

Architectural  
Structural  
Geotechnical



Materials Testing  
Forensic  
Civil/Planning

## SUBSURFACE SOIL INVESTIGATION

**Fox Run Nature Center  
2110 Stella Drive  
El Paso County, Colorado**

### PREPARED FOR:

**TDG Architecture, Inc  
201 E. Las Animas St, Ste 113  
Colorado Springs, CO 80903**

**JOB NO. 183925**

**June 12, 2023**

Respectfully Submitted,

RMG – Rocky Mountain Group

**Kelli Zigler  
Project Geologist**

Reviewed by,

RMG – Rocky Mountain Group

**Tony Munger, P.E.  
Sr. Geotechnical Project Manager**



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# GENERAL SITE AND PROJECT DESCRIPTION

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## **Project Description and Scope of Work**

RMG has completed a geotechnical investigation for the proposed Fox Run Nature Center at 2110 Stella Dive in the northern portion of Colorado Springs, Colorado. The purpose of the investigation was to evaluate the subsurface soil conditions and provide geotechnical design and construction criteria for the project. These services were provided in accordance with our Proposal for RMG Job No. 183925 dated April 10, 2023.

RMG understands the proposed construction is to consist of two one-story structures of conventional construction, with a combined footprint of approximately 8,245 square feet and a covered patio area with a footprint of approximately 4,565. A 54-foot tall tower and 345-foot canopy walk is also proposed. Improvements include trails and a 50 space parking area.

## **Existing Site Conditions**

The site is currently an undeveloped portion of the Fox Run Park. The site is undeveloped and is currently vegetated with native grass and weeds. The location of the site is shown on the Site Vicinity Map, Figure 1.

# FIELD INVESTIGATION AND LABORATORY TESTING

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## **Drilling**

Based on site access restrictions and our conversations with the contractor, a scope of work was undertaken that could readily be performed with a truck-mounted drill rig and limited site disturbance. If additional soil information and/or a more in-depth investigation are desired, please contact personnel of RMG for a proposal for these additional services.

The subsurface conditions on the site were investigated by drilling two exploratory test borings to depths of approximately 20 feet within the proposed building footprint. The approximate locations of the test borings are presented in the Test Boring Location Plan, Figure 2.

The test borings were advanced with a power-driven, continuous-flight auger drill rig. Soil samples were obtained in general accordance with ASTM D-1586 utilizing a 2-inch OD split-barrel sampler or in general accordance with ASTM D-3550 utilizing a 2½-inch OD modified California sampler. Samples were returned to RMG's materials testing laboratory for testing and analysis. An Explanation of Test Boring Logs is presented in Figure 3. The Test Boring Logs are presented in Figure 4.

## **Laboratory Testing**

The moisture content for the recovered samples was obtained in the laboratory. Grain-size analysis, Atterberg Limits, and Denver Swell/Consolidation tests were performed on selected samples for purposes of classification and to develop pertinent engineering properties. A Summary of Laboratory Test Results is presented in Figure 6. Soil Classification Data are presented in Figure 7.

# SUBSURFACE CONDITIONS

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## Subsurface Materials

The test borings revealed the soil strata across the site to be fairly consistent from boring to boring. The subsurface materials encountered in the test borings consisted of silty sand, silty to clayey sandstone, and sandy claystone.

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Logs. The classifications shown on the logs are based upon the engineer's classification of the samples at the depths indicated. Stratification lines shown on the logs represent the approximate boundaries between material types and the actual transitions may be gradual and vary with location.

## Groundwater

Groundwater was not observed in the test borings at the time of drilling. Groundwater is not expected to be a significant factor in foundation design. Fluctuations in groundwater and subsurface moisture conditions may occur due to seasonal variations in rainfall and other factors not readily apparent at this time.

## Soil Parameters

The following table presents estimated in-situ soil parameters.

