Memorandum

MATERIALS AND GEOTECHNICAL BRANCH
GEOTECHNICAL PROGRAM
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IM 088A-024
Federal Blvd over US-6
SA 16228

TO: Mahmood Hasan, Staff Bridge

FROM: David Thomas, Geotechnical Program

DATE: December 3, 2009

SUBJECT: **GEOTECHNICAL RECOMMENDATIONS FOR REPLACEMENT OF STRUCTURE F-16-EK**

1.0 INTRODUCTION

This report presents geotechnical investigation observations and recommendations for the replacement of existing bridge structure F-16-EK, which carries Colorado Highway 88 (Federal Blvd) over US-6 at mile marker 1. The purpose of the geotechnical investigation is to characterize physical properties of foundation materials at the proposed bridge and ramp retaining wall locations. Foundation recommendations are also provided for design and construction. The scope of work was based on conversations with Hsu-Kun (Nick) Cheng of Region 6 South Engineering and Mansour (Mike) Mohseni with Staff Bridge.

1.1 PROJECT DESCRIPTION

The current four span bridge was built in 1958 on timber piles. The proposed bridge will be a two span bridge, but widened to accommodate additional traffic and turn lanes. Retaining walls will be required to the south along US-6 to support a proposed on-ramp reconfiguration from Federal Blvd to east bound US-6 with heights estimated from 3 to 27 feet.

2.0 GEOTECHNICAL INVESTIGATION

Geotechnical field activities were completed from May 4th through 20th, 2009. Five borings, TH1 through TH5, where advanced at the proposed pier and abutment locations. Ten borings, TH6 through THl5, where advanced at the proposed wall locations along US-6. The borings were advanced using a CME 75 truck mounted and a CME 550 all-terrain drill rigs with hollow stem auger and wire line core techniques. Standard penetration tests using split spoon samplers and California samplers were performed in the borings at select intervals per ASTM D-l586 and D-3550, respectively.

Traffic control was required for the abutment borings (THl through TH3) to allow for drilling on the exit and on ramps to US-6. Traffic control for the ramps was coordinated and provided by Jeff Martinez with CDOT. Night traffic control was also required to drill three borings. The

first was the pier location (TH5) in the No. 1 east bound lane on US-6. The remaining two borings (TH14 and TH15) were drilled on the Bryant St. exit ramp from US-6 for wall foundations. The borings were advanced in the exit lane because the rig could not safely access the proposed wall location approximately 20 feet to the south due to steep embankment topography and adjacent private property. The night traffic control was coordinated with Anthony Bertram from CDOT Patrol 7.

2.1 GEOLOGY

The general geology consists of medium stiff to very stiff clay overlaying medium dense to very dense well graded sand overlaying very hard claystone bedrock. Bedrock was encountered between 5,171 feet above mean sea level (amsl) (83 feet below ground suface [bgs]) to the north and 5,173 feet amsl (84 feet bgs) to the south. Soil and bedrock characteristics were consistent among borings. Groundwater was encountered in the borings during drilling between 5,194 feet amsl (28 feet bgs) to the east in TH14 and 5,224 feet amsl (32 feet bgs) to the west in TH3. Flowing sand conditions existed in areas where sand was present below the groundwater table. The boring logs and geology sheets are presented in Attachments 1 and 2, respectively.

2.2 PHYSICAL PROPERTIES

Clay samples resulted in AASHTO classifications of A-6 to A-7-6 with group indexes ranging from 1 to 31. Claystone samples resulted in an AASHTO classification of A-7-6 with group indexes of 29 to 40. The uniaxial compressive strengths for four bedrock samples ranged from 12.2 to 15.6 kips per square foot (ksf) and averaged 14.5 ksf. The unconfined compression test samples were obtained with a California sampler and may be lower than insitu values. Swell-consolidation results ranged from 0.1% to 2.0% under a 1 ksf load for clay samples collected beneath the proposed wall footings. Detailed material properties are presented in the laboratory test summary in Table l.

2.3 GEOCHEMISTRY

The bedrock was analyzed for percent sulfate, pH and resistivity. Based on the results of water soluble sulfate testing obtained from CP 2103, the potential for sulfate attack on Portland cement concrete in direct contact with the bedrock would be classified as a Class 0 exposure per Table 601.4 of the CDOT Standard Special Revision Section 601. Results for bedrock pH suggests no corrosion potential or non-aggressive behavior, however, bedrock resistivity values suggest a strong corrosion potential or aggressive behavior. Foundation design should consider a strong corrosion potential based on the resistance values per Table C.1 of FHWA report FHWAO-IF-3-017, Geotechnical Engineering Circular No. 7 - Soil Nail Walls.

3.0 RECOMMENDATIONS

The subsurface conditions are favorable for a bridge on drilled shaft or driven pile foundations. The ultimate capacity for design typically assumes a weighted load factor of 1.5 and a resistance factor of 0.5 when using the Load and Resistance Factor Design (LRFD) method.

TABLE 1
SA 16628: FEDERAL BLVD (SH-88) OVER US-6
LABORATORY TEST SUMMARY

Boring No.	Depth (ft bgs)	Elevation (ft amsl)	Sample No.	Visual Description	USCS	AASHTO	AASHTO Gradation				Liquid Limit	Plastic Limit	Plastic Index	Water Content (%)	Dry Density (lb/ft³)	Uniaxial Compressive Strength (psf)	Water Soluble Sulfates (%)	Swell Consolidation (%)	Soil pH H_2O/C_aC1_2	Resistivity ohm/cm Saturated
							Gravel (%)	Coarse Sand (%)	Fine Sand (%)	Silt & Clay (%)										
TH1	4.0		1B	Clay	CL	A-6 (9)	4.8	8.6	30.0	56.5	38	16	22	15.6	–	–	–	–	–	–
THI	19.0		1C	Clayey Sand	SC	A-6 (1)	9.0	17.5	37.5	35.9	35	19	16	19.8	–	–	–	–	–	–
TH1	74.0		1G	Gravel	GW-GC	–	48.3	24.0	18.1	9.6	–	–	–	8.6	–	–	–	–	–	–
TH2	23.0		2C	Clay	CL	–	0.0	0.5	10.3	89.1	–	–	–	28.8	–	–	–	–	–	–
TH2	68.5		2G	Sand	SW	–	31.4	33.0	31.5	4.1	–	–	–	13.2	–	–	–	–	–	–
TH2	98.0		2J	Claystone	CH	A-7-6 (30)	0.2	0.0	0.3	99.5	50	24	26	15.2	117.7	15,623	0.02	–	–	–
TH3	33.0		3C	Clay	CL	–	0.1	0.9	15.6	83.5	–	–	–	27.2	–	–	0.01	–	–	–
TH3	93.0		3F	Claystone	CL	–	0.0	0.0	0.0	100.0	–	–	–	15.1	116.4	15,047	0.01	–	–	–
TH4	18.5		4C	Clayey Sand	SC	–	0.6	12.2	39.3	47.9	–	–	–	19.4	–	–	–	–	–	–
TH4	28.5		4D	Clay	CH	A-7-6 (31)	0.1	0.6	11.9	87.5	53	19	34	30.1	93.2	–	–	–	–	–
TH4	53.5		4F	Clay	CL	A-6 (11)	0.3	4.7	30.5	64.5	40	19	21	28.1	94.8	–	0.01	–	–	–
TH4	93.5		4I	Claystone	CH	A-7-6 (29)	0.0	0.0	0.1	99.9	50	25	25	17.1	114.3	12,236	0.01	–	–	–
TH4	90.0		4-BR	Claystone	–	–	–	–	–	–	–	–	–	15.3	118.3	–	0.01	–	8.27	–
TH5	69.0		5G	Claystone	CH	A-7-6 (40)	0.0	0.0	0.1	99.9	55	19	36	15.3	118.3	15,029	0.00	–	–	–
TH6	15.0		6B	Sandy Clay	CL	A-7-6 (11)	3.4	11.2	29.7	55.7	42	16	26	17.9	–	–	–	–	–	–
TH6	24.0		6C	Clay	CL	A-6 (10)	4.0	5.9	30.8	59.3	40	19	21	28.4	94.1	–	0.00	–	–	–
TH6	35.0		6D	Clay	CL	–	–	–	–	76.5	–	–	–	26.9	–	–	–	–	–	–
TH7	13.5		7B	Clay	CL	A-7-6 (17)	0.9	7.5	27.5	64.1	48	18	30	22.7	102.1	–	–	1.5	–	–
TH8	18.0		8C	Clay	CL	A-7-6 (20)	0.0	0.2	18.7	81.1	42	17	25	25.5	–	–	0.00	–	–	–
TH8	48.0		8F	Clay	–	–	–	–	–	73.7	–	–	–	32.1	–	–	–	–	–	–
TH9	23.5		9C	Clay	CL	A-7-6 (21)	0.0	1.7	13.9	84.4	44	19	25	31.7	92.2	–	–	1.1	–	–
TH9	33.5		9D	Clay	CL	A-7-6 (17)	1.1	8.1	26.9	63.9	47	17	30	22.5	103.9	–	–	–	–	–
TH9	58.5		9F	Clay	CL	–	–	–	–	90.0	–	–	–	36.6	–	–	–	–	–	–
TH10	4.5		10B	Clay	–	–	–	–	–	89.3	–	–	–	17.6	105.3	–	–	–	–	–
TH10	14.5		10E	Clay	CL	A-7-6 (11)	1.9	11.0	31.9	55.1	45	18	27	21.7	102.4	–	–	2.0	–	–
TH11	19.5		11C	Clay	CL	A-7-6 (30)	0.0	1.3	14.2	84.5	54	20	34	26.3	–	–	0.08	–	–	–
TH11	39.5		11E	Gravel	GW	–	51.2	33.4	13.6	1.8	–	–	–	10.2	–	–	–	–	–	–
TH12	9.5		12B	Sandy Clay	CL	A-6 (10)	3.2	6.2	25.8	64.7	37	18	19	12.7	–	–	0.03	–	–	–
TH13	14.5		13C	Sand	SW-SC	–	46.5	40.9	8.4	5.1	–	–	–	2.1	–	–	–	–	–	–
TH13	39.5		13F	Sand	SW	–	37.8	48.7	11.1	2.5	–	–	–	12.7	–	–	–	–	–	–
TH14	9.5		14B	Clay	CL	–	–	–	–	63.8	–	–	–	23.2	–	–	0.07	–	–	–
TH15	24.0		15C	Clay	CL	A-7-6 (10)	13.8	7.5	23.5	55.2	43	18	25	11.6	111.1	–	–	0.1	–	–
COM	88.0		BR	Claystone	–	–	–	–	–	–	–	–	–	–	–	–	0.01	–	8.40	700

