regarding this report or if NWCC may be of further service, please do not hesitate to contact us.

Sincerely,
NWCC, INC.

Erika K. Hill, P.E., P.G.
Project Engineer

Reviewed by Brian D. Len, P.E.
Principal Engineer



cc: Jake Mielke - SEAD

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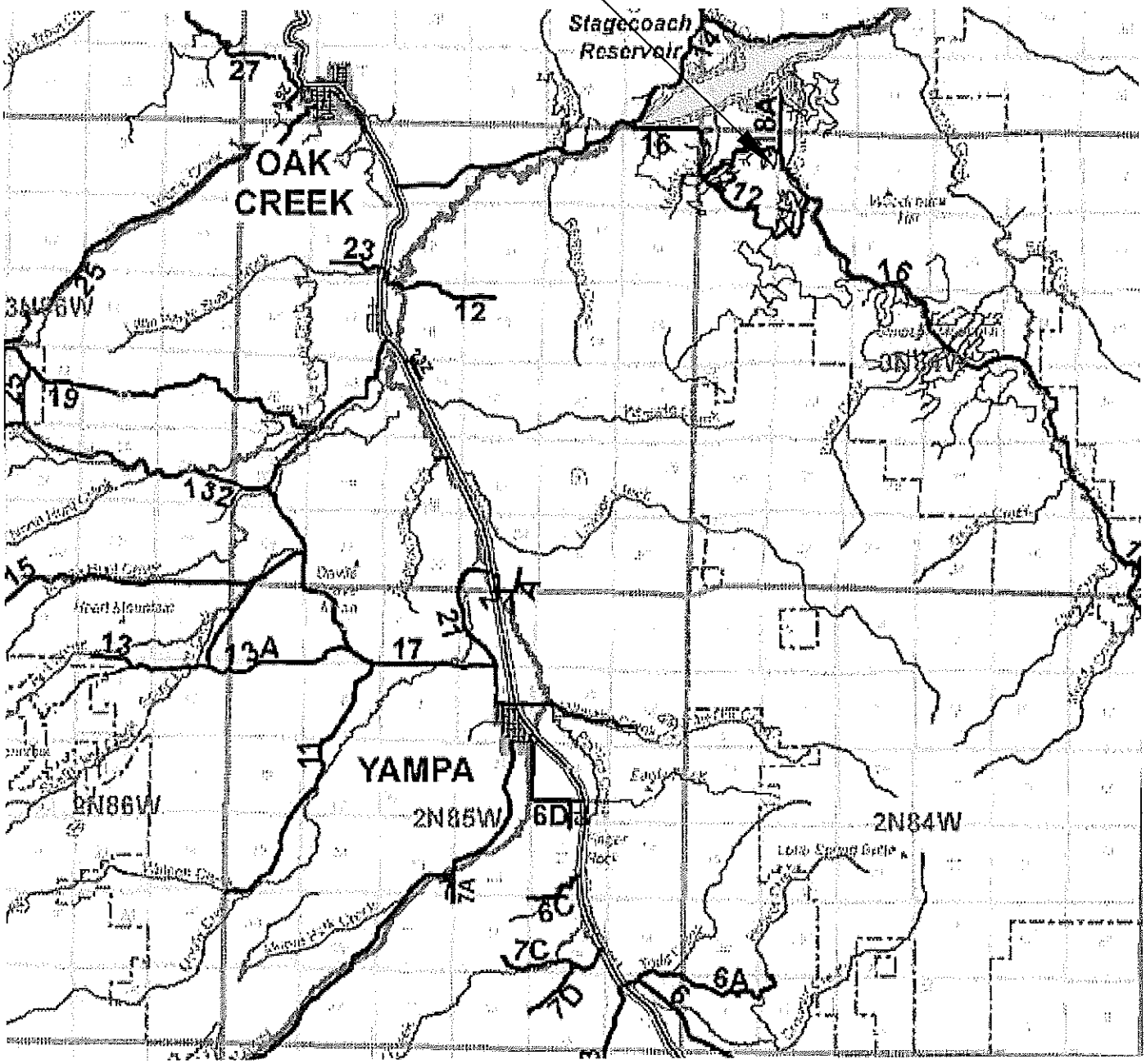
NOT TO SCALE

PROJECT SITE



Title: VICINITY MAP	**Date:** 4/22/22	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Berlet Residence	**Job No.** 22-12594	(970)879-7888- Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 23570 Frayser Lane, Routt County, CO	**Figure** #1	

