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

January 24, 2022

Dave Epstein
2893 Honeysuckle Lane
PO Box 774964
Steamboat Springs, CO 80477

Job Number: 21-12526

Subject: Subsoil and Foundation Investigation, Buckethead Ranch Riding Arena, 30857 CR 53, Routt County, Colorado.

Dave,

As requested, NWCC, Inc. (NWCC) has prepared this report that presents the results of the Subsoil and Foundation Investigation for the proposed riding arena to be constructed at the Buckethead Ranch in Routt County, Colorado. The approximate project site location is shown in the attached 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: NWCC understands a 60 x 150-foot riding arena will be constructed at the site. NWCC assumes a portion of the lower level of the structure will be constructed with concrete slab-on-grade floor systems located from approximately 0 to 2 feet below the existing grades.

For design purposes, we have assumed that the building loads will be light to moderate typical of this type of 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 project site is located north of County Road 53 and south of Hayden in Routt County, Colorado. At the time of the investigation, stables were located to the west of the proposed building site. Based on conversations with the client and review of historic photographs, an old mining building was located at the building site and was demolished/buried. A historic longwall and significant reclamation area is located to the south of County Road 53, across from the subject property.

Vegetation at the site appeared to consist primarily of grasses and weeds. The building area appears to have been disturbed, and vegetation is sparser than in surrounding areas, where sagebrush is more prevalent. An elevation difference of approximately 2 to 3 feet appears to exist across the proposed building site.

Topography at the building site was fairly flat and with a gentle slope down to the southwest. Natural topography in the surrounding areas appears to slope down to the south.

Subsurface Conditions: To investigate the subsurface conditions at the site, three test holes were advanced on December 7, 2021, with an all-terrain drill rig using 4-inch diameter continuous flight augers. The approximate test hole locations are shown in Figure #2.

Subsurface conditions encountered in the test holes were highly variable and generally consisted of a layer of fill materials overlying natural bedrock that extended to the maximum depth investigated, 25 feet below existing ground surface (bgs). Graphic logs of the exploratory test holes are presented in Figure #3, and associated Legend and Notes are presented in Figure #4.

A layer of fill materials was encountered at the ground surface in all of the test holes and extended to 14 ½ feet bgs in Test Hole 1 and to 9 feet bgs in Test Holes 2 and 3. Fill materials consisted of approximately 6 inches of topsoil and organic materials overlying clay with shale and sandstone bedrock fragments and gravels, cobbles and boulders with construction debris. Fill materials consisting of gravels, cobbles, boulders and construction debris were encountered in Test Holes 2 and 3, extending from the topsoil and organic materials down to 5 feet bgs in Test Hole 2 and to 6 feet bgs in Test Hole 3. Refusal in fill materials was encountered at approximately 3 ½ feet bgs in Test Hole 2 on construction debris, and the test hole was subsequently offset approximately 3 feet. Fill materials were low to highly plastic, fine to coarse grained, moist and light brown to dark gray with occasional iron staining. Samples of the clay fill materials classified as CL-CH and CH soils in accordance with the Unified Soil Classification System (USCS).

Interbedded sandstone and claystone bedrock materials were encountered beneath the fill materials in all of the test holes. Bedrock materials were low to highly plastic, fine to medium grained, hard, dry to wet and gray to tan in color. A sample of the claystone bedrock materials classified as a CH soil in accordance with the USCS.

Swell-consolidation tests conducted on samples of the fill materials and claystone bedrock indicate the materials tested will exhibit a high swell potential when wetted under a constant load. Swell-consolidation test results are presented in Figures #5, #6 and #7, and all other laboratory test results are summarized in the attached Table 1.

Groundwater was encountered in Test Holes 1 and 2 at 23 feet bgs 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 results of the field and laboratory investigations and our experience with similar projects in this subdivision, NWCC believes a safe and economical foundation system will consist of a deep foundation system consisting of straight shaft skin friction/end bearing piers drilled into the underlying bedrock. Foundation movement should be within tolerable limits if the following design and construction precautions are observed.

1) A minimum pier diameter of 12 inches, a minimum bedrock penetration of 6 feet and a minimum pier length of 20 feet are recommended. A maximum pier length to diameter ratio of 25 is also recommended.

2) Piers should be designed using allowable skin friction value of 3,000 psf for the portion of pier drilled into the bedrock materials. The pier penetration in the fill materials should be neglected in skin-friction calculations. A drill rig of sufficient size, type and operating condition should be used so bottom of the piers can be cleaned out properly and minimum length requirements can be met. Difficult drilling should be anticipated due to large bedrock fragments and debris encountered in the fill materials. If the bottom of piers are properly cleaned and approved by an engineer from this office, then an allowable end bearing pressure of 30,000 psf for the bedrock materials may be used in the design.

3) Piers should be reinforced their full length with at least one #5 reinforcing rod for each 16 inches of pier perimeter.

