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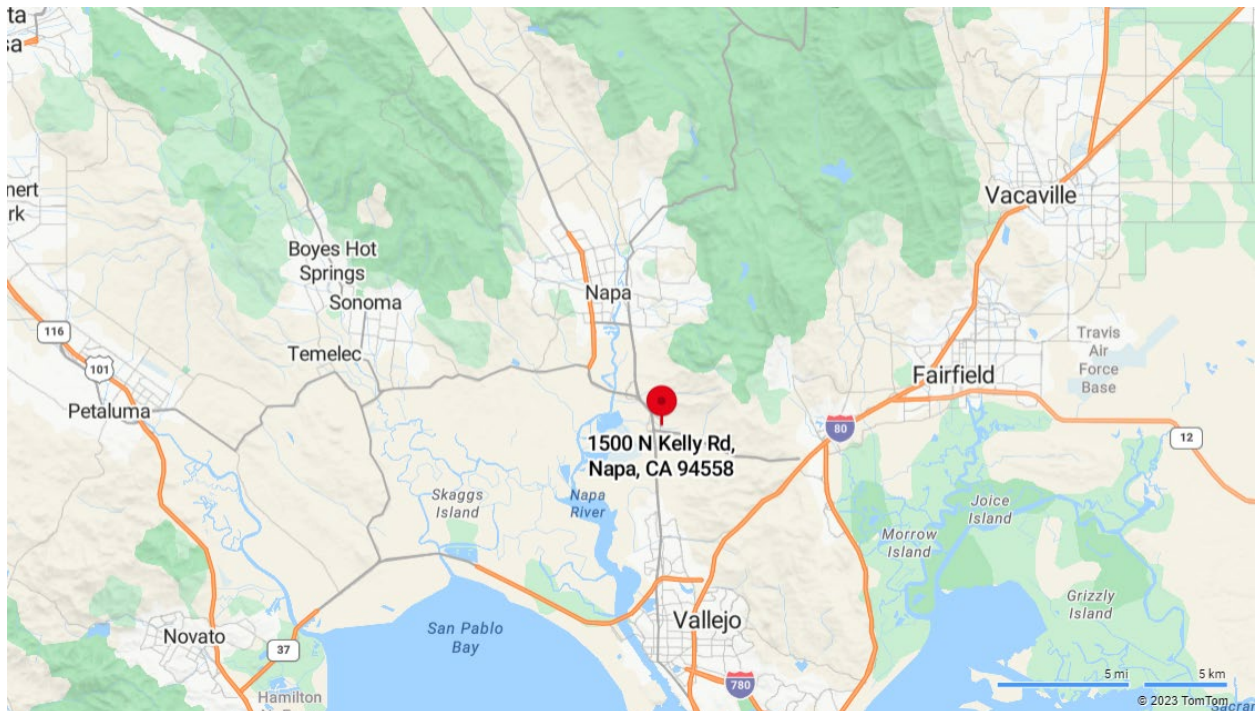
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Geotechnical Study
Suscol Headwaters Park Trailhead Parking Lot
1500 North Kelly Road
Napa, California

Project Number: 9260.03.04.20

INTRODUCTION

This report presents the results of our geotechnical study for the parking lot to be constructed at 1500 North Kelly Road in Napa, California. The undeveloped property extends over relatively level terrain. The site location is shown below.



We understand it is planned to construct a predominantly gravel parking lot with approximately 24 standard stalls, four horse-trailer stalls, a bulb turnaround, and two handicapped stalls. We believe there may be concrete work associated with the handicap stalls. An asphalt paved entrance will be provided off North Kelly Road. Grading plans are not available, but we anticipate that the planned grading will be the minimum amount needed to provide positive parking lot drainage.

SCOPE

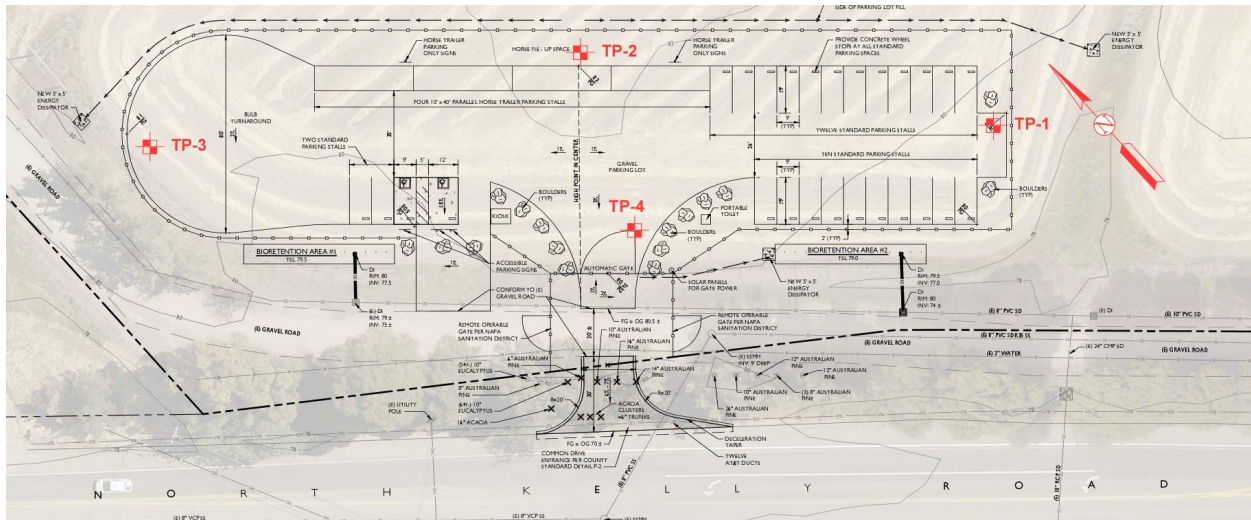
The purpose of our study, as outlined in our Professional Service Agreement dated September 26, 2023, was to generate geotechnical information for the design and construction of the project. Our scope of services included reviewing selected published geologic data pertinent to the site; evaluating the subsurface conditions with test pits and laboratory tests; analyzing the field and laboratory data; and presenting this report with the following geotechnical information:

1. A brief description of the soil, bedrock, and groundwater conditions observed during our study; and
2. Conclusions and recommendations regarding:
 - a. Primary geotechnical engineering concerns and mitigating measures, as applicable;
 - b. Site preparation and grading including remedial grading of weak, expansive surface soil;
 - c. Support of concrete slabs-on-grade;
 - d. Preliminary pavement thickness based on our experience with similar soil and projects and the results of an R-value test on the anticipated subgrade soil;
 - e. Utility trench backfill;
 - f. Geotechnical engineering drainage improvements; and
 - g. Supplemental geotechnical engineering services.

STUDY

Site Exploration

We reviewed our previous geotechnical studies in the vicinity and selected geologic references pertinent to the site. The geologic literature reviewed is presented at the end of this report. On October 10, 2023, we performed a geotechnical reconnaissance of the site and explored the subsurface conditions by excavating four test pits with a track-mounted excavator at the approximate locations shown below. The test pit locations were determined approximately and should be considered accurate only to the degree implied by the method used. Our project engineer located and logged the test pits and obtained samples of the materials encountered for visual examination, classification, and laboratory testing.



Reference: Conceptual Site Improvement Plan by Applied Civil Engineering, Sheet C1, dated April 2023

A summary of our test pits is shown in the **Subsurface** section below. The test pit summary shows our interpretation of the subsurface soil, bedrock, and groundwater conditions on the date and at the locations indicated. Subsurface conditions may vary at other locations and times. Our interpretation is based on visual inspection of soil and bedrock samples, laboratory test results, and interpretation of excavation resistance. The location of the soil and bedrock boundaries should be considered approximate. The transition between soil and bedrock types may be gradual.

Laboratory Testing

The samples obtained from the test pits were transported to our office and re-examined to verify soil classifications, evaluate characteristics, and assign tests pertinent to our analysis. Selected samples were laboratory tested to determine their classification (Atterberg Limits, percent of silt and clay), expansion potential (Expansion Index - EI), and R-value. The test results are presented below in the **Subsurface** section.

SITE CONDITIONS

Surface

The property extends primarily over relatively level to moderately sloping terrain. In general, the ground surface is soft and spongy. This is a condition generally associated with weak, porous surface soil. The surface soil is disturbed by randomly arrayed shrinkage cracks generally associated with expansive soil. Locally, expansive soil shrinks and swells with the weather cycle. The cyclic shrinking and swelling tends to disturb the upper portion of the expansive clay. This zone is defined hereinafter as the active layer. Natural drainage consists of sheet flow over the ground surface and slopes that concentrates in man-made surface drainage elements such as roadside ditches, and natural drainage elements such as swales and creeks.

Subsurface

Our test pits and laboratory tests indicate that the portion of the site we studied is blanketed by highly expansive surface soil in all test pits. This soil exhibits high plasticity (LL = 54.9; PI = 37.8) and high expansion potential (EI = 98) and is disturbed by 2- to 4-inch-wide shrinkage cracks that extend 1 to 2 feet below the ground surface. In test pit TP-2, we encountered old, abandoned PVC pipes from depths of around 1½ to 3½ feet. The pipes were encased in sand with clay material. A summary of the subsurface conditions found in our test pits is given below.

Test Pit #	Depth (ft.)	Description
TP-1	0 - 2	DARK BROWN CLAY (CH), stiff, dry to moist, rootlets
	2 - 5	GRAY CLAY WITH SAND (CH), stiff, moist, rootlets to 4 feet
	5 - 6½	BROWN CLAY (CH), stiff, moist
	6½ - 8	BROWN SANDY CLAY (CL), stiff, moist
TP-2	0 - 3	DARK BROWN CLAY (CH), stiff, dry to moist, rootlets, 2-inch black PVC capped pipe at 2 feet and 3-inch white PVC pipe at 3 feet, PVC pipes in cased in about 4 to 6 inches of Brown Sand with Clay (SP-SC) backfill
	3 - 7	BROWN SANDY CLAY (CL), stiff, moist
	7 - 8	YELLOW BROWN SILTSTONE, firm, friable, highly weathered

Test Pit #	Depth (ft.)	Description
TP-3	0 - 3	BROWN SANDY CLAY (CH), stiff, dry to moist LL=54.9, PI=37.8, %<#200=65.5, EI=98, R-Value<5
	3 - 8	LIGHT BROWN CLAYEY SAND (SC), medium dense, moist
TP-4	0 - 3	DARK BROWN CLAY (CH), stiff, dry to moist, rootlets
	3 - 8	LIGHT BROWN CLAYEY SAND (SC), medium dense, moist

Groundwater

Free groundwater was not observed in our test pits at the time of excavation. On hillsides, rainwater typically percolates through the porous surface materials and migrates downslope in the form of seepage at the interface of the surface materials and bedrock, and through fractures in the bedrock. Fluctuations in the seepage rates typically occur due to variations in rainfall intensity, duration, and other factors such as periodic irrigation.

DISCUSSION AND CONCLUSIONS

General

Based on our study, we judge the proposed improvements can be built as planned, provided the recommendations presented in this report are incorporated into their design and construction. The primary geotechnical concerns during design and construction of the project are the presence of highly expansive clayey surface soil.

Expansive Soil

Expansive surface soil shrinks and swells as it loses and gains moisture throughout the yearly weather cycle. Near the surface, the resulting movement can heave and crack lightly loaded slabs and pavements. The zone of significant moisture variation (active layer) is dependent on the expansion potential of the soil and the extent of the dry season. In the Napa area, the active layer is generally considered to range in thickness from about 2 to 3 feet. The detrimental effects of the above-described movement can be reduced by pre-swelling the expansive soil and covering it with a moisture fixing and confining blanket of properly compacted select fill, as subsequently defined. In order to effectively reduce exterior slab and asphalt paving heave given the expansion potential of the site’s soil, a blanket thickness of 12 inches will be needed.

Exterior Slabs and Asphalt Pavements

Exterior slabs and asphalt pavements will heave and crack as the expansive soil shrinks and swells through the yearly weather cycle. Slab and asphalt pavement cracking and distress are typically concentrated along edges where moisture content variation is more prevalent within the subgrade soil. Slab and asphalt pavement performance can be improved and the incidence of repair can be reduced, but not eliminated, by covering the pre-swelled expansive soil with at least 12 inches of select fill (see “On-Site Soil Quality” section) prior to constructing the slab or pavement required to carry the anticipated traffic.

On-Site Soil Quality

All fill materials used in the upper 12 inches of exterior slab and asphalt pavement subgrade must be select, as subsequently described in “Recommendations.” We anticipate that, with the exception of organic matter and of rocks or lumps larger than 6 inches in diameter, the excavated material will be suitable for re-use as general fill but will not be suitable for use as select fill unless stabilized with lime.

Select Fill

The select fill can consist of import materials with a low expansion potential or lime stabilized on-site clayey soil. Lime stabilized soil may prevent the growth of landscape vegetation due to the inherent elevated pH level of the soil. The geotechnical engineer must approve the use of on-site soil as select fill during grading.

RECOMMENDATIONS

Grading

Site Preparation

Areas to be developed should be cleared of vegetation and debris. Trees and shrubs that will not be part of the proposed development should be removed and their primary root systems grubbed. Cleared and grubbed material should be removed from the site and disposed of in accordance with County Health Department guidelines. We did not observe septic tanks, leach lines or underground fuel tanks during our study. Any such appurtenances found during grading should be capped and sealed and/or excavated and removed from the site, respectively, in accordance with established guidelines and requirements of the County Health Department. Voids created during clearing should be backfilled with engineered fill as recommended herein.

Stripping

Areas to be graded should be stripped of the upper few inches of soil containing organic matter. Soil containing more than two percent by weight of organic matter should be considered organic. Actual stripping depth should be determined by a representative of the geotechnical engineer in the field at the time of stripping. The strippings should be removed from the site, or if suitable, stockpiled for re-use as topsoil in landscaping.

Excavations and Fill Placement

Following initial site preparation, excavation should be performed as recommended herein. Excavations extending below the proposed finished grade should be backfilled with suitable materials compacted to the requirements given below.

Within fill areas, the parking lot, and access driveway, PVC piping and fill around the piping should be excavated in their entirety, and the disturbed active layer for the expansive surface soil should be excavated to within 6 inches of its depth or to at least 12 inches below exterior slab and asphalt pavement subgrade, whichever is deeper. PVC piping and backfill were found to about 3 feet plus or minus in TP-2. Shrinkage cracks, representing the disturbed active layer, were observed to as deep as 24 inches in our test pits and could extend deeper depending on the time of year of construction. These excavations should extend at least 3 feet beyond the toe of new fills and the edge of the driveway and parking lot. The excavated materials should be stockpiled for later use as compacted fill, or removed from the site, as applicable.

At all times, temporary construction excavations should conform to the regulations of the State of California, Department of Industrial Relations, Division of Industrial Safety or other stricter governing regulations. The stability of temporary cut slopes, such as those constructed during the installation of underground utilities, should be the responsibility of the contractor. Depending on the time of year when grading is performed, and the surface conditions exposed, temporary cut slopes may need to be excavated to 1½:1, or flatter. The tops of the temporary cut slopes should be rounded back to 2:1 in weak soil zones.

The surface exposed by stripping and removal of the PVC piping and backfill and expansive surface soil should be scarified to a depth of at least 6 inches, uniformly moisture-conditioned to at least 4 percent above optimum and compacted to at least 90 percent of the maximum dry density of the materials as determined by ASTM Test Method D-1557. In expansive soil areas, moisture conditioning should be sufficient to completely close all shrinkage cracks for their full depth within pavement and exterior slab areas. If grading is performed during the dry season, the shrinkage cracks may extend to a few feet below the surface. Therefore, it may be necessary to excavate a portion of the cracked soil to obtain the proper moisture condition and degree of compaction. Approved fill material should then be spread in thin lifts, uniformly moisture-conditioned to near optimum and properly compacted. All structural fills, including those placed to establish site surface drainage, should be compacted to at least 90 percent relative compaction. Expansive soil used as fill should be moisture-conditioned to at least 4 percent above

optimum. Only approved select materials should be used for fill within the upper 12 inches of exterior slab and asphalt pavement subgrade.

Select Fill

Select fill should be free of organic matter, have a low expansion potential, and conform in general to the following requirements:

SIEVE SIZE	PERCENT PASSING (by dry weight)
6 inch	100
4 inch	90 – 100
No. 200	10 – 60

Liquid Limit – 40 Percent Maximum
Plasticity Index – 15 Percent Maximum
R-value – 20 Minimum (pavement areas only)

Expansive on-site soil may be used as select fill if it is stabilized with lime. In general, imported fill, if needed, should be select. Material not conforming to these requirements may be suitable for use as import fill; however, it shall be the contractor’s responsibility to demonstrate that the proposed material will perform in an equivalent manner. The geotechnical engineer should approve imported materials prior to use as compacted fill. The grading contractor is responsible for submitting, at least 72 hours (3 days) in advance of its intended use, samples of the proposed import materials for laboratory testing and approval by the soils engineer.

Lime Stabilization

For preliminary planning purposes, we estimate that high calcium lime mixed at a minimum of 5½ percent (dry weight) will stabilize the expansive site soil. This percentage of lime needs to be verified prior to construction with engineering analysis and laboratory Atterberg Limits and/or pH testing using lime from the same source as that planned for use on the project and a sample of the soil to be treated. Laboratory test results and engineering analysis may indicate that a higher percentage of lime is required. The contractor should allow a minimum of 5 business days for the laboratory tests to be completed.

The lime stabilization should be performed in accordance with Section 24 of the Caltrans Standard Specifications except that a curing seal will not be required, provided the moisture content of the lime-stabilized material is maintained at or above optimum moisture content until it is permanently covered with subsequent construction.

Wet Weather Grading

Generally, grading is performed more economically during the summer months when the on-site soil is usually dry of optimum moisture content. Delays should be anticipated in site grading performed during the rainy season or early spring due to excessive moisture in on-site soil. Special and relatively expensive construction procedures, including dewatering of excavations and importing granular soil, should be anticipated if grading must be completed during the winter and early spring or if localized areas of soft saturated soil are found during grading in the summer and fall.

Open excavations also tend to be more unstable during wet weather as groundwater seeps towards the exposed cut slope. Severe sloughing and occasional slope failures should be anticipated. The occurrence of these events will require extensive clean up and the installation of slope protection measures, thus delaying projects. The general contractor is responsible for the performance, maintenance and repair of temporary cut slopes.

Pavements

Gravel Surfaced Parking Lot

We understand that the finished parking lot surface will consist of aggregate base. There is no established design procedure or known lifetime performance for aggregate base travel surfaces. Due to the presence of expansive soils and the anticipated traffic, we recommend that the aggregate base section be at least 18 inches thick. Aggregate base parking lot surfaces will require frequent maintenance and repair. Maintenance and repair could range from regrading washboard and filling in potholes or low areas with new material to completely repairing/reconstructing the section. The maintenance and repair process will be on-going through the life of the parking lot.

Asphalt Surface

Provided the site grading is performed to remediate expansive soil heave, as recommended herein, the uppermost 12-inches of pavement subgrade soil will be either imported select fill with a minimum R-value of 20 or lime stabilized site soil that generally has an R-value of at least 50. Based on those R-values we recommend the pavement sections listed in the tables below be used.

PAVEMENT SECTIONS WITH IMPORTED SELECT FILL SUBGRADE				
		CLASS 2	IMPORTED SELECT	
TI	ASPHALT CONCRETE (feet)	AGGREGATE BASE (feet)	FILL* (feet)	
7.0	0.30	1.15	1.0	
6.0	0.25	1.05	1.0	
5.0	0.20	0.90	1.0	

* R-value ≥ 20

PAVEMENT SECTIONS WITH LIME STABILIZED SELECT FILL SUBGRADE				
		CLASS 2	LIME STABILIZED	
TI	ASPHALT CONCRETE (feet)	AGGREGATE BASE (feet)	SELECT FILL* (feet)	
7.0	0.35	0.50	1.0	
6.0	0.30	0.50	1.0	
5.0	0.20	0.50	1.0	

* R-value ≥ 50

Subgrade Preparation and Aggregate Placement

Pavement thicknesses were computed using the Caltrans Highway Design Manual and are based on a pavement life of 20 years. These recommendations are intended to provide support for traffic represented by the indicated Traffic Indices. They are not intended to provide pavement sections for heavy concentrated construction storage or wheel loads such as forklifts, parked truck-trailers and concrete trucks or for post-construction concentrated wheel loads such as self-loading dumpster trucks. In areas where heavy construction storage and wheel loads are anticipated, the pavements should be designed to support these loads. Support could be provided by increasing pavement sections or by providing reinforced concrete slabs. Alternatively, paving can be deferred until heavy construction storage and wheel loads are no longer present. Loading areas for self-loading dumpster trucks should be provided with reinforced concrete slabs.

Because of the very high expansion potential of the soil at the site and the difficulty in controlling seasonal moisture variation beneath and adjacent to the driveway, significant cracking may develop in the pavement even if 12-inches of select fill is installed. Increasing the thickness of select fill or installing moisture cutoffs may reduce but not eliminate the potential for cracks to develop. It should be understood that pavements will likely require regular maintenance including crack sealing and the aesthetics may not be desirable.

Prior to placement of aggregate base, the upper 6 inches of the gravel section subgrade soil should be scarified to a depth of at least 6, uniformly moisture-conditioned to at least 3 percent above optimum moisture content, and compacted to at least 92 percent relative compaction. For asphalt and concrete slab areas, the upper 6 inches of subgrade soil (excluding lime stabilized soil) should be scarified, uniformly moisture-conditioned to near optimum, and compacted to at least 95 percent relative compaction to form a firm, non-yielding surface. Lime stabilized select fill subgrade soil should be compacted as specified in Section 24 of the Caltrans Standard Specifications. Aggregate base materials should be spread in thin layers, uniformly moisture-conditioned, and compacted to at least 95 percent relative compaction to form a firm, non-yielding surface. The materials and methods used should conform to the requirements of the County of Napa and the current edition of the Caltrans Standard Specifications, except that compaction requirements should be based on ASTM Test Method D-1557. Aggregate used for the base course should comply with the minimum requirements specified in Caltrans Standard Specifications, Section 26 for Class 2 Aggregate Base.

Wet Weather Paving

In general, the pavements should be constructed during the dry season to avoid the saturation of the subgrade and base materials, which often occurs during the wet winter months. If pavements are constructed during the winter, a cost increase relative to drier weather construction should be anticipated. Unstable areas may have to be overexcavated to remove soft soil. The excavations will probably require backfilling with imported crushed (ballast) rock. The geotechnical engineer should be consulted for recommendations at the time of construction.

Slab-On-Grade

Provided grading is performed in accordance with the recommendations presented herein, exterior slabs, such as may be required for ADA parking stalls, should be underlain by 12 inches of select engineered fill. Slab-on-grade subgrade should be rolled to produce a dense, uniform surface. The slabs should be underlain with a capillary moisture break consisting of at least 4 inches of clean, free-draining crushed rock or gravel (excluding pea gravel) at least ¼-inch and no larger than ¾-inch in size. Class 2 aggregate base can be used for slab rock under exterior slabs. Slabs should be designed by the project civil to support the anticipated loads and reduce cracking.

Utility Trenches

The shoring and safety of trench excavations is solely the responsibility of the contractor. Attention is drawn to the State of California Safety Orders dealing with "Excavations and Trenches."

Unless otherwise specified by the County of Napa, on-site, inorganic soil may be used as (general) utility trench backfill. Where utility trenches support pavements, slabs and foundations, trench backfill should consist of aggregate baserock. The baserock should comply with the minimum requirements in Caltrans Standard Specifications, Section 26 for Class 2 Aggregate Base. Trench backfill should be moisture-conditioned as necessary, and placed in horizontal layers not exceeding 8 inches in thickness, before

compaction. Each layer should be compacted to at least 90 percent relative compaction as determined by ASTM Test Method D-1557. The top 6 inches of trench backfill below vehicle pavement subgrades should be moisture-conditioned as necessary and compacted to at least 95 percent relative compaction. Jetting or ponding of trench backfill to aid in achieving the recommended degree of compaction should not be attempted.

Geotechnical Drainage

Surface water should be diverted away from edges of pavements. Water seepage or the spread of extensive root systems into the soil subgrade of slabs or pavements could cause differential movements and consequent distress in these structural elements. Landscaping should be planned with consideration for these potential problems.

Maintenance

Periodic land maintenance will be required. Surface and subsurface drainage facilities should be checked frequently, and cleaned and maintained as necessary or at least annually. A dense growth of deep-rooted ground cover must be maintained on all slopes to reduce sloughing and erosion. Sloughing and erosion that occurs must be repaired promptly before it can enlarge.

Supplemental Services

Pre-Bid Meeting

It has been our experience that contractors bidding on the project often contact us to discuss the geotechnical aspects. Informal contacts between RGH Consultants (RGH) and an individual contractor could result in incomplete or misinterpreted information being provided to the contractor. Therefore, we recommend a pre-bid meeting be held to answer any questions about the report prior to submittal of bids. If this is not possible, questions or clarifications regarding this report should be directed to the project owner or their designated representative. After consultation with RGH, the project owner or their representative should provide clarifications or additional information to all contractors bidding the job.

Plan and Specifications Review

Coordination between the design team and the geotechnical engineer is recommended to assure that the design is compatible with the soil, geologic and groundwater conditions encountered during our study. RGH recommends that we be retained to review the project plans and specifications to determine if they are consistent with our recommendations. In the event we are not retained to perform this recommended review, we will assume no responsibility for misinterpretation of our recommendations.

Construction Observation and Testing

Prior to construction, a meeting should be held at the site that includes, but is not limited to, the owner or owner's representative, the general contractor, the grading contractor, the foundation contractor, the underground contractor, any specialty contractors, the project civil engineer, other members of the project design team and RGH. This meeting should serve as a time to discuss and answer questions regarding the recommendations presented herein and to establish the coordination procedure between the contractors and RGH.

In addition, we should be retained to monitor all soil related work during construction, including, but not limited to:

- Site stripping, over-excavation, grading, and compaction of near surface soil;
- Placement of all engineered fill and trench backfill with verification field and laboratory testing;
- Observation of all foundation excavations; and
- Observation of foundation and subdrain installations.

If, during construction, we observe subsurface conditions different from those encountered during the explorations, we should be allowed to amend our recommendations accordingly. If different conditions are observed by others, or appear to be present beneath excavations, RGH should be advised at once so that these conditions may be evaluated and our recommendations reviewed and updated, if warranted. The validity of recommendations made in this report is contingent upon our being notified and retained to review the changed conditions.

If more than 18 months have elapsed between the submission of this report and the start of work at the site, or if conditions have changed because of natural causes or construction operations at, or adjacent to, the site, the recommendations made in this report may no longer be valid or appropriate. In such case, we recommend that we be retained to review this report and verify the applicability of the conclusions and recommendations or modify the same considering the time lapsed or changed conditions. The validity of recommendations made in this report is contingent upon such review.

These supplemental services are performed on an as-requested basis and are in addition to this geotechnical study. We cannot accept responsibility for items that we are not notified to observe or for changed conditions we are not allowed to review.

LIMITATIONS

This report has been prepared by RGH for the exclusive use of the Applied Civil Engineering and the property owner as an aid in the design and construction of the proposed improvements described in this report.

The validity of the recommendations contained in this report depends upon an adequate testing and monitoring program during the construction phase. Unless the construction monitoring and testing program is provided by our firm, we will not be held responsible for compliance with design recommendations presented in this report and other addendum submitted as part of this report.

Our services consist of professional opinions and conclusions developed in accordance with generally accepted geotechnical engineering principles and practices. We provide no warranty, either expressed or implied. Our conclusions and recommendations are based on the information provided to us regarding the proposed construction, the results of our field exploration, laboratory testing program, and professional judgment. Verification of our conclusions and recommendations is subject to our review of the project plans and specifications, and our observation of construction.

The test pits represent the subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions elsewhere or at other times. Site conditions and cultural features described in the text of this report are those existing at the time of our field exploration and may not necessarily be the same or comparable at other times.

The scope of our services did not include an environmental assessment or a study of the presence or absence of toxic mold and/or hazardous, toxic or corrosive materials in the soil, surface water, groundwater or air (on, below or around this site), nor did it include an evaluation or study for the presence or absence of wetlands. These studies should be conducted under separate cover, scope and fee and should be provided by a qualified expert in those fields.

We trust this provides the information you require at this time. If you have questions, please contact the undersigned.

Very truly yours,
RGH Consultants



Eric G. Chase
Principal Geotechnical Engineer
Project Manager



EGC:JJP:aku:brw
Electronically submitted

https://rghgeo.sharepoint.com/sites/shared/shared_documents/project_files/9000's/9260_applied_civil_engineering/9260.03.04.2_suscol_headwaters_trailhead_prkg_lot/.01-gs/9260.03.04.20_gs_letter.docx

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