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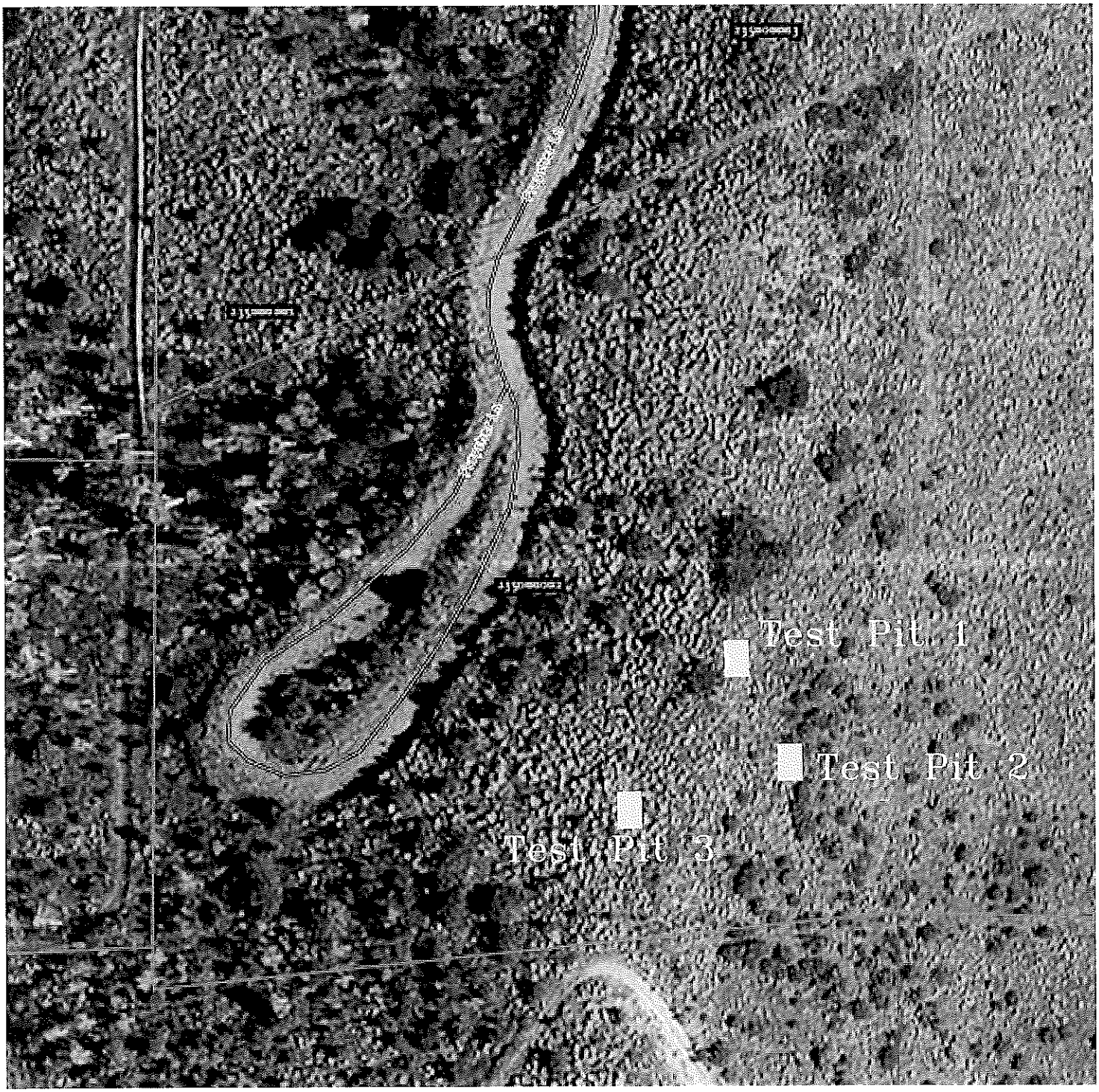
NOT TO SCALE



Title: SITE PLAN – TEST PIT LOCATIONS	Date: 4/22/22	
Job Name: Berlet Residence	Job No. 22-12594	
Location: 23570 Frayser Lane, Routt County, CO	Figure #2	

