TCI
WHE

*Map

RE:

Tuttle & Associates

303.653.5584
PO Box 485
Broomfield, CO 80038
garyjtuttle@gmail.com

RECEIVED
JUN 04 2015
TO: DIVISION OF RECLAMATION, MINING AND SAFETY

June 4, 2015

Tim Cazier, PE
DRMS
1313 Sherman Street
Room 215
Denver, CO 80203

Re: Canon Dolomite Quarry, M1977-376
Technical Revision #1

Request TR01

Dear Tim:

Enclosed with this letter is our documents for the Technical Revision #1 on Canon Dolomite Quarry. The documents include the check #00188379 for the application fee and Exhibits C, D, E, F, and L. The drainage report for the Old Quarry Fines Disposal Area is with Exhibit E as part of the reclamation plan.

Please use me as the contact for the site inspection and adequacy questions. I will be away from June 17 to July 1, 2015.

Cordially;
Tuttle & Associates

Gary J Tuttle

Gary J. Tuttle

Encl

Cc: file, J Schnabel

√ AF & Report
√ Violations
MV1987028 4/22/1987
MV2000043 11/20/2000

CANON DOLOMITE QUARRY
M1977-376

TECHNICAL REVISION #1

To clarify the mining and reclamation plan and to update the financial warranty. This technical revision includes Exhibits C, D, E, F, and L.

Operator: **Continental Materials Corp.**
444 East Costilla
Colorado Springs, CO 80903

Consultants: **Tuttle & Associates**
EME Solutions

Date: **June 4, 2015**

6.4.4 EXHIBIT D – MINING PLAN

Introduction

The mining on this quarry site started in late 1920's. The first area mined is the Old Quarry area (see Detail 3 on Exh. C-1). The second area mined is the present mining area (see Detail 2 on Exh. C-1). The dolomite limestone was used by CFI in Pueblo for steel manufacturing. CFI permitted the quarry in 1977 when the reclamation law was implemented.

The land of the permit was purchased by private investor in 1993. The land was purchased by Continental Materials in 2003. Thus Continental Materials is liable for reclamation of disturbances since 1977. Exh C1 defines this area. Any disturbance not inside the dashed line is not the responsibility of the operator. Much of the disturbance in the mine area (Detail 2, Exh C-1) will be incorporated into the future mining area.

The last amendment done in 1982 by CFI included a vague mining and reclamation plan. Thus the purpose of this TR is to detail the plans and update the financial warranty. There is no change in permit boundary.

(a) Methods of Mining

This is a hard rock quarry on a mountain side. The standard benching technique moving downward on the hill will be employed. Refer to Exh. C-2.
Prior to 1977, the original operator started mining up the slope at the western boundary line. The present mining is occurring 300 to 600 feet from the boundary line. The operator will continue the present mining on the 6190 foot bench. One bench above the mining is used as the road up to drill / blast area.

The blasting cuts out approximately 50' of horizontal distance once a year. The rock material is used for landscape purposes.

The present bench for mining (approx. 6150' elev) slopes upward to the south. This presents a problem as rainfall drainage flows northward back into crusher/screen and stockpile area. Mining of the remaining bench and the next (third) bench will bring the benches to horizontal. Thus rainfall drainage can be directed to the east and off the bench.

Mining will proceed down to the east to 6000 elev. Seven benches in total will be mined. Approximately 1.2 M tons are mined out per bench.

No mining will occur any farther into the canyons of Echo and Diablo as noted in 1982 amendment.

The portable crusher and screen plant moves with mining face. Product stockpiles are located to north of the plant. After blasting, rock is picked up by loader and taken to the hopper of the crusher. The screen plant sorts rock material into desirable sizes and belt stackers move the rock into stockpiles.

(a) Earthmoving

With very little overburden on top of the dolomite and mining occurring on land previously disturbed, there is no earthmoving or stockpiling.

(b) Water diversions and impoundments

No groundwater is encountered in mining. No impoundments are built to catch rainfall. No drainages are diverted.

(c.) Timetable

Mining production now is approximately 50,000 tpy. We forecast that production will increase in the future as the market area grows. Up to 300,000 tpy could be mined in later stages of the operation. Each bench involves 15 to 20 acres. Refer to Section B-B on Exh. C-2 for bench locations.

This mining operation may have perils of inactivity exceeding 180 days. This may occur in the fall and winter when landscaping is usually not installed and if rock stockpiles at the sales yard in Pueblo West are full. This statement serves as the substitute for Notice of Temporary Cessation.

The following timetable shows possible bench mining.

Bench 6200	****									
Bench 6153		****	****							
Bench 6120				****	**					
Bench 6090					**	****				
Bench 6060							****			
Bench 6030								****		
Bench 6000									****	
Years	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060

(f) Dolomite is a carbonate mineral made of calcium magnesium carbonate' instead of pure calcium carbonate material. Therefore, dolomite is called a double carbonate rock, and it doesn't readily dissolve in dilute acidic media. The way dolomite is formed is not quite clear, and it has been found to form under high saline conditions in environments like lagoons. Dolomite is also a **sedimentary rock** type. When dolomite is formed, several steps of **dissolution** and re-precipitation is passed where the structure of the mineral is modified into more stable forms and crystallizes in a trigonal-rhombohedral manner.

Dolomite is used as an ornamental decoration, as a source for magnesium extraction, in the making of concrete, and in horticulture to add richness to the soil by balancing the pH of soil. This deposit is unique for its high percentage of pink or rose color rock, valued as a landscape ground cover.

Exploratory drilling has gone to the depth of 100' and still encounters dolomite. The lower levels are less dense and lower hardness than the upper levels. Below the dolomite is various forms of igneous rock, as evident in the exposed rock of the Royal Gorge.

g. The Primary commodity is dolomite rock for landscape and construction uses. No secondary uses.

h. No incidental products are made.

i. Explosives are used to mine the dolomite rock. Blasting has occurred here since the mine began in the late 1920's. No offsite areas or improvements have been adversely affected by the mine operation. The nearest residence is one mile away and 500 feet lower in elevation, thus in a different geologic formation. No complaints regarding blasting have been received by the DRMS.

6.4.5 EXHIBIT E – RECLAMATION PLAN

(2) (a) Reclamation acres

Fines Disposal Area	3
Old Quarry	5
Mine Area	32.5
Access Road area	0.5
Total	41

Access road will remain as access for landowner.

The type of reclamation is revegetation with grass, forb, and shrub seed. Most seed is broadcast due to the steeper slopes. Flat areas will be drill seeded, which is the 12 acres on the 6000 foot elevation bench.
Most mulch is sprayed with a hydro-spray equipment. Flat areas will be crimped in straw. Fertilizer will be applied on all revegetated areas.

Earthmoving is the distribution of quarry fines on disturbed land on the Mine, Access Road, and Old Quarry areas. Fines Disposal Area has fines now. It will be graded to reasonable slopes as possible with no additional fines added.

(b) The post mining land use is rangeland. Surrounding land uses are rangeland. Fremont County has zoned the land agriculture. Urban uses and urban services are not planned here.
The grazing productivity is poor due to steep slopes, low precipitation, and sparse vegetation.
Vegetation coverage on undisturbed land is now 40% to 60%.

(c)C The reclamation plan to meet applicable requirements of Section 3.1
3.1.5 Materials Handling –
(1) The final topography will be for rangeland and will match the adjoining topography.

(2) The Old Quarry area is the site for deposit of unmarketable quarry fines. We expect half of these fines will go into Old Quarry. Backfilling will build up the floor of area sequentially. Compaction by the equipment movement placing fines. Fines are granular and will compact against their faces in a fairly tight matrix.

(3) The mining benches in the Mine Area will be filled and graded with fines as the mining progresses on the below bench in a north to south direction. The typical bench is 30' high and 60' wide and filled at a typical 4:1 slope. Therefore the fill extends up the vertical face halfway at 15'. Any weeds on the slope will be removed by mowing, pulling, or chemical spraying. A track dozer will run vertically up and down the slope so the tracks can imprint horizontal ridges in the soil. Where vertical gullies exist on the slope, the dozer blade will be lowered to the depth of the gullies on the up run and lifted on the down run.

(4) The bench filling and grading happen concurrently with mining as benches will be inaccessible as mining moves down.
Grading of Fines Disposal Area within five years of TR approval
Grading of Old Quarry Fines Disposal happen as the area is filled to final elevation.

(5) No refuse or toxic materials

(6) Drill holes eliminated by blasting

(7) The maximum slopes in reclamation will be 4:1 and occur on grading of mining benches and on the eastern finger of the Old Quarry area. Undisturbed surrounding land can be as steep as 25% to 30%. Occasional rock outcrops are near vertical.

(8) No agricultural crops in the reclamation plan.

(9) Inert backfill from sources outside of the permit area may be hauled in for reclamation filling. Since this mine is away from urban areas and one mile from US 50, we do not expect this filling to occur frequently. In fact the chances of a contractor hauling backfill to this location is slight.

(10) The unmarketable fines disposed within the affected area are inert and contain no pollutants.

(11) No groundwater is encountered during mining. Echo and Diablo Canyon will be avoided.

3.1.6 Water – General Requirements

(1) The operation does and will comply with State water law and Federal/State water quality laws
(2) No earthen dams
(3) Post law disturbed area will be revegetated

3.1.7 Groundwater – Specific Requirements

(1) No groundwater will be encountered in the mining, thus groundwater quality will not be affected directly. BMP's are and will be utilized for fueling of equipment. No permanent fuel storage is planned for the site.
(2) No reasonable potential to adversely affect the quality of unclassified groundwater.
(3) No reasonable potential to adversely affect the quality of unclassified groundwater. The rock product is not washed and no water impoundments are included. The operator follows the Stormwater Management Plan for the site. There is a Water Discharge permit for the site and sheet flow sampling at the stockpiles and road side ditch is noted quarterly if possible.

3.1.8 Wildlife

The reclamation plan for revegetation will create habitat for insects, rodents, and small birds. This may encourage predators such as raptors, fox, and coyote to frequent the site.

3.1.9 Topsoiling

Much of the Mine area is on disturbed land. No topsoil stockpiles exist now. Existent overburden and topsoil is of such insufficient quantities to not allow any segregation and salvage. Unmarketable quarry fines will used for growth media and augmented by fertilizer and mulch.

3.1.10 Revegetation

The reclamation plan is for rangeland and the seed mix is selected for that use. Slopes will be the same as or less than existing slopes and suitable for livestock, except for parts of the near vertical benches exposed. Weeds will be controlled during reclamation. Seeding will be done by drill and broadcast.

(d) See the descriptions in (f) below for specific reclamation plans.

(e) Reclamation Schedule

Fines Disposal Area - Detail 1 on Exh. F

Grading will begin in 2016 on the site. A dozer will slope out the gullies and steep sections. A backhoe will pull up sediment from the drainage along the line of Section C-C. Grass seeding, mulching, and fertilizing can occur the next spring.

Mine Area - Detail 2 on Exh. F

The post law bench above the present bench being mining is not accessible by equipment, so filling with fines is not possible. Grass seed will be broadcast by hand on this bench. Fertilizer and mulch will be hydrosprayed from below on the seed. This upper bench is slightly more than one acre. This seeding work will be done within the next three years.

The small piece of disturbance below the mine area and along the access road will be reclaimed within the next three years by filling with quarry fines and seeded. The area may contain a water tank and a hose for truck filling.

As mining continues on the second bench and the succeeding six benches, reclamation will occur concurrently. Backfilling of the 30 foot vertical face will be done with quarry fines at a typical 4:1 slope as the mining moves southward. Seeding with fertilizer and mulch will be done on the slope every second or third year and at the end of that bench mining.

Old Quarry Fines Disposal Area - Detail 3 on Exh. F

More unmarketable fines will be produced at the mine than can be used in that filling and grading. These excess fines will be hauled to the Old Quarry. Fines placement will begin at the eastern "finger" at the 5840' elevation. Successive filling will move work westward and up the slope into the box canyon area. As a section reached its final elevation, the surface will be graded and seeded. Fertilizer and mulch will be applied. Also the drainage channels will be built in that section.

(f) Description of Reclamation

(i.) Final Grading – Maximum slopes are 4:1 on the vertical bench faces and in the Old Quarry area. Minimum slopes are 1% on the last bench in the Mine Area at 6000' elevation.

(ii.) Seeding – see the seed mix on the following page.

(iii) Fertilization per acre -- 120 lbs. N, 200 lbs. P2O5, 60 lbs. K2O; mulching with clean straw at 2 tons/acre crimped in by a disc or hydro-sprayed wood cellulose fiber mulch application at 2,000 lbs. per acre with tackifier at 100 lbs. per acre.

(iv) Revegetation – no potted or B&B trees and shrubs will be installed. All plants are seeded.

(v) Topsoiling – No topsoil is available on the site.

SEED MIX Plant species mixture and seeding rate in pure live seed per acre

SPECIES		
Common Name	Scientific Name	Seeding Rate
GRASSES		
Nordan crested wheatgrass	Agropyron desertorum	0.7
Critana thickspike wheatgrass	Agropyron dasystaciyum	0.7
Bozoisky II Russian wildrye	Elymus junceus	1.0
Poloma Indian ricegrass	Oryzopsis hymenoides	1.5
Cache meadow brome	Bromus erectus	1.7
Sand dropseed	Sporobolus cryptandrus	0.1
Green needlegrass	Stipa viridula	1.4
FORBS		
Ladak alfalfa	Medicoago scoioc	0.1
Lewis flax	Linum laviati	0.5
Palmer penstemon	Penstemom palmeri	0.7
Lutana cicer milkvetch	Astragalus cicer	0.7
Emerald crownvetch	Coronilla varia	1.0
SHRUBS		
Fourwing saltbush	Atriplam carescans	0.5
Rubber rabbitbrush	Chrysothamnus rausaosus	0.01
Winterfat	Caratoides Canata	0.8
TOTAL		11.51

Final Drainage Report for the Canyon Dolomite Old Quarry Project Cañon City, Colorado

Prepared For:
Transit Mix Concrete Co.
444 E. Costilla Street
Colorado Springs, Colorado

Prepared By:
EME Solutions, Inc.
15248 W. Ellsworth Drive
Golden, CO 80401
John L. Jankousky, P.E.
Phone: 303-279-1707
john.jankousky@eme-solutions.com

May 29, 2015

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This report for the drainage design of the Canyon Dolomite Old Quarry Project was prepared by me or under my direct supervision in accordance with good engineering standards and was designed to comply with the provisions thereof.

COLORADO REGISTERED
JOHN LIBBY JANKOUSKY
30941
PROFESSIONAL ENGINEER

John L. Jankousky, P.E.
Registered Professional Engineer
State of Colorado No. 30941

I. GENERAL LOCATION AND DESCRIPTION

EME Solutions, Inc. (EME) has been retained by Transit Mix Concrete Company (Client) to provide this Final Drainage Report for the Canyon Dolomite Old Quarry Project.

A. Location

The Project Site (or Site) is located at the Canyon Dolomite Quarry Site located approximately 1 mile west of Cañon City, Colorado. The latitude and longitude of the site are 38.453954°, -105.267026°.

B. Description of Property and Proposed Development

The Old Quarry portion of the Canyon Dolomite Quarry site will be used for fines disposal. The purpose of this report is to provide the calculations and design for a channel and rock chute that can safely pass the 100-year storm flows across this fines disposal area.

C. Other Drainage Studies

No other drainage studies were provided or discovered.

II. DRAINAGE BASINS AND SUB-BASINS

A. Basin Description

The drainage basin area that contributes flows to the Site is 33.7 acres. Flows from the Site go to Sand Creek, located about 1 mile east of the Site. The terrain within the basin is relatively steep. There is no baseflow. Although the soil hydrologic type is D, the runoff does not appear to be substantial or rapid. At a site visit during a rainstorm on May 19, 2015 (and after several days of rain), the runoff across the site was estimated at less than 50 gallons per minute.

B. Sub-Basin Description

Because the Project is located at the mouth of a small canyon, the hydrology was evaluated as a single basin.

The Proposed Project will not affect existing offsite drainage flow patterns, and vice versa.

III. DRAINAGE DESIGN CRITERIA

A. Regulations and Criteria

The Division of Reclamation, Mining, and Safety (DRMS) does not have defined drainage design criteria. This drainage report has been prepared in accordance with good engineering practices and the references provided.

B. Selection of BMPs

The major Best Management Practice (BMP) under consideration for this Project is a rock chute.

C. Hydrological Criteria

The rainfall data presented in the *NOAA Atlas 14, Volume 8, Version 2* was used. The Rational Method was used to calculate runoff. The Site was evaluated for the 10-year and 100-year rainfall events. Site soils are Hydrologic Group D based on soil survey data and site observations.

D. Hydraulic Criteria

The rock chute was designed using the methods presented in a series of papers by K.M. Robinson and others. See the References section. The channel leading to the rock chute was designed using the Manning Equation. See attached calculations.

IV. DRAINAGE DESIGN

A. Design Elements

The site design consists of the rock chute and its approach channel.

B. Offsite Runoff Considerations

The Project is designed to safely pass the offsite runoff from the upstream basin. The

Project should have no impact on flows at upstream or downstream sites.

C. Tables, Charts, Figures, and Drawings

This drainage report includes the following tables, charts, figures, and drawings:

- Drainage Basin Map
- Soil Survey information
- Basin area, % impervious, and Time of Concentration calculations
- Rainfall from NOAA Atlas
- Runoff by Rational Method
- Approach channel flow calculations by Manning Equation
- Rock chute calculations using methods by K.M. Robinson

All calculations are in conformance with the design criteria presented above.

