HEPWORTH-PAWLAK GEOTECHNICAL

Hepworth-Pawlak Geotechnical, Inc.
5020 County Road 154
Glenwood Springs, Colorado 81601
Phone: 970-945-7988

Fax: 970-945-8454
email: hpgeo@hpgeotech.com

SUBSOIL STUDY
FOR FOUNDATION DESIGN
PROPOSED STORAGE BUILDING
COLORADO MOUNTAIN COLLEGE
SPRING VALLEY CAMPUS
3000 COUNTY ROAD 114
GARFIELD COUNTY, COLORADO

JOB NO. 114 411A

OCTOBER 31, 2014

P.O. NO. B0008375

PREPARED FOR:

COLORADO MOUNTAIN COLLEGE
ATTN: PETE WALLER
831 GRAND AVENUE
GLENWOOD SPRINGS, CO 81601
pwaller@coloradomtn.edu

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a subsoil study for a proposed storage building to be located on the Spring Valley Colorado Mountain College Campus at 3000 County Road 114, Garfield County, Colorado. The project site is shown on Figure 1. The purpose of the study was to develop recommendations for the foundation design. The study was conducted in accordance with our notice to proceed from Pete Waller on September 22, 2014 and accompanying Purchase Order B0008375 dated September 25, 2014.

A field exploration program consisting of exploratory borings was conducted to obtain information on the subsurface conditions. Samples of the subsoils obtained during the field exploration were tested in the laboratory to determine their classification and other engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for foundation types, depths and allowable pressures for the proposed building foundation. This report summarizes the data obtained during this study and presents our conclusions, design recommendations and other geotechnical engineering considerations based on the proposed construction and the subsurface conditions encountered.

PROPOSED CONSTRUCTION

The proposed building will be a one story metal storage building with slab-on-grade construction. Grading for the structure is assumed to be relatively minor with cut depths between about 1 to 5 feet. We assume relatively light foundation loadings, typical of the proposed type of construction.

If building loadings, location or grading plans change significantly from those described above; we should be notified to re-evaluate the recommendations contained in this report.

SITE CONDITIONS

At the time of our study the proposed building location consisted of an existing outside storage area with several small structures and a concrete retaining wall approximately 4 feet in height. The ground surface has been graded flat to accommodate the parking and driveway areas with cuts/fills of up to 4 feet. Vegetation surrounding the gravel parking and driveway areas consisted of weeds with the sagebrush, pinon pine and juniper trees typical of the area. Numerous basalt boulders were observed on the surface behind the retaining wall.

SUBSIDENCE POTENTIAL.

The site is located in an area known to have basalt outcroppings and potentially underlain with Eagle Valley Evaporite. The Pennsylvania Age Eagle Valley Evaporite bedrock contains gypsum deposits. Dissolution of the gypsum under certain conditions can cause sinkholes to develop and can produce areas of localized subsidence. During previous work in the area, sinkholes have been observed scattered throughout the lower to Roaring Fork River valley including a sinkhole that opened in 2003 adjacent to the soccer fields located to the east of the project site. Sinkholes were not currently observed in the immediate area of the subject site. No evidence of cavities was encountered in the subsurface materials; however, the exploratory boring was relatively shallow, for foundation design only. Based on our present knowledge of the site, it cannot be said for certain that sinkholes will not develop. In our opinion, the risk of ground subsidence throughout the service life of the project site is low but the owner should be aware of the potential for sinkhole development.

FIELD EXPLORATION

The field exploration for the project was conducted on October 2, 2014. Two exploratory borings were drilled at the locations shown on Figure 1 to evaluate the subsurface conditions. The borings were advanced with 4 inch diameter continuous flight augers powered by a truck-mounted CME-45B drill rig. The borings were logged by a representative of Hepworth-Pawlak Geotechnical, Inc.

Samples of the subsoils were taken with a 1⅜ inch I.D. spoon sampler. The sampler was driven into the subsoils at various depths 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. The penetration resistance values are an indication of the relative density or consistency of the subsoils. Depths at which the samples were taken and the penetration resistance values are shown on the Logs of Exploratory Borings, Figure 2. The samples were returned to our laboratory for review by the project engineer and testing.