NWCC
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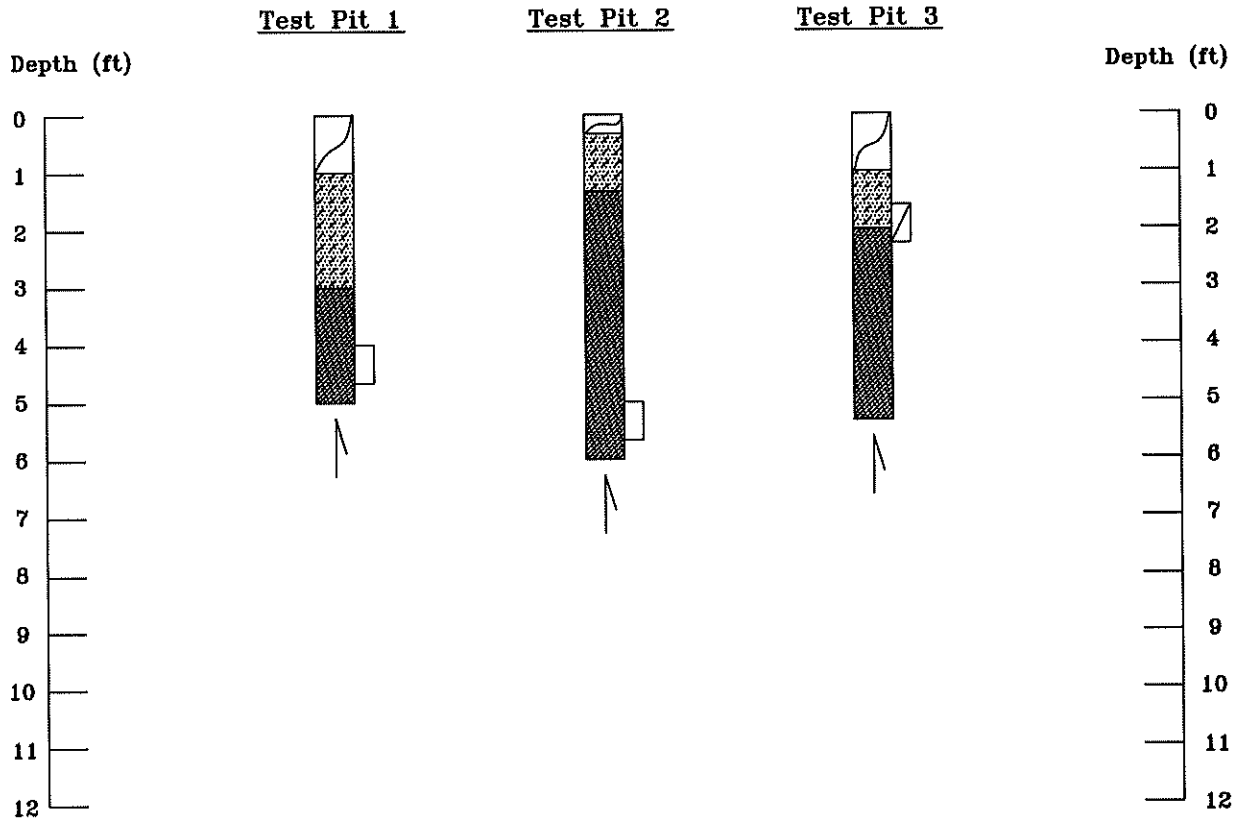


LEGEND:

TOPSOIL AND ORGANICS.

CLAYS AND SANDS: Fine grained, low to moderately plastic, very stiff to weathered, moist and brown to light brown.

SILTSTONE–SANDSTONE BEDROCK: Clayey, non to very low plastic, fine to coarse grained, hard, moist and light brown to tan.

Small Disturbed Bag Sample.

Hand Drive Sample.

Indicates Depth of Rig Refusal in Bedrock.

NOTES:

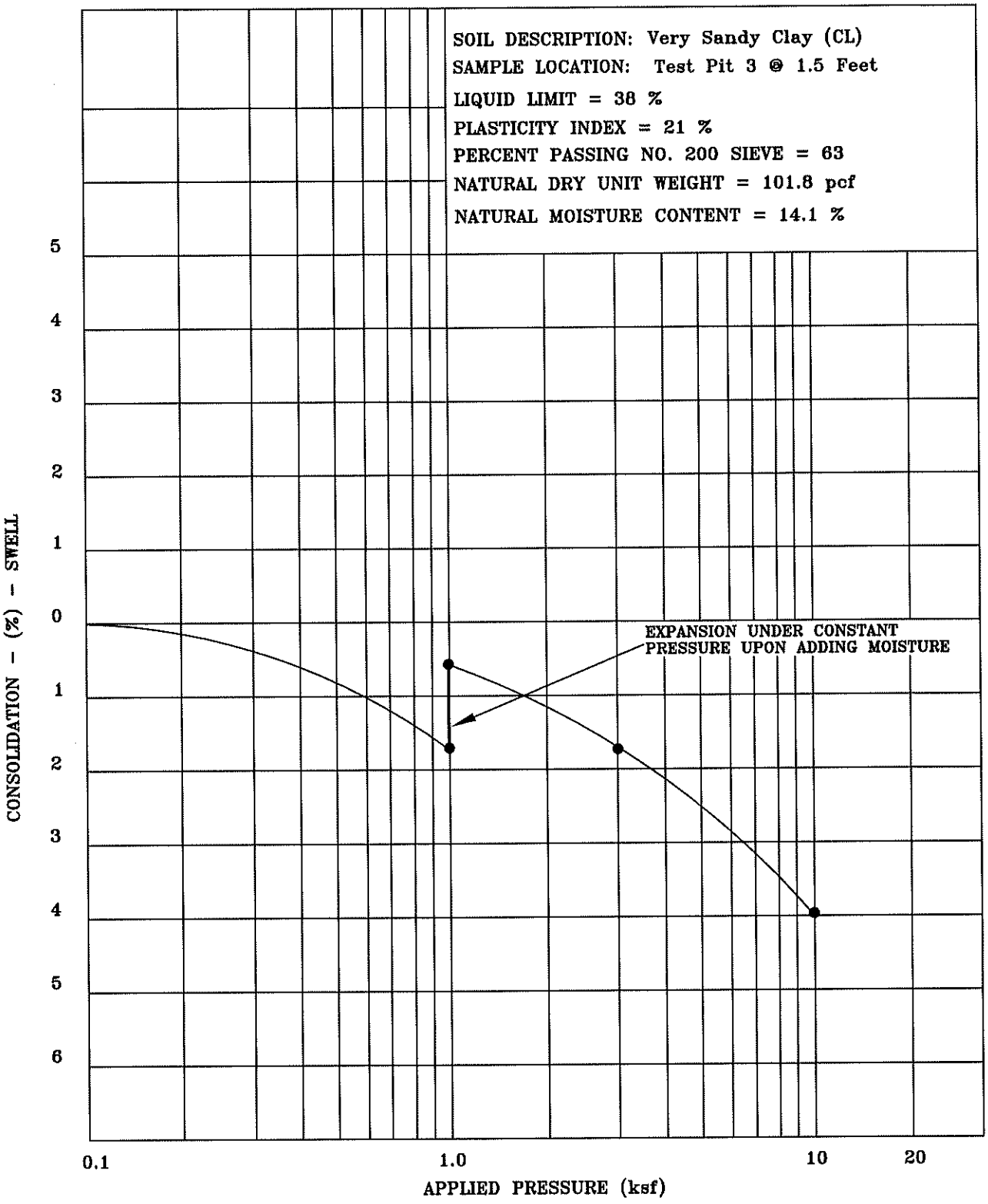
1) Test pits were excavated on March 15, 2022 with a Cat trackhoe.

2) Test pit locations were determined by pacing from existing site features.

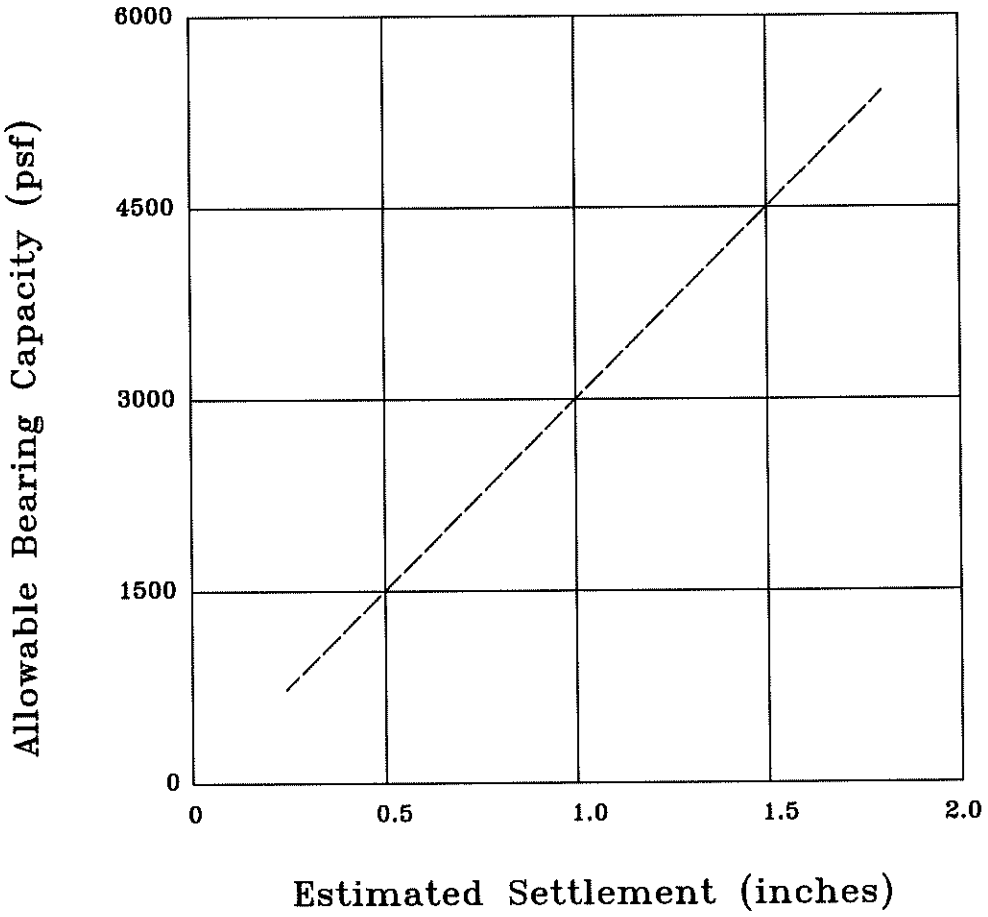
3) The elevations of the test pits were not measured and the logs are drawn to the depths investigated.

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

Title: LOGS, LEGEND AND NOTES	Date: 4/22/22	NWCC North West 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: Berlet Residence	Job No. 22-12594	
Location: 23570 Frayser Lane, Routt County, CO	Figure #3	