Soil Description	Unit Weight (lb/ft <sup>3</sup> )	Friction Angle (degree)	Active Earth Pressure $K_a$	Passive Earth Pressure $K_p$	At-Rest Earth Pressure $K_o$	Modulus of Elasticity $E_s$ (lb/in <sup>2</sup> )	Poisson's Ratio $\mu_s$
Sand, Silty	115	28	0.361	2.77	0.531	1,500	0.20

## Seismic Design

In accordance with the Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SEI 7-16, seismic design parameters have been determined for this site. The seismic site class has been interpreted from the results of the soil test borings drilled within the project site. The Advanced Technology Council seismic design tool has been used to determine the seismic response acceleration parameters. The soil on this site is not considered susceptible to liquefaction.

The following recommended seismic design parameters are based upon Seismic Site Class D, and a 2-percent probability of exceedance in 50 years. The Seismic Design Category is “B”.

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
	S <sub>s</sub>	0.207	F <sub>a</sub>	1.6	S <sub>ms</sub>	0.332	S <sub>ds</sub>	0.221
0.2	S <sub>s</sub>	0.207	F <sub>a</sub>	1.6	S <sub>ms</sub>	0.332	S <sub>ds</sub>	0.221
1.0	S <sub>1</sub>	0.058	F <sub>v</sub>	2.4	S <sub>m1</sub>	0.139	S <sub>d1</sub>	0.093

Notes: MCE = Maximum Considered Earthquake  
g = acceleration due to gravity

## CONCLUSIONS AND RECOMMENDATIONS

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The following discussion is based on the subsurface conditions encountered in the test borings and the project characteristics previously described. If conditions are different from those described in this report or the project characteristics change, RMG should be retained to review and revise our recommendations as necessary.

### Geotechnical Considerations

Based on the subsurface soil conditions encountered in our test borings, it is our opinion that a shallow foundation system is suitable for the proposed structure. Soil improvements required to achieve the allowable bearing capacity presented herein are discussed below. Deep foundation systems, while not anticipated to be necessary, are also a suitable alternative for the proposed structures. If a deep foundation system is desired, please contact personnel of RMG for revised recommendations.

### Site Preparation

Standard Penetration Test blow counts vary across the site and with depth. Due to this variability we recommend removing (overexcavating) the foundation areas and backfilling with compacted structural fill. The on-site material is suitable as structural backfill. Site preparation should include clearing and grubbing the site of all vegetation, topsoil, and any other deleterious material within the construction area and disposing this material appropriately. Following clearing and grubbing, the area within the tower footprint and a 3-foot perimeter beyond should be overexcavated 3-feet below the bottom of footing elevation. For the remaining portions of the buildings, the area within the foundation footprint and a 2-foot perimeter beyond should be overexcavated 2-feet below the bottom of footing elevation. The excavated material may be stockpiled for reuse as structural backfill. An Open Excavation Observation should be made at this point to verify soil conditions are as reported in the soil boring logs herein.

Upon verification, the upper 6 inches of the exposed subsurface soils should then be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) prior to placing structural fill.

After compaction, the native material previously removed may be used as structural backfill to bring the site to bottom-of-footing grade. The material should not be excessively wet, should be free of organic matter and construction debris, and should not contain rock fragments greater than 3-inches in any dimension. The fill material should be moisture-conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and placed in lifts of not more than 10 inches. Each loose lift should be compacted to a minimum of 95 percent of Modified Proctor maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698). The first density tests should be conducted when 12 inches of compacted fill have been placed.

### **Foundation Recommendations**

Building and covered patio structures may be supported on shallow foundations bearing on approved soils when prepared in accordance with the recommendations above. When so prepared, a maximum allowable bearing pressure of 1,500 psf with no minimum dead load requirement may be used for design. The foundation design should be prepared by a qualified Colorado Registered Professional Engineer using the recommendations presented in this report. This foundation system should be designed to span a minimum of 10 feet under the design loads. The bottoms of exterior foundations should be at least 30 inches below finished grade for frost protection. When prepared and properly compacted, total settlement of 1-inch or less with differential settlement on the order of ½ inch or less is estimated. Settlement in granular material generally occurs relatively rapidly with construction loads. Long term consolidation settlement should not be an issue, provided that the site material is prepared as recommended above.