SUBSURFACE CONDITIONS

Graphic logs of the subsurface conditions encountered at the site are shown on Figure 2. The subsoils consist of about 1 foot of parking lot gravel overlying medium dense to dense, basalt cobbles and boulders in a calcareous, sandy silt matrix. Drilling in the coarse granular soils with auger equipment was difficult due to the cobbles and boulders and drilling refusal was encountered in the deposit for both borings.

Laboratory testing performed on a sample obtained from the borings included natural moisture content and gradation analyses. Results of gradation analyses performed on small diameter drive samples (minus 1½ inch fraction) of the coarse granular soils are shown on Figure 4.

No free water was encountered in the borings at the time of drilling and the subsoils were slightly moist to moist.

DESIGN RECOMMENDATIONS

FOUNDATIONS

Considering the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, we recommend the building be founded with spread footings bearing on the natural granular soils.

The design and construction criteria presented below should be observed for a spread footing foundation system.

1) Footings placed on the undisturbed natural granular soils should be designed for an allowable bearing pressure of 2,500 psf. Based on experience, we expect settlement of footings designed and constructed as

discussed in this section will be about 1 inch or less. The matrix soils may compress when wetted and precautions should be taken to keep the bearing soil dry.

2) The footings should have a minimum width of 16 inches for continuous walls and 2 feet for isolated pads.

3) Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 36 inches below exterior grade is typically used in this area.

4) Continuous foundation walls should be reinforced top and bottom to span local anomalies such as by assuming an unsupported length of at least 12 feet. Foundation walls acting as retaining structures should also be designed to resist lateral earth pressures as discussed in the "Foundation and Retaining Walls" section of this report.

5) All existing fill, topsoil and any loose or disturbed soils should be removed and the footing bearing level extended down to the relatively dense natural granular soils. The exposed soils in footing area should then be moistened and compacted. Voids created by boulder removal should be backfilled with concrete or structural fill compacted to at least 98% of standard Proctor density at near optimum moisture content.

6) A representative of the geotechnical engineer should observe all footing excavations prior to concrete placement to evaluate bearing conditions.

FOUNDATION AND RETAINING WALLS

Foundation walls and retaining structures which are laterally supported and can be expected to undergo only a slight amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 45 pcf for backfill consisting of the on-site granular soils. Cantilevered retaining structures which are separate from the building and can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 40 pcf for backfill consisting of the on-site granular soils excluding rock larger than about 6 inches.

All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent footings, traffic, construction materials and equipment. The pressures recommended above assume drained conditions behind the walls and a horizontal backfill surface. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a foundation wall or retaining structure. An underdrain should be provided to prevent hydrostatic pressure buildup behind walls.

Backfill should be placed in uniform lifts and compacted to at least 95% of the maximum standard Proctor density at a moisture content near optimum. Backfill in pavement and walkway areas should be compacted to at least 95% of the maximum standard Proctor density. Care should be taken not to overcompact the backfill or use large equipment near the wall, since this could cause excessive lateral pressure on the wall. Some settlement of deep foundation wall backfill should be expected, even if the material is placed correctly, and could result in distress to facilities constructed on the backfill.

The lateral resistance of foundation or retaining wall footings will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.45. Passive pressure of compacted backfill against the sides of the footings can be calculated using an equivalent fluid unit weight of 375 pcf. The coefficient of friction and passive pressure values recommended above assume ultimate soil strength. Suitable factors of safety should be included in the design to limit the strain which will occur at the ultimate strength, particularly in the case of passive resistance. Fill placed against the sides of the footings to resist lateral loads should be a granular material compacted to at least 95% of the maximum standard Proctor density at a moisture content near optimum.

FLOOR SLABS

The natural on-site soils, exclusive of topsoil, are suitable to support lightly loaded slab-on-grade construction. To reduce the effects of some differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement. Floor slab control joints should be used to reduce damage due to shrinkage cracking. The requirements for joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use. A minimum 4 inch layer of relatively well graded sand and gravel should be placed beneath interior slabs for support. This material should consist of minus 2 inch aggregate with at least 50% retained on the No. 4 sieve and less than 12% passing the No. 200 sieve.

