NorthWest Colorado Consultants, Inc.

Geotechnical / Environmental Engineering • Materials Testing

January 19, 2023

Routt County
Department of Environmental Health
Scott Cowman
136 6th Street, Suite 201
Steamboat Springs, CO 80487

Job Number: 22-12814

Subject: Subsoil and Foundation Investigation, Proposed Wastewater Treatment Building, Town of Milner WWTP, Routt County, Colorado.

Scott,

This report presents the results of the Subsoil and Foundation Investigation for the proposed Wastewater Treatment Building to be constructed at the Town of Milner Wastewater Treatment Plant (WWTP) located at the south end of Main Street in the Town of Milner 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 two (2) test holes, 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 the building will consist of a one-story metal structure constructed over a concrete multi-compartment treatment tank. The building will be constructed over the structural concrete slab on top of the tank. The treatment tank will be constructed with a structural concrete slab-on-grade floor system located approximately 12 to 22 feet beneath the existing ground surface.

For design purposes, NWCC has assumed that building loadings will be light to moderate, typical of this type of 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 will be located east of the existing lift station for the WWTP located at the south end of Main Street in the Town of Milner in Routt County, Colorado. Vegetation at the building sites primarily consists of grasses and weeds.

Topography of the building site is relatively flat and generally slopes gently down to the east. An existing access road is located north of the existing lift station.

Subsurface Conditions: To investigate the subsurface conditions at the site, two test holes were advanced on October 10, 2022 with a truck-mounted drill rig using 4-inch diameter continuous flight augers. A site plan showing existing features, along with the approximate test hole locations is presented in Figure #2.

Subsurface conditions encountered at the site were variable and generally consisted of a topsoil and organic materials overlying natural silts-clays, gravels and sands to the maximum depth investigation, 30 feet below the existing ground surface (bgs). Graphic logs of the exploratory test holes are presented in Figure #3 and the associated Legend and Notes are presented in Figure #4.

Topsoil and organic materials were encountered at the ground surface in both test holes and were 6 to 8 inches in thickness. Natural silts-clays were encountered beneath the topsoil materials in Test Hole 1 and extended to a depth of 3 feet bgs. The natural silts-clays were sandy, very low to low plastic, medium stiff, moist and brown in color. A sample of the silts-clays classified as a CL soil in accordance with the Unified Soil Classification System (USCS).

Natural gravels were encountered beneath the silts-clays in Test Hole 1 and beneath the topsoil materials in Test Hole 2. The natural gravels extended to depths of 6 ½ and 10 feet bgs in Test Holes 1 and 2, respectively. The gravels were sandy to very sandy, slightly silty, fine to coarse grained with occasional cobbles, non-plastic, dense, dry to moist and brown to gray in color. A sample of the gravels classified as a GP soil in accordance with the USCS. Natural sands were encountered below the gravels in both test holes and extended to the maximum depth investigated in each test hole. The sands were silty to very silty, fine to coarse grained with gravels, very low to non-plastic, loose to medium dense, moist to wet and brown to gray in color. A sample of the natural sands classified as an SM soil in accordance with the USCS.

A swell-consolidation testing conducted on a sample of the natural clays indicates the material tested will exhibit a low degree of consolidation under relatively light loading (1,000 psf) and then exhibit a low swell potential when wetted under constant load. The swell-consolidation test results are presented in Figure #5, and all the other laboratory test results are summarized in the attached Table 1.

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.

Groundwater was encountered at a depth of 10 feet bgs in Test Holes 1 and 2 at the time of drilling. The test holes were backfilled after immediately after drilling. 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 subsurface conditions encountered in the test holes, the results of the field and laboratory investigations and our assumptions regarding the proposed construction,

NWCC believes an economically feasible and safe type of foundation system for the proposed structure to be constructed at the site would consist of structural mats or spread/continuous footings placed directly on the natural gravels, natural sands or on properly compacted structural fill materials placed over the gravels or sands. Due to the swell-consolidation potential of the natural clays, NWCC does not recommend foundations be constructed on these materials.

1) Foundations placed on the natural gravels, natural sands or properly compacted structural fill materials placed over the natural gravels or sands should be designed using an allowable soil bearing pressure of 3,000 psf.

2) Foundations sizes should be computed using the above soil pressures and placed on the natural gravels or sands or on properly compacted structural fill materials placed over the natural gravels or sands.