3.1 DRILLED SHAFTS

For drilled shafts embedded into the bedrock the ultimate end bearing capacity, q_p, and the ultimate side shear capacity, q_s, required for the LRFD method are presented in Table 2. Allowable end bearing capacity, q_a, and the allowable side shear capacity, f_a, for the Allowable Stress Design (ASD) method also are reproduced in Table 2. The side shear values are applicable in both vertical directions without reduction. Should a different load factor be applied for shafts, the resistance factor should be adjusted by dividing the new load factor by 3, to obtain the corresponding resistance factor.

The recommended minimum bedrock penetration is l0 feet. Side shear in the overburden soil should be ignored due to the difference in strain limit between the soil and bedrock. Also, the top 5 feet of bedrock penetration should be ignored for side shear resistance due to material weathering and potential disturbance from temporary casing.

TABLE 2. RECOMMENDED DRILLED SHAFT RESISTANCE VALUES FOR BEDROCK

Location	Estimated Bedrock Elevation (feet)	ASD		LRFD	
		q_a (ksf)	f_a (ksf)	q_p (ksf)	q_s (ksf)
North Abutment, West Edge	5,172	45	4.5	135	13.5
North Abutment, East Edge	5,172				
South Abutment, West Edge	5,172				
South Abutment, East Edge	5,172				
Center Pier	5,173				

The recommended axial capacities assume a minimum spacing of 2.5 shaft diameters, center-to center, between adjacent drilled shafts. Drilled shafts spaced at 2 diameters will require a reduction factor of 0.9. Closer spacing would require additional analysis and iteration with the structural engineer. The native soil overlying the bedrock or new embankment fill should be neglected when calculating the axial resistance, however, these materials can be considered for the lateral resistance. Material properties presented in Table 3 should be utilized when performing the lateral load analysis of the drilled shafts using LPILE or similar software.

Caving soil may occur above the bedrock elevation. Slurry and/or casing will be needed to support the soils overlying the bedrock during drilled shaft excavation if caving occurs. Dewatering of the drilled holes also may be required prior to placement of the concrete. The potential for dewatering may increase with the amount of time the drill holes remain open. Alliteratively, the concrete may be placed by tremie or other methods to avoid placement of concrete into water.

3.2 DRIVEN PILES

For driven piles with Grade 36 steel, a combined skin friction and end bearing ultimate capacity of 27 kips per square inch (ksi) times the cross sectional area of the pile is recommended. For Grade 50 steel, the ultimate capacity would be increased to 36 ksi. Per CDOT Construction Manual Standard Special Provision 502, a pile driving analyzer will be recommended to establish driving criteria. A resistance factor of 0.65 may be used in accordance with AASHTO LRFD specifications. Driven piles would function as end bearing piles at this site with generally less than 5 feet of penetration into bedrock estimated without pre-drilling. Battered piles no steeper than 1:4 (H:V) may be used to provide lateral capacity.

TABLE 3. RECOMMENDED MATERIAL PROPERTIES FOR LATERAL LOAD ANALYSIS USING LPILE

Material	Internal Friction Angle ϕ (degrees)	Cohesion C (lb/ft^2)	Horizontal Subgrade Reaction k_h (lb/in^3)	Strain at ½ the max principle stress difference ε_{50} (in/in)	Total Unit Weight γ_T (lb/ft^3)	Saturated Unit Weight γ_T (lb/ft^3)
New Class 1 Structure Backfill	34	0	64	–	125	135
Native Clay	0	1,000	250	0.010	110	120
Native Sand	32	0	20	–	125	135
Bedrock	0	10,000	1,000	0.005	135	145

3.3 RETAINING WALLS

The subsurface conditions appear favorable for a shallow foundation for retaining walls. Retaining walls vary in height and length from approximately 15 to 33 feet and 40 to 775 feet, respectively. Wall construction will also vary including MSE, cast in place, caisson, cut and fill walls. For retaining wall requiring fill, it is assumed new fill will consist of Class 1 Structure Backfill or borrow material from the onsite sources. Approved backfill from onsite borrow sources or Class 1 Structural Backfill should be compacted to at least 95 percent of the maximum dry density and within 2 percent of optimum moisture content as determined by AASHTO T180 (ASTM D 1557) and as described in Section 203 of the 2005 CDOT Standard Specification for Road and Bridge Construction. Table 4 summarizes the proposed walls and characteristics. The locations of the walls are presented on the attached geology sheets.

TABLE 4. SUMMARY OF RETAINING WALL CHARACTERISTICS

Wall No.	Approx. Maximum Height (ft)	Approx. Length (ft)	Approx. Footing Elevation (ft amsl)	Wall Type (Cut/Fill)	Foundation Soil Type
1	27	40	5,224	Cut	Clay
2	27	775	5,224	Cut & Fill	Clay
3	18	610	5,202	Cut & Fill	Clay
4	18	275	5,208	Fill	Clay & Sand
5	15	120	5,232	Fill	Clay

Retaining wall material parameters for design are presented in Table 5. The coefficients of earth pressure correspond to an active pressure equivalent fluid unit weight of 35 pounds per cubic foot (lb/ft^3) for Class 1 Structural Backfill. Lateral pressures must be reevaluated when sloping backfill or surcharge loads exist. A coefficient of sliding resistance (μ) of 0.45 may be used between concrete or MSE and undisturbed foundation soil. Temporary excavation support will be required where slopes are steeper than 1:1 (H:V). Parameters presented in Table 5 also are suitable for temporary excavation support design. Paramaters presented in Table 3 should be utilized when performing the lateral load analysis of drilled shafts using LPILE or similar software.

TABLE 5. MATERIAL PARAMETERS FOR RETAINING WALLS AND TEMPORARY EXCAVATIONS

Material	Typical Total Unit Weight γ_T (pcf)	Internal Friction Angle ϕ (degrees)	Cohesion C (psf)	Earth Pressure Coefficients		
				Active (Ka)	At Rest (Ko)	Passive (Kp)
New Class 1 Structure Backfill	125	34	0	0.28	0.44	3.5
Native Clay	110	20	1,000	0.49	0.66	2.0
Native Sand	125	32	0	0.33	0.47	3.3

The recommendations for drilled shafts presented in Section 3.1 may be used for caisson wall design. It is recommend that the edge to edge spacing between the caissons be limited to 0.25 times the caisson diameter or 18 inches, whichever is less.

The subsurface conditions appear favorable for a soil nail wall along cut wall sections. Using Table 3.10 from Geotechnical Engineering Circular No. 7: Soil Nail Walls (FHWA Report No. A0-IF-03-017), estimated ultimate bond strength for soil nails are 0.6 to 1.2 kip/ft^2 in the silty clay soils and 2.0 to 2.7 kip/ft^2 in the sand soils. It is recommended that Class I corrosion protection involving grout and PVC sheathing encapsulation be used for soil nail walls.

Ultimate bearing capacity values for walls 1, 2 and 5 were calculated to be 5.5 kip/ft^2 in the native clay. Ultimate bearing capacity values for walls 3 and 4 were calculated to be 8 kip/ft^2 where the native clay was underlain by sand. Bearing capacity values assume a foundation width of 40% of height, 3 foot minimum embedment for frost protection, a resistance factor of 0.5 and a load factor of 1.5. The global stability of the walls should be verified after final design is completed. Maximum wall settlement should be less than 3 inches and take up to two years. A majority of the settlement will occur during construction of the walls.

