C/041/002 Incoming

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resources Partner, LLC

Sufco Mine
Kenneth E. May
General Manager
597 South SR24
Salina Utah 84654
(435) 286-4400
Fax (435) 286-4499

C/041/0002
Received 9/22/15
Task ID #4982

September 21, 2015

Permit Supervisor
Utah Coal Regulatory program
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, UT 84114-5801

#4953

Re: Expansion of Waste Rock Site, Task ID# ~~4935~~, Canyon Fuel Company, LLC, Sufco Mine

Dear Sirs:

Please find enclosed with this letter an amendment to the Sufco Mine Permit to revise the area of the Waste Rock Disposal Site. We have included one copy of the text and maps associated with this amendment.

We are planning to expand the area of the waste rock disposal site by approximately 46 acres. The site will be developed in phases, to allow the disturbance of the surface to be minimal in each phase. The existing pond will be sufficient for treatment during the first phase, but will be replaced by a larger pond during the first phase.

Once the Division has received this amendment and has had some time to give it a cursory review, we need to meet and wrap up any outstanding issues. The construction contractors are currently scheduled to start moving dirt on October 5, 2015.

A cover sheet has been placed at the front of the document detailing which text, figures, drawings, exhibits, appendices have been changed since the last review, to assist in this review.

If you have questions or need addition information please contact Vicky Miller at (435)286-4481.

CANYON FUEL COMPANY
SUFCO Mine

Jacob Smith
Technical Services Manager

Encl.

cc: DOGM Correspondence File

RECEIVED
SEP 22 2015
DIV. OF OIL, GAS & MINING

Sufco Mine

APPLICATION FOR COAL PERMIT PROCESSING

Permit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐

Permittee: Canyon Fuel Company, LLC
Mine: Sufco Mine **Permit Number:** C/041/0002
Title: Expansion of Waste Rock Disposal Site, Task ID#4953
Description, Include reason for application and timing required to implement:

Instructions: If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

☒ Yes ☐ No 1. Change in the size of the Permit Area? Acres: 46.3 Disturbed Area: _ ☒ increase ☐ decrease.
☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# _____
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes ☒ No 6. Does the application require or include public notice publication?
☒ Yes ☐ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☒ Yes ☐ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: _____
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☒ Yes ☐ No 13. Does the application require or include collection and reporting of any baseline information?
☒ Yes ☐ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☒ Yes ☐ No 15. Does the application require or include soil removal, storage or placement?
☒ Yes ☐ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes ☒ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☒ Yes ☐ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☒ Yes ☐ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☐ Yes ☒ No 21. Have reclamation costs for bonding been provided?
☐ Yes ☒ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

Jacob D. Smith
Print Name

[signature], Engineering Manager, 9/15/15
Sign Name, Position, Date

Subscribed and sworn to before me this 15th day of September, 2015

Jill White
Notary Public
My commission Expires: _____, 20___ }
Attest: State of _____ } ss:
County of _____

JILL WHITE
Notary Public
State of Utah
My Commission Expires 3/28/2016
COMMISSION NUMBER 654061

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining
		RECEIVED SEP 22 2015 DIV. OF OIL, GAS & MINING

APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

Permittee: Canyon Fuel Company, LLC
Mine: Sufco Mine **Permit Number:** C/041/002
Title: Expansion of Waste Rock Disposal Site, Task ID# 4953

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☐ Replace	☐ Remove	M&RP - WRDS Volume 3
☒ Add	☒ Replace	☐ Remove	Chapters 1, 2, 3, 4, 5, 6, 7 and 8
☒ Add	☐ Replace	☐ Remove	Exhibit 7 - Geology Drawing
☒ Add	☒ Replace	☐ Remove	Table of Contents
☒ Add	☐ Replace	☐ Remove	Appendix VII - Hydrology Report
☒ Add	☐ Replace	☐ Remove	Appendix I(A) - Cultural Resource Evaluations
☒ Add	☐ Replace	☐ Remove	Appendix II(A) - Slope Stability Report
☒ Add	☐ Replace	☐ Remove	Appendix IV(A) -Vegetation Report
☒ Add	☐ Replace	☐ Remove	Appendix V(A) - Soils Report
☒ Add	☐ Replace	☐ Remove	Figure 4 - Property Ownership
☒ Add	☐ Replace	☐ Remove	Figure 5 - Soils Map and Monitoring Wells
☒ Add	☐ Replace	☐ Remove	Figure 6 - Typical Road Section
☒ Add	☐ Replace	☐ Remove	Figure 7 - Land Use
☒ Add	☐ Replace	☐ Remove	Maps 2A - 2F, 3A - 3C, 4A -4F, 5, 5A, 7, 8, and 8A - 8C
☐ Add	☒ Replace	☐ Remove	Map 1
☐ Add	☐ Replace	☒ Remove	Map 2, 3, 4, 5
☒ Add	☐ Replace	☐ Remove	Maps 2v8 Historic, Map 4v4 Historic
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	M&RP
☐ Add	☒ Replace	☐ Remove	Chapter 5, Appendix 5-9 Bond, specific pages
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
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☐ Add	☐ Replace	☐ Remove	

Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	Received by Oil, Gas & Mining
September 21, 2015	RECEIVED SEP 22 2015 DIV. OF OIL, GAS & MINING

Changes to permit associated with Task ID No. 4953

Text Highlighted in Blue, with September date in heading

Chapter 2, Pages 2-4 thru 2-6, 2-10 thru 2-13, 2-17 thru 2-21, 2-23 thru 2-28

Chapter 3, Pages 3-10 and 3-11

Chapter 5, Page 5-12

MAPS

Maps 2A thru 2F

Maps 3A thru 3C

Maps 4A thru 4F

CHAPTER 5

ENGINEERING

APPENDIX 5-9

Reclamation Bond Estimate

Direct Costs

Subtotal Demolition and Removal	$1,725,380.50	
Subtotal Backfilling and Grading	$1,261,193.00	
Subtotal Revegetation	$164,246.00	
Direct Costs	$3,150,819.50	*2014 Dollars*

Indirect Costs

Mob/Demob	$315,082.00	10.0%
Contingency	$157,541.00	5.0%
Engineering Redesign	$78,770.00	2.5%
Main Office Expense	$214,256.00	6.8%
Project Management Fee	$78,770.00	2.5%
Subtotal Indirect Costs	$844,419.00	26.8%

Total Cost	**$3,995,238.50**	*2014 Dollars*

Escalation factor for 2014		0.019
Number of years from 2005 to 2014		5
Escalation Amount	$394,247.00	

Reclamation Cost Escalated	**$4,389,485.50**	*2019 Dollars*

Bond Amount (rounded to nearest $1,000) 2019 Dollars	**$4,389,000.00**

Posted Bond May 2010	$2,874,000.00
Difference Between Cost Estimate and Bond	-$1,515,000.00
Percent Difference	-52.71%

EARTHWORK COSTS

July 2015

	Equipment Cost	Hourly Operating Costs	Equipment Overhead	Operator's Hourly Wage Rate	Hourly Cost	Number of Men or Eq.	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Units	Equip. – Labor Time/Dis.	Units	Cost
Cut and Fill Mine Site															893908
Waste Rock Site															358333
Link Canyon Substation 03															678
Link Canyon Portals 04															3526
SITLA Muddy Tract Exploration															4748
Subtotal															1261193

	Equipment Cost	Hourly Operating Costs	Equipment Overhead	Operator's Hourly Wage Rate	Hourly Cost	Number of Men or Eq	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Units	Equip. + Labor Time/Dis.	Units	Cost
Waste Rock Site															
D9R Semi-U EROPS (9-35) (2H14)	23835	250	0.1	48.9	472.87	1	472.87	$/HR	58626	CY	225	CY/HR	260.56	HR	123211
826H ((6-12) (2N14)	23545	250	0.1	48.9	471.06	1	471.06	$/HR					260.56	HR	122739
CLAB					56.55	1.5	84.83	$/HR					260.56	HR	22103
8,000 gal H2O truck Diesel (20-16) (2N14)	13165	72.35	0.1	56.55	218.42	1	218.42	$/HR					260.56	HR	56912
Pickup Truck Crew 4x4 1 ton (20-17) (2N14)	850	9	0.1	36.5	51.71	1	51.71	$/HR					260.56	HR	13474
Foreman Average, Outside					76.35	1	76.35	$/HR					260.56	HR	19894
Existing Waste Rock Site 2015									15730	CY					
Phase 1 through 3									20668	CY					
									22228	CY					
Total									58626	CY					
Subtotal															**358333**

