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SUBSURFACE SOIL INVESTIGATION

District 49 North Site Elementary School
11243 Londonderry Road Falcon, Colorado

PREPARED FOR:

Falcon School District 49
10850 E. Woodmen Rd
Falcon, CO 80831

JOB NO. 155688

January 5, 2017
Revised January 20, 2017

Respectfully Submitted,
RMG – Rocky Mountain Group

Reviewed by

GW for Kelli Zigler

COLORADO LICENSED GEOFF WEBSTER 45046 PROFESSIONAL ENGINEER

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Project Geologist

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01/20/2017

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GENERAL SITE AND PROJECT DESCRIPTION

Location

The site is located in the northeast portion of El Paso County, Colorado, northeast of the intersection of Meridian Drive and Stapleton Road. More specifically, the site is located at 11243 Londonderry Drive in Falcon, Colorado. The location of the site is shown on the Site Vicinity Map, Figure 1.

Existing Site Conditions

The site is presently an undeveloped parcel of land situated just north of the existing Falcon Middle School. The site is vegetated with low to moderate growth of native weeds and grasses. The topography undulates across the site, has a high point near the middle of the site, and trends in a mild slope downwards to the south.

Project Description

The site is to be developed as a new PK-5 school. According to a site layout plan provided to RMG by District 49 improvements will include the school building with an allowance for Phase 2 expansion, play areas, a multipurpose sports field, and associated paved school parking areas.
Rocky Mountain Group (RMG) was retained to explore the subsurface conditions at the site and develop geotechnical engineering recommendations for design and construction. Our investigation focused on the new school building and the parking areas.

FIELD INVESTIGATION AND LABORATORY TESTING

Drilling

The subsurface conditions on the site were investigated by drilling nine (9) exploratory test borings. The approximate locations of the test borings are presented in the Test Boring Location Plan, Figure 2.

Six test borings for the structure were advanced with a power-driven, continuous-flight auger drill rig to a depth of 25-feet below the existing ground surface. Three test borings for the parking areas were advanced to a depth of 10-feet each. 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 lab for further analysis. An Explanation of Test Boring Logs is presented in Figure 3. The Test Boring Logs are presented in Figures 4 through 8.

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 9. Soil Classification Data are presented in Figures 10 and 11. Swell/Consolidation Test Results are presented in Figure 12.

SUBSURFACE CONDITIONS

Subsurface Materials

The subsurface investigation revealed the soil strata across the site to be consistent from boring to boring. Beneath a thin veneer of silty sand, each boring showed dense silty sandstone with interbedded claystone seams from the surface to the depth tested.

The subsurface materials were classified by laboratory testing in accordance with the Unified Soils Classification System (USCS).

Sandstone: Sandstone bedrock consists of silty sandstone with some interbedded claystone seams in various locations. The sandstone classifies as SW-SM, well graded sand and silty sand. This material is non-plastic with no to little swell potential. The sparse interbedded claystone material classifies as CL, lean clay. This material is of low plasticity and exhibited very little swell potential.

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Logs. The descriptions shown on the logs are based upon the engineer's visual 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 observed in only one of the test borings, B-1, when checked five days subsequent to drilling. At that time groundwater was measured at a depth of 8.5-feet below the existing ground surface. Fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Development of the property and adjacent properties may also affect groundwater levels.

CONCLUSIONS AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the test borings and on 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 our recommendations and adjust them, if necessary.

Geotechnical Considerations

Based upon RMG's subsurface investigation and laboratory testing, conventional shallow foundations will be suitable for the proposed improvements. A deep foundation system will not be necessary on this site.

Foundation design recommendations, based on the field investigation and laboratory testing, are presented below. It must be understood that these recommendations should be verified after initial excavation is completed.

Foundation Recommendations

A spread footing foundation supported by the on-site sandstone or compacted structural fill is suitable for the proposed school structures. All structural fill placed below foundations should be constructed in accordance with the Structural Fill Section, below, and this paragraph. Fill should be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D1557. Lifts should be limited to 8-inches in confined areas and 12-inches in open areas where larger compactors can be utilized.

If the bottom of the excavation consists entirely of either compacted structural fill or sandstone, a maximum allowable bearing pressure of 3,000 psf with no minimum dead load requirement may be used for design. However, the structure should not be supported atop soil/bedrock of significantly different bearing capacities. If any portion of the structure is to be supported atop structural fill, the remaining portions of the excavation should have the top 12 inches of exposed sandstone bedrock scarified and compacted, or removed and replaced with structural fill.

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 with differential settlement on the order of ½ inch is estimated. Settlement in granular material will occur relatively rapidly with construction loads. Long term consolidation settlement is not an issue in granular material, and is not anticipated in compacted structural fill or the sandstone bedrock.

Open Excavation Observations

During construction, 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. The recommendations presented herein are intended only as preliminary guidelines to be used for interpreting the subsurface soil conditions exposed in the excavation and determining the final recommendations for foundation construction.

Seismic Design

In accordance with the International Building Code, 2012/2015, 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 USGS seismic design tool has been used to determine the seismic response acceleration parameters. USGS output is presented in Appendix A. The sandstone bedrock on this site is not considered susceptible to liquefaction.

The following recommended Seismic Design Parameters are based upon Seismic Site Class C, and a 2 percent probability of exceedance in 50 years. The Seismic Design Category is "A".

