FINAL
Geotechnical Report

Dumont Trail Head Parking Area
And
West Idaho Springs Segment

Clear Creek Greenway
Clear Creek County, Colorado

Yeh Project No.: 215-114

November 11, 2016

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Yeh and Associates, Inc.
Consulting Engineers & Scientists

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November 10, 2016

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1. Purpose and Scope of Study

This report presents the results of our geotechnical engineering investigation for the proposed improvements to the Clear Creek Greenway Trail at the proposed Dumont Trailhead Parking Lot and the West Idaho Springs Segment. The trail is located along the I-70 corridor between Idaho Springs and Dumont, Colorado. Our Scope of Work for these two locations includes a geotechnical investigation and design recommendations for the following:

- The West Idaho Springs Segment consists of a rock cut to widen the trail for a distance of about 100 to 200 feet as it passes from the Forest Service parking lot westward along the cut bench that immediately overlooks Clear Creek.
- The proposed Dumont Trail Head Parking area general geotechnical and pavement recommendations.

2. Proposed Construction

This project includes upgrading the existing open area near Dumont on the south bank of Clear Creek. Currently this area is being used for access to the creek for rafting and fishing purposes but it is in primitive form and the current project will upgrade this with a formal hard-surfaced parking area, a formal access trail down to the creek and a restroom facility.

Additionally the project includes widening the rock bench that directly overlooks Clear Creek near I-70 exit 240. The purpose of widening the bench is to allow the Greenway trail an access route directly from the Forest Service parking lot area westward along the trail since the goal is to have a 10 foot wide concrete trail wherever possible. The bench has to be widened by a minimum of about two feet in some places to allow space for the trail and a safety railing.

Figure 1 – Aerial Photo Showing Location of West Idaho Springs Bench Widening

Figure 2 – The Dumont Trail Head along Clear Creek.

3. Geological Setting and Site Conditions

The West Idaho Springs Bench Widening area is mapped as artificial fill underlain probably by terrace. The mapped materials appear to be consistent with the subsurface conditions encountered in the borings drilled at this location.

The Dumont Trail Head area is mapped as Quaternary alluvium, colluvium, and glacial material deposited along the Clear Creek channel. This description is consistent with the subsurface material encountered in the borings at this location. Underlying bedrock is mapped as biotite gneiss, generally a very hard, dense metamorphic rock.

Figure 2 – Geologic Map of Project Area (CGS, Widmann et. al., 2000)

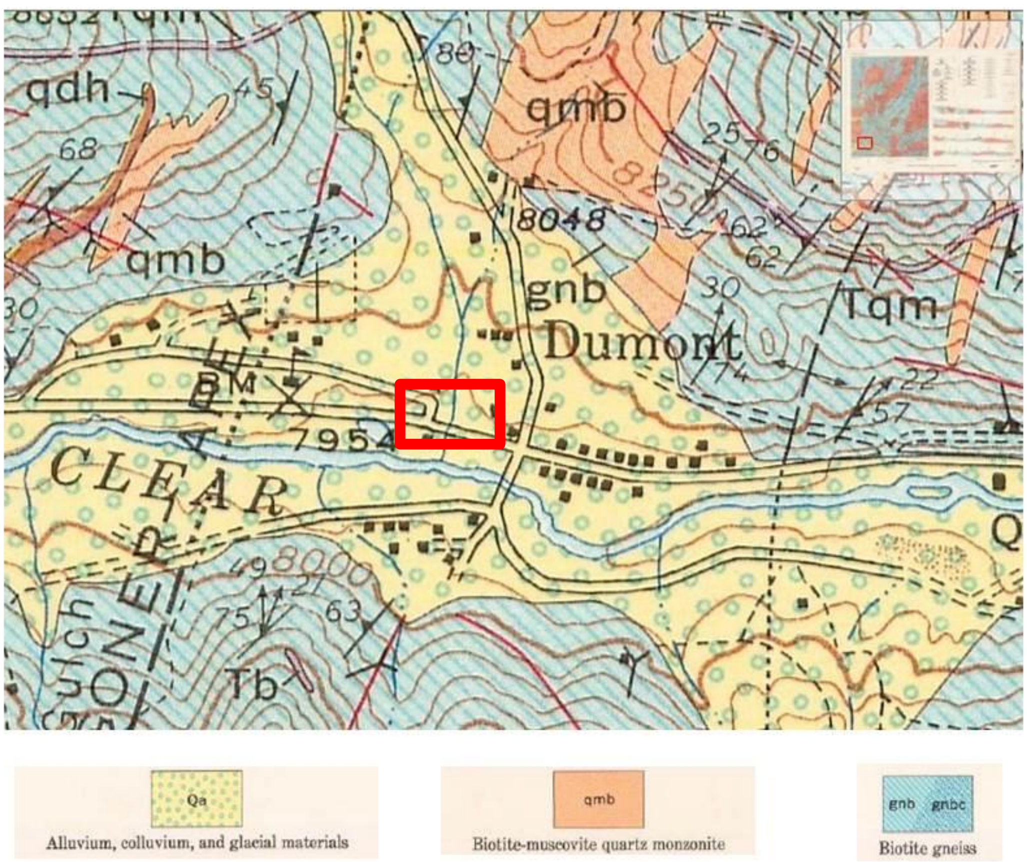


Figure 3 - Geologic Map of Dumont Trailhead Area (USGS, P.K. Sims, 1964)

4. Subsurface Investigation

On July 18, 2016 three (3) pavement borings (YA-TH-1 to YA-TH-3) were drilled at the Dumont Trail Head site. The boring locations are shown on the Boring Location Plan Sheet presented in Appendix A. The borings were drilled by a Yeh and Associates subcontractor, Dakota Drilling, using a CME 75, rubber tired drill rig. The borings were advanced using 4 inch solid-stem augers.

The subsurface conditions encountered in the boring were logged by a representative of Yeh and Associates. The Boring Log Legend and Logs are included in Appendix B.

Recorded penetration resistance measurements, N-values, were obtained by driving a Standard Penetration Sampler into the subsurface materials with a 140-pound automatic hammer falling 30 inches. Samples collected by the Standard Penetration Sampler are similar to ASTM D1586, "Standard Test Method for Standard Penetration Test (SPT) and Split Barrel Sampling of Soils". The Penetration Resistance (N-value) is a useful index to the consistency and relative density or hardness of the materials encountered.

Shallow probe-hole drilling was performed in the rock bench face using a very heavy duty rotary percussion drill with 36 inch long 5/8 inch tungsten carbide drill bit. In all 19 holes were drilled as shown on Figure 3. The intent was to determine penetration rates into the rock face as a rough means of determining whether the rock was capable of being excavated by machine or not. Penetration data obtained from this drilling are also presented in Appendix B (hole numbers run sequentially left to right across cut).

Figure 4 – Location of Probe-holes on Bench Overlooking Clear Creek in West Idaho Springs

4.1 Laboratory Testing

Yeh and Associates performed laboratory testing on selected samples from the Dumont Trail Head Borings to determine the classification and engineering characteristics of the on-site soil and bedrock. Laboratory tests included natural moisture content, gradation analyses, Atterberg Limits, pH, water soluble sulfates, water soluble chlorides, and resistivity. The test results are incorporated into the boring logs and provided in Appendix C, Laboratory Test Results.

4.2 Surface Conditions

At the bench location, much of the existing Idaho Springs trail is in hard rock with exception of the outboard (creek side) edge of the existing trail which is an oversteepened fill slope consisting of large cobbles and boulders overlying bedrock (Figure 3). The bedrock is visibly outcropping along the trail outboard with soil infilling between the outcrops. The outboard slope appears to be about 1/2H: 1V. The existing outboard slope is raveling.

The proposed Dumont trail head is unsurfaced and composed mostly of silty sand fill of unknown origin.