All fill materials for support of floor slabs should be compacted to at least 95% of maximum standard Proctor density at a moisture content near optimum. Required fill can consist of the on-site granular soils devoid of vegetation, topsoil and oversized rock.

UNDERDRAIN SYSTEM

Although free water was not encountered during our exploration, it has been our experience in mountainous areas that local perched groundwater can develop during times of heavy precipitation or seasonal runoff. Frozen ground during spring runoff can create a perched condition. We recommend below-grade construction, such as retaining walls be protected from wetting and hydrostatic pressure buildup by an underdrain system.

The drains should consist of drainpipe placed in the bottom of the wall backfill surrounded above the invert level with free-draining granular material. The drain should be placed at each level of excavation and at least 1 foot below lowest adjacent finish grade and sloped at a minimum 1% to a suitable gravity outlet. Free-draining granular material used in the underdrain system should contain less than 2% passing the No. 200

sieve, less than 50% passing the No. 4 sieve and have a maximum size of 2 inches. The drain gravel backfill should be at least 1½ feet deep.

SURFACE DRAINAGE

The following drainage precautions should be observed during construction and maintained at all times after the storage building has been completed:

1) Inundation of the foundation excavations and underslab areas should be avoided during construction.
2) Exterior backfill should be adjusted to near optimum moisture and compacted to at least 95% of the maximum standard Proctor density in pavement and slab areas and to at least 90% of the maximum standard Proctor density in landscape areas.
3) The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 12 inches in the first 10 feet in unpaved areas and a minimum slope of 3 inches in the first 10 feet in paved areas.
4) Roof downspouts and drains should discharge well beyond the limits of all backfill.
5) Landscaping which requires regular heavy irrigation should be located at least 5 feet from foundation walls. Consideration should be given to use of xeriscape to reduce the potential for wetting of soils below the building caused by irrigation.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering principles and practices in this area at this time. We make no warranty either express or implied. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings drilled at the locations indicated on Figure 1, the proposed type of construction and our experience in the area.

Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants (MOBC) developing in the future. If the client is concerned about MOBC, then a professional in this special field of practice should be consulted. Our findings include interpolation and extrapolation of the subsurface conditions identified at the exploratory borings and variations in the subsurface conditions may not become evident until excavation is performed. If conditions encountered during construction appear different from those described in this report, we should be notified so that re-evaluation of the recommendations may be made.

This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our information. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations have been appropriately interpreted. Significant design changes may require additional analysis or modifications to the recommendations presented herein. We recommend on-site observation of excavations and foundation bearing strata and testing of structural fill by a representative of the geotechnical engineer.

Respectfully Submitted,

HEPWORTH - PAWLAK GEOTECHNICAL, INC.

