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

March 12, 2020

Steamboat Springs School District RE-2
Mark Rydberg
325 7th Street
Steamboat Springs, Colorado 80487

Job Number: 19-11673

Subject: Subsoil and Foundation Investigation, Steamboat Springs Middle School, Steamboat Springs, Colorado.

Mark,

This report presents the results of the Subsoil and Foundation Investigation for the proposed Steamboat Springs Middle School Addition to be constructed at 39610 Amethyst Drive in Steamboat Springs, Colorado. The approximate location of the project site is shown in Figure #1.

It should be noted that NWCC previously provided *Foundation Recommendations Report* for the North Entrance/Administration Addition constructed in 2008. This report was prepared under our job number 06-7160 and dated August 7, 2006. NWCC also previously completed a *Subsoil and Foundation Investigation* for earlier Strawberry Park Middle School additions under Job Number 02-5162 and dated May 6, 2002. Copies of both reports are included in Appendix A.

NWCC, Inc.'s (NWCC) scope of work included obtaining data from cursory observations made at the site, logging of three (3) foundation test holes and four (4) pavement holes, sampling of the probable foundation soils, laboratory testing of the samples obtained and the review of the previously completed field and laboratory investigations and reports. 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 and review of a preliminary site plan provided by the architect, NWCC understands that an addition to the existing middle school will be constructed north of the existing building and east of the main entrance constructed in 2008. NWCC assumes the addition will be constructed with a slab-on-grade floor system that will match the elevations of the existing building floor slabs and be located slightly below to slightly above the existing ground surface.

NWCC also understands that an artificial turf field and asphalt track will be constructed at the location of the existing grass field and gravel-surfaced track. It is also NWCC's understanding that the maintenance road around the perimeter of the building will be improved and most likely be paved.

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For design purposes, NWCC has assumed that building and pavement loadings will be light to moderate, typical of these types 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 addition site is located north of the existing middle school building and east of the main entrance. A large portion of this site is paved with concrete and used for unloading service trucks. A snow-melt system was installed in the concrete when it was installed constructed in 2008. Vegetation at this portion of the site primarily consists of weeds and grasses and landscaping with trees and bushes.

A majority of the building site is relatively flat due to the previous site grading. However, a hill that slopes down to the west and northwest is located northeast of the northeast corner of the existing building and at the east end of the proposed addition. A maximum elevation difference of approximately 3 to 6 feet appears to exist across the proposed building site.

An existing gravel surfaced maintenance road runs around the perimeter of the existing building. The topography around the building and along the maintenance road is fairly level with very poor drainage characteristics.

The exiting grass field and track are located to the west of the existing school building and at least 10 feet lower in elevation than the school building. The field is vegetated with grasses and the track is gravel surfaced. Topography of the site is somewhat variable and generally fairly flat due to previous site grading.

It should be noted that the ground surface across the property was covered with 1 to 4 inches of snow at the time of the field investigation.

Subsurface Conditions: To investigate the subsurface conditions at the site, three (3) foundation test holes and four (4) pavement test holes were advanced on November 20, 21 and 22, 2019 with a truck-mounted CME 55 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 layer of fill materials overlying natural sands and clays overlying natural sands and gravels to the maximum depth investigated, 22 feet beneath the existing ground surface (bgs). Graphic logs of the exploratory test holes are presented in Figures #3 and #4, and associated Legend and Notes are presented in Figure #5.

Fill materials were encountered at the ground surface in all of the test holes, with the exception of Test Hole 1 and extended to depths ranging from 1 to 5 feet bgs. The fill materials encountered from the surface to 1-foot bgs in Test Hole P3 consisted of topsoil fill materials. Whereas, the remainder of the fill materials generally consisted of gravelly clay and sand to clayey sands and gravels that were low plastic, fine to coarse grained, low to moderately plastic, loose to medium dense, moist to wet and brown in color. Samples of the fill materials classified as SC soils in accordance with the Unified Soil Classification System (USCS).

Natural sands and clays were encountered at the ground surface in Test Hole 1 and beneath the fill materials in Test Holes 2, 3, P3 and P4, extending to depths ranging from 13 to 18 feet bgs. The natural sands and clays were low to moderately plastic, fine to coarse grained with occasional gravels, medium stiff to medium dense, moist to wet and brown to gray in color. Samples of the natural sands and clays classified as SC and CL soils in accordance with the USCS.

Natural sands and gravels were encountered beneath the sands and clays in Test Holes 1, 2 and 3 and extended to the maximum depth investigated. It should be noted that practical rig refusal was encountered on very dense cobbles in all three foundation test holes. The sands and gravels were clayey to slightly silty, low to non plastic, fine to coarse grained with cobbles, dense to very dense, wet and brown in color. Samples of the natural sands and gravels classified as SM soils in accordance with the USCS.

Swell-consolidation testing conducted on samples of the natural sands and clays, as well as the fill materials indicate the material tested will exhibit nil to low swell potentials when wetted under constant load. Swell-consolidation test results are presented in Figures #6, #7, #8, #9 and #10, and all the other laboratory test results are summarized in the attached Table 1.

Groundwater was encountered in the test holes at depths ranging from 6 to 6 ½ feet bgs in Test Holes 1, 2 and 3 when measured at the time of the investigation and at 3 to 4 feet bgs when measured 11 days after drilling. Groundwater was encountered at 3 ½ feet bgs in Test Hole P1 at the time of drilling and at 2 feet bgs when measured 11 days after drilling. Groundwater was not encountered at the existing field and track at the time of drilling. It should be noted that the groundwater conditions at the site can be expected to fluctuate with seasonal changes in precipitation and runoff.

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.

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 addition any other structures constructed at the site would consist of spread or continuous footings placed directly on the natural sands and clays or on properly compacted structural fill materials placed over the natural sands and clays.

1) Footings placed on the natural sands and clays or properly compacted structural fill materials placed over the sands and clays should be designed using an allowable soil bearing pressure of 2,500 psf and with a minimum dead load pressure of at least 600 psf.

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

3) Any existing fill materials and/or topsoil and organic materials found beneath the footings when excavations are opened should be removed and footings extended down to the natural sands and clays 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 footings should be a non-expansive granular soil approved by NWCC prior to placement. Based on the relatively shallow depth to ground water, NWCC recommends that clean gravel fill materials meeting the gradation specifications for Colorado Department of Transportation (CDOT) Class A or Class B Filter Materials.

   The gravel fill materials placed under the footings should be uniformly placed and compacted in 6 to 8-inch loose lifts and compacted to at least 80% of the maximum relative density in accordance with ASTM D4253/4254. 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 from frost heave. Forty-eight (48) inches is typical for this location considering normal snow cover and other winter factors.

6) The proposed footing elevations may be below the groundwater level. Therefore, it will probably be necessary to dewater the footing 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 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 #11.

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.

Alternate Deep Foundation Recommendations: Alternative deep foundation system recommendations would consist of either helical screw piles or rammed aggregate piers advanced into the natural sands and gravels encountered below the existing fill materials and underlying natural sands and clays.

Helical Piles: The helical screw pile foundations will place the bottom of the foundations in a zone of relatively stable moisture content, reduce the risk of foundation movement from the swell-consolidation potential of the sands and clays and eliminate the need for removing these materials from beneath the foundations.

Foundation movement should be less than ½-inch if the following design and construction conditions are observed. The following recommendations have been included for foundation design purposes.

A 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.

We strongly recommend that at least two test piles be advanced at the site and observed by NWCC so that the torque versus depth relationships can be established and the proper shaft and helix size and type can be determined. 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 8-inch diameter helix.
- Minimum pile depth of 6 feet from upper 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.

Rammed Aggregate Piers: NWCC believes rammed aggregate piers, such as *Geopier* foundation system, would be another safe type of foundation system. The rammed aggregate piers are typically constructed to bridge poor bearing soils, such as the existing fill materials and underlying natural sands and clays, encountered at this site, extending down to a suitable bearing layer, such as the underlying natural sands and gravels.

A rammed aggregate pier foundation system should develop an end bearing pressure of at least 4,000 psf for aggregate piers founded in the sand and gravels. A rammed aggregate pier foundation system has the advantage of not only supporting shallow foundation elements, but also supporting floor slab areas and improving the engineering characteristics of the native soils between the piers, thus decreasing the potential for floor slab movement and sometimes eliminating the need for structural slabs or structural floors over crawlspaces.

- *Geopier* and other rammed aggregate pier foundation elements are designed as proprietary foundation systems and as noted on the Geopier website *"Geopier has a team of local representatives to provide you with a high level of service and support during the project design phase. The engineers work with project geotechnical and structural engineers, using loads and geotechnical information to detail the best ground improvement solution. These registered professional engineers develop the design. After preliminary design work is completed, each project undergoes an internal peer-review process by engineers at Geopier headquarters. Before going to construction, design submittals and "shop" drawings are prepared and stamped by a P.E. and provided to the general contractor".*

- If a *Geopier* foundation system is selected, NWCC should be contacted to coordinate with the *Geopier* design team during foundation design. Additional information of the *Geopier* foundation systems can be found at: https://www.geopier.com/FAQs.

Floor Slab Recommendations: NWCC has assumed the lower level of the proposed addition will most likely be constructed with a concrete slab-on-grade floor system with an elevation that matches the existing floor slab elevations.

On-site soils, apart from any topsoil and organic materials and existing fill 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 sands and clays 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 sands and 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. 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 #12.

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 and any existing fill 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 soil 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 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 where expansive soils 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 structures. Caution should be taken when backfilling so as not to damage or disturb the installed underdrains. NWCC recommends the drainage systems include a clean out 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 flow tests prior to backfilling the systems.

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 #13.

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 on the basis of an equivalent fluid unit weight of 45 pcf for imported, free draining granular backfill and 55 pcf for on-site soils.

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.

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 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 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 a 2(Horizontal) to 1(Vertical) configuration for the sands and clays. 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.

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 Recommendations: NWCC understands that new pavement will most likely be constructed for the maintenance road and track. NWCC has assumed the maintenance road and track will only be subjected to light automobile and equipment traffic. Based on this assumption, NWCC recommends the pavement section to be used for the maintenance road and track consist of a composite pavement section consisting of a minimum of 3 inches of hot mix asphalt (HMA) overlying 4 inches of aggregate base course (ABC) materials and a minimum of 6 inches of subbase (pit run) gravels. A full-depth asphalt section consisting of a minimum of 6 inches of HMA can be used in lieu of the composite section provided above. If the maintenance road and track are subjected to heavier vehicle loads such as service trucks or construction equipment, then the HMA thickness provided above should be increase by at least 1 inch.

NWCC recommends the areas subjected to heavy truck traffic turning movements, such as in the apron in front of the trash dumpster approach areas or loading docks, be paved with a rigid pavement section consisting of at least 7 inches of Portland cement concrete (PCC). Sidewalks subjected to pedestrian traffic should be paved using at least 4 inches of PCC and 5 inches in areas where occasional emergency or snow removal vehicle traffic is anticipated.

If the maintenance road is not paved with asphalt, NWCC believes that a suitable gravel section will consist of a minimum of 4 inches of ¾-inch minus recycled asphalt product overlying 8 inches of 4-inch minus RAP.

The HMA should consist of a hot bituminous plant mix meeting the job mix formula established by a qualified engineer, which also meets Colorado Department of Transportation (CDOT), City of Steamboat Springs and Routt County specifications. The base course materials should consist of a well-graded aggregate base course (ABC) material that meets CDOT Class 6 grading and durability requirements. The subbase (pit run) sands and gravels should be a well-graded sand and gravel that meets the CDOT Class 2 grading and durability requirements. The ABC, pit run and RAP materials placed in the pavement areas should be uniformly placed and compacted in 4 to 6-inch loose lifts to at least 95 percent of the maximum modified Proctor density and within +/- 2 percent of the optimum moisture content as determined by ASTM D1557.

Prior to placement of subbase materials or coarser RAP materials, NWCC recommends the exposed subgrade soils be uniformly mixed, moisture treated to within 2 % of the optimum moisture content and then be recompacted to at least 95 % of the maximum standard Proctor density. Depending on the time of year when subgrade preparation is considered, moisture conditioning including drying and/or moistening of subgrade materials will likely be required in order to attain uniform compaction. NWCC also recommends that the properly moisture conditioned and recompacted subgrade soils be proofrolled with a loaded tandem dump truck prior to placing the subbase gravels or coarse RAP materials. Areas exhibiting deflection and rutting will most likely require deeper stabilization. The depth and type of stabilization should be determined at the time of construction.

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 not greater than 12 feet on centers. The depth of the control joints should be at least ¼ of the slab thickness.

The collection and diversion of surface and subsurface drainage away from the paved areas is extremely important to 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. NWCC recommends subgrade areas be graded to drain if feasible so that surface runoff is not allowed to pond on the subgrade surface.

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.

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.
Project Engineer

COLORADO LICENSED
BRIAN D. LEN
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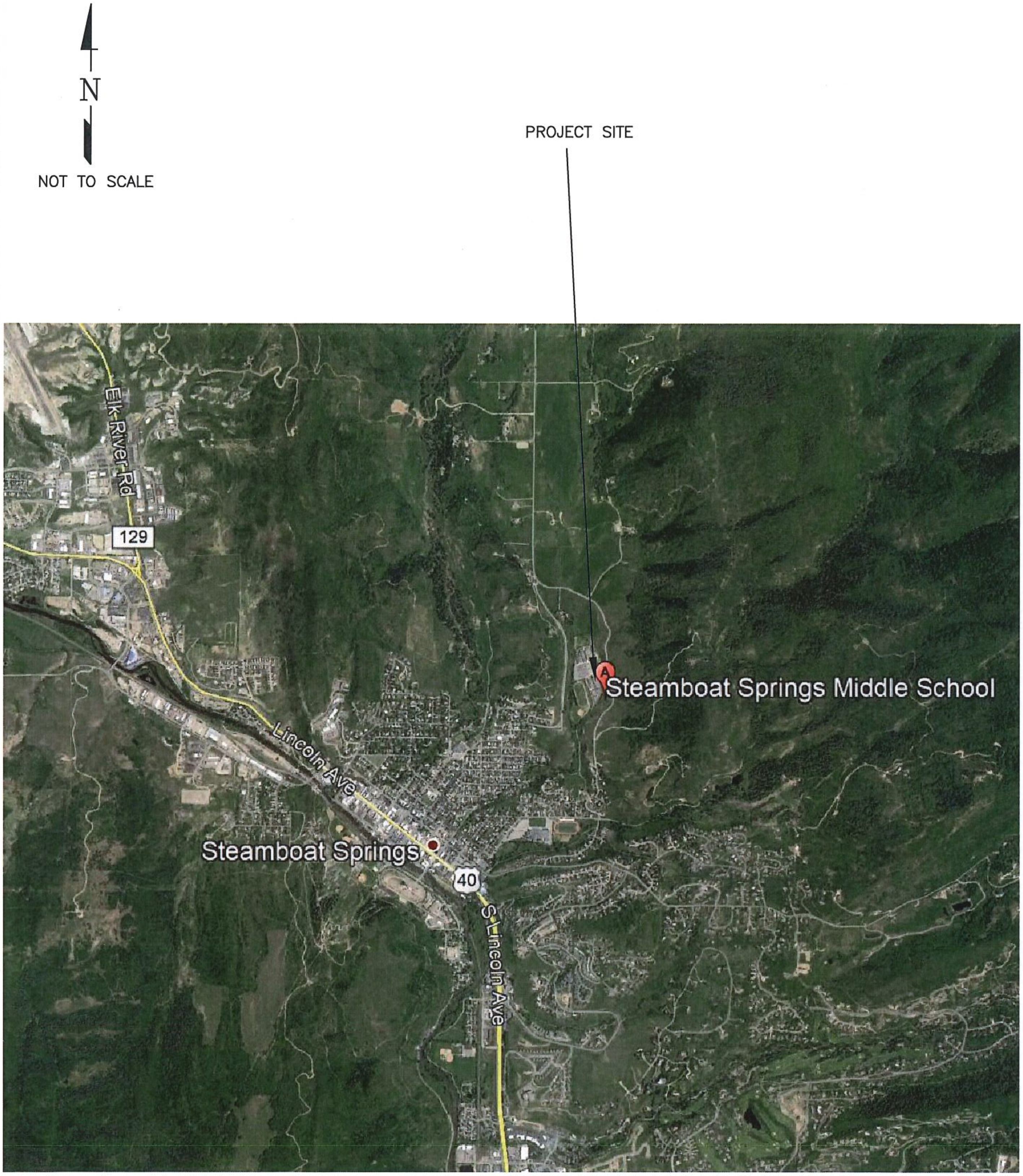
PROFESSIONAL ENGINEER
3/12/2020