4.3 Subsurface Conditions

4.3.1 Probe-hole Borings

The probe-hole borings were performed to determine the condition of the rock that forms the bench in West Idaho Springs. Generally the rock is considered to be as competent as class D concrete based on a comparison of penetration rates in the rock as compared to a test hole drilled into a large concrete block. A table showing a summary of the rates obtained is presented as Table 1.

Table 1 – Probe Drilling Penetration Rates

Probe Number	Height from Trail Surface (ft)	Time (minutes)	Total Depth (in)	Rate (in/Minute)
1	2.5	5-10	30	3
2	5	4	30	7.5
3	2.5	6	30	5
4	5	4	30	7.5
5	2.5	2	30	15
6	5	3:30	30	8.6
7	2.5	2:15	30	13.3
8	5	3	30	10
9	2.5	2:40	30	11.25
10	5	2:50	30	10.6
11	2.5	5	30	6
12	5	3:15	30	9.2
13	2.5	2:45	30	10.9
14	5	3:45	30	8
15	2	1:45	30	17.1
16	5	2:20	30	12.9
17	2.5	3	30	10
18	5	2:55	30	10.3
19	2.5	2:40	30	11.25
Concrete Block		2:17	23	10

There is an existing high pressure gas line in the trail varying in depth from about 1 to 3 feet below existing surface according to verbal information obtained from an Xcel Energy representative.

4.3.2 Pavement Borings

Three pavement borings were drilled in the proposed Dumont Trail Head parking area (YA-TH-1, YA-TH-2 and YA-TH-3). The boring logs are provided in Appendix B. Silty sand was encountered below surface down to a depth of 10 feet at which point the drilling was terminated. Field penetration data indicates that the sandy soils are loose to very dense in relative density.

4.3.3 Groundwater

Groundwater was encountered in boringYA-TH-1 at 10 feet during the field investigation and is shown on the boring logs. Groundwater was not observed in the boring YA-TH-2 and YA-TH-3 at the time of field exploration, nor when checked immediately after drilling. Year-round groundwater conditions were not established as part of the field investigation. Groundwater conditions in the study area will likely vary considerably throughout the year. Variations can occur during different seasons, creek flows, storm events, after construction and site grading, and due to changes in surface and subsurface drainage characteristics of the surrounding area.

5. Foundation Design Recommendations

As presently planned, the proposed Dumont Restroom Building will be supported on a series of concrete strip footings supporting a slab-on-grade. To reduce potential differential movement of the equipment building footings due to the loose soils, the natural subgrade soils should be scarified; moisture conditioned and compacted to a minimum depth of 12 inches. The native soils and any new fill placed for footing or slab support should be compacted to a minimum of 95 percent of the maximum density defined by AASHTO T-180, at a moisture content within 2 percent of the optimum water content.

The footings may be designed for a maximum allowable bearing pressure of 2,000 psf. The design bearing pressure may be increased for transient loads such as wind or seismic by 1/3 or as allowable by local building code. The footings should be placed a minimum of 36 inches below finished grade for frost protection.

Total movement of the footings and slab resulting from structural loads and soil conditions is estimated to be on the order of 1 to 2 inches. Differential movement should be about ½ to ¾ of the total movement, provided infiltration of water from any source is minimized. As additional movement of the foundation and slab may occur should water infiltrate the soils, proper drainage around the building must be provided in final design and construction.

Foundations and slabs should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

6. West Idaho Springs area rock cut

The West Idaho Springs area requires a rock cut to widen the trail for a distance of about 100 to 200 feet as it passes from the Forest Service parking lot westward along the cut bench that immediately overlooks Clear Creek.

As previously noted the outboard slope between the existing bench and Clear Creek is an oversteepened slope consisting of large cobbles and boulders overlying bedrock (Figure 3). The bedrock is visibly outcropping along the trail outboard with soil infilling between the outcrops. The outboard slope appears to be about 1/2H: 1V. The existing outboard slope is raveling.

The outboard slope will over time ravel back to a more stable slope estimated to be about 1H: 1V to1.25H:1V. Assuming the height from the creek to the bench is about 20 feet, a 1:1 slope will eventually encroach an addition 10 feet into the existing bench. A 1.25:1 slope would encroach an additional 15 feet. Considering stabilizing this slope while technically feasible would be very expensive and the existing slope has been raveling for many years. We recommend the following to provide additional time before the trail bench is adversely impacted.

- Move into the existing bench sufficiently into the rock slope to provide a 6 foot minimum offset from the outside edge of the trail to the outboard slope.
- Reduce the width of the trail to 8 feet.
- Super the trail into the rock slope sufficiently to capture surface water from draining onto the raveling slope.

Considering there is a shallow gas line running along the existing trail bench, the bench is above Clear Creek and the close proximity of I-70, we recommend limiting the rock excavation to mechanical means.

We recommend excavating the existing rock cut at a maximum slope ratio of 0.1H:1V.

7. PAVEMENT DESIGN RECOMMENDATIONS

The pavement design recommendations for the Dumont Trail Head Parking Area are provided in our September 15, 2016 Memorandum in Appendix D and are summarized in this section.

The recommended pavement thicknesses are in Table 2.

Table 2 – Minimum Pavement Thickness

Pavement Type	Minimum HMA Thickness (inches)
Full Depth HMA	6.0
HMA with 6" ABC[1]	3.0

[1]Existing in-situ soil will provide an excellent subbase. ABC depth can be reduced to minimum of 3"

7.1 Pavement Subgrade Preparation

We recommend that the existing subgrade be scarified to a depth of 6 inches and recompacted prior to placement of any new base or pavement. Before placing the pavement section, the entire subgrade should be compacted to a minimum 95% of its maximum proctor density (AASHTO T-180), and within -2 to +2 percent of optimum moisture content.

The pavement subgrade should be proof rolled with a heavily loaded pneumatic-tire vehicle. Areas which deform more than 0.5 inch under heavy wheel loads should be removed, replaced if necessary, and reworked to achieve a stable subgrade prior to paving. We recommend that proof rolling and subgrade compaction tests be inspected and approved by a representative of the geotechnical engineer prior to placing any pavement.

7.2 HMA Recommendations

We recommend the Hot Mix Asphalt (HMA) mix for this project meet the requirements of SX (75), and that the binder meet the requirements of PG 58-28.

8. OTHER CONSTRUCTION CONSIDERATIONS

The following presents recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project.

Earthwork on the project should be observed and evaluated by Yeh and Associates. The evaluation of earthwork should include observation and testing of engineered fills, subgrade preparation, foundation bearing soils and other geotechnical conditions exposed during the construction of the project.

8.1 Site Grading Considerations

The soils encountered by the proposed excavations may vary significantly across the site. The preliminary classifications presented above are based solely on the materials encountered in widely spaced exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation.

Strip and remove existing vegetation and other deleterious materials from proposed building and pavement areas. All exposed surfaces should be free of mounds and depressions, which could prevent uniform compaction.

Stripped materials consisting of vegetation and organic materials should be wasted from the site or used to revegetate landscaped areas after completion of grading operations.

All exposed areas which will receive fill, once properly cleared, should be scarified to a minimum depth of 12 inches, conditioned to near optimum moisture content, and compacted.

Although evidence of underground facilities such as septic tanks and utilities was not observed during the site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed and the excavation extended to native materials prior to backfill placement and/or construction.

Based upon the subsurface conditions encountered, subgrade soils exposed during construction are anticipated to be relatively stable. However, the stability of the subgrade may be affected by precipitation, repetitive construction traffic and other factors. If unstable conditions are encountered or develop during construction, stability may be improved by scarifying and drying the subgrade soils. Over excavation of wet zones and replacement with granular materials or crushed rock may be necessary. Use of fly ash, kiln dust, cement or geotextiles could also be considered as stabilization techniques. Laboratory evaluation is recommended to determine the effect of chemical stabilization on subgrade soils prior to construction.