STEVEN L. PAWLAK
REGISTERED
15222
10/10/14
PROFESSIONAL ENGINEER
STATE OF COLORADO

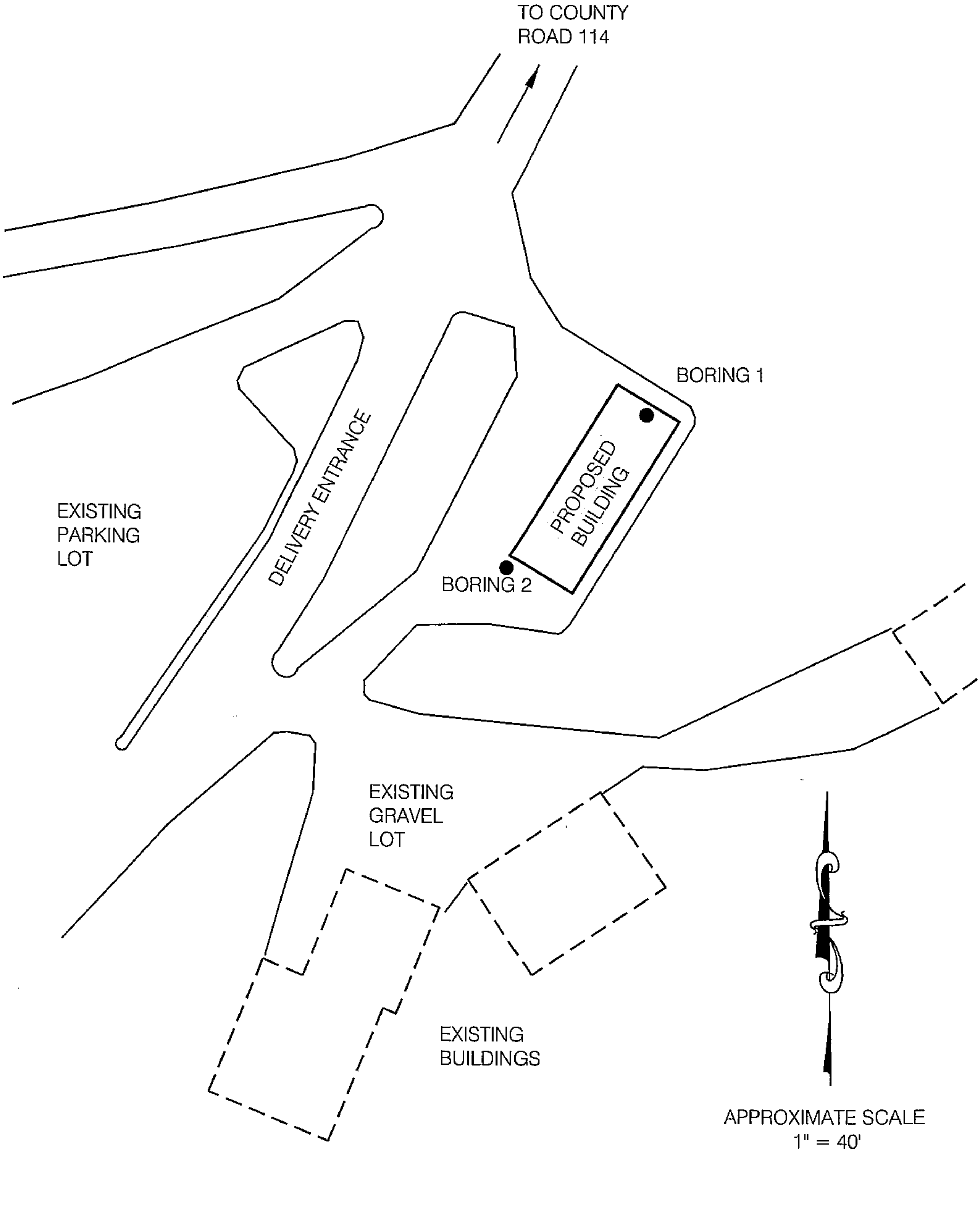
Steven L. Pawlak, P.E.

Reviewed by:

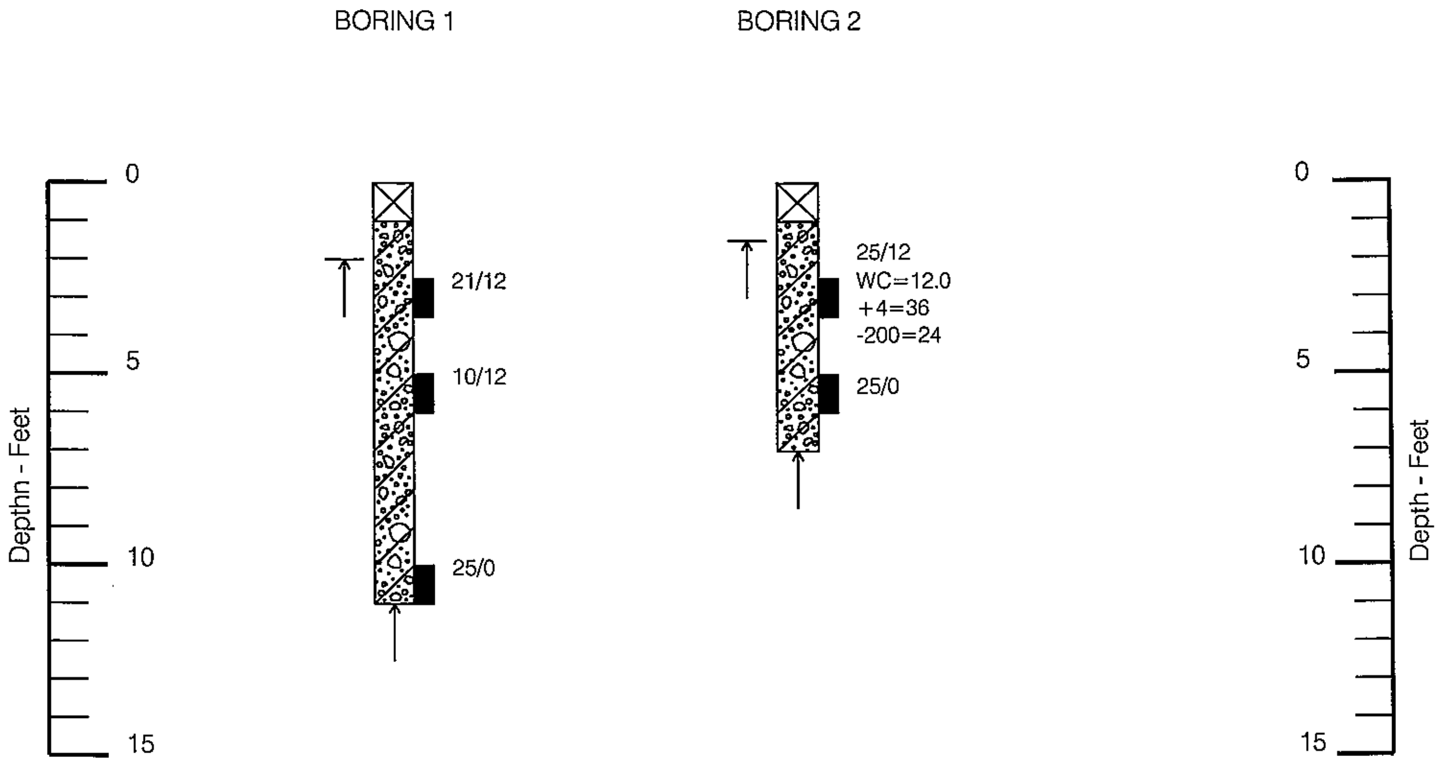
Daniel E. Hardin, P.E.

SLP/ksw

cc: Johnson Carter Architects – Rich Carter (richcarter@rof.net)
Kaup Engineering – Dale Kaup (kaupeng@rof.net)



114 411A	HP Geotech Hepworth–Pawlak Geotechnical	LOCATION OF EXPLORATORY BORINGS	Figure 1



Note: Explanation of symbols is shown on Figure 3.

LEGEND:

PARKING LOT GRAVEL; silty sand and gravel, medium dense, moist, brown.

BASALT COBBLES AND BOULDERS (GM); in a sandy silt matrix, medium dense to dense, slightly moist to moist, brown and light brown, calcareous.