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

cc: Pascal Ginesta – SSSD RE-2
Todd Raper - Dynamic Program Management
Colleen Kaneda – Dynamic Program Management



Title: VICINITY MAP	Date: 12/11/19	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing
Job Name: Steamboat Springs Middle School	Job No. 19-11673	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #1	

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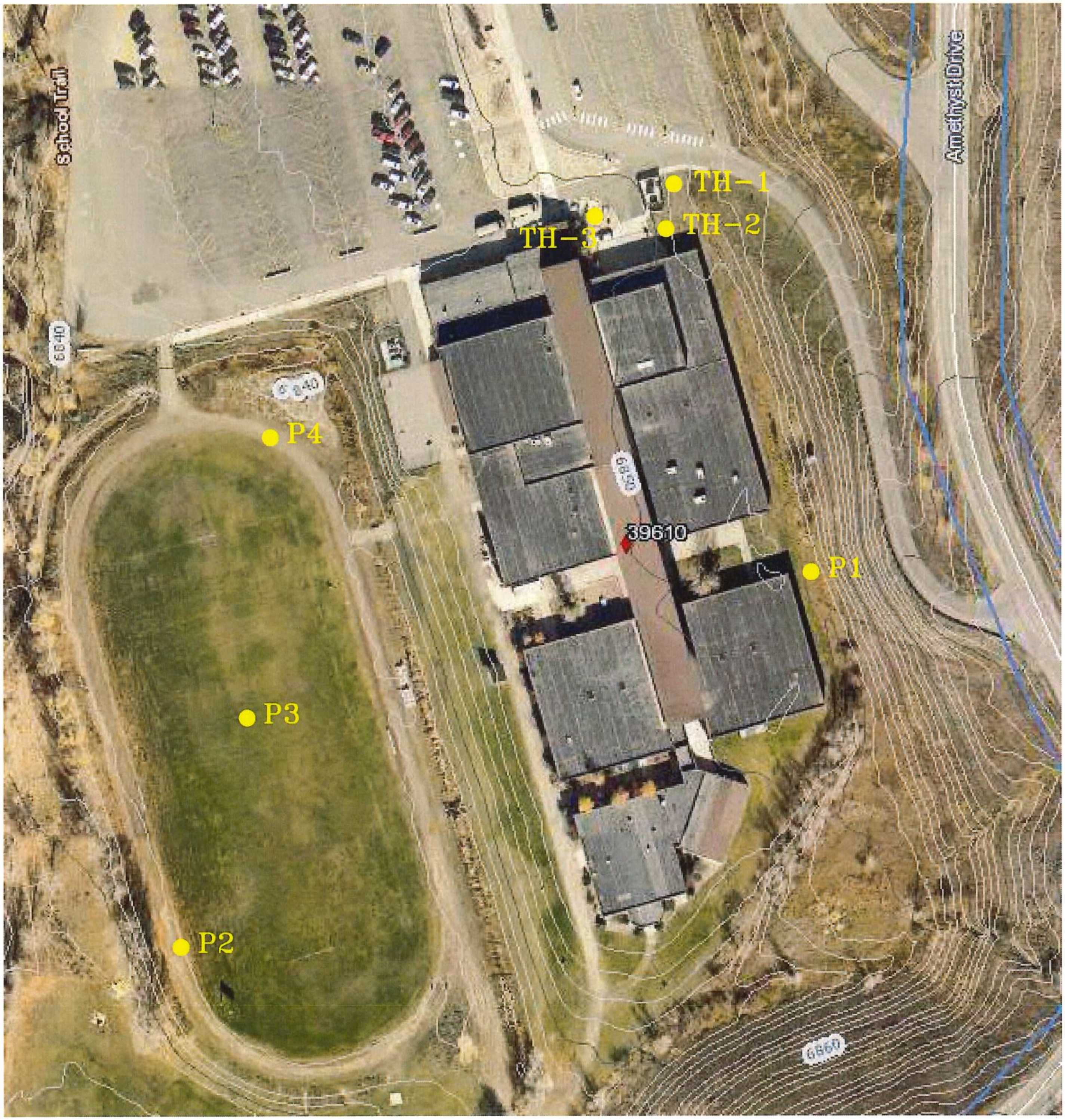

Title: SITE PLAN-LOCATION OF TEST HOLES	Date: 12/11/19
Job Name: Steamboat Springs Middle School	Job No. 19-11673
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #2

NWCC
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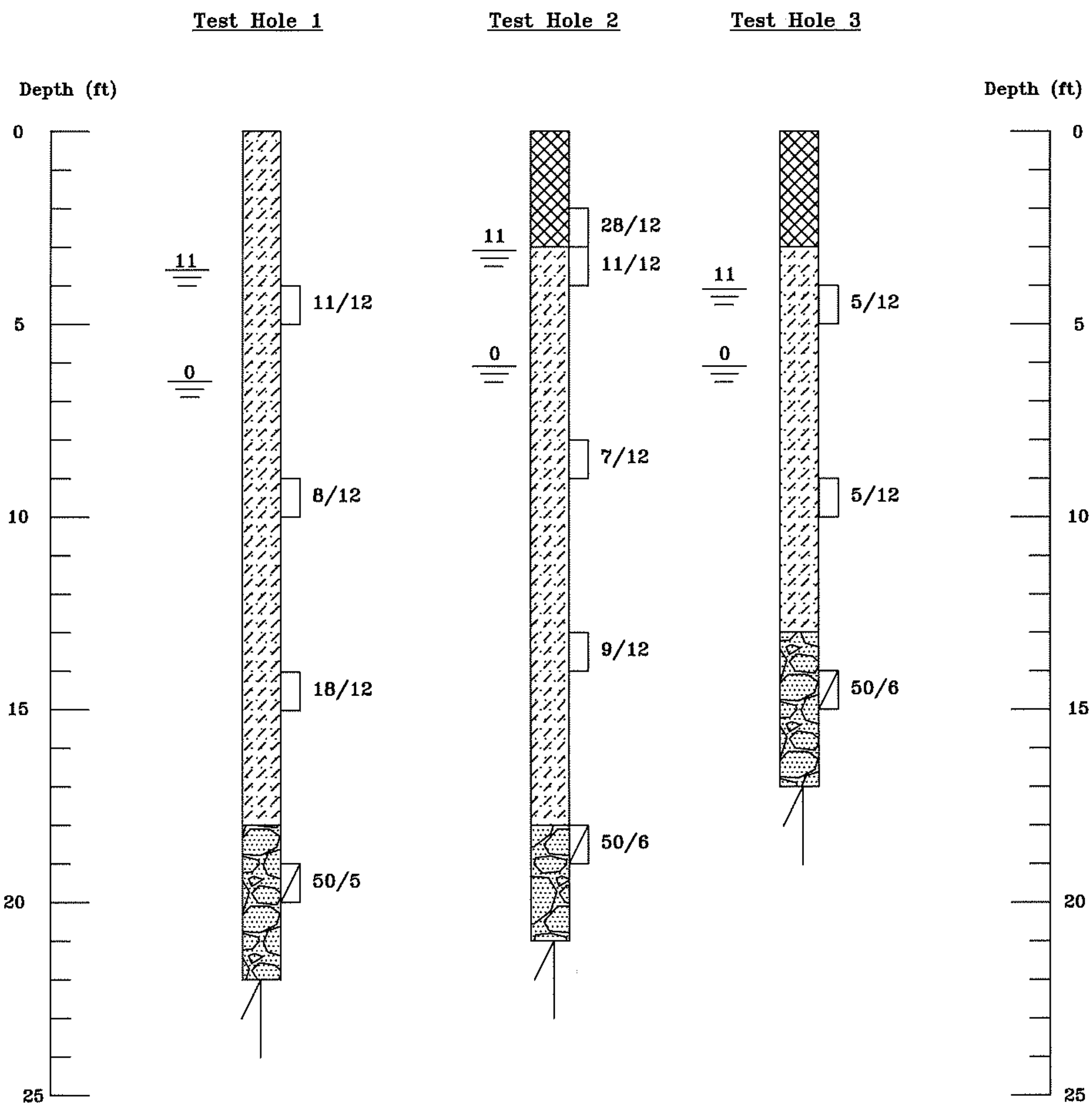
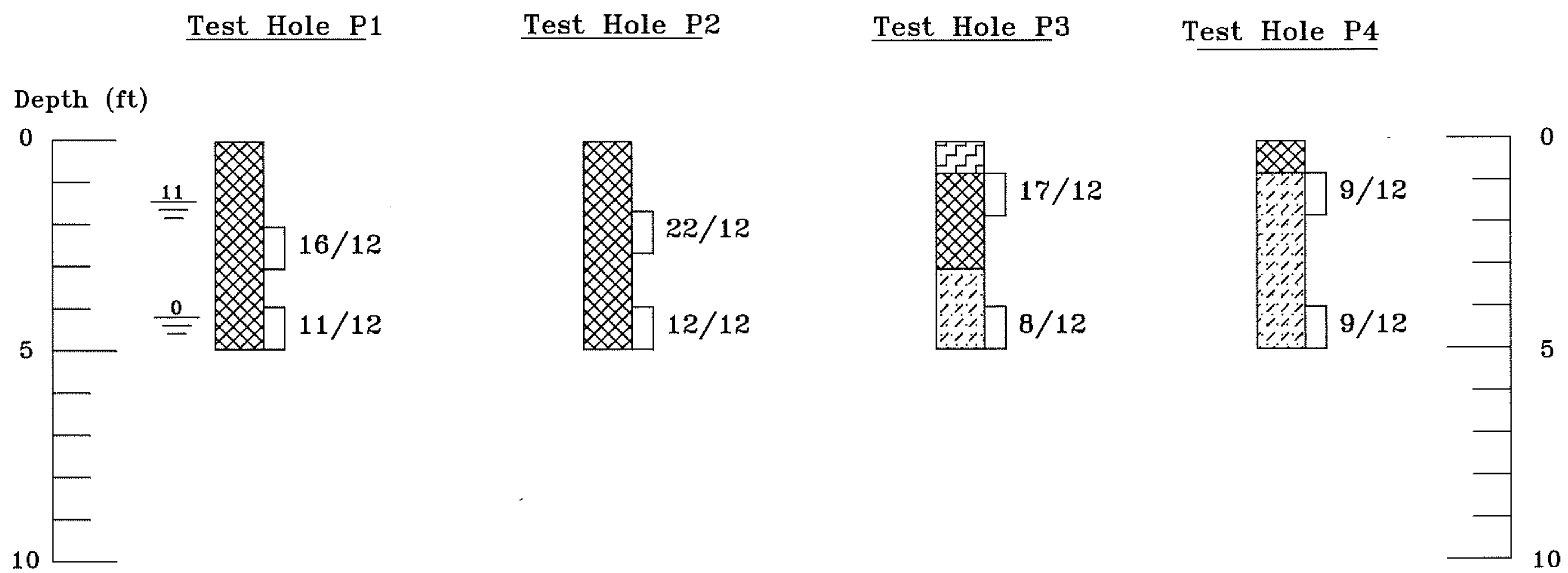


Title: LOGS OF EXPLORATORY TEST HOLES	Date: 12/11/19	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Steamboat Springs Middle School	Job No. 19-11673	
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #3	



Title: LOGS OF PAVEMENT TEST HOLES	Date: 12/11/19
Job Name: Steamboat Springs Middle School	Job No. 18-11128
LOCATION: 39610 Amethyst Dr,, Steamboat Springs, Colorado	Figure #4

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Steamboat Springs, Colorado 80487

LEGEND:

TOPSOIL FILL

FILL: Gravelly clay and sand to clayey sands and gravels, low plastic, fine to coarse grained, low to moderately plastic, loose to medium dense, moist to wet and brown.

SANDS and CLAYS: Low to moderately plastic, fine to coarse grained with occasional gravels, medium stiff to medium dense, moist to wet and brown to gray.

SANDS and GRAVELS: Clayey to slightly silty, low to non plastic, fine to coarse grained with cobbles, dense to very dense, wet and brown.

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

Drive Sample, Standard Split Spoon Sampler.

11/12 Drive Sample Blow Count, indicates 11 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates depth of practical rig refusal on very dense cobbles.

0, 11 Indicates depth at which groundwater was encountered at the time of drilling and when measured 11 days after drilling.

NOTES:

1) Test holes were drilled on November 20, 21 and 22 2019 with a truck-mounted CME 55 drill rig using 4-inch diameter continuous flight augers.