8.2 Subgrade Preparation

Subgrade soils beneath interior and exterior slabs should be scarified; moisture conditioned and compacted to a minimum depth of 12 inches. The moisture content and compaction of subgrade soils should be maintained until slab construction.

8.3 Fill Materials and Placement

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce a uniform fill with the recommended moisture contents and densities throughout the lift. Recommended compaction criteria for engineered fill is 95 percent of the maximum dry density as determined by AASHTO T-180.

On-site sands and/or imported soils should be compacted within a moisture range of 2 percent below to 2 percent above optimum unless modified by the project geotechnical engineer.

8.4 Corrosion

The concentration of water-soluble sulfates measured in the laboratory on a representative sample of the sand soils measured 0.002 percent. This concentration of water-soluble sulfates represents a Class 0 degree of sulfate attack on concrete exposed to these geologic materials. The degree of attack is based on a range of Class 0 (negligible) to Class 3 (very severe) as described in the American Concrete Institute (ACI) Standard 201.2R, "Guide to Durable Concrete". Based on the sulfate test result, a Class 0 severity of concrete exposure is appropriate for all concrete on site per CDOT specification 601.14.

The pH, water soluble chlorides, and electrical resistivity were determined for selected samples. Test results measured a pH value of 7.2. Water soluble chlorides sample measurement was 0.0065 percent. The soil resistivity measurement was 3953 ohm-centimeters. A qualified corrosion engineer should review this data to determine the appropriate level of corrosion protection.

9. Limitations

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the data obtained from exploratory borings, laboratory testing, field reconnaissance, aerial photographs, and our understanding of the proposed type of construction. The nature and extent of subsurface variations across the site may not become evident until excavation is performed. If during construction, fill, soil, or water conditions appear to be different from those described herein, this office should be advised at once so reevaluation of the recommendations may be made. We recommend on-site observation of excavations and foundation bearing strata, by a representative of the geotechnical engineer.

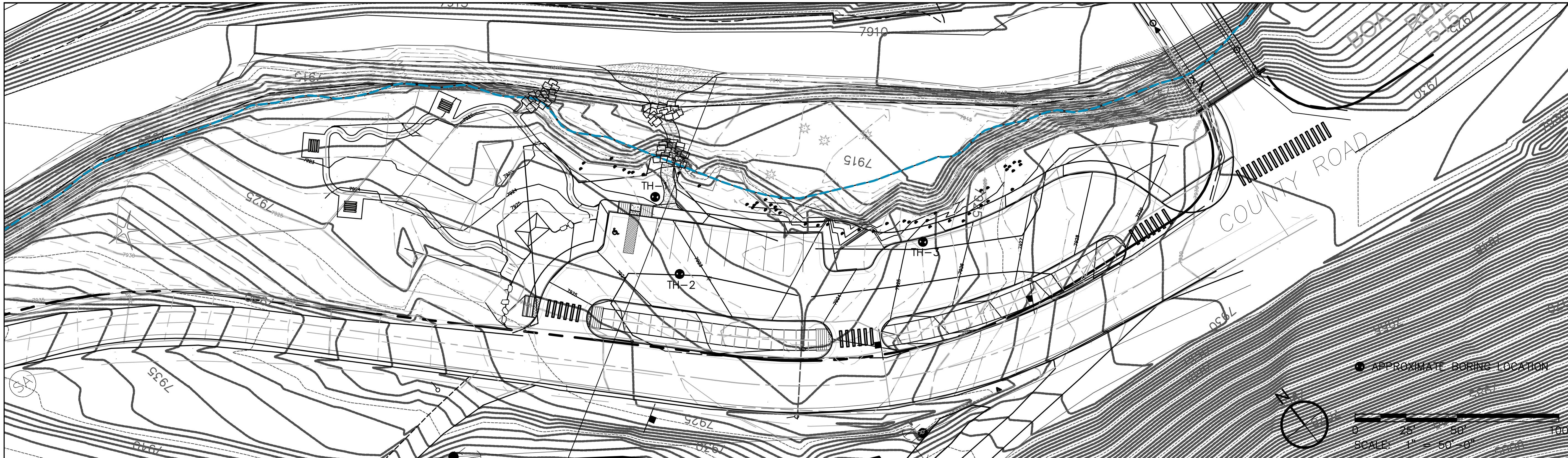
10. References

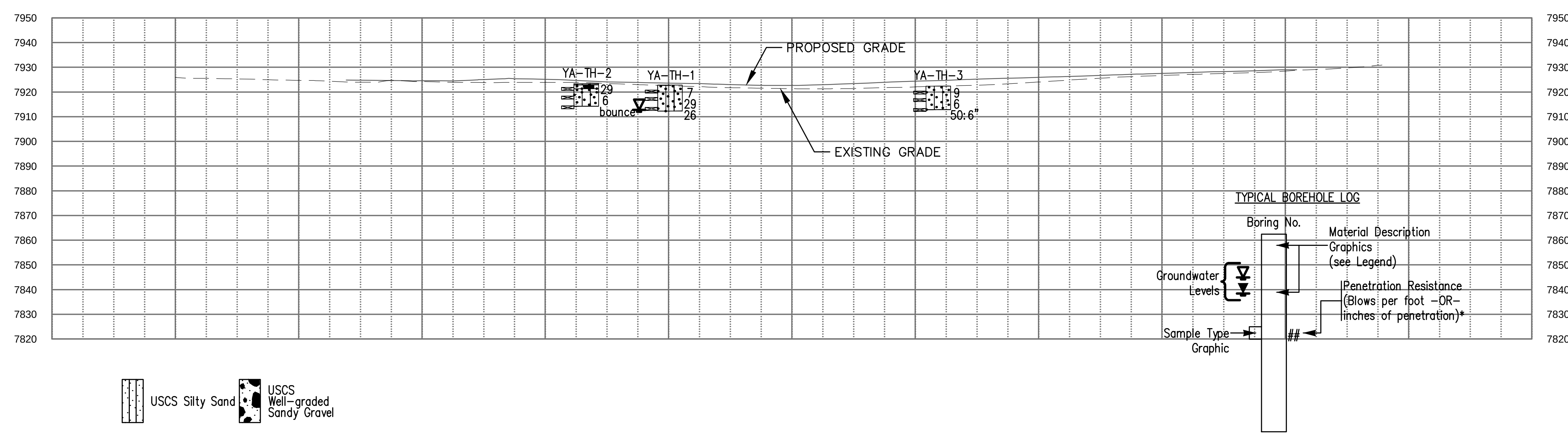
Geologic Map of the Idaho Springs Quadrangle, Clear Creek County, Colorado: Colorado Geol. Survey Open-File Report 00-2, Colorado Geological Survey, Widmann et. al., 2000

Geology of the Central City quadrangle, Colorado, P.K. Sims, USGS, Geologic Quadrangle Map GQ-267, 1964

Appendix A

BORING LOCATION PLAN SHEET





*e.g. A value of 50/3 or 50:3 indicates that 50 blows were applied to the sampler, with a penetration of 3 inches.