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	0.170	F_a	1.2	S_{ms}	0.204	S_{ds}	0.136
1.0	S_1	0.058	F_v	1.7	S_{m1}	0.099	S_{d1}	0.066

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

PAVEMENTS

Parking areas throughout the proposed new development are anticipated to be classified as private, and should be designed in accordance with Appendix D of the El Paso County Engineering Criteria Manual. The actual paving will be completed following oversite grading and rough cutting of the parking area subgrade.

For preliminary planning purposes, estimated composite asphalt pavement sections have been evaluated based on Colorado Asphalt Pavement Association Parking Lot Guidelines. For purposes of this report, we anticipate the subgrade soils will have American Association of State Highway and Transportation Officials (AASHTO) Soil Classifications of A-1 or A-2 with estimated design subgrade "R-values" on the order of approximately 43 to 52, and California Bearing Ratio (CBR) values in the range 10 to 19.

Estimated Hot-Mix Asphalt Pavement Section	
Traffic Level	**Composite Sections Asphalt/Base (in.)**
Moderate Traffic / Some Trucks	4.0 in. / 6.0 in.

Rigid concrete pavements are recommended in areas exhibiting heavy vehicle loading such as drop-off/pick-up areas, loading docks, trash receptacle areas, and other locations where heavy trucks will be making frequent turning and braking movements. Rigid pavements may be constructed directly on proof-rolled non-expansive granular subgrade, the top one foot of which has been compacted to a minimum of 95% of maximum dry density as determined by ASTM D1557.

Minimum Rigid Concrete Pavement Section	
Traffic Level	**Portland Cement Concrete (in.)**
Heavy Vehicles with Turning Motions	5.0 in.

These recommendations are for preliminary planning purposes only. CBR and R value is based on the materials encountered at the time of drilling and will be dependent upon the soil material used for site fill and subgrade construction. We suggest evaluating the soil conditions after site grading and pavement layout to assess our recommendations.

CONSTRUCTION CONSIDERATIONS

Floor Slabs

The insitu soil exhibited low swell potential in laboratory testing and should be relatively stable at its natural moisture content. The fill material to be used to bring the site to grade is not known at this time, but in any case should be non-expansive granular material to control any swell potential.

Interior floor slabs may be supported on compacted structural fill placed as described in the Structural Fill Section, below, and in accordance with this section. Prior to placing structural fill, the entire floor area should be proof-rolled to a firm and unyielding condition. Fill material for support of floor slabs should be placed in 8-inch loose lifts and compacted to a minimum of 95 percent of maximum dry density (ASTM D1557) at +/- 2 percent of the optimum moisture content. For design purposes, a modulus of subgrade reaction equal to 150 pci is recommended floor slabs bearing on compacted structural fill.

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. Further, a structural slab supported on stemwalls or gradebeams, or reinforced with ribbing should be considered for strength and to reduce the potential for movement, curling or differential settlement.

Exterior Concrete Flatwork

Reinforced concrete exterior slabs should be constructed similarly to floor slabs on compacted fill, with the additional caveat they be isolated from the building with expansion material, and have a downturned reinforced thickened edge.

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.

Surface Grading and Drainage

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. If a 10-foot zone is not possible on the upslope side of the structure, then a well-defined swale should be created a minimum 5 feet from the foundation and sloped parallel with the wall with a minimum slope of 2 percent to intercept 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. Water should be kept from 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. Excess water may increase the likelihood of slab and foundation movements.

Perimeter Drain

A subsurface perimeter drain is recommended around portions of the structure which will have habitable space, storage space, or crawlspaces located below the finished ground surface. Where main level slab-on-grade foundation systems (stiffened, monolithic, or isolated) are utilized, a subsurface perimeter drain will not be required around the foundation.

Foundation Stabilization

If groundwater conditions encountered at the time of foundation excavation result in either water flow into the excavation or destabilization of the foundation bearing soils, dewatering techniques should be implemented so that construction is performed in the dry.

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 on exterior walls and in landscaped areas should be placed in loose lifts not exceeding 8 to 12 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. In areas where backfill supports pavement and concrete flatwork, the materials should be compacted to 95 percent of the maximum dry density.

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 non-expansive granular soil.

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

Areas to receive structural fill should have topsoil, organic material, and 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).

Structural fill should be placed in loose lifts not exceeding 8 to 12 inches 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).

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 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

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.