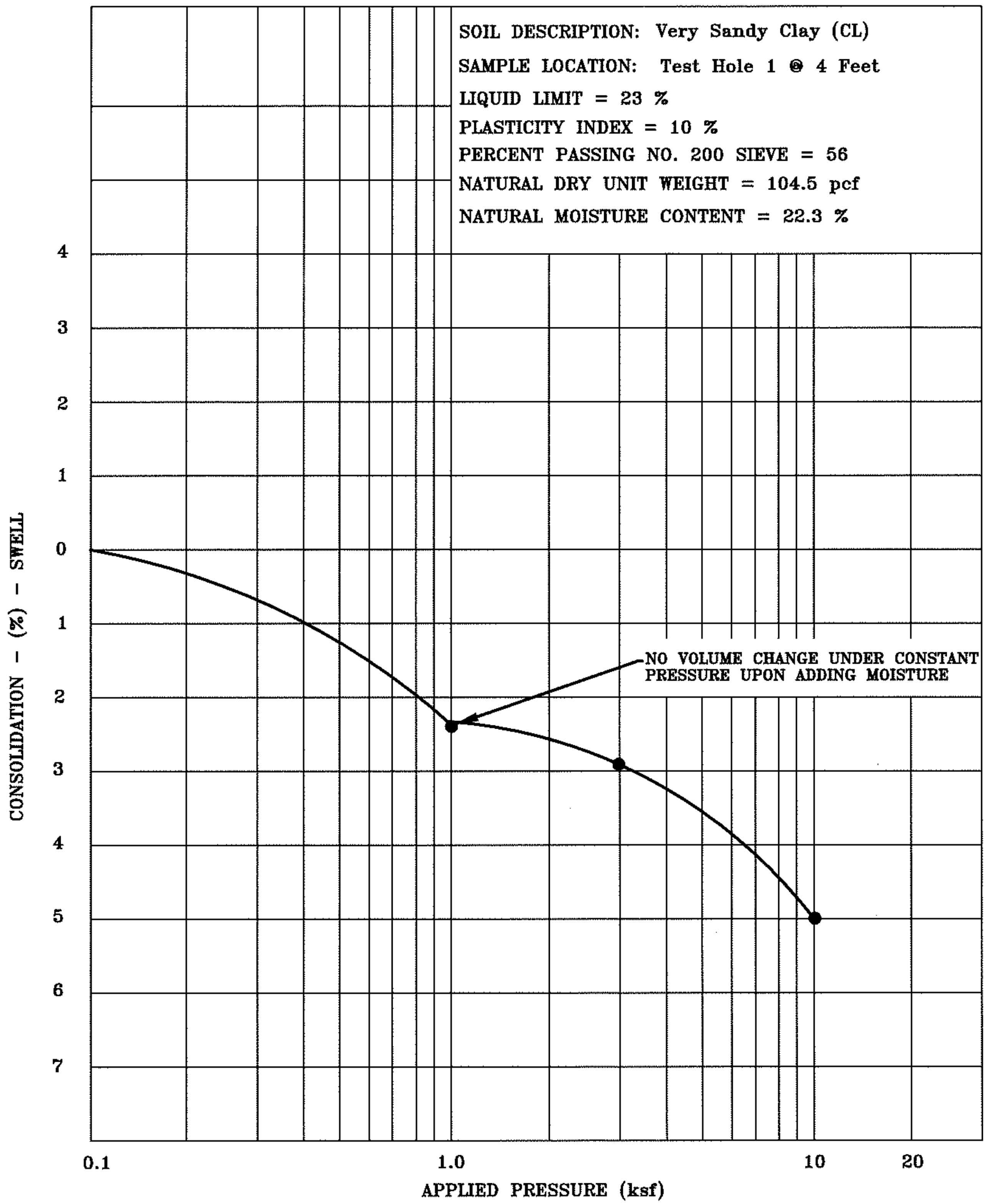
2) Locations of the test holes were determined in the field by pacing from existing features at the site.

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

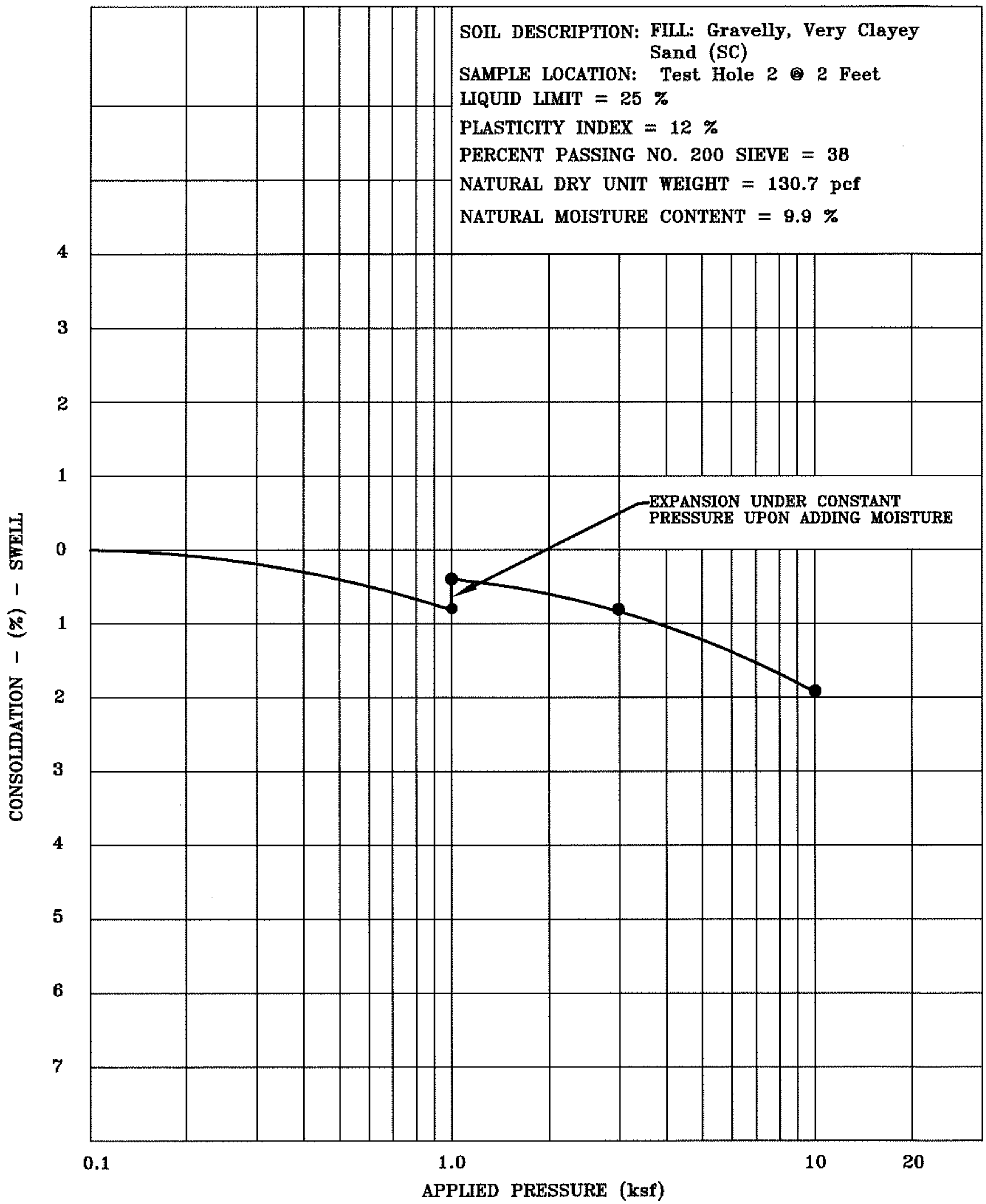
4) The lines between materials shown on the logs represent the approximate boundaries between material types and transitions may be gradual.

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

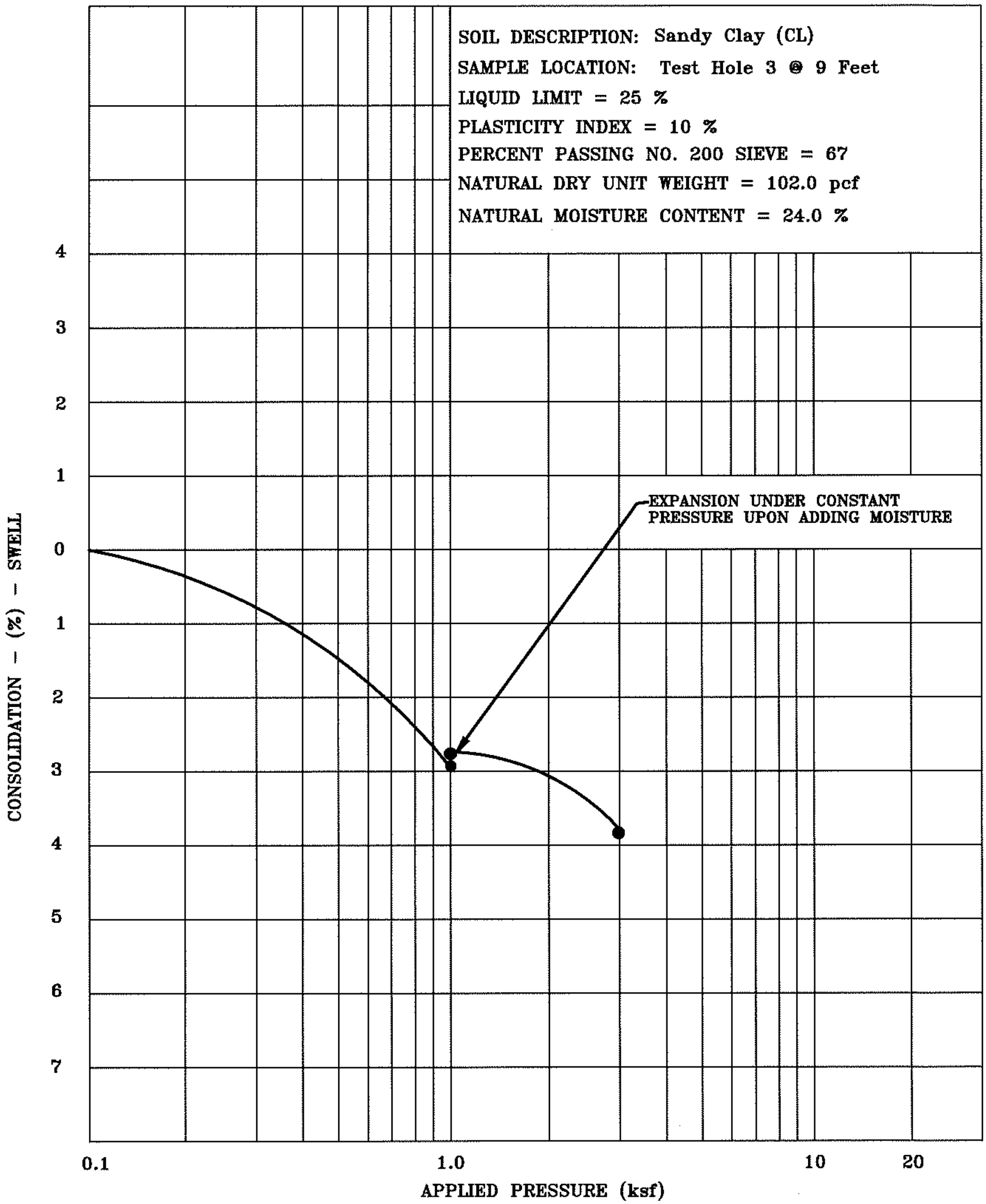
Title: LEGEND AND NOTES	Date: 12/12/19	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing
Job Name: Steamboat Springs Middle School	Job No. 19-11673	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #5	



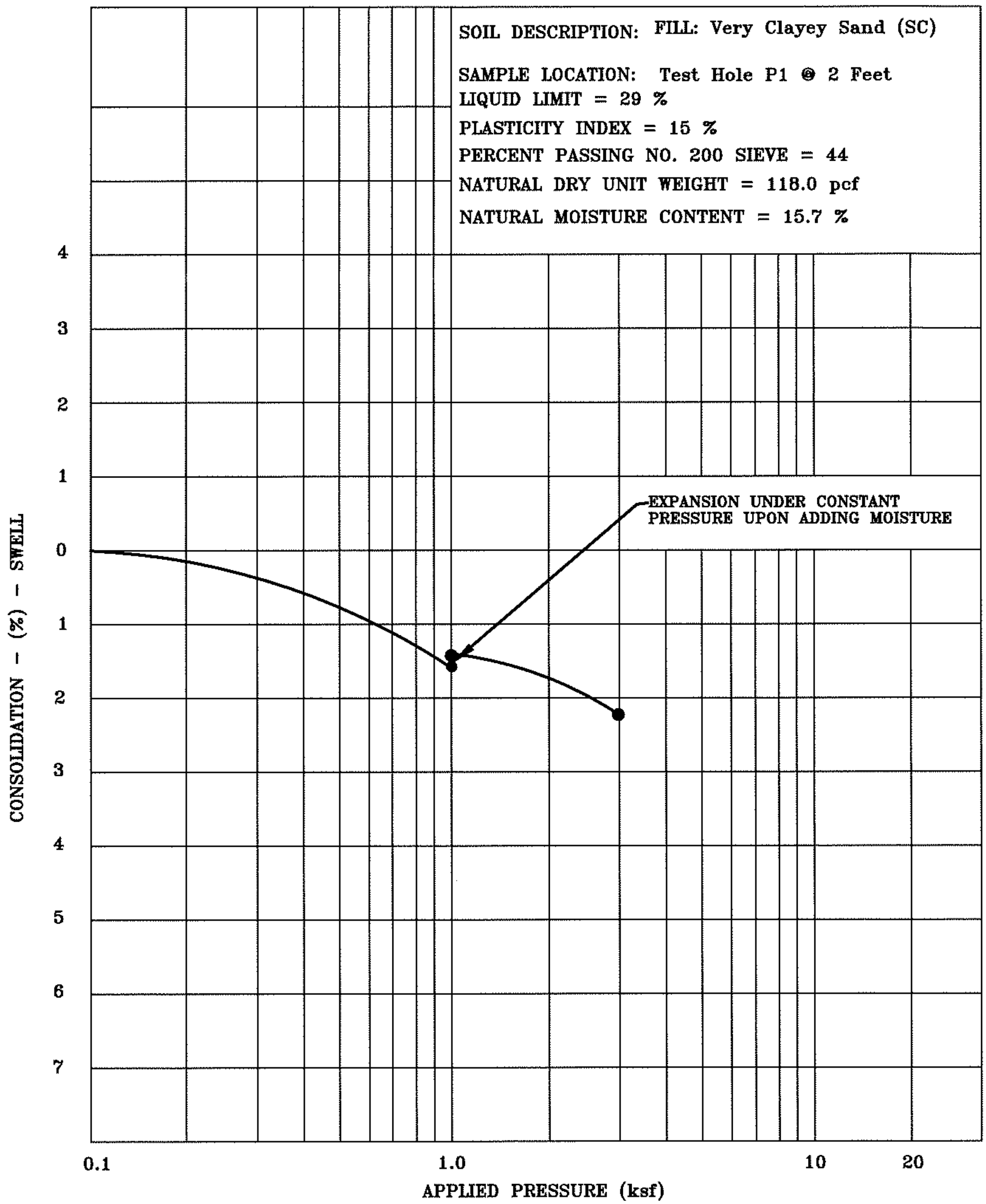
Title: SWELL–CONSOLIDATION TEST RESULTS	Date: 12/12/19	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Steamboat Springs Middle School	Job No. 19-11673	
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #6	