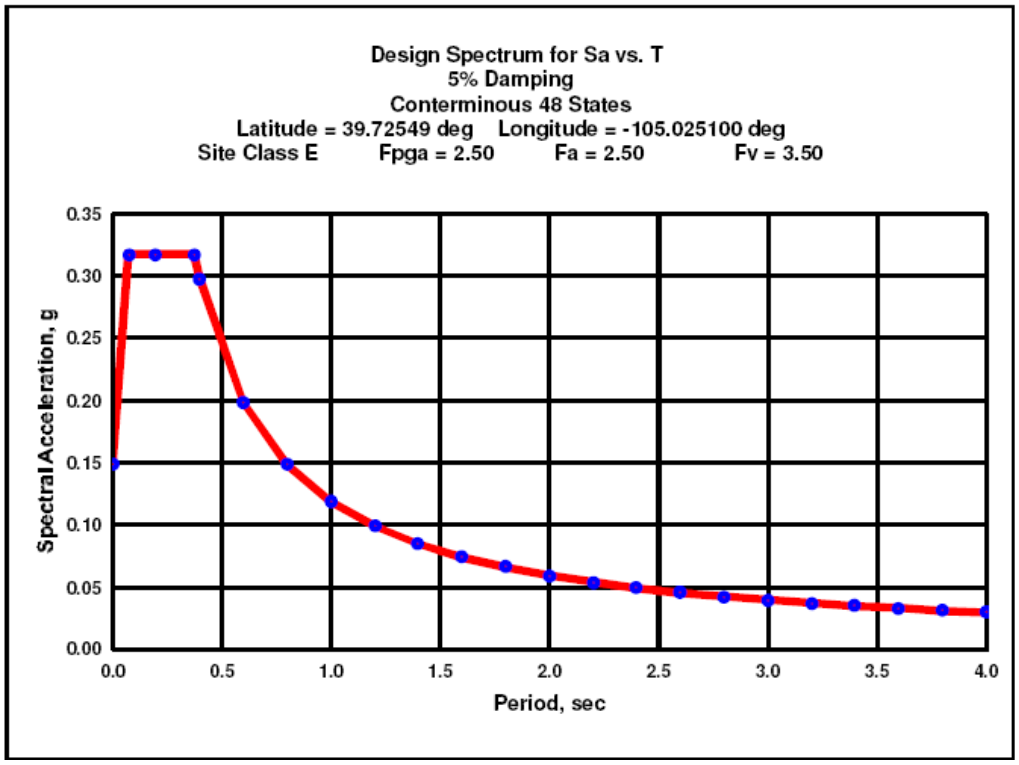
4.0 SEISMIC DESIGN PARAMETERS

The AASHTO Specifications for LRFD Seismic Bridge Design classify the site as “E" and the seismic zone as “1" using Tables 3.10.3.1-1 and 3.10.6-1, respectively. Using the USGS AASHTO Earthquake Motion Parameters program, the seismic design spectrum plots were created for Spectral Acceleration vs. Time and Spectral Acceleration vs. Spectral Displacement and are presented in Figures 1 and 2, respectively. Additional data from the program is included in Attachment 3. Please contact the Geotechnical Program at 303-398-6604 with questions.

REVIEW: Liu

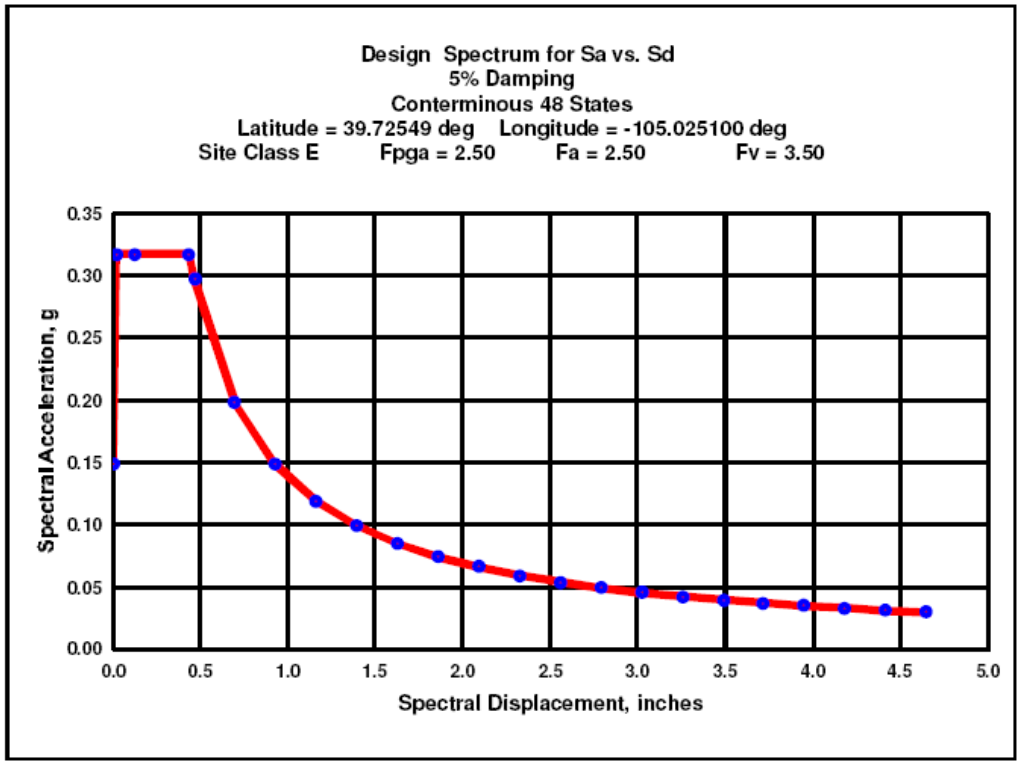
COPY: Akhavan – Reg.6 RTD
Gross – Reg. 6 South Resident Engineer
Cheng – Reg. 6 South Engineering
Ghaeli/Mero – Reg. 6 Materials
Mohseni – Staff Bridge
Werdel – Reg. 6 Hydraulics
Zufall/Kotzer – Branch Materials & Geotech

FIGURE 1. DESIGN SPECTRAL ACCELERATION VS. TIME



Graph Data	
Period, sec	Sa, g
0.00	0.1488
0.08	0.3172
0.20	0.3172
0.38	0.3172
0.40	0.2974
0.60	0.1982
0.80	0.1487
1.00	0.1189
1.20	0.0991
1.40	0.0850
1.60	0.0743
1.80	0.0661
2.00	0.0595
2.20	0.0541
2.40	0.0496
2.60	0.0457
2.80	0.0425
3.00	0.0396
3.20	0.0372
3.40	0.0350
3.60	0.0330
3.80	0.0313
4.00	0.0297

FIGURE 2. DESIGN SPECTRAL ACCELERATION VS. SPECTRAL DISPLACEMENT



Graph Data	
Sd, inches	Sa, g
0.00	0.1488
0.02	0.3172
0.12	0.3172
0.44	0.3172
0.46	0.2974
0.70	0.1982
0.93	0.1487
1.16	0.1189
1.39	0.0991
1.63	0.0850
1.86	0.0743
2.09	0.0661
2.32	0.0595
2.56	0.0541
2.79	0.0496
3.02	0.0457
3.25	0.0425
3.49	0.0396
3.72	0.0372
3.95	0.0350
4.18	0.0330
4.42	0.0313
4.65	0.0297

ATTACHMENT 1
IM 088A-024, SA 16628, FEDERAL BLVD OVER US-6
BORING LOGS

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 1

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/4/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,254.5ft	90.0ft	N: 687,604 E: 952,764	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
	0.6	Pavement Asphalt		0.0		
		Sandy Silt, light brown, stiff, slightly plastic, fine sand		3.0		
5250				4.0	1A 1B 4-4-5	9
				5.5		
5245						
5240						
5235	19.0	sandy silt, very stiff		19.0	1C 5-6-10	16
				20.5		
	22.0	Sandy Clay, stiff, light brown to blue gray				
5230	24.0	no recovery				
5225	29.0	sandy clay, stiff, light brown, plastic, slightly blocky		29.0	1D 4-4-5	9
				30.5		
5220						
5215						
5210						
5205	49.0	clay, mottled light brown & yellowish orange, stiff		49.0	1E 3-4-5	9
				50.5		
5200	54.0	clay, blue gray, stiff, plastic, sandy, blocky		54.0	1F	12

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH					
DATE					
TIME					

NOTES: CME 75, Wireline backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 1

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/4/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,254.5ft	90.0ft	N: 687,604 E: 952,764	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5195		Sandy Clay, stiff, light brown to blue gray *(continued)*		55.5	3-6-6	
5190						
5185						
	72.0	well graded gravel & sand, light brown, very dense, angular cobbles up to 4" diameter		74.0	1G 37-36-34	70
5180						
	78.0	*Drilling harder. Try to pull barrel but it's locked. Snap wireline cable*				
5175						
	83.0	Claystone, blue gray, very hard, blocky *drills harder - bedrock*				
5170						
5165				88.5	1H 32-41-42	83
	90.0	Total Boring Depth 90.0ft				
5160						
5155						
5150						
5145						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH					
DATE					
TIME					

NOTES: CME 75, Wireline backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 2

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/5/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,254.6ft	99.0ft	N: 687,606 E: 952,625	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5250	0.6	Asphalt sandy silt & clay, light brown, medium stiff, plastic				
5245				8.0	2A 4-3-4	7
5240	13.0	soft to medium soft		13.0	2B 3-2-2	4
5235						
5230	23.0	clay, light brown, stiff, plastic, interbedded fine sands		23.0	2C 3-4-7	11
5225						
5220	33.0	clay, stiff, mottled light brown & dark red		33.0	2D 4-4-5	9
5215						
5210	43.0	clay, stiff, mottled color, trace gravels		43.0	2E 4-6-7	13
5205						
5200	50.0	clay, blue gray, very stiff, silt-sandy, plastic				

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 32.0
DATE	5/5/09
TIME	

NOTES: CME 75, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 2

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/5/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,254.6ft	99.0ft	N: 687,606 E: 952,625	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5195		clay, blue gray, very stiff, silt-sandy, plastic *(continued)*		58.0	2F 4-8-8	16
5190						
5185	68.0	clay, blue gray, graded into sand		68.0	2G 12-10-20	30
	68.5	well graded sand, light brown, subangular, quartz & feldspar rich, medium dense to dense				
5180						
5175				78.0	2H 3-6-17	23
5170	83.0	Claystone Bedrock, light blue to blue gray, very hard, blocky				
5165				88.0	2I 19-31-60	91
5160						
5155	99.0	Total Boring Depth 99.0ft		98.0	2J 51-60/5"	111/11"
5150						
5145						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 32.0				
DATE	5/5/09				
TIME					

