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

September 16, 2015

Twin Enviro Services
Marlin Mullet
P.O. Box 774362
Steamboat Springs, CO 80477

Job Number: 15-10176

Subject: Subsoil and Foundation Investigation, Proposed Materials Recovery Facility, Milner Landfill, 2650 County Road 205, Routt County, Colorado.

Dear Marlin,

This report presents the results of the Subsoil and Foundation Investigation for the proposed Materials Recovery Facility (MRF) to be constructed within the Milner Landfill in Routt County, Colorado. The location of the project site is shown in Figure #1.

NWCC, Inc. (NWCC) scope of our work included obtaining data from cursory observations made at the site, the logging of two test pits, 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: Based on conversations with the client, NWCC understands that a new building/shop will be built on the property. This new building will be built west of the existing shop and north of the fuel tanks. The building will be a one-story metal framed structure with a single sloped roof. NWCC also understands the building will be constructed with a slab-on-grade floor system placed with 2 feet of the existing ground surface.

For design purposes, we have assumed that the building loads will be light to moderate typical of this type of commercial/industrial building 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 proposed building site is situated in the northeast corner of the Milner Landfill and at the south end of County Road 205 in Routt County, Colorado. The proposed building site is currently occupied by a gravel surfaced parking area located west and south of the existing shop building and east of the existing, buried leachate collection pipe.

The topography of the lot is somewhat variable due to previous development near the site and the site generally slopes gently to the northwest. It appears that a maximum elevation difference of approximately 2 to 4 feet exists across the proposed building site. The Yampa River is located approximately ½ mile north of the proposed building site.

Subsurface Conditions: To investigate the subsurface conditions at the site, two test pits were advanced on August 26, 2015 with a John Deere 200 LC trackhoe. The approximate test pit locations are shown in Figure #2.

The subsurface conditions encountered were variable and generally consisted of a layers of fill overlying natural clays that extended 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.

Layers of fill ranging from base course to sandy and gravelly clays were encountered in both test pits and ranged from approximately 2 ½ to 3 feet in thickness. It was also noted that there was a strong smell of petroleum hydrocarbons in the fill materials encountered in test pit #1. Natural clays were encountered below the fill in both test pits and extended to depths of 8 and 6 feet bgs in test pits #1 and #2. The natural clays were slightly sandy to sandy with occasional gravels, low to moderately plastic, stiff, moist and light brown in color. Samples of the natural clays classified as CL soils in accordance with the Unified Soil Classification System.

Two swell-consolidation tests were conducted on samples of the natural clays exposed in test pits #1 and #2. The samples tested exhibited a low to moderate swell potential when wetted under a constant load. Swell-consolidation test results are presented in Figures #4 and #5, and all of the other laboratory test results are summarized in the attached Table 1.

Groundwater was not encountered in either test pit. It should be noted that the groundwater conditions at the site can be expected to fluctuate with changes in precipitation and runoff flows in the area.

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 the most economical type of foundation system is spread footings or individual pads with grade beams founded on the undisturbed natural clays or on properly compacted structural fill materials placed over the natural clays. The precautions and recommendations itemized below will not prevent the movement of the foundations if the underlying clays swell. However, they should reduce the amount of differential movement beneath the foundation system. Differential movements on the order of 1 to 2 inches could still occur if the clays undergo moisture changes.

1) Footings placed on the undisturbed, natural clays or properly compacted structural fill materials placed over the natural clays should be designed using an allowable soil bearing pressure of 3,000 psf. A minimum dead load pressure of at least 900 psf is also required for the footings.

2) Footings or pad sizes should be computed using the above soil pressures and placed on the natural undisturbed clays found below the existing fill materials or on properly compacted structural fill materials placed over the natural clays.

3) Any existing fill materials encountered within the foundation excavations should be removed and the excavations extended to competent natural clays prior to structural fill or concrete placement. Any fill materials placed beneath the footings should be a non-expansive granular soil approved by this office. The 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. 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) Footings or pads should be placed well enough below final backfill grades to protect them frost heave. Forty-eight (48) inches is typical for this location considering normal snow cover and other winter factors.

6) Based on experience, NWCC estimates 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 #6.

7) NWCC strongly 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, as well as test the fill materials placed under the foundations for compaction.

Alternate Foundation Recommendations: If the owner is not willing to accept the risks associated with placing the shallow foundations on swelling clays, or if the minimum dead load requirement cannot be met, we recommend that the building be placed on a deep foundation system consisting of straight shaft skin friction/end piers drilled into the underlying clays. Foundation movement should be within tolerable limits if the following design and construction precautions are observed.

1) A minimum pier diameter of 12 inches and a minimum pier length of 20 feet are recommended.

2) The piers should be designed using an allowable skin friction value of 900 psf for the portion of the pier drilled into the natural clays. The upper 5 feet of the pier should be neglected in the skin friction calculations. If a drill rig of sufficient size, type and operating condition is used, and the bottom of the piers can be cleaned out properly and approved by this office, then an allowable end bearing pressure of 3,000 psf can be used for the piers drilled into the undisturbed natural clays.