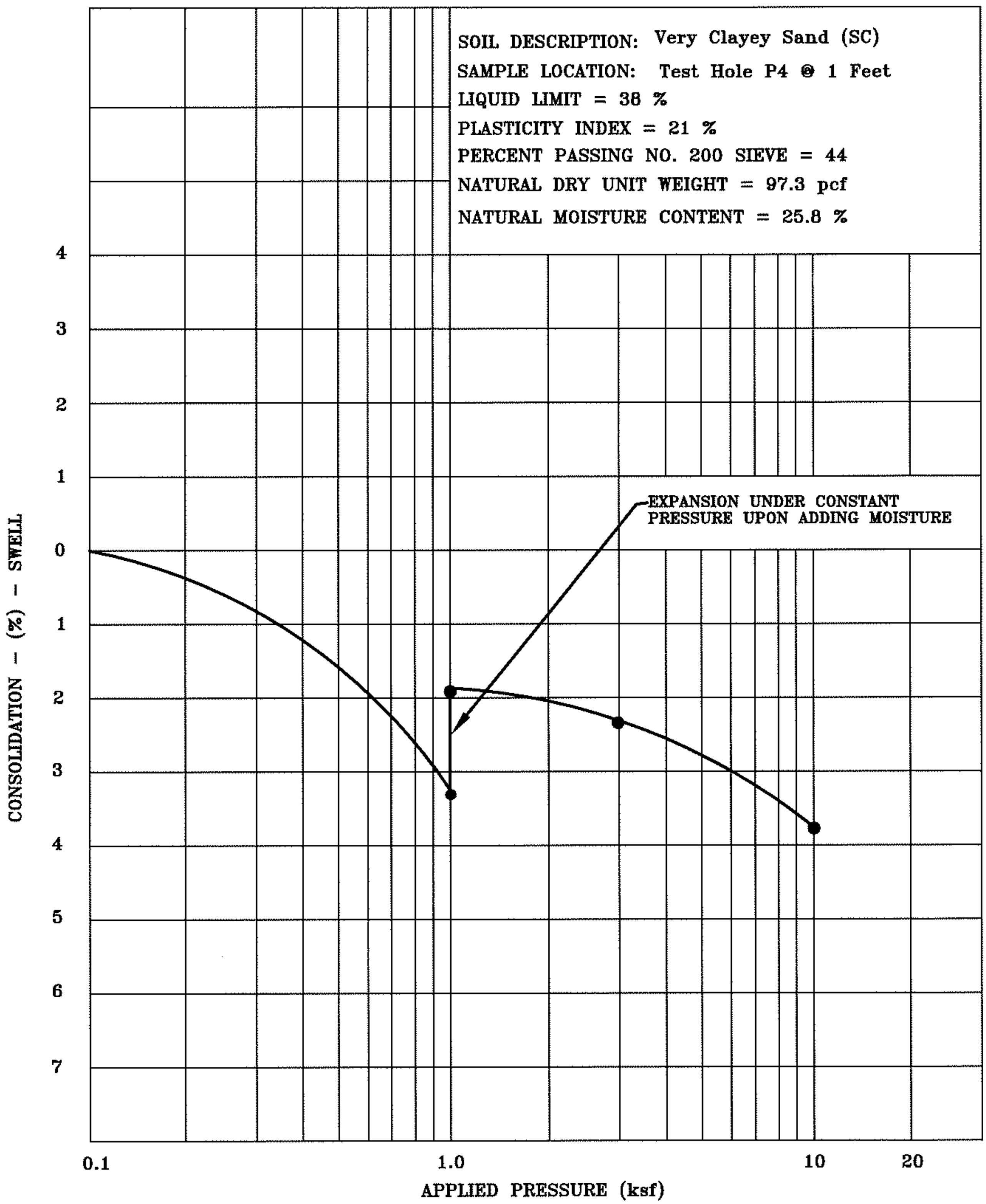
Title: SWELL–CONSOLIDATION TEST RESULTS	Date: 12/12/19	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Steamboat Springs Middle School	Job No. 19–11673	
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #7	



Title: SWELL–CONSOLIDATION TEST RESULTS	Date: 12/12/19	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: Steamboat Springs Middle School	Job No. 19–11673	
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #8	



Title: SWELL–CONSOLIDATION TEST RESULTS	Date: 12/12/19	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: Steamboat Springs Middle School	Job No. 19-11673	
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #9	



Title: SWELL–CONSOLIDATION TEST RESULTS	Date: 12/12/19		
Job Name: Steamboat Springs Middle School	Job No. 19–11673		
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #10		

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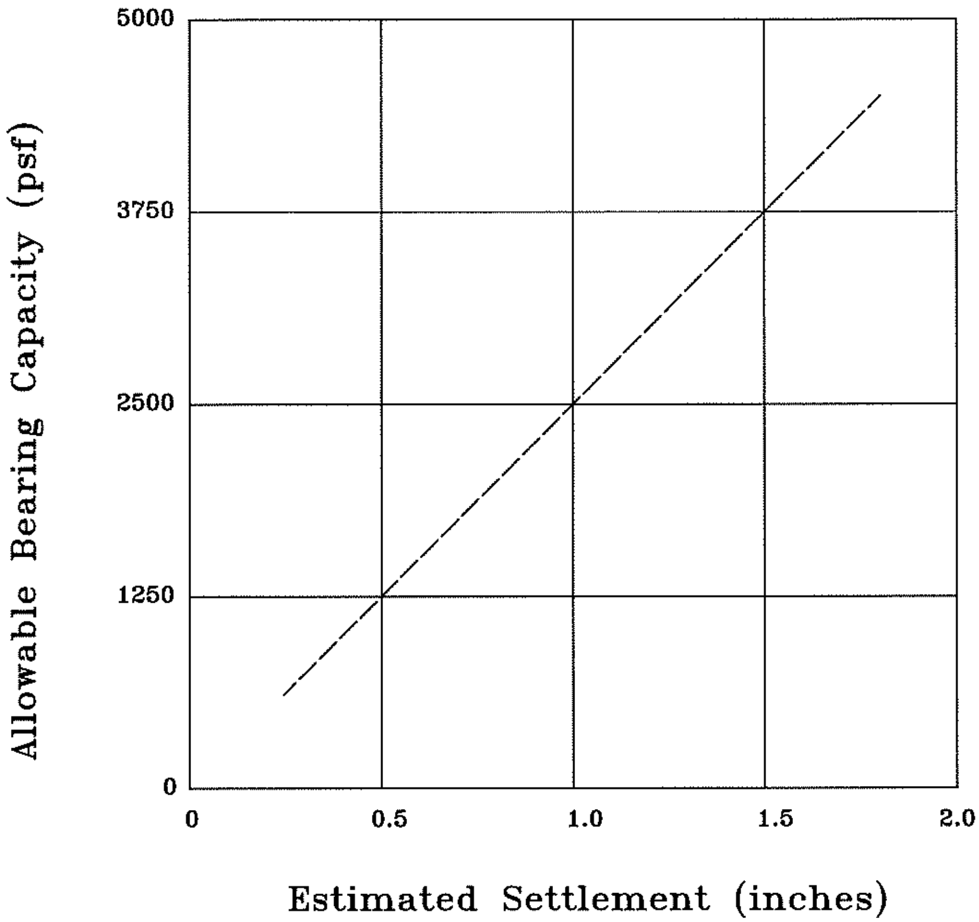
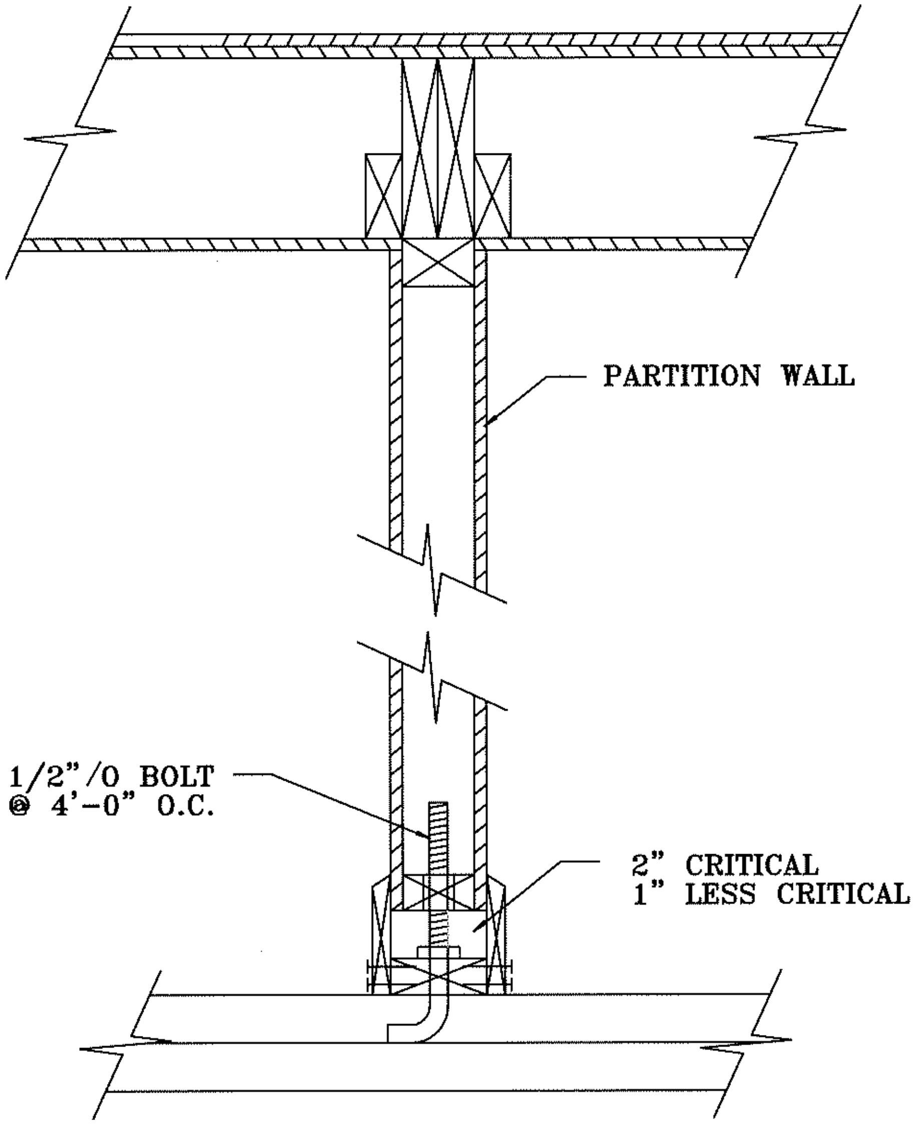


Note: These values are based on footing widths of 1 to 4 feet. If the footing width is to be greater than 4 feet in width, then we should be notified to re-evaluate these recommendations.

Title: BEARING CAPACITY CHART	Date: 12/11/19	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: Steamboat Springs Middle School	Job No. 19-11673	
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #11	



Title: HUNG PARTITION WALL DETAIL

Date: 12/12/19

Job Name: Steamboat Springs Middle School

Job No. 19-11673

Location: 39610 Amethyst Dr., Steamboat Springs, CO

Figure #12

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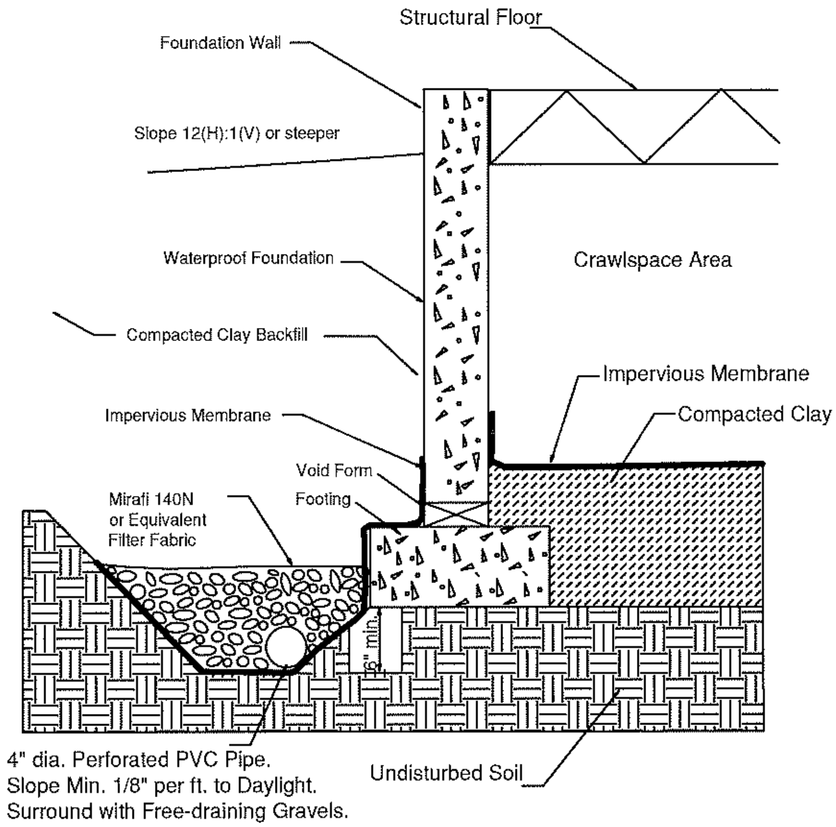
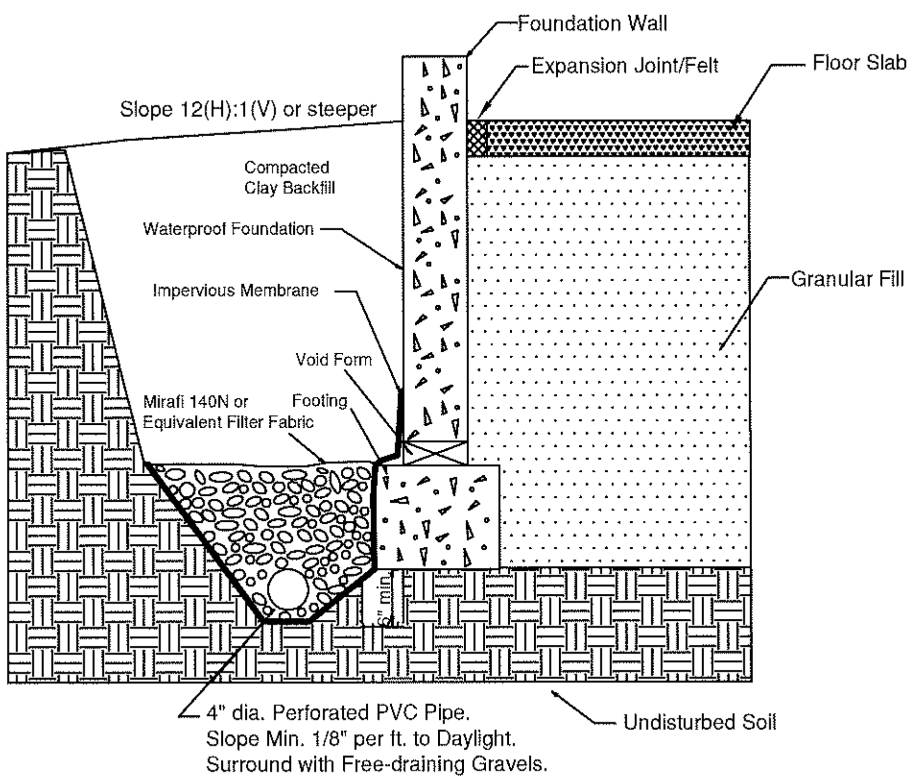
2580 Copper Ridge Drive
Steamboat Springs, Colorado 80487



Area Crawlspace



Floor Slab

Title: PERIMETER/UNDERDRAIN DETAIL	Date: 12/12/19	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: Steamboat Springs Middle School	Job No. 19-11673	
Location: 39610 Amethyst Dr., Steamboat Springs, CO	Figure #13	

NWCC, Inc.