Note, the recommendations presented herein do not apply to the foundations for the proposed elevated walkway. It is our understanding that a drilled-pier (caisson) style foundation is preferred for the elevated walkway. Other “deep” foundation systems may also be considered, based on site access limitations. Further discussion and recommendations for “deep” foundation systems are on hold pending site access for additional test pits and/or test borings. Once access can be provided, a separate investigation is to be performed to provide foundation design and construction recommendations for the elevated walkway, and those recommendations are to be presented in a separate report.

### **Open Excavation Observations**

As referenced above, foundation excavations should be observed by RMG prior to placing structural fill, forms, or concrete to verify the foundation bearing conditions for each structure. Based on the conditions observed in the foundation excavation, the recommendations made at the time of construction may vary from those contained herein. In the case of differences, the Open Excavation Observation report shall be considered to be the governing document to be used to modify the site preparation recommendations as necessary.

### **Floor Slabs**

The in-situ sand soil should be stable at its natural moisture content. Any fill material placed below slabs should be granular, non-expansive material to reduce the potential for slab movement.

Areas under floor slabs should be overexcavated a minimum of 1-foot and the upper 6 inches of the exposed subsurface soils should then be scarified and moisture-conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or 98 percent of

the maximum dry density as determined by the Standard Proctor test (ASTM D-698) prior to placing structural fill. Floor slabs should bear upon a minimum of 1-foot of structural backfill compacted to a minimum of 95 percent of Modified Proctor maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698). Non-structural slabs should be isolated from foundation members with expansion material. To reduce the possibility of capillary rise of groundwater into the floor slab, and to reduce the potential for concrete curling, a minimum 3-inch layer of ¾-inch crushed stone over 6-mil vapor retarder may be placed atop the compacted structural fill. A conventionally-reinforced or post-tensioned slab supported on stemwalls or grade beams may also be considered for strength and to reduce the potential for movement, curling, and differential settlement.

### **Exterior Concrete Flatwork**

Reinforced concrete exterior slabs should be constructed similarly to floor slabs on compacted structural fill, with the additional caveat they be isolated from the building with expansion material and have a downturned reinforced thickened edge. Conventionally-reinforced or post-tensioned slabs supported on stemwalls or grade beams may also be considered to reduce the potential for movement, curling, and differential settlement.

### **Lateral Earth Pressures**

Foundation and basement walls should be designed to resist lateral pressures. For non-expansive backfill materials, we recommend an equivalent fluid pressure of 40 pcf for design. Expansive soils or bedrock should not be used as backfill against walls. The above lateral pressure applies to level, drained backfill conditions. Equivalent Fluid Pressures for sloping/undrained conditions should be determined on an individual basis.

## **CONSTRUCTION CONSIDERATIONS**

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### **Surface Grading and Drainage**

A contributing factor to foundation settlement and floor slab heave in Colorado Front Range soils is the introduction of excess water. Improper site grading and irrigation water are respectively the most common cause and source of excess water. The ground surface should be sloped from the building with a minimum gradient of 10 percent for the first 10 feet. This is equivalent to 12 inches of fall across this 10-foot zone. Where a 10-foot zone cannot be achieved, a well-defined swale should be created a minimum 5 feet from the foundation and parallel with the wall, with a minimum slope of 2 percent to collect the surface water and transport it around and away from the structure. Roof drains should extend across backfill zones and landscaped areas to a region that is graded to direct flow away from the structure(s). Future maintenance operations should include activities to maintain the surface grading and drainage recommendations herein to help prevent water from being directed toward and/or ponding near the foundations.