REVEGETATION COST

July 2015

Ref	Description	Material	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Vegetation																			
	Waste Rock Site																			
	Soil Preparation	Ripping	31 23 16.32 2820	0.41	BCY					23.733						AC		38289.24	CY	$ 15,699
	Seed	SUFCo WasteRock	SUFCo1	389	/AC					23.733						AC		23.73	AC	9231
	Hydro seed Equipment and Labor	Hydro Seeding, Mulch & Fertilizer	32 92 19.14 5800	31.05	/MSF					23.733						AC		1034	MSF	32106
	Mulch	Hay 1"	31 25 14.16 1200	624	TON					23.733						AC		1	ton/acre	14809
	Tackifer	Tackifer	Tackifer	52.5	/AC					23.733						AC		60	lb/ac	1246
	Existing and Phases 1 through 3									23.733						AC		23.73	AC	0
															425	/AC				
										23.733						AC		10087	EA	0
	All Others Except Link Canyon																			
	Soil Preparation	Ripping	31 23 16.32 2820	0.41	BCY					19.214						AC		30998.59	CY	$ 12,709
	Seed	SUFCo WasteRock	SUFCo1	746	/AC					19.214						AC		19	AC	14174
	Hydro seed Equipment and Labor	Hydro Seeding, Mulch & Fertilizer	32 92 19.14 5800	31.05	/MSF					19.214						AC		19.21	MSF	596
	Mulch	Hay 1"	31 25 14.16 1200	624	TON					19.214						AC		1	ton/acre	11990
	Tackifer	Tackifer	Tackifer	52.5	/AC					19.214						AC		60	lb/ac	1009
	Plant Seedlings	SUFCoTransplants	SUFCo3	487	/AC					19.214						AC		19.21	AC	9355
															425	/AC				
	Plant Seedlings	Bare root seedlings 6 to 10 inch heavy soil	32 93 43.10 0561	0.81	EA					19.214						AC		8166	EA	6614
	Subtotal																			129538
	Revegetation																			
	25% Revegetation Rate																			32385
	Subtotal																			32385
	Link Canyon Portal																			
	Soil Preparation	Ripping	31 23 16.32 2820	0.41	BCY					0.48						AC		774.4	CY	$ 318
	Seed	SUFCo WasteRock	SUFCo1	746	/AC					0.48						AC		0.48	AC	358
	Hydro seed Equipment and Labor	Hydro Seeding, Mulch & Fertilizer	32 92 19.14 5800	31.05	/MSF					0.48						AC		20.91	MSF	649
	Mulch	Hay 1"	31 25 14.16 1200	624	TON					0.48						AC		1	ton/acre	300
	Tackifer	Tackifer	Tackifer	52.5	/AC					0.48						AC		60	lb/ac	25
	Plant Seedlings	SUFCoTransplants	SUFCo3	487	/AC					0.48						AC		0.48	AC	234
															425	/AC				
	Plant Seedlings	Bare root seedlings 6 to 10 inch heavy soil	32 93 43.10 0561	0.81	EA					0.48						AC		204	EA	165
	Subtotal																			1731
	Revegetation																			
	25% Revegetation Rate																			433
	Subtotal																			433
	Total																			164246

CHAPTER 1

LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

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CHAPTER 1

LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

CHAPTER 1

LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

110 MINIMUM REQUIREMENTS FOR LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

111 Introduction

Canyon Fuel Company LLC operates a waste rock disposal site (WRDS) at a location west of their SUFCO Mine. ~~The facility is required for disposal of underground development wastes generated during mining operations.~~ The disposal site is located ~~on part of a 9,640 acre~~ on a large parcel of private land located within the boundaries of the Fishlake National Forest. SUFCO hauls the development wastes by truck approximately 6.5 miles from the mine to the waste rock disposal site via a paved county road. ~~Travel distance along the road is 6.4 miles from the portal to the disposal site exit.~~ The site will not be used as a sanitary land fill or for disposal of mining related rubbish~~. Efforts will be made to haul to the site on week days.~~ Waste rock will be contemporaneously spread and compacted.

The waste rock disposal site is located on ~~forty acres~~ acreage owned by Southern Utah Fuel Company and Canyon Fuel Company. The site is located in the north half ~~northwest 1/4 of the northeast 1/4~~ of Section 18, Township 22 South, Range 4 East, Salt Lake Base and Meridian. The waste rock site is bordered by private and Forest Service land. The Warranty Deed showing Southern Utah Fuel Company's right of ownership for Section 18, Township 22S, Range 4E is included as Exhibit 1. The adjacent property owners are shown on Map 1. ~~A copy of SUFCO's Warranty Deed is included as Exhibit 1.~~ This location ~~some 6 miles west from the mine site and~~ is within Sevier County. ~~It is estimated that approximately 10,000 tons of non-toxic, non-acid forming waste shale, coal, and sandstone per year will be generated by the mining operation. Life of the facility at this rate is estimated at 20 years. The design of the disposal area conforms to all State and Federal regulations.~~

Many of the general requirements for an operating permit are covered in Chapters 1 thru 9 of the mine site's M&RP~~, Volumes 1 and 2,~~ and are not repeated in this document. Only those items considered site specific or those items requested by the Division have received detailed attention in this Waste Rock Disposal site M&RP. When specifically referenced, the information contained in the SUFCO Mine M&RP application and the appendices of Waste Rock Disposal Site application (Volume 3) should ~~also~~ be considered during the review of this document. A portion of the information within the appendices is historical and has been replaced/supplimented with updated information.

Canyon Fuel Company currently operates under approved mining permit Number C/041/002. This permit was approved and issued by the State of Utah Division of Oil, Gas, and Mining in June of 1980. ~~A NOV history of Canyon Fuel Company's operations and liability insurance are provided in General Chapter 1 of the M&RP.~~ No underground mining will occur at the waste rock disposal site.

~~1.1 Scope of Operation~~

~~1.2 Access and Use~~

~~1.3 Disposal Site~~

~~1.4 Contiguous Owners~~

~~1.5 Mining Permits - Compliance Information~~

~~1.6 Insurance Coverage~~

112 Identification of Interests

For information pertaining to these sections, refer to the approved General Chapter 1 binder for Canyon Fuel Company, LLC. There are no buildings or structures within 300 feet of the disposal site. There are no holders of lease hold interest or purchasers of record in the waste rock disposal area.