NOTES: CME 75, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 3

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/6/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,256.4ft	94.0ft	N: 687,305 E: 952,618	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%	SPT DATA (5 10 20 40 70)	WELL DIAGRAM
5255	0.6		Asphalt Clay, sandy, light brown, medium stiff, plastic		3.0	3A			
5250									
5245									
5240									
5235									
5230									
	28.0		clay, sandy, mottled light brown & red, medium stiff to stiff, blocky		28.0	3B 3-3-3	6		
5225					33.0	3C 4-4-5	9		
5220									
5215									
5210									
	49.0		*cuttings change color*						
	50.0		Clay, blue gray, medium stiff to stiff, plastic						
5205									

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 32.0				
DATE	5/5/09				
TIME					

NOTES: CME 75, Auger

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 3

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/6/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,256.4ft	94.0ft	N: 687,305 E: 952,618	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5200		Clay, blue gray, medium stiff to stiff, plastic *(continued)*				
5195						
5190				68.0	3D 3-5-11	16
	69.0	well graded sand, light gray, grading into light brown, subangular, coarsing downward				
5185						
5180						
5175						
	84.0	*drills harder*				
5170		Claystone bedrock, blue gray, very hard, blocky, > 4.5 T.S.F. on pocket penetrometer		88.0	3E 37-58	95
5165				93.0	3F 37-39	76
	94.0	Total Boring Depth 94.0ft				
5160						
5155						
5150						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 32.0				
DATE	5/5/09				
TIME					

NOTES: CME 75, Auger

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING #	PROJECT ID	SA	PROJECT NAME	DATE DRILLED
4		16628	US 6 off ramp to Federal	5/6/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,256.4ft	95.0ft	N: 687,315 E: 952,759	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5255	1.0	Topsoil, grass				
		silt, sandy, light brown, very stiff, micaceous		1.0	4A	
5250						
				8.5	4B 5-7-10	17
5245						
	14.0					
	14.0	sandy clay, light brown, stiff, plastic				
5240						
				18.5	4C 4-6-6	12
5235						
5230						
	28.5	clay, medium stiff		28.5	4D 4-5	9
5225						
5220						
	38.5	clay, medium stiff		38.5	4E 4-4-6	10
5215						
5210						
5205						
	53.5	clay, sandy with interbedded medium grained		53.5	4F	14

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 33.0				
DATE	5/6/09				
TIME					

NOTES: CME 75, Auger

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 4

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/6/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,256.4ft	95.0ft	N: 687,315 E: 952,759	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5200		sand layers, light brown, stiff, plastic, 1.5 T.S.F. with pocket penetrometer			5-9	
5195						
5190						
	68.5	CL - clay, blue gray, very stiff, plastic		68.5	4G 4-6-12	18
	70.0	well graded sand, medium dense, grading blue gray to light brown, coarsing downward				
5185						
5180						
5175						
	84.0	Claystone, blue gray, hard, blocky, > 4.5 T.S.F. on pocket penetrometer				
5170				88.5	4H 13-28-38 4-BR	66
	90.0	*bag sample taken from auger cuttings*		90.0		
5165				93.5	4I 26-60/5"	86/11"
	95.0	Total Boring Depth 95.0ft				
5160						
5155						
5150						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 33.0				
DATE	5/6/09				
TIME					

NOTES: CME 75, Auger

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 5

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/7/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,234.9ft	70.0ft	N: 687,450 E: 952,723	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
	0.7	Pavement				
		Clay, light brown, sandy, plastic, medium stiff				
5230						
	6.0	water, clean, storm drain? (no clay, plastic or steel in cuttings or sampler)				
	9.0	no recovery		9.0	5A 5-3-3	6
5225						
5220						
	19.0	no recovery		19.0	5B 7-8-9	17
5215						
5210						
	29.0	clay, stiff		29.0	5C 4-6-5	11
5205						
5200						
	39.0	clay, blue gray, sandy, very stiff, plastic, minor recovery in shoe		39.0	5D 6-8-9	17
5195						
5190						
	49.0	well graded sand, light gray grading to light brown, dense, angular, coarsing down		49.0	5E 10-24	34
5185						
5180						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH					
DATE					
TIME					

NOTES: CME 75, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 5

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/7/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,234.9ft	70.0ft	N: 687,450 E: 952,723	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%	SPT DATA (5 10 20 40 70)	WELL DIAGRAM
5175	59.0		well graded sand, light gray grading to light brown, dense, angular, coarsing down *(continued)*						
			no recovery, flowing sands		59.0	5F 5-10-11	21		
	62.0		Claystone Bedrock, blue gray, very hard, blocky, > 4.5 T.S.F. on pocket penetrometer						
5170									
5165					69.0	5G 60-50/4"	110/10"		
	70.0		Total Boring Depth 70.0ft						
5160									
5155									
5150									
5145									
5140									
5135									
5130									
5125									

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH					
DATE					
TIME					

NOTES: CME 75, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 6

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/11/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,252.6ft	60.0ft	N: 687,280 E: 953,142	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5250		silty sand, light brown, medium dense, roots				
	5.0	sandy clay, light brown, stiff, slightly plastic, fine grained sand lenses		4.0	6A 5-8-9	17
5245						
5240				14.0	6B 4-4-6	10
5235						
5230						
	24.0	sandy clay, medium stiff to stiff, 0.75 T.S.F. on pocket penetrometer		24.0	6C 3-5	8
5225						
	30.0					
5220						
	34.0	clay, light brown, stiff, plastic		34.0	6D 5-5-6	11
	36.0	*hit resistance*				
5215						
	39.5	*refusal at 39.5, augers came loose, lost 5' in bottom of hole, move 5' south & redrill*		39.5	6E 4-4-5	9
5210		clay, light brown				
5205						
	49.0	clay with sand lenses, light brown, stiff plastic, medium grained sand, 1.75 T.S.F. on pocket penetrometer		49.0	6F 4-6	10
5200						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 36.0				
DATE	5/11/09				
TIME					

NOTES: CME 75, Auger

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 6

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/11/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,252.6ft	60.0ft	N: 687,280 E: 953,142	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%	SPT DATA (5 10 20 40 70)	WELL DIAGRAM
5195									
	59.0		clay with sand lenses, olive gray, very stiff,		59.0	6G	23		
	60.0		medium grained sand			7-12-11			
5190			Total Boring Depth 60.0ft						
5185									
5180									
5175									
5170									
5165									
5160									
5155									
5150									
5145									

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 36.0					NOTES: CME 75, Auger
DATE	5/11/09					
TIME						

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 7

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/12/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,236.1ft	50.0ft	N: 687,284 E: 953,263	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5235		sandy silt, light brown, stiff, roots				
5230				5.5	7A 8-7-7	14
	7.0	clay with sand lenses, light brown, stiff, fine to medium grained sand, plastic				
5225				13.5	7B 5-9	14
5220						
5215						
	23.5	clay, same as above, 1.75 T.S.F. on pocket penetrometer		23.5	7C 4-7	11
5210						
5205						
	33.5	clay with sand lenses, light brown, medium stiff to stiff, plastic, minor iron oxide staining, sand is medium grained, subrounded & wet		33.5	7D 5-7-8	15
5200						
5195						
	42.0	clay, blue gray, stiff, plastic				
5190						
				48.5	7E 4-5-5	10
	50.0	Total Boring Depth 50.0ft				
5185						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 23.0
DATE	5/12/09
TIME	

NOTES: CME 75, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 8

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/12/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,251.6ft	59.5ft	N: 687,330 E: 953,160	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5250		sandy silt, olive gray to dark gray, very stiff, slightly plastic		1.0	8A	
5245				8.0	8B 5-8-13	21
5240	12.0	sandy clay, mottled light brown & light red, medium stiff to stiff, plastic, sand lenses				
5235						
	18.0	2.25 T.S.F. on pocket penetrometer		18.0	8C 4-7	11
5230						
5225				28.0	8D 3-4-4	8
5220						
5215						
	38.0	1.25 T.S.F. on pocket penetrometer		38.0	8E 4-6	10
5210						
5205	46.0	*color change*				
	46.0					
	48.0	clay, mottled light brown & light gray, stiff		48.0	8F 4-4-5	9
5200						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 30.0
DATE	5/12/09
TIME	

NOTES: CME 75, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 8

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/12/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,251.6ft	59.5ft	N: 687,330 E: 953,160	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%	SPT DATA (5 10 20 40 70)	WELL DIAGRAM
5195									
	58.0		clay, blue gray, stiff, plastic, 2 T.S.F. on pocket penetrometer	▲	58.0	8G 6-8	14		
	59.5		Total Boring Depth 59.5ft						
5190									
5185									
5180									
5175									
5170									
5165									
5160									
5155									
5150									
5145									

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 30.0				
DATE	5/12/09				
TIME					

NOTES: CME 75, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 9

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/12/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,253.8ft	60.0ft	N: 687,315 E: 952,947	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5250		sandy silt, yellowish orange to light brown, stiff, slightly plastic		3.5	9A 6-7-6	13
5245						
5240				13.5	9B 4-5-6	11
5235	18.0					
	18.0	clay, light brown, medium stiff to stiff, plastic, sand lenses, fine to medium grained, 0.5 T.S.F. on pocket penetrometer				
5230				23.5	9C 3-5	8
5225						
5220	33.5	2.0 T.S.F. on pocket penetrometer		33.5	9D 5-9	14
5215						
5210	43.5	sandy clay, as above		43.5	9E 4-5-6	11
5205	48.0	*color change*				
5200						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 32.0				
DATE	5/12/09				
TIME					