Landscaping should be selected to reduce irrigation requirements. Plants used close to foundation walls should be limited to those with low moisture requirements and irrigated grass should not be located within 5 feet of the foundation. To help control weed growth, geotextiles should be used below landscaped areas adjacent to foundations. Impervious plastic membranes are not recommended. Irrigation devices should not be placed within 5 feet of the foundation. Irrigation should be limited to the amount sufficient to

maintain vegetation. Application of excess water will increase the likelihood of slab and foundation movements.

### **Perimeter Drain**

The site soil is generally anticipated to be well-draining, and groundwater was not encountered at depths anticipated to impact the proposed construction. A subsurface perimeter drain is recommended around portions of the structure which will have habitable or storage space located below the finished ground surface. This includes crawlspace areas if applicable. Where main-level slab-on-grade foundation systems are utilized, a subsurface perimeter drain will not be required around the foundation. An underslab drain is not anticipated to be necessary.

### **Concrete**

Type I/II cement is recommended for concrete in contact with the subsurface materials. Calcium chloride should be used with caution for soils with high sulfate contents. The concrete should not be placed on frozen ground. If placed during periods of cold temperatures, the concrete should be kept from freezing. This may require covering the concrete with insulated blankets and heating. Concrete work should be completed in accordance with the latest applicable guidelines and standards published by ACI.

### **Exterior Backfill**

Backfill around foundation stemwalls and other buried structures should be placed in loose lifts of not more than 10-inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to 85 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or to 92 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) on exterior sides of walls in landscaped areas. In areas where backfill supports pavement and concrete flatwork, the materials should be compacted to 92 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or to 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698).

Fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

The appropriate government/utility specifications should be used for fill placed in utility trenches. If material is imported for backfill, the material should be approved by the Geotechnical Engineer prior to hauling it to the site.

The backfill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement. Backfill should be compacted by mechanical means, and foundation walls should be braced during backfilling and compaction.

### **Structural Fill - General**

Areas to receive structural fill should have topsoil, organic material, or debris removed. The upper 6 inches of the exposed surface soils should be scarified and moisture-conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or to 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) prior to placing



structural fill. Structural fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

Structural fill should be placed in loose lifts of not more than 10-inches, moisture-conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or to 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698). The materials should be compacted by mechanical means.

Materials used for structural fill should be approved by the RMG prior to use. Structural fill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement.

To verify the condition of the compacted soils, density tests should be performed during placement. The first density tests should be conducted when 24 inches of fill have been placed.

## CLOSING

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This report has been prepared for the exclusive purpose of providing geotechnical engineering information and recommendations for development described in this report. RMG should be retained to review the final construction documents prior to construction to verify our findings, conclusions and recommendations have been appropriately implemented.