Print Date: 09/21/2016	Sheet Revisions	Clear Creek Greenway Clear Creek County	As Constructed
File Name:	Date: / Comments / Init.	111 Rose St. Georgetown, CO 80444 Phone: 303-679-2421 FAX: 303-569-1103	No Revisions:
Horiz. Scale: 1:20 Vert. Scale:			Revised:
THK associates inc. 2953 South Peoria Street, Ste 101 Aurora, Colorado 80014 303-770-7201 FAX 770-7132 Yeh and Associates, Inc. Geotechnical Engineering Consultants			Void:

DUMONT TRAILHEAD SEGMENT
ENGINEERING GEOLOGY

Designer: HH
Detailer: MJW
Sheet Subset:
Structure Numbers
Subset Sheets: 1 of 1

Project No./Code

Sheet Number ###

Appendix B

BORING LOGS AND LEGEND

Yeh and Associates, Inc.
Consulting Engineers & Scientists

Project: Clear Creek Greenway

Project Number: 215-114

Legend for Symbols Used on Borehole Logs

Sample Types

Auger Cuttings

Bulk Sample of auger/odex cuttings

Standard Penetration Test (ASTM D1586)

Lithology Symbols (see Boring Logs for complete descriptions)

USCS Well-graded Sandy Gravel

USCS Silty Sand

Lab Test Standards

Moisture Content	ASTM D2216
Dry Density	ASTM D7263
Sand/Fines Content	ASTM D421, ASTM C136, ASTM D1140
Atterberg Limits	ASTM D4318
AASHTO Class.	AASHTO M145, ASTM D3282
USCS Class.	ASTM D2487

(Fines = % Passing #200 Sieve
Sand = % Passing #4 Sieve, but not passing #200 Sieve)

Other Lab Test Abbreviations

pH	Soil pH (AASHTO T289-91)
S	Water-Soluble Sulfate Content (AASHTO T290-91, ASTM D4327)
Chl	Water-Soluble Chloride Content (AASHTO T291-91, ASTM D4327)
S/C	Swell/Consolidation (ASTM D4546)
UCCS	Unconfined Compressive Strength (ASTM D2166)
R-Value	Resistance R-Value (ASTM D2844)
DS (C)	Direct Shear cohesion (ASTM D3080)
DS (phi)	Direct Shear friction angle (ASTM D3080)
Re	Electrical Resistivity (AASHTO T288-91)
PtL	Point Load Strength Index (ASTM D5731)

Notes

1. "Penetration Resistance" on the Boring Logs refers to the N value for SPT samples only, as per ASTM D1586. For samples obtained with a Modified California sampler, drive depth was 12 inches, and "Penetration Resistance" refers to the sum of all blows. For all sample types, where blow counts were more than 50 for the last increment, the blows and length for the last increment are reported under "Penetration Resistance."

2. The Modified California sampler used to obtain samples is a 2.5-inch OD, 2.0-inch ID (1.95-inch ID with liners), split-barrel sampler with internal liners, as per ASTM D3550. Sampler is driven with a 140-pound hammer, dropped 30 inches per blow.

Yeh and Associates, Inc. Consulting Engineers & Scientists	Project Name: Clear Creek Greenway	PAGE 1 of 1
	Project Number: 215-114	Boring No.: **YA-TH-1**

Boring Began: 7/18/2016
Boring Completed: 7/18/2016
Drilling Method(s): Solid-Stem Auger (4" OD)
Driller: Dakota Drilling
Drill Rig: CME 75
Hammer Type: Automatic (hydraulic)

Total Depth: 10.5 ft
Ground Elevation:
Coordinates: N: E:
Location:
Logged By: M. Boyd
Final By: M. Boyd

Weather Notes: Sunny, cool
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels:			
Symbol	∇		
Depth	10.0 ft	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/ Advancement Method	Blows per 6 in	Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
	0 - 2	Solid-stem auger				**0.0 - 10.5 ft. silty SAND** with gravel, light brown to brown, dry to wet, loose to medium dense, organic material to 5 ft.									
	2 - 3.5	Sample	3-3-4	7											
	3.5 - 5	Auger													
	5 - 6.5	Sample	9-9-20	29		Increasing gravel with depth.									
	6.5 - 9	Auger													
	9 - 10.5 (∇ 10)	Sample	14-12-14	26			5.8		33	54	13	NV	NP	A-1-b (0) SM	

Bottom of Hole at 10.5 ft.

Yeh and Associates, Inc.
Consulting Engineers & Scientists

Project Name: Clear Creek Greenway

Project Number: 215-114 *Boring No.:* **YA-TH-2**

Boring Began: 7/18/2016
Boring Completed: 7/18/2016
Drilling Method(s): Solid-Stem Auger (4" OD)
Driller: Dakota Drilling
Drill Rig: CME 75
Hammer Type: Automatic (hydraulic)

Total Depth: 9.1 ft
Ground Elevation:
Coordinates: N: E:
Location:
Logged By: M. Boyd
Final By: M. Boyd

Weather Notes: Sunny, cool
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels:			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/ Advancement Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
		Auger				**0.0 - 0.5 ft. silty SAND** with gravel, light brown, dry.									
		Auger				**0.5 - 2.0 ft. sandy GRAVEL**, brown and gray, dry to moist, medium dense to dense, organic material. Auger refusal at 1.5 ft, took drive sample.									
		Drive sample	40-15-14	29		**2.0 - 9.1 ft. silty SAND** with gravel, dark brown, moist, loose to very dense, organic material to ~7 ft.									
		Auger													
	5	Drive sample	3-3-3	6											
		Auger													
			50:1"-bounce	bounce		Bottom of Hole at 9.1 ft.	3.8		16	72	12	NV	NP	A-1-b (0) SM	pH=7.2 S=0.002% Chl=0.0065% Re=3953ohm·cm

Yeh and Associates, Inc.
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Project Name: Clear Creek Greenway

Project Number: 215-114 *Boring No.:* **YA-TH-3**

Boring Began: 7/18/2016
Boring Completed: 7/18/2016
Drilling Method(s): Solid-Stem Auger (4" OD)
Driller: Dakota Drilling
Drill Rig: CME 75
Hammer Type: Automatic (hydraulic)

Total Depth: 9.5 ft
Ground Elevation:
Coordinates: N: E:
Location:

Logged By: M. Boyd
Final By: M. Boyd

Weather Notes: Cloudy, warm
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels:			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/ Advancement Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
						0.0 - 9.5 ft. silty SAND with variable amounts of gravel, light brown to dark brown, dry to moist, loose to very dense.	*0.2*		*25*	*64*	*11*	NV	NP	*A-1-b (0) SP-SM*	
			4-4-5	9											
	5		5-3-3	6		Organic material in sample. Increase in gravel 6-8 ft.	9.0		32	52	16	NV	NP	A-1-b (0) SM	
			50:6"	50:6"			1.5		23	58	19	NV	NP	A-1-b (0) SM	

Bottom of Hole at 9.5 ft.

Probe Hole Drilling Penetration Rates

Probe Number	Height from Trail Surface (ft)	Time (minutes)	Total Depth (in)	Notes
1	2.5	5-10	30	rock dust in first 2", consistently smooth drilling
2	5	4	30	Crumbly in first 1", rock dust in first 2", then solid rock
3	2.5	6	30	Dust throughout drilling, 20" light tan to reddish material
4	5	4	30	Soft at start, consistently hardening with depth, tan dust
5	2.5	2	30	Gray rock dust to 15", then tan and softer material
6	5	3:30	30	Gray rock dust and consistent drilling throughout
7	2.5	2:15	30	Weathered outer 1", white to cream rock dust to 18", then brown to gray dust and easier drilling
8	5	3	30	Gray throughout, hardens at 15"
9	2.5	2:40	30	Tan rock dust to 12", then harder and gray
10	5	2:50	30	Tan dust to 12", then dark gray to 18", then white and tan
11	2.5	5	30	Gray to light gray rock dust, hardens to at 18"
12	5	3:15	30	Tan to gray to 6", then brown and softer drilling to 24", then grading to dark brown
13	2.5	2:45	30	Tan rock dust to 6", then gray. Hardened at 24"
14	5	3:45	30	Tan rock dust to 6", then gray to 10", then grading to dark brown
15	2	1:45	30	Soily to 6", tan to 18", then grades to gray. Weathered
16	5	2:20	30	Tan to gray rock dust, hard at 24". Weathered
17	2.5	3	30	Tan/light brown
18	5	2:55	30	Tan/light brown, harder drilling at 18", softer at 24"
19	2.5	2:40	30	Light brown to 15", then tan
Concrete Block	-	2:17	23	Class D Concrete