NOTES: CME 75, Auger

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 9

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/12/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,253.8ft	60.0ft	N: 687,315 E: 952,947	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%	SPT DATA (5 10 20 40 70)	WELL DIAGRAM
5195	58.5		clay, blue gray, stiff, plastic		58.5	9F 4-5-5	10		
	60.0		Total Boring Depth 60.0ft						
5190									
5185									
5180									
5175									
5170									
5165									
5160									
5155									
5150									
5145									

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 32.0					NOTES: CME 75, Auger
DATE	5/12/09					
TIME						

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 10

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/13/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,234.3ft	21.0ft	N: 687,338 E: 953,374	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
	0.0	sandy silt, light brown to dark red, stiff, slightly plastic, fine sand, roots		0.0	10A 4-4-5	9
5230	4.0	sandy clay, light brown, very stiff to hard		4.5	10B 11-19	20
5225	9.5	mottled light brown & red, very stiff		9.5	10C 6-12-14	26
5220	14.5	light brown, some white crystalization, calcite?, very stiff, > 4.5 T.S.F. on pocket penetrometer		14.5	10D 8-15	23
5215	19.5	mottled light brown, light gray and red, very stiff		19.5	10E 4-7-10	17
	21.0	Total Boring Depth 21.0ft				

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH					
DATE					
TIME					

NOTES: CME 550, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 11

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/13/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,225.5ft	60.0ft	N: 687,306 E: 953,563	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
		silt, sandy, light brown		1.0	11A	
5220	5.0	sandy clay, mottled light brown and iron oxide red, very stiff, slightly plastic				
5215				9.5	11B 5-8-10	18
5210						
5205	19.5	2.75 T.S.F. on pocket penetrometer		19.5	11C 6-9	15
5200						
5195	30.0	well graded sand, yellowish orange to tan, dense, subangular		29.5	11D 7-16-19	35
5190						
5185	39.5	8' of flowing sand in auger		39.5	11E 5-19-17	36
5180						
5175	49.5	skip drive, flowing sand in auger				
	53.0	Claystone, blue gray, very hard, blocky, 4.5 T.S.F. on pocket penetrometer				

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 32.0				
DATE	5/13/09				
TIME					

NOTES: CME 550, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 11

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/13/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,225.5ft	60.0ft	N: 687,306 E: 953,563	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%	SPT DATA (5 10 20 40 70)	WELL DIAGRAM
			Claystone, blue gray, very hard, blocky, 4.5 T.S.F. on pocket penetrometer *(continued)*						
5165	60.0		Total Boring Depth 60.0ft		59.5	11F	59/6"	>>	
5160									
5155									
5150									
5145									
5140									
5135									
5130									
5125									
5120									

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 32.0					NOTES: CME 550, Auger backfilled with cuttings
DATE	5/13/09					
TIME						

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 12

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/13/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,212.4ft	40.5ft	N: 687,122 E: 953,596	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5210	0.0	sandy silt, dark brown, stiff		0.0	12A 3-3-6	9
	4.0	sandy clay, light brown, stiff, slightly plastic cobbles up to 6" diameter in cuttings, well rounded				
5205	9.0	cobbles up to 6" diameter in cuttings, well rounded		9.5	12B 6-6	12
5200	13.0	well graded sand, light brown, medium dense, flowing sands beneath water table				
5195						
	19.0	no recovery, 1.5' flowing sand in auger, *raise auger to prevent sand locking sampler*		19.0	12C 5-5-8	13
5190						
5185						
5180						
5175						
	39.0	no sample, flowing sands in auger		39.0	12D 3-2-4	6
	40.5	Total Boring Depth 40.5ft				
5170						
5165						
5160						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 17.0				
DATE	5/13/09				
TIME					

NOTES: CME 550, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 13

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/13/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,225.6ft	41.0ft	N: 686,899 E: 953,596	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
			sandy silt, dark brown, medium stiff		0.0	13A 3-2-3	5
	2.0		well graded sand, yellowish orange, medium dense, subrounded to subangular, quartz rich, 5-10% gravel by volume		4.5	13B 6-6	12
5220							
5215							
5210					14.5	13C 4-5-7	12
5205							
5200					24.5	13D 1-7-12	19
5195							
5190					34.5	13E 6-5-13	18
5185					39.5	13F 5-10-15	25
	41.0		Total Boring Depth 41.0ft				
5180							
5175							

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 15.0				
DATE	5/13/09				
TIME					

NOTES: CME 550, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 14

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/19/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,222.1ft	40.0ft	N: 687,346 E: 953,806	D. Thomas/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5220					1.0	14A	
5215	9.5		sandy silt, light brown, medium stiff to stiff, 1.25 T.S.F on pocket penetrometer, plastic		9.5	14B 3-5	8
5210							
5205	19.5		sandy clay, light brown & olive gray, stiff, 2.0 T.S.F. on pocket penetrometer		19.5	14C 4-6	10
5200							
5195	28.0						
	29.5		well graded sand, loose, subangular, wet		29.5	14D 5-5-9	14
5190							
5185	36.0		no recovery 5' flowing sand in auger, have to pull up 4' to clear sand, hammer has major hydraulic leak, won't run again, sampler sand locked in augers		36.0	14E 3-3-4	7
	40.0		Total Boring Depth 40.0ft				
5180							
5175							
5170							

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 28.0				
DATE	5/19/09				
TIME					

NOTES: CME 550, Auger backfilled with cuttings

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # 15

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
	16628	US 6 off ramp to Federal	5/19/09

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
US 6	Denver	/	at SH 88

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
5,220.3ft	40.5ft	N: 687,308 E: 954,006	D. Thomas/P. Spahr/R, Brown

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
5215	4.0	silt, with sand, olive gray, stiff, plastic		4.0	15A 3-6-8	14
5210	10.0					
5205	14.0	sandy clay, olive gray, medium stiff to stiff		14.0	15B 3-6-8	14
5200						
5195	24.0	sandy clay, dark gray to olive gray, medium stiff, 1.25 T.S.F on pocket penetrometer		24.0	15C 3-4	7
5190	30.0					
5185	34.0	well graded sand, light brown, medium dense, subangular		34.0	15D 5-9-14	23
5180	39.0	no recovery		39.0	15E 1-7-13	20
	40.5	Total Boring Depth 40.5ft				
5175						
5170						

SPT DATA: 5 10 20 40 70

WELL DIAGRAM

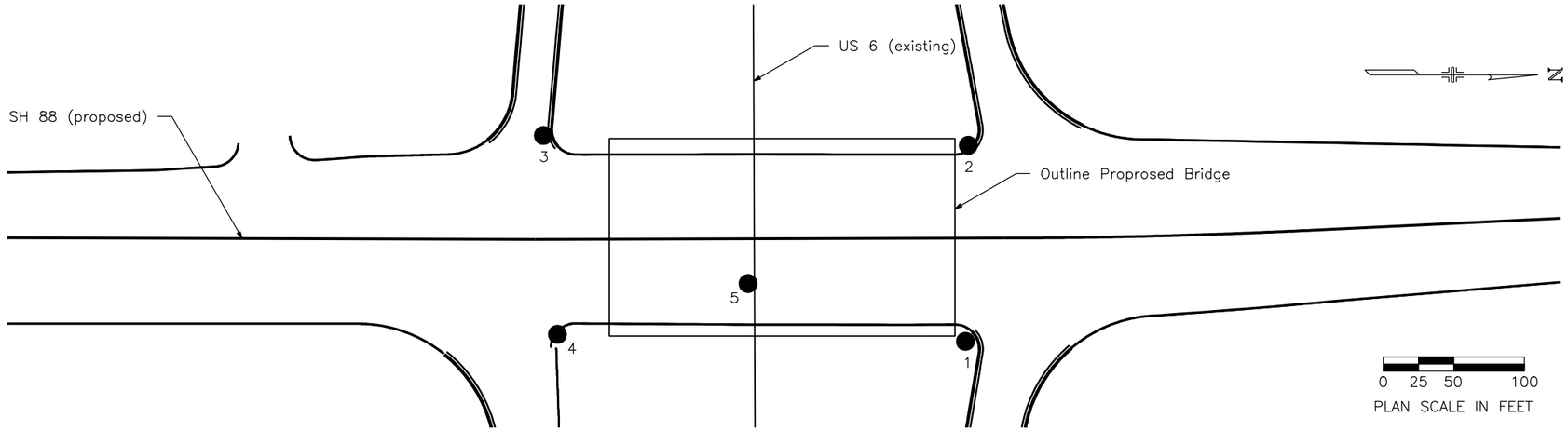
SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH						
DATE						
TIME						