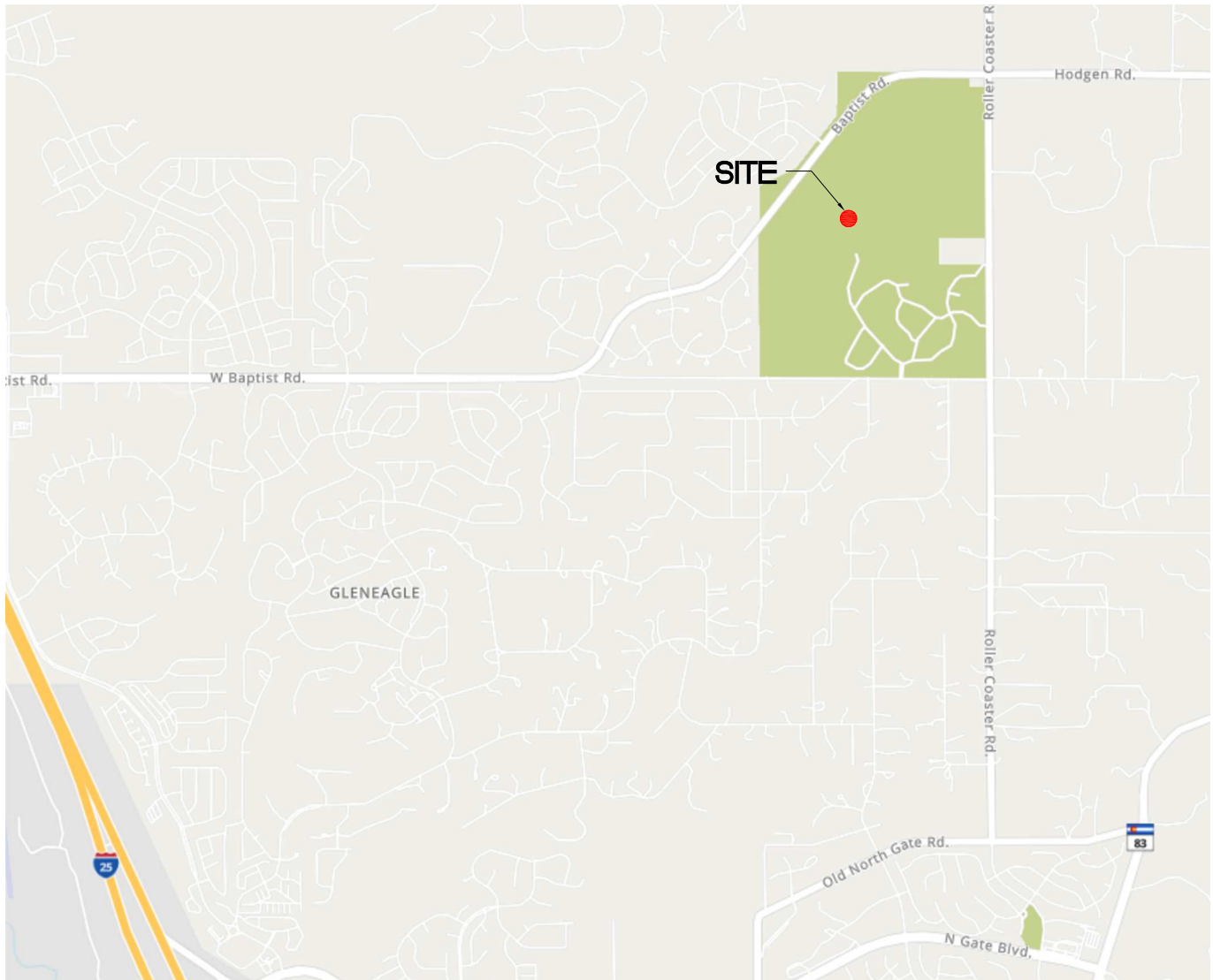
This report has been prepared for the exclusive use by **TDG Architecture, Inc** for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based in part upon data obtained from test borings, site observations and the information presented in referenced reports. The nature and extent of variations may not become evident until construction. If variations then become evident, RMG must be retained to review and revise the recommendations presented in this report as appropriate.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers practicing in this or similar localities. RMG does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied is made by the preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

The scope of services for this project does not include, either specifically or by implication, environmental assessment of the site or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to biological or toxicological issues, are beyond the scope of this report. If the Client desires investigation into the potential for such contamination or conditions, other studies should be undertaken.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering point-of-view, please feel free to contact us.

## FIGURES



NOT TO SCALE



ROCKY MOUNTAIN GROUP

Southern Office  
 Colorado Springs, CO  
 80918  
 (719) 548-0600  
Central Office:  
 Englewood, CO 80112  
 (303) 688-9475  
Northern Office:  
 Greeley / Evans, CO 80620  
 (970) 330-1071