3) Any topsoil and organic materials, natural silts-clays or loose natural soils found beneath the foundations when excavations are opened should be removed and foundations extended down to the natural gravels or natural sands prior to structural fill or concrete placement. Foundation design should be closely checked to assure that it distributes loads per the allowable pressures given. Any fill materials placed beneath the foundations should be a non-expansive granular soil approved by NWCC prior to placement. Groundwater will likely be encountered in the foundation excavations; therefore, NWCC recommends that clean gravel fill materials meeting the gradation specifications for Colorado Department of Transportation (CDOT) Class A or Class B Filter Materials be used. The fill materials placed under the foundations should be uniformly placed and compacted 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, or to at least 80% of the maximum relative density in accordance with ASTM D4253/4254 if free draining gravels are used as structural fill. The 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) Structural slabs 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) The proposed foundation elevations will likely be below the groundwater level. Therefore, it will be necessary to dewater the foundation excavations during construction. If the concrete is not to be placed in the excavations within 24 hours, we would recommend that a layer of lean concrete or 1 ½ inch gravels be placed in the base of the foundation excavations immediately after the

excavations are completed. This "mud mat" will reduce disturbance of the natural soils caused by exposure to the elements and the construction operations.

7) Based on experience, NWCC estimates total settlement for foundations pads designed and constructed as discussed in this section will be approximately 1 inch or less. Additional bearing capacity values along with the associated settlements are presented in Figure #6.

8) NWCC must be retained by the client to observe the foundation excavations when they are near completion to identify bearing soils and confirm the recommendations in this report, as well as test the structural fill materials for compaction.

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 an at-rest lateral earth pressure computed based on an equivalent fluid unit weight of 50 pcf for the natural gravels or free draining granular backfill and 60 pcf for on-site sands. For the portion of the tank walls that will be below the groundwater table, an at-rest lateral earth pressure computed based on an equivalent fluid unit weight of 85 pcf for the natural gravels or free draining granular backfill and 90 pcf for on-site sands.

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 the natural gravels or imported, free draining granular backfill and 45 pcf for on-site sands. For the portion of the tank walls that will be below the groundwater table, an at-rest lateral earth pressure computed based on an equivalent fluid unit weight of 80 pcf for the natural gravels or free draining granular backfill and 85 pcf for on-site sands.

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 at the site will be a combination of sliding resistance of the foundations on the foundation materials and passive pressure against the sides of foundations. Sliding friction can be taken as 0.4 times the vertical dead load. Passive pressure against the sides of the foundations can be calculated using an equivalent fluid pressure of 250 pcf. Fill placed against the sides of foundations 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 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) 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 possible, 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: General site grading 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) 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 topsoil and organic materials and natural clays. We recommend these cuts be limited to 5 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.

2) 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.

3) Fills up to 10 feet in height can be constructed at the site and should be constructed to a 2(Horizontal) to 1(Vertical) or flatter configuration. The fill areas should be prepared by stripping any 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 (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.

4) 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.

5) 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.

Pavement Section Recommendations: Pavement section alternatives presented below are based on anticipated soil conditions, assumed traffic loadings, pavement design procedures presented in the AASHTO Guide for Design of Pavement Structures, and our experience with similar sites and conditions in this part of Routt County. AASHTO pavement design procedures have been adopted and are used by the Colorado Department of Transportation (CDOT). NWCC has assumed the proposed pavement areas will be subjected to automobiles with occasional delivery trucks.

Based on the soil conditions encountered at the site during our investigation and our understanding of the proposed construction, the materials to be encountered at proposed pavement subgrade elevations will most likely consist of clay fill materials. The clay fill materials and natural clays will generally classify as CL to CH soils in accordance with the USCS, which is the worst-case scenario. NWCC recommends the pavement areas subjected to both truck and automobile traffic, such as the main roadway be constructed with a minimum of 4 inches of hot mix asphalt (HMA) overlying a minimum of 4 inches of CDOT class 6 aggregate base course (ABC) and a minimum of 8 inches of subbase aggregates (Pit Run). The pavement areas subjected to automobiles only, such as the parking stalls, can be paved with a minimum of 3 inches of HMS, 4 inches of CDOT class 6 aggregate base course (ABC), and a minimum of 6 inches of subbase aggregates (subbase).