Legal and Equitable Owner - The surface property to be affected by this mining operation during the duration of the permit period is owned by Canyon Fuel Company, LLC.

Canyon Fuel Company, LLC

225 North 5th Street, 9th Floor
Grand Junction, CO 81501

Contiguous Owners - The waste rock site is bordered by private and Forest Service land. The Warranty Deed showing Southern Utah Fuel Company's right of ownership for Section 18, Township 22S, Range 4E is included as Exhibit 1. ~~Table 1.3 gives~~ The names of the present property owners of record contiguous to the waste rock disposal site are:

Kenneth M. Christensen ETAL

Fishlake National Forest, U.S. Department of Agriculture

~~Ark Land Company~~

Canyon Fuel Company, LLC

Cary & Leanna Beagley

~~Table 1.3 Continuous Property Owners~~

Reference Plate 5-6 in the M&RP and Map1 of the WRDS amendment for ownership information.

MSHA Numbers - Waste Rock ID#1211-UT-09-00089-01

Interest in Contiguous Lands - Canyon Fuel Company has no interest in contiguous lands other than those currently owned as shown on Plate 5-6 and Map 1 (WRDS).

Certification of Submitted Information - Refer to the approved M&RP.

113 Violation Information

For information pertaining to this section (s) refer to the General Chapter 1 binder for Canyon Fuel Company, LLC.

114 Right-of-Entry Information

The Applicant, Canyon Fuel Company, LLC, owns the property on which the refuse pile is placed. The applicant bases their legal right to enter and begin operations on the Warranty Deed and ownership of parcels 4-167-3, 4-167-5, and 4-167-6. Refer to the approved M&RP for additional information.

115 Status of Unsuitability Claims

Refer to the approved M&RP.

116 Permit Term

Refer to the approved M&RP.

117 Insurance, Proof of Publication, and Facilities and Structures Used in Common

The waste rock disposal site is included in the liability insurance coverage held by the operator (See General Chapter ~~1 for a copy~~).
The refuse pile site has no facilities or structures.

118 Filing Fee

Refer to the approved M&RP.

120 PERMIT APPLICATION FORMAT AND CONTENTS

Refer to the approved M&RP.

130 REPORTING OF TECHNICAL DATA

Refer to the approved M&RP.

140 MAPS AND PLANS

The maps and plans in the Mining and Reclamation Plan will correspond with the requirements in R645-301-140.

150 COMPLETENESS

CFC believes the information in this permit application to be complete and correct.

CHAPTER 2

SOILS

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CHAPTER 2
SOILS

210 INTRODUCTION

The M&RP and this document contain pertinent information relating to identification, management, and reclamation activities associated with the soil resources present in the disturbed area.

The soil studies were conducted in accordance with the Utah Division of Oil, Gas, and Mining guidelines that were in effect at the time each study was conducted. .

220 ENVIRONMENTAL DESCRIPTION

The site is located at an elevation of about 7,900 feet and a portion of the site was previously used as a borrow area for material to repair a slide on the county road in 1981.

"Climate data for the *Proposed Waste Rock Expansion Area* is of limited availability. PRISM (GIS data for maximum air temperature, minimum air temperature, and average annual precipitation were downloaded from the Geospatial Data Gateway (USDA 2014a). This estimated data is based on 30 year averages, which are updated annually. The average annual maximum air temperature is 54°F and the average annual minimum air temperature is 29°F, based on current PRISM data. The average annual air temperature is 42°F (based on the average maximum and minimum PRISM values). The average annual precipitation is 17 to 18 inches, based on current PRISM data. These estimated annual temperature and precipitation averages reflect the taxonomic classification of the soils and the existing vegetation."(Long Resource Consultant, 2014).

Additional climatological information is provided in Section 7.2.4.4 of the M&RP.

221 Prime Farmland Investigation

The site has no developed water supply suitable for irrigation and is located in an area not considered to be prime farm land. Soil Conservation Service confirmation of this opinion may be found as Exhibit 4.

According to the U.S. Department of Agriculture "Soil Survey Manual", prime farmland has the soil quality, growing season and moisture supply needed for agricultural productivity to sustainably produce high yields of crops when treated and managed according to acceptable farming methods (e.g. water management).

A prime farmland assessment was conducted by the Soil Conservation Service (Allgood 1987) in which it was determined that "The property located in the NW1/4 of the NE1/4 of Section 18, Township 22 South, Range 4 East does not meet the criteria for prime farmland" (LRCI, 2014).

The waste rock disposal site (WRDS) does not have a dependable water supply for irrigation, the soils do not qualify, the slopes are steep, the temperatures are not favorable, and the growing season is short. "The soil moisture regime is ustic and the soil temperature regime is frigid" (Fishlake NF 2013).

A letter located in Exhibit 4 discusses an earlier negative prime farmland qualification by the Soil Conservation Service for the WRDS.