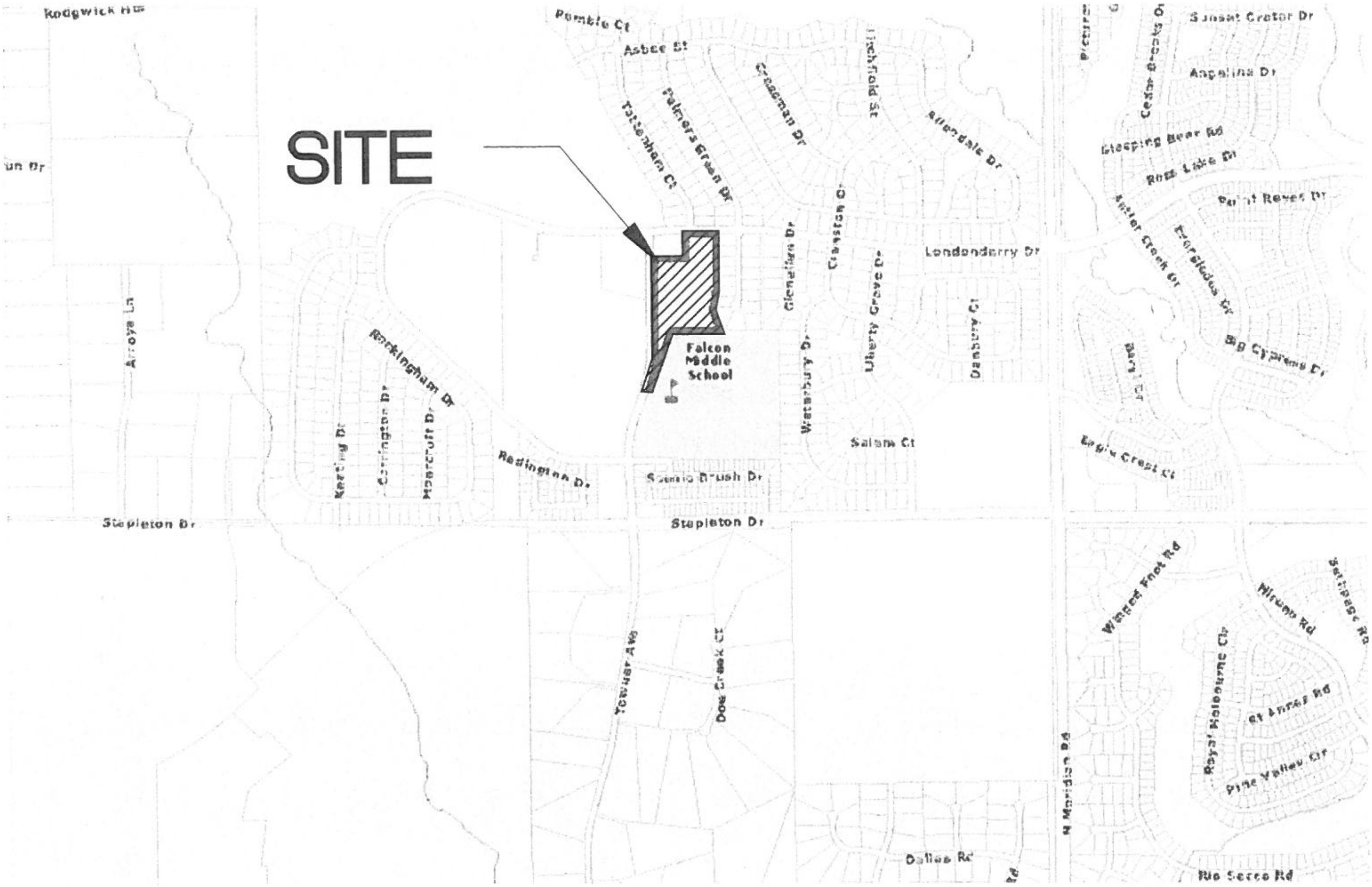
This report has been prepared for the exclusive use by **Falcon School District 49** for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based 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 should be retained to review the recommendations presented in this report considering the varied condition, and either verify or modify them in writing.

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

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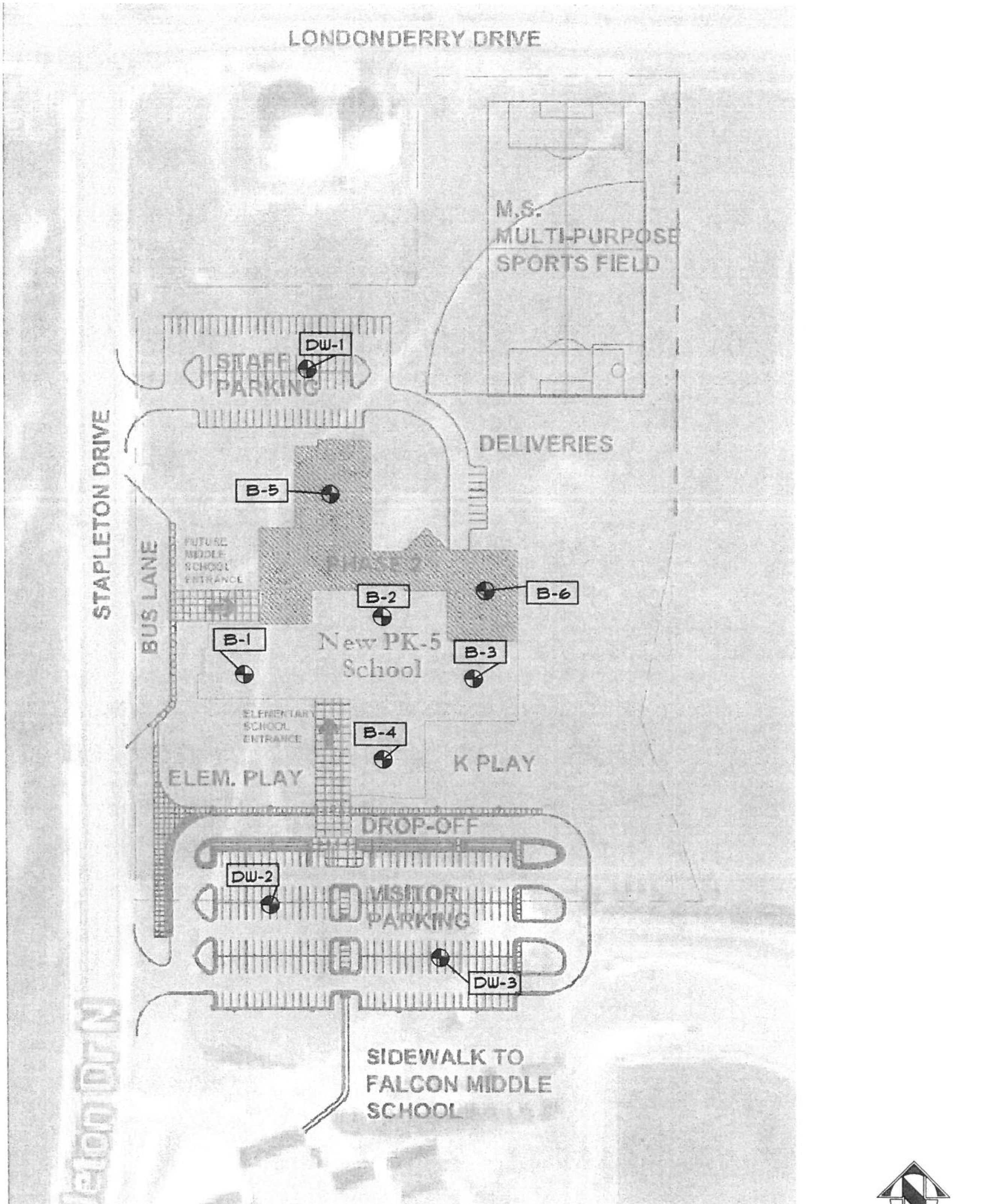
SITE VICINITY MAP