Appendix C

LABORATORY TEST RESULTS

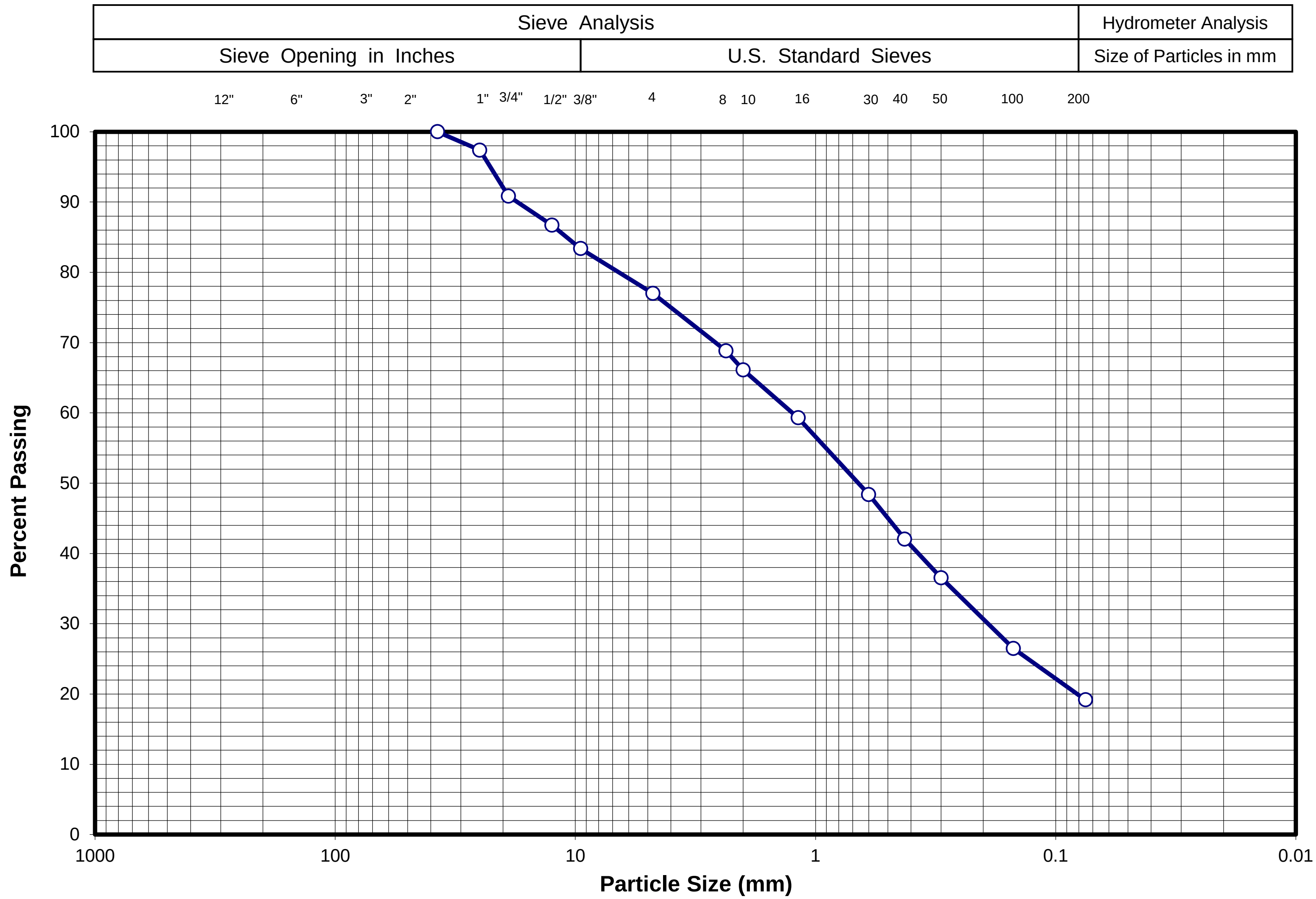
YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 215-114 Project Name: ES CCC Clear Creek Greenway and Bike Path Date: 8/15/2016

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			PH	Water Soluble Sulfate %	Resistivity ohm.cm	Chloride %	CLASSIFICATION	
Boring No.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI					AASHTO	USCS
TH-1	9	SPT	5.8	–	33	54	13	NV	NP	NP	–	–	–	–	A-1-B (0)	SM
TH-2	9	SPT	3.8	–	16	72	12	NV	NP	NP	7.2	0.002	3953	0.0065	A-1-b (0)	SM
TH-3	0-2	Bulk	0.2	–	25	64	11	NV	NP	NP	–	–	–	–	A-1-b (0)	SP-SM
TH-3	5	SPT	9.0	–	32	52	16	NV	NP	NP	–	–	–	–	A-1-b (0)	SM
TH-3	9	SPT	1.5	–	23	58	19	NV	NP	NP	–	–	–	–	A-1-b (0)	SM

Rev 2 - 8/02



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	100
1"	97
¾ "	91
½"	87
⅜"	83
#4	77
#10	66
#40	42
#200	19

Gravel (%)	23	LL	NV	Project Name:	ES CCC Clear Creek Greenway and Bike Path
Sand (%)	58	PL	NP	Sample ID:	TH-3
Fines (%)	19	PI	NP	Sample Depth (ft.):	9
Sample Description:	A-1-b (0) / SM				

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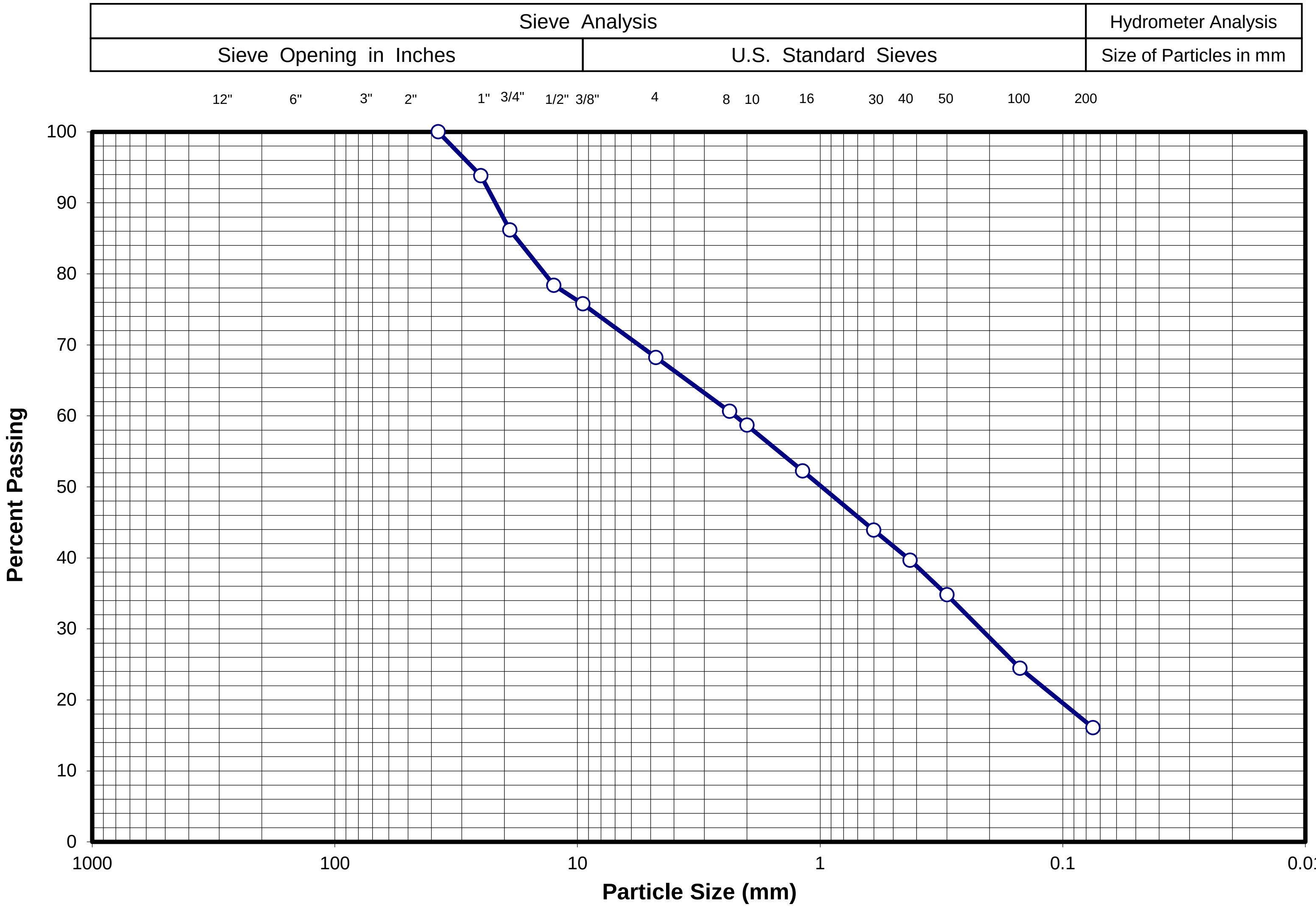
Geotechnical Engineering Consultants