222 Soil Survey

~~3.1.6 Subsoil Stockpile~~

Piles Existing in June 2015 (Historic). Excess subsoil material and a small amount of topsoil from the mine site is stockpiled at the Waste Rock Disposal Site for possible use during final reclamation of Sufco mine site facilities. The location of the subsoil and topsoil material is shown on Map 2V8 (Historic). Total acreage of the subsoil stockpile and associated topsoil piles 1A and 1B is 1.19 acres. Approximately 11,747 cubic yards of subsoil material and approximately 8.2 cubic yards of mine site topsoil material are stockpiled at the site. The associated original topsoil pile 1B and new topsoil piles 2 and 3 removed from the subsoil stockpile area contains ~~about~~ approximately 756.4 cubic yards. The top 24 inches of soil material was removed from the subsoil stockpile area ~~as described in Section 312, Site Preparation.~~ This topsoil was stored along the westerly boundary of the WRDS and east of the subsoil stockpile as shown on Map 2V8 (Historic) . Topsoil handling procedures complied with those described in Section 231, Topsoil Handling. These topsoil stockpiles will be stored and seeded using the grasses and forbes of the standard seed mix .Section 341 ~~, Table 4.6.1-1.~~ When the subsoil and mine site topsoil are removed, the topsoil will be redistributed and the area reclaimed and seeded in accordance with Sections 242 ~~4.5~~ and ~~4.6~~ 340.

Historic - Subsoil material was placed in 2-3 ft. lifts using dump trucks and a D-7 Cat dozer. Exterior slopes of the subsoil stockpile are approximately 1v:1.25h. At this slope the material will be stable as placed. The subsoil stockpile was seeded using the grasses and forbes of the standard seed mix, ~~Table 4.6.1-1.~~ Section 341 This subsoil may be taken to the mine site and used for fill material during final reclamation of the mine site.

Run off from the subsoil and associated topsoil stockpiles is collected and routed through a silt fence treatment located as shown on Map 2V8 (Historic) . The total acreage of the five stockpiles is 1.24 acres. Alternate sediment control measures are in place as described above. This area is classified as an approved Alternate Sediment Control Area (ASCA).

Topsoil and Subsoil Storage Piles at Waste Rock Disposal Site(Pre-Expansion - Historic)

TOPSOIL				
Description	Volume (cy)[(a)]	Area (acres)	Distribution Location	Location Post Expansion

1A	8.2	1.19*	Mine Site	#
1B	456.9	0*	Waste Rock	#
Topsoil Storage Combined Pile (2, 3 & Lift 5 Exp.)***	4,114	0.24	Waste Rock	#
Sediment Pond	634.9	0.293	Waste Rock	#
Lift # 4 Area**	1847	0.34	Waste Rock	#
TOTAL	7061	NA	NA	
SUBSOIL				
Subsoil	11,260	0*	Mine Site	##
Soil Nail Wall	487	0*	Mine Site	##

(a) Estimated Quantity

* The acreages for Piles 1A,1B and Subsoil are combined

** Topsoil stored in piles on top of Lift #4, estimated depth of stored topsoil - 3.5 feet

***Topsoil excavated for the Lift 5 Expansion was combined into a single pile with piles 2 and 3, Figure 2A shows dimensions and cross sections of this pile.

Used to reclaim Lift 5 or moved to large soil pile north of new sediment pond during the construction of Phase I.

Remain where located prior to WRDS expansion (2015-2016)

WRDS EXPANSION (2015-2016) TOPSOIL/SUBSOIL SALVAGE (Estimated*)

	Soil Type (Figure 5)	Topsoil Volume (CY)	Subsoil Volume (CY)	Year Salvaged and Stockpiled (Estimated)**
PHASE 1	1	3400	6460	2015 - 2017
	2	17100	2740	
	4	500	0	
	Rehandled***	3500	0	
PHASE 2	1	6600	15300	2015 - 2017
	3	3400	1600	
	5	2500	1300	
PHASE 3	1	2838	5392	2018 - 2020
	2	5818	5486	
	3	7299	3369	
	Rehandled***	2398	0	
PHASE 4	2	9286	8756	2020 .....
	3	7716	3561	
	Rehandled***	3335	0	
PHASE 5	1	690	1312	2020 .....
	2	14065	13261	
	3	4748	2191	
	Rehandled***	3344	0	
PHASE 6	1	2068	3929	
	2	8431	7949	
	3	83	38	

* Quantities are estimated using data from LRCI 2014 soils report, Appendix V(A)and areas on Maps 2A thru 2F.

** Dates correspond with 2015 projected mine plan, plan subject to change.

*** Rehandled refers to in-place topsoil placed during reclamation of the existing waste rock pile, which will be removed to enable the placement of waste during Phases 1, 3, 4 and 5.

222.100 Soils Map

A description of the soils within the WRDS Expansion area on an Order III soil survey level can be found in the Long Resources Consultant (LRCI), 2014 report in Appendix V(A). Figure 2 of the report show the Order 3 Soil Survey results prepared by the Fish Lake National Forest. An Order II soil survey was performed by Long Resource Consultants, Figure 3 showing the results of the survey are included in the 2014 report, Appendix V(A). The locations of the soil test pits excavated during the survey are shown on Figure 5 of the waste rock disposal site figures.