11243 LONDONDERRY DRIVE
NORTH SITE ELEMENTARY SCHOOL
EL PASO COUNTY, COLORADO
FALCON DISTRICT 49

JOB No. 155688

FIG No. 1

DATE 1-3-2016



⊕ DENOTES APPROXIMATE LOCATION OF TEST BORINGS

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TEST BORING LOCATION PLAN

11243 LONDONDERRY DRIVE
NORTH SITE ELEMENTARY SCHOOL
EL PASO COUNTY, COLORADO
FALCON DISTRICT 49

JOB No. 155688

FIG No. 2

DATE 1-3-2016

SOILS DESCRIPTION

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 (%)

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EXPLANATION OF TEST BORING LOGS

JOB No. 155688

FIGURE No. 3

DATE 1/3/17

TEST BORING: **B-1** DATE DRILLED: 12/16/17 REMARKS: GROUNDWATER @ 8.5 ' 12/22/17	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel, reddish brown, dense, moist	5			48	6.5
SANDSTONE, SILTY, reddish brown, hard to very hard, moist to wet	10			50/9"	8.3
	15			51	11.7
	20			50/9"	13.1
	25			50/7"	10.3

TEST BORING: **B-2** DATE DRILLED: 12/16/17 REMARKS: NO GROUNDWATER ON 12/22/17	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SANDSTONE, SILTY, interbedded claystone seams, reddish brown to brown and grey, hard to very hard, moist	5			50/6"	5.9
	10			50/6"	8.0
	15			50/9"	7.7
	20			50/8"	11.8
	25			50/6"	9.4

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TEST BORING LOGS

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FIGURE No. 4

DATE 1/3/17

TEST BORING: **B-3** DATE DRILLED: 12/16/17 REMARKS: NO GROUNDWATER ON 12/22/17	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SANDSTONE, SILTY, reddish brown to brown and grey, hard to very hard, moist					
	5		■	50/10"	5.1
	10		■	50/11"	11.1
	15		■	50/11"	10.9
	20		■	50/4"	11.0
	25		■	50/4"	8.4

TEST BORING: **B-4** DATE DRILLED: 12/16/17 REMARKS: NO GROUNDWATER ON 12/22/17	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SANDSTONE, SILTY, reddish brown to brown, hard, moist					
	5		■	43	9.6
	10		■	50/9"	10.3
	15		■	50/8"	7.9
	20		■	50/11"	14.7
	25		■	50/9"	9.6

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TEST BORING LOGS

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FIGURE No. 5

DATE 1/3/17

TEST BORING: **B-5** DATE DRILLED: 12/16/17 REMARKS: NO GROUNDWATER ON 12/22/17	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SANDSTONE, SILTY, with interbedded claystone seams, light grey to brown, hard to very hard, moist					
	5			50/9"	6.9
	10			50/6"	8.2
	15			50/12"	12.9
	20			50/3"	6.6
	25			50/6"	8.4

TEST BORING: **B-6** DATE DRILLED: 12/16/17 REMARKS: NO GROUNDWATER ON 12/22/17	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SANDSTONE, SILTY, reddish brown to gray and brown, hard to very hard, moist					
	5			50/9"	7.3
	10			50/7"	8.8
	15			50/11"	10.5
	20			50/9"	10.6
				50/5"	7.1

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TEST BORING LOGS

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FIGURE No. 6

DATE 1/3/17

TEST BORING: **DW-1**
DATE DRILLED: 12/16/17
REMARKS: NO GROUNDWATER ON 12/22/17

Description	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SANDSTONE, SILTY, gray to brown, medium hard, moist				50/10"	4.7
	5			50/8"	6.4
	10			50/8"	10.2