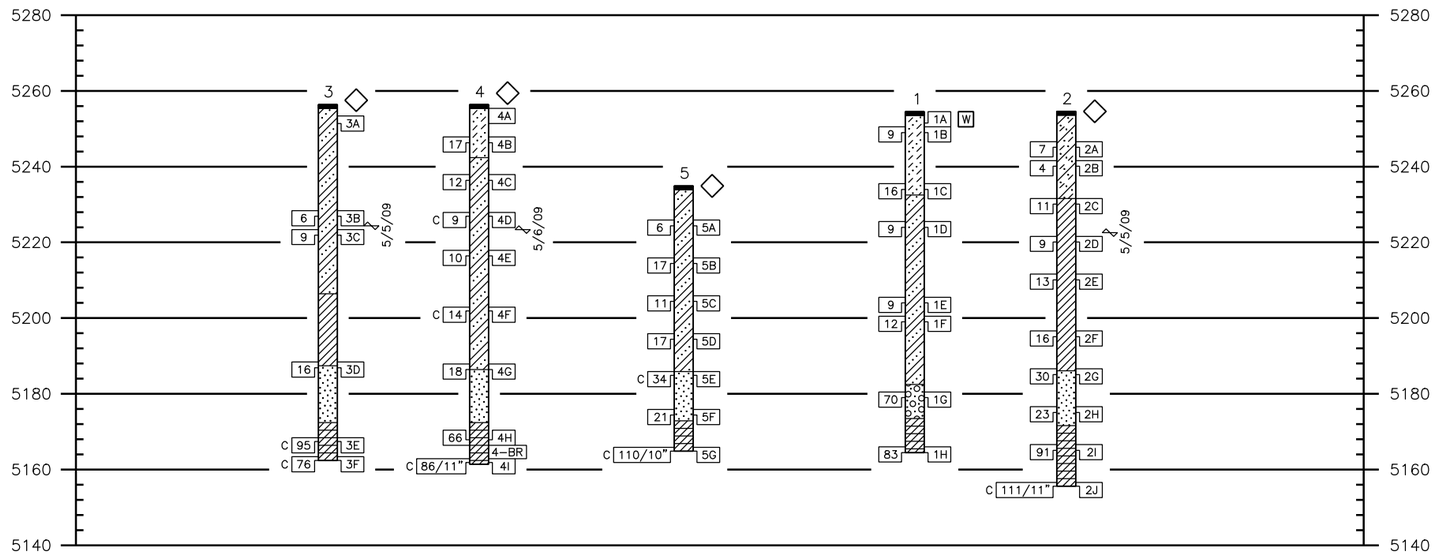
NOTES: CME 75, Auger

GEOLOGIC BORING LOG US6 FEDERAL RAMP.GPJ CO_DOT.GDT 9/1/09

ATTACHMENT 2
IM 088A-024, SA 16628, FEDERAL BLVD OVER US-6
GEOLOGY SHEETS



The boring logs of these test holes and geotechnical report are on file in the Geotechnical Program Office, Staff Materials and Geotechnical Branch, (303)398-6601



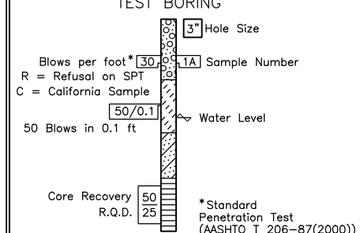
SUMMARY OF TEST RESULTS

Sample Number	Depth (feet)	Classification			Grading Analysis (AASHTO) Percent				Atterberg Limits			Water Content W %
		Corps of Engrs. or Visual	USCS	AASHTO	Gravel	Coarse Sand	Fine Sand	Silt and Clay	L.L. L_W	P.L. P_W	P.I. I_W	
1B	4.0	Clay	CL	A-6(9)	4.8	8.6	30.0	56.5	38	16	22	15.6
1C	19.0	Clayey Sand	SC	A-6(1)	9.0	17.5	37.5	35.9	35	19	16	19.8
1G	74.0	Gravel	GW-GC	–	48.3	24.0	18.1	9.6	–	–	–	8.6
2C	23.0	Clay	CL	–	0.0	0.5	10.3	89.1	–	–	–	28.8
2G	68.5	Sand	SW	–	31.4	33.0	31.5	4.1	–	–	–	13.2
2J	98.0	Claystone	CH	A-7-6(30)	0.2	0.0	0.3	99.5	50	24	26	15.2
3C	33.0	Clay	CL	–	0.1	0.9	15.6	83.5	–	–	–	27.2
3F	93.0	Claystone	CL	–	0.0	0.0	0.0	100.0	–	–	–	15.1
4C	18.5	Clayey Sand	SC	–	0.6	12.2	39.3	47.9	–	–	–	19.4
4D	28.5	Clay	CH	A-7-6(31)	0.1	0.6	11.9	87.5	53	19	34	30.1
4F	53.5	Clay	CL	A-6(11)	0.3	4.7	30.5	64.5	40	19	21	28.1
4I	93.5	Claystone	CH	A-7-6(29)	0.0	0.0	0.1	99.9	50	25	25	17.1
4-BR	90.0	Claystone	–	–	–	–	–	–	–	–	–	15.3
5G	69.0	Claystone	CH	A-7-6(40)	0.0	0.0	0.1	99.9	55	19	36	15.3

TYPE OF MATERIAL

- Pavement, Asphalt, Topsoil
- Clay
- Sandy Clay
- Sandy Clay, Sandy Silt
- Sandy Silt
- Sand
- Gravel & Sand
- Claystone

LEGEND



- Location of Test Boring
- Location of Continuous Penetration Test
- W 3 Inch Wireline Boring
- Rotary Boring
- Auger Boring

Print Date: 8/24/2009
Drawing File Name: 16628geosheet01 bridge.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Staff Geotechnical Program HCL

R-X

Sheet Revisions

Date:	Comments	Init.

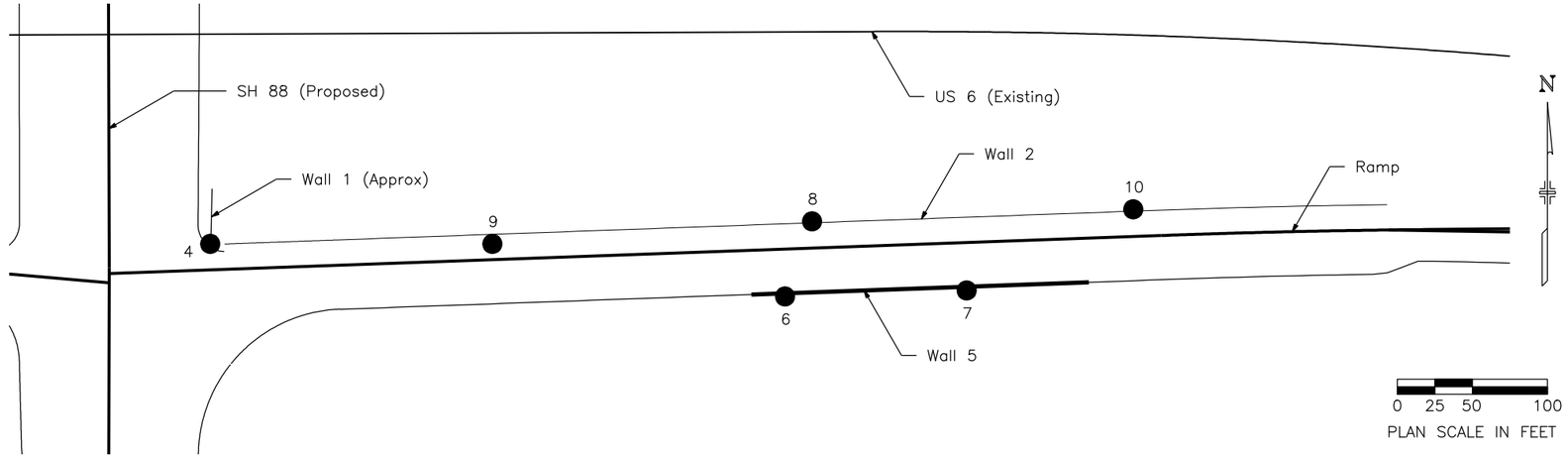
Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
4670 Holly Street, Unit A
Denver, CO 80216
Phone: 303-398-6601 FAX: 303-398-6504
Staff Geotechnical Program HCL

As Constructed
No Revisions:
Revised:
Void:

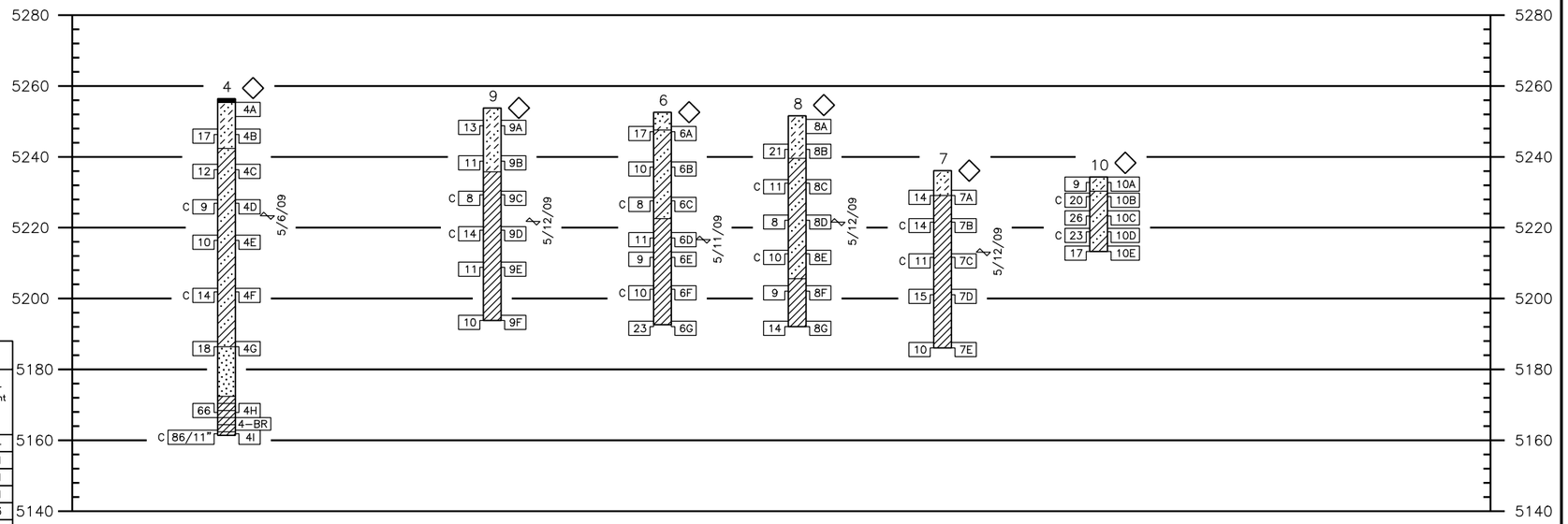
ENGINEERING GEOLOGY

Designer: D. Thomas
Detailer: T. McNulty
Sheet Subset: Geology
Structure Numbers
Subset Sheets: XXX of XXX