SIEVE ANALYSIS

Drawn By:	M.A	Project No.:	215-114
Checked By:	H.Hume	Figure No.:	-
Date:	08/15/16		

Revised 04/27/2004



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	100
1"	94
¾ "	86
½"	78
⅜"	76
#4	68
#10	59
#40	40
#200	16

Gravel (%)	32	LL	NV	Project Name:	ES CCC Clear Creek Greenway and Bike Path
Sand (%)	52	PL	NP	Sample ID:	TH-3
Fines (%)	16	PI	NP	Sample Depth (ft.):	5

Sample Description: A-1-b (0) / SM

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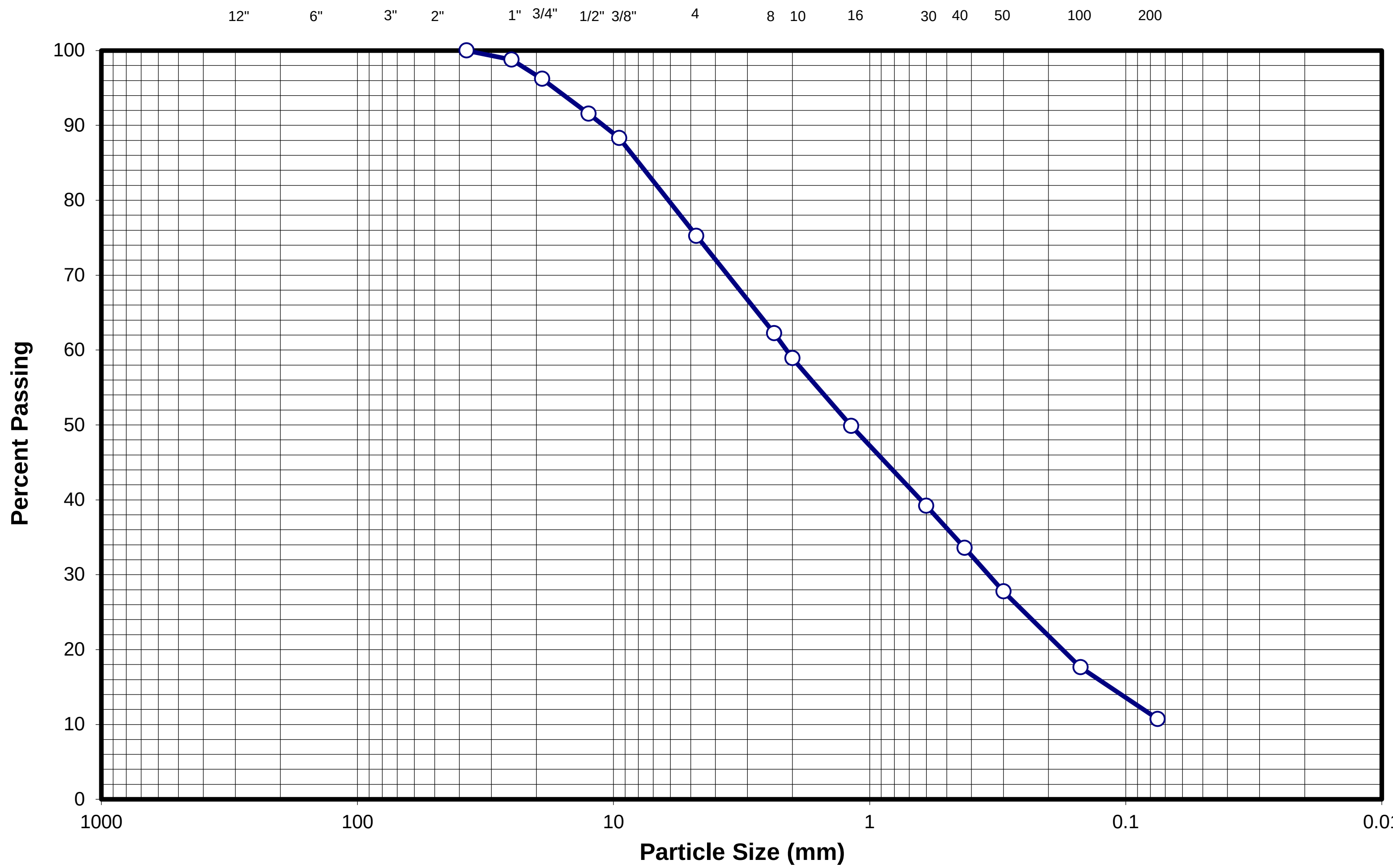
SIEVE ANALYSIS

Drawn By:	M.A	Project No.:	215-114
Checked By:	H.Hume		
Date:	08/15/16	Figure No.:	-

Revised 04/27/2004



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	100
1"	99
¾ "	96
½"	92
⅜"	88
#4	75
#10	59
#40	34
#200	11

Gravel (%)	25	LL	NV	Project Name:	ES CCC Clear Creek Greenway and Bike Path
Sand (%)	64	PL	NP	Sample ID:	TH-3
Fines (%)	11	PI	NP	Sample Depth (ft.):	0-2