TEST BORING: **DW-2**
DATE DRILLED: 12/16/17
REMARKS: NO GROUNDWATER ON 12/22/17

Description	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SANDSTONE, SILTY, light brown, medium hard, moist				50/10"	1.6
	5			50/10"	4.6
	10			50/9"	8.7

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TEST BORING LOGS

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FIGURE No. 7

DATE 1/3/17

TEST BORING: **DW-3**
DATE DRILLED:
12/16/17
REMARKS:
NO GROUNDWATER ON
12/22/17

Description	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SANDSTONE, SILTY, light brown, firm to medium hard, moist					
				41	1.3
	5			50/10"	4.0
	10			50/8"	7.4

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TEST BORING LOGS

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FIGURE No. 8

DATE 1/3/17

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	FHA Expansion Pressure (psf)	% Swell @ 1000 psf	USCS Classification
B-1	4.0	6.5		NP	NP	11.1	10.2			SW-SM
B-1	9.0	8.3		NP	NP	8.8	7.7			SP-SM
B-1	14.0	11.7		NP	NP	11.3	27.6			SM
B-1	19.0	13.1		NP	NP	5.5	18.3			SM
B-1	24.0	10.3		NP	NP	9.4	12.5			SM
B-2	4.0	5.9								
B-2	9.0	8.0								
B-2	14.0	7.7								
B-2	19.0	11.8		35	19	0.0	59.3			CL
B-2	24.0	9.4								
B-3	4.0	5.1								
B-3	9.0	11.1								
B-3	14.0	10.9								
B-3	19.0	11.0								
B-3	24.0	8.4								
B-4	4.0	9.6								
B-4	9.0	10.3								
B-4	14.0	7.9								
B-4	19.0	14.7								
B-4	24.0	9.6								
B-5	4.0	6.9								
B-5	9.0	8.2								
B-5	14.0	12.9	111.6						1.7	
B-5	19.0	6.6								
B-5	24.0	8.4								
B-6	4.0	7.3								
B-6	9.0	8.8								
B-6	14.0	10.5								
B-6	19.0	10.6								
B-6	24.0	7.1								
DW-1	2.0	4.7		NP	NP	19.6	12.5			SM
DW-1	4.0	6.4		NP	NP	1.9	35.4			SM
DW-1	9.0	10.2		NP	NP	0.6	10.7			SP-SM
DW-2	2.0	1.6								

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SUMMARY OF LABORATORY TEST RESULTS

JOB No. 155688
FIGURE No. 9
PAGE 1 OF 2
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Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	FHA Expansion Pressure (psf)	% Swell @ 1000 psf	USCS Classification
DW-2	4.0	4.6								
DW-2	9.0	8.7								
DW-3	2.0	1.3								
DW-3	4.0	4.0								
DW-3	9.0	7.4								

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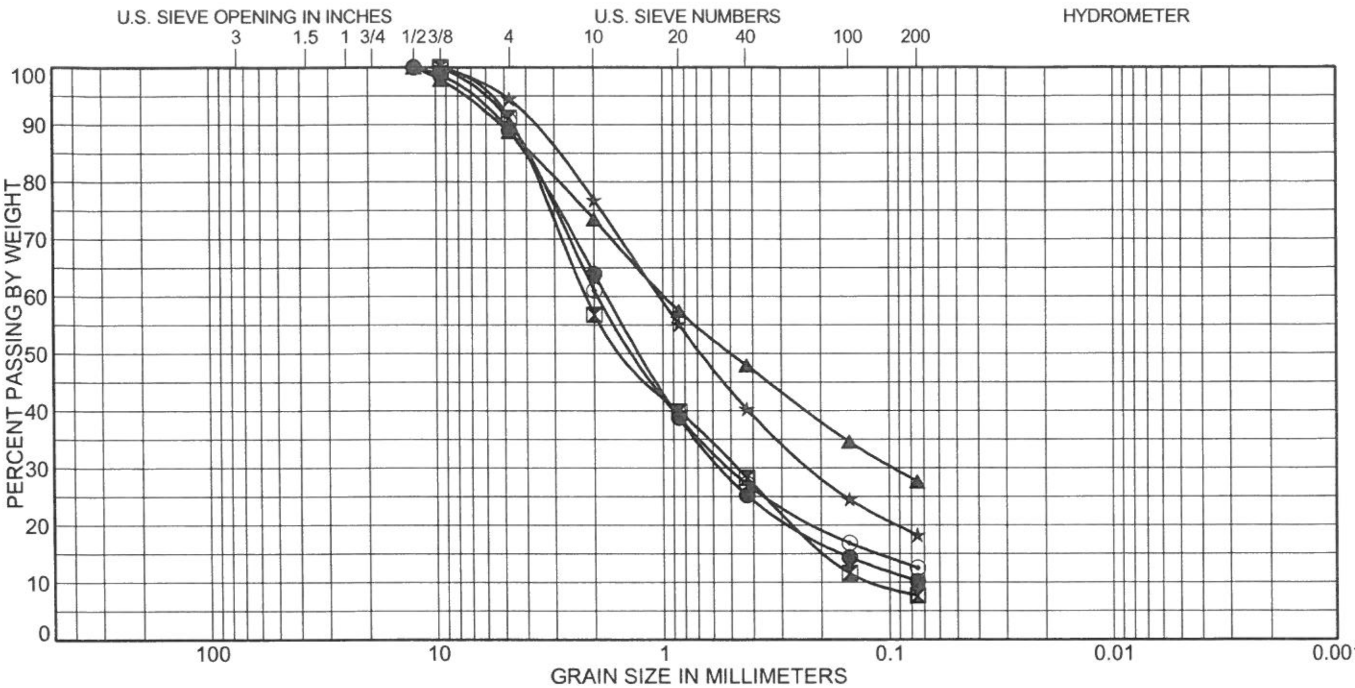
SUMMARY OF LABORATORY TEST RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Test Boring	Depth (ft)	Classification	LL	PL	PI
●	**B-1**	**4.0**	**WELL-GRADED SAND with SILT(SW-SM)**	**NP**	**NP**	**NP**
⊠	**B-1**	**9.0**	**POORLY GRADED SAND with SILT(SP-SM)**	**NP**	**NP**	**NP**
▲	**B-1**	**14.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**
★	**B-1**	**19.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**
⊙	**B-1**	**24.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**4.0**	**11.1**	**78.8**	**10.2**	
⊠	**B-1**	**9.0**	**8.8**	**83.5**	**7.7**	
▲	**B-1**	**14.0**	**11.3**	**61.1**	**27.6**	
★	**B-1**	**19.0**	**5.5**	**76.2**	**18.3**	
⊙	**B-1**	**24.0**	**9.4**	**78.1**	**12.5**	