222.200 Soil Identification

The following is a list of the soils found in the general area of the WRDS area as delineated by the Fish Lake National Forest Order 3 survey (LCRI, 2014, Appendix V(A)).

Map Unit	Slope Range %	%	Taxonomic family
29	10-40	65	Typic Argiustolls, lo-skeletal, mix, super, frigid
		25	Pachic Argiustolls, fine-loamy, mix, super, frigid
30D	3-25	40	Pachic Argiustolls fine, mix, super, frigid
		40	Pachic Argiustolls fine-loamy, mix, super, frigid
65	25-65	50	Typic Argiustolls lo-skel, mix, super, frigid
		25	Lithic Haplustepts lo-skel, mix, super, frigid
		15	Typic Haplocalcids fi-loamy, mix, super, frigid
70	15-60	40	Lithic Ustorthents lo-skel, mix, super, calc, frigid

		20	Typic Argiustolls fi-loamy, mix super, frigid
		20	Rock Outcrops
92	3-15	40	Ustic Haplargids fine, mix, super, frigid

The Order 2 Soil Survey (LCRI, 2014, Section 2, Appendix V(A)) map units are as follows:

Slope Range %	Map Unit % of Family Complex
4 - 24	Kunz (45%)-Trag (35%)-Crow (15%) families complex
2 - 15	Chivers (50%) - Kunz (40%) families complex
	Trag (10%) on strongly sloping backslopes
15 - 40	Tuntsa-Trag-Zillion families association
3 - 28	Boyett-Veatch families complex
15 - 60	Wiggler-Helper-Trag families complex

222.300 Soil Description

(Historic) Soils surveys were ~~done~~ prepared for different purposes by both the engineering consultant and by a soils specialist. Seven exploratory borings were drilled with truck-mounted equipment to depths of 25 to 51 feet below existing grades at the site. The borings were performed using 6 ½ inch O.D. hollow stem augers. Standard penetration testing and open-end drive sampling were performed at selected intervals in the borings.

In addition, five backhoe test pits were ~~performed~~ excavated at the site to supplement the soil boring data ~~program~~. The results of the field investigation are presented in Appendix A of the Sergent Hauskins & Beckwith (SHB) report, which includes a brief description of drilling and sampling equipment and procedures, logs of the test borings, logs of the test pits, and records of the observation well construction details. A site plan showing the boring, test pit, and observation well locations is included ~~in a pocket~~ at the back of the report. The field investigation was supervised by Paul Kaplan and Donald Curran, engineers with SHB.

Moisture content determinations were made on selected tube samples recovered, and dry densities were determined for selected 2.42 inch diameter open-end drive samples. The results of these tests are shown on the boring logs.

Grain-size analysis, Atterberg limits, and direct shear tests were performed on selected soil samples. The results of these tests are presented in Appendix B of the SHB report along with a brief description of testing procedures.

A soil survey report dated December 22, 1987 is included as Appendix V. A facilities map overlay is provided that shows the outline of the sagebrush-grass vegetative type. Essentially all of the permitted waste rock disposal site is within that vegetative type. A very small proportion was mapped previously as mountain brush, and about two acres of the site was modified historically as a source of fill materials.

Four soil test pits were dug at the site, within the undisturbed area on December 10, 1987, and five more were dug on December 16, 1987 (to ascertain the adequacy of the first four pits). It was ascertained that the soils in the sagebrush-grass vegetative type are all sufficiently similar as to not be further divisible into mapable units. There are no rock outcrops within the undisturbed area. Rock outcrops were exposed in the borrow area, prior to using the area for waste rock disposal.

The contemporary study of soils at the waste rock disposal site indicate "that this small area is predominated by a single soil type which is classified as Typic Torrifluvents and in land capability class V with limitations due to climate and slope. Surrounding soils have been previously classified as Typic Argixerolls and the soil on the proposed soil site is small enough to have been considered an inclusion on previous soil maps." See the appended soil analysis report for additional details.

A discussion of the soil taxonomic classification availability of topsoil and other related soils discussion may be found in the report prepared by Dr. Sheldon D. Nelson located in Appendix V.

Waste Rock Expansion - An Order 3 survey has been conducted in the vicinity of the WRDS area by the Fishlake National Forest, but has not been published as of February 2015. Preliminary information is included as a reference in the LRCI report, Appendix V(A).

Sixteen soil profile descriptions were described, examined and sampled in hand dug and backhoe pits. Soil profiles depths ranged from 16 to 78 inches, with hand dug pits being dug to a minimum depth of 40 inches or to a restrictive layer. Representative samples of each soil horizon were collected for examination. Photographs of the soils profiles location are provided in Appendix B of the LRCI report. Soil samples were analyzed for the parameters outlined in Table 2 of the "Guidelines for Management of Topsoil and Overburden" (DOGM, 2005). Soil Map Units are described in Section Two of the LRCI report, Appendix V(A).