4) Piers should be properly cleaned and dewatered prior to steel and concrete placement. Concrete should not be placed in more than 3 inches of water unless the tremie or pump methods are used to place the concrete. Due to the presence of groundwater, casing may be required to prevent piers from caving.

5) A 4-inch void should be provided beneath grade beams to prevent expansive soils from exerting uplift forces on grade beams and to concentrate pier loadings. A void should also be provided beneath necessary pier caps.

6) A representative of NWCC must observe the test hole and pier drilling operations.

Alternate Deep Foundation Recommendations: An alternative type of deep foundation system would consist of helical screw piles advanced into the bedrock materials. The helical screw pile foundations will place the bottom of the foundation in a zone of relatively stable moisture content and mitigate the risk of foundation movement from swelling of the fill materials and bedrock materials.

Utilizing this type of foundation, each column is supported on a single or group of screw piles, and the structures are founded on grade beams or pile caps supported by a series of piles. Load applied to the piles is transmitted to the bedrock materials through the end bearing pressure at the helices of the screw pile. Foundation movement should be less than ½-inch if the following design and construction conditions are observed.

The helical screw pile foundation system should be designed by a qualified engineer, using industry standards and be installed by a licensed/certified installer. If pile groups are required, we recommend a minimum pile spacing of 3 times the largest helix to achieve the maximum capacity of each individual pile. Lateral loads should be resisted using battered piles or tiebacks or through passive soil pressures against foundation walls or grade beams. **Refusal in fill materials will not be acceptable.**

We strongly recommend at least two test piles be advanced at the site to confirm subsoil conditions and establish torque versus depth relationships to determine the proper shaft and helix size and type. In addition, load testing of the helical screw piles is strongly recommended to verify the design capacity of the piles. A representative of this office should observe the test piles, load test and helical screw pile installations.

NWCC also recommends the following:

- Minimum 6-inch diameter helix;
- Minimum 8 foot depth of top helix;
- Minimum installation torque of 4,000 ft-lbs;
- Full-time installation observation by a qualified special inspector;
- Review of the Contractor's quality control plan regarding instrumentation calibration and testing, materials QC and pile installation procedures.

Floor Slabs: NWCC has assumed portions of the lower levels of the proposed structure will be constructed with concrete slab-on-grade floor systems. On-site soils, apart from the 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 the fill materials and bedrock materials encountered at the site, NWCC recommends structural floor systems over well-ventilated crawlspaces or void form materials be used in the proposed structures.

If the client elects to construct concrete slab-on-grade floor systems, we recommend the following special design and construction precautions be followed so that the amount of movement in the floor slabs can be reduced if the clays become wetted and swell. Differential slab movements on the order of 1 to 3 inches could occur if the fill materials are wetted.

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 #8.

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, 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, 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 10 to 12 feet on center in each direction 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 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 3 feet of the expansive clay fill 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 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 should be protected by a drainage system to help reduce the problems associated with surface and subsurface drainage during high runoff periods.

To enhance site drainage and improve foundation and interior slab-on-grade performance, NWCC recommends a perimeter drainage system be installed around the building perimeter. Localized perched water or runoff can infiltrate the structure at the foundation level. This water can be one of the primary causes of differential foundation and slab movement.

The drainage system should be located around the entire building perimeter and be placed and at least 12 inches below interior slab or crawl space grades and a minimum of 24 inches below final grades to provide frost protection. Ideally, the drainage system should be centered along roof drip-line locations. In locations where roof drip-lines are not present, the drainage system 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 are recommended for the proposed structures. A typical perimeter/underdrain detail is shown in Figure #9.

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 system is 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 based on an equivalent fluid unit weight of 45 pcf for imported, free draining granular backfill and 60 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 50 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.

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 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 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. 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 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.

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 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 soils and bedrock 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 a 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 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