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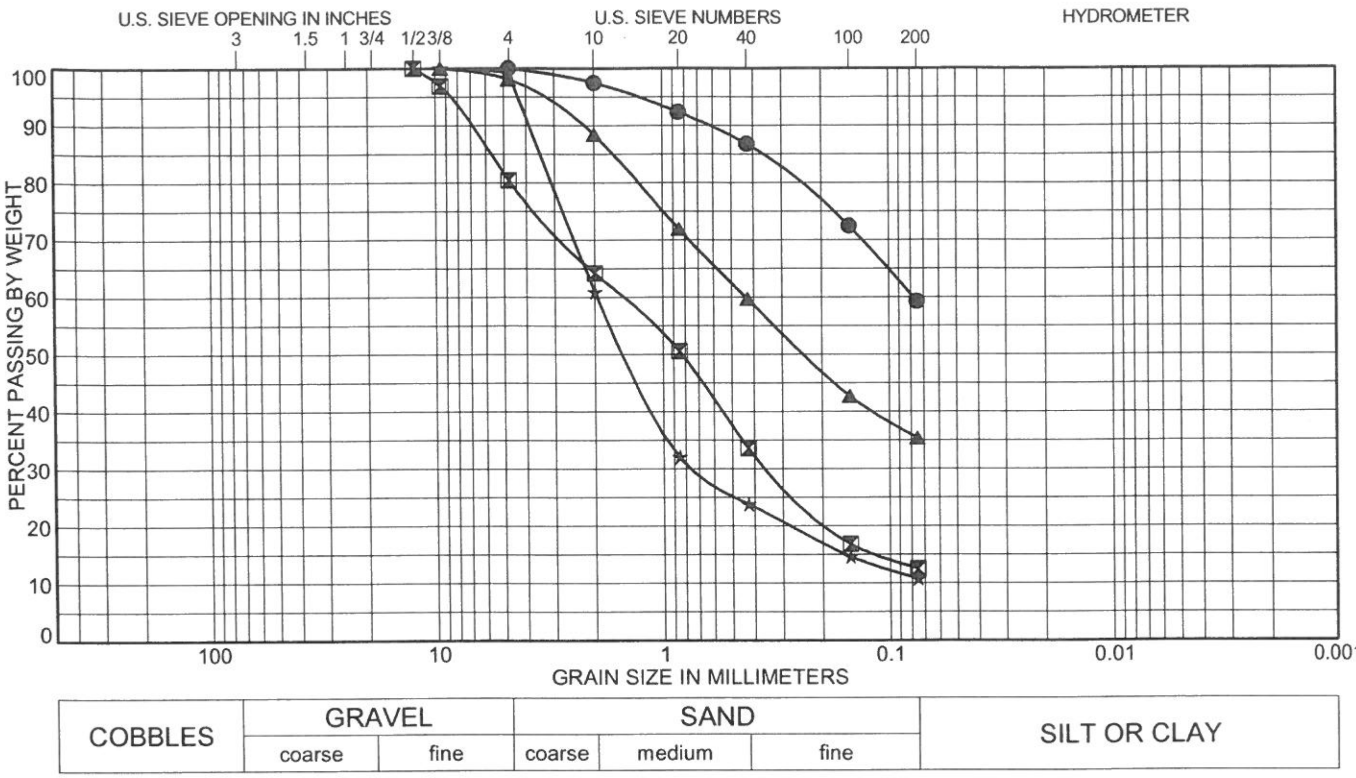
SOIL CLASSIFICATION DATA

JOB No. 155688

FIGURE No. 10

DATE 1/3/17



	Test Boring	Depth (ft)	Classification	LL	PL	PI
●	**B-2**	**19.0**	**SANDY LEAN CLAY(CL)**	**35**	**16**	**19**
⊠	**DW-1**	**2.0**	**SILTY SAND with GRAVEL(SM)**	**NP**	**NP**	**NP**
▲	**DW-1**	**4.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**
★	**DW-1**	**9.0**	**POORLY GRADED SAND with SILT(SP-SM)**	**NP**	**NP**	**NP**