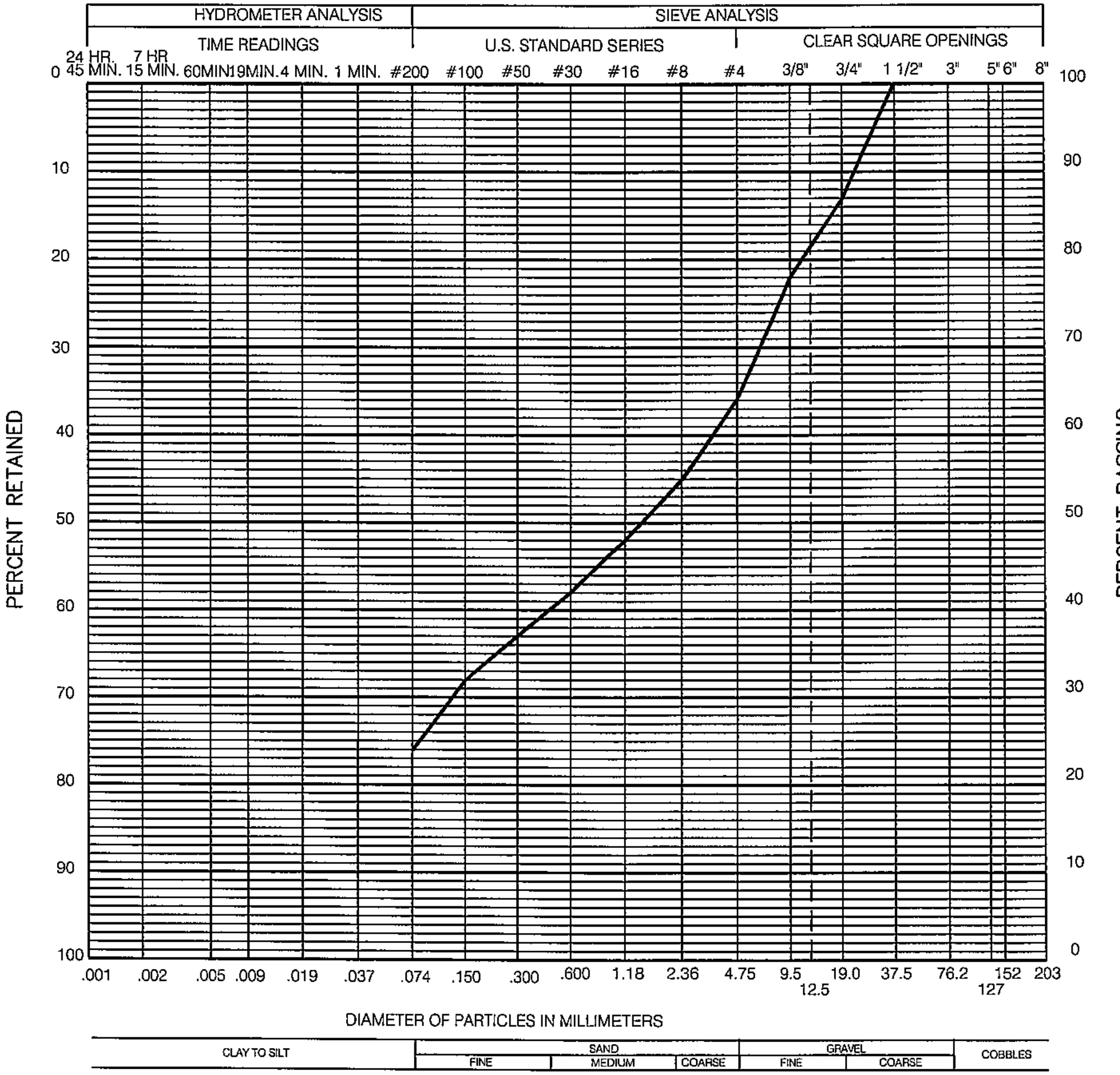
Drive sample; standard penetration test (SPT), 1 3/8 inch I.D. split spoon sample, ASTM D-1586.

21/12 Drive sample blow count; indicates that 21 blows of a 140 pound hammer falling 30 inches were required to drive the SPT sampler 12 inches.

Practical drilling refusal. Where shown above bottom of log, indicates that multiple attempts were made to advance the boring.

NOTES:

1. Exploratory borings were drilled on October 2, 2014 with 4-inch diameter continuous flight power auger.
2. Locations of exploratory borings were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of exploratory borings were not measured and the logs of exploratory borings are drawn to depth.
4. The exploratory boring locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between materials shown on the exploratory boring logs represent the approximate boundaries between material types and transitions may be gradual.
6. No free water was encountered in the borings at the time of drilling. Fluctuation in water level may occur with time.
7. Laboratory Testing Results:
   WC = Water Content (%)
   +4 = Percent retained on the No. 4 sieve
   -200 = Percent passing No. 200 sieve



GRAVEL 36 % SAND 40 % SILT AND CLAY 24 %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF: Silty Sand and Gravel FROM: Boring 2 at 2 ½ Feet

114 411A	HP Geotech Hepworth–Pawlak Geotechnical	GRADATION TEST RESULTS	Figure 4