COLORADO LICENSED
BRIAN D. LEN
1/24/2022
25750
PROFESSIONAL ENGINEER

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

N

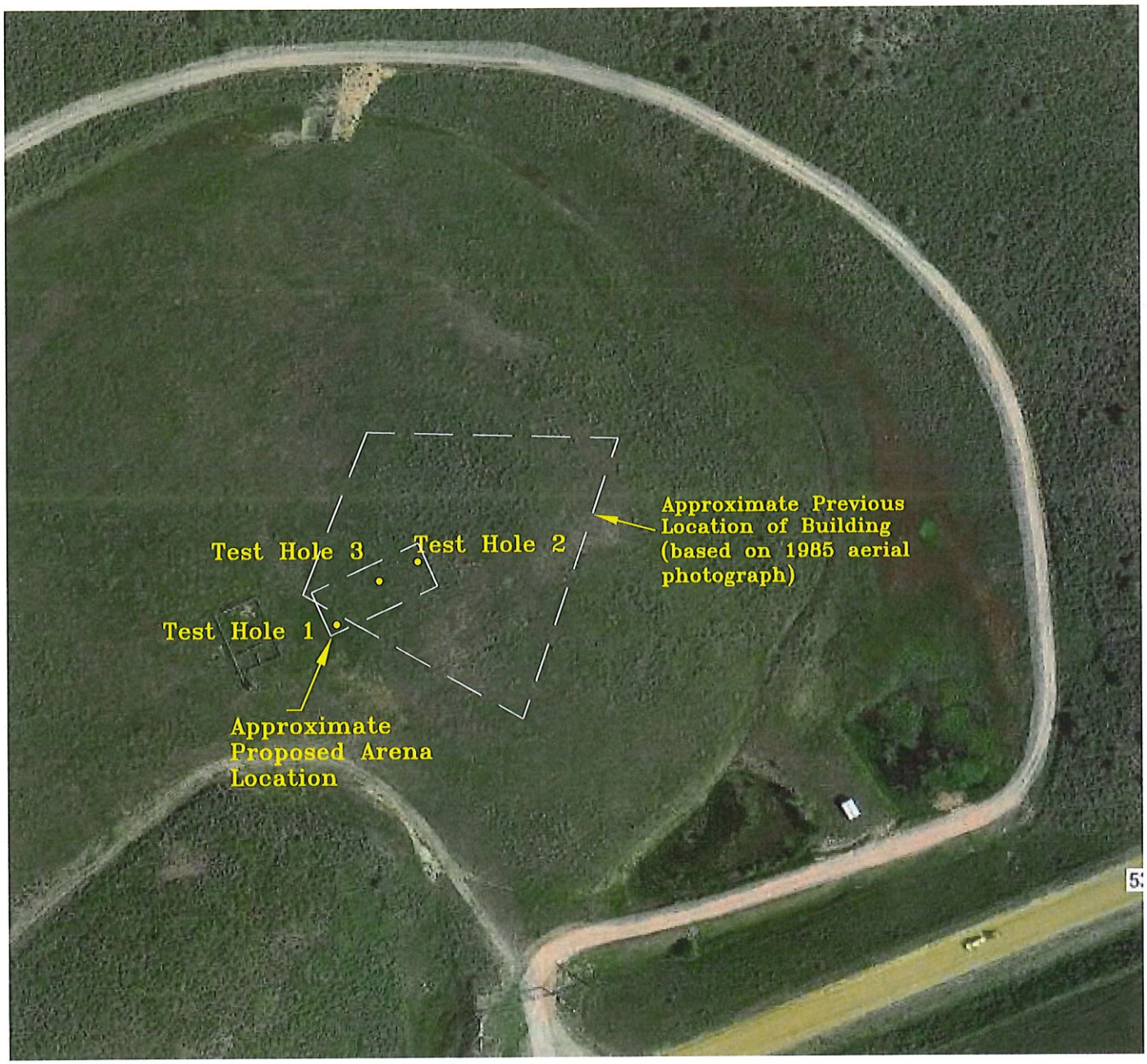
NOT TO SCALE

PROJECT SITE

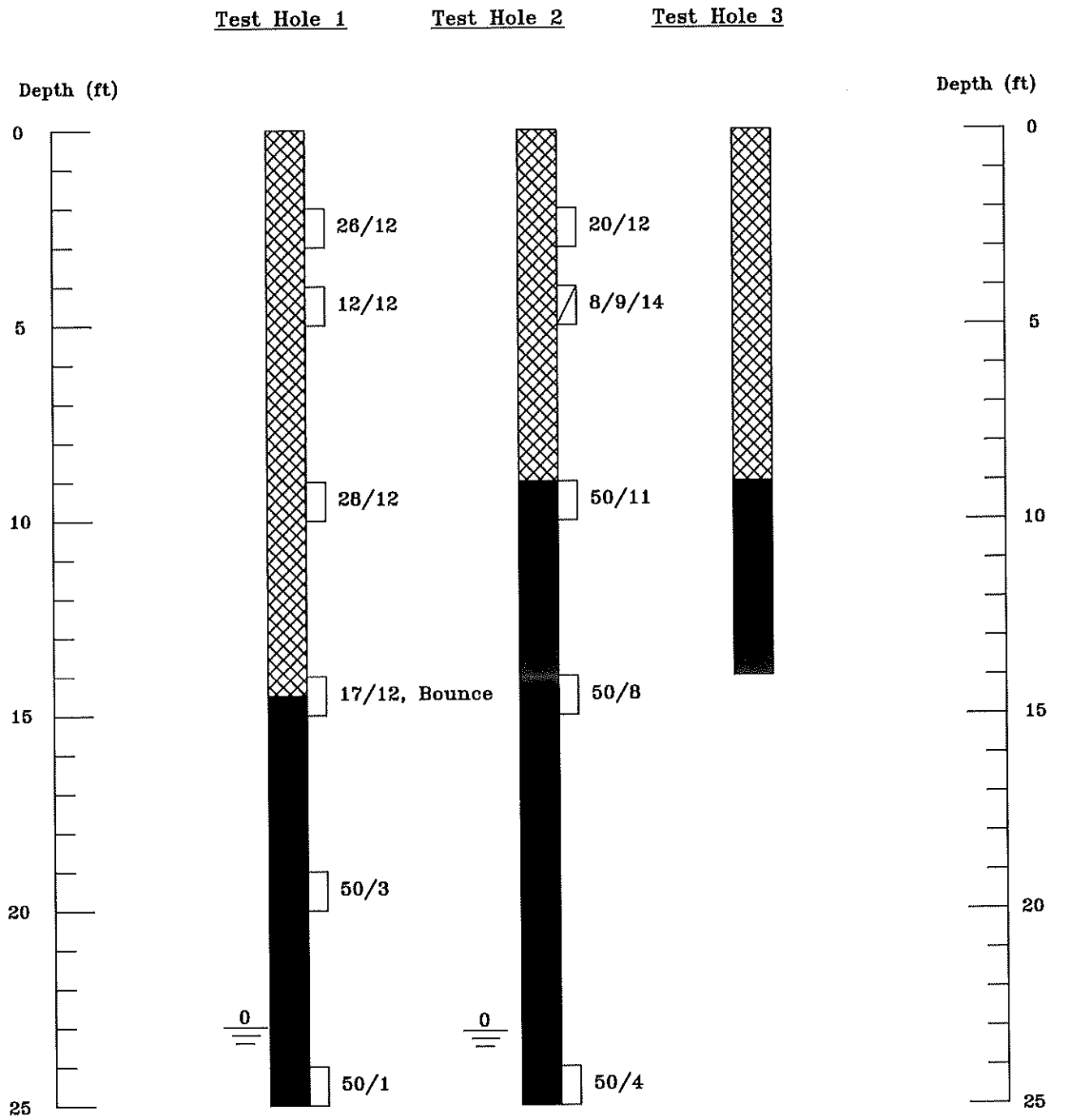
Title: VICINITY MAP	**Date:** 1/20/22	NWCC North West Colorado Consultants, Inc Geotechnical / Environmental Engineering - Materials Testing
Job Name: Buckethead Ranch Riding Arena	**Job No.** 21-12526	(970)879-7888- Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 30857 CR 53, Routt County, Colorado	**Figure** #1	

N

NOT TO SCALE



Title: SITE PLAN–LOCATION OF TEST HOLES	Date: 1/20/22	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing
Job Name: Buckethead Ranch Riding Arena	Job No. 21–12526	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 30857 CR 53, Routt County, Colorado	Figure #2	



Title: LOGS OF EXPLORATORY TEST HOLES		Date: 1/20/22	NWCC Northwest Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2560 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Buckethead Ranch Riding Arena		Job No. 21-12526	
Location: 30857 CR 53, Routt County, Colorado		Figure #3	

LEGEND:

FILL: Thin topsoil overlying clay with shale and sandstone fragments to gravels, cobbles and boulders with construction debris, low to highly plastic, fine to coarse grained, moist and light brown to dark gray with occasional iron staining.

BEDROCK: Claystone to sandstone, low to highly plastic, fine to medium grained, hard, dry to wet and gray to tan.

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

Drive Sample, Split Spoon Sampler.

8/9/14 Split Spoon Sample Blow Count, indicates 8 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 6 inches, then another 9 blows to drive the sampler the next 6 inches and then 14 blows to drive the sampler the final 6 inches.

26/12 Drive Sample Blow Count, indicates 26 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates depth at which groundwater was encountered at the time of drilling.

NOTES:

1) The test holes were drilled on December 7, 2022 with an all terrain drill rig using 4-inch diameter continuous flight augers.

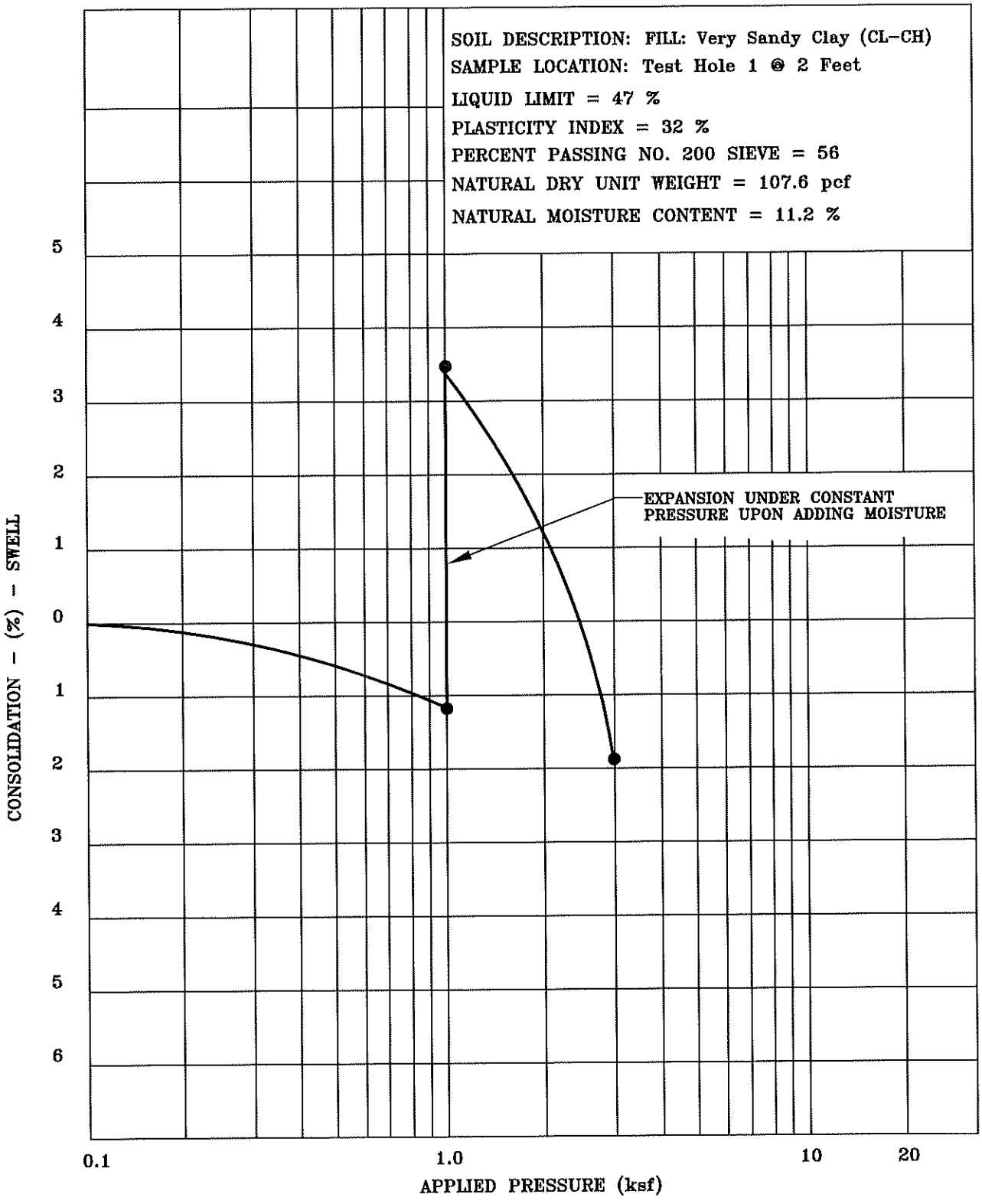
2) Locations of the test holes were determined in the field by pacing from staked building corners at the site.

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.

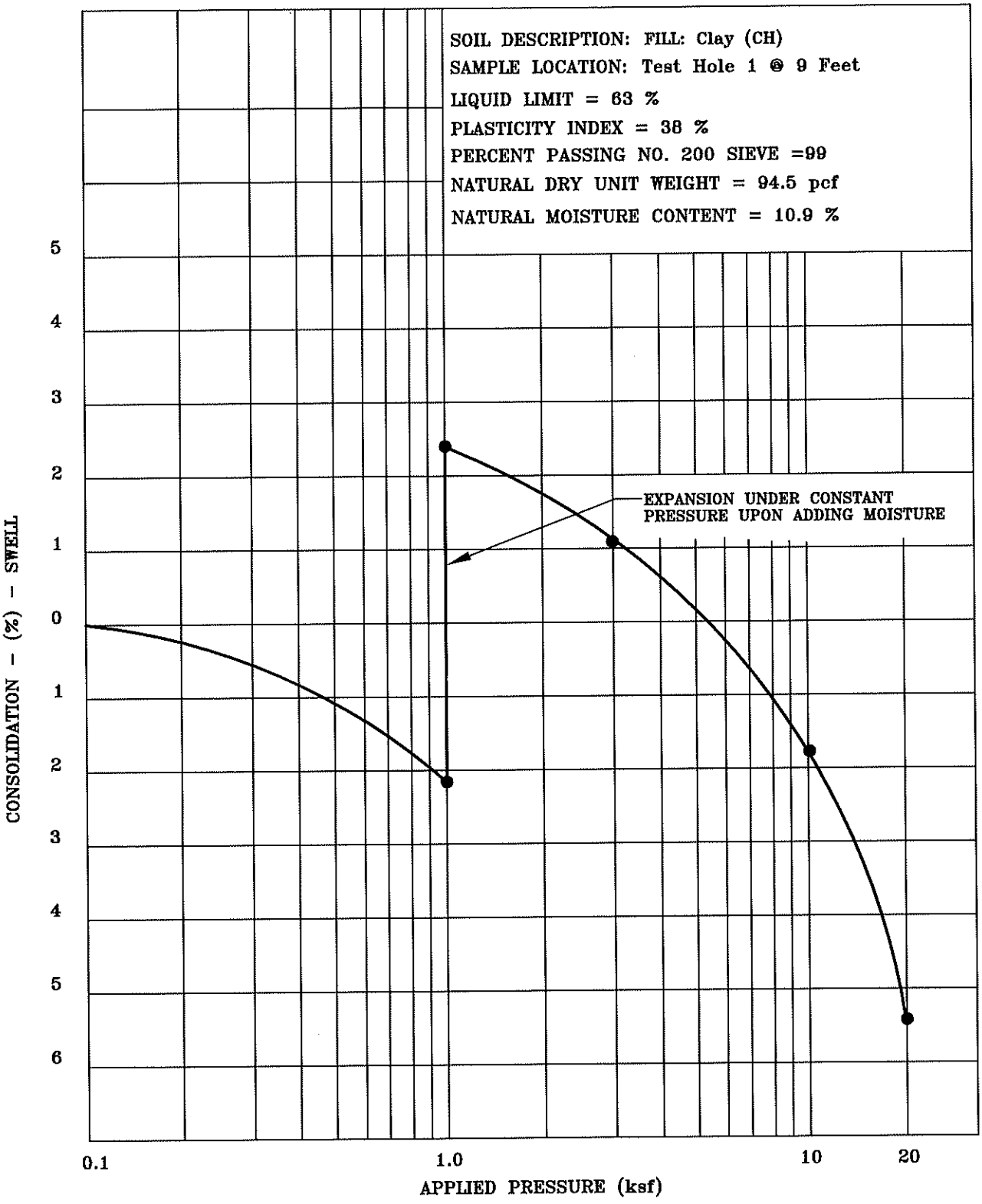
5) The water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water levels will probably occur with time.

Title: LEGEND AND NOTES	Date: 1/20/22	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Buckethead Ranch Riding Arena	Job No. 21-12526	(970)879-7888 Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 30857 CR 53, Routt County, Colorado	Figure #4	

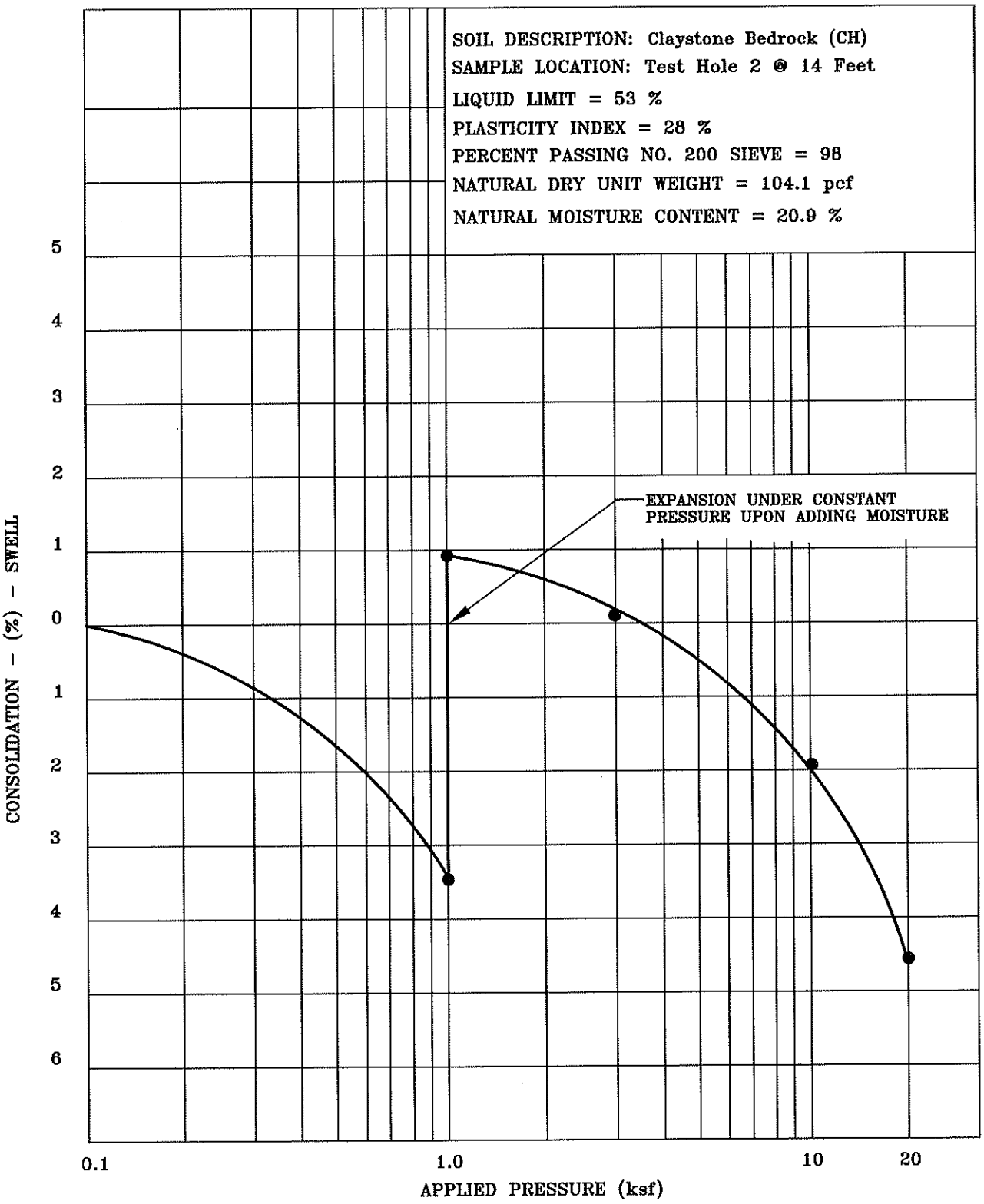


Title: SWELL-CONSOLIDATION TEST RESULTS		Date: 1/20/22
Job Name: Buckethead Ranch Riding Arena		Job No. 21-12526
Location: 30857 CR 53, Routt County, Colorado		Figure #5

NWCC
NorthWest Colorado Consultants, Inc.
Geotechnical / Environmental Engineering · Materials Testing
(970)879-7885 · Fax (970)879-7891
2580 Copper Ridge Drive
Steamboat Springs, Colorado 80487

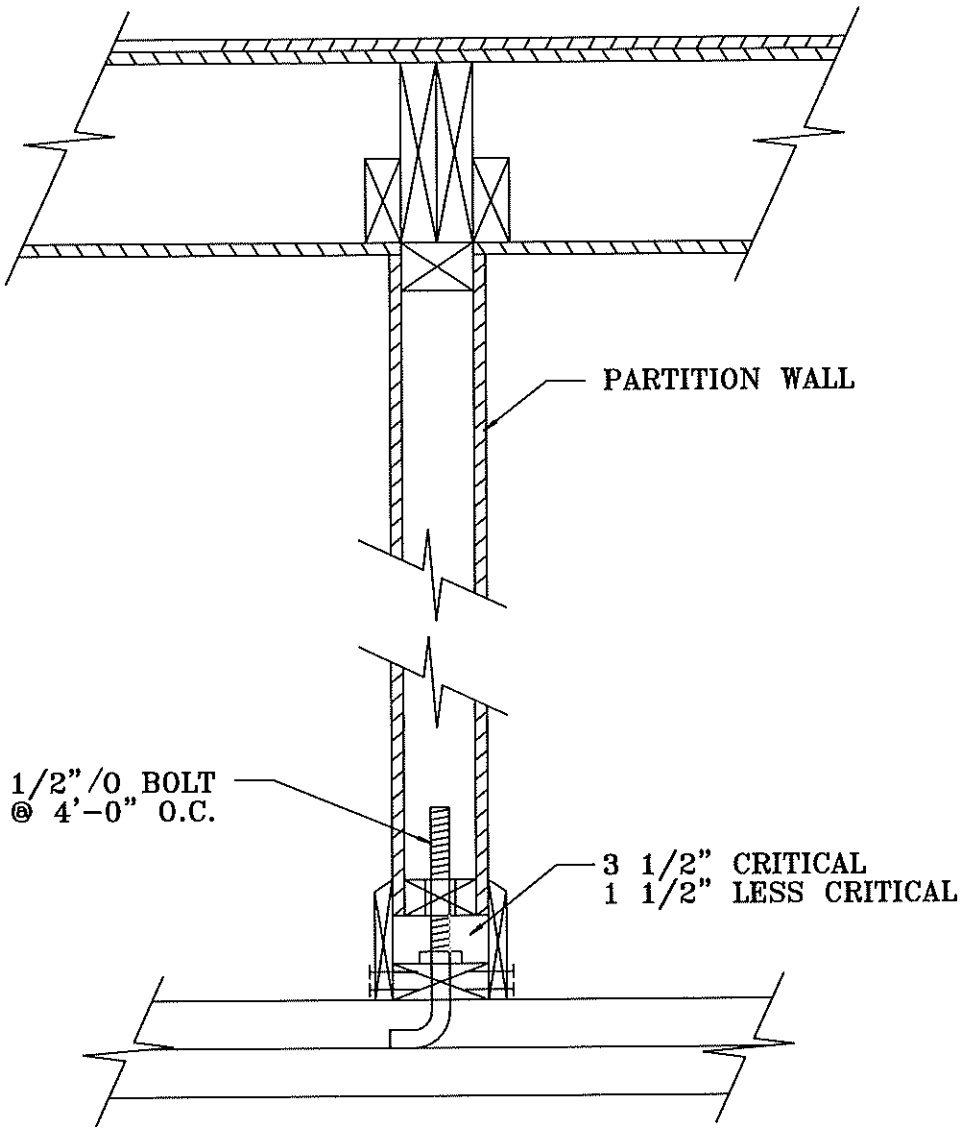


Title: SWELL–CONSOLIDATION TEST RESULTS		Date: 1/20/22	NWCC Northwest Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Bucketheat Ranch Riding Arena		Job No. 21–12526	
Location: 30857 CR 53, Routt County, Colorado		Figure #6	

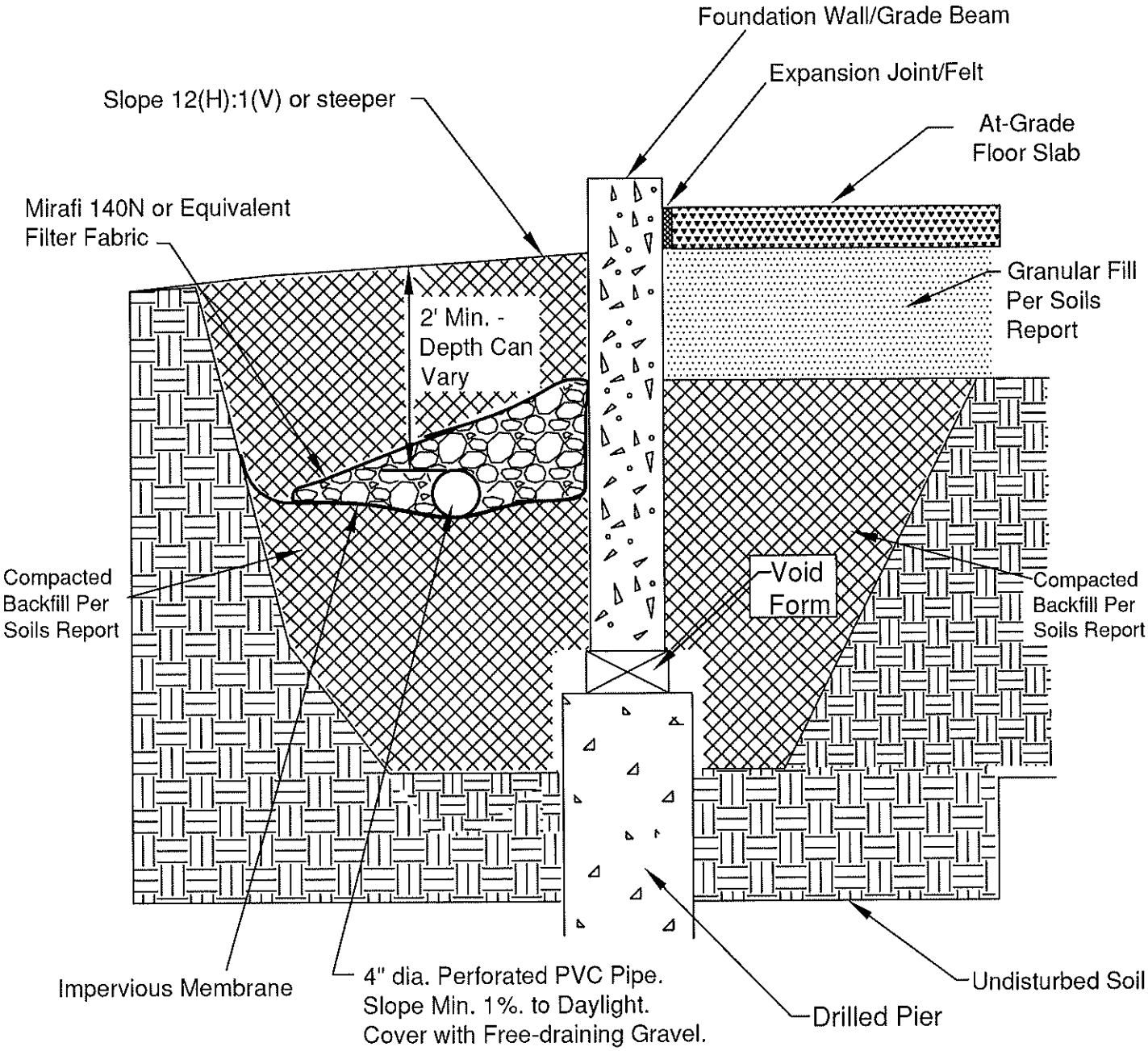


Title: SWELL–CONSOLIDATION TEST RESULTS		Date: 1/20/22
Job Name: Buckethead Ranch Riding Arena		Job No. 21-12526
Location: 30857 CR 53, Routt County, Colorado		Figure #7

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



Title: HUNG PARTITION WALL DETAIL	Date: 1/20/22	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Bucketheat Ranch Riding Arena	Job No. 21-12526	(970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 30857 CR 53, Routt County, Colorado	Figure #8	



Title: SHALLOW PERIMETER DRAIN DETAIL		Date: 1/20/22
Job Name: Buckethead Ranch Ridging Arena		Job No. 21-12526
Location: 30857 CR 53, Routt County, Colorado		Figure #9

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

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 Hole	DEPTH (feet)			LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAVEL (%)	SAND (%)				
1	2	11.2	107.6	47	32	23	21	56		FILL: Sandy Gravelly Clay	CL-CH
1	9	10.9	94.5	63	38	0	1	99		FILL: Clay	CH
2	14	20.9	104.1	53	28	0	2	98		Claystone Bedrock	CH

JOB NUMBER: 21-12526