B. Summary of Results

Hydrology Results
Flows for the 10-year 100-year storms were calculated using the Rational Method. The 10-year flow is estimated at 29.6 cubic feet per second (cfs) and the 100-year flow is estimated at 98.7 cfs.

modeled using HEC-HMS. Flows for the 10-year and 100-year storms were also calculated using the Rational Method as a basis of comparison. The HEC-HMS flows are considered to be more accurate because HEC-HMS is a more appropriate method to use for a basin the size of Gilson Gulch.

Hydraulics Results
The approach channel shall be trapezoidal, with bottom width 6 feet, side slopes 3:1, and two feet deep.

The rock chute has a slope from ranging from approximately 15% to 25%. To be conservative, it was assumed that the entire chute is 25% slope. See the calculation sheets for the configuration of the rock chute.

VI. CONCLUSIONS

The calculations and design elements presented here are designed to safely pass the 100-year storm flows through the Canyon Dolomite Old Quarry Site.

VII. REFERENCES

American Society of Agricultural Engineers 2010. Rock Chute Design Program – Rock_Chute.xls. Excel spreadsheet based on "Design of Rock Chutes," Robinson et. al., 1998.

NRCS 2015. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed May 21, 2015.

Robinson et. al., 1997. *Design of Rock Chutes.* K. M. Robinson, P.E., C. E. Rice, P.E. and K. C. Kadavy, P.E. Research Hydraulic Engineers and Agricultural Engineer, USDA, Agricultural Research Service, Stillwater, Oklahoma. Written for presentation at the 1997 ASAE Annual International Meeting. Sponsored by ASAE. Minneapolis Convention Center, Minneapolis, Minnesota. August 10-14, 1997

Robinson et. al., 1998. *Design of Rock Chutes.* K. M. Robinson, C. E. Rice, K. C. Kadavy. Transactions of the ASAE. VOL. 41(3):621-626. 1998 American Society of Agricultural Engineers.

APPENDIX A
Drainage Calculations

APPENDIX A
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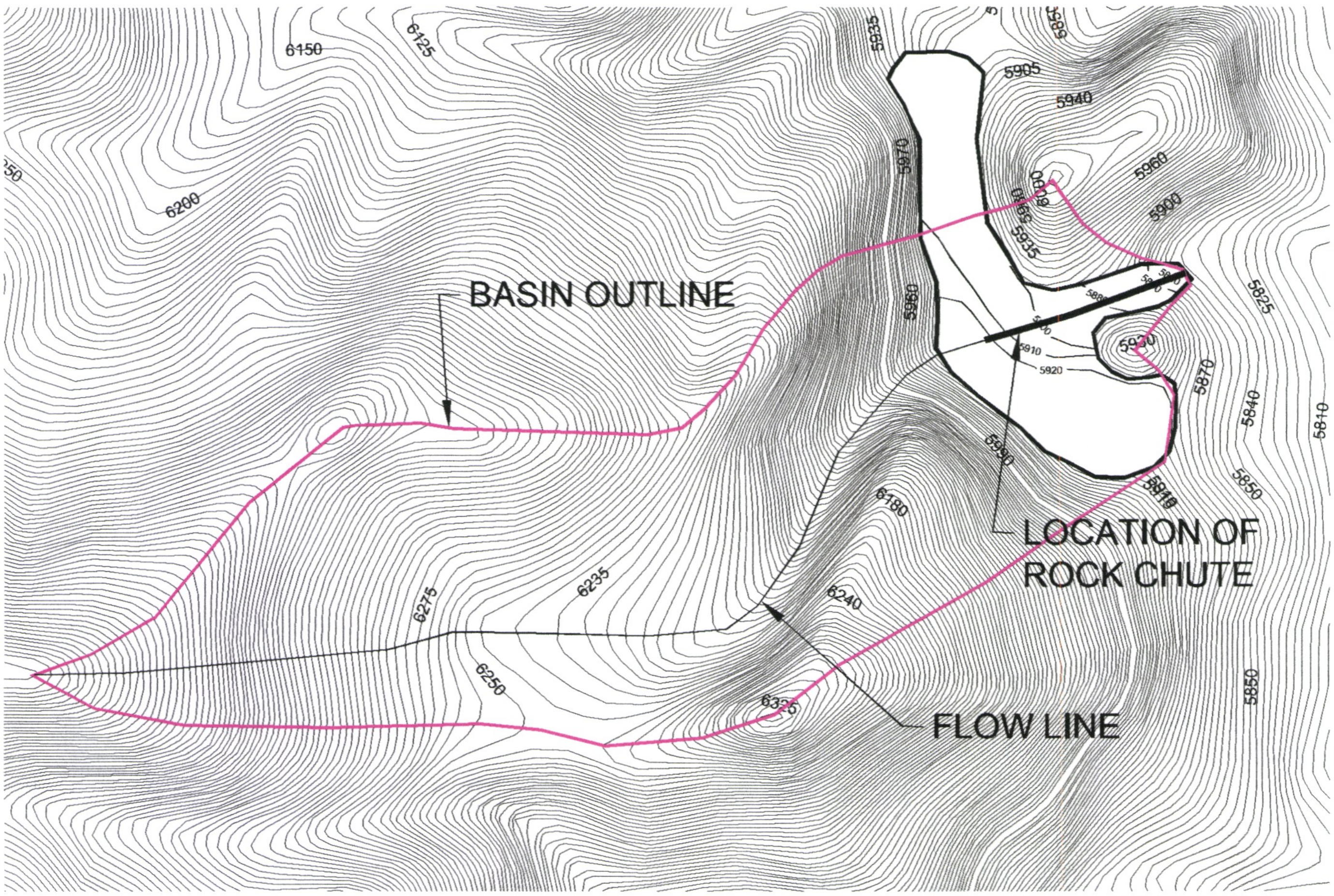

OLD QUARRY – DRAINAGE BASIN

PREPARED BY:		PREPARED FOR:		PROJECT:			
EME SOLUTIONS, INC. 15248 W. ELLSWORTH DR. GOLDEN, CO 80401 303-279-1707		Transit Mix Concrete Co. 444 E. Costilla Street Colorado Springs, CO 80903		Canyon Dolomite Quarry Old Quarry – Fines Disposal Canon City, Colorado			
JOB NO	DATE	SCALE	DRAWN BY	DESIGNED BY	APPROVAL	REV	SHEET
CDolo	5-28-2015	-	JLJ	JLJ	-	0	1

SUMMARY OF NRCS WEB SOIL SURVEY INFORMATION

Soils survey information from the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) was accessed at the Web Soil Survey on May 21, 2015 (NRCS 2015. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed May 21, 2015).

There are three types of soils in the basin above the site:

- Roygorge very gravelly sandy, clay loam, 25 to 50 percent slopes
- Ustic Torriorthents, bouldery-Rock outcrop complex, 35 to 90 percent slopes
- Wesix very channery loam, 5 to 40 percent slopes

These soils are all Soil Hydrologic Group D.

Table 1. Areas, Lengths, and Elevation Changes from Site Map
Canyon Dolomite - Old Quarry
Final Drainage Report

Calculated by: John Jankousky Revision: 5/29/2015

Number	Basin Designation	Area (ft^2)	Area (acres)	Area (mi^2)	Flow Length, L (ft)	Flow Length, L (mi)	Length of Overland Flow, L(OL) (ft)	Length of Concentrated Flow, L(P) (ft)	Top Elevation (ft)	Bottom Elevation (ft)	Change in elevation, H (ft)	Overall Slope, S = H/L (ft/ft)	Overland Flow Top Elevation (ft)	Overland Flow Bottom Elevation (ft)	Overland Change in elevation, H (ft)	Overland Flow Slope, S = H/L (ft/ft)	Concentrated Flow Top Elevation (ft)	Concentrated Flow Bottom Elevation (ft)	Concentrated Change in elevation, H (ft)	Concentrated Flow Slope, S = H/L (ft/ft)
1	Quarry-outlet	1,467,897	33.70	0.053	2814	0.53	500	2314	6565.0	5847.0	718.0	0.2552			0.0	0.2552			0.0	0.2552

Canyon Dolomite - Old Quarry
Final Drainage Report
Percent Impervious Calculations and Rational Method "C" Calculations

Calculated by: John Jankousky Revision: 5/29/2015

Soil Hydrologic Group D

Land Use	% Imp.	C2	C5	C10	C100
Landscape Area*	0	0.04	0.15	0.25	0.5
Railroad Yard Area	40	0.28	0.35	0.42	0.58
Gravel Street	80	0.6	0.63	0.66	0.74
Building/Roof Area	90	0.73	0.75	0.77	0.83
Pavement Area	100	0.89	0.90	0.92	0.96

Number	Basin Designation	Total Area (ft^2)	Total Area (acres)	Landscape Area* (ft^2)	Railroad Yard Area (ft^2)	Gravel Street Area (ft^2)	Building/Roof Area (ft^2)	Pavement Area (ft^2)	Combined % Impervious	Combined C2	Combined C5	Combined C10
1	Quarry-outlet	1,467,897	33.70	1,394,502		0	0	73,395	5.00	0.083	0.188	0.28

* For "Landscape Area", assume zero percent impervious (sandy soils)

Combined C values are equal to area weighted average; that is, C combined = summation(C_i x $Area_i$) / total Area

For Basins J5 and J6 assume that haul roads and other activities result in some areas of partial imperviousness.

Basin J7 is undisturbed except for the access road.

Use 80% impervious (Gravel Street) for haul roads and access road.

STANDARD FORM SF-1
TIME OF CONCENTRATION
Canyon Dolomite - Old Quarry
Final Drainage Report

Calculated by: John Jankousky Revision: 5/29/2015

	Sub-Basin Data			Initial Overland Time (t_i)			Travel Time (t_t)				$t_c = t_i + t_t$	Check t_c	Final t_c	Remarks
Number	Designation	Area, Ac	C10	Overland Flow Length, L, Ft.	Slope, %	t_i, min*	Concen-trated Flow Length, Ft.	Slope, %	Velocity, FPS **	t_t, min	Comp. t_c, min	t_c = (L/180) +10, min	Final t_c, min	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)		(14)	
PROPOSED CONDITIONS														
1	Quarry-outlet	33.70	0.28	500	25.52	11.6	2314	25.52	8.36	4.6	16.2	25.6	16.2	

* Calculated using formula: $t_i = (1.87 * (1.1 - C10) * L^{0.5}) / (S^{0.333})$; where C10 = runoff coeff for 10-year storm; L = overland flow length (ft); and S = slope in %

** For travel time velocity, use Manning's equation for a grass-lined channel, v = 1.49/n * r^0.667 * s*0.5
Where r = hydraulic radius = area / wetted perimeter; n = Manning's "n" = 0.035; s = slope in ft/ft

Rainfall Estimates for Design Storms

Canyon Dolomite - Old Quarry

Rainfall Depth

Minutes	10-Year	100-Year
5	0.45	0.81
10	0.65	1.18
15	0.80	1.44
30	1.11	2.01
60	1.35	2.53
120	1.58	3.05
360	1.67	3.30

Rainfall Intensity

Minutes	10-Year	100-Year
5	5.36	9.70
10	3.92	7.08
15	3.19	5.76
30	2.22	4.02
60	1.35	2.53
120	0.79	1.53
360	0.28	0.55

Source: NOAA Atlas 14, Volume 8, Version 2
Accessed at http://hdsc.nws.noaa.gov/hdsc/pfds/ on 5/26/2015

NOAA Atlas 14, Volume 8, Version 2
Location name: Cañon City, Colorado, US*
Latitude: 38.4540°, Longitude: -105.2670°
Elevation: 5916 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF tabular | PF graphical | Maps & aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.220 (0.172-0.286)	0.270 (0.211-0.352)	0.362 (0.281-0.473)	0.447 (0.345-0.587)	0.577 (0.436-0.805)	0.688 (0.505-0.970)	0.808 (0.573-1.17)	0.939 (0.639-1.40)	1.13 (0.736-1.74)	1.28 (0.810-1.99)
10-min	0.322 (0.251-0.419)	0.396 (0.308-0.515)	0.530 (0.411-0.692)	0.654 (0.505-0.859)	0.845 (0.639-1.18)	1.01 (0.740-1.42)	1.18 (0.839-1.72)	1.38 (0.935-2.05)	1.65 (1.08-2.54)	1.88 (1.19-2.91)
15-min	0.393 (0.307-0.511)	0.483 (0.376-0.628)	0.646 (0.502-0.844)	0.798 (0.616-1.05)	1.03 (0.779-1.44)	1.23 (0.903-1.73)	1.44 (1.02-2.09)	1.68 (1.14-2.51)	2.01 (1.32-3.10)	2.29 (1.45-3.55)
30-min	0.548 (0.427-0.713)	0.673 (0.524-0.876)	0.901 (0.699-1.18)	1.11 (0.858-1.46)	1.44 (1.09-2.00)	1.71 (1.26-2.41)	2.01 (1.42-2.91)	2.33 (1.59-3.48)	2.80 (1.83-4.31)	3.18 (2.01-4.93)
60-min	0.697 (0.544-0.907)	0.830 (0.647-1.08)	1.09 (0.846-1.42)	1.35 (1.04-1.77)	1.76 (1.34-2.48)	2.12 (1.57-3.02)	2.53 (1.80-3.69)	2.98 (2.04-4.48)	3.65 (2.39-5.64)	4.20 (2.66-6.51)
2-hr	0.846 (0.668-1.09)	0.987 (0.779-1.27)	1.28 (1.01-1.65)	1.58 (1.24-2.05)	2.08 (1.61-2.92)	2.54 (1.90-3.57)	3.05 (2.20-4.41)	3.63 (2.51-5.40)	4.50 (2.98-6.86)	5.22 (3.34-7.98)
3-hr	0.933 (0.742-1.19)	1.06 (0.844-1.35)	1.35 (1.07-1.73)	1.67 (1.31-2.14)	2.21 (1.74-3.10)	2.72 (2.06-3.82)	3.30 (2.41-4.75)	3.97 (2.77-5.87)	4.98 (3.33-7.56)	5.83 (3.75-8.83)
6-hr	1.09 (0.875-1.36)	1.22 (0.982-1.53)	1.53 (1.23-1.93)	1.88 (1.50-2.38)	2.48 (1.97-3.42)	3.04 (2.33-4.21)	3.69 (2.72-5.24)	4.44 (3.13-6.48)	5.57 (3.77-8.34)	6.53 (4.25-9.74)
12-hr	1.26 (1.02-1.55)	1.44 (1.17-1.79)	1.82 (1.48-2.26)	2.20 (1.78-2.75)	2.83 (2.26-3.80)	3.40 (2.63-4.60)	4.04 (3.01-5.61)	4.77 (3.39-6.80)	5.84 (3.98-8.56)	6.73 (4.42-9.89)
24-hr	1.47 (1.21-1.79)	1.70 (1.40-2.07)	2.13 (1.75-2.61)	2.55 (2.09-3.15)	3.22 (2.59-4.22)	3.81 (2.96-5.04)	4.46 (3.34-6.05)	5.17 (3.71-7.24)	6.22 (4.28-8.95)	7.09 (4.71-10.2)
2-day	1.68 (1.40-2.02)	1.97 (1.65-2.37)	2.50 (2.08-3.02)	2.99 (2.47-3.62)	3.73 (3.01-4.77)	4.36 (3.42-5.65)	5.04 (3.81-6.70)	5.77 (4.18-7.91)	6.83 (4.73-9.63)	7.69 (5.16-10.9)
3-day	1.83 (1.54-2.18)	2.15 (1.81-2.57)	2.73 (2.29-3.27)	3.27 (2.73-3.93)	4.07 (3.31-5.16)	4.75 (3.75-6.10)	5.48 (4.17-7.22)	6.27 (4.56-8.51)	7.40 (5.16-10.3)	8.31 (5.61-11.7)
4-day	1.96 (1.66-2.32)	2.30 (1.95-2.73)	2.92 (2.47-3.48)	3.49 (2.93-4.17)	4.34 (3.55-5.47)	5.06 (4.02-6.45)	5.83 (4.46-7.63)	6.66 (4.87-8.97)	7.84 (5.50-10.9)	8.80 (5.97-12.3)
7-day	2.31 (1.98-2.71)	2.70 (2.31-3.17)	3.39 (2.90-3.99)	4.02 (3.41-4.74)	4.95 (4.08-6.14)	5.73 (4.59-7.19)	6.55 (5.06-8.45)	7.45 (5.49-9.89)	8.71 (6.15-11.9)	9.72 (6.65-13.4)
10-day	2.63 (2.27-3.05)	3.05 (2.63-3.55)	3.80 (3.26-4.43)	4.46 (3.81-5.23)	5.44 (4.51-6.68)	6.25 (5.04-7.77)	7.11 (5.52-9.08)	8.02 (5.95-10.6)	9.31 (6.61-12.6)	10.3 (7.11-14.2)
20-day	3.50 (3.07-4.01)	4.04 (3.53-4.62)	4.93 (4.30-5.67)	5.71 (4.94-6.59)	6.81 (5.69-8.16)	7.69 (6.26-9.35)	8.59 (6.74-10.7)	9.54 (7.14-12.3)	10.8 (7.77-14.4)	11.8 (8.25-16.0)
30-day	4.22 (3.72-4.79)	4.85 (4.28-5.51)	5.89 (5.17-6.71)	6.76 (5.90-7.74)	7.97 (6.70-9.43)	8.91 (7.30-10.7)	9.86 (7.77-12.2)	10.8 (8.15-13.8)	12.1 (8.74-15.9)	13.1 (9.18-17.5)
45-day	5.11 (4.55-5.74)	5.88 (5.23-6.62)	7.12 (6.31-8.04)	8.14 (7.16-9.22)	9.50 (8.02-11.1)	10.5 (8.67-12.5)	11.5 (9.14-14.0)	12.5 (9.48-15.7)	13.8 (10.0-17.9)	14.8 (10.4-19.5)
60-day	5.85 (5.24-6.54)	6.76 (6.04-7.56)	8.19 (7.30-9.18)	9.34 (8.26-10.5)	10.8 (9.19-12.5)	12.0 (9.89-14.0)	13.0 (10.4-15.7)	14.1 (10.7-17.5)	15.4 (11.2-19.7)	16.3 (11.5-21.3)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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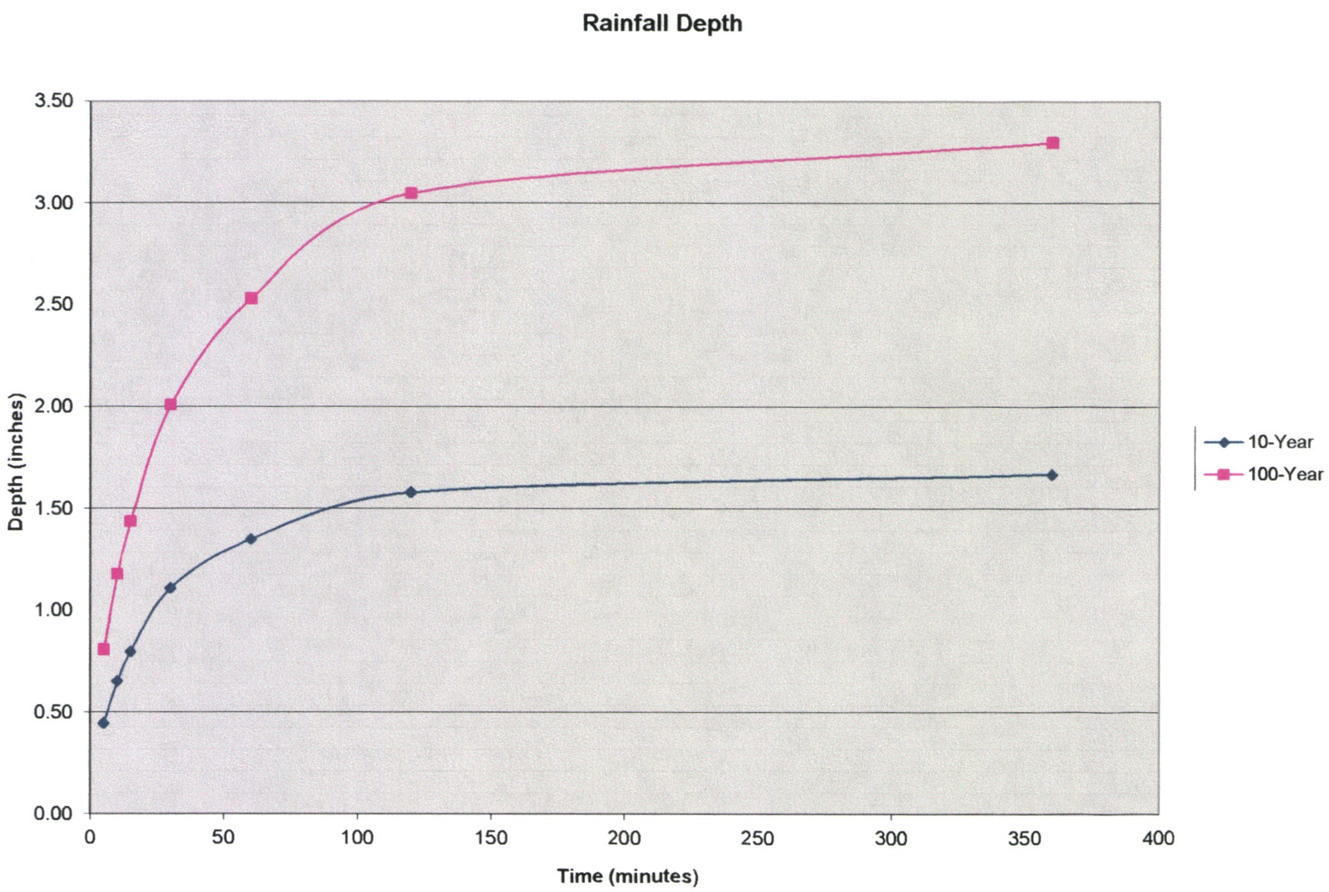
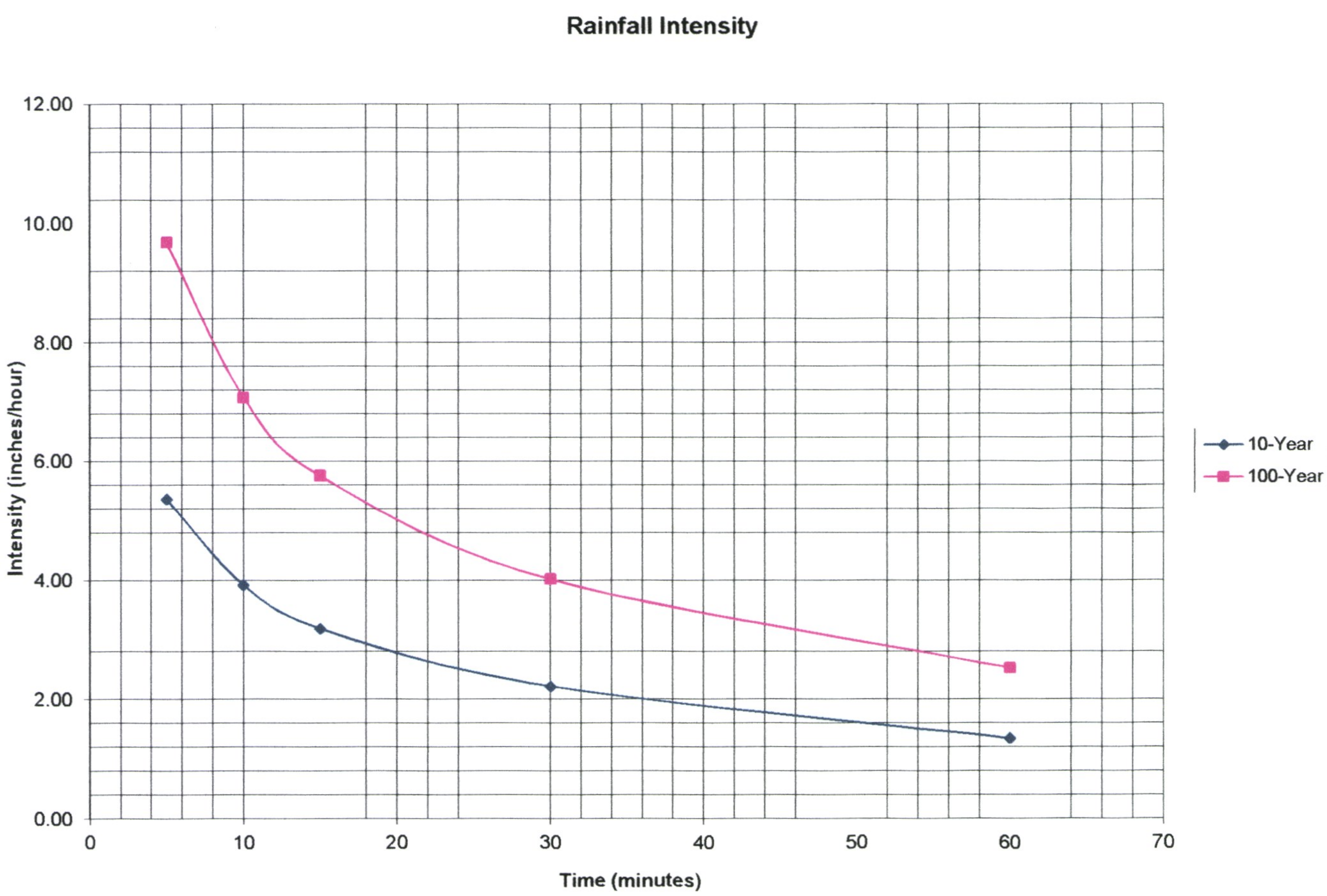
PF graphical


Rainfall Depth
Depth (inches)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
50
100
150
200
250
300
350
400
Time (minutes)
10-Year
100-Year


Rainfall Intensity
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Intensity (inches/hour)
0
10
20
30
40
50
60
70
Time (minutes)
10-Year
100-Year

Standard Form SF-2 -- Rational Method Procedure -- Storm Drainage System Design

Canyon Dolomite - Old Quarry

Calculated by: John Jankousky Revision: 5/29/2015

DESIGN STORM: 10-YR

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
	Street	Design Point	Area Designation	Area (ac)	Runoff Coeff., C	tc (min)	C*A (AC)	Intensity, I (in/hr)	Q (cfs)	t_c (min)	sum(C*A) (AC)	Intensity, I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (in)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1		Quarry-outlet	Quarry-outlet	33.70	0.28	16.2	9.55	3.10	29.62													

FORMULA: Q = C i A (Q is flow in cfs; C is runoff coefficient [dim'less]; i is rainfall intensity in inches/hr (based on t_c); A is area in acres;

Velocity in pipe estimated by V = (1.49/0.013) x ((Diameter(inches)/(12*4))^0.667) x ((Slope(%)/100)^0.5); Travel time, T_t = Length (ft) / Velocity (fps) /(60 sec/min)

Velocity in street flow estimated from Figure RO-1; Travel time, T_t = Length (ft) / Velocity (fps) /(60 sec/min)

Standard Form SF-2 -- Rational Method Procedure -- Storm Drainage System Design

Canyon Dolomite - Old Quarry

Calculated by: John Jankousky Revision: 5/29/2015

DESIGN STORM: 100-YR

			DIRECT RUNOFF							TOTAL RUNOFF				SWALE		PIPE			TRAVEL TIME			
	Street	Design Point	Area Designation	Area (ac)	Runoff Coeff., C	tc (min)	C*A (AC)	Intensity, I (in/hr)	Q (cfs)	t_c (min)	sum(C*A) (AC)	Intensity, I (in/hr)	Q (cfs)	Slope (%)	Swale Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (in)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
3		Quarry-outlet	Quarry-outlet	33.70	0.52	16.2	17.6	5.60	98.70													

FORMULA: Q = C i A (Q is flow in cfs; C is runoff coefficient [dim'less]; i is rainfall intensity in inches/hr (based on t_c); A is area in acres;

Velocity in pipe estimated by V = (1.49/0.013) x ((Diameter(inches)/(12*4))^0.667) x ((Slope(%)/100)^0.5); Travel time, T_t = Length (ft) / Velocity (fps) /(60 sec/min)

Velocity in street flow or swale flow estimated from Figure RO-1; Travel time, T_t = Length (ft) / Velocity (fps) /(60 sec/min)

Required Cross-Sectional Areas for Channels

Description	Channel A	Channel A
Flows Collected in Channel	Basin C-D	Basin C-D
Length of Channel (ft)	100	100
Change in Elevation (ft)	1.5	1.5
Slope, S (ft/ft)	0.0150	0.0150
Roughness Factor, n (dimension-less) for grass channel	0.035	0.035
Design for 10-year with freeboard, 100-year should be within freeb		
Design Storm	10-year	100-year
Source of Peak Flow, Q	Basin C-D	Basin C-D
Required Peak Flow (cfs)	29.6	98.7
Manning Formula Peak Flow (cfs)	**30.0**	**99.1**
Side Slope factor, Z (Z:1)	3.0	3.0
Cross-sectional Area, A (ft^2)	7.6	17.9
Wetted Perimeter, P (ft)	11.6	16.4
Hydraulic Radius, R (ft^2/ft)	0.66	1.09
Slope, S (ft/ft)	0.015	0.015
Flow Depth, Y (ft)	0.88	1.64
Top Width, T (ft), without freeboard	11.3	15.8
Bottom Width, W (ft)	6	6
Flow Velocity, V (fps)	3.9	5.5
Hydraulic Mean Depth, D	0.67	1.13
Froude Number, F	0.85	0.92
Subcritical/Supercritical	Subcritical	Subcritical

Note: assume 1 foot freeboard

Total depth (ft) =	**1.88**
Top Width, T (ft), with freeboard	**17.3**

APPROACH CHANNEL SHALL BE TRAPEZOIDAL, BOTTOM WIDTH 6 FEET, SIDE SLOPES 3:1, 2 FEET DEEP.

Equations:

Slope, S = Change in Elevation / Length of Channel

Area, $A = Z \times Y^2 + Y \times W$

Wetted Perimeter, $P = 2 \times Y \times (1 + Z^2)^{0.5} + W$

Hydraulic Radius, $R = A / P$

Top Width, $T = 2 \times Z \times Y + W$

Flow, $Q = (1.49 \times A \times R^{0.667} \times S^{0.5}) / n$

Flow Velocity, $V = Q / A$

Bottom Width, W = initial assumption

Height, Y = trial and error input

Hydraulic Mean Depth, $D = A / T$

Froude Number, $F = V / (g \times D)^{0.5}$

where: g = gravity acceleration = 32.2 ft/sec^2

Rock chute calculations using methods by K.M. Robinson

Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Canyon Dolomite - Old Quarry
County: Fremont County, CO
Designer: John Jankousky
Checked by:
Date: May 28, 2015
Date:

Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 6.0 ft.	Bw = 6.0 ft.	Bw = 6.0 ft.
Side slopes = 3.0 (m:1)	Factor of safety = 1.20 (F_s) **1.2 Min**	Side slopes = 3.0 (m:1)
Velocity n-value = 0.035	Side slopes = 2.0 (m:1) → **2.0:1 max.**	Velocity n-value = 0.035
Bed slope = 0.0150 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → **3.0:1 max.**	Bed slope = 0.0150 ft./ft.
Note: n value = a) velocity n from waterway program	Freeboard = 0.5 ft.	
or b) computed mannings n for channel	Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

Apron elev. --- Inlet = 5920.0 ft. ------ Outlet 5850.0 ft. --- (H_{drop} = 69 ft.)

Q_{high} = Runoff from design storm capacity from Table 2, FOTG Standard 410

Q_5 = Runofff from a 5-year,24-hour storm.

***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*

***Input tailwater (Tw)**:*

Q_{high} = 98.7 cfs — High flow storm through chute → Tw (ft.) = Program

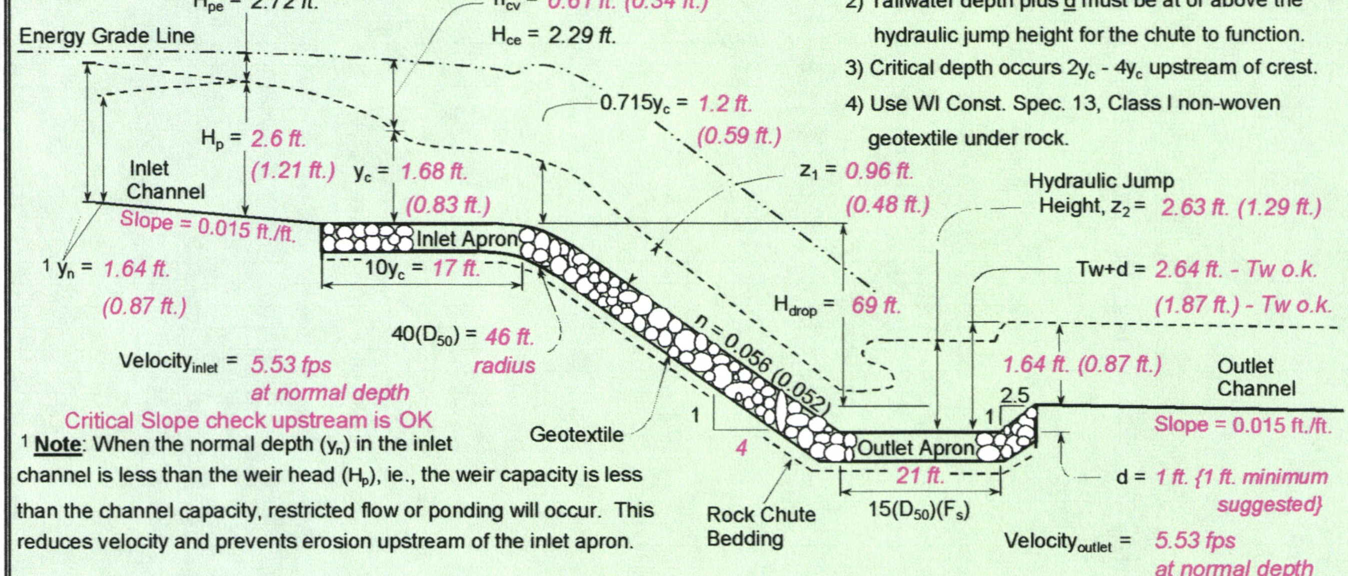
Q_5 = 29.6 cfs — Low flow storm through chute → Tw (ft.) = Program

Profile and Cross Section (Output):

Starting Station = 0+00.0

Notes:

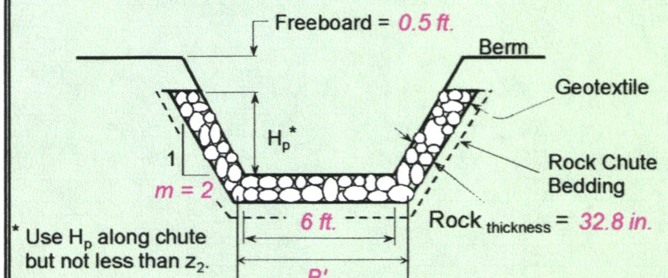
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.
4) Use WI Const. Spec. 13, Class I non-woven geotextile under rock.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than z_2.

	12.3 cfs/ft.	Equivalent unit discharge
F_S =	1.20	Factor of safety (multiplier)
z_1 =	0.96 ft.	Normal depth in chute
n-value =	0.056	Manning's roughness coefficient
$D_{50}(F_s)$ =	16.4 in.	Minimum Design D50*
$2(D_{50})(F_s)$ =	32.8 in.	Rock chute thickness
Tw + d =	2.64 ft.	Tailwater above outlet apron
z_2 =	2.63 ft.	Hydraulic jump height
*** ***The outlet***	will	***function adequately***

High Flow Storm Information

Rock Chute Design Calculations

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Canyon Dolomite - Old Quarry **County:** Fremont County, CO
Designer: John Jankousky **Checked by:** ____________
Date: 5/28/2015 **Date:** ________

I. Calculate the normal depth in the inlet channel

	High Flow			Low Flow		
y_n =	**1.64**	**ft.**	**y_n =**	**0.87**	**ft.**	(Normal depth)
Area =	17.9	ft^2	Area =	7.5	ft^2	(Flow area in channel)
Q_{high} =	98.7	cfs	Q_{low} =	29.6	cfs	(Capacity in channel)
Scupstreamchannel =	0.018	ft/ft				

II. Calculate the critical depth in the chute

	High Flow			Low Flow		
y_c =	**1.68**	**ft.**	**y_c =**	**0.83**	**ft.**	(Critical depth in chute)
Area =	15.7	ft^2	Area =	6.3	ft^2	(Flow area in channel)
Q_{high} =	98.7	cfs	Q_{low} =	29.6	cfs	(Capacity in channel)
H_{ce} =	2.29	ft.	H_{ce} =	1.17	ft.	(Total minimum specific energy head)
h_{cv} =	0.61	ft.	h_{cv} =	0.34	ft.	(Velocity head corresponding to y_c)
$10y_c$ =	**16.75**	**ft.**	---	---		(Required inlet apron length)
$0.715y_c$ =	**1.20**	**ft.**	**$0.715y_c$ =**	**0.59**	**ft.**	(Depth of flow over the weir crest or brink)

III. Calculate the tailwater depth in the outlet channel

	High Flow			Low Flow		
Tw =	**1.64**	**ft.**	**Tw =**	**0.87**	**ft.**	(Tailwater depth)
Area =	17.9	ft^2	Area =	7.5	ft^2	(Flow area in channel)
Q_{high} =	98.7	cfs	Q_{low} =	29.6	cfs	(Capacity in channel)
H_2 =	0.00	ft.	H_2 =	0.00	ft.	(Downstream head above weir crest, $H_2 = 0$, if $H_2 < 0.715*y_c$)

IV. Calculate the head for a trapezoidal shaped broadcrested weir

Cd = 1.00 (Coefficient of discharge for broadcrested weirs)

	High Flow				
H_p =	2.67	ft.	**2.60**	**ft.**	(Weir head)
Area =	37.4	ft^2	36.0	ft^2	(Flow area in channel)
V_o =	0.00	fps	**2.74**	**fps**	(Approach velocity)
h_{pv} =	0.00	ft.	0.12	ft.	(Velocity head corresponding to H_p)
Q_{high} =	98.7	cfs	98.7	cfs	(Capacity in channel)

Trial and error procedure solving simultaneously for velocity and head

	Low Flow				
H_p =	1.28	ft.	**1.21**	**ft.**	(Weir head)
Area =	12.6	ft^2	11.7	ft^2	(Flow area in channel)
V_o =	0.00	fps	**2.54**	**fps**	(Approach velocity)
h_{pv} =	0.00	ft.	0.10	ft.	(Velocity head corresponding to H_p)
Q_{low} =	29.6	cfs	29.6	cfs	(Capacity in channel)

Trial and error procedure solving simultaneously for velocity and head

Rock Chute Design Calculations

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Canyon Dolomite - Old Quarry **County:** Fremont County, CO
Designer: John Jankousky **Checked by:**
Date: 5/28/2015 **Date:**

V. Calculate the rock chute parameters (w/o a factor of safety applied)

	High Flow			*Low Flow*		
q_t =	1.14	cms/m	q_t =	0.40	cms/m	(Equivalent unit discharge)
D_{50} (mm) =	347.31 → ***(13.67 in.)***		D_{50} =	198.28	mm	(Median ***angular*** rock size)
n =	0.056		n =	0.052		(Manning's roughness coefficient)
z_1 =	0.96	ft.	z_1 =	0.48	ft.	(Normal depth in the chute)
A_1 =	7.6	ft^2	A_1 =	3.4	ft^2	(Area associated with normal depth)
Velocity =	13.00	fps	Velocity =	8.79	fps	(Velocity in chute slope)
z_{mean} =	0.77	ft.	z_{mean} =	0.42	ft.	(Mean depth)
F_1 =	2.61		F_1 =	2.38		(Froude number)
$L_{rock\ apron}$ =	17.09	ft.	----	----		(Length of rock outlet apron = $15*D_{50}$)

VI. Calculate the height of hydraulic jump height (conjugate depth)

	High Flow			*Low Flow*		
z_2 =	**2.63**	**ft.**	**z_2 =**	**1.29**	**ft.**	(Hydraulic jump height)
Q_{high} =	98.7	cfs	Q_{high} =	29.6	cfs	(Capacity in channel)
A_2 =	29.7	ft^2	A_2 =	11.0	ft^2	(Flow area in channel)

VII. Calculate the energy lost through the jump (absorbed by the rock)

	High Flow			*Low Flow*		
E_1 =	3.58	ft.	E_1 =	1.68	ft.	(Total energy before the jump)
E_2 =	2.81	ft.	E_2 =	1.40	ft.	(Total energy after the jump)
R_E =	21.72	%	R_E =	16.92	%	(Relative loss of energy)

Calculate Quantities for Rock Chute

-------Rock Riprap Volume-------

Area Calculations	**Length @ Rock CL**
h = 2.63	Inlet = 16.82
x_1 = 6.71	Outlet = 21.47
L = 5.88	Slope = 288.62
A_s = 17.64	2.5:1 Lip = 2.38
x_2 = 6.00	**Total = 329.29 ft.**
A_b = 40.25	**Rock Volume**
A_b+2*A_s = 75.53 ft^2	**921.21 yd^3**

-------Bedding Volume-------

Area Calculations	
h = 5.63	**Bedding Thickness**
x_1 = 0.00	t_1, t_2 = ***0.00*** in.
L = 12.59	
A_s = 0.00	**Length @ Bed CL**
x_2 = 0.00	**Total = 329.27 ft.**
A_b = 0.00	**Bedding Volume**
A_b+2*A_s = 0.00 ft^2	**0.00 yd^3**

-------Geotextile Quantity-------

Width	**Length @ Bot. Rock**
2*Slope = 25.18	**Total = 329.27 ft.**
Bottom = 7.42	**Geotextile Area**
Total = 32.59 ft.	**1192.47 yd^2**

Note: 1) The radius is not considered when calculating quantities of riprap, bedding, or geotextile.
2) The geotextile quantity does not include over-overlapping (18-in. min.) or anchoring material (18-in. min. along sides, 24-in. min. on ends).

Rock Chute Design - Plan Sheet

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Canyon Dolomite - Old Quarry
Designer: John Jankousky
Date: 5/28/2015
County: Fremont County, CO
Checked by:
Date:

Minimum Design Values		*Enter Plan Values*
16.4 in.	D_{50} dia. =	18.00 in.
32.8 in.	$Rock_{chute}$ thickness =	36.00 in.
17 ft.	Inlet apron length =	17.00 ft.
21 ft.	Outlet apron length =	21.00 ft.
46 ft.	Radius =	50 ft.

Will bedding be used? No

Rock Gradation Envelope

% Passing	*Diameter, in. (weight, lbs.)*
D_{100}	27 - 36 (1393 - 3302)
D_{85}	23 - 32 (907 - 2407)
D_{50}	18 - 27 (413 - 1393)
D_{10}	14 - 23 (211 - 907)

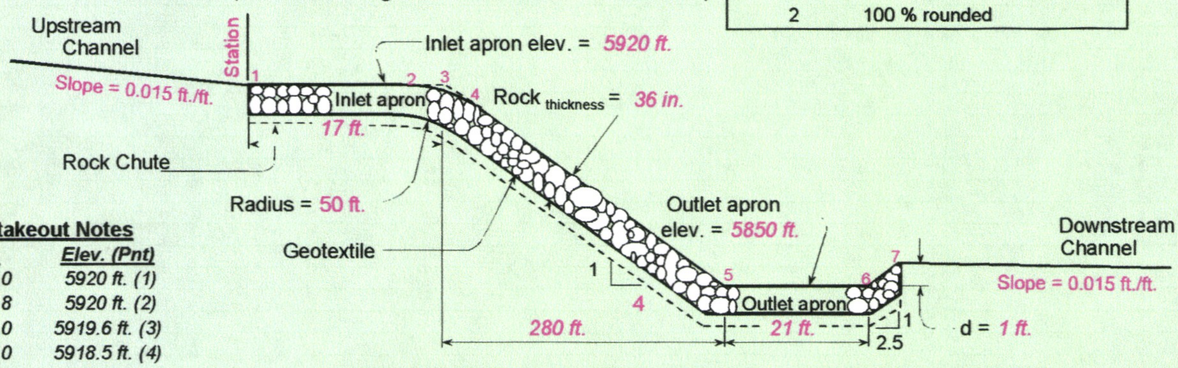
Quantities [a]

Rock =	922	yd^3
Geotextile (WCS-13)[b] =	1193	yd^2
Bedding =	0	yd^3
Excavation =	0	yd^3
Earthfill =	0	yd^3
Seeding =	0.0	acres

Degree of angularity = 1

1	50% angular, 50% rounded
2	100 % rounded

Notes: [a] *Rock, bedding, and geotextile quantities are determined from the x-section below (neglect radius).*
[b] *Geotextile Class I (non-woven) shall be overlapped and anchored (18-in. min. along sides and 24-in. min. on the ends).*



Profile Along Centerline of Rock Chute

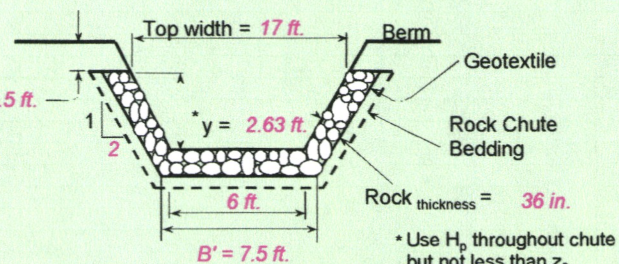
Note*: *The outlet will function adequately

Stakeout Notes

Sta.	*Elev. (Pnt)*
0+00.0	5920 ft. (1)
0+10.8	5920 ft. (2)
0+17.0	5919.6 ft. (3)
0+23.0	5918.5 ft. (4)
2+97.0	5850 ft. (5)
3+18.0	5850 ft. (6)
3+20.5	5851 ft. (7)

Class I non-woven

Rock gradation envelope can be met with Gradation printed



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Profile, Cross Sections, and Quantities

Rock Chute Cost Estimate

Unit	*Unit Cost*		*Cost*
Rock	See	$/yd^3$	#VALUE!
Geotextile	Eng	$/yd^2$	#VALUE!
Bedding	Est.	$/yd^3$	#VALUE!
Excavation	\$0.00	$/yd^3$	\$0.00
Earthfill	\$0.00	$/yd^3$	\$0.00
Seeding	\$0.00	/ac.	\$0.00
	Total		#VALUE!

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Canyon Dolomite - Old Quarry

Fremont County, CO County

	Date	
Designed	John Jankousky	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet __ of __

Rock_Chute.xls
for construction plan

Rock Chute Design - Cut/Paste Plan

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Canyon Dolomite - Old Quarry **County:** Fremont County, CO
Designer: John Jankousky **Checked by:** ______
Date: 5/28/2015 **Date:** ______

Design Values

D_{50} dia. = 18.0 in.
$Rock_{chute}$ thickness = 36.0 in.
Inlet apron length = 17 ft.
Outlet apron length = 21 ft.
Radius = 50 ft.
Will bedding be used? No

Rock Gradation Envelope

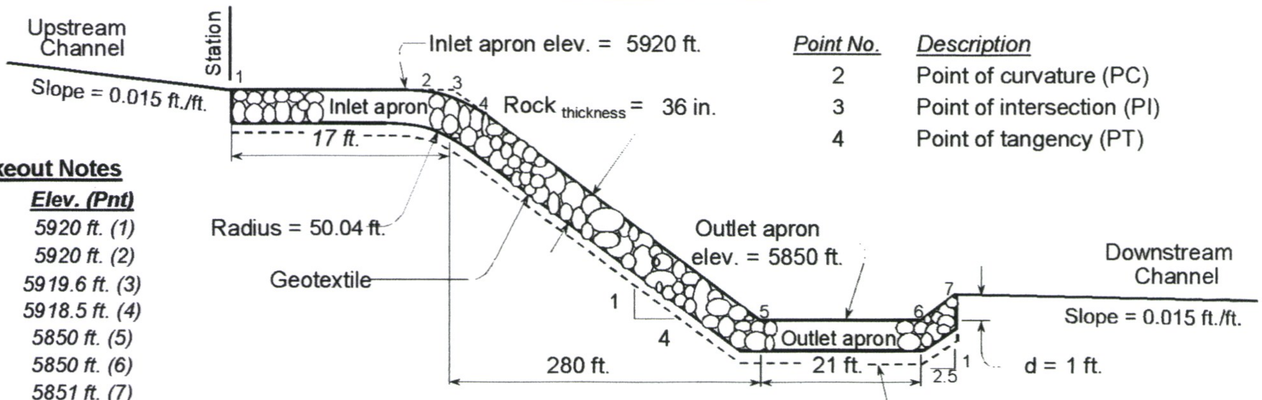
% Passing	*Diameter, in. (weight, lbs.)*
D_{100}	27 - 36 (1393 - 3302)
D_{85}	23 - 32 (907 - 2407)
D_{50}	18 - 27 (413 - 1393)
D_{10}	14 - 23 (211 - 907)

Coefficient of Uniformity, $(D_{60})/(D_{10}) < 1.7$

Quantities [a]

Rock = 922 yd^3
Geotextile (WCS-13)[b] = 1193 yd^2
Bedding = 0 yd^3
Excavation = 0 yd^3
Earthfill = 0 yd^3
Seeding = 0.0 acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*

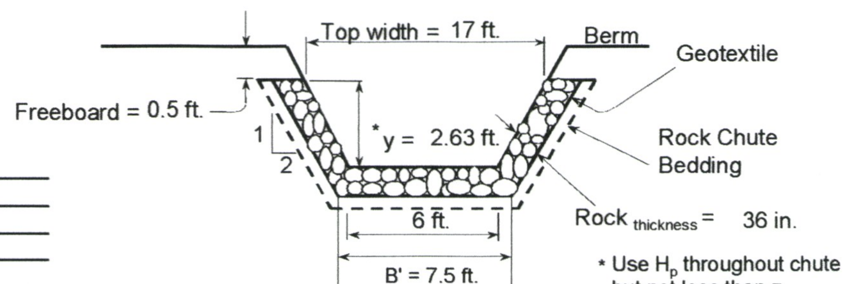


Point No.	*Description*
2	Point of curvature (PC)
3	Point of intersection (PI)
4	Point of tangency (PT)

Stakeout Notes

Sta.	*Elev. (Pnt)*
0+00.0	5920 ft. (1)
0+10.8	5920 ft. (2)
0+17.0	5919.6 ft. (3)
0+23.0	5918.5 ft. (4)
2+97.0	5850 ft. (5)
3+18.0	5850 ft. (6)
3+20.5	5851 ft. (7)

Profile Along Centerline of Rock Chute



Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
Gradation printed

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Canyon Dolomite - Old Quarry
Fremont County, CO County

		Date
Designed	John Jankousky	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet __ of __

Engineer's Cost Estimate for Rock Chute

Calculated by: John Jankousky   Revision: 5/29/2015

Description	Number	Units	Cost $/unit	Cost
Length of Chute	**450**	ft		
Excavation Bottom Width, Wb	12.00	ft		
Excavation Top Width, Wt	25.00	ft		
Depth of Excavation	6.13	ft		
Cross Sectional Area of excavation	**113.41**	ft^2		
Volume of Excavation	51,032	ft^3		
Volume of Excavation	**1,890**	yd^3	$ 12.00	$ 22,681.00
Cross Sectional Area of Rock	**60.00**	ft^2		
Volume of Rock	27,000	ft^3		
Volume of Rock	**1,000**	yd^3	$ 25.00	$ 25,000.00
Geotextile	**1400**	yd^2	$ 12.00	$ 16,800.00
Approximately 28 ft^2 per LF				
TOTAL COST				**$ 64,481.00**

6.4.11 EXHIBIT L – RECLAMATION COSTS

The reclamation work at the site will proceed concurrently with the mining. Therefore the costs to finish reclamation at a point in time can vary. The costs for reclamation in this Exhibit are calculated for a point in the operation where disturbed land is identified as maximum. That point is several years from now (4 to 7 years) when:

- The Fines Disposal Area is seeded but not released. Reseeding may be necessary.
- The Mine Area has mining on the second bench (elev. 6135 at the north to elev. 6153 at the south) and a substantial flat area of the bench is open. The post law disturbed area east of the mine must be reclaimed.
- The Old Quarry Fines Disposal Area is undergoing filling and is half disturbed.

Acres in various stages of reclamation are:

- Fines Disposal Area 3
- Mine Area 19
- Old Quarry 3
- Total 25

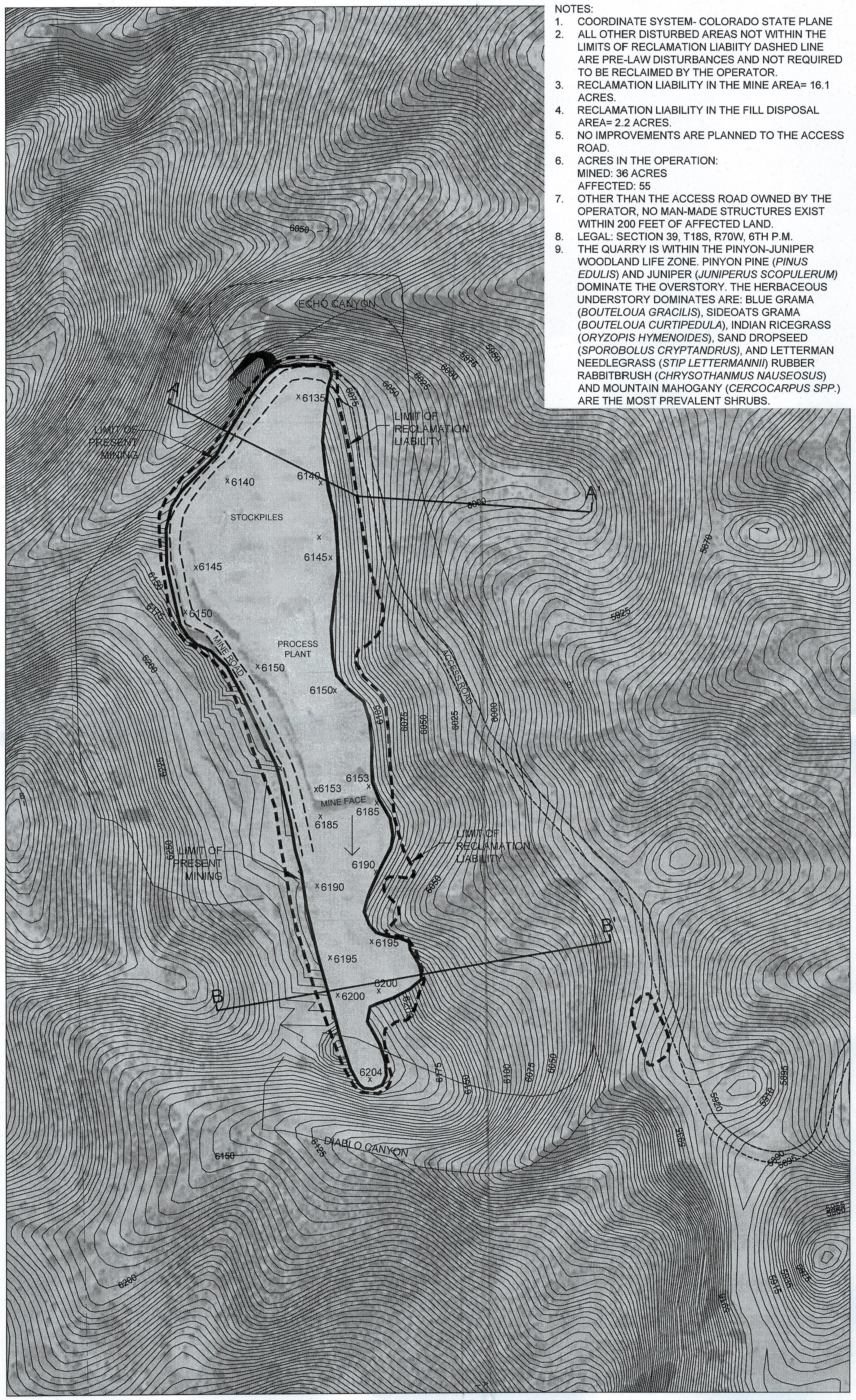
The table on the following pages details the reclamation work items, provides quantities, and calculates costs.

Exhibit L | **Reclamation Costs**

TABLE L-1 | Estimated | 5/29/2015

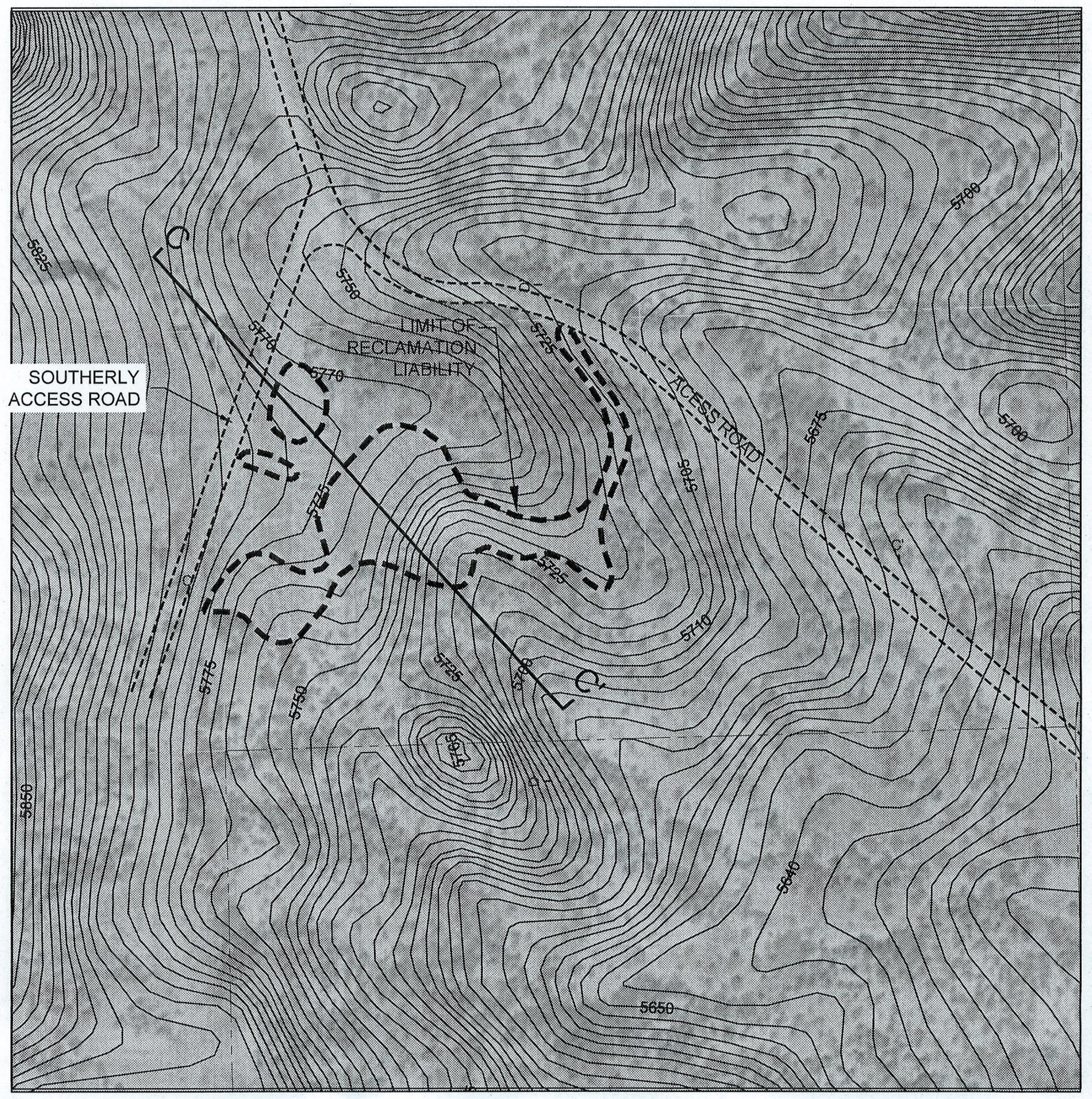
#	ITEM	QTY	UNITS	UNIT COST	COST
A	**Fines Disposal Area, Detail 1, Exh. F**				
1	reseed by broadcast	3	ac	$300.00	$900.00
2	apply mulch and fertilizer by hydrospray	3	ac	$550.00	$1,650.00
B	**Mine Area, Detail 2, Exh. F**				
1	fill at 4:1 the vertical face of bench, 1000'	16667	cy	$1.15	$19,167.05
2	Haul & dump fines on half of flat second bench with fines, 6 acres, 8" to 12" depth, 3500' haul	6486	cy	$4.10	$26,592.60
3	grade out fines on second bench	6486	cy	$0.55	$3,567.30
4	Haul & dump fines on half of flat first bench with fines, 4 acres, 8" to 12" depth, 4500' haul	4324	cy	$4.25	$18,377.00
5	Grade out fines on first bench	4324	cy	$0.55	$2,378.20
6	Haul & dump fines at east edge of bench	3243	cy	$4.10	$13,296.30
6	Push fines over onto post law disturbed area on east side of bench, 3 acres, 8" to 12" depth	3243	cy	$0.55	$1,783.65
7	Hydrospray seed, fertilizer, and mulch on #1 face	1.4	ac	$850.00	$1,190.00
8	Drill seed, fertilizer, and straw mulch on bench, #2	6	ac	$850.00	$5,100.00
9	Drill seed, fertilizer, and straw mulch on bench, #4	4	ac	$850.00	$3,400.00
10	Remove water tank	1	ea	$600.00	$600.00
C	**Old Quarry Fines Disposal Area, Detail 3, Exh. F**				
1	Haul large diam. rock from mine for channel, 4000'	800	cy	$2.25	$1,800.00
2	Construct rock lined channel, 450 ', See p. A-18 of Drainage Report, Exh. E	450	lf	$143.29	$64,480.50
3	Hydrospray seed, fertilizer, & mulch on sloped area, 1 acre	1	ac	$850.00	$850.00
4	Drill seed, fertilize, and straw mulch on open area, 2 acres	2	ac	$850.00	$1,700.00
	Weed control for two years	2	ea	$4,000.00	$8,000.00
	Subtotal				$174,832.60
	Adminstration			0.1	$17,483.26
	Contingency			0.05	$8,741.63
	GRAND TOTAL				$201,057.49
	FINANCIAL WARRANTY AMOUNT				**$202,000.00**

NOTES:
1. COORDINATE SYSTEM- COLORADO STATE PLANE
2. ALL OTHER DISTURBED AREAS NOT WITHIN THE LIMITS OF RECLAMATION LIABIITY DASHED LINE ARE PRE-LAW DISTURBANCES AND NOT REQUIRED TO BE RECLAIMED BY THE OPERATOR.
3. RECLAMATION LIABILITY IN THE MINE AREA= 16.1 ACRES.
4. RECLAMATION LIABILITY IN THE FILL DISPOSAL AREA= 2.2 ACRES.
5. NO IMPROVEMENTS ARE PLANNED TO THE ACCESS ROAD.
6. ACRES IN THE OPERATION:
   MINED: 36 ACRES
   AFFECTED: 55
7. OTHER THAN THE ACCESS ROAD OWNED BY THE OPERATOR, NO MAN-MADE STRUCTURES EXIST WITHIN 200 FEET OF AFFECTED LAND.
8. LEGAL: SECTION 39, T18S, R70W, 6TH P.M.
9. THE QUARRY IS WITHIN THE PINYON-JUNIPER WOODLAND LIFE ZONE. PINYON PINE (*PINUS EDULIS*) AND JUNIPER (*JUNIPERUS SCOPULERUM*) DOMINATE THE OVERSTORY. THE HERBACEOUS UNDERSTORY DOMINATES ARE: BLUE GRAMA (*BOUTELOUA GRACILIS*), SIDEOATS GRAMA (*BOUTELOUA CURTIPEDULA*), INDIAN RICEGRASS (*ORYZOPIS HYMENOIDES*), SAND DROPSEED (*SPOROBOLUS CRYPTANDRUS*), AND LETTERMAN NEEDLEGRASS (*STIP LETTERMANNII*) RUBBER RABBITBRUSH (*CHRYSOTHANMUS NAUSEOSUS*) AND MOUNTAIN MAHOGANY (*CERCOCARPUS SPP.*) ARE THE MOST PREVALENT SHRUBS.



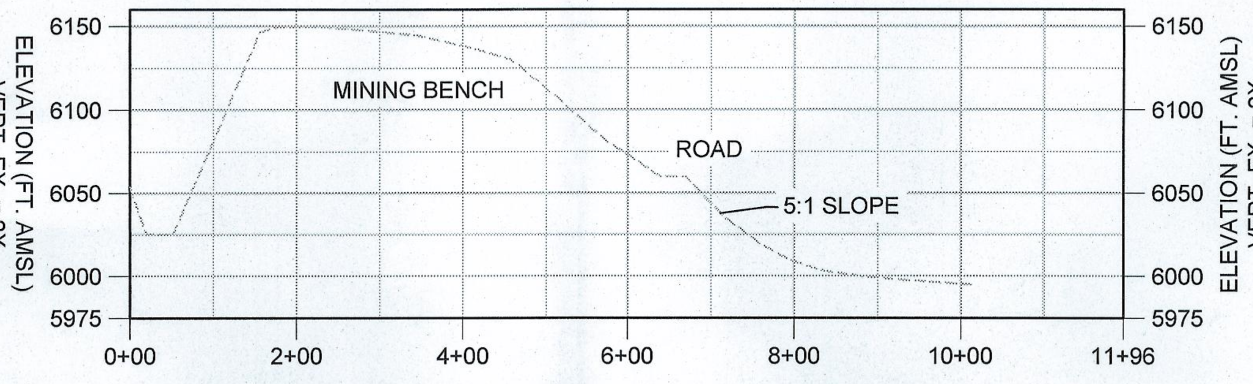
2 MINE AREA
SCALE: 1"=200'

SIGNED: [signature]
DATE: 6-4-15

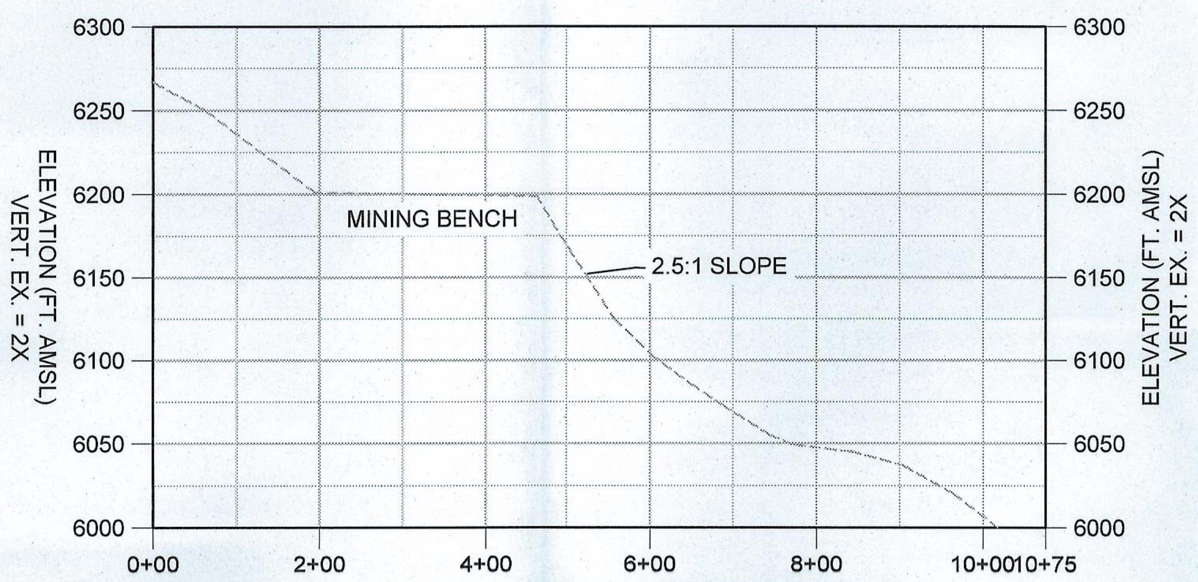


1 FINES DISPOSAL AREA
SCALE: 1"=200'

LEGEND:
- LIMITS OF PRESENT MINING
- LIMIT OF RECLAMATION LIABILITY
- ROADS
- × 0.0 EXISTING ELEVATION
- • 0.0 PROPOSED ELEVATION

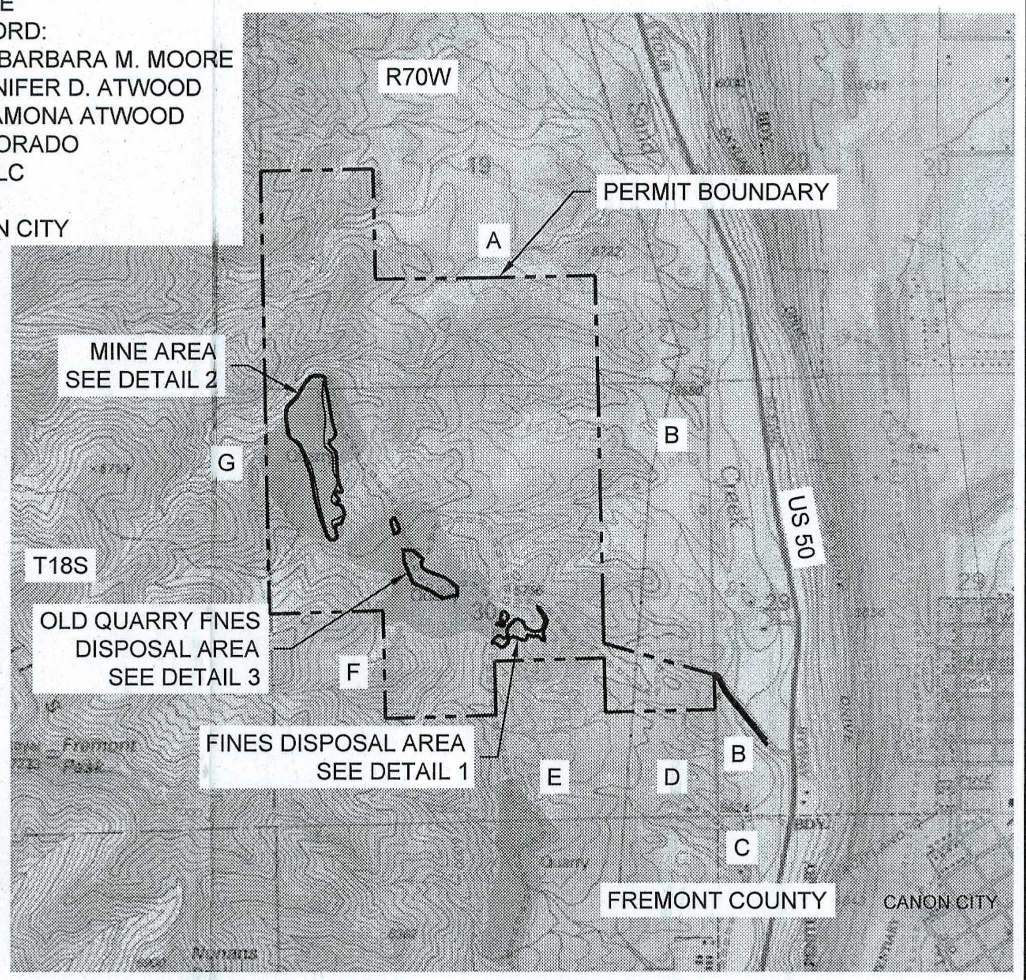


A MINE AREA - SECTION A-A
SCALE: H=1"=200' V=1"=100'

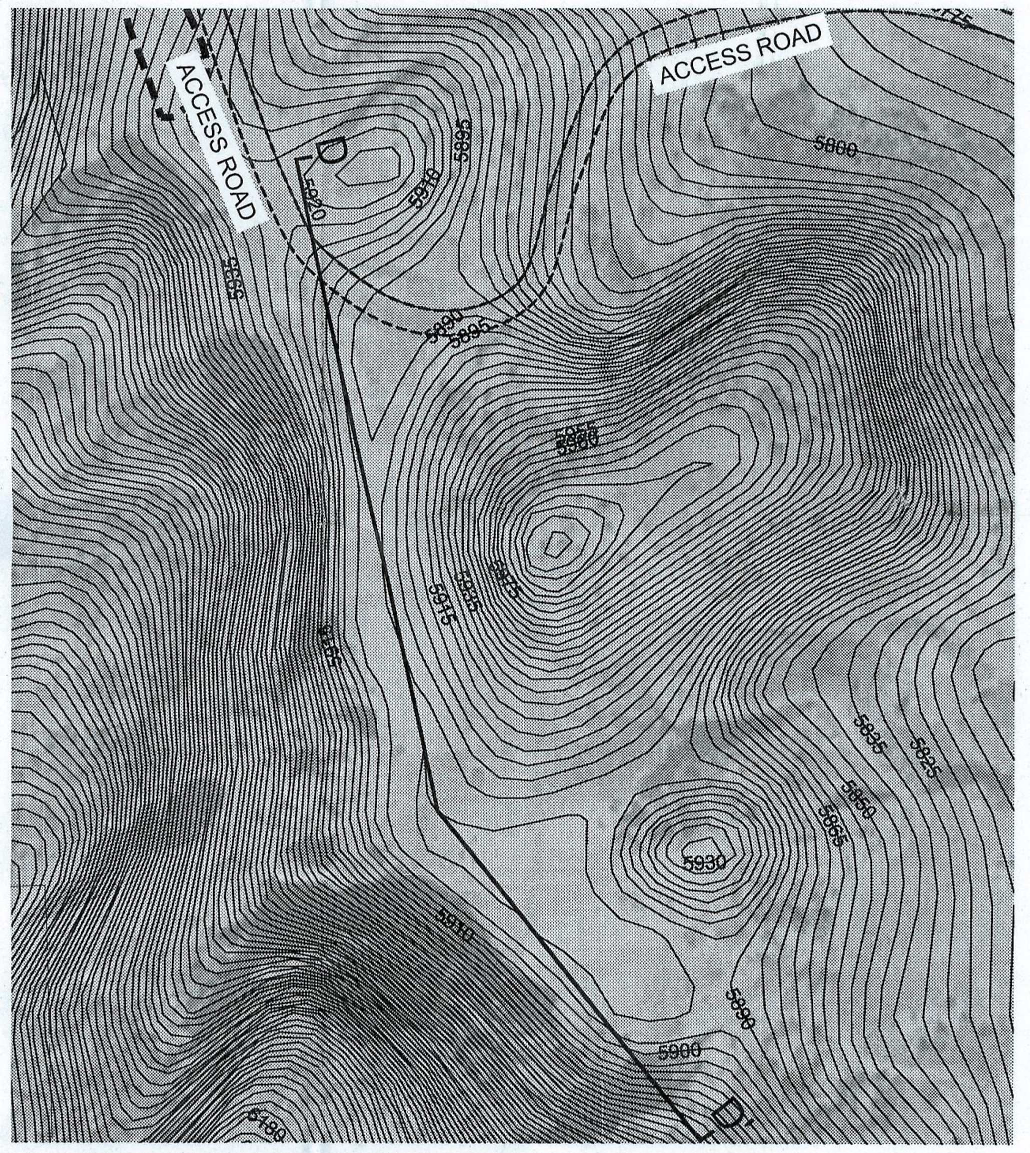


B MINE AREA - SECTION B-B
SCALE: H=1"=200' V=1"=100'

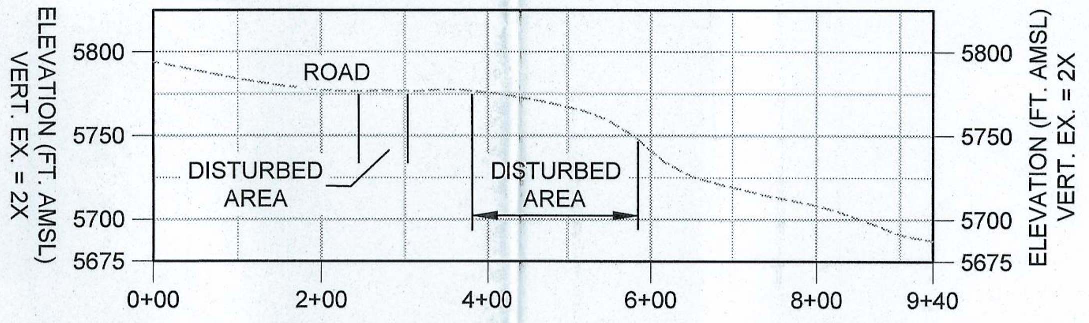
AJACENT SURFACE OWNERS OF RECORD:
A TOMMY E. AND BARBARA M. MOORE
B PAUL AND JENNIFER D. ATWOOD
C AARON AND RAMONA ATWOOD
D STATE OF COLORADO
E AGGSOURCE LLC
F BLM
G CITY OF CANON CITY



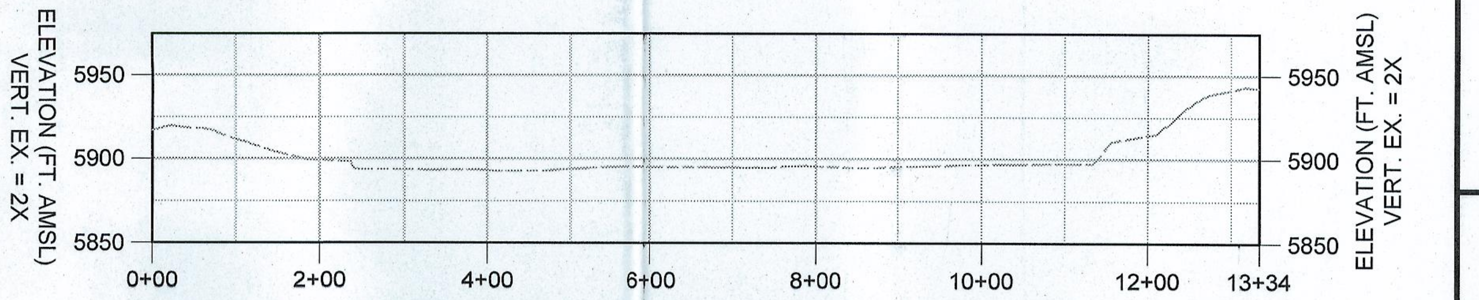
KEY MAP - PERMIT AREA
SCALE: 1"=2000'



3 OLD QUARRY FINES DISPOSAL AREA
SCALE: 1"=200'



C FINES DISPOSAL AREA - SECTION C-C
SCALE: H=1"=200' V=1"=100'



D OLD QUARRY FINES DISPOSAL AREA - SECTION D-D
SCALE: H=1"=200' V=1"=100'

DATE:	REVISION:
4-10-15	RE-FORMAT
4-26-15	RE-FORMAT
5-17-15	ADD OWNERS SIG., SECTIONS, NOTES

PREPARED FOR:
TRANSIT MIX CONCRETE
COLORADO SPRINGS, COLORADO

CANYON DOLOMITE QUARRY
M-1977-376
PRE-MINING PLAN
EXHIBIT C-1

TR02

PREPARED BY:
Tuttle & Associates
Planning and Permitting Services
PO BOX 485,
Broomfield, Co 80038-0485
Phone: 303.653.5584
garytuttle@gmail.com

Project No.
CC001-2012

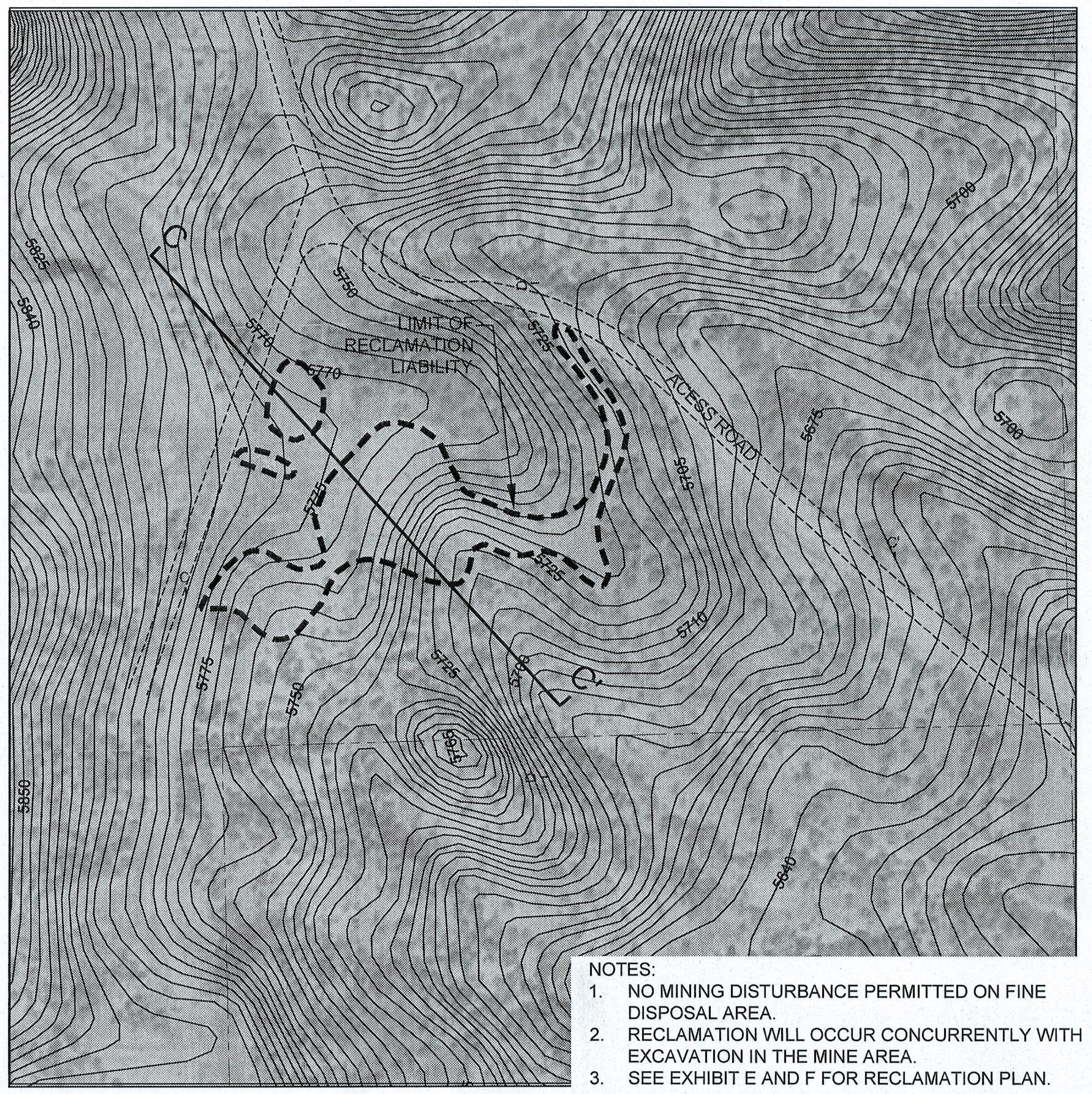
Date	Sheet
03-01-2015	1 OF 1

2 MINE AREA

SCALE: 1"=200'

SIGNED: Gary J Tuttle

DATE: 6-4-15



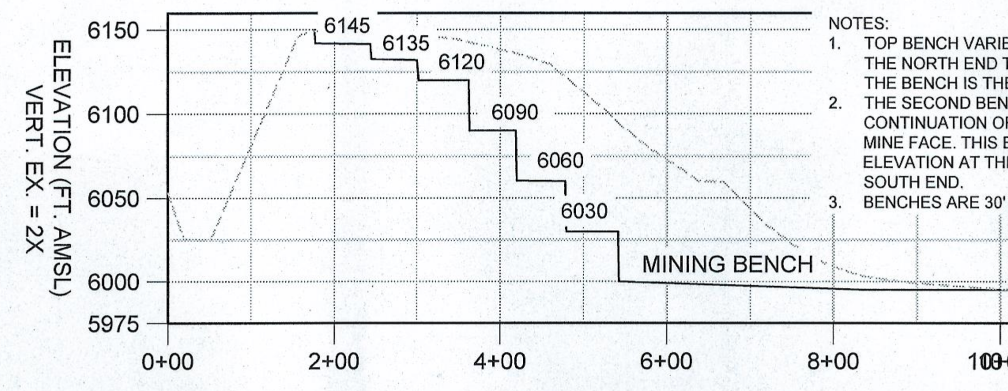
NOTES:
1. NO MINING DISTURBANCE PERMITTED ON FINE DISPOSAL AREA.
2. RECLAMATION WILL OCCUR CONCURRENTLY WITH EXCAVATION IN THE MINE AREA.
3. SEE EXHIBIT E AND F FOR RECLAMATION PLAN.

1 FINES DISPOSAL AREA

SCALE: 1"=200'

LEGEND:
- LIMITS OF PRESENT MINING
- LIMIT OF RECLAMATION LIABILITY
- ROADS
- × 0.0 EXISTING ELEVATION
- • 0.0 PROPOSED ELEVATION

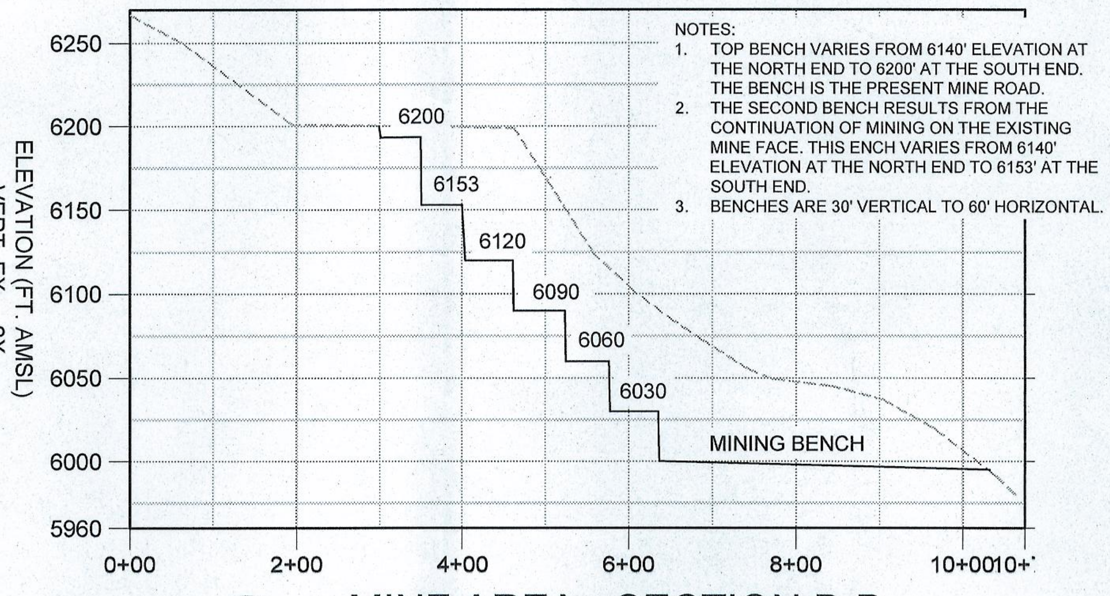
NOTES:
1. NO MINING DISTURBANCE PERMITTED ON FINE DISPOSAL AREA.
2. FINES FILLING AND RECLAMATION WILL OCCUR CONCURRENTLY WITH EXCAVATION IN THE MINE AREA.
3. DURING THE MINING OPERATION, APPROXIMATELY HALF OF THE UNMARKETABLE FINES WILL BE TRUCKED TO THE OLD QUARRY AREA FOR DISPOSAL.
4. OFF-SITE DRAINAGE FROM THE WEST WILL BE DIRECTED THROUGH THE NEW FILL AREA IN A CONTROLLED FASHION.
5. SEE EXHIBIT E AND F FOR RECLAMATION PLAN AND FINAL LAND CONFIGURATION.



NOTES:
1. TOP BENCH VARIES FROM 6140' ELEVATION AT THE NORTH END TO 6200' AT THE SOUTH END. THE BENCH IS THE PRESENT MINE ROAD.
2. THE SECOND BENCH RESULTS FROM THE CONTINUATION OF MINING ON THE EXISTING MINE FACE. THIS ENCH VARIES FROM 6140' ELEVATION AT THE NORTH END TO 6153' AT THE SOUTH END.
3. BENCHES ARE 30' VERTICAL TO 60' HORIZONTAL.

A MINE AREA - SECTION A-A

SCALE: H=1"=200' V=1"=100'

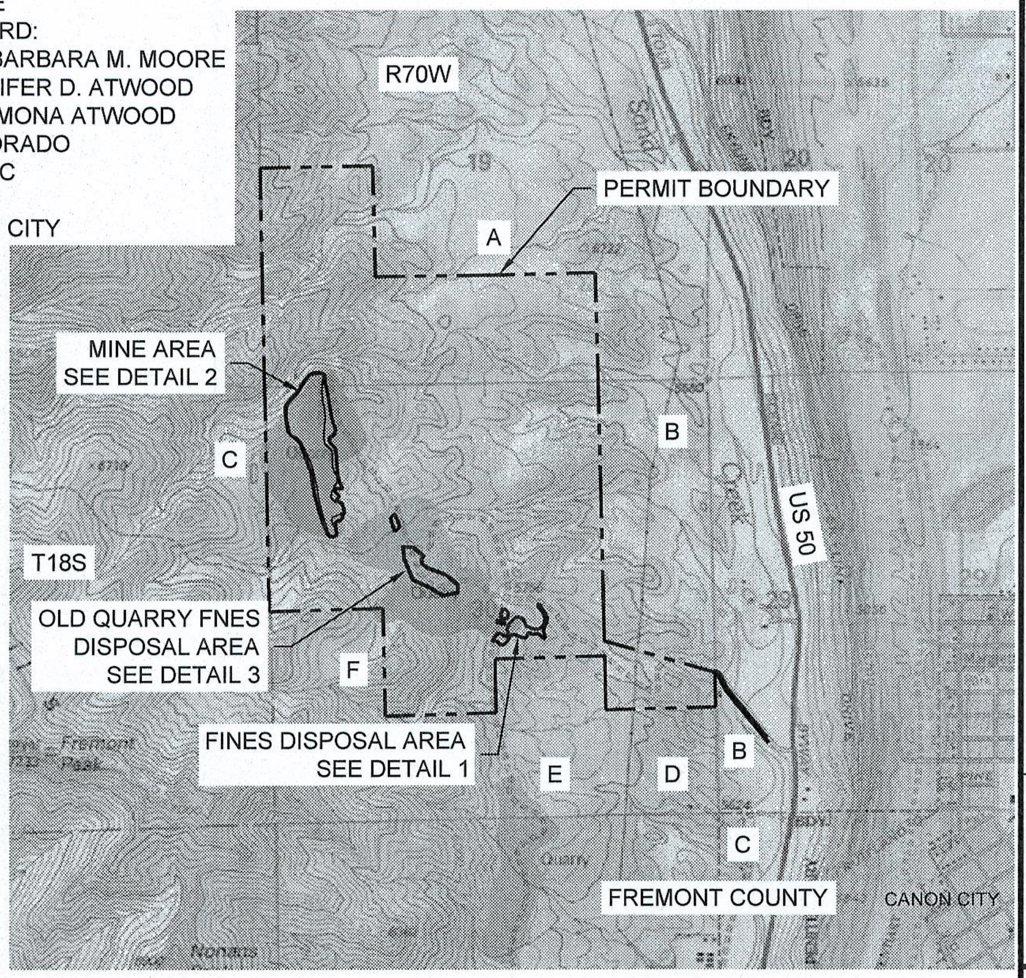


NOTES:
1. TOP BENCH VARIES FROM 6140' ELEVATION AT THE NORTH END TO 6200' AT THE SOUTH END. THE BENCH IS THE PRESENT MINE ROAD.
2. THE SECOND BENCH RESULTS FROM THE CONTINUATION OF MINING ON THE EXISTING MINE FACE. THIS ENCH VARIES FROM 6140' ELEVATION AT THE NORTH END TO 6153' AT THE SOUTH END.
3. BENCHES ARE 30' VERTICAL TO 60' HORIZONTAL.

B MINE AREA - SECTION B-B

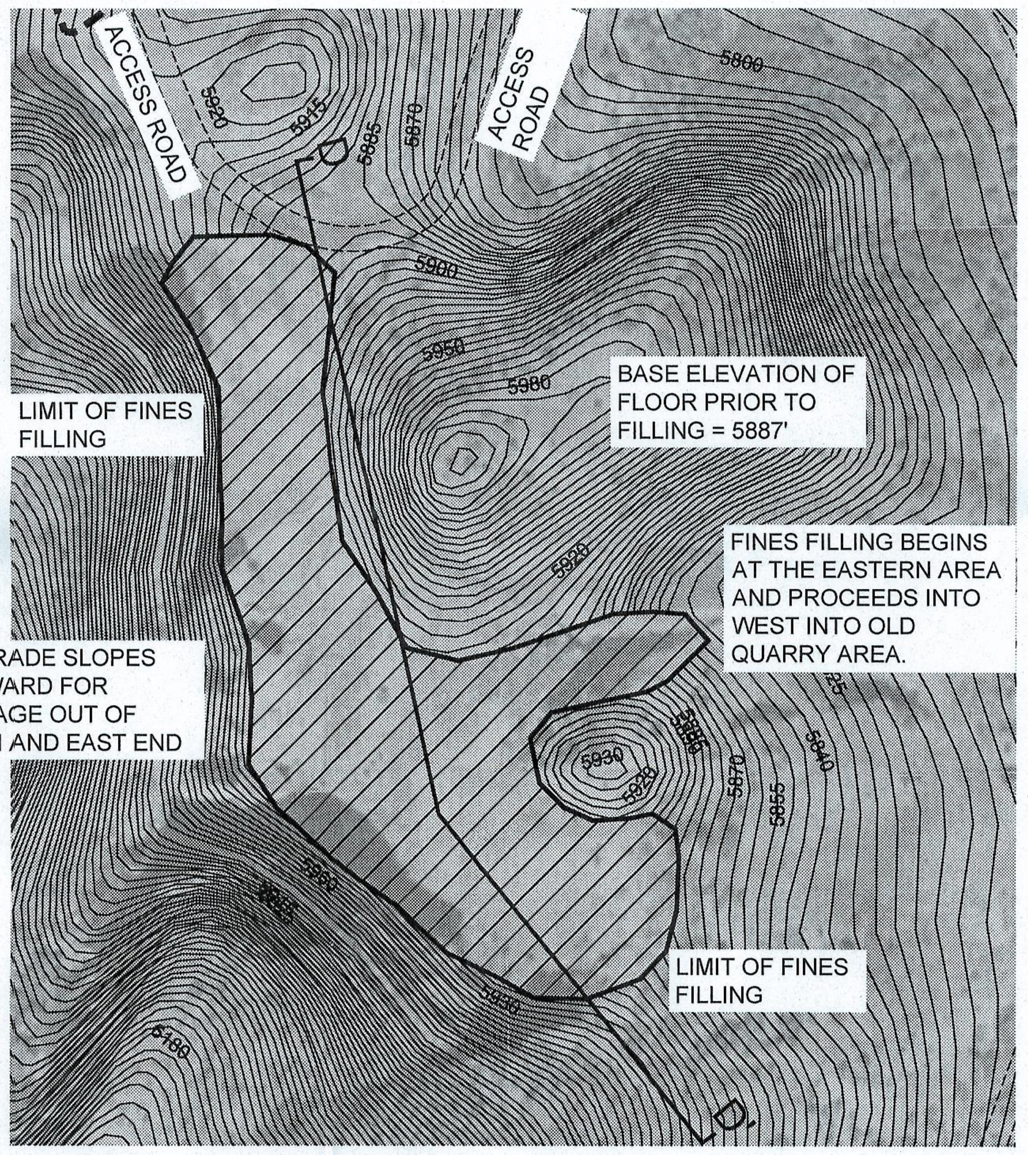
SCALE: H=1"=200' V=1"=100'

AJACENT SURFACE OWNERS OF RECORD:
- A TOMMY E. AND BARBARA M. MOORE
- B PAUL AND JENNIFER D. ATWOOD
- C AARON AND RAMONA ATWOOD
- D STATE OF COLORADO
- E AGGSOURCE LLC
- F BLM
- G CITY OF CANON CITY



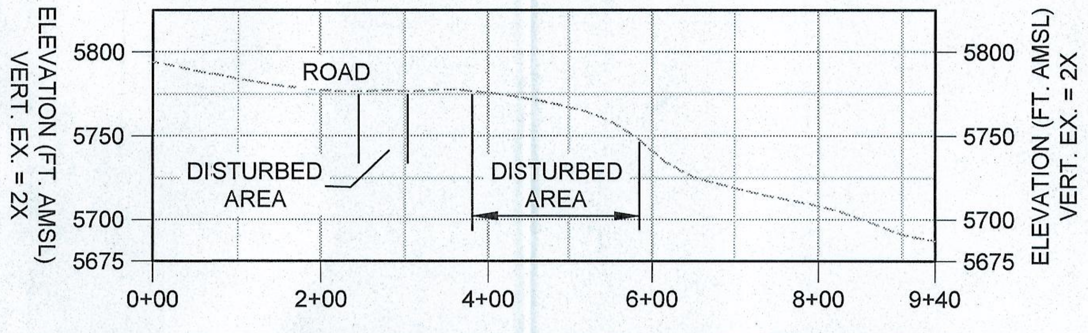
KEY MAP - PERMIT AREA

SCALE: 1"=2000'



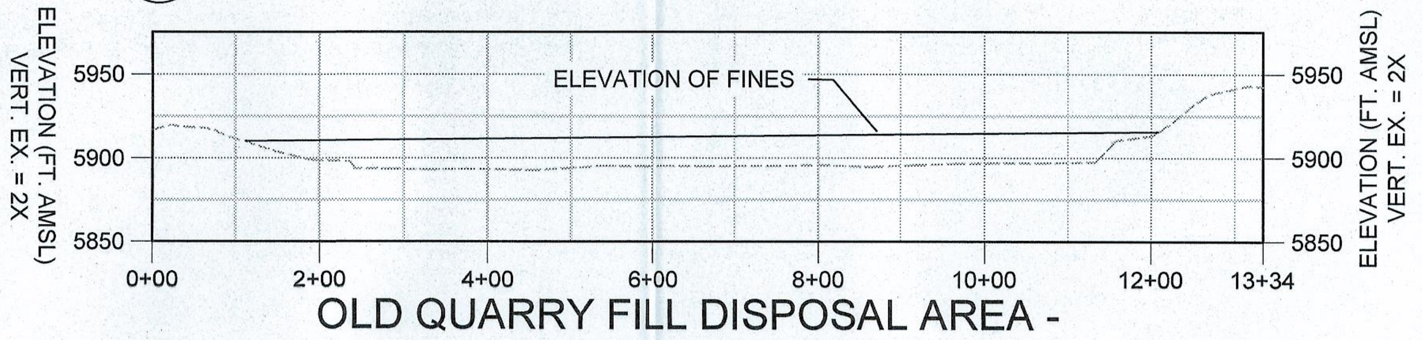
3 OLD QUARRY FINES DISPOSAL AREA

SCALE: 1"=200'



C FINES DISPOSAL AREA - SECTION C-C

SCALE: H=1"=200' V=1"=100'



D OLD QUARRY FILL DISPOSAL AREA - SECTION D-D

SCALE: H=1"=200' V=1"=100'

DATE:	REVISION:
4-13-15	MINE PLAN AND SECTIONS
4-26-15	RE-FORMAT
5-17-15	ADD OWNERS SIG., SECTIONS, NOTES

PREPARED FOR:

TRANSIT MIX CONCRETE

COLORADO SPRINGS, COLORADO

CANYON DOLOMITE QUARRY

M-1977-376

MINING PLAN EXHIBIT C-2

PREPARED BY:
Tuttle & Associates
Planning and Permitting Services
PO BOX 485,
Broomfield, Co 80038-0485
Phone: 303.653.5584
garytuttle@gmail.com

Project No. CC001-2012

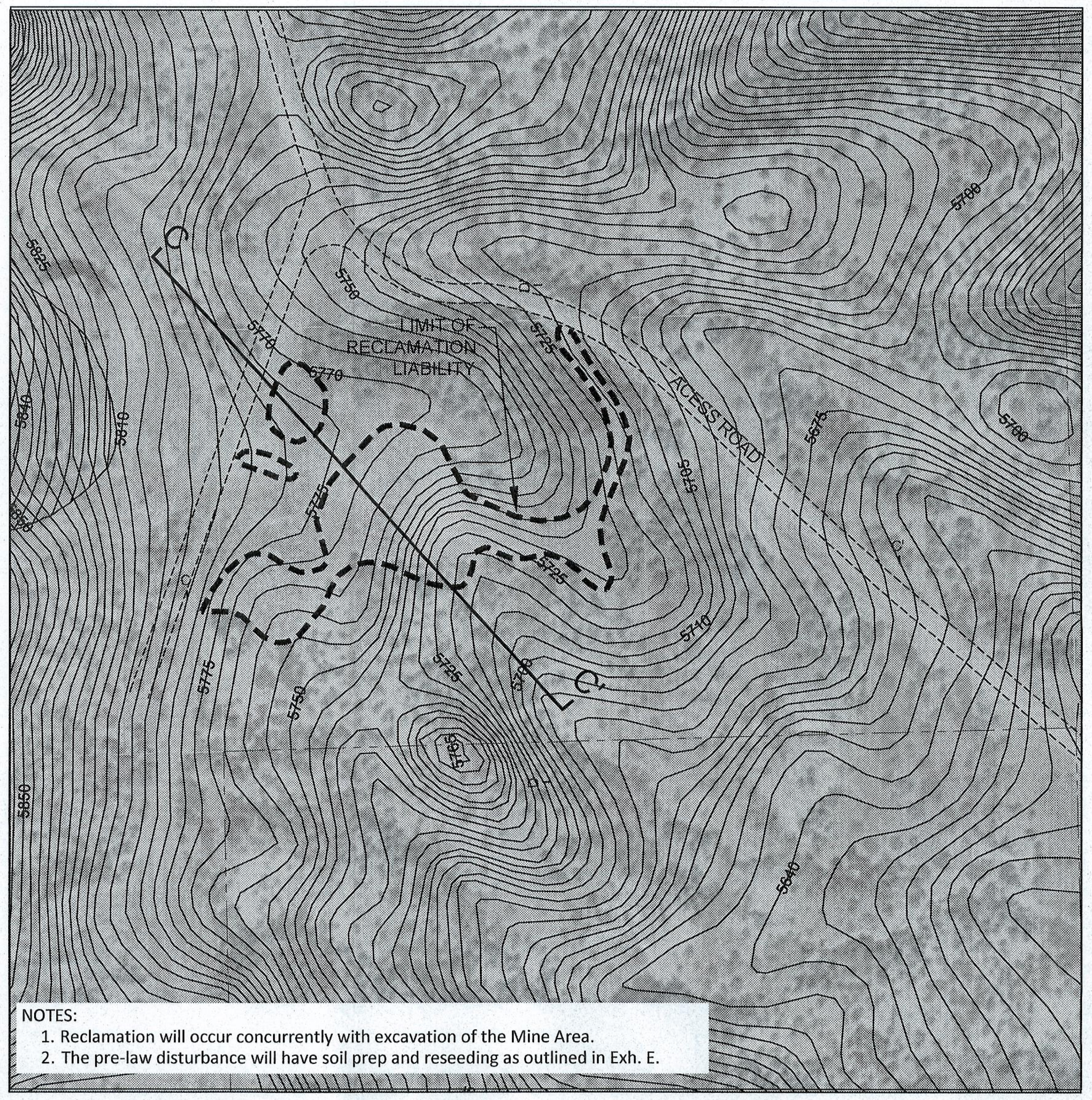
Date	Sheet
03-01-2015	1 OF 1

NOTES:
1. The current disturbance and the post-law disturbance will have soil prep and reseeding as outlined in Exh. E.
2. Access road from US 50 will remain in final reclamation.
3. Bench backfill varies from 4:1 slope to 6:1 slope to avoid the visual appearance of a horizontal fill line on the rock.
4. Backfilling of each bench will occur as mining progresses on that bench.
5. Native topsoil on the undisturbed areas and in stockpiles from previous mining does not exist. Crusher fines with fertilizer and mulch will be used to establish vegetation.
6. The mine floor will be covered with 6" to 12" of crusher fines.
7. Lip on the eastern edge of the mine floor will be removed. Grading of the mine floor will direct drainage to existing swales.

SIGNED: Gary J Tuttle

DATE: 6-4-15

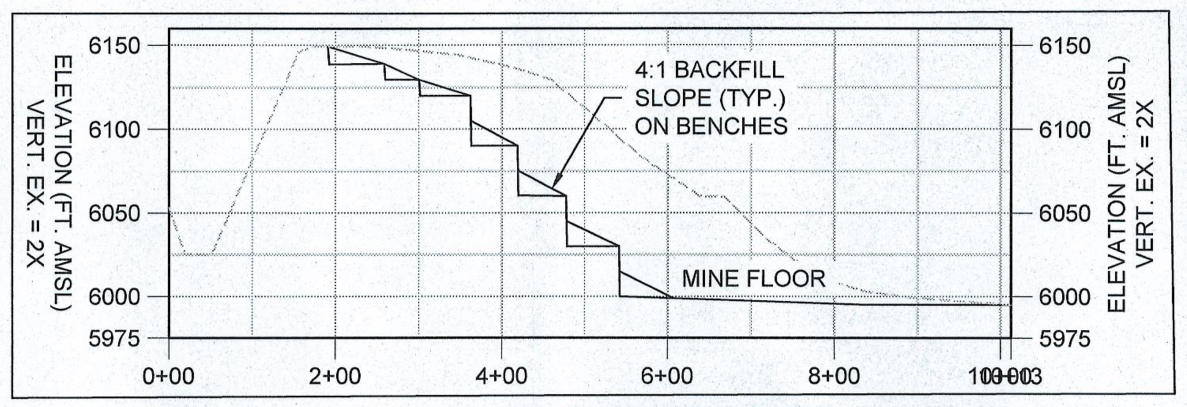
(2) MINE AREA
SCALE: 1"=200'



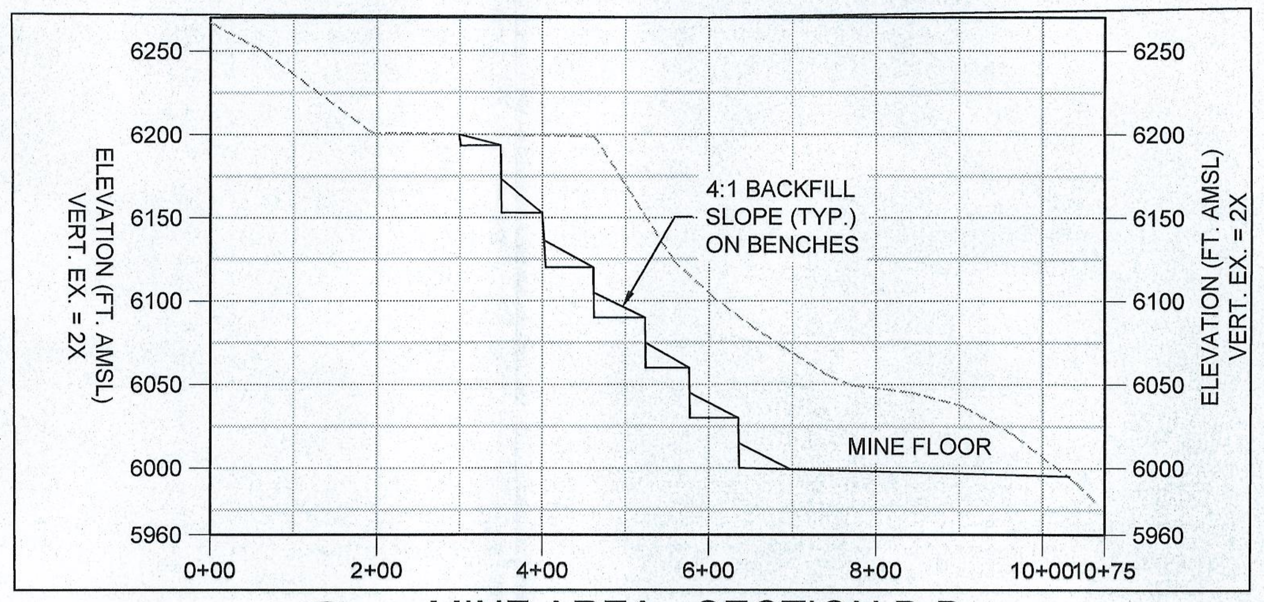
NOTES:
1. Reclamation will occur concurrently with excavation of the Mine Area.
2. The pre-law disturbance will have soil prep and reseeding as outlined in Exh. E.

(1) FINES DISPOSAL AREA
SCALE: 1"=200'

LEGEND:
- LIMITS OF PRESENT MINING
- LIMIT OF RECLAMATION LIABILITY
- ROADS
- × 0.0 EXISTING ELEVATION
- • 0.0 PROPOSED ELEVATION

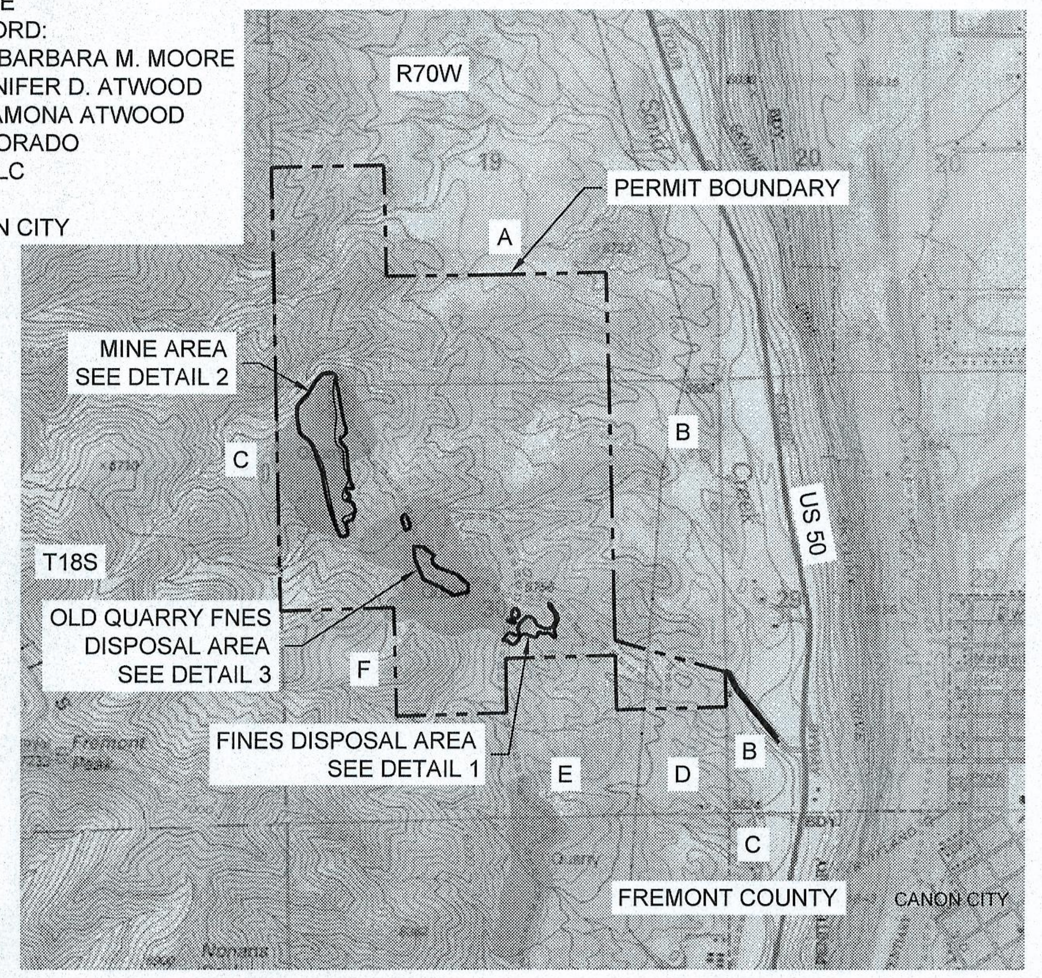


(A) MINE AREA - SECTION A-A
SCALE: H=1"=200' V=1"=100'

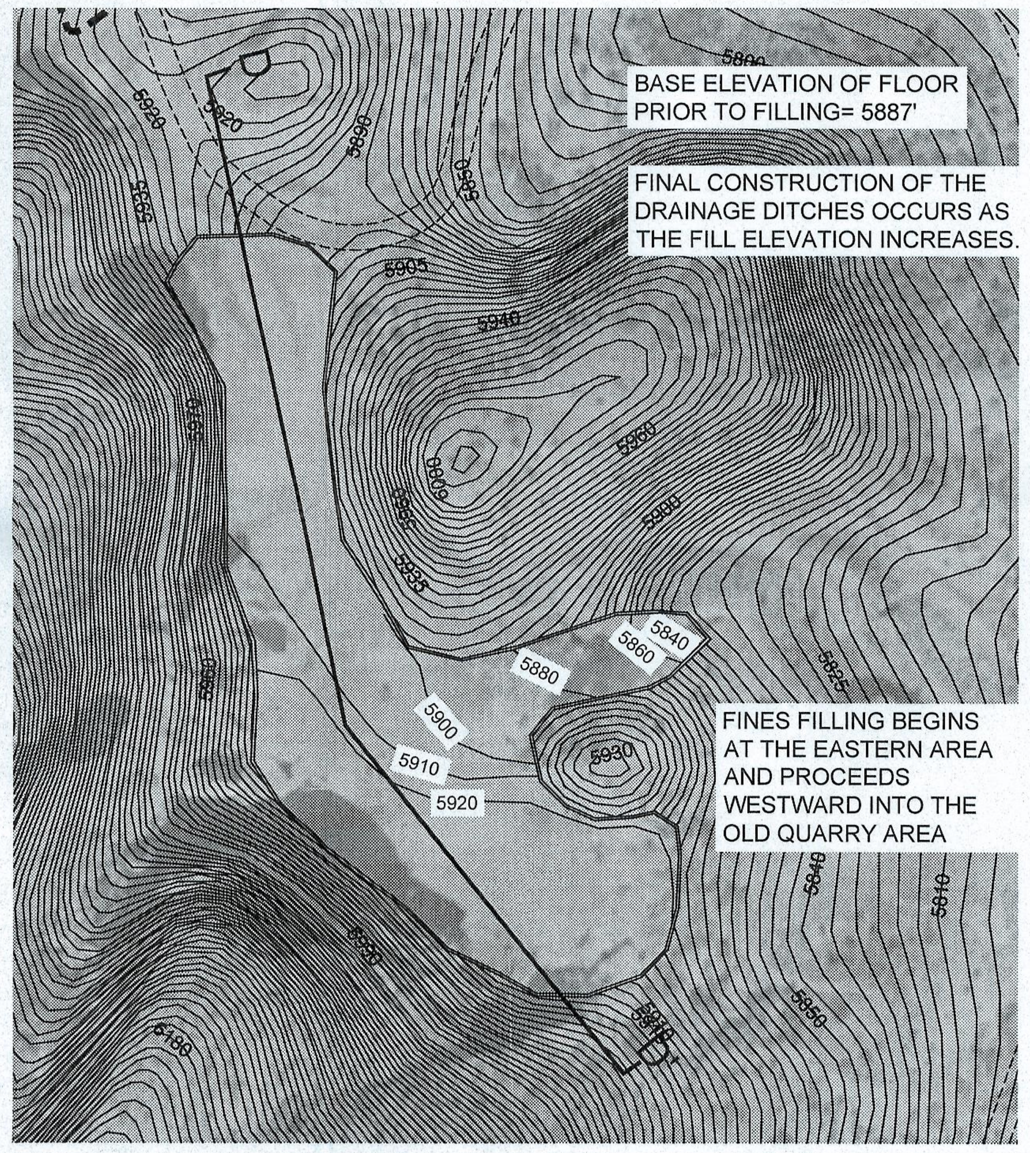


(B) MINE AREA - SECTION B-B
SCALE: H=1"=200' V=1"=100'

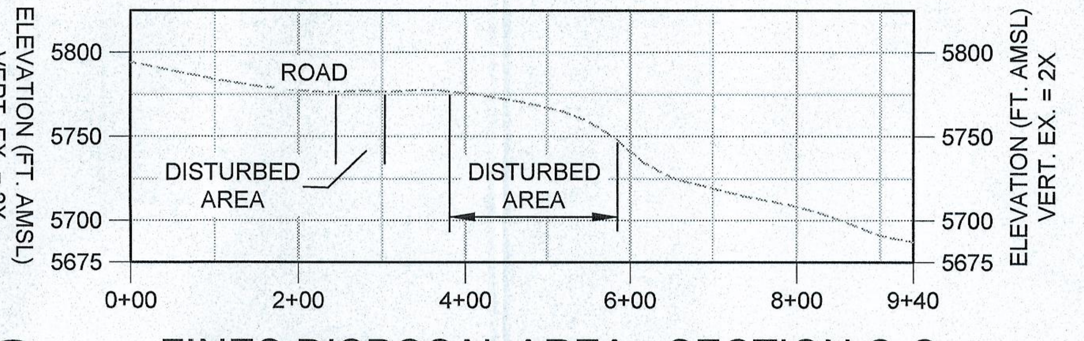
AJACENT SURFACE
OWNERS OF RECORD:
A TOMMY E. AND BARBARA M. MOORE
B PAUL AND JENNIFER D. ATWOOD
C AARON AND RAMONA ATWOOD
D STATE OF COLORADO
E AGGSOURCE LLC
F BLM
G CITY OF CANON CITY



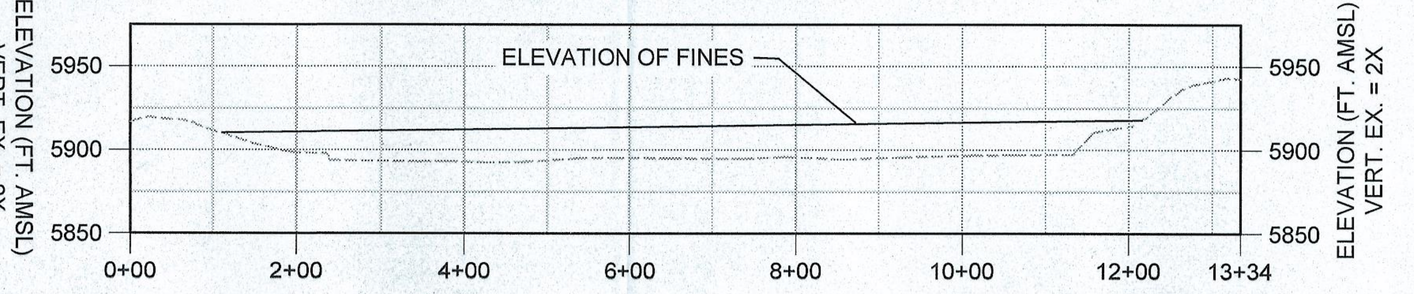
KEY MAP - PERMIT AREA
SCALE: 1"=2000'



(3) OLD QUARRY FINES DISPOSAL AREA
SCALE: 1"=200'



(C) FINES DISPOSAL AREA - SECTION C-C
SCALE: H=1"=200' V=1"=100'



(D) OLD QUARRY FINES DISPOSAL AREA - SECTION D-D
SCALE: H=1"=200' V=1"=100'

DATE:	REVISION:
4-10-15	RE-FORMAT
4-26-15	MINE PLAN AND SECTIONS
5-17-15	ADD OWNERS SIG., SECTIONS, NOTES

PREPARED FOR:
TRANSIT MIX CONCRETE
COLORADO SPRINGS, COLORADO

CANYON DOLOMITE QUARRY
M-1977-376
RECLAMATION PLAN
EXHIBIT F

PREPARED BY:
Tuttle & Associates
Planning and Permitting Services
PO BOX 485,
Broomfield, Co 80038-0485
Phone: 303.653.5584
garytuttle@gmail.com

Project No.
CC001-2012

Date	Sheet
03-01-2015	1 OF 1

Date: 4/16/2015 5:16:04 PM D:\mmorison\tuttle-2-16-2105\Exhibit-F-Reclamation-Plan.dwg Plotted By: Mike Morrison

Division of Reclamation, Mining, and Safety

Fee Receipt for M1977376

Continental Materials Corporation

000000000

Receipt #: 19662

Date: 06/04/2015

Permit: M1977376

Payment Method	Revenue Code	Fee Description/Notes	Amount
00188379 msr	4300-MTR0	Minerals Technical Revision M1977-376 paid by Transit Mix Concrete Co. / Castle Concrete Company / Transit Mix of Pueblo	$216.00
		Receipt Total:	**$216.00**