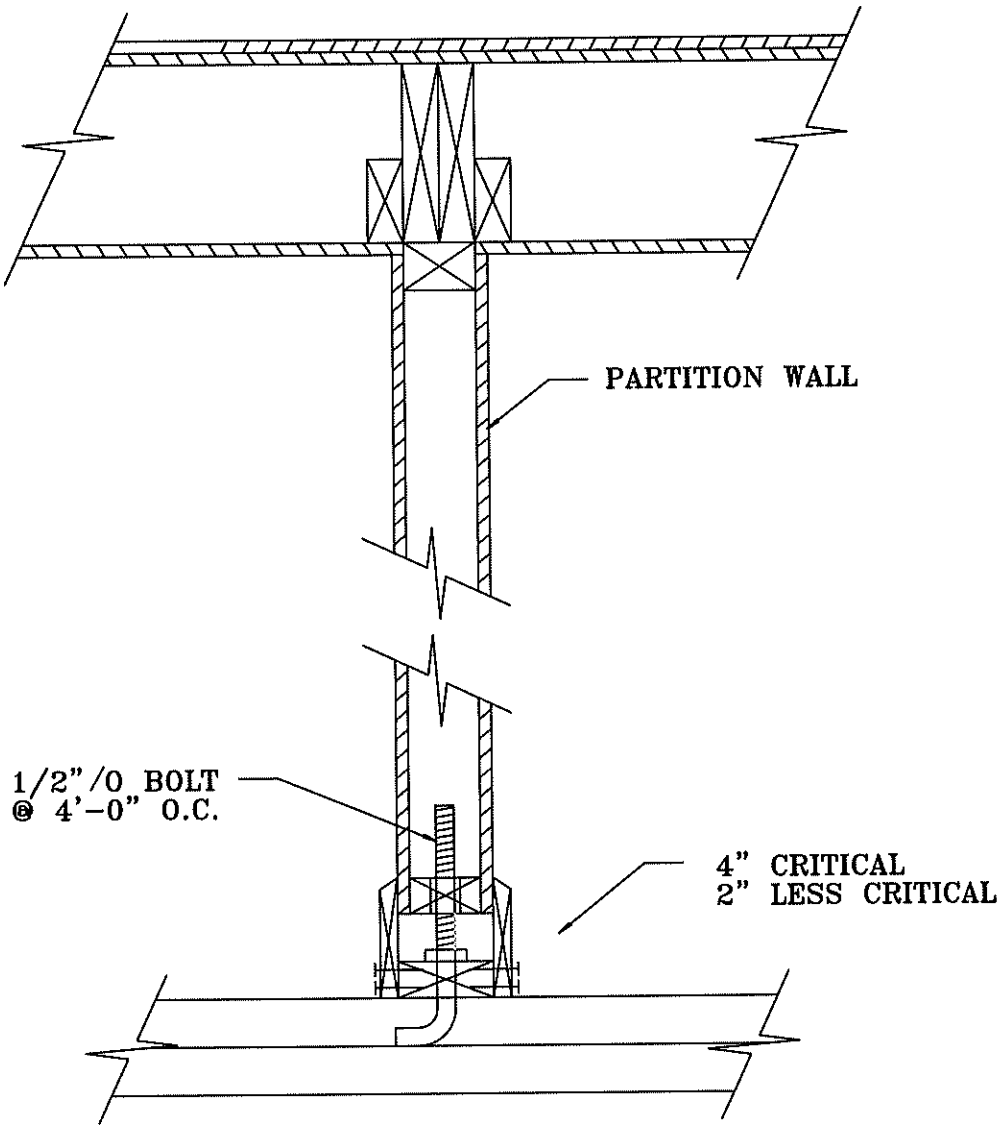


Title: SWELL–CONSOLIDATION TEST RESULTS		Date: 4/22/22	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing (970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Berlet Residence		Job No. 22-12594	
Location: 23570 Frayser Lane, Routt County, CO		Figure #4	