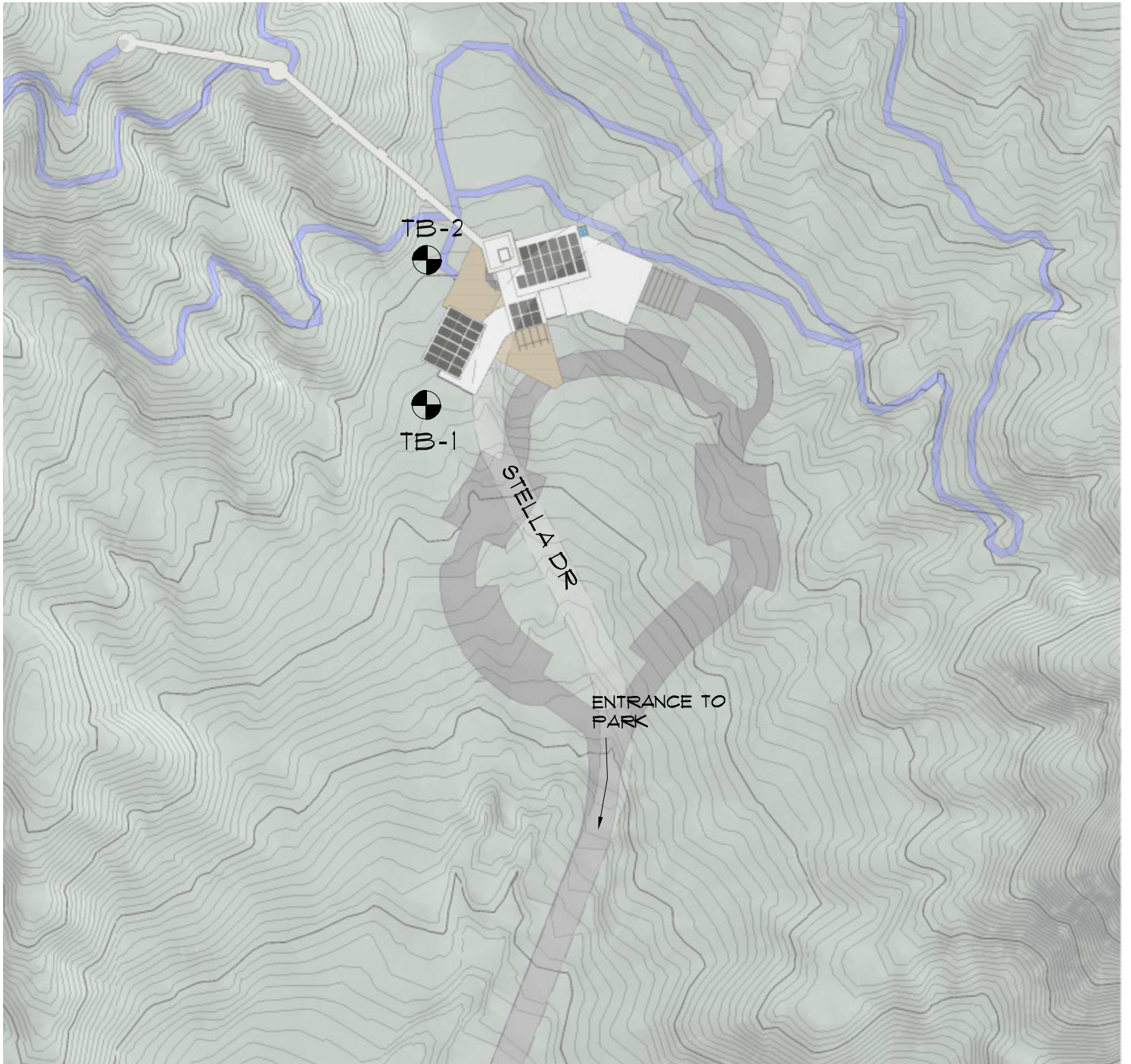
## SITE VICINITY MAP

FOX RUN NATURE CENTER  
 2110 STELLA DRIVE  
 EL PASO COUNTY, COLORADO  
 TDG ARCHITECTURE, INC.

JOB No. 183925

FIG No. 1

DATE 6-12-2023



NOT TO SCALE

⊕ DENOTES APPROXIMATE LOCATION OF TEST BORINGS



ROCKY MOUNTAIN GROUP

*Southern Office*  
 Colorado Springs, CO  
 80918  
 (719) 548-0600  
*Central Office:*  
 Englewood, CO 80112  
 (303) 688-9475  
*Northern Office:*  
 Greeley / Evans, CO 80620  
 (970) 330-1071

**TEST BORING  
 LOCATION PLAN**  
 FOX RUN NATURE CENTER  
 2110 STELLA DRIVE  
 EL PASO COUNTY, COLORADO  
 TDG ARCHITECTURE, INC.

JOB No. 183925

FIG No. 2

DATE 6-12-2023

# SOILS DESCRIPTION



CLAYSTONE



SANDSTONE



SILTY SAND

UNLESS NOTED OTHERWISE, ALL LABORATORY TESTS PRESENTED HEREIN WERE PERFORMED BY:  
RMG - ROCKY MOUNTAIN GROUP  
2910 AUSTIN BLUFFS PARKWAY  
COLORADO SPRINGS, COLORADO

## SYMBOLS AND NOTES



XX

STANDARD PENETRATION TEST - MADE BY DRIVING A SPLIT-BARREL SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-1586. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).



XX

UNDISTURBED CALIFORNIA SAMPLE - MADE BY DRIVING A RING-LINED SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-3550. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).



FREE WATER TABLE



DEPTH AT WHICH BORING CAVED



BULK DISTURBED BULK SAMPLE



AUG AUGER "CUTTINGS"

4.5

WATER CONTENT (%)

ROCKY MOUNTAIN GROUP

Architectural  
Structural  
Forensics



Engineers / Architects

Colorado Springs: (Corporate Office)  
2910 Austin Bluffs Parkway  
Colorado Springs, CO 80918  
(719) 548-0600

SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

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## EXPLANATION OF TEST BORING LOGS

JOB No. 183925

FIGURE No. 3

DATE May/30/2023

TEST BORING: 1  DATE DRILLED: 5/12/23 NO GROUNDWATER ON 5/12/23	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	TEST BORING: 2  DATE DRILLED: 5/12/23 NO GROUNDWATER ON 5/12/23	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel, tan, loose, moist	5			4	3.6	SAND, SILTY, with gravel, tan, loose, moist	5			8	2.6
SANDSTONE, SILTY, with gravel, tan, hard to very hard, moist	10			50/8"	3.9	SANDSTONE, SILTY TO CLAYEY, with gravel, tan, very hard, moist	10			50/7"	6.2
CLAYSTONE, SANDY, brown to gray, very hard, moist	15			50/6"	7.2		15			50/6"	4.8
	20			50/7"	14.6		20			50/6"	10.8

ROCKY MOUNTAIN GROUP

Architectural  
Structural  
Forensics



Engineers / Architects

Colorado Springs - (Corporate Office)  
2910 Austin Bluffs Parkway  
Colorado Springs, CO 80918  
(719) 548-0600

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# TEST BORING LOG

JOB No. 183925

FIGURE No. 4

DATE May/30/2023



Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load at Saturation (psf)	% Swell/ Collapse	USCS Classification
1	4.0	3.6		NP	NP	9.2	3.1			SW
1	9.0	3.9								
1	14.0	7.2								
1	19.0	14.6								
2	2.0	2.6								
2	7.0	6.2								
2	14.0	4.8		NP	NP	15.0	11.0			SW-SM
2	19.0	10.8								