Project No./Code
IM 088A-24
16628
Sheet Number XXX



The boring logs of these test holes and geotechnical report are on file in the Geotechnical Program Office, Staff Materials and Geotechnical Branch, (303)398–6601



SUMMARY OF TEST RESULTS

Sample Number	Depth (feet)	Classification			Grading Analysis (AASHTO) Percent				Atterberg Limits			Water Content W %
		Corps of Engrs. or Visual	USCS	AASHTO	Gravel	Coarse Sand	Fine Sand	Silt and Clay	L.L. L_W	P.L. P_W	P.I. I_W	
4C	18.5	Clayey Sand	SC	–	0.6	12.2	39.3	47.9	–	–	–	19.4
4D	28.5	Clay	CH	A–7–6(31)	0.1	0.6	11.9	87.5	53	19	34	30.1
4F	53.5	Clay	CL	A–6(11)	0.3	4.7	30.5	64.5	40	19	21	28.1
4I	93.5	Claystone	CH	A–7–6(29)	0.0	0.0	0.1	99.9	50	25	25	17.1
4–BR	90.0	Claystone	–	–	–	–	–	–	–	–	–	15.3
6B	15.0	Sandy Clay	CL	A–7–6(11)	3.4	11.2	29.7	55.7	42	16	26	17.9
6C	24.0	Clay	CL	A–6(10)	4.0	5.9	30.8	59.3	40	19	21	28.4
6D	35.0	Clay	CL	–	–	–	–	76.5	–	–	–	26.9
7B	13.5	Clay	CL	A–7–6(17)	0.9	7.5	27.5	64.1	48	18	30	22.7
8C	18.0	Clay	CL	A–7–6(20)	0.0	0.2	18.7	81.1	42	17	25	25.5
8F	48.0	Clay	–	–	–	–	–	73.7	–	–	–	32.1
9C	23.5	Clay	CL	A–7–6(21)	0.0	1.7	13.9	84.4	44	19	25	31.7
9D	33.5	Clay	CL	A–7–6(17)	1.1	8.1	26.9	63.9	47	17	30	22.5
9F	58.5	Clay	CL	–	–	–	–	90.0	–	–	–	36.6
10B	4.5	Clay	CL	–	–	–	–	89.3	–	–	–	17.6
10E	14.5	Clay	–	A–7–6(11)	1.9	11.0	31.9	55.1	45	18	27	21.7

TYPE OF MATERIAL

- Pavement, Asphalt, Topsoil
- Clay
- Sandy Clay
- Sandy Silt
- Sand
- Silty Sand
- Claystone

LEGEND

TEST BORING

- 3" Hole Size
- Blows per foot* 30 / 1A Sample Number
- R = Refusal on SPT
- C = California Sample
- 50/0.1 — 50 Blows in 0.1 ft
- Water Level
- Core Recovery 50 / R.Q.D. 25
- *Standard Penetration Test (AASHTO T 206–87(2000))

CONTINUOUS PENETRATION TEST

2 Inch Diameter Drive Point
30 Inch Free Fall
140 Pound Hammer

0 50 100
Blows Per Foot

- Location of Test Boring
- Location of Continuous Penetration Test
- W 3 Inch Wireline Boring
- Rotary Boring
- Auger Boring

Print Date: 9/1/2009
Drawing File Name: 16628geosheet02 wall1 2 5.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Staff Geotechnical Program HCL

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Sheet Revisions

Date:	Comments	Init.

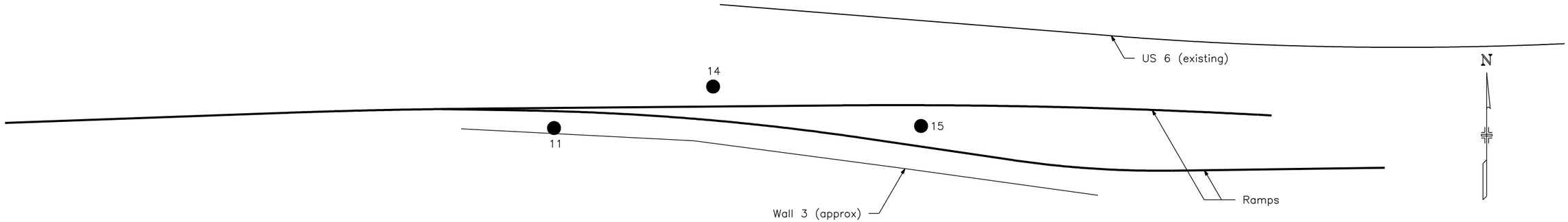
Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
4670 Holly Street, Unit A
Denver, CO 80216
Phone: 303-398-6601 FAX: 303-398-6504
Staff Geotechnical Program HCL

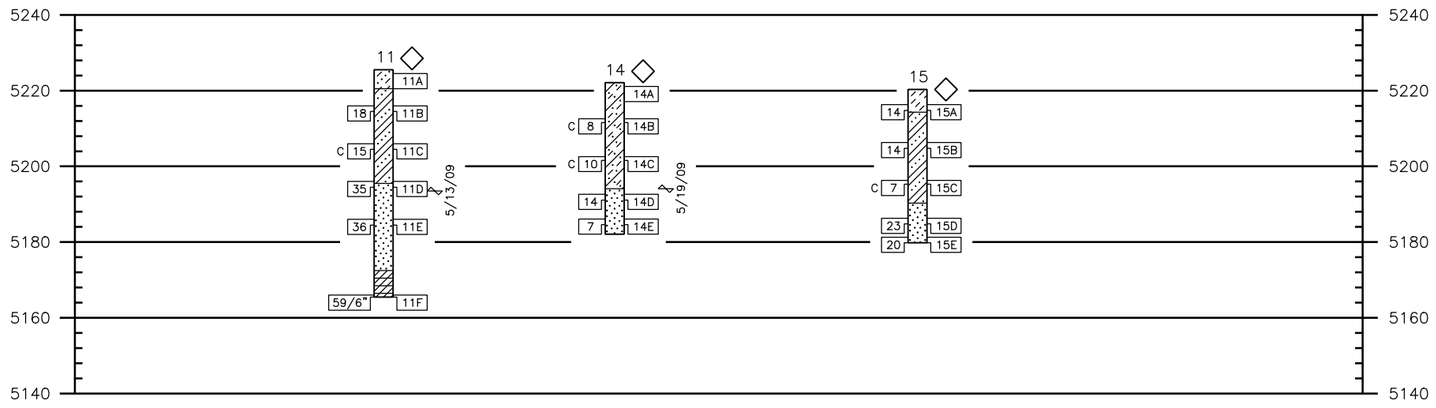
As Constructed
No Revisions:
Revised:
Void:

ENGINEERING GEOLOGY

Designer: D. Thomas
Detailer: T. McNulty
Sheet Subset: Geology
Structure Numbers: Walls 1, 2 / Wall 5
Subset Sheets: XXX of XXX

Project No./Code
IM 088A-24
16628
Sheet Number XXX





The boring logs of the above test holes and geotechnical report are on file in the Geotechnical Program Office, Staff Materials and Geotechnical Branch, (303)398-6601

SUMMARY OF TEST RESULTS

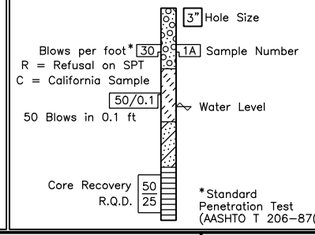
Sample Number	Depth (feet)	Classification			Grading Analysis (AASHTO) Percent				Atterberg Limits			Water Content W %
		Corps of Engrs. or Visual	USCS	AASHTO	Gravel	Coarse Sand	Fine Sand	Silt and Clay	L.L. L_W	P.L. P_W	P.I. I_W	
11C	19.5	Clay	CL	A-7-6(30)	0.0	1.3	14.2	84.5	54	20	34	26.3
11E	39.5	Gravel	GW	–	51.2	33.4	13.6	1.8	–	–	–	10.2
14B	9.5	Clay	CL	–	–	–	–	63.8	–	–	–	23.2
15C	24.0	Clay	CL	A-7-6(10)	13.8	7.5	23.5	55.2	43	18	25	11.6

TYPE OF MATERIAL

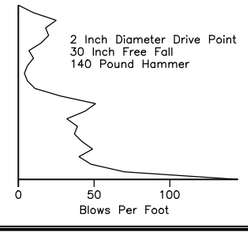
- Sandy Clay
- Sandy Clay, Sandy Silt
- Sandy Silt
- Silt
- Sand
- Claystone

LEGEND

TEST BORING



CONTINUOUS PENETRATION TEST



- Location of Test Boring
- Location of Continuous Penetration Test
- W 3 Inch Wireline Boring
- Rotary Boring
- Auger Boring

Print Date: 8/24/2009
Drawing File Name: 16628geosheet03 wall 3.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Staff Geotechnical Program HCL

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Sheet Revisions

Date:	Comments	Init.