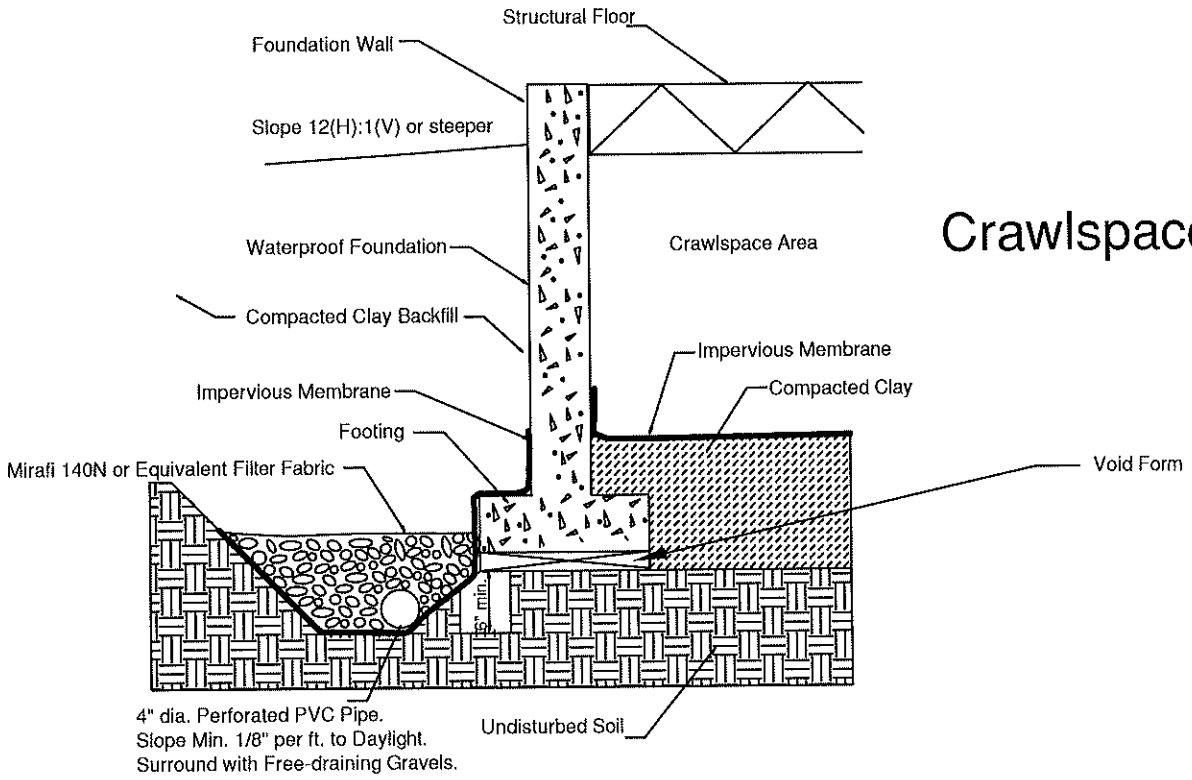


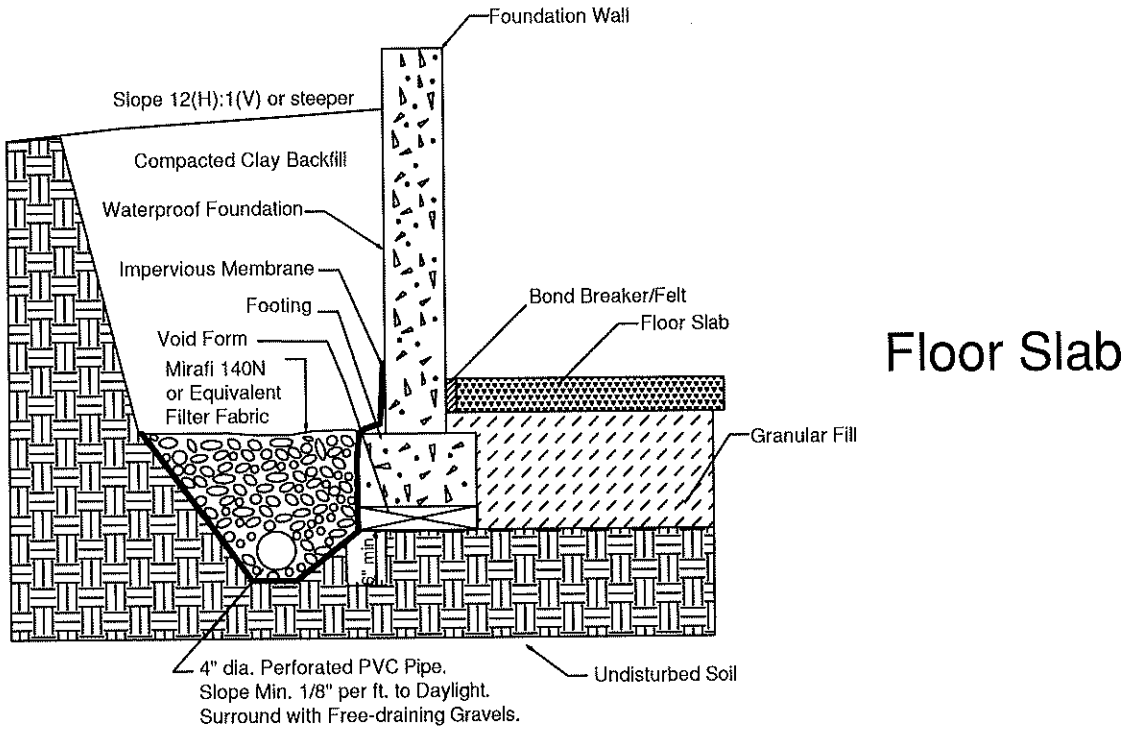
Note: These values are based on footing widths of 1 to 4 feet. If the footing width is to be greater than 4 feet in width, then we should be notified to re-evaluate these recommendations.

Title: BEARING CAPACITY CHART	Date: 4/22/22	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing
Job Name: Berlet Residence	Job No. 22-12594	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 23570 Frayser Lane, Routt County, CO	Figure #5	



Title: HUNG PARTITION WALL DETAIL	Date: 4/22/,22	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Berlet Residence	Job No. 22-12594	(970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 23570 Frayser Lane, Routt County, CO	Figure #6	





Title: PERIMETER/UNDERDRAIN DETAIL	**Date:** 4/22/22	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing
Job Name: Berlet Residence	**Job No.** 22-12594	(970)879-7858 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 23570 Frayser Lane, Routt County, CO	**Figure** #7	

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	4-5	19.0		27	2	0	41	59		Siltstone-Sandstone	ML
2	5-6	13.6		NA	NP	0	45	55		Siltstone-Sandstone	ML
3	1.5	14.1	101.8	38	21	0	37	63		Very Sandy Clay	CL

JOB NUMBER: 22-12594