Sample Description: A-1-b (0) / SP-SM

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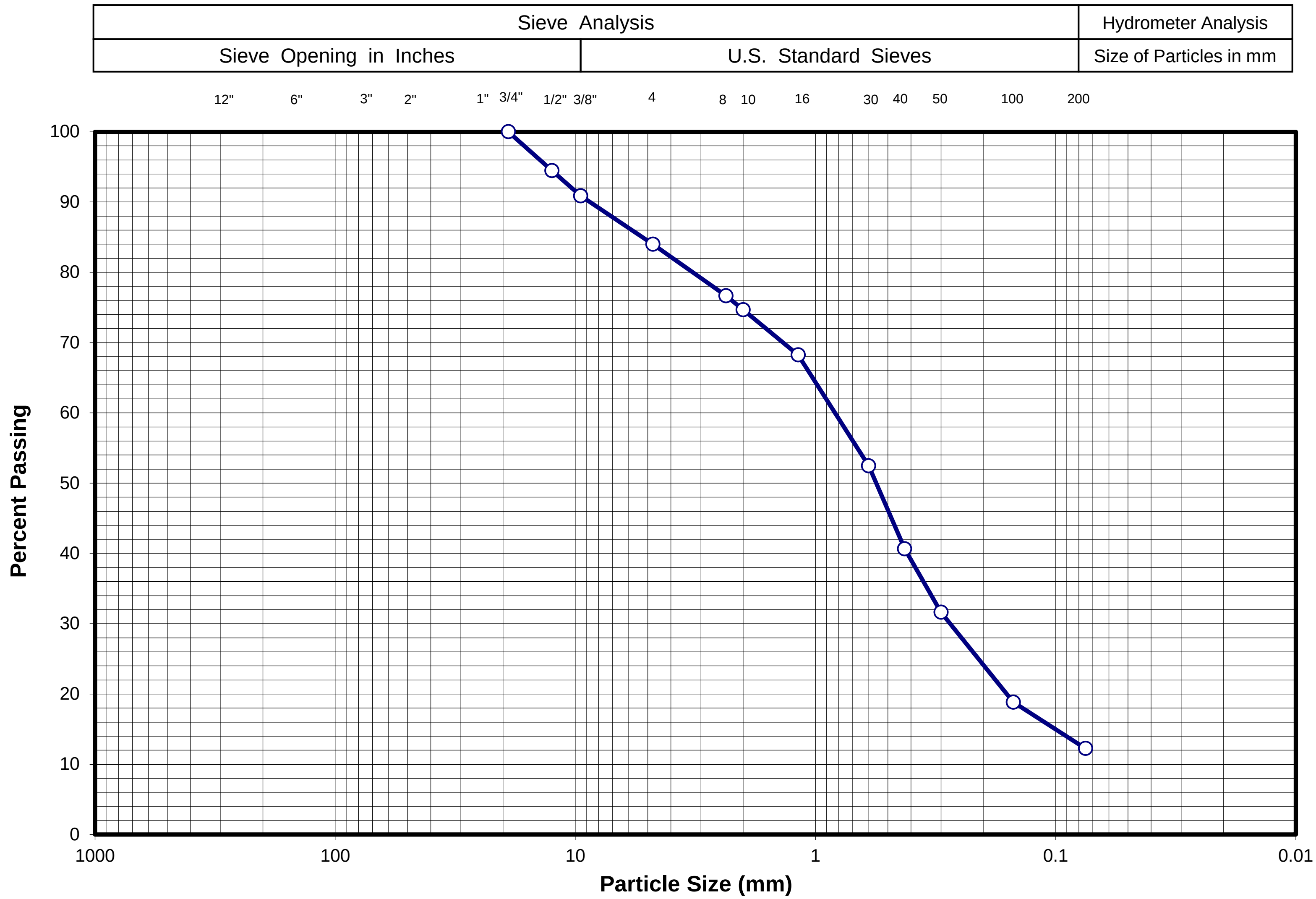
SIEVE ANALYSIS

Drawn By:	M.A	Project No.:	215-114
Checked By:	H.Hume	Figure No.:	-
Date:	08/15/16		

Revised 04/27/2004



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	94
⅜"	91
#4	84
#10	75
#40	41
#200	12

Gravel (%)	16	LL	NV	Project Name:	ES CCC Clear Creek Greenway and Bike Path
Sand (%)	72	PL	NP	Sample ID:	TH-2
Fines (%)	12	PI	NP	Sample Depth (ft.):	9
Sample Description:	A-1-b (0) / SM				

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SIEVE ANALYSIS

Drawn By:	M.A	Project No.:	215-114
Checked By:	H.Hume	Figure No.:	-
Date:	08/15/16		

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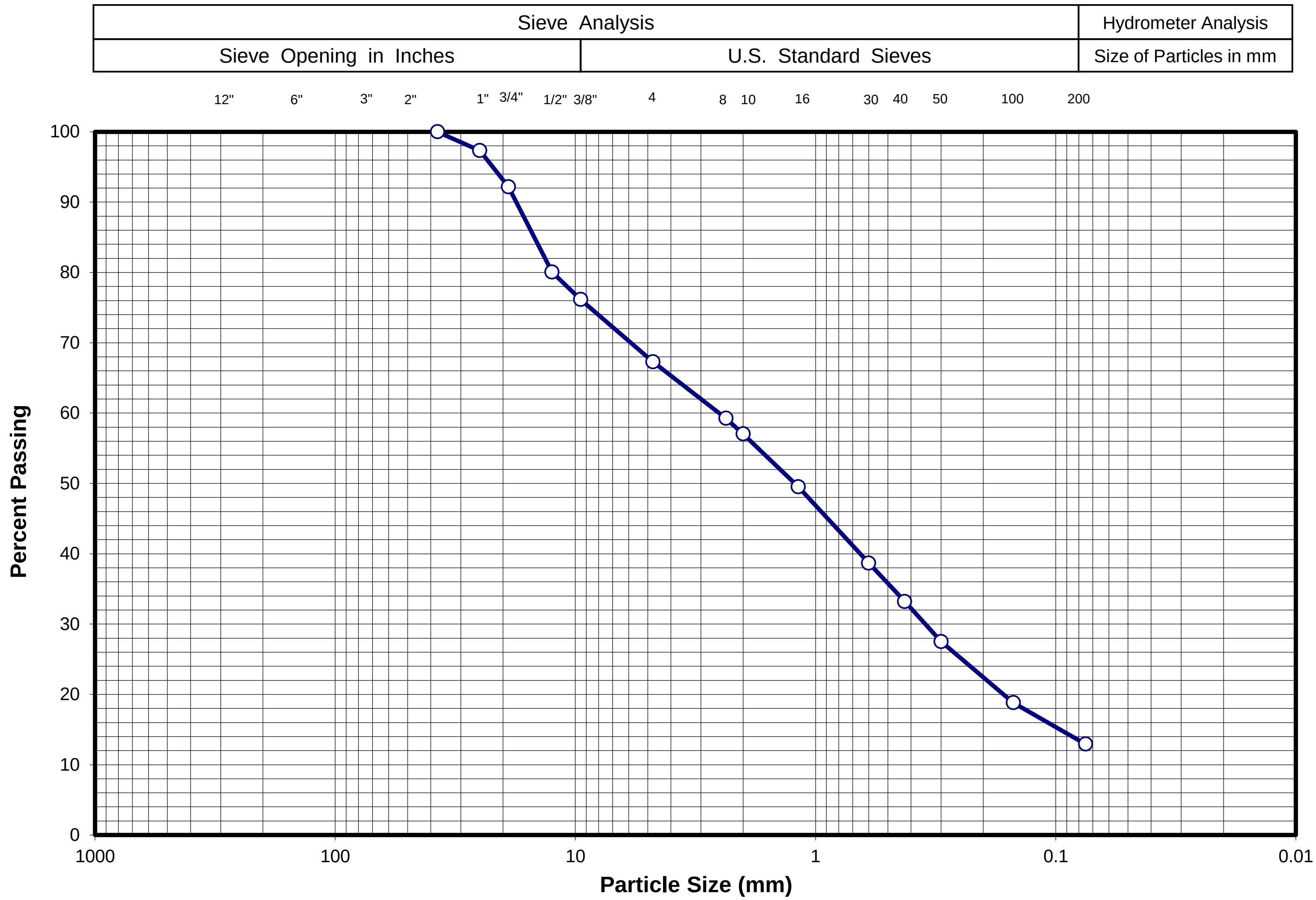

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	100
1"	97
¾ "	92
½"	80
⅜"	76
#4	67
#10	57
#40	33
#200	13

Gravel (%)	33	LL	NV	Project Name:	ES CCC Clear Creek Greenway and Bike Path
Sand (%)	54	PL	NP	Sample ID:	TH-1
Fines (%)	13	PI	NP	Sample Depth (ft.):	9
Sample Description:	A-1-b (0) / SM				

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SIEVE ANALYSIS

Drawn By:	M.A	Project No.:	215-114
Checked By:	H.Hume	Figure No.:	-
Date:	08/15/16		

Revised 04/27/2004

Appendix D

PAVEMENT DESIGN MEMORANDUM

Yeh and Associates, Inc.
Consulting Engineers & Scientists

Memorandum

Clear Creek Greenway Trail

Yeh Project Number: 215-114

Date: September 15, 2016

To: Kevin Shanks, R.L.A, Sarah Moll R, L.A., THK Associates

From: Masoud Ghaeli, P.E., Yeh and Associates

Subject: **Pavement Thickness Recommendations for the Dumont Trail Head Parking Lot**

This memorandum summarizes the pavement thickness recommendations for the Dumont Trail Head Parking Lot in Clear Creek County.