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

4) The piers should be properly cleaned and dewatered prior to steel and concrete placement.

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

6) We strongly recommend that at least one test hole or pier be drilled at this site prior to starting the pier drilling operations so that the deeper subsurface/bedrock conditions can be determined and the recommendations given above can be verified.

7) This office must be retained by the client to observe the test hole/pier and pier drilling operations during construction of the building.

Floor Slabs: NWCC understands the structure will be constructed utilizing a concrete slab-on-grade floor system. The on-site soils, with the exception of the existing fill materials, are capable of supporting slab-on-grade construction. However, floor slabs present a 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 clays encountered at the 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 should be taken to reduce structure damage that could result from floor slab movement should underslab clays 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. We recommend 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 that in the event the floor slab moves, this movement is not transmitted to the upper structure. A typical hung wall detail is shown on Figure #7.

3) A minimum 6-inch gravel layer must be provided beneath all floor slabs to act as a capillary break and to help distribute loadings. Prior to placing the gravel, the excavation must be shaped so that if water does get under the slab, it will flow to the low point of the excavation. Prior to placement of underslab fills, all of topsoil and organic materials and existing fills must be removed.

4) Floor slabs must be provided with control joints placed a maximum of 12 feet on center in each direction to help control shrinkage cracking. Joint locations should be carefully checked to assure

that natural, unavoidable cracking will be controlled. The depth of the control joints must be a minimum of ¼ of the thickness of the slab.

5) The 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 the floor slab could result in differential movement after the slabs are constructed.

6) It has been our experience that the risk of floor slab movement can be reduced by removing at least 3 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 the underslab soils to the desired grade, the fill should consist of non-expansive, granular materials. The 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.

The precautions and recommendations outlined above will not prevent floor slab movement in the event the clays undergo moisture changes. However, they should reduce the amount of structural damage if such movement occurs. The only way to eliminate the risk of floor slab movement is to employ a structural floor system placed over a well-vented crawl space or void form materials.

Perimeter Drain System: Groundwater is not anticipated at proposed lower level grade. However, NWCC recommends perimeter drainage systems be used to provide site drainage and shallow groundwater relief around the building structure.

In general, NWCC recommends lower structure levels be protected by a perimeter drainage system to help reduce problems associated with surface and subsurface drainage during high runoff periods. Localized perched groundwater associated with seasonal or other surface runoff events can infiltrate the lower levels of the structure from the building perimeter at foundation levels. This water can be one of the primary causes of differential foundation and slab movement, especially when expansive soils are encountered. Excessive moisture in crawl space areas or lower levels can lead to rotting and mildewing of wooden structural members and the formation of mold and mold spores. The 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.

Drainage systems should be provided around the structures at lower level perimeter foundations. Drainpipe should be placed at least 6 inches below adjacent footing voids or 12 inches below adjacent floor slabs. NWCC recommends the use of perforated PVC pipe for the drainpipe that meets ASTM 3034/SDR35 requirements to minimize the potential for crushing the pipe during backfill operations. Drainpipe perforations should be oriented down at the 4 o'clock and 8 o'clock positions to promote rapid runoff of the water. Drainpipes should be covered 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. Drainpipes should have a minimum slope of 1% and should be daylighted at an outfall that is protected from freezing, or be led to a sump from which the water can be pumped. Multiple daylights should be considered for larger and more complex structures. Caution should be taken when backfilling so as not to damage or disturb the installed drain systems. NWCC recommends the drainage system include at least one cleanout, be protected against intrusion by animals at the outfall and be tested prior to backfilling. NWCC should be retained to observe underdrain system construction and flow testing prior to backfill in order to verify installation and performance.

An impervious membrane should be provided at the base of the foundation wall and footing to enhance perimeter drain performance and prevent water from infiltrating through voided areas and/or under footings and entering underslab or crawlspace areas. The barrier should consist of a heavy-duty impervious membrane (e.g. 20 mil PVC) material approved NWCC and placed as shown on Figure #8.

Foundation Walls and Retaining Structures: Foundation walls and retaining structures that 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 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, near the optimum moisture content.

NWCC recommends the use of imported granular soils for foundation and retaining wall backfill walls because their use results in lower lateral earth pressures. Imported granular materials should be placed within a zone beginning at the base of the wall and up extending at a 45 degree angle, placed to within 2 to 3 feet of the ground surface and contain less than 7 percent passing the No. 200 sieve. The upper 2 to 3 feet of fill should be a relatively impervious soil or pavement structure to inhibit surface water infiltration into the backfill.

Wall backfill should be carefully placed in uniform lifts and compacted to a minimum of 95 percent of the maximum standard Proctor density, near the optimum moisture content. Care should be taken not to overcompact the backfill since this could cause excessive lateral pressure on the walls. Some settlement of deep foundation wall backfill materials will occur even if the material is placed correctly.

Surface Drainage: Proper surface drainage at this site is of paramount importance for minimizing the infiltration of surface drainage into the wall backfill and bearing soils, which could result in increased wall pressures, differential foundation and slab movement. The following drainage precautions should be observed during construction and at all times after the structure has been completed:

1) The ground surface surrounding the structure should be sloped (minimum of 1.0 inch per foot) to drain away from the structure 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 structure 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) The top 2 to 3 feet of soil placed within 10 feet of the foundation 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 structure.

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

Limitations: The recommendations given in this report are based on the soils encountered at this site and NWCC's understanding of the proposed construction. We believe that this information gives a high degree of reliability for anticipating the behavior of the proposed structure; however, our recommendations are professional opinions and cannot control nature, nor can they assure the soils profiles beneath those or adjacent to those observed. No warranties expressed or implied are given on the content of this report.

Swelling soils were encountered at this site. These soils are stable at their natural moisture content but can shrink or swell with changes in moisture and loading. The behavior of swelling soils is not fully understood. The swell and/or consolidation potential of any particular site can change erratically both in lateral and vertical extent. Moisture changes also occur erratically, resulting in conditions, which cannot always be predicted. The recommendations presented in this report are based on the current state of the art for foundations and floor slabs on swelling/consolidating soils. The owner should be aware that 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 this office.

This report is based on the investigation at the described site and on the specific anticipated construction as stated herein. If either of these conditions is changed, the results would also most likely change. Therefore, NWCC strongly recommends that our firm be contacted prior to finalizing the construction plans so that we can verify that our recommendations are being properly incorporated into the construction plans. Man-made or natural changes in the conditions of a property can also occur over a period of time. In addition, changes in requirements due to state of the art knowledge and/or legislation do from time to time occur. As a result, the findings of this report may become invalid due to these changes. Therefore, this report is subject to review and not considered valid after a period of 3 years or if conditions as stated above are altered.

It is the responsibility of the owner or his representative to insure 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 we may be of further service, please do not hesitate to contact us.

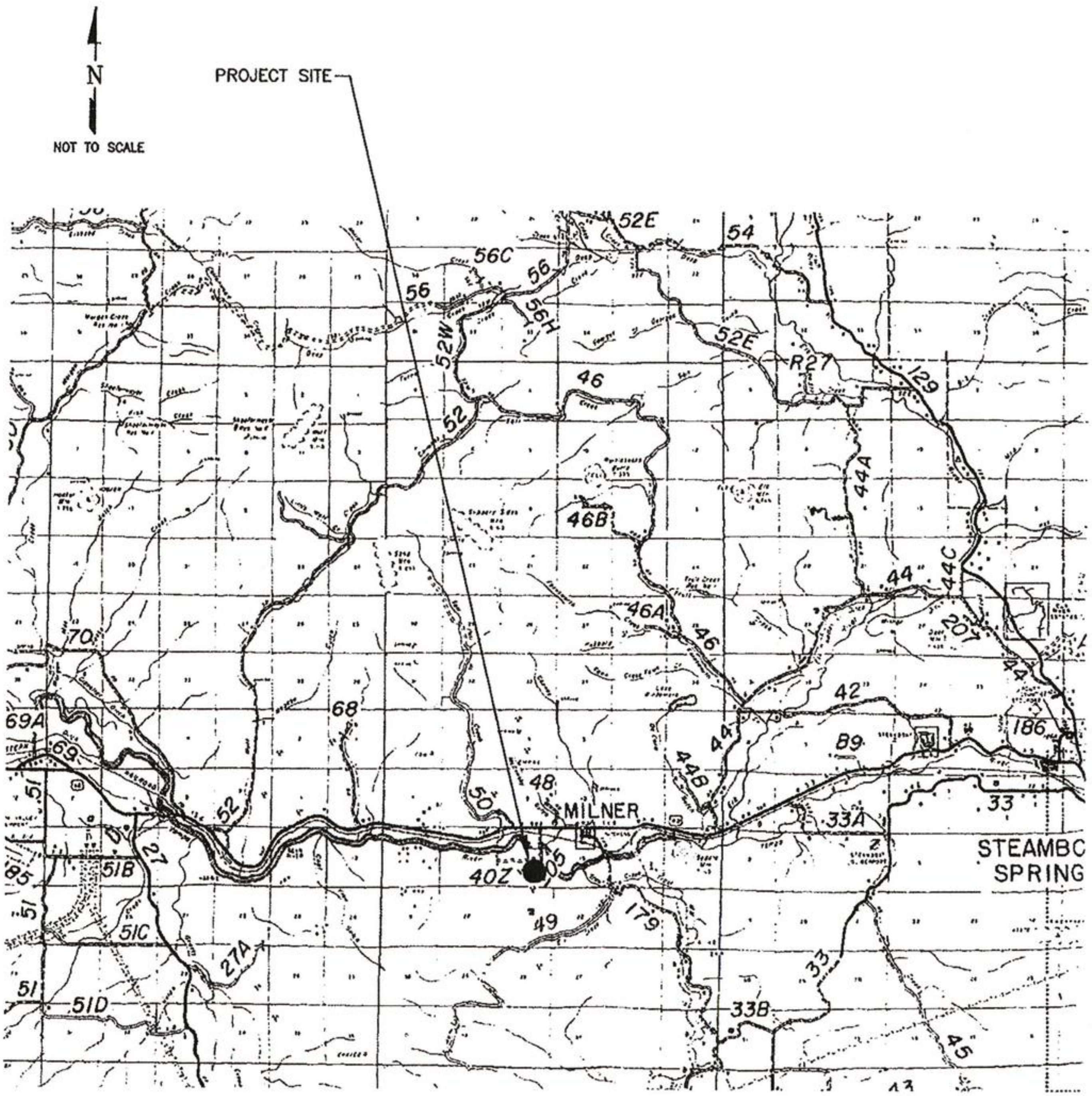
Sincerely,
NWCC, INC.

Richard S. Sterling, P.E.
Project Engineer

COLORADO LICENSED
BRIAN D. LEN
25750
PROFESSIONAL ENGINEER
9/16/15

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

cc: Ben Schutt-Alpenglow Engineering Solutions, LLC



Title: VICINITY MAP	Date: 8/26/15
Job Name: MILNER MATERIALS RECOVERY FACILITY	Job No. 15-10176
Location: 20650 County Road 205, Routt County, Colorado	Figure #1

NWCC
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Title: SITE PLAN – TEST PIT LOCATIONS	Date: 8/26/15	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive · P.O. Box 775226 Steamboat Springs, Colorado 80477
Job Name: MILNER MATERIALS RECOVERY FACILITY	Job No. 15-10176	
Location: 20650 County Road 205, Routt County, Colorado	Figure #2	

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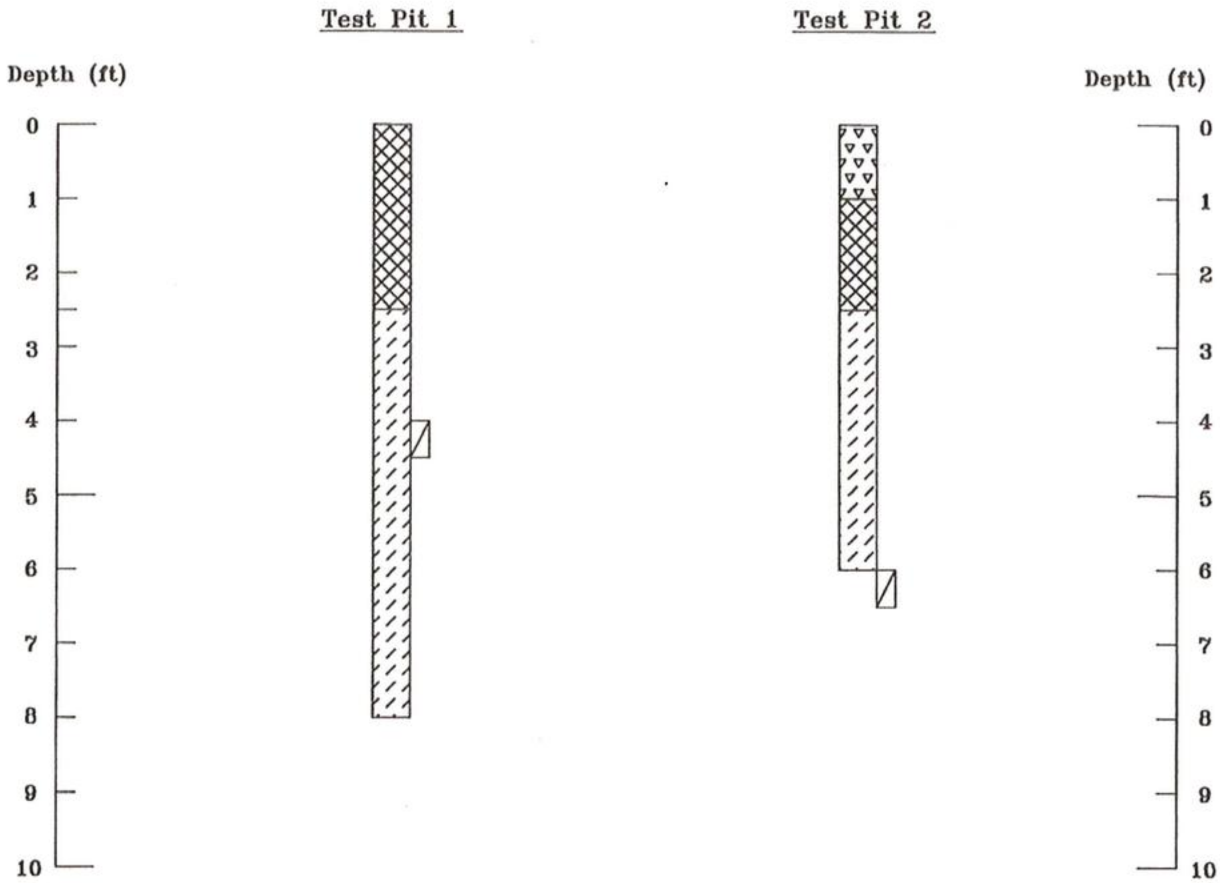


LEGEND:

FILL: BASE COURSE

FILL: Sands and Clays with gravels. Also contains sections of soil contaminated with petroleum hydrocarbons.

CLAY: Slightly sandy to sandy with occasional gravels, low to moderately plastic, stiff, moist, and light brown in color.

Hand Drive Sample– 2" California Liner.

NOTES:

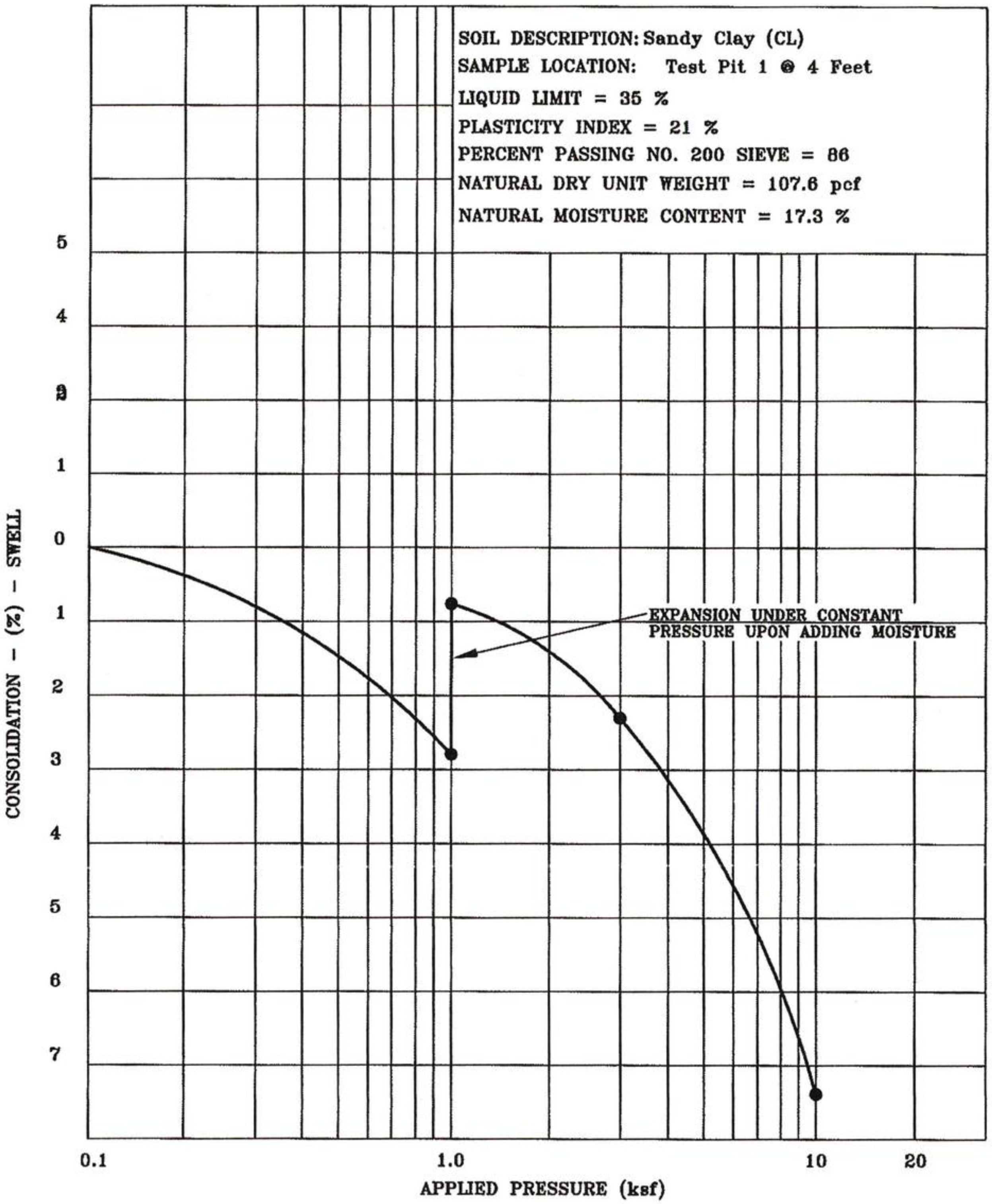
1) Test pits were excavated on August 26, 2015 with a John Deere 200LC trackhoe.

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

3) 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: 8/26/15	North West Colorado Consultants, Inc.
Job Name: MILNER MATERIALS RECOVERY FACILITY	Job No. 15–10176	Geotechnical / Environmental Engineering - Materials Testing
Location: 20650 County Road 205, Routt County, Colorado	Figure #3	(970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487



Title: SWELL–CONSOLIDATION TEST RESULTS	Date: 8/26/15	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: MILNER MATERIALS RECOVERY FACILITY	Job No. 15–10176	
Location: 20650 County Road 205, Routt County, Colorado	Figure #4	

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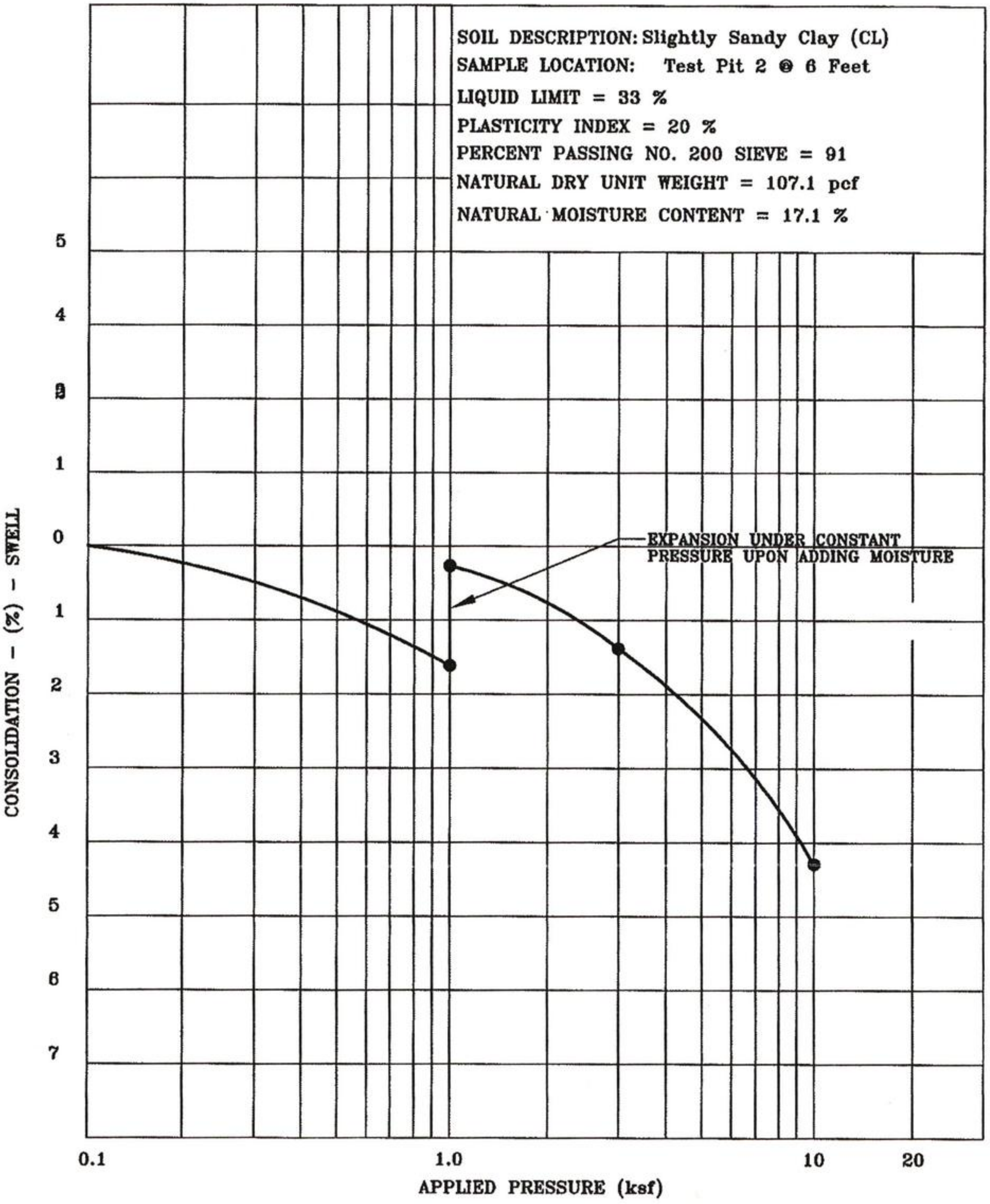
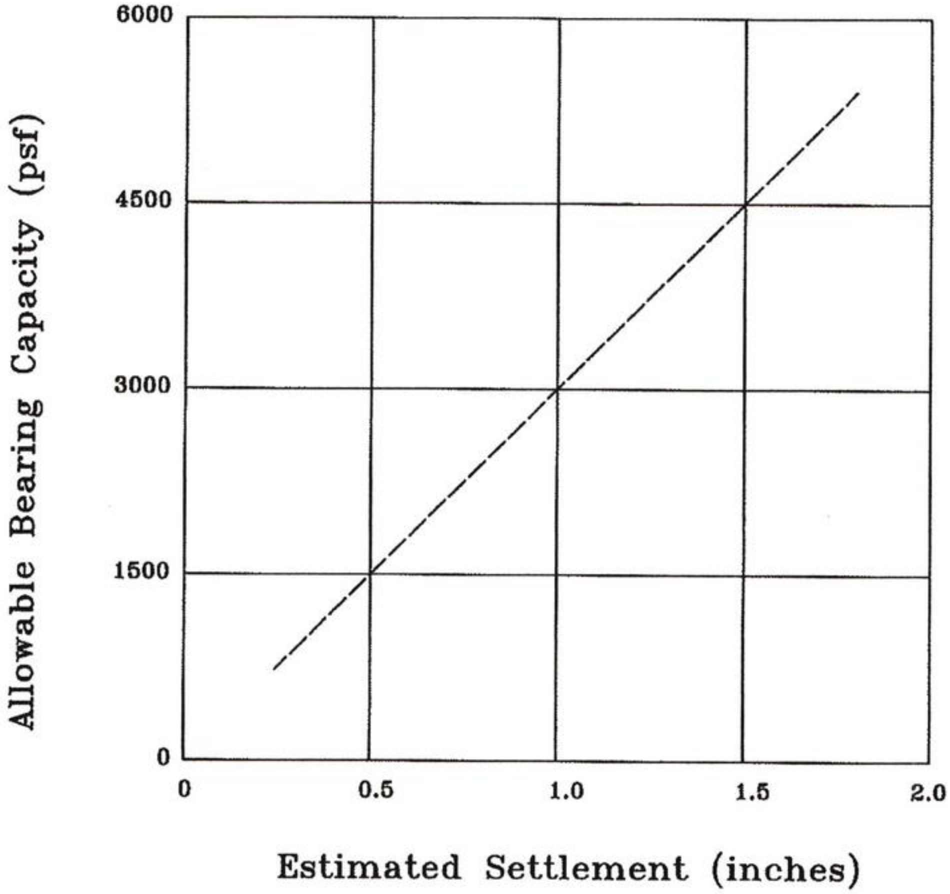
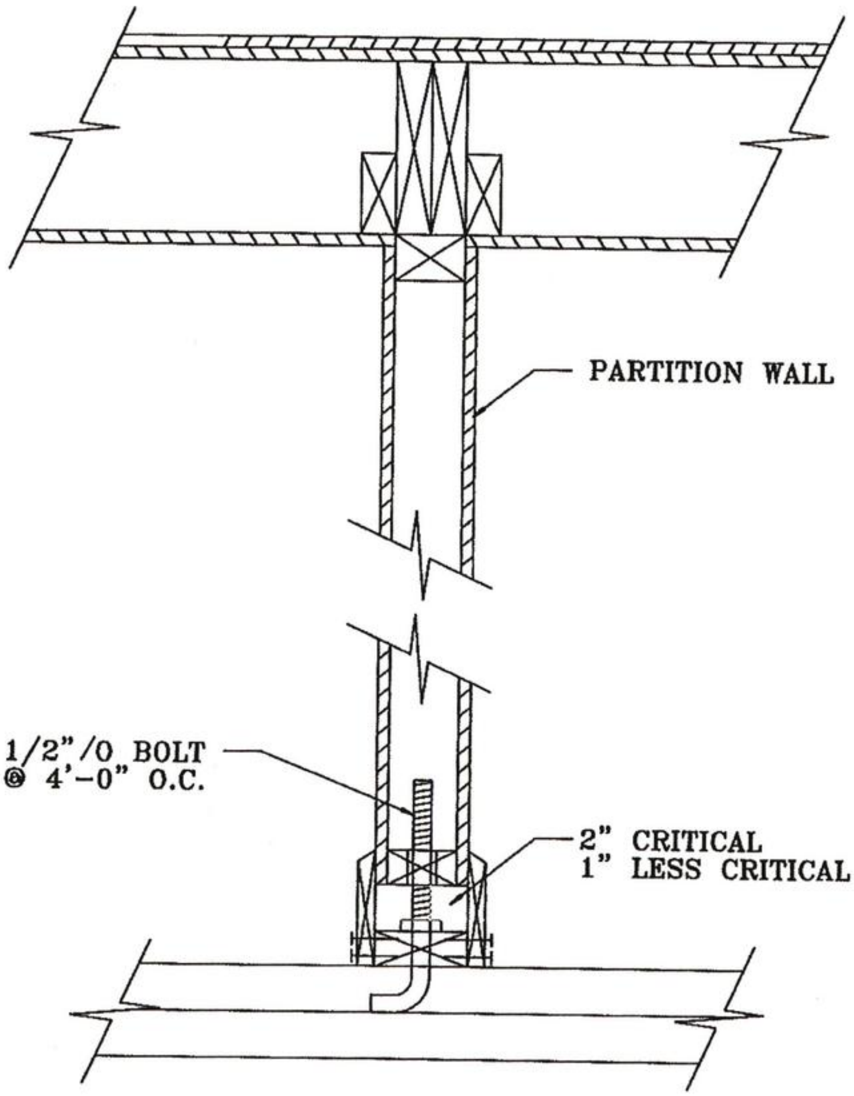


Title: SWELL-CONSOLIDATION TEST RESULTS	**Date:** 8/26/15	NWCC North West Colorado Consultants, Inc.
Job Name: MILNER MATERIALS RECOVERY FACILITY	**Job No.** 15-10176	Geotechnical / Environmental Engineering - Materials Testing
Location: 20650 County Road 205, Routt County, Colorado	**Figure** #5	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487



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 – NATURAL SOILS	Date: 8/26/15	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: MILNER MATERIALS RECOVERY FACILITY	Job No. 15–10176	(970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 20650 County Road 205, Routt County, Colorado	Figure #6	



Title: HUNG PARTITION WALL DETAIL	Date: 8/26/15	North West Colorado Consultants, Inc. NWCC Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: MILNER MATERIALS RECOVERY FACILITY	Job No. 15-10176	
Location: 20650 County Road 205, Routt County, Colorado	Figure #7	

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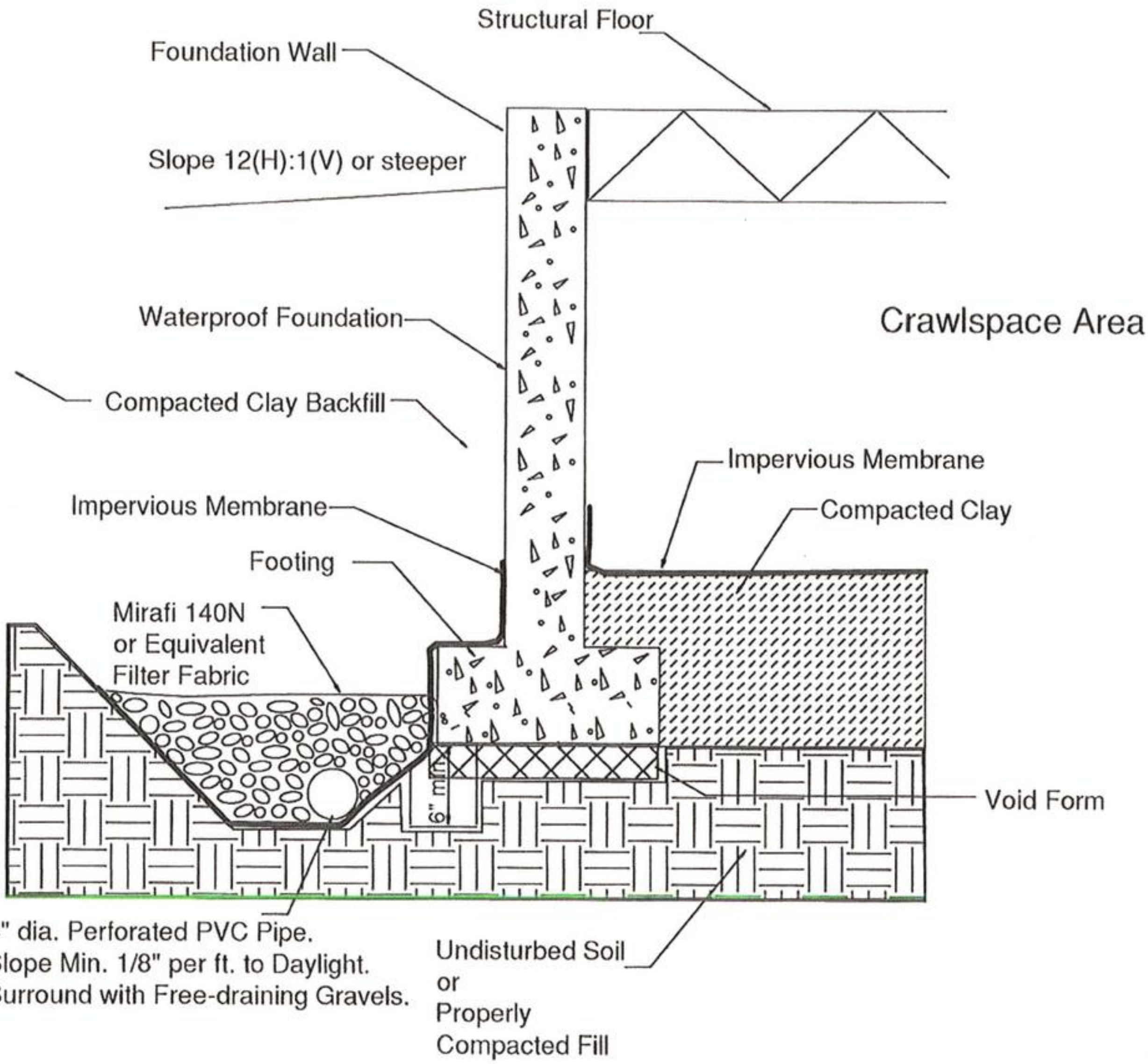

Title: PERIMETER/UNDERDRAIN DETAIL	Date: 8/26/15
Job Name: MILNER MATERIALS RECOVERY FACILITY	Job No. 15-10176
Location: 20650 County Road 205, Routt County, Colorado	Figure #8

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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	17.3	107.6	35	21	1	13	86		Sandy Clay	CL
2	6	17.1	107.1	33	20	0	9	91		Slightly Sandy Clay	CL

JOB NUMBER: 15-10176

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