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	**B-2**	**19.0**	**0.0**	**40.7**	**59.3**	
⊠	**DW-1**	**2.0**	**19.6**	**67.9**	**12.5**	
▲	**DW-1**	**4.0**	**1.9**	**62.7**	**35.4**	
★	**DW-1**	**9.0**	**0.6**	**88.6**	**10.7**	

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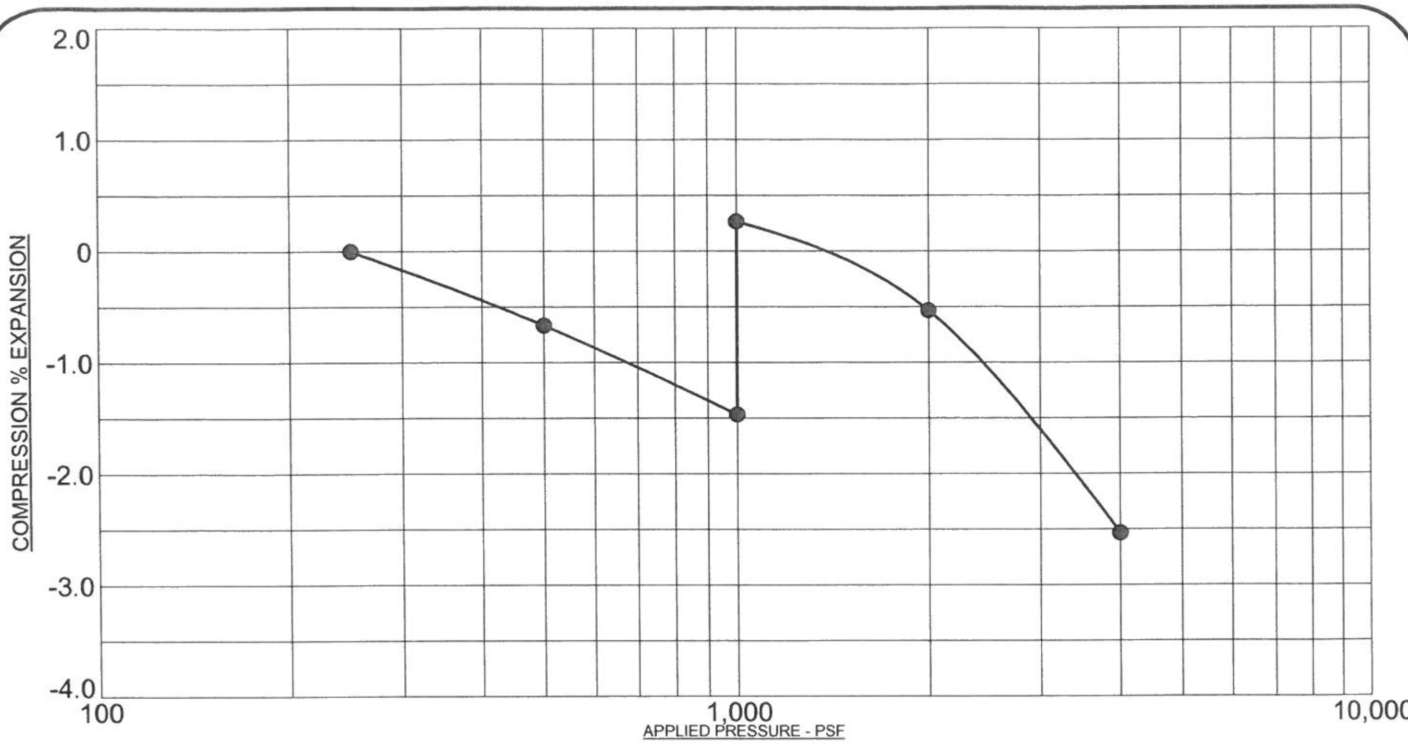
SOIL CLASSIFICATION DATA

JOB No. 155688

FIGURE No. 11

DATE 1/3/17



PROJECT: **11243 Londonderry Drive, El Paso County, Colorado**
SAMPLE DESCRIPTION: **SANDSTONE, SILTY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-5 @ 14 FT**
NATURAL DRY UNIT WEIGHT: **111.6 PCF**
NATURAL MOISTURE CONTENT: **12.9%**
PERCENT SWELL/COMPRESSION: **1.7**

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SWELL/CONSOLIDATION TEST RESULTS