222.400 Soil Productivity

The data obtained from soil testing are provided in Appendix V(A). Table 7 (LRCI Report) showing the estimated topsoil and subsoil salvage can be found in Appendix V. On Table 7 the estimated salvage depths for topsoil and subsoil meet the Good and Fair criteria established by UDOGM in 2005 and are considered suitable for use for reclamation.

A summary of the soil testing results and ratings are provided in Appendix D, Table D-1 of the LRCI report located in Appendix V(A).

While salvaging topsoil during Phases 1 thru 6 of the waste rock expansion a composite sample will be taken during each phase and analyzed for the pH; % Saturation; EC; Soluble Na, K, Mg, Ca; Available NO3-N; Available Phosphorus; Particle Size% very fine sand, sand, silt, clay; Organic Matter%; CaCO3%; and Extractable Potassium. (January 2008, Division's Soil Guidelines, Page 6 of 57). The results of the soil analysis will be placed in Appendix V.

223 Soil Characterization

Recent soil surveys performed by LRCI for the Waste Rock Disposal Site were conducted in accordance with the standards set by the National Cooperative Soil Survey and analyzed according to the Division's guidelines.

224 Substitute Topsoil

Not applicable. ~~If necessary, CFC may use selected overburden materials as a substitute or supplement to the salvaged soil. The proposed material will be evaluated in conjunction with UDOGM and upon approval for use will be applied as a subsoil layer beneath topsoil.~~

230 OPERATION PLAN

231 General Requirements

231.100 Removing and Storing Soil Methods

~~After vegetative matter has been removed from the site,~~Topsoil and subsoil shall be removed and stockpiled, and properly protected for future reclamation purposes. ~~The topsoil storage piles will be located on site and will be protected as necessary.These materials will be stored in a graded stockpiles with silt fences to help prevent erosion of the topsoil. The topsoil that is expected to be stored for less than two years, will not be revegetated.~~

~~3.1.2 Site Preparation~~

Prior to the placement of ~~any~~ underground development waste, ~~all~~ large vegetative cover shall be removed from the site. After removal of the large vegetation, the topsoil shall be removed, stockpiled, and properly protected for future reclamation purposes. It is estimated that ~~approximately~~ between 17 and 35 ~~24~~ inches of topsoil will be removed and stockpiled for future use. Subsoil (0-38") will also be removed and stockpiled. The parent material remaining following the removal of topsoil and subsoil will be tracked with heavy equipment prior to the placement of waste.

Phase 1 thru 6 Expansion- To assist in the prevention of topsoil compaction during salvage and storage the following will be implemented:

Excess wheel traffic and the tillage of wet soils will be avoided;

Equipment with wider tires, dual tires or tracts will be used;

The equipment will make as few passes as possible;

The weight and size of the equipment will be as small as possible to accomplish the work in a timely and economical fashion.

Prior to placement of the topsoil and subsoil in their respective piles for storage the area will be grubbed and marked with a fabric or tape to allow the distinction of in-place soil and stored soil. Vegetation which can be shredded will be incorporated into the topsoil/subsoil prior to being placed in a stockpile for storage. The few trees collected during grubbing will be placed on top of storage pile(s) or hauled to a licensed disposal facility.

It is anticipated that the soil piles will be constructed in horizontal lifts of 1.5 to 2.0 feet. ~~Tracked equipment will be used to reduce compaction.~~ Qualified supervision will be on-site during soil salvage operation for topsoil/subsoil identification, to determine the distinction between topsoil/ subsoil, stripping the topsoil to be rehandled on the existing reclaimed piles and to control soil stripping. A backhoe will be used to dig pits or trenches to the depth of topsoil/subsoil to be remove as a method of monitoring salvage depth along with information provided in soil reports. The supervision will be an individual(s) with experience in soil salvage operations.

The quantity of topsoil/subsoil salvaged during the construction of the expanded WRDS will be determined by surveying the phased area prior to salvage and post salvage. The M&RP will be updated with as-built drawings, cross sections and a table(s) listing volumes of subsoil and topsoil stockpiles.

The operator will endeavor to remove and store as much topsoil as possible in the designated stockpiles, thereby maximizing the protection of the soil resources of the site.

~~The upper 9 inches of natural soils beneath cut surfaces where topsoil and subsoil and in the area to receive development waste shall be scarified and recompacted. to at least 95 percent of the maximum dry density as determined by ASTM D1557 procedures. Moisture contents during compaction shall be maintained within ±2 percent of the optimum moisture content for the soil as determined by ASTM D1557.~~

Historic - The existing sediment pond topsoil stockpile will be revegetated with the grasses and forbs of the standard seed mix to help control erosion. A berm ~~that will contain a 10 year, 24 hour precipitation event~~ was built around the sediment pond topsoil pile. This stockpile will have runoff controlled by alternate sediment controls as described above. This stockpile is designated as an Alternate Sediment Control Area (ASCA).