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

SODA CREEK ELEMENTARY SCHOOL

SAMPLE LOCATION		NATURAL MOISTURE CONTENT	NATURAL DRY DENSITY	ATTERBERG LIMITS		GRADATION		PERCENT PASSING No. 200 SIEVE	AASHTO SOIL CLASS.	SOIL or BEDROCK DESCRIPTION	UNIFIED SOIL CLASS.
TEST HOLE	DEPTH (feet)	(%)	(pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAVEL (%)	SAND (%)				
1	4	22.3	104.5	23	10	1	43	56	A-4	Very Sandy Clay	CL
1	19	10.1		NV	NP	45	50	5	A-1	Gravel and Sand	SM
2	2	9.9	130.7	25	12	18	44	38	A-6	FILL: Gravelly Very Clayey Sand	SC
2	18	9.2		NV	NP	43	51	6	A-1	Very Gravelly Sand	SM
3	9	24.0	102.0	25	10	3	30	67	A-4	Sandy Clay	CL
P1	2	15.7	118.0	29	15	7	49	44	A-6	FILL: Very Clayey Sand	SC
P2	1 1/2	13.9	119.1	31	15	6	50	44	A-6	FILL: Very Clayey Sand	SC
P3	1	20.6	106.2	34	16	4	52	44	A-6	FILL: Very Clayey Sand	SC
P4	1	25.8	97.3	38	21	2	54	44	A-6	Very Clayey Sand	SC

NV = No Value
NP = Non Plastic

JOB NUMBER: 19-11673

APPENDIX A

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

August 7, 2006

Steamboat Springs School District RE-2
P.O. Box 774368
Steamboat Springs, CO 80477

Attn: Rick Denney

Job Number: 06-7160

Subject: Foundation Recommendations, Proposed North Entrance/Administration Addition – Steamboat Springs Middle School, 5100 Amethyst Drive, Steamboat Springs, Colorado.

Gentlemen,

As requested, NWCC, Inc. has prepared this report that provides foundation recommendations for the North Entrance/Administration Addition to the Steamboat Springs Middle School, which is located at 5100 Amethyst Drive in Steamboat Springs, Colorado. It should be noted that our firm previously prepared a Subsoil and Foundation Investigation for the other additions to be constructed in the central portions of the Middle School. The previous report was completed under our job number 02-5162 and dated May 6, 2002.

Proposed Construction: It is our understanding that the proposed addition will be constructed along the north side of the existing building and will extend from the existing building entrance to the western edge of the building. We have assumed that the addition will consist of a single-story masonry structure founded on spread footings. We have also assumed that a slab-on-grade floor system will be constructed in the addition and that the floor level of the addition will match the existing floor level in the adjacent building. It should be noted that we have not yet been provided plans for this project and our assumptions above have been based on our discussions with the excavator regarding their understanding of the proposed construction.

Subsurface Conditions: One test pit was excavated by the excavator, Johnson Excavation, at the time of our site visit on July 25, 2006. The test pit was located approximately 20 feet east and 30 feet north of the northwest corner of the existing building.

The subsurface conditions encountered in the test pit were variable and generally consisted of a sand and gravel (pit run) fill materials overlying a layer of clay fill materials, which in turn were overlaying a layer of natural topsoil and organic materials that were overlying natural clays, which extended to the maximum depth investigated, 7 feet. The sand and gravel fill materials, which consisted of clayey pit run sands and gravels, extended down to a depth of approximately 16 inches. A layer of clay fill materials was encountered below the pit run fill materials and these fill materials were encountered to a depth of approximately 3½ feet beneath the existing ground surface. The clay fill materials were sandy with gravels, medium stiff, low to moderately plastic, moist and brown in color.

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A layer of natural topsoil and organic materials was encountered below the clay fill materials at a depth of approximately 3½ feet and these materials extended to a depth of approximately 5½ feet beneath the ground surface. The natural clays were sandy, low to moderately plastic, stiff, moist and brown in color. A sample of the natural clays classified as a CL soil in accordance with the Unified Soil Classification System. A swell-consolidation test conducted on a sample of the natural clays indicates that the materials tested will exhibit a low swell potential when wetted under a constant load. The swell-consolidation and laboratory test results are presented in the attached Figure #1.

Foundation Recommendations: Based on the subsurface conditions encountered in the test pit excavated at the site and our experience with similar projects at this site, we recommend that the proposed addition be founded on spread footings placed directly on the natural clays, found below the natural topsoil and organics or on properly compacted structural fill materials placed over the natural clays. For foundation design, we recommend the footings be designed using an allowable soil bearing pressure of 2,500 psf. Due to the swell potential of the clays, we also recommend that the footings be designed using a minimum dead load pressure of at least 600 psf.

If structural fill materials are placed beneath the foundations, they should extend out from the edge of the footings at a slope of at least 1 (horizontal) : 1 (vertical) or flatter. The structural fill materials should consist of an imported granular fill material approved by this office prior to placement. The structural fill materials should be placed and compacted in 6 to 8 inch lifts to at least 100 percent of the maximum standard Proctor density and within 2 percent of the optimum moisture content determined in accordance with ASTM D698/AASHTO T99 or to at least 95 percent of the maximum modified Proctor density and within 2 percent of the optimum moisture content determined in accordance with ASTM D1557/AASHTO T180. All of the existing fill materials and natural topsoil and organic materials must be removed prior to the placement of the footings or structural fill materials.

An engineer from this office must be called to the site when the foundation excavations are near completion to identify the soils in the excavations and confirm the recommendations in this report. We also recommend that the structural fill materials placed in the excavations be tested for compaction by this office.

Limitations: The recommendations given in this report are based on the soils encountered in the test pit excavated at the site, our experience with similar projects at this site and our assumptions regarding 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. The behavior of swelling soils is not fully understood. The swell 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 on swelling soils. The owner should be aware that 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 these soils, it is necessary that the changes in moisture content be kept to a minimum. This requires providing positive surface drainage away from the building. Any distress noted in the building should be brought to the attention of a professional engineer.

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.

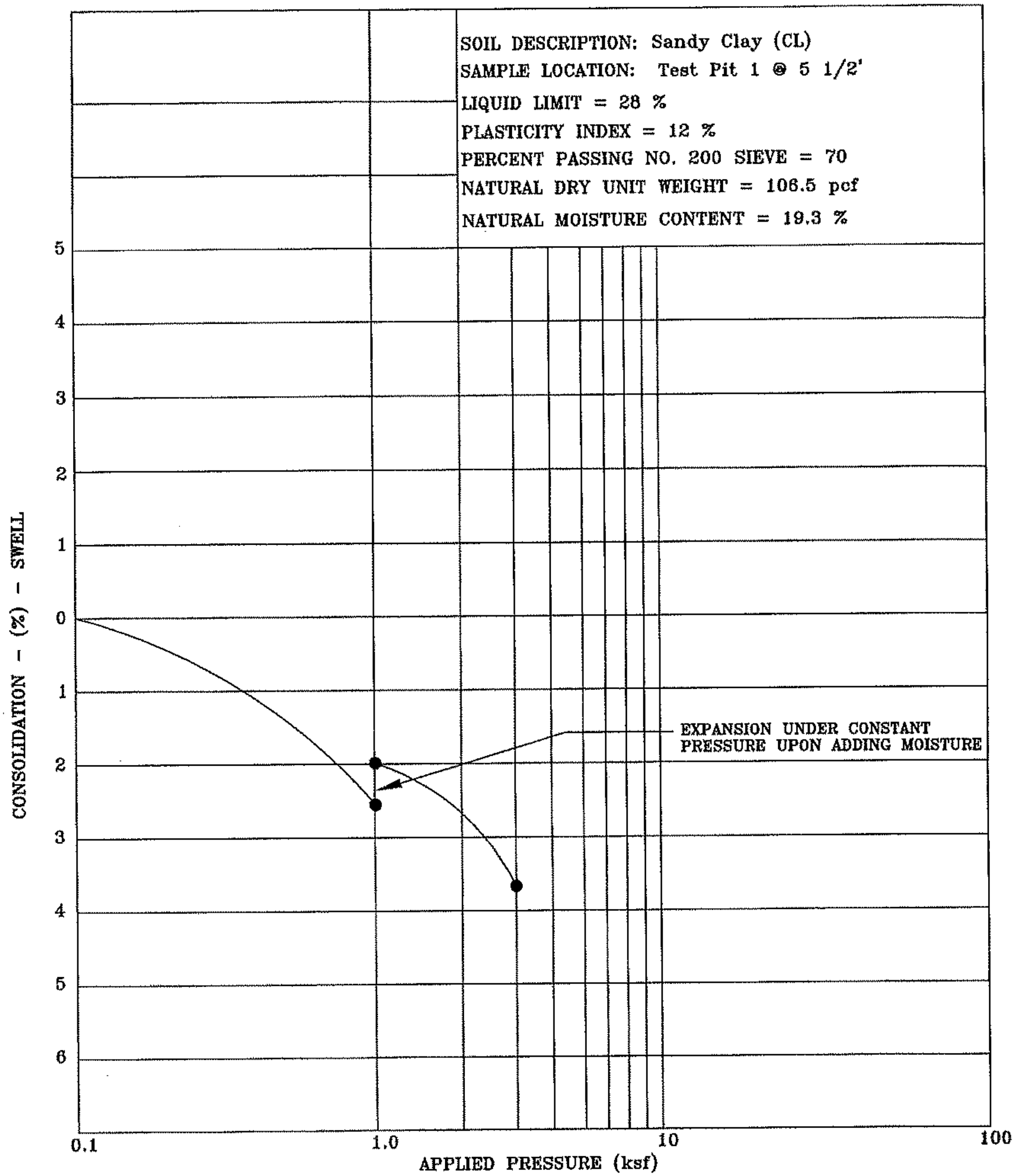
We appreciate the opportunity to be of professional service to you in this matter. If you have any questions regarding this report, or if we can be of further service, please contact this office.

Sincerely,
NWCC, INC.,

COLORADO LICENSED BRIAN D. LEN 25750 PROFESSIONAL ENGINEER

Brian D. Len, P.E.

xc: Brandon Baker - ESA
Mike Gaines - MGA Structural Engineers



Title: SWELL–CONSOLIDATION TEST RESULTS		Date: 8/4/06	North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive · P.O. Box 775220 Steamboat Springs, Colorado 80477
Job Name: North Entrance/Administration Addition		Job No. 06-7160	
Location: 5100 Amethyst Drive, Steamboat Springs, CO		Figure #1	

NorthWest Colorado Consultants, Inc.

Geotechnical / Environmental Engineering • Materials Testing

Subsoil and Foundation Investigation
Proposed Strawberry Park Middle School Additions
5100 Amethyst Drive
Steamboat Springs, Colorado

Prepared for:

Steamboat Springs School District RE-2
P.O. Box 774368
Steamboat Springs, CO 80477

Attn: Mr. Rick Denney

Job Number: 02-5162

May 6, 2002

TABLE OF CONTENTS

CONCLUSIONS

The proposed additions should be supported on a foundation system consisting of spread footings placed on the natural clays or on properly compacted structural fill materials placed over the natural clays. If the client is not willing to accept the risk of foundation movement associated with placing shallow foundations on swelling soils, we recommend the structures be founded on helical screw piles advanced into the underlying sands and gravels. Design parameters and/or additional recommendations for the spread footing and helical pile foundation systems are outlined herein.

PURPOSE AND SCOPE OF STUDY

This report presents the results of Subsoil and Foundation Investigation for the proposed Strawberry Park Middle School Additions to be constructed at 5100 Amethyst Drive in Steamboat Springs, Colorado. The approximate location of the project site is shown in Figure #1.

A field exploration program was conducted to obtain information on subsurface conditions. Material samples obtained during the subsurface investigation were tested in the laboratory to provide data on the classification and engineering characteristics of the on-site soils. The results of the field and laboratory investigations are presented herein.

This report has been prepared to summarize the data obtained and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed additions are included.

PROPOSED CONSTRUCTION

We understand that the proposed construction will consist of the construction of a second floor over the existing auxiliary gymnasium, which is located to the south of the existing gymnasium and the construction of classrooms within the two existing courtyard areas in the central portion of the existing building. The Middle School is located to the west of Amethyst Drive in Steamboat Springs, Colorado. It is our understanding that the construction of the second floor of the auxiliary gymnasium will consist of removing the roof above the of the existing auxiliary gymnasium and then extending the existing masonry walls upward. We have assumed that the proposed classroom additions will consist of masonry construction with concrete slab-on-grade floor systems.

For design purposes, we have assumed the structure loadings to be light to moderate, typical of this type of construction. If loadings or conditions are significantly different from those described above, we should be notified to reevaluate the recommendations contained in this report.

SITE CONDITIONS

The proposed additions to be constructed to the existing Strawberry Park Middle School in Steamboat Springs, Colorado. The vegetation surrounding the existing building consists of grasses and weeds with aspen trees in the existing courtyards. Concrete flatwork (sidewalks) occupies a large portion courtyard areas and asphalt pavement is located along the west side of the building.

The site generally slopes gently away from the existing structure on the order of 0 to 1 percent. It appeared that a maximum elevation difference of approximately 0 to 1 foot exists across each of the courtyard areas.

FIELD INVESTIGATION

The field investigation for this project was conducted on April 17, 2002. Six (6) test holes were advanced at the approximate locations shown in Figure #2 to determine the subsurface conditions. Locations of the test holes were determined by pacing from the existing features at the site.

The test holes were advanced through the natural topsoil and overburden soils with 4-inch diameter continuous flight augers. The test holes were advanced with a track-mounted CME 45 drill rig and were logged by a representative of NWCC, Inc.

Samples of the subsurface materials were taken with a California Liner sampler. The sampler was driven into the various strata with blows from a 140-pound hammer falling 30 inches. This test is similar to the standard penetration test described by ASTM Method D-1586. Penetration resistance values, when properly evaluated, indicate the relative density or consistency of the soils. Depths at which the samples were taken and the penetration resistance values are shown on the logs of the exploratory hole in Figure #3. The Legend and Notes associated with the logs are shown in Figure #4.

LABORATORY INVESTIGATION

Samples obtained from the exploratory test holes were examined and classified in the laboratory by the project engineer. The laboratory testing included standard property tests, such as natural moisture contents, density, grain size analyses, unconfined compressive strengths and liquid and plastic limits. Swell-consolidation tests were also conducted on relatively undisturbed samples of the natural clays to determine the swell-consolidation potential of these materials.

Results of the swell-consolidation testing are presented on Figures #5 through #7 and all of the other laboratory test results are summarized in Table 1. The laboratory testing was conducted in general accordance with applicable ASTM specifications.

SUBSURFACE CONDITIONS

The subsurface conditions encountered at the site were variable and generally consisted of a layer of topsoil and organics or concrete sidewalk and road base sands and gravels overlying clay fill materials, natural clays and sands and gravels to the maximum depth investigated, 24 feet. The logs of the exploratory test holes are shown in Figure #3 and the associated Legend and Notes are shown in Figure #4.

A layer of topsoil fill materials was encountered at the ground surface in test holes 1 and 6, and was generally 12 inches or less in thickness. A 4 to 5 inch thick concrete sidewalk was encountered at the ground surface in test holes 2, 3, 4 and 5. A layer of road base sands and gravels was encountered beneath the concrete sidewalk and was approximately 3 to 4 inches in thickness. Clay fill materials were encountered below the topsoil and road base sands and gravels in test holes 1 through 5. The clay fill materials extended to depths of 4 to 5 feet. The fill materials are most likely wall backfill materials placed adjacent to the existing foundations and in the courtyard areas during the original construction. The clay fill materials were sandy to very sandy, low to moderately plastic, soft to medium stiff, moist to very moist and brown to gray in color. Natural clays were encountered beneath the fill materials in test holes 1 through 5 and below the topsoil in test hole 6. The clays extended to depths of 18 to 22 feet. The clays were sandy to very sandy with occasional gravels, low to moderately plastic, soft to stiff, moist to wet and brown to gray in color. Samples of the clays classified as CL soils in accordance with the Unified Soil Classification System. Natural sands and gravels were encountered below the clays in all of the test holes and extended to the maximum depths investigated. The sands and gravels were silty to clayey, fine to coarse grained with cobbles, low to non-plastic, dense, very moist and brown in color.

Swell-consolidation tests conducted on samples of the natural clays indicate that these materials will exhibit a very low swell to low consolidation potential when wetted under a constant load. The swell-consolidation test results are presented in Figures #5 through #7 and all of the laboratory test results are summarized in Table 1.

Groundwater seepage was encountered at depths ranging from 5 to 15 feet below the ground surface at the time of drilling. However, when measured one day after the drilling was completed, the groundwater levels were encountered at depths ranging from 6½ to 10 feet below the existing ground surface. The depth at which the groundwater levels were encountered and the number of days in which the measurements were taken are shown on the Logs of the Exploratory Test Holes. It should be noted that groundwater conditions can be expected to fluctuate with changes in precipitation and runoff at the site.

ANALYSIS OF EXISTING FOUNDATIONS

It is our understanding that the existing footings under the proposed Auxiliary Gymnasium were designed using an allowable soil bearing pressure of 2,000 psf. Based on the subsoils encountered adjacent to the existing foundations in this area, we believe that the existing footings are bearing on the natural clays. We did not observe any evidence of compacted structural fill materials in this area. In addition, we did not observe any distress in the existing masonry walls. Therefore, we believe that the soils situated below the existing foundation system will provide an allowable soil bearing pressure of 2,500 psf based on 1 inch of theoretical settlement.

FOUNDATION RECOMMENDATIONS – PROPOSED ADDITIONS

Based on the subsurface conditions encountered in the test holes, the results of the field and laboratory investigations, our observations made of the condition of the existing building structure and the proposed construction, we recommend that the proposed additions be founded on spread footing foundation systems placed directly on the natural clays or on structural fill materials placed over the natural clays. We believe that the risk of foundation movement should be reduced if the following design and construction precautions are observed.

1) The footings placed on the natural clays or structural fill materials placed over the natural clays should be designed using an allowable soil bearing pressure of 2,500 psf. The footings placed on the natural clays or structural fill materials placed over the natural clays should also be designed for a minimum dead load pressure of 600 psf.

2) All footings or pad sizes should be computed using the above soil pressures and placed on either the natural clays or on properly compacted structural fill materials placed over the natural clays. Any topsoil, existing fill materials, loose or soft natural soils found beneath or within the footings when the excavations are opened should be removed and the footings should be extended down to more competent natural clays prior to concrete or structural fill placement. If structural fill materials are used to bring the excavations to the desired grade, the fill materials should consist of a non-expansive granular material approved an engineer from this office. The fill materials should be placed and compacted in 6 to 8 inch lifts to at least 97 percent of the maximum modified Proctor density, near the optimum moisture content determined in accordance with ASTM D1557, prior to the placement of the foundation forms.

3) All footings should be placed well enough below final backfill grades to protect them from frost heave. Four-feet of soil cover is normal for this area considering snow cover and other winter factors.

4) Based on experience, we estimate total settlement for footings and pads designed and constructed as discussed in this section will be approximately 1 inch. Additional bearing capacities along with the associated settlements are shown in Figure #8.

5) Care should be taken when excavating the foundations to avoid disturbing the natural soils. Disturbing the bearing materials may increase settlements.

6) We suggest an engineer from this office be called to the site when the foundation excavations are near completion to identify the bearing soils and confirm the recommendations in this report. We also recommend that foundations areas located on structural fills be tested for compaction prior to placement of footing forms.

ALTERNATE FOUNDATION RECOMMENDATIONS

If the owner is not willing to accept the risk of movements due to swelling or consolidation of the natural soils under spread footings, we recommend that the structures be founded on helical screw piles advanced into the underlying natural sands and gravels.

The helical screw pile foundation system should be designed by a qualified engineer, using industry standards and be installed by a licensed/certified installer. A minimum penetration of 3 feet into the underlying natural sands and gravels is recommended. We strongly recommend that at least one test pile be advanced at the site so that the torque versus depth relationships can be established and the proper shaft and helix size and type can be determined.

FLOOR SLABS

We have assumed that the proposed additions will be constructed with concrete slab-on-grade floor systems. Floor slabs present a very difficult problem where expansive soils 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 this site, we believe 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 the damage, which could result from movement should the underslab materials be subjected to moisture changes.

1) The floor slabs must be separated from all bearing walls, columns and their foundation supports with a positive slip joint. We recommend the use of 1/2-inch thick cellotex or impregnated felt.

2) Interior non-bearing partition walls resting on the floor slabs should 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. This detail is also important for wallboard and doorframes. A typical hung partition wall detail is shown in Figure #9.

3) A minimum 6-inch gravel layer should 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 perimeter of the slab or the low point of the excavation. We also recommend that all of the topsoil fill materials be removed from beneath the floor slabs. The upper 12 inches of existing fill materials should also be removed and the exposed soils should be scarified to a minimum depth of 8 inches, brought to within 2 percent of the optimum moisture content and then be recompacted to at least 92% of the maximum modified Proctor density.

4) The floor slabs should be provided with control joints placed a maximum of 12 feet on center in each direction to help control shrinkage cracking. The location of the joints should be carefully checked to assure that the natural, unavoidable cracking will be controlled.

5) The underslab soils should 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) If fills are required to bring the underslab soils to the desired grade, they should consist of non-expansive, granular materials. The fills should be uniformly compacted in 6 to 8 inch lifts to at

least 95% of the maximum modified Proctor density at or near the optimum moisture content, as determined by ASTM D-1557.

The above precautions and recommendations will not prevent floor slab movement in the event the clays beneath the floor slabs undergo moisture changes. However, they should reduce the amount of damage if such movement occurs. If some floor slab movement and cracking is not tolerable, all of the clays should be removed or a structural floor system above a well-vented crawl space should be employed.

UNDERDRAIN SYSTEM

We recommend that the lower floor levels, crawl space areas and foundations of the proposed additions be protected by underdrain systems to help reduce the problems associated with the surface and subsurface drainage during high runoff periods. Groundwater or runoff can infiltrate the foundation at the foundation and floor slab levels. This water can be one of the primary causes of differential foundation and slab movement, especially where expansive soils have been encountered. Excessive moisture in crawl spaces can lead to rotting and mildewing of wooden structural members. 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.

The underdrain systems should be located around the entire perimeter of the additions and be placed at least 12 inches below any foundation voids, floor slab and crawl space level. The underdrain systems should consist of a layer of free draining granular material beneath the floor slab connected to the perimeter and lateral drains. The lateral drains should be spaced on approximately 25-foot centers beneath the floor slab. We recommend the use of perforated PVC pipe for the drain tile, which meets ASTM D-2729 requirements to minimize the potential for crushing the pipe during backfill operations. The drain tile should be surrounded by at least 12 inches of free draining gravel. The holes in the drain tile should be oriented down between 4 o'clock and 8 o'clock to promote rapid runoff of the water. The drain tile system should be protected from contamination by a filter covering of Mirafi 140N subsurface drainage fabric or an equivalent product. The drain should have a minimum slope of 1/8 inch per foot and should be daylighted at a positive outfall protected from freezing, or be led to a sump from which the water can be pumped. Caution should be taken when backfilling so as not to damage or disturb the installed underdrain. We recommend the drainage system include cleanouts spaced no greater than 50 feet, be protected against intrusion by animals at the outfall and be tested prior to backfilling.

In areas where foundation voids are required to achieve minimum loadings and the voids extend completely through the width of the foundation, we recommend that a barrier be constructed to keep water from infiltrating the voided area. The barrier may be constructed of the on-site clays compacted against the side of the foundations in the voided area. A typical perimeter/underdrain detail is shown in Figure #10. The design of the underdrain systems should be finalized after the excavations for the buildings have been completed and the amount of groundwater and/or surface/subsurface drainage coming from the site can be estimated.

FOUNDATION WALLS AND RETAINING STRUCTURES

Foundation walls and retaining structures, which are laterally supported and can be expected to undergo only a moderate amount of deflection, may be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 45 pcf for imported granular backfill and 55 pcf for the on-site materials.

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 granular backfill and 45 pcf for the on-site materials.

The 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 also increases the earth pressures on foundation walls and retaining structures.

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 footing on the foundation materials and the passive pressure against the side of the footing. 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 95% of the maximum modified Proctor density, near the optimum moisture content.

We recommend imported granular soils for backfilling foundation walls and retaining structures because their use results in lower lateral earth pressures. The 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 10 percent passing the No. 200 sieve. 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.

The wall backfill should be carefully placed in uniform lifts and compacted to between 90 and 95 percent of the maximum modified 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 building has been completed:

1) The ground surface surrounding the building should be sloped (minimum of 1.0 inch per foot) to drain away from the building 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 building should be compacted to at least 90% of the maximum modified 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 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 building.

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 exposed at this site and the behavior of the existing structures at the project site. We believe that this information gives a high degree of reliability for anticipating the behavior of the proposed structures. However, our recommendations are professional opinions and cannot control nature, nor can they assure the soils profiles beneath those or adjacent to those observed; therefore, no warranties of the accuracy of these recommendations beyond the limits of the obtained data is herein expressed or implied.

Swelling soils occur on this site. These soils are stable at their natural moisture content but can shrink or swell with changes in moisture. The behavior of swelling soils is not fully understood. The swell 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 soils. The owner should be aware that there is a risk in construction on these types of soil. Performance of the building will depend on following the recommendations and in proper maintenance after construction is complete. As water is the main cause for volume change in these 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 building. Any distress noted in the building should be brought to the attention of a professional engineer.

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 are changed, the results would also most likely change. 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,
NORTHWEST COLORADO CONSULTANTS, INC.

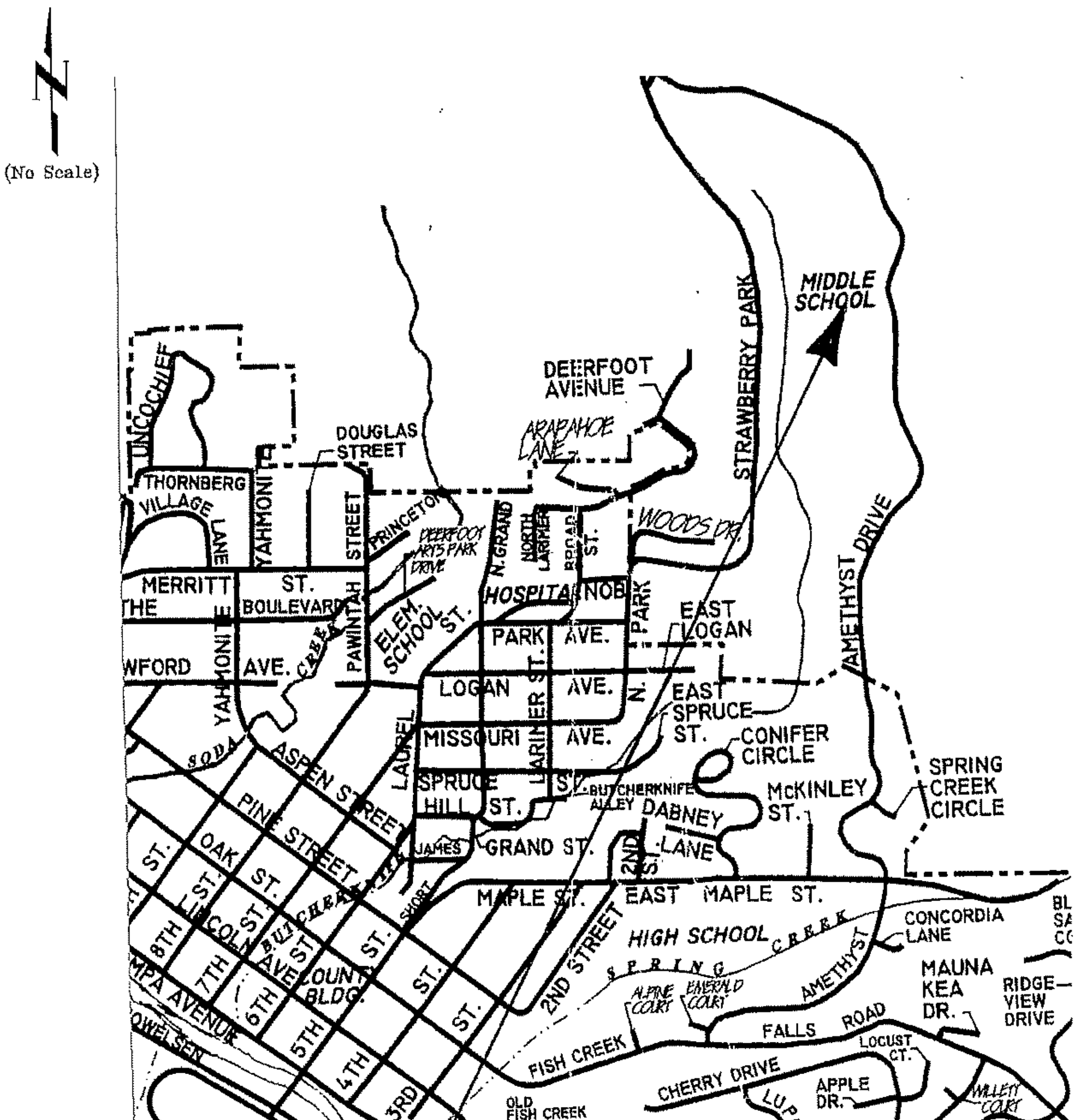
Timothy S. Travis, P.E.

Reviewed by Brian D. Len, P.E.

xc: Lee Fischer – ESA
Roy Townsley – Martin Design

NORTHWEST COLORADO CONSULTANTS

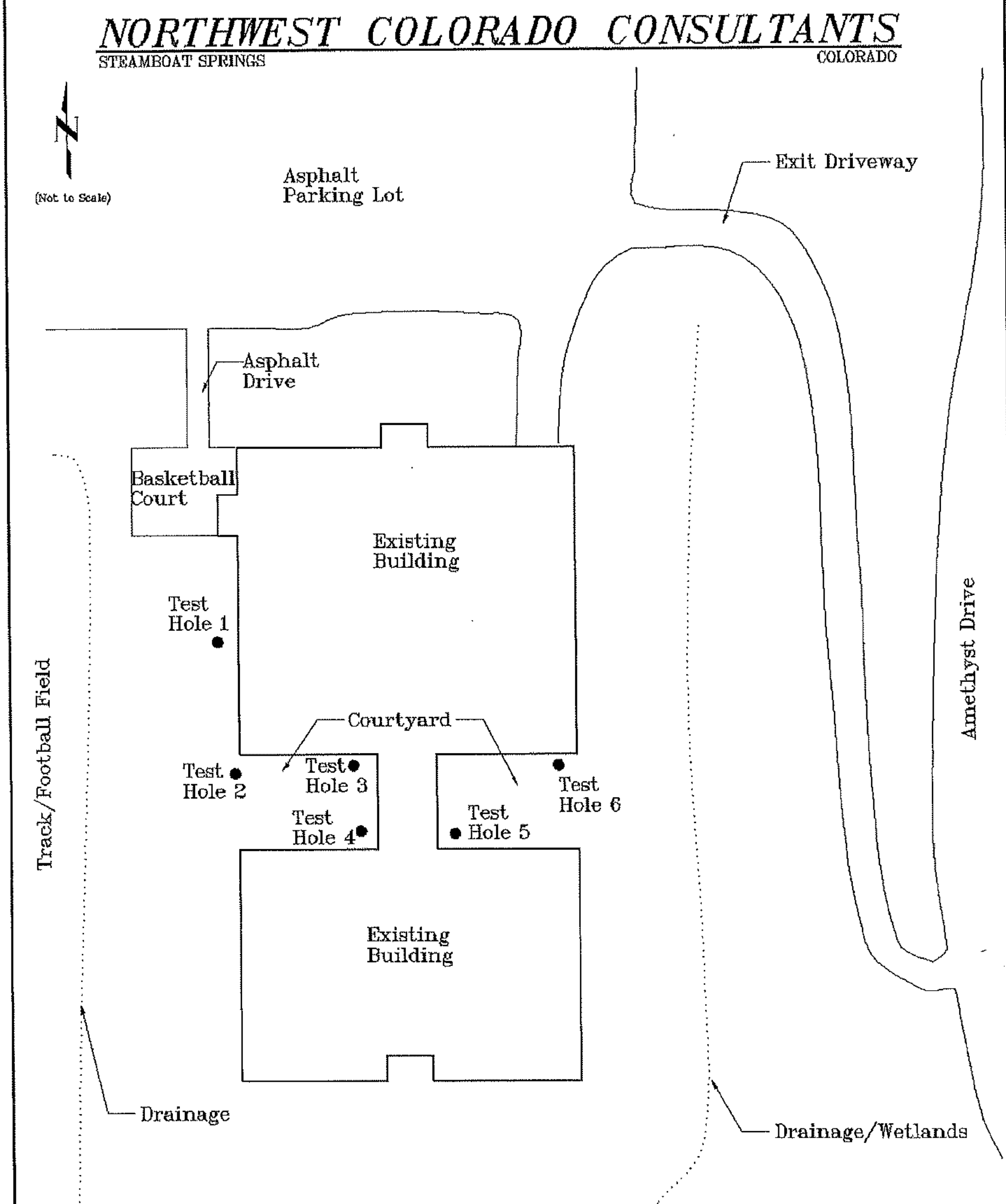
STEAMBOAT SPRINGS COLORADO



Project Site

VICINITY MAP

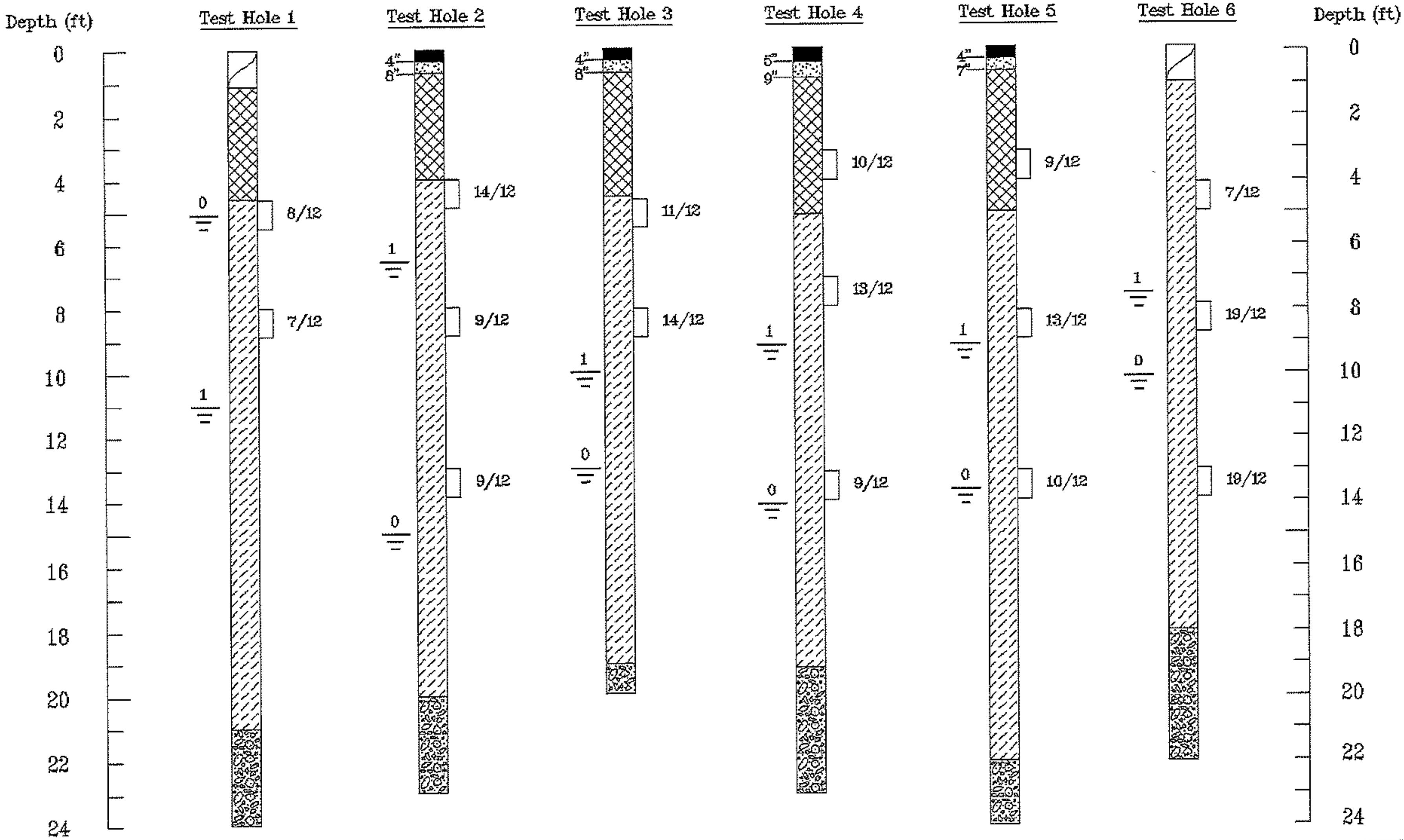
Job Name: Proposed Middle School Additions	Job No. 02-5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #1



SITE PLAN–LOCATION OF TEST HOLES

Job Name: Proposed Middle School Additions	Job No. 02–5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #2

NORTHWEST COLORADO CONSULTANTS
STEAMBOAT SPRINGS, COLORADO



LOGS OF EXPLORATORY TEST HOLES

Job Name: Proposed Middle School Additions	Job No. 02-5162
Location: 5100 Amethyst Drive, Steamboat Springs, CO	Figure #3

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STEAMBOAT SPRINGS COLORADO

LEGEND:

TOPSOIL FILL.

CONCRETE SIDEWALK

CRUSHED ROAD BASE SANDS AND GRAVELS

FILL: Clays, sandy to very sandy, low to moderately plastic, soft to medium stiff, moist to very moist and brown to gray in color.

CLAYS: Sandy to very sandy with occasional gravels, low to moderately plastic, soft to stiff, moist to wet and brown to gray in color.

SANDS AND GRAVELS: Silty to clayey, fine to coarse grained with cobbles low to non-plastic, dense, very moist and brown in color.

Drive sample, 2-inch I.D. California Barrel sample.

8/12 Drive Sample Blow Count, indicates 8 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 12 inches.

0 Depth at which groundwater seepage was encountered, and number of days after drilling measurement was taken.

NOTES:

1) Test holes were drilled on April 17, 2002 with 4-inch diameter continuous flight power augers.

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

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

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

LEGEND & NOTES

Job Name: Proposed Middle School Additions	Job No. 02-5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #4

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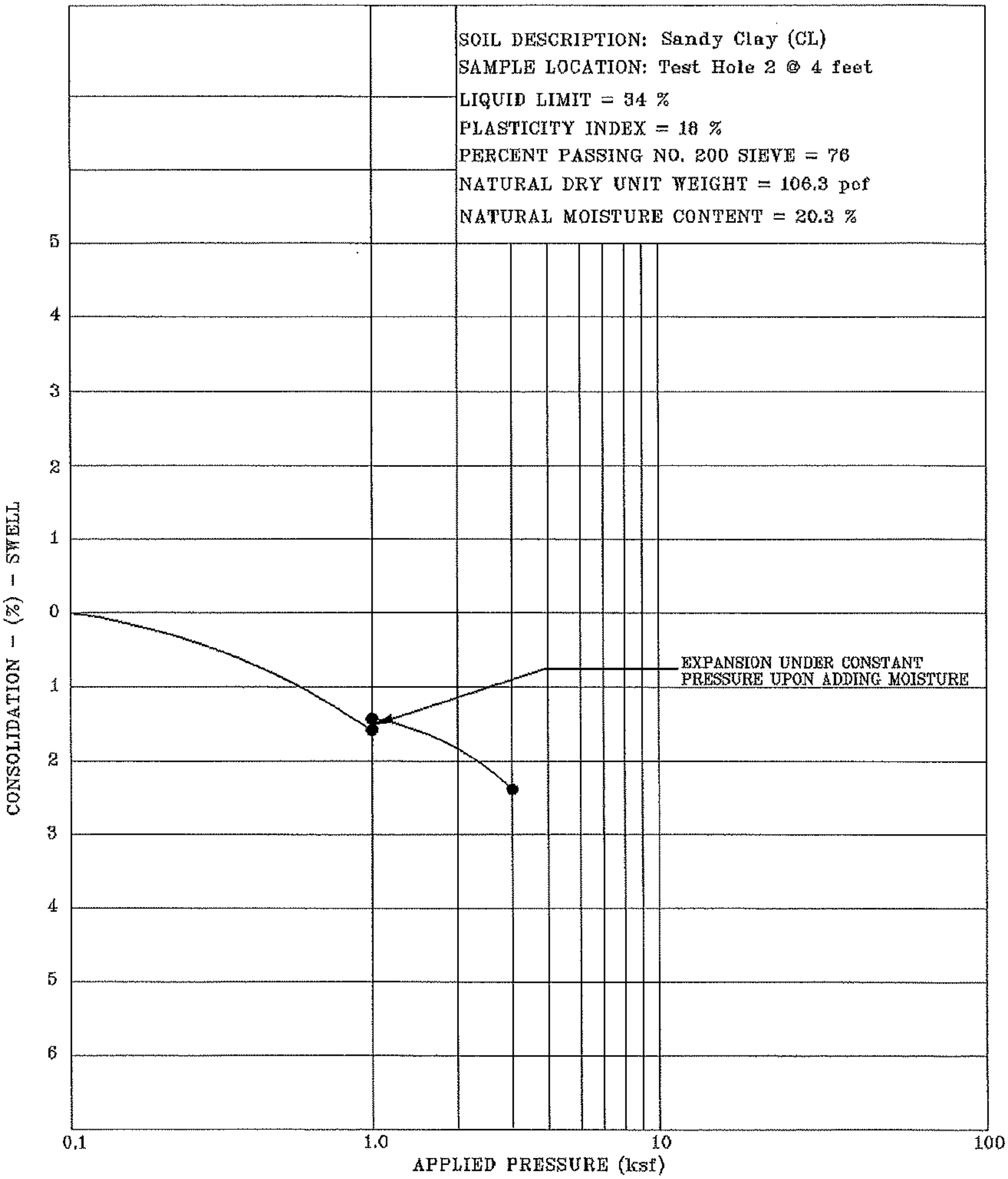
STEAMBOAT SPRINGS COLORADO

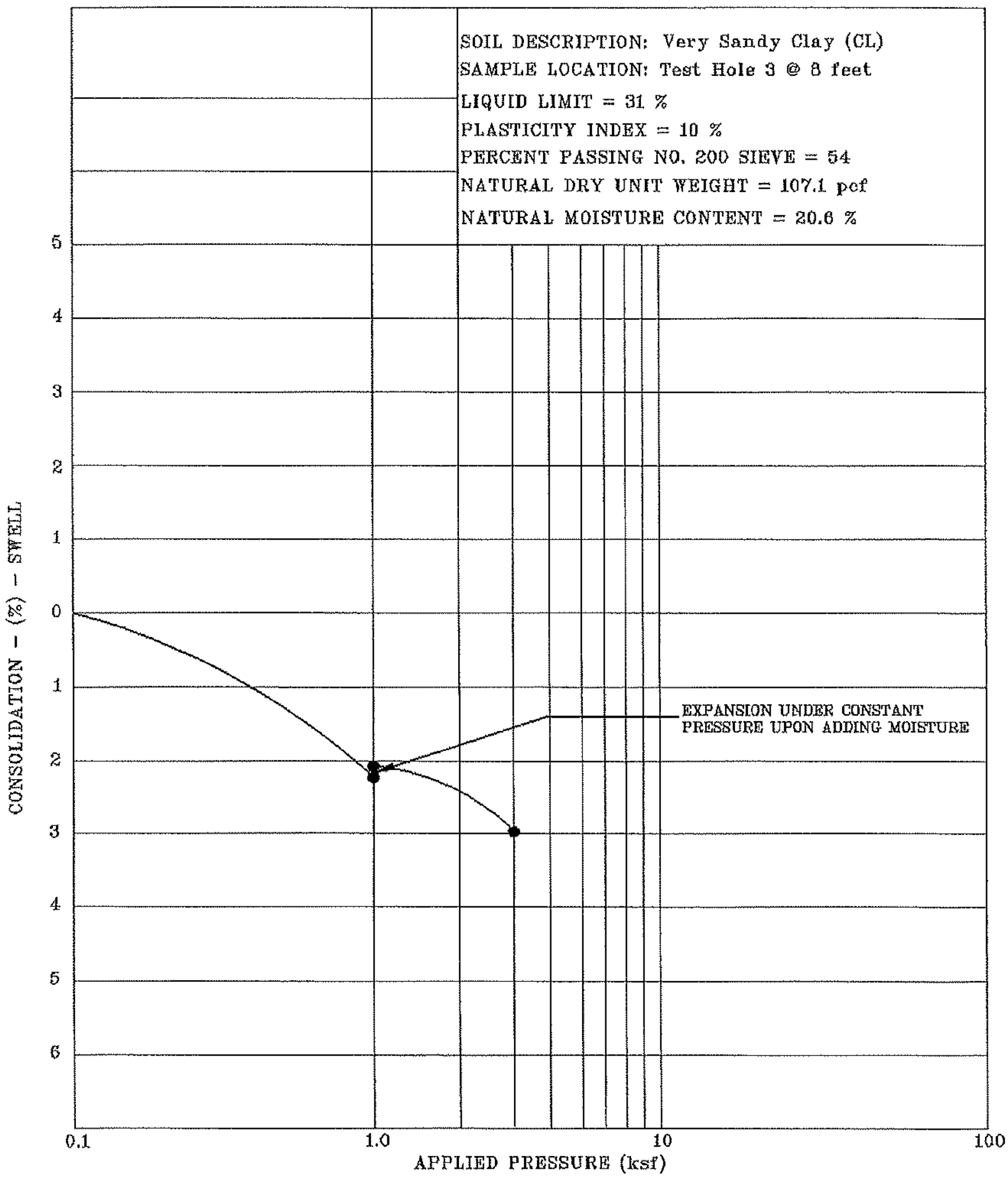


SWELL – CONSOLIDATION TEST RESULTS

Job Name: Proposed Middle School Additions	Job No. 02–5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #5

NORTHWEST COLORADO CONSULTANTS

STEAMBOAT SPRINGS COLORADO

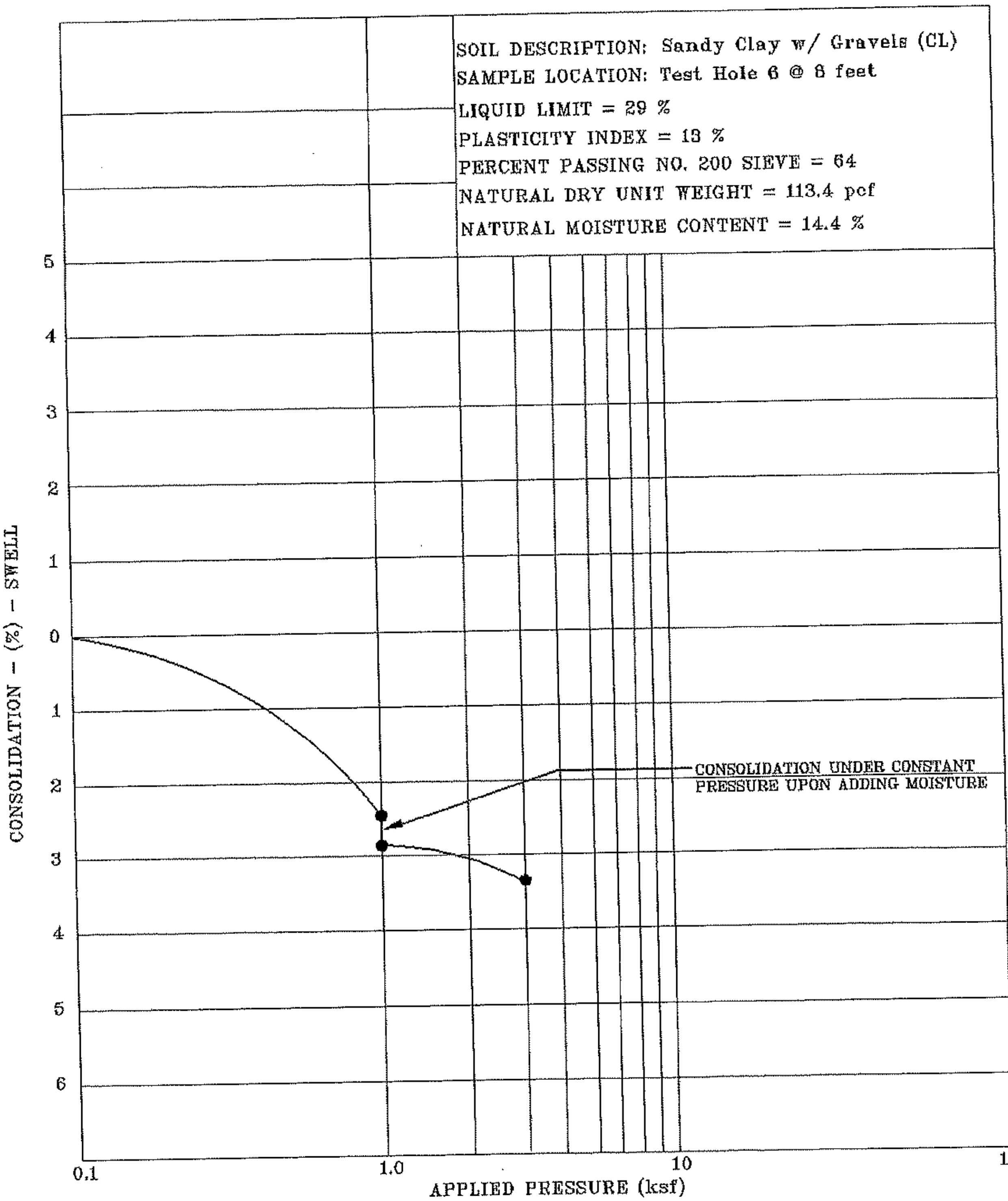


SWELL – CONSOLIDATION TEST RESULTS

Job Name: Proposed Middle School Additions	Job No. 02–5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #6

NORTHWEST COLORADO CONSULTANTS

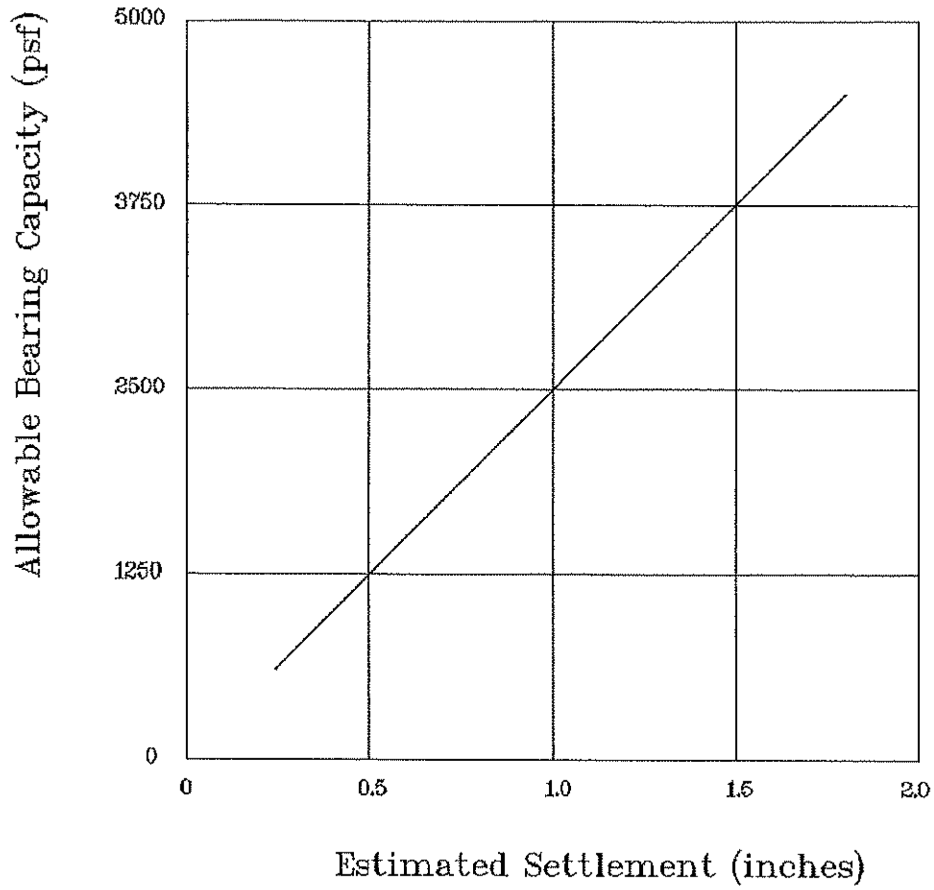
STEAMBOAT SPRINGS COLORADO



SWELL – CONSOLIDATION TEST RESULTS

Job Name: Proposed Middle School Additions	Job No. 02–5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #7

NORTHWEST COLORADO CONSULTANTS
STEAMBOAT SPRINGS COLORADO



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.

BEARING CAPACITY CHART

Job Name: Proposed Middle School Additions	Job No. 02-5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #8

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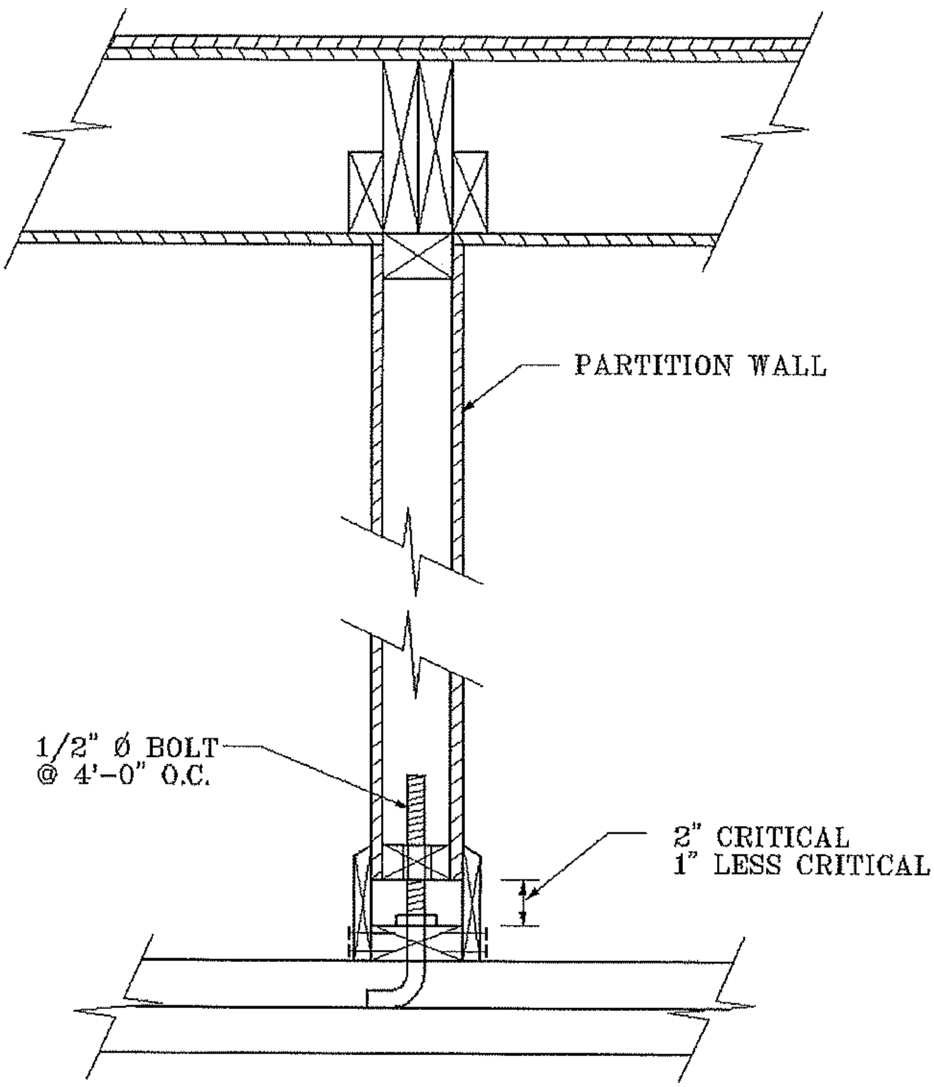
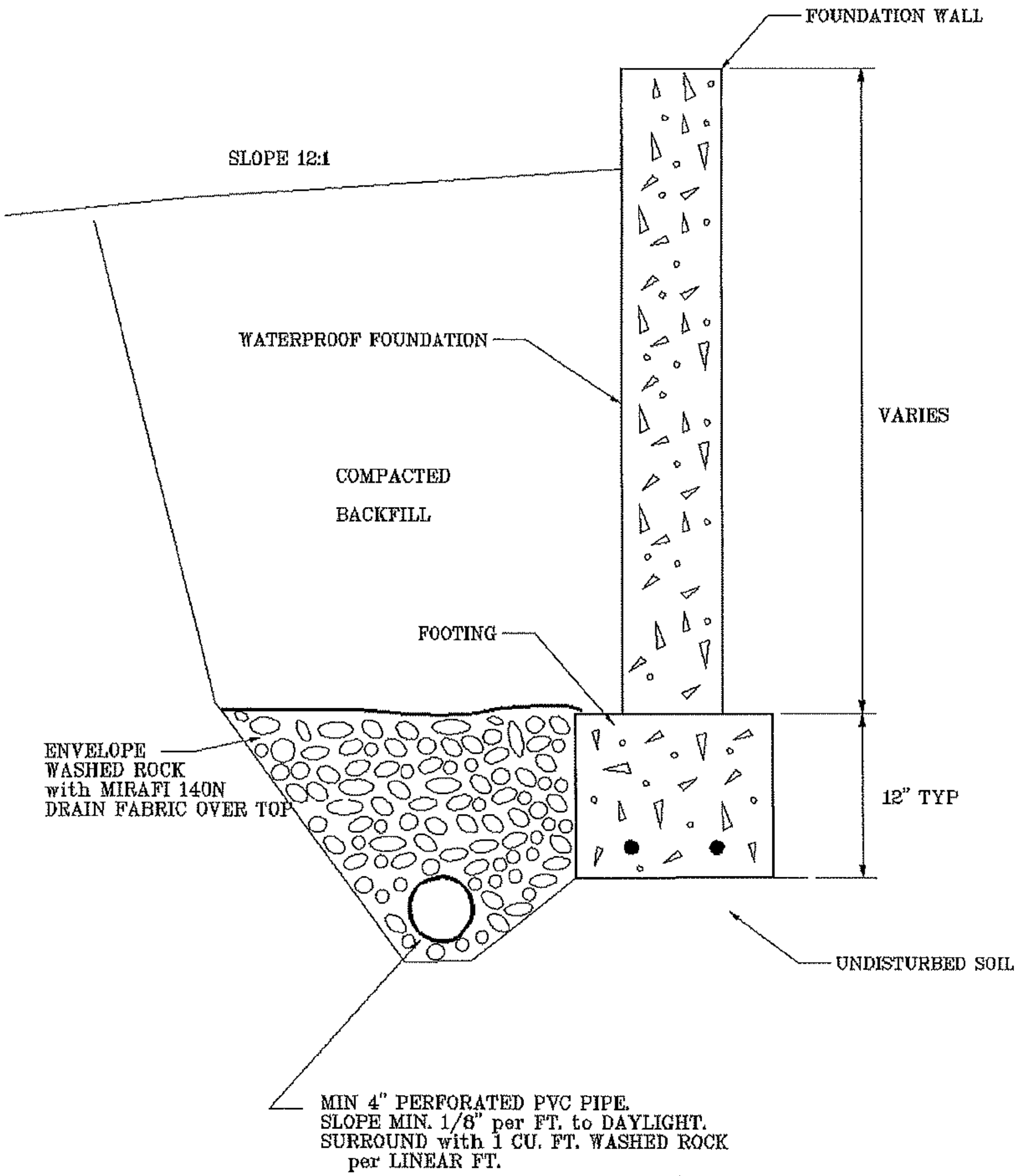
STEAMBOAT SPRINGS COLORADO



HUNG PARTITION WALL DETAIL

Job Name: Proposed Middle School Additions	Job No. 02-5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #9

NORTHWEST COLORADO CONSULTANTS
STEAMBOAT SPRINGS COLORADO



PERIMETER/UNDERDRAIN DETAIL

Job Name: Proposed Middle School Additions	Job No. 02-5162
Location: 5100 Amethyst Drive, Steamboat Springs, Colorado	Figure #10

NORTHWEST COLORADO CONSULTANTS

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	4 1/2	16.6	111.6	27	10	6	44	50	7,690	Very Sandy Clay with Gravels	CL
2	4	20.3	106.3	34	18		24	76		Sandy Clay	CL
3	4 1/2	18.6	109.6	33	17	2	26	72	5,530	Sandy Clay w/ Gravels	CL
3	8	20.6	107.1	31	10		46	54		Very Sandy Clay	CL
6	8	14.4	113.4	29	13	12	24	64		Sandy Clay w/ Gravels	CL

JOB NUMBER: 02-5162