The existing gravel materials may be used for the subbase aggregates in the composite pavement section. The depth of the existing gravel section must be evaluated prior to placement of the base course or asphalt pavement materials. Additional subbase and base course materials may be required if the existing gravels sections do not meet the recommendations indicated above.

NWCC recommends the asphalt pavement material (HMA) consist of an approved "Superpave" mix designed by a qualified, registered engineer. The mix design should be designed using the SX gradation and mixed with PG 58-28 oil or other performance graded asphaltic materials. The mix should be produced and placed by a qualified contractor and should be compacted to between 92 and 96 percent of the maximum theoretical (Rice) density or at least 92 percent of the maximum Rice density. Quality control activities should be conducted on paving materials at the time of placement.

Base course materials (ABC) should consist of a well-graded aggregate base course material that meets CDOT Class 6 ABC grading and durability requirements and the subbase should consist of well-graded aggregate materials that meet CDOT Class 2 ABC grading and durability requirements.

ABC and subbase materials should be uniformly placed and compacted in 4 to 6-inch loose lifts to at least 95 % of the maximum modified Proctor density and within +/- 2 % of the optimum moisture content as determined by ASTM D1557.

NWCC recommends the areas subjected to heavy truck turning movements, such as the pads in front of trash dumpsters, if used, be paved with a rigid pavement section consisting of at least 8 inches of Portland cement concrete (PCC).

Concrete pavement materials shall be based on a mix design established by a qualified engineer. Concrete should have a minimum 28-day compressive strength of 4,500 psi, be air-entrained with approximately 6 percent air, and have a maximum water/cement ratio of 0.42. Concrete should have a maximum slump of 4 inches and should contain control joints no greater than 10 to 12 feet on center, depending on slab configurations. The depth of the control joints should be at least ¼ of the slab thickness.

Prior to placement of any subgrade fill materials the existing clay fill materials should be scarified and recompacted to a depth of 12 inches. The scarified fill materials and subgrade materials should be compacted in 6 to 8 inch lifts to at least 95 % of the maximum standard Proctor density and within +/- 2 % of the optimum moisture content as determined by ASTM D698. The finished subgrade surface, after recompaction, should also be sloped at least 1 percent to avoid ponding and to reduce the potential for wetting and expansion of the subgrade soils. The finished subgrade surface should be proof rolled with a loaded tandem dump truck or loaded water truck and any areas deflecting or rutting should be removed and or stabilized prior to placing the subbase aggregates.

The collection and diversion of surface and subsurface drainage away from the paved areas is extremely important to the satisfactory performance of the pavement. The design of the surface and subsurface drainage features should be carefully considered to remove all water from paved areas and to prevent ponding of water on and adjacent to paved areas.

Limitations: The recommendations provided in this report are based on the soils encountered at this site and NWCC's assumptions regarding 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.

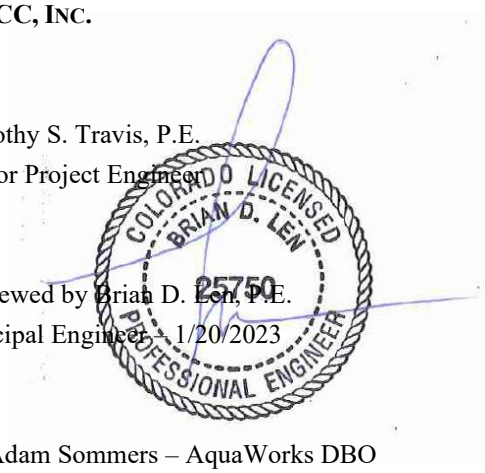
Expansive soils were encountered at this site. These soils are stable at their natural moisture content but can shrink or swell with changes in moisture. The behavior of expansive soils is not fully understood. The swell or consolidation potential of a site can change erratically both in lateral and 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 for foundations and floor slabs on swelling soils. As noted previously, the owner must be made aware there is a risk in construction on these types of soils. 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, 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 from time to time occur. As a result, the findings of this report may become invalid due to these changes. Therefore, this report is subject to review and not considered valid after a period of 3 years or if conditions as stated above are altered. It is the responsibility of the owner or his representative to ensure that the information in this report is incorporated into the plans and/or specifications and construction of the project. It is advisable that a contractor familiar with construction details typically used to dealing with the local subsoils and climatic conditions be retained to build the structure.

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

Sincerely,
NWCC, INC.



Timothy S. Travis, P.E.
Senior Project Engineer

Reviewed by Brian D. Len, P.E.
Principal Engineer – 1/20/2023

cc: Adam Sommers – AquaWorks DBO

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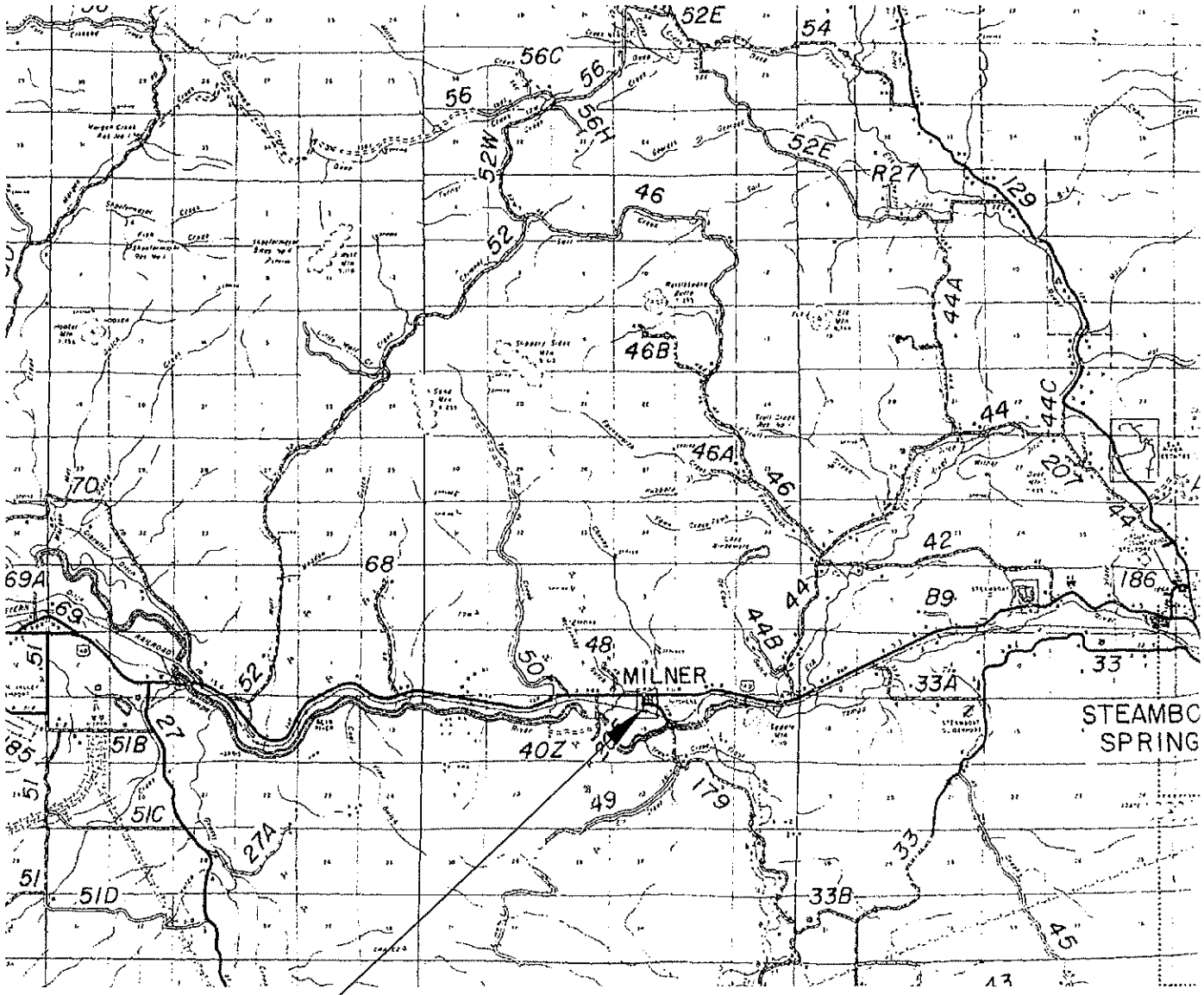
NOT TO SCALE



Title: VICINITY MAP		**Date:** 1/16/2023	NWCC North West Colorado Consultants Inc Geotechnical / Environmental Engineering - Materials Testing (970)879-7888- Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Proposed Wastewater Treatment Building		**Job No.** 22-12814	
Location: Town of Milner WWTF, Routt County, Colorado		**Figure** #1	