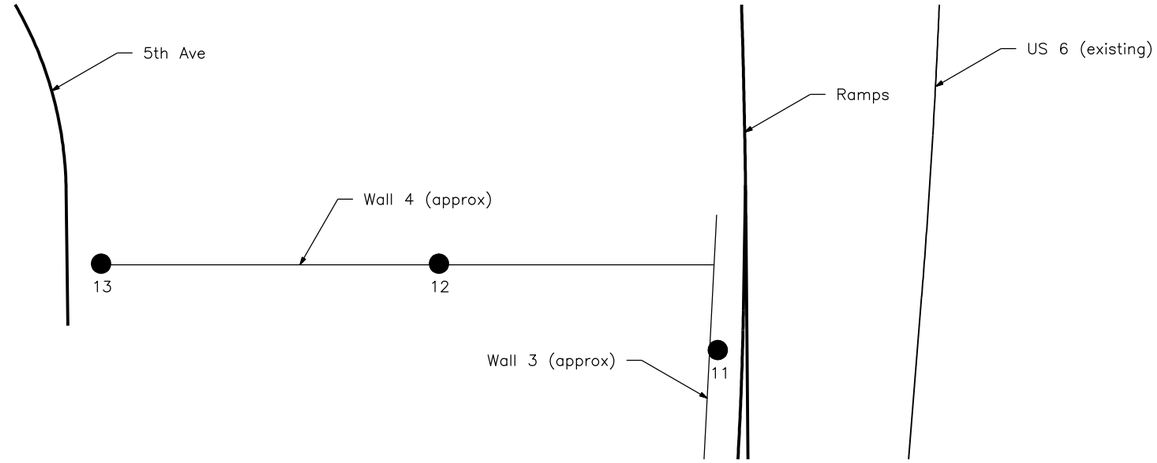
Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
4670 Holly Street, Unit A
Denver, CO 80216
Phone: 303-398-6601 FAX: 303-398-6504
Staff Geotechnical Program HCL

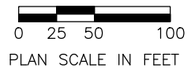
As Constructed
No Revisions:
Revised:
Void:

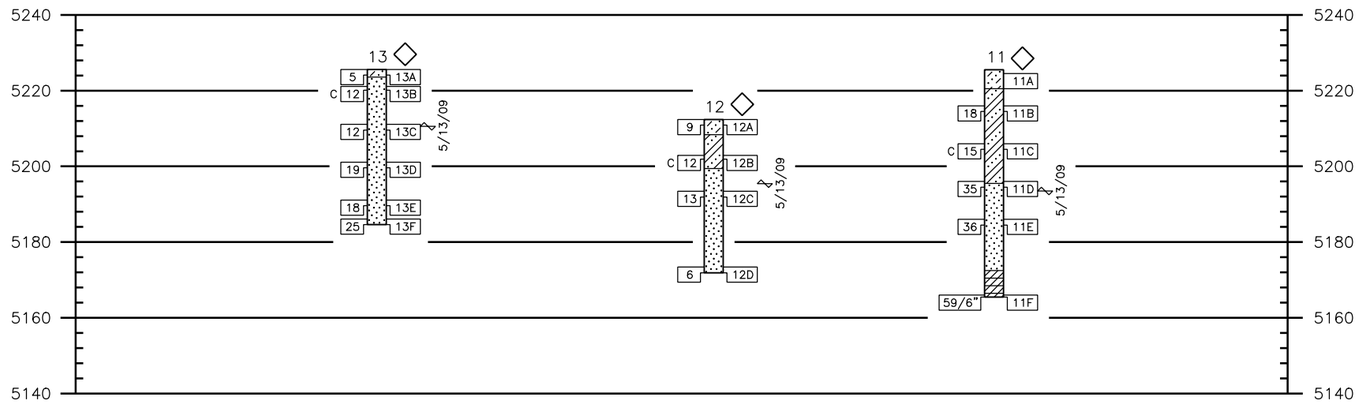
ENGINEERING GEOLOGY

Designer: D. Thomas
Detailer: T. McNulty
Sheet Subset: Geology
Structure Numbers: Wall 3
Subset Sheets: XXX of XXX

Project No./Code
IM 088A-24
16628
Sheet Number XXX







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SUMMARY OF TEST RESULTS

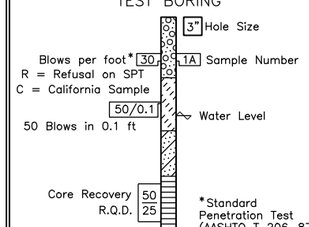
Sample Number	Depth (feet)	Classification			Grading Analysis (AASHTO) Percent				Atterberg Limits			Water Content W %
		Corps of Engrs. or Visual	USCS	AASHTO	Gravel	Coarse Sand	Fine Sand	Silt and Clay	L.L. L_W	P.L. P_W	P.I. I_W	
11C	19.5	Clay	CL	A–7–6(30)	0.0	1.3	14.2	84.5	54	20	34	26.3
11E	39.5	Gravel	GW	–	51.2	33.4	13.6	1.8	–	–	–	10.2
12B	9.5	Sandy Clay	CL	A–6(10)	3.2	6.2	25.8	64.7	37	18	19	12.7
13C	14.5	Sand	SW–SC	–	46.5	40.9	8.4	5.1	–	–	–	2.1
13F	39.5	Sand	SW	–	37.8	48.7	11.1	2.5	–	–	–	12.7

TYPE OF MATERIAL

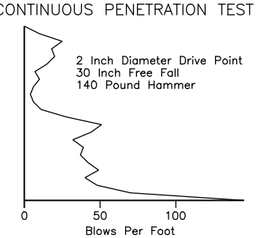
- Sandy Clay
- Sandy Silt
- Sand
- Claystone

LEGEND

TEST BORING



CONTINUOUS PENETRATION TEST



- Location of Test Boring
- Location of Continuous Penetration Test
- W 3 Inch Wireline Boring
- Rotary Boring
- Auger Boring

Print Date: 8/24/2009
Drawing File Name: 16628geosheet04 wall4.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Staff Geotechnical Program HCL

R-X

Sheet Revisions

Date:	Comments	Init.

Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
4670 Holly Street, Unit A
Denver, CO 80216
Phone: 303-398-6601 FAX: 303-398-6504
Staff Geotechnical Program HCL

As Constructed
No Revisions:
Revised:
Void:

ENGINEERING GEOLOGY

Designer: D. Thomas
Detailer: T. McNulty
Sheet Subset: Geology
Structure Numbers: Wall 4
Subset Sheets: XXX of XXX

Project No./Code
IM 088A-24
16628
Sheet Number XXX

ATTACHMENT 3
IM 088A-024, SA 16628, Federal Blvd over US-6
2007 AASHTO Bridge Design Guidelines

AASHTO Spectrum for 7% PE in 75 years
Latitude = 39.725495
Longitude = -105.025130
Site Class B
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.060	PGA - Site Class B
0.2	0.127	Ss - Site Class B
1.0	0.034	S1 - Site Class B

Map Response Spectra for Site Class B
Latitude = 39.725495
Longitude = -105.025130
Ss and S1 = Mapped Spectral Acceleration Values
Site Class B
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	Sd in.	
0.000	0.060	0.000	T = 0.0, Sa = PGA
0.054	0.127	0.004	T = To, Sa = Ss
0.200	0.127	0.050	T = 0.2, Sa = Ss
0.268	0.127	0.089	T = Ts, Sa = Ss
0.300	0.113	0.100	
0.400	0.085	0.133	
0.600	0.057	0.199	
0.800	0.042	0.266	
1.000	0.034	0.332	T = 1.0, Sa = S1
1.200	0.028	0.398	
1.400	0.024	0.465	
1.600	0.021	0.531	
1.800	0.019	0.598	
2.000	0.017	0.664	
2.200	0.015	0.730	
2.400	0.014	0.797	
2.600	0.013	0.863	
2.800	0.012	0.930	
3.000	0.011	0.996	
3.200	0.011	1.063	
3.400	0.010	1.129	
3.600	0.009	1.195	
3.800	0.009	1.262	
4.000	0.008	1.328	

Spectral Response Accelerations SDs and SD1
Latitude = 39.725495
Longitude = -105.025130
As = FpgaPGA, SDs = FaSs, and SD1 = FvS1
Site Class E - Fpga = 2.50, Fa = 2.50, Fv = 3.50
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.149	As - Site Class E
0.2	0.317	SDs - Site Class E
1.0	0.119	SD1 - Site Class E

Design Response Spectra for Site Class E
Latitude = 39.725495
Longitude = -105.025130
As = FpgaPGA, SDs = FaSs, SD1 = FvS1
Site Class E - Fpga = 2.50, Fa = 2.50, Fv = 3.50
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	Sd in.	
0.000	0.149	0.000	T = 0.0, Sa = As
0.075	0.317	0.017	
0.200	0.317	0.124	T = 0.2, Sa = SDs
0.375	0.317	0.436	T = Ts, Sa = SDs
0.400	0.297	0.465	
0.600	0.198	0.697	
0.800	0.149	0.930	
1.000	0.119	1.162	T = 1.0, Sa = SD1
1.200	0.099	1.395	
1.400	0.085	1.627	
1.600	0.074	1.859	
1.800	0.066	2.092	
2.000	0.059	2.324	
2.200	0.054	2.557	
2.400	0.050	2.789	
2.600	0.046	3.022	
2.800	0.042	3.254	
3.000	0.040	3.486	
3.200	0.037	3.719	
3.400	0.035	3.951	
3.600	0.033	4.184	
3.800	0.031	4.416	
4.000	0.030	4.649	