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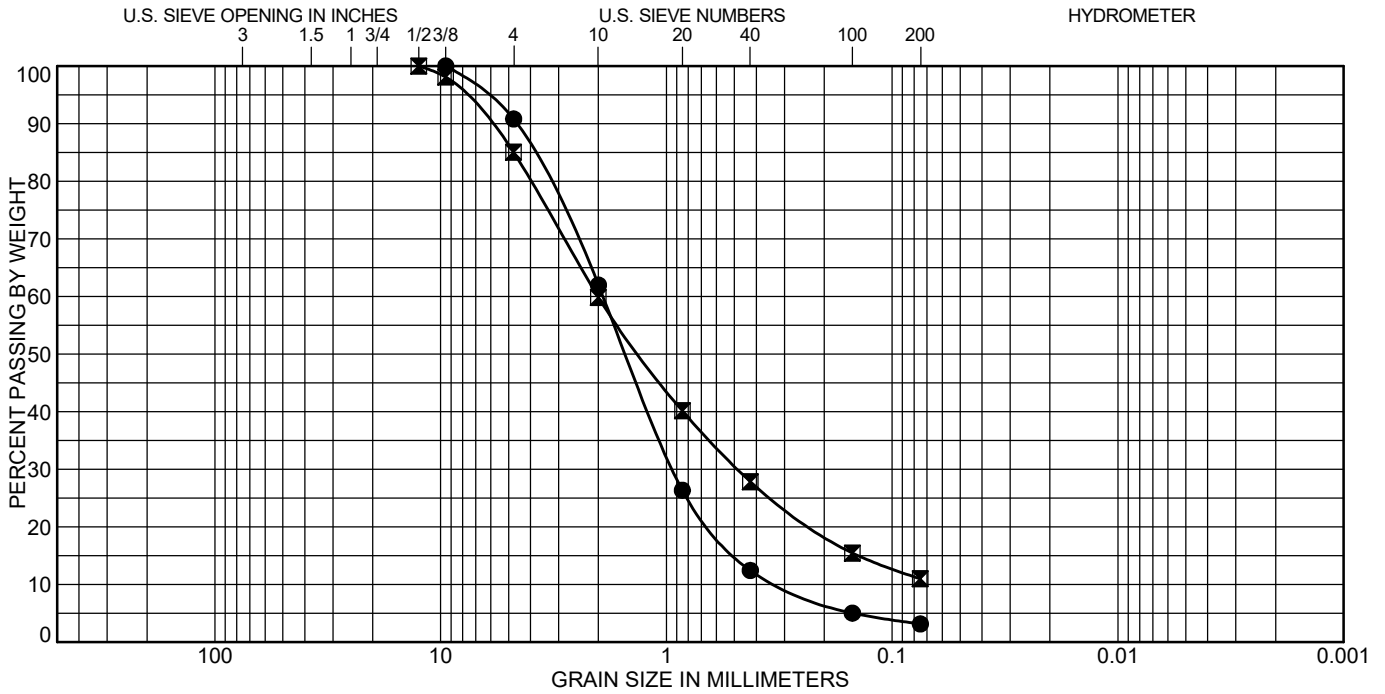
Engineers / Architects

Colorado Springs: (Corporate Office)  
2910 Austin Bluffs Parkway  
Colorado Spings, CO 80918  
(719) 548-0600  
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

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## SUMMARY OF LABORATORY TEST RESULTS

JOB No. 183925  
FIGURE No. 5  
PAGE 1 OF 1  
DATE May/30/2023



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring	Depth (ft)	Classification	LL	PL	PI
● 1	4.0	WELL-GRADED SAND(SW)	NP	NP	NP
☒ 2	14.0	WELL-GRADED SAND with SILT(SW-SM)	NP	NP	NP

Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
● 1	4.0	9.2	87.7	3.1	
☒ 2	14.0	15.0	74.1	11.0	

ROCKY MOUNTAIN GROUP



**Engineers / Architects**

Colorado Springs: (Corporate Office)  
2910 Austin Bluffs Parkway  
Colorado Springs, CO 80918  
(719) 548-0600  
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

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**SOIL CLASSIFICATION DATA**

JOB No. 183925

FIGURE No. 6

DATE May/30/2023