Project Location Map

Pavement Design and Recommendations

The pavement subgrade soils were classified as A-1-b according to AASHTO classification and found to be predominantly silty sand (SM) according to Unified Soil Classification System when materials obtained from three test boring holes, TH1, TH2, and TH3 were tested.

According to the Clear Creek County Roadway Design and Construction (Manual), structural pavement sections for roads and other facilities must be designed based on the following equation, as per Section C, Structural Sections:

$$T = 0.0384(TI) \times (100-R)$$

where T is the thickness of the structure section, HMA and base in inches, TI is the Traffic Index, and R is the Hveem R-value of the base course material. For this parking area, the Traffic Index of 4.5 for low volume roads and parking areas was determined based on Table-8 of the Manual, Minimum Traffic Indexes. Low volume road is defined as a facility with ADT ranging from 100-500 based on Table 1,

2000 Clay Street, Suite 200, Denver, CO 80211, (303) 781-9590, Fax (303) 781-9583
1525 Blake Avenue, Glenwood Springs, CO 81601, (970) 384-1500, Fax (970) 384-1501
588 North Commercial Drive, Grand Junction, CO 81505 (970) 242-5125, Fax (970) 255-8512
570 Turner Drive, Suite D, Durango, CO 81303, (970) 382-9590, Fax (970) 382-9583
341 Front Street, Suite D, Grover Beach, CA 93433 (805) 481-9590

Design Capacity for Classes of Roadway. Limited surface area for this parking lot leads us to assume that Average Daily Traffic (ADT) classifies as a low volume facility and therefore from the above equation,

$$T = 0.0384(4.5) \times (100-70) = 5.2 \text{ or say 6 inches}$$

Alternatively, for a low volume facility the Manual requires a minimum of 6 inches of aggregate base course with 3 inches of HMA

The recommended pavement thicknesses are summarized in table below

Minimum Pavement Thickness

Pavement Type	Minimum HMA thickness (inches)
Full Depth HMA	6.0
HMA with 6" ABC*	3.0

*Existing in-situ soil will provide an excellent subbase. ABC depth can be reduced to minimum of 3" according to Table 9, Minimum Structural Sections. (See attachment)

Pavement Subgrade Preparation
We recommend that the existing subgrade be scarified to a depth of 6 inches and recompacted prior to placement of any new base or pavement. Prior to placing the pavement section, the entire subgrade should be compacted to a minimum 95% of its maximum proctor density (AASHTO T-180), and within -2 to +2 percent of optimum moisture content.

The pavement subgrade should be proof rolled with a heavily loaded pneumatic-tire vehicle. Areas which deform more than 0.5 inch under heavy wheel loads should be removed, replaced if necessary, and reworked to achieve a stable subgrade prior to paving. We recommend that proof rolling and subgrade compaction tests be inspected and approved by a representative of the geotechnical engineer prior to placing any pavement.

HMA Recommendations
We recommend an HMA mix for this project meeting the requirements of SX (75), and that the binder meet the requirements of PG 58-28.

cc:

Project file

Attachments

Table 1
Design Capacity for Classes of Roadways

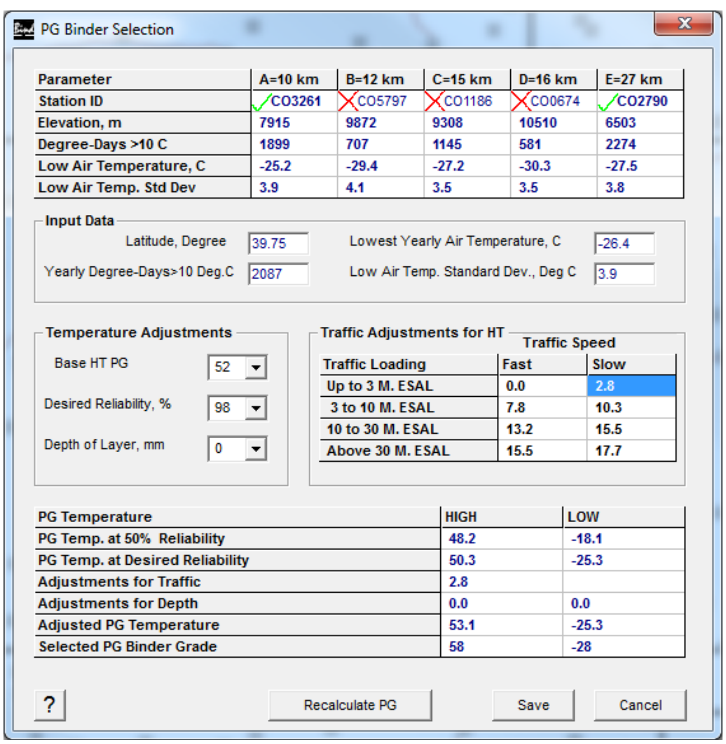
Classification	ADT
Principal Arterial	5,000 - 10,000
Arterial	3,500 - 5,000
Collector	2,000 - 3,500
Local Access	500 - 2,000
Low Volume	100 - 500
Primitive	Less than 100

Table 8
Minimum Traffic Indexes

Road Class		Minimum TI
Primitive		3.5
Low Volume		4.5
Local Access		5.0
Collector:	Residential	6.0
	Commercial	7.0
	Industrial	8.5
Arterial		10.0

Table 9
Minimum Structural Sections

Road Class	Gravel	Paved*
Primitive	3" Base Course 3" Subbase	3" Asphalt 3" Base Course 3" Subbase
Low Volume	3" Base Course 3" Subbase	3" Asphalt 3" Base Course 3" Subbase
Local Access	4" Base Course 4" Subbase	3" Asphalt 3" Base Course 3" Subbase
Collector	Not Applicable	4" Asphalt 4" Base Course 4" Subbase
Arterial	Not Applicable	6" Asphalt 4" Base Course 4" Subbase


PG Binder Selection

Parameter	A=10 km	B=12 km	C=15 km	D=16 km	E=27 km
Station ID	CO3261	CO5797	CO1186	CO0674	CO2790
Elevation, m	7915	9872	9308	10510	6503
Degree-Days >10 C	1899	707	1145	581	2274
Low Air Temperature, C	-25.2	-29.4	-27.2	-30.3	-27.5
Low Air Temp. Std Dev	3.9	4.1	3.5	3.5	3.8

Input Data
Latitude, Degree: 39.75
Yearly Degree-Days>10 Deg.C: 2087
Lowest Yearly Air Temperature, C: -26.4
Low Air Temp. Standard Dev., Deg C: 3.9

Temperature Adjustments
Base HT PG: 52
Desired Reliability, %: 98
Depth of Layer, mm: 0

Traffic Adjustments for HT

Traffic Loading	Traffic Speed Fast	Slow
Up to 3 M. ESAL	0.0	2.8
3 to 10 M. ESAL	7.8	10.3
10 to 30 M. ESAL	13.2	15.5
Above 30 M. ESAL	15.5	17.7

PG Temperature	HIGH	LOW
PG Temp. at 50% Reliability	48.2	-18.1
PG Temp. at Desired Reliability	50.3	-25.3
Adjustments for Traffic	2.8	
Adjustments for Depth	0.0	0.0
Adjusted PG Temperature	53.1	-25.3
Selected PG Binder Grade	58	-28

? Recalculate PG Save Cancel