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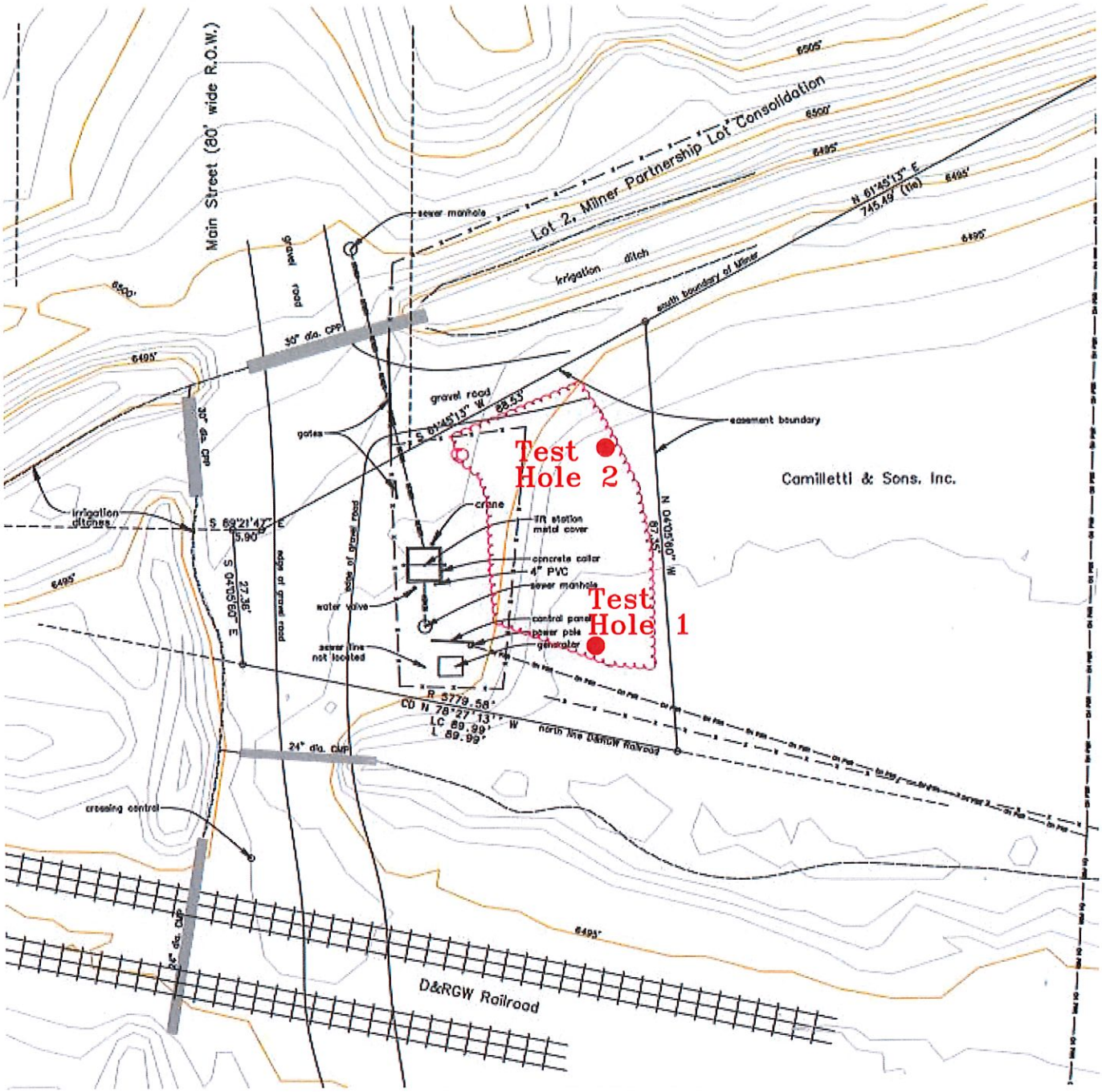
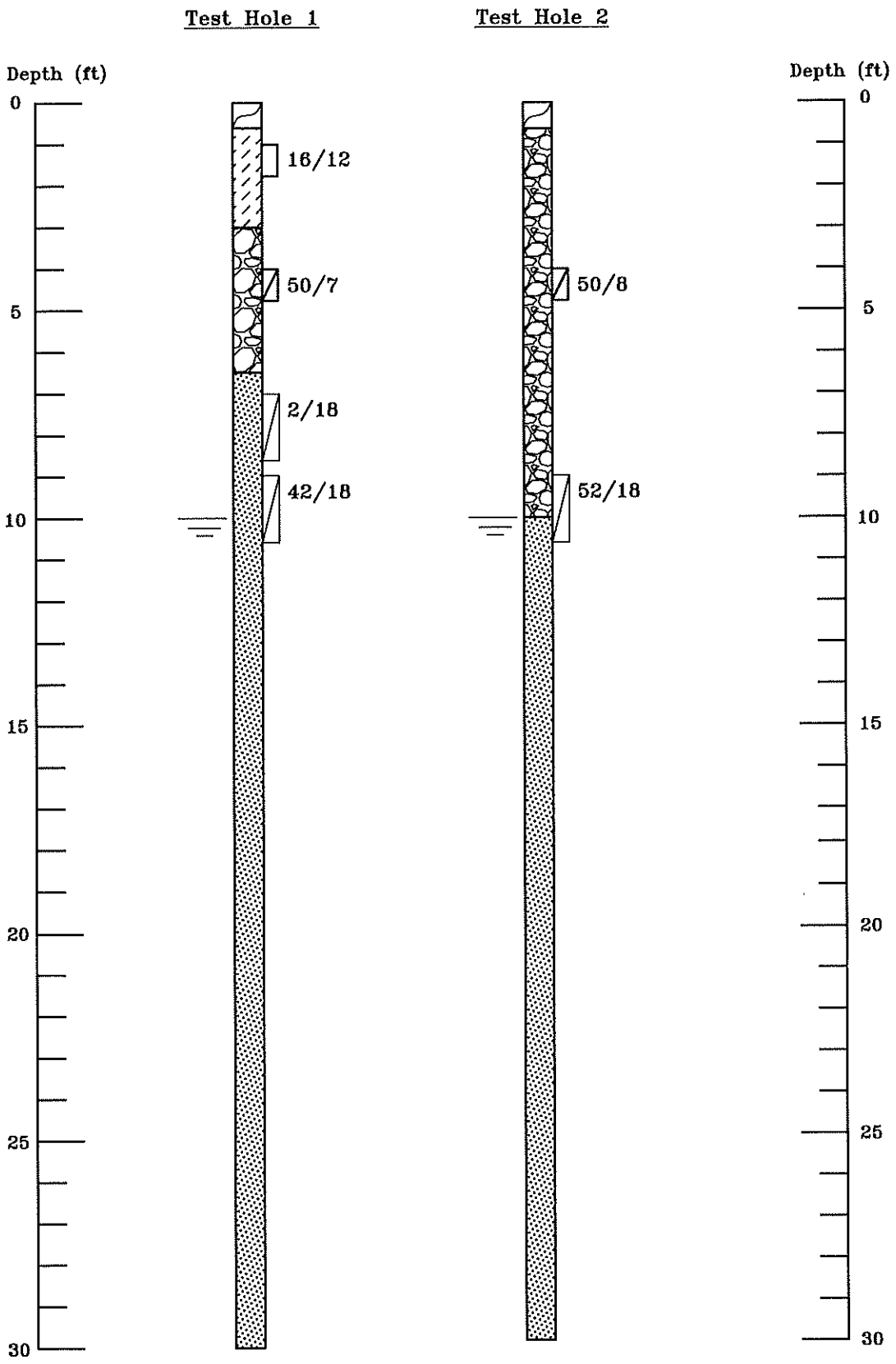
NOT TO SCALE



Title: SITE PLAN–LOCATION OF TEST HOLES		**Date:** 1/16/2023	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Proposed Wastewater Treatment Building		**Job No.** 22-12814	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: Town of Milner WWTF, Routt County, Colorado		**Figure** #2	



Title: LOGS OF EXPLORATORY TEST HOLES		Date: 1/16/2023	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 Wastewater Treatment Building		Job No. 22-12814	
Location: Town of Milner WWTF, Routt County, Colorado		Figure #3	

LEGEND:

TOPSOIL AND ORGANICS.

SILT-CLAY: Sandy, very low to low plastic, medium stiff, moist and brown in color.

GRAVEL: Sandy to very sandy, slightly silty, fine to coarse grained with occasional cobbles, non-plastic, dense, dry to moist and brown to gray in color.

SANDS: Silty to very silty, fine to coarse grained with gravels, very low to non-plastic, loose to medium dense, moist to wet and brown to gray in color.

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

Drive Sample, 1 3/8-inch I.D. Split Spoon Sampler.

16/12 Drive Sample Blow Count, indicates 16 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 October 10, 2022 with a truck-mounted drill rig using 4-inch diameter continuous flight power augers.

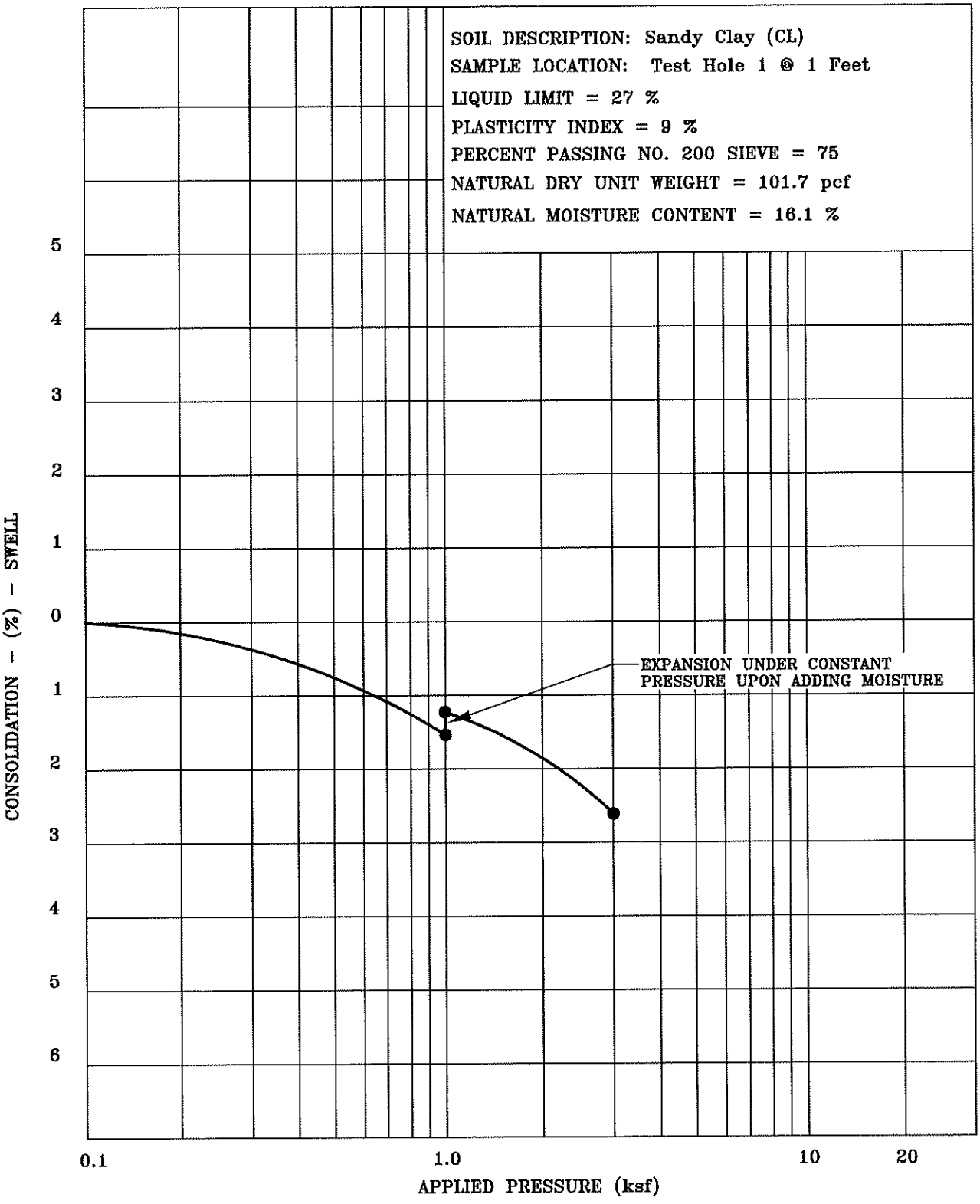
2) Locations of the test holes were determined in the field by pacing from topographic features at the site.

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

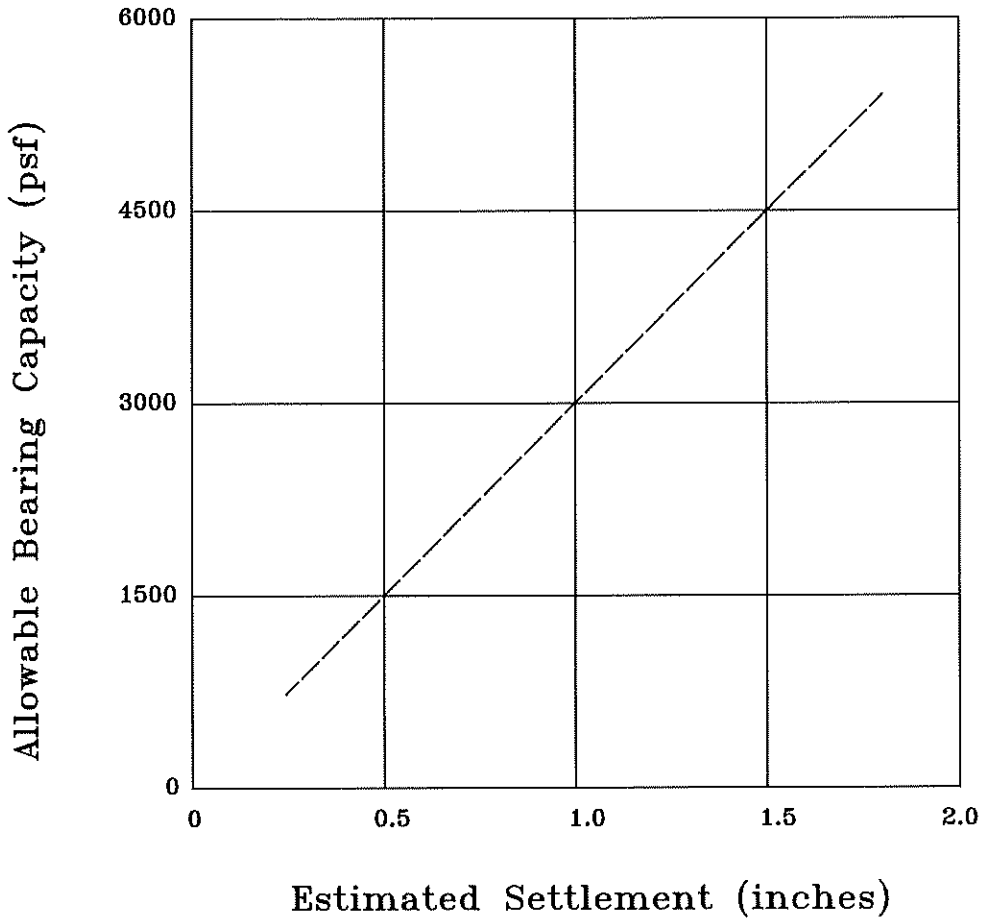
4) The lines between materials shown on the logs represent the approximate boundaries between material types and transitions may be gradual.

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

Title: LEGEND AND NOTES	Date: 1/16/2023	NWCC North West Colorado Consultants Inc Geotechnical / Environmental Engineering · Materials Testing
Job Name: Proposed Wastewater Treatment Building	Job No. 22-12814	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: Town of Milner WWTF, Routt County, Colorado	Figure #4	



Title: SWELL–CONSOLIDATION TEST RESULTS		Date: 1/16/2023	NWCC Northwest Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing (970)879-7668 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Proposed Wastewater Treatment Building		Job No. 22-12814	
Location: Town of Milner WWTF, Routt County, Colorado		Figure #5	



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: 1/16/2023	NWCC Northwest Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Proposed Wastewater Treatment Building	Job No. 22-12814	(970)879-7888- Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: Town of Milner WWTF, Routt County, Colorado	Figure #6	

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	1	16.1	101.7	27	9	0	25	75		Sandy Clay	CL
1	9	13.2		nv	np	17	67	16		Gravelly, Silty Sand	SM
2	4	6.7		nv	np	58	38	4		Slightly Silty, Sandy Gravels	GP

JOB NUMBER: 22-12814