JOB No. 155688

FIGURE No. 12

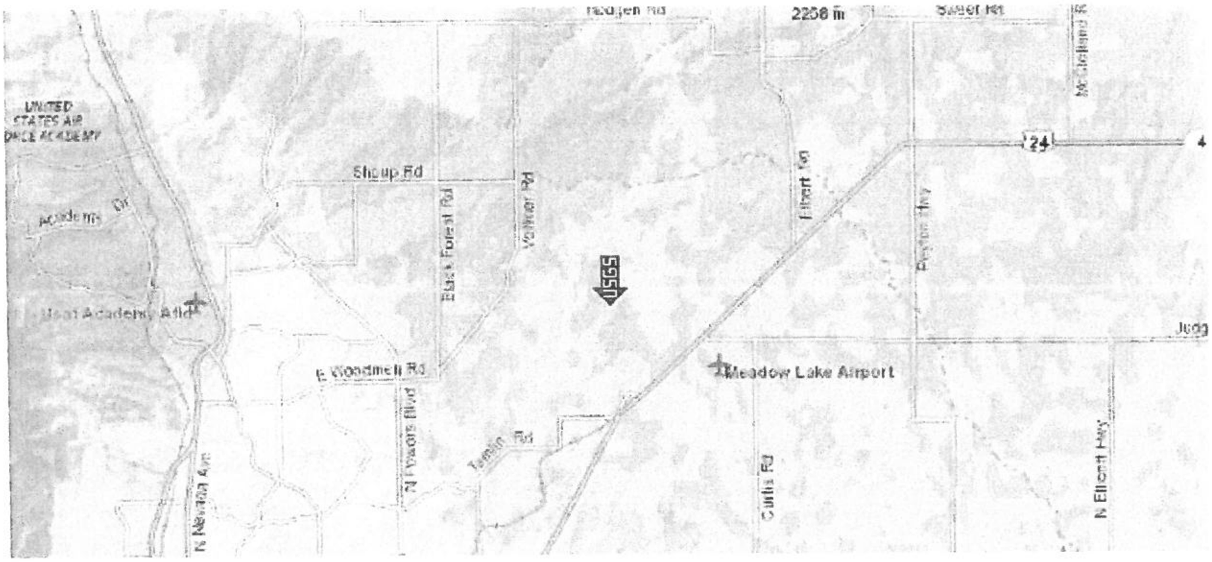
DATE 1/3/17

APPENDIX A

USGS Design Maps Summary Report

User–Specified Input

Report Title	D49 - New Elementary School- Falcon, CO Wed January 4, 2017 17:03:17 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	38.97667°N, 104.62094°W
Site Soil Classification	Site Class C – "Very Dense Soil and Soft Rock"
Risk Category	I/II/III

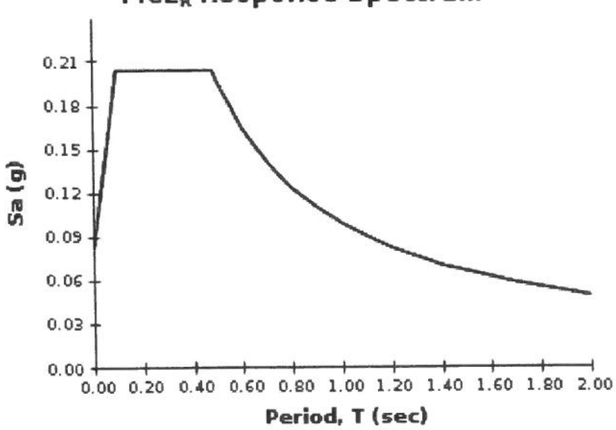


USGS–Provided Output

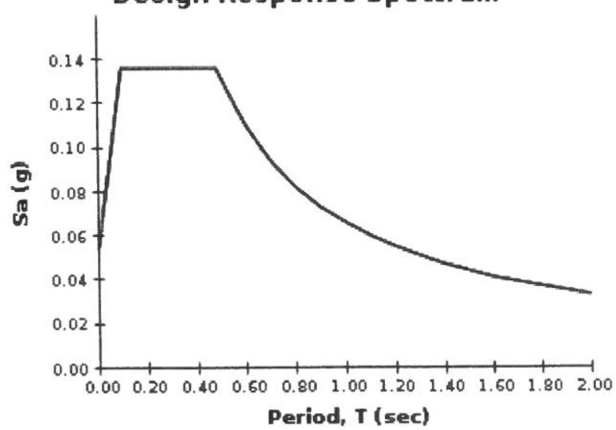
S_S =	0.170 g	S_{MS} =	0.204 g	S_{DS} =	0.136 g
S_1 =	0.058 g	S_{M1} =	0.099 g	S_{D1} =	0.066 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

MCE_R Response Spectrum



Design Response Spectrum



USGS Design Maps Detailed Report

2012/2015 International Building Code (38.97667°N, 104.62094°W)

Site Class C – "Very Dense Soil and Soft Rock", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1] $S_S = 0.170$ g

From Figure 1613.3.1(2) [2] $S_1 = 0.058$ g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class C, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index $PI > 20$, • Moisture content $w \geq 40\%$, and • Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_S

For Site Class = C and S_S = 0.170 g, F_a = 1.200

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1-s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_1

For Site Class = C and S_1 = 0.058 g, F_v = 1.700

Equation (16-37): $S_{MS} = F_aS_S = 1.200 \times 0.170 = 0.204$ g

---

Equation (16-38): $S_{M1} = F_vS_1 = 1.700 \times 0.058 = 0.099$ g

---

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39): $S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 0.204 = 0.136$ g

---

Equation (16-40): $S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 0.099 = 0.066$ g

---

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \leq S_{DS} < 0.33g$	B	B	C
$0.33g \leq S_{DS} < 0.50g$	C	C	D
$0.50g \leq S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.136 g, Seismic Design Category = A

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \leq S_{D1} < 0.133g$	B	B	C
$0.133g \leq S_{D1} < 0.20g$	C	C	D
$0.20g \leq S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.066 g, Seismic Design Category = A

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = A

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf
2. *Figure 1613.3.1(2)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf