Report of Geotechnical Exploration

Kum & Go Store #0692
Space Village Ave and Peterson Blvd
Colorado Springs, Colorado

Prepared for
Kum & Go, LC

Prepared by
Olsson Associates

COLORADO LICENSED PROFESSIONAL ENGINEER
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46267
9/13/17

September 13, 2017

Olsson Project No: 017-1754

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Project address:	**Space Village Ave and Peterson Blvd, Colorado Springs, CO**	Date:	**9/8/2017**
Engineer:	**Michael Flanagan**	Phone #:	**303-237-2072**

SITE PREPARATION

Is building demolition necessary (Y/N):	**No**	
Are below grade structures known to exist (basements, crawlspaces, UST's) (Y/N/U):	**Unknown**	
Above or below ground utility demolition/relocation (Y/N/U):	**Yes**	
Old fill encountered that will require rework (Y/N):	**No**	
Estimated topsoil stripping depth (in):	**6-12**	
Scarification thickness (in):	**12**	
Proofrolling (Y/N): Where feasible. Not recommended in areas of fuel lines or UST installation	**Yes**	**See Report**
Maximum recorded groundwater elevation (ft):	**6257.0**	
Minimum recorded groundwater elevation (ft):	**6250.5**	
Unsuitable or unstable soil identified during exploration (Y/N):	**No**	
Exterior pavement subgrade preparation thickness (in):	**12**	
Pavement underslab drainage system recommended (Y/N):	**No**	
Additional pavement subgrade recommendations necessary (Y/N):	**No**	
Do available reports indicate the site was utilized by others prior to Kum & Go (Y/N):	**No**	

Additional Comments:
Moisture conditioning and recompaction recommended below and around building, 2 feet below foundations. See report for details. Excavated soils are suitable for reuse as structural fill. Underground utilities noted along north and west sides of site; electric lines noted throughout pavement areas.

STRUCTURAL FILL

On site soils suitable for reuse? (Y/N):	**Yes**	**See Report**
Import Fill Soils Maximum Liquid Limit (%):	**45**	
Import Fill Soils Maximum Plastic Limit (%):	**25**	
Maximum Swell Potential (%):	**0.5 %**	
Maximum Particle Size (in):	**2**	
Recommended lift thickness (in):	**4 to 8**	

FOUNDATION DESIGN/FLOOR SLAB

Recommended Building Foundation Type:	**Shallow Spread or Trench Type Foundations**	
Finish Floor Elevation (ft):	**6270.80+/-**	
Recommended Frost Depth (in):	**30**	
Are overexcavation and structural fill recommended below shallow foundations? (Y/N):	**Yes**	**See Report**
Is surcharge or preload necessary to prepare the building pad (Y/N):	**No**	
Net allowable soil bearing pressure (psf):	**2000**	
Minimum column footing width dimensions (in):	**30**	
Minimum continuous footing width dimensions (in):	**16**	
Are perimeter foundation drains recommended for the building (Y/N)	**No**	
Floor slab subgrade preparation thickness (in):	**12**	**See Report**

****This Fact Sheet only provides a limited overview of the report and is subject to any and all clarifications, conditions, contingencies, limitations and/or qualifications that may exist in the body of the report. The information contained in this Fact Sheet is provided pursuant to Client's request and is provided solely for the convenience of Client and neither Client nor any other party can rely solely on this Fact Sheet. Client and any other party using this report must review the entire report and interpret the information contained in this Fact Sheet in conjunction with the remainder of the report.**

Created by: Michael Flanagan

A. Project Understanding

A.1. Geotechnical Scope

This Report of Geotechnical Exploration was requested and authorized by Mr. Ryan Halder of Kum & Go, L.C. for the purpose of evaluating existing subsurface conditions and providing geotechnical design recommendations for the new Kum & Go #0692 building, signs, and pavements.

The scope of this geotechnical exploration included the following:

- Site reconnaissance and review of soil and geologic subsurface information from USDA Natural Resource Conservation Services (NRCS).
- Review of the ALTA Survey completed for this property (A Parcel of Land Situated in the Northwest Quarter of Section 17, Township 14 South, Range 65 West of the Sixth Principal Meridian, City of Colorado Springs, County of El Paso, State of Colorado by Olsson Associates dated 08-09-2017.
- Review of the USGS map titled "Potentially Swelling Soil and Rock in the Front Range Urban Corridor, Colorado," Sheet 3 of 4 – Front Range Urban Corridor.
- Review of the Phase I Environmental Assessment for this property by Seneca Companies dated July 19, 2017.
- Drilling and sampling of 10 soil test borings extending to depths of about 20 to 25 feet below existing grades.
- Coordinating field operations with Seneca Companies in association with their Phase II Environmental Assessment.
- Laboratory testing (as noted in the appendices) of soil samples obtained during the field operations.
- Completion of a geotechnical engineering evaluation using information obtained from our field observations, soil test borings, and laboratory testing program.
- Preparation of this Report of Geotechnical Exploration presenting the soil test borings, laboratory test results, and a summary of our engineering evaluations and recommendations.

A.2. Site Location and Description

Olsson understands that Kum & Go, L.C. plans to develop approximately 1.77 acres in the southeast quadrant of the intersection of Space Village Ave and Peterson Blvd in Colorado Springs, Colorado. The ALTA survey completed by Olsson indicates there is approximately 7 feet of grade change across the site, ranging from a high elevation of about 6274 feet at the northeast corner of the property to a low elevation of about 6267 feet at the southwest corner. Based on the information provided by the civil design team for this project the finished floor elevation (FFE) of the new Kum & Go building will be 6270.80 +/- feet. Utilizing this FFE, we anticipate up to 3 feet of cut will be required to prepare the building pad for new construction and less than 2 feet of structural fill will be required to establish design grades across the rest of the project site. A Site Location Plan and Boring Location Map are presented in *Appendix A*.

The site consisted of an existing parking lot with a central grass covered area at the time of our field studies. Light poles and parking islands with landscaped trees and bushes were present in the paved areas. The site is bordered on the west and north by paved arterial roads. The surrounding properties to the south and east appear to be commercial.

Underground utilities located through Colorado 811 and by private utility locators at the time of our site investigation indicated water, sewer, and gas lines along the north and west sides of the site. Electric power lines were present across the paved lot, including in the proposed building area.

A review of historic aerial photographs indicates the site is essentially unchanged since 1999. The site appears to have been used as a parking lot for the commercial properties to the south and east since that time.

A.3. PROJECT INFORMATION

The proposed new Kum & Go #0692 facility will include a 6,210 square-foot, single-story building utilizing light gauge steel framework and brick veneer with concrete floor slab on-grade. The new building will be situated in the east portion of the site, facing west. Eight new fuel pump islands with an overhead canopy (40' x 123') will be positioned south of the new building. The new UST's will be positioned west of the canopy. Access to the facility will be provided by new entrances at the northeast corner and south perimeter. A monument sign is proposed at the northeast corner of the site.

Based on our experience with similar Kum & Go building design, Olsson anticipates maximum live and dead loads for the new building will be on the order of 67 kips each for isolated interior column with up to 15 kips additional load per column for snow and wind loading. Maximum total loads of 50 kips or less are anticipated for perimeter building columns. We understand there are no significant wall loads with the current store design.

Olsson understands that the type and design of canopy support foundations will be determined by the Canopy Manufacturer/Installer based on their review of the contents of this geotechnical report and the soil conditions encountered at the time of foundation installation. Olsson will provide recommendations for canopy foundation design, subgrade improvements, or stabilization of canopy foundation subgrades if requested by Kum & Go.

B. Exploratory and Test Procedures

B.1. Field Exploration

A truck-mounted CME-75 drill rig was used to complete 10 soil test borings for this project. Preliminary soil boring depths and locations were provided by Olsson and reviewed by Mr. Halder during the proposal phase of this project. Boring B-8 was advanced to 25 feet at the request of Seneca Companies for the Phase II Environmental Assessment. Boring B-9 was advanced to 20 feet to allow for design of a monument sign on the southwest side of the site. The soil boring locations and depths were modified or shifted in the field only if necessary to avoid known underground or overhead utilities, existing structures, site features, public right-of-way, or areas of limited access. Refer to the *Boring Location Map* in *Appendix A* and the *Boring Logs* in *Appendix B* for the final locations and depths of each.

Relatively undisturbed and split-barrel soil samples were obtained at 2.5- to 5-foot depth intervals during the drilling process and returned to the laboratory for additional testing. Soil samples designated as "SS" were obtained in general accordance with ASTM D-1586 (Penetration Test and Split-Barrel Sampling of Soils). Soil samples designated as "MC" on the boring logs (*Appendix B*) were obtained in general accordance with ASTM D-3550 (Thick Wall, Ring-Lined, Split-Barrel, Drive Sampling of Soils), with a Modified California Barrel Sampler. The "MC" sampler was driven to a 12-inch depth, as it can only sample a maximum 16-inches of soil. Recovered samples were sealed in plastic containers or sampling tubes, labeled, and protected for transportation to the laboratory for testing.

B.2. Laboratory Testing

Soil stratification, as shown on the boring logs, represents soil conditions at the specific boring locations; however, variations may occur between or beyond the borings. The stratification lines represent the approximate boundary between soil types, but the actual transition between soil layers may be gradual.

Per the laboratory scope and sample conditions, tests were completed to evaluate the engineering properties of recovered soil samples. Moisture content and density tests were completed to determine the existing moisture state and unit weight of subsurface soils. Percent passing #200 sieve tests (P-200) were completed to determine the ratio of fines (clay and silt) to sands and gravels. Atterberg Limits were completed to help classify cohesive samples. A corrosion series was performed on a composite soil sample. Laboratory tests were conducted in general accordance with current ASTM test procedures. A summary of the laboratory test results is presented in *Appendix C*.

C. Subsurface Conditions

C.1. Area Geology

The USDA Soil Survey for El Paso County, Colorado considers this area part of the Truckton sandy loam complex with 0 to 3 percent slopes. The soil survey indicates this area of El Paso County is characterized by sandy loam overlying coarse sandy loam and loamy coarse sand.

C.2. Test Borings and Laboratory Summary

The subsurface soil profile for this site generally consists of clayey sand and poorly to well graded sand with varying fines content. A surficial layer of topsoil was present throughout the unpaved center of the site, ranging up to 12-inches in thickness. Two to three inches of asphalt pavement was present around the perimeter of the site. Refer to the boring logs presented in *Appendix B* for specific soil profile descriptions.

C.3. Soil Properties

Clayey sand and poorly graded sand with varying fines contents; Loose to medium dense, light brown, brown to dark brown, moist to wet						
USCS Classification	**Dry Density (pcf)**	**Moisture Content (%)**	**Saturation (%)**	**LL / PI (%)**	**P-200 (%)**	**SPT "N" Values (bpf)**
SC/SP/SP-SM/SP-SC/SW-SC	84.6-117.9	1.5-20.8	16.5-100	21-26 / 9-10	4.3-38.2	3 - 65

Sandy Clay – Soft to very stiff, grayish brown, scattered rust stains, moist to wet						
USCS Classification	**Dry Density (pcf)**	**Moisture Content (%)**	**Saturation (%)**	**LL / PI (%)**	**P-200 (%)**	**SPT "N" Values (bpf)**
CL	95	14.5-36.3	N/T	44 / 27	64.1	4 - 12

*N/T indicates no tests performed

C.4. Groundwater Summary

Free water was encountered in 6 of the borings during drilling operations. The depths were recorded during drilling and immediately after drilling. Groundwater is not expected to adversely impact site grading, earthwork, or shallow building construction. Groundwater may be encountered during the installation of the underground fuel tanks or drilled shaft foundations (where applicable) depending on the excavation depths. Groundwater measurements obtained during this exploration are presented in the following table:

GROUNDWATER MEASUREMENTS

Boring No.	Groundwater depth while drilling (ft)	Groundwater elevation while drilling (ft)	Groundwater depth immediately after drilling (ft)
B-1	14.5	6257.0	15.5
B-2	16.0	6254.0	16.0
B-3	14.3	6254.7	13.0
B-4	N/E	N/E	N/E
B-5	N/E	N/E	N/E
B-6	20.5	6250.5	N/E
B-7	17.5	6256.0	17.0
B-8	15.5	6257.0	12.5
B-9	N/E	N/E	N/E
B-10	N/E	N/E	N/E

*N/E: Groundwater not encountered during drilling operations

It should be noted that groundwater levels (perched or otherwise) typically fluctuate with seasonal variations in precipitation, runoff, snowmelt, irrigation demands, or other factors that may differ from those at the time of the drilling operations. *Section D.3* of this report addresses general groundwater or drainage concerns as applicable to the site design and earthwork as we now understand them.

C.5. Corrosivity of Soils

The results of the water-soluble sulfate, pH, and resistivity testing are summarized as follows:

Test/Sample Location	Sulfate (mg/L)	Relative Degree of Sulfate Attack	Chloride (mg/L)	pH	Soil resistivity (ohms-cm)
Composite Bulk Sample of B-4 and B-5 6.0 – 10.0 ft depth	0.0	Negligible	4.2	7.4	3,300

The USDA Soil Survey indicates this area of Colorado exhibits a low rating for corrosion of buried metal pipe. The sulfate content of the soils evaluated within the upper 10.0 feet indicate a nil to negligible risk of sulfate attack for concrete exposed to soils on this site. A mechanical/electrical designer, experienced with local building code requirements and local practice, should review the laboratory test results presented above and determine if corrosion protection of buried utility lines is required and how it is to be implemented.

The use of Type V Portland cement, or an equivalent high sulfate resistant cement, is recommended where sulfate levels are greater than 1,500 parts per million (ppm) or in areas designated "Considerable" or "Severe." Type I or Type II cement is considered acceptable across areas of the site with sulfate levels less than 1,000 ppm or designated "Negligible." To help control superficial damage in concrete exposed to prolonged moisture or high groundwater, the water/cement ratio should not exceed 0.50. Refer to *Appendix C, Summary of Laboratory Test Results* for additional information. An experienced designer should review these results and evaluate suitability of proposed designs based on corrosivity concerns.

C.6. Evaluation of On-Site Soils

The soils encountered on this site were primarily loose to medium dense sands with varying silt and clay contents underlain by sandy clays and sands. These soils will support conventional shallow spread footings and on-grade concrete floor slabs, if constructed in accordance with the recommendations presented in this report.

Considering the position, depth, and relative density of the existing soils, over-excavation of the building area to a uniform elevation at least 12 inches below the deepest footing elevation is recommended. The overexcavation area should also extend a minimum 10 feet beyond the building perimeter. New fill materials should be selected, placed, and compacted in accordance with *Section D.4* of this report. To provide uniform bearing conditions for the new Kum & Go building and floor slab, we recommend lightly scarifying, moisture conditioning, and compacting the exposed subgrade prior to placing new fill.

Native bearing soils loosened at the bottom of footing excavations should be removed or compacted prior to placement of reinforcing steel and concrete. Subgrade soils at the base of foundation excavations should be firm and unyeilding.

Based on laboratory testing results from areas sampled during this exploration, the excavated soils are suitable for reuse as structural fill if they are moisture conditioned, prepared and compacted in accordance with *Section D.4* of this report. An Olsson representative should be present at the time of building foundation excavation to document the soil conditions encountered are consistent with those identified during this exploration.

D. SITE PREPARATION

D.1. GENERAL SITE PREPARATION

At the time of our field studies, 6 inches to one-foot mantle of topsoil with grass was observed across the central ground surface, while several inches of asphalt pavement was present across the perimeter of the site. Vegetation, topsoil, frozen soils, trees (including root ball), unsuitable or deleterious materials including asphalt and demolition debris should be removed from areas of new construction. Topsoil and organic laden soils may be stockpiled for later use in landscaped or other non-loaded areas. Isolated areas may require stripping to slightly greater depths.

Prior to site grading, any existing above and below grade utilities, building foundations, floor slabs, pavements, and demolition debris encountered during earthwork or construction should be completely removed from the site. The native soils on this site appear suitable for reuse as structural fill. The soils will need to be properly moisture conditioned and compacted following the recommendations in *Section D.4* of this report. We recommend that an Olsson representative be on-site to observe and document uniform and stable subgrade conditions in these areas prior to placing new structural fill.

Site clearing, grubbing, and stripping should be completed during periods of dry weather. Operating heavy equipment on the site during periods of wet weather could result in excessive pumping and rutting of the subgrade soils. The base of new construction excavations should be evaluated by an Olsson geotechnical engineer or their authorized representative prior to the placement of new fill soils.

On-site soils, free of debris, trash, organics, and other deleterious material can be reused as structural fill if properly moisture conditioned, placed, and compacted following the recommendations in *Section D.4*. Imported borrow materials, if required, should be selected with enough cohesive soils to act as a binder to allow shallow trenches to stand unsupported during foundation construction. If imported fill materials are required for site grading, we recommend that low plasticity (LL<45, PI<25), non-expansive, sandy clays or clayey sands with at least 25 percent passing the #200 sieve be used. If alternate borrow materials are considered, the contractor should provide laboratory documentation from the supplier to Olsson engineers for review and approval prior to site delivery.

Areas to accept new fill should be lightly scarified, moisture conditioned as necessary, and compacted as described in *Section D.4*. Areas of unstable materials that cannot be adequately densified in place should be removed and replaced with compacted structural fill. When the exposed subgrade has been moisture conditioned and compacted, these areas should be proofrolled (if feasible) using a loaded, tandem-axle dump truck or similar rubber-tired equipment weighing at least 20 tons. Proofrolling operations should be observed and documented by the geotechnical engineer or his authorized field representative. The geotechnical engineer should be contacted if more extensive subgrade stabilization procedures are necessary to prepare the site for new fill placement or construction.

D.2. UTILITIES

New underground utilities should be installed in accordance with local building codes. Utility trench backfill should consist of compacted structural fill placed in accordance with *Section D.4* of this report. Where utilities will penetrate the footprint of the building, it is recommended that a utility trench "plug" be constructed that extends at least 5 feet beyond the building perimeter. The trench plug should consist of non-expansive backfill materials having at least 25 percent passing the #200 sieve, to provide a moisture barrier to the soils within the influence zone of the new building.

Granular pipe bedding for new utilities is acceptable, but the remaining trench should be backfilled and compacted using the sandy clays and clayey sands originally removed from the trench.

Water should be prevented from entering utility trenches before, during, and after construction. Excavations should not remain open if rain is anticipated. Excavations should be backfilled as soon as possible with approved structural fill to reduce the potential for moisture infiltration or sidewall sloughing.

D.3. DRAINAGE AND GROUNDWATER CONSIDERATIONS

Groundwater was encountered at depths of about 14.3 to 20.5 feet during our field exploration. At these depths, groundwater or saturated soil conditions are not anticipated to impact shallow site grading, earthwork, or building construction; however, groundwater may be encountered near the base of fuel tank, utility or drilled shaft excavations, depending on the depths required for installation.

Water should not be allowed to collect near foundations, floor slabs, or in areas of new pavements, either during or after construction. As applicable, provisions should be made to quickly remove accumulating seepage water or storm water runoff from excavations. Undercut or excavated areas should be sloped toward one corner to allow rainwater or surface runoff to be quickly collected and gravity drained or pumped from construction areas. Subgrade soils that are exposed to precipitation or runoff should be evaluated by the geotechnical engineer prior to the placement of new fill, reinforcing steel, or concrete, to determine if corrective action is required.

To minimize concerns related to improper or inadequate drainage away from foundation bearing subgrades or from cohesive backfill materials used in utility or foundation trenches, we provide the following general recommendations:

- Site grading should provide efficient drainage of rainfall or surface runoff away from new structures and pavements.
- Roof drains from the new building and canopy should be collected and discharged directly to the storm sewer or directed to a down gradient location away from structures and pavements.
- External hose connections in unpaved areas should incorporate splash blocks to prevent localized flooding of foundation bearing or backfill soils. External hose connections should have cut-off valves inside the building to prevent accidental or unauthorized use.
- Maintenance personnel should be informed of the potential concerns associated with excessive watering near the building.

D.4. STRUCTURAL FILL

On-site clayey sands and sandy clays are suitable for reuse as general fill, structural fill, or utility backfill below the building and new pavements. With trench foundations typically preferred for Kum & Go buildings, on-site or imported borrow materials with sufficient cohesive binder should be selected to allow shallow trenches to stand unsupported for foundation construction. However, the native sands may not stand unsupported in vertical excavations. This may require the footing excavations be sloped back, and the foundations formed and subsequently backfilled.

Imported fill materials, if required, should be low plasticity, non-expansive, sandy clays or clayey sands with a liquid limit less than 45, a plasticity index less than 25, and having at least 25 percent passing the #200 sieve. If alternate borrow materials are considered, we recommend the contractor provide supplier gradation and/or laboratory plasticity and swell documentation to Olsson engineers for review and approval prior to site delivery. In addition to maintaining the recommended plasticity criteria, imported and on-site fill soils should be relatively free of organics (less than about 2 percent by weight) or other deleterious material and should not contain particles larger than 2 inches.

Suitable fill materials should be placed in thin lifts. Lift thickness depends on the type of compaction equipment, but in general, lifts of 4 to 8-inch loose measurement are recommended. Soils should be compacted using equipment of appropriate size and type to achieve the requirements of this report. A self-propelled, smooth drum roller is generally recommended for compacting cohesionless (sandy) soils while a self-propelled, vibratory sheepfoot roller is generally recommended for compacting cohesive (clay) soils. A loose lift thickness of 6 inches is suggested for static (no vibration) compaction procedures. Wheel rolling using rubber-tired equipment is not an acceptable method of compaction and is not recommended. Within small excavations, such as in footing trenches, utility trenches, or around manholes, "Wacker-Packers" or "Rammax" compactors for cohesive soils or vibrating plate compactors for granular soils can be used to achieve the specified compaction. Lift thicknesses should be reduced to 4 inches in small fill areas requiring hand-operated equipment. Flooding of granular fill materials as a method of compaction is not recommended and should be reported to the geotechnical engineer immediately.

During grading operations, representative samples of general and structural fill materials should be initially and periodically checked via laboratory testing to document that the previously mentioned soil parameters are maintained. An Olsson representative should regularly observe and monitor the excavation and grading operations and perform field density tests to document that the specified moisture and compaction requirements are being achieved.

FILL PLACEMENT/COMPACTION GUIDELINES

Areas of Fill Placement	Minimum Compaction (ASTM D698 Standard Proctor)	Moisture Content (Percent of Optimum)
Structural Fill – On-site or imported soils placed below and within 10 feet of the building (including exterior slabs), signs, and pavements	98%	As necessary to obtain density for cohesionless soil or -1 to +3 percent for non-expansive cohesive soil
Floor Slab Subgrade – Structural fill placed below the building floor slab or below the granular cushion layer, if utilized.	98%	
Utility Trenches – Cohesive backfill soils placed within new utility trenches	95%	
Granular Cushion Layer – Beneath floor slab	95%*	
Pavement Subgrade – On-site or imported soils below areas of new pavement	98%	
Sidewalk Subgrade – Below grade-supported sidewalks	95%	
Non-Structural Fill – Beneath non-loaded landscape/grass areas	92%	

*May be substituted with 65% "relative density" in accordance with ASTM D 4253 and D4252

The moisture content for imported and on-site soils at the time of compaction should generally be maintained between the ranges specified above. More stringent moisture limits may be necessary with certain soils, and some adjustments to moisture contents may be necessary to achieve compaction in accordance with project specifications.

D.5. Construction Equipment Mobility

On-site or imported soils may be susceptible to softening under construction equipment traffic during periods of wet weather. Reducing equipment mobility problems and managing soft surface soils will be dependent on the severity of the circumstances, the soil types, the season in which construction is performed, and prevailing weather conditions.

Some general guidelines for reducing equipment mobility problems and addressing potential soft and wet surface soils are as follows:

- Optimize surface water drainage at the site during construction.
- Whenever possible, wait for dry weather conditions to prevail and do not operate construction equipment on the site during wet conditions. Rutting the surface soils will aggravate the condition and accelerate subgrade disturbance.
- Disk or scarify wet surface soils during periods of favorable weather to accelerate drying. Temporarily compact loose subgrade soils if rain is forecast to promote site drainage and reduce moisture infiltration.
- Use construction equipment that is well-suited for the intended job under the existing site conditions. Heavy rubber-tired equipment typically requires better site conditions than light, track-mounted equipment.
- Implement a construction schedule that realistically allows for rain days. Pressure to perform earthwork under a tight schedule is frequently counterproductive.

If requested, Olsson engineers can help determine a cost-effective approach for stabilizing unsuitable soils at the time of construction.

D.6. Temporary Slopes and Excavations

Construction site safety is the responsibility of the general contractor. The contractor shall also be solely responsible for the means, methods, techniques, sequencing, and operations during construction. Olsson is providing the following information solely as a service to our client. Under no circumstances should Olsson's provision of the following information be construed to mean that we are assuming responsibility for construction site safety or the contractor's activities. Such responsibility is not implied and should not be inferred.

The contractor should be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should not exceed those specified in local, state, or federal safety regulations; e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations.

Such regulations are strictly enforced, and if not followed, the owner, contractor, earthwork, or utility subcontractors could be liable for substantial penalties. The contractor is responsible for reviewing this geotechnical report, determining the appropriate OSHA slope criteria for the soil conditions encountered, and implementing it during construction. Soils encountered in construction excavations may vary significantly across this site. Our preliminary soil classifications are based solely on the materials encountered in the widely spaced borings. The contractor should verify that similar soil conditions exist throughout the proposed areas of excavation. If different subsurface conditions are encountered at the time of construction, Olsson recommends that they be contacted to reevaluate existing site conditions.

If excavations, including utility trenches, are extended to depths of more than 20 feet, OSHA requires that the side slopes of such excavations be designed by a professional engineer registered in the state where construction is occurring.

As an alternative to temporary slopes, vertical excavations can be temporarily shored. The contractor should be responsible for the design of temporary shoring in accordance with applicable regulatory requirements.

E. Buildings and Structures

E.1. Shallow Foundation Design

The site will be suitable for supporting the lightly loaded Kum & Go building on conventional shallow spread or trench type foundations bearing on a minimum 12 inches compacted structural fill. Spread foundations bearing on the recommended thickness of compacted structural fill may be designed using a net allowable soil bearing pressure of up to 2,000 pounds per square foot (psf). This recommended bearing pressure can be increased by 1/3rd for transient loads. These design recommendations are based on the anticipated maximum structural loads noted in *Section A.3* of this report.

Building footings should have minimum dimensions in accordance with local building codes. Olsson recommends minimum dimensions of 16 inches for continuous footings and 30 inches for isolated column footings to minimize the potential for localized bearing failure. Exterior footings and footings in unheated areas should bear at a minimum depth of 30 inches below the lowest adjacent final ground surface for frost protection. Interior footings in heated areas can bear at a depth as shallow as possible below the lowest adjacent final ground surface.

The use of the recommended design bearing pressure is contingent on having prepared foundation subgrades observed by an Olsson geotechnical engineer or his authorized field representative prior to placing new structural fill, reinforcing steel, or concrete to document that the subgrade soils and conditions are consistent with the bearing subgrade requirements of this report. Although compacted structural fill will be provided below new building foundations if the recommendations of this report are followed, we recommend bearing subgrades also be hand probed before placing reinforcing steel or concrete to identify soft, loose, or otherwise unsuitable conditions.

Since groundwater was not encountered at anticipated foundation bearing levels during this exploration, perimeter foundation drains for the building should not be necessary for this project.

After foundation subgrades have been observed and documented by an Olsson representative, concrete should be placed as soon as possible to avoid subjecting the exposed soils to drying, wetting, or freezing conditions. If foundation subgrade soils are subjected to such conditions, the geotechnical engineer should be contacted to reevaluate the foundation bearing materials. It will not be acceptable for the contractor to place lean concrete, flowable fill, or other types of “mud mat” below shallow foundations unless specifically directed by the geotechnical engineer.

The total post-construction movement for the new Kum & Go building is anticipated to be less than 1-inch with differential movement limited to less than ½-inch over 50 feet or between adjacent columns.

To reduce the effects of differential settlement, floating floor slabs with expansion joints, independent from wall and column loads, will be important in minimizing the potential cracking that can occur along and around foundation systems. Floor slab control joints should be used to reduce potential damage due to shrinkage cracks.

E.2. DEEP FOUNDATION ALTERNATE DESIGN – POLE SIGNS

The relatively small diameter soil borings drilled for this study partially caved immediately following drilling, at depths near the groundwater level. Poorly graded sands, at or below groundwater, may not stay open during drilled shaft construction. Typically, clayey and silty sands will need to be stabilized or cased to stay open for the construction of conventional drilled shaft foundations. We recommend that the installation contractor review this report, the soils encountered, and adjust their means and methods for drilled shaft installation accordingly.

If designing lateral capacity of drilled shaft foundations using LPILE (by Ensoft Inc.) or similar programs, the following parameters are applicable for this project site. The design parameters are based on the results of our laboratory testing program and information obtained from boring B-7.

- Olsson recommends that drilled shaft foundations be a minimum of 18 inches in diameter and be designed in accordance with the soil parameters provided below. It is our opinion that the overturning moment will be the controlling loading condition and as such will govern the total depth of the pier; however, a minimum tip depth of 10 feet below adjacent final grade is recommended. The final shaft diameter and tip depth should be provided by the structural engineer or sign manufacturer based on their review of this report and the soil conditions encountered at the time of installation.

DESIGN PARAMETERS FOR DRILLED SHAFT DESIGN NEAR B-7

Soil Type	Approximate Formation Depths (ft)	Ultimate Skin Friction (psf) *	Ultimate End Bearing (psf) *	Cohesion / Friction Angle	Soil Modulus K (pci)	Strain Factor E50
Clayey Sand (SC) **(Frost Zone)**	0 – 2.5	N/R	N/R	N/R	N/A	N/A
Clayey Sand and Sand with Clay (SC, SP/SC, SW/SC)	2.5 – 8.0	150	N/R	27 degrees	25	N/A
Clayey Sand and Sand with Clay (SC, SP/SC, SW/SC)	8.0 – 17.0	550	8,500	32 degrees	Above Water table – 90 Below Water table – 60	N/A
Sandy Clay (CL)	17.0 – 20.0	700	10,000	1,400 psf	Static – 500 Cyclic – 200	0.007
* These are ultimate values and do not include any factor of safety. The structural designer should apply an appropriate factor of safety. We recommend using a minimum factor of safety of 2 and 3 for side friction and end bearing, respectively.						

N/A = Not Applicable, N/R= Not Recommended

- An uplift capacity equal to 75 percent of the allowable skin friction resistance can be used in combination with the overall pile weight for the design of a steel reinforced pile and uplift calculations. The structural capacity of the piles should be determined using applicable local building codes.
- Drilled shafts required to resist uplift forces must be reinforced over their entire length. It is common for drilled shaft foundations to be designed with sufficient reinforcing steel to accommodate incidental bending moments and transient lateral loads. Typically, the reinforcing steel area requirement is equal to about 1 percent of the pile cross-sectional area. A distance equal to the shaft diameter should be neglected at the base of the drilled shaft for side friction calculations to account for the side friction and end bearing interaction that occurs at the tip of the shaft.
- Construction specifications for drilled shafts should include a concrete mix designed to limit bleeding of installed shafts and the pile contractor's responsibility to increase individual or group shaft lengths, the installation of additional shafts to compensate for any soil disturbance created by the contractor's means and methods during construction. The concrete or grout mix, at a minimum, should be designed to achieve a minimum 28-day compressive strength of 4,000 psi.

- An Olsson field technician should be on-site to observe the shaft as it is drilled and also during concrete and reinforcing steel placement.
- The base of the drilled shaft boring should be clean and free of debris or loose soil prior to placing concrete or reinforcing steel. Concrete for the drilled shaft foundation should be placed promptly to reduce exposing the subsoil to rain, surface runoff, or drying conditions. If foundation bearing soils are subjected to such conditions, the soils should be reevaluated by an Olsson representative prior to reinforcing steel or concrete placement.
- We recommend that concrete for drilled shaft foundations have a slump of 5 to 7 inches at the time of placement.
- Free-fall concrete placement is not recommended unless approved by the structural engineer. The use of a bottom dump hopper or tremie pipe could be considered to prevent potential aggregate segregation or sidewall disturbance.

E.3. Seismic Classification

Per the International Building Code (IBC), soils within the upper 100 feet determine the seismic structural design criteria for the project site. Based on the soils encountered in the test borings and our understanding of the local geology, Olsson estimated the soil properties below the deepest boring to a depth of 100 feet. The soil shear strengths and blow counts (N values) were estimated based on the results of the laboratory testing program and the assumed soil properties on the undocumented soils below the lowest boring. For this project site, we recommend using a Site Class D (stiff soil profile) in accordance with Section 1613 of the 2012 IBC.

E.4. Floor Slab Subgrade Preparation

If the recommendations for site preparation (*Section D*) are followed, the floor slab will be supported by a minimum 2-feet of properly compacted native soils or imported structural fill. The floor slab subgrade is often disturbed during foundation or building construction and at the time of floor slab construction. If these subgrade soils have dried out or have been disturbed since original placement and compaction, it is recommended that the upper 12 inches of subgrade soil, or the soils which were disturbed, be scarified, moisture conditioned as needed, and recompacted to a minimum 98 percent of the materials maximum dry density as determined by ASTM D698, Standard Proctor. The subgrade soil moisture content at the time of compaction should be maintained between -1 and +3 percent of optimum for cohesive soils or as necessary to achieve compaction for cohesionless soils. The floor slab subgrade should be evaluated by proofrolling (if feasible) with an Olsson representative present. If unstable soils are encountered which cannot be adequately densified in place, these soils should be removed and replaced with structural fill in accordance with the recommendations of this report.

It may be necessary to adjust the moisture content of the subgrade soils immediately prior to floor slab construction. The granular cushion, if placed, beneath the floor slab should be free-draining, well-graded, and compacted by vibration prior to placing reinforcing steel or concrete. Locally available, free-draining crushed aggregate or crushed recycled concrete with less than 5 percent passing the #200 sieve is acceptable for the granular cushion below the floor slab.

We recommend that the granular cushion beneath the floor slab be compacted to a minimum 95 percent of the materials maximum Standard Proctor (ASTM D-698) dry density. The granular material may alternatively be compacted by a vibratory compactor to at least 65 percent “relative density,” as determined in accordance with ASTM D4253 (Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table) and D4254 (Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density). The moisture content of the granular cushion at the time of compaction should be maintained as necessary to achieve compaction. Flooding of granular materials as an alternative to proper compaction is not recommended and should not be allowed.

Lightly loaded interior partition walls (applying less than 0.75 klf) may be supported directly on the slab on grade floor. Although depending on the floor slab design and the specific wall loads, it may be appropriate to increase the floor slab reinforcement or provide a thickened slab cross section below interior walls. For interior walls with loads greater than 0.75 klf, Olsson recommends that a footing be installed, independent from the floor slab, to properly distribute the wall loads to the underlying soil and reduce the potential for floor slab damage.

If these recommendations are followed and the subgrade soils are prepared and compacted as recommended, the building floor slab may be designed using a subgrade modulus (“k” value) of 150 psi/in.

It may be appropriate to provide a sealed polyethylene vapor barrier between the new floor slab and granular drainage materials to reduce moisture infiltration. The decision to place a vapor barrier in direct contact with the slab or beneath the layer of granular fill should be made by the design engineer after considering the moisture sensitivity of new flooring materials or finishes.

E.5. EXTERIOR SLABS AND SIDEWALKS

If the recommendations of this report are followed, exterior slabs or sidewalks within 10 feet around the Kum & Go building will be underlain with moisture conditioned and recompacted structural fill material or on-site materials prepared as structural fill that could be frost susceptible. If these soils become very moist or saturated and freeze, slab heaving is possible. Positive grading to direct surface drainage away from the building will help limit the potential for moisture infiltration of slab subgrade soils and subsequent heaving. Considering the total thickness of new structural fill anticipated below the building footprint and surrounding area, the standard Kum & Go “turn-down” design for approach and entrance slabs should be appropriate. Refer to the applicable Kum & Go detail provided in the project plans for specific information.

E.6. LATERAL EARTH PRESSURES

The following soil parameters are provided for use in designing foundation or below grade retaining walls which are subjected to lateral earth pressures. The maximum toe pressure for below grade walls should not exceed the bearing capacity recommended in this report for shallow spread foundations. The parameters are based on the understanding that retained soils will be similar in composition to the on-site soils encountered during this exploration. The effects of lateral earth pressure should be considered during selection of the underground fuel tank.

Walls which are rigidly restrained at the top and are essentially unable to deflect or rotate should be designed for "at rest" earth pressure conditions. Walls that are unrestrained at the top and are free to deflect or rotate slightly may be designed for "active" earth pressure conditions. The "passive" earth pressure condition should be used to evaluate the resistance of soil to lateral loads. Provided in the table below, equivalent fluid densities are frequently used for the calculation of lateral earth pressures for the "at rest" and "active" conditions. The values provided assume that positive drainage is present to prevent hydrostatic forces from developing behind the wall. The equivalent fluid densities below do not include the effects of surcharge loading.

EARTH PRESSURE PARAMETERS

Condition	Soil Type	Equivalent Fluid Density Drained Condition
Active (K_a)	Clayey Sand	46 pcf*
	Clean Granular Material	34 pcf*
At Rest (K_0)	Clayey Sand	55 pcf*
	Clean Granular Material	67 pcf*
Passive (K_p)	Clayey Sand	320 pcf
	Clean Granular Material	425 pcf

* Assumed level backfill.

These design recommendations are based on the following assumptions:

- For active earth pressure, wall must rotate about base, with top lateral movements 0.002 Z to 0.004 Z (granular) or 0.010 Z to 0.020 Z (clays), where Z is wall height. This is necessary to allow the active condition to develop.

- For passive earth pressure, wall must rotate about base, with top lateral movements 0.020 Z to 0.060 Z (granular) or 0.020 Z to 0.040 Z (clays), where Z is wall height. This is necessary to allow the passive condition to develop.
- These soil parameters assume the backfill is level with the top of the wall. If sloping backfill is utilized, the parameters will need to be reevaluated. In addition to sloping backfill, the walls should be designed to resist surcharge loads, including nearby shallow foundations and traffic loads.
- Lower passive pressures should be utilized if the ground surface slopes downward away from the face of the wall.
- The upper 30 inches do not contribute resistance against horizontal movement if the soil is subject to frost action and seasonal volume change.
- On-site backfill soils having a bulk unit weight of 120 pcf.
- Backfill soils placed within the height of the retained wall consisting of selected non-expansive lean clay should be tested to verify the lean clays exhibit low plasticity and can achieve a minimum friction angle of 26 degrees.
- On-site or imported granular backfill materials having a minimum friction angle of 32 degrees.
- Uniform surcharge.
- Heavy equipment and other concentrated load components not included.
- No safety factor is included.
- To calculate the resistance to sliding on native soil, a coefficient of friction value of 0.35 should be used where the footing is supported by engineer-approved bearing soil. A factor of safety of at least 1.5 should be applied to sliding calculations for the overall wall design.

E.7. Underground Fuel Tanks

The use of approved backfill materials is critical for long term tank performance. Do not mix approved backfill materials with sand or native soils.

- Excavated native soils should be replaced with approved backfill of proper size and gradation. Granular backfill materials should meet ASTM C-33 requirements for quality and soundness.
- Backfill suppliers should provide sieve analysis documentation that the materials meet these requirements.

- Backfill materials should be kept dry and free of ice or snow in freezing conditions.

Typical backfill material for new fuel tank installation consists of free-draining naturally rounded aggregates (pea gravel) with a maximum ¾-inch particle size and no more than 5 percent passing a #8 sieve. Crushed and washed stone with a maximum angular particle size of ½ inch and no more than 5 percent passing the #8 sieve can also be used. If material which meets these typical specifications is not locally available, the tank manufacturer should be contacted for information or approval of alternate materials and installation instructions.

Tank backfill materials should be compacted carefully to prevent tank damage; however, if new pavements will cover the backfill materials, adequate compactive efforts must be applied to prevent future settlement and pavement damage. If new pavements will be placed over the new underground fuel tanks, we recommend that the backfill be compacted to a minimum 95 percent of the materials Standard Proctor (ASTM D-698) maximum dry density.

These backfill recommendations are provided as a general guideline for underground fuel tank applications. They are not intended to supersede the material recommendations or installation requirements of a specific tank manufacturer. We recommend that the manufacturer's recommendations be reviewed and followed, as appropriate, for the surface covering proposed, the tank type selected, and the site conditions anticipated by the installation contractor.

Groundwater was encountered at depths between 14.3 and 20.5 feet during this exploration and could potentially impact fuel tank excavations. If free water is encountered during the tank excavation, the contractor should follow an applicable local and state dewatering plan. The installation contractor is responsible for the design of shoring or benching of excavation sidewalls as applicable for his selected means and methods. The near surface clayey sands, silty sands, and poorly graded sands encountered during this exploration may not stand unsupported for the UST excavation sidewalls. The installation contractor should be aware of this. The contractor should review this report thoroughly and determine if shoring or benching of the excavation sidewalls are applicable and select his means and methods accordingly.

F. Pavements

F.1. Pavement Subgrade Preparation

It is important that pavement subgrade support be relatively uniform, with no abrupt changes in the degree of support. Non-uniform pavement support can occur at the transition from cut to fill areas, or as a result of varying soil moisture contents or soil types, or where improperly placed utility backfill has been placed across or through areas to be paved. Improper subgrade preparation such as inadequate vegetation removal, failure to identify soft or unstable areas by proofrolling, and inadequate or improper compaction can also produce non-uniform subgrade support.

During grading operations and pavement construction, subgrades can deteriorate rapidly as a result of moisture infiltration and repetitive construction traffic. It is recommended that the upper 12 inches of pavement subgrade be scarified, moisture conditioned, and recompacted to a minimum 98 percent of the materials maximum Standard Proctor (ASTM D-698) dry density. Pavement subgrade moisture content at the time of compaction should be maintained between -1 and +3 percent of optimum for cohesive soils or as necessary to achieve compaction for cohesionless soils. The range of acceptable moisture contents for imported fill materials should be determined during laboratory Proctor testing of specific supplier delivered materials prior to earthwork.

The final pavement subgrade should be tested for compaction and proofrolled immediately prior to concrete placement to detect localized areas of instability. Unsuitable or unstable areas should be reworked as necessary to provide a uniform, moisture conditioned, and compacted subgrade. For subgrade soils consisting of clayey and silty sands prepared in accordance with this report, a modulus of subgrade reaction (k) of 150 pci is recommended for pavement design.

If soft areas are identified during the subgrade preparation or if the subgrade soils have been exposed to adverse weather conditions, frost, excessive construction traffic, standing water, or similar conditions, the geotechnical engineer or his authorized field representative should be consulted to determine if corrective action is necessary. Proofrolling operations are not recommended in areas of new underground fuel tanks, fuel delivery lines, or underground utilities. Granular subgrade soils lacking adequate cohesive binder may rut or roll under construction equipment traffic. In these areas, the geotechnical engineer may elect to eliminate the proofrolling requirement.

It is recommended the prepared subgrades extend a minimum of 2 feet outside the pavements, where feasible. A representative of the geotechnical engineer should be present during subgrade preparation to observe, document, and test compaction of the materials at the time of placement or rework. As recommended for all prepared soil subgrades, Olsson recommends that heavy, repetitive construction traffic be controlled, especially during periods of wet weather, to minimize disturbance.

The final grades across this site should account for some post construction movement of exterior pavements due to moisture related shrink/swell or freeze/thaw cycles. To minimize this movement, it is recommended that the paved areas be designed with the maximum grades practical to further reduce the potential for ponding water. Our estimation of total movement is dependent on the grading plan incorporating positive drainage to reduce surface water infiltration of pavement subgrades. To increase pavement life and reduce the potential for heaving, a pavement maintenance program is recommended to regularly clean out and seal control joints and cracks that may develop.

F.2. Pavement Design

For Kum & Go stores, the daily traffic associated with beverage, food, fuel delivery, and trash trucks is relatively consistent and predictable. Based on the information provided by the client, the traffic volume for standard duty consists of 1,250 passenger cars and pickups per day, 4 3-axle, single-unit, delivery trucks per day, 1 3-axle, single-unit, trash truck every 2 days, and 2 5-axle, single trailer, fuel tanker per day. Olsson recommends that rigid concrete pavement be used in areas designated for heavily loaded trucks, lanes or concentrated lanes of repetitive traffic, or in non-designated areas that could experience turning truck traffic. For this project site, the following Portland cement pavement section is recommended. If the recommendations in this report are followed, a design life of 20 years should be anticipated.

CONCRETE PAVEMENT – STANDARD DUTY

Depth (in)	Material Designation	Material Specification
6.0		Concrete: CDOT Section 412 Portland Cement Concrete Pavement, El Paso County Engineering Criteria Manual
12.0		Minimum prepared subgrade thickness: In accordance with *Sections D.4 and F.1* of this report.

Curbs should be backfilled as soon as possible after pavement construction. Backfill should be properly compacted and sloped to prevent water from ponding and/or infiltrating pavement subgrades. Pavement joints should be caulked, and cracks should be quickly patched or sealed as they occur to prevent moisture from infiltrating and softening the subgrade soils. Due to granular nature of the native soils, a granular base or subbase below new pavements should not be necessary.

F.3. SIDEWALK SUBGRADE PREPARATION

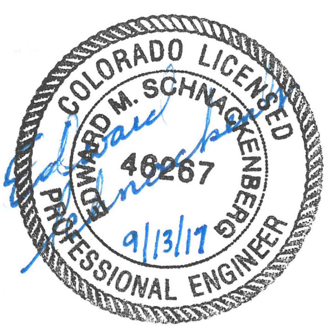
Olsson recommends that new sidewalks away from the Kum & Go building be supported by a minimum 8 inches of compacted subgrade soil. This recommendation can be achieved by scarifying the upper 8 inches of sidewalk subgrade, moisture conditioning as necessary, and recompacting to a minimum 95 percent of the materials Standard Proctor maximum dry density at a moisture content between -1 and +3 percent of optimum for cohesive soils or as necessary to obtain compaction in cohesionless soils. In areas of the site where this thickness of compacted structural fill or reworked on-site soils were provided during site grading or earthwork, no additional subgrade preparation should be necessary unless the subgrade was damaged or disturbed during construction or inclement weather. Prepared subgrades should extend a minimum of one-foot beyond each edge of the sidewalks, where feasible.

G. LIMITATIONS

The conclusions and recommendations presented in this report are based on the information available regarding the proposed construction, the results obtained from our soil test borings and sampling procedures, the results of the laboratory testing program, and our experience with similar projects. The soil test borings represent a very small statistical sampling of subsurface soils, and it is possible that conditions may be encountered during construction that are substantially different from those indicated by the soil test borings. In these instances, adjustments to design and construction may be necessary. This geotechnical report is based on the site plan and information provided to Olsson and our understanding of the project as noted in this report. Changes in the location or design of new structures and/or pavements could significantly affect the conclusions and recommendations presented in this geotechnical report. Olsson should be contacted in the event of such changes to determine if the recommendations of this report remain appropriate for the revised site design.

This report was prepared under the direction and supervision of a Professional Engineer registered in the State of Colorado and a Professional Geologist as defined by Colorado state statute, both of whom are employed by Olsson Associates. The conclusions and recommendations contained herein are based on generally accepted, professional geotechnical engineering practices at the time of this report, within this geographic area. No warranty, express or implied, is intended or made. This report has been prepared for the exclusive use of Kum & Go and their authorized representatives for specific application to the proposed project. Olsson appreciates the opportunity to provide our services on this project and look forward to working with you during construction. Should you have any questions, please do not hesitate to contact us.

Respectfully submitted,
Olsson Associates



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APPENDIX A

SITE LOCATION PLAN
BORING LOCATION MAP

APPENDIX B

SYMBOLS AND NOMENCLATURE
BORING LOGS

APPENDIX C

SUMMARY OF LABORATORY TEST RESULTS

APPENDIX D

GEOLOGIC PROFILE AND CROSS SECTION MAP

APPENDIX E

POTENTIAL SWELLING SOIL AND ROCK MAP