~~Two additional soil stockpile storage areas will be established in a portion of the waste rock disposal area away from the areas of initial use.~~

Historic - For reclamation purposes it is proposed that the top 45 inches of growth medium should be removed for stockpiling. The soils surveyed in the SHB report (Appendix II) have excellent chemical and physical properties which support a better plant growth medium than the surficial material alone. Samples for lab analysis will be collected from the mixture in the stockpile. The soil pits sampled demonstrate an A horizon about 4 inches in thickness underlain by 12-14 inches of stratified C horizon material. Below that is a prominent buried A horizon. Present vegetation indicates that this is a very fertile soil on a slightly eroded landscape but present conditions suggest that this has been a stable landscape for several decades with slow runoff but which is subject to periods of erosional deposition during high storm runoff events. Present erosion hazard is slight (Class I) with existing vegetation but could be moderate to severe if vegetation is removed. This soil is moderately well drained, has moderate permeability and medium available water within 3 feet but has low water holding capacity within the C horizon material from 4-18 inches. Because there is a prominent buried A horizon starting at 16-20 inches, with excellent chemical and physical properties for plant growth, this material will be mixed with the top 18 inches of soil and will make a better plant growth medium than the surficial material alone.

Historic - The initial lift of waste material will be covered by topsoil from the adjacent existing topsoil stockpile. Topsoil from the second lift area will be placed in long term storage in the northwest stockpile. Subsequent lifts will be covered with topsoil removed from the succeeding lift area. Sediment pond area topsoil will be placed in long term storage in the stockpile site located immediately east of the sediment pond. ~~Topsoil removal will be primarily by front-end loader. The volume of topsoil removed will be monitored by a grid stake method.~~

Historic - The 45 inches of available topsoil/subsoil is more than adequate for revegetation purposes. Consequently, the topsoil will be redistributed to a minimum depth of 30 inches with sufficient surplus placed in the long term storage stockpiles to ensure the same minimum topsoil depth on the final lift and 12 inches over the sedimentation pond.

SELECT WRDS 1987 SOIL ANALYTICAL DATA

Appendix V - Soil Profile Descriptions for Proposed Waste Disposal Site (Sheldon D. Nelson, Ph.D.)

PARAMETER	UNITS	SAMPLE NUMBER AND DEPTH			
		PIT-1 0-4"	PIT-1 4-10"	PIT-1 10-16"	PIT-1 16-24"
pH		7.1	7	7	7.4
EC	mmhos/cm	1.32	0.88	0.88	0.65
SAR		0.15	0.01	0.01	0.11
CALCIUM	mg/l	276	183	183	68
MAGNESIUM	mg/l	29.5	19.5	19.5	13
SODIUM	mg/l	9.5	0.5	0.5	5.5
SAND	%	52	57.3	57.3	56
SILT	%	28.7	14	14	22.7
CLAY	%	19.3	18	18	21.3
AVAILABLE WATER HOLDING CAPACITY	%	4.52	0.47	0.47	2.41
NEUTRALIZATION POTENTIAL (% $CaCO_3$)	tons $CaCO_3$/ 1,000 tons material	18.44	14.42	14.42	6.25
TEXTURE		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Clay Loam

PARAMETER	UNITS	SAMPLE NUMBER AND DEPTH			
		PIT-2 0-4"	PIT-2 4-12"	PIT-2 12-16"	PIT-2 16-24"
pH		7.1	7.4	7.4	7.4
EC	mmhos/cm	1.32	0.67	0.67	0.65

SAR		0.36	1.63	1.63	3.01
CALCIUM	mg/l	235	81	81	67
MAGNESIUM	mg/l	42	17	17	13
SODIUM	mg/l	22.5	62	62	103.5
SAND	%	42	70.7	70.7	56
SILT	%	30.7	14	14	22.7
CLAY	%	27.3	15.3	15.3	21.3
AVAILABLE WATER HOLDING CAPACITY	%	5.13	1.1	1.1	2.41
NEUTRALIZATION POTENTIAL (% $CaCO_3$))	tons $CaCO_3$/ 1,000 tons material	13.78	8.82	8.82	6.25
TEXTURE		Loam	Sandy Loam	Sandy Loam	Sandy Clay Loam

PARAMETER	UNITS	SAMPLE NUMBER AND DEPTH			
		PIT-3 0-5"	PIT-3 5-11"	PIT-3 11-18"	PIT-3 18-24"
pH		7.2	7.2	7.2	7.5
EC	mmhos/cm	0.76	0.74	0.74	0.50
SAR		0.16	0.05	0.05	0.13
CALCIUM	mg/l	150	162	162	100
MAGNESIUM	mg/l	16.5	20	20	16
SODIUM	mg/l	7.5	2.5	2.5	5.5
SAND	%	42	70.7	70.7	56
SILT	%	30.7	14	14	22.7
CLAY	%	27.3	15.3	15.3	21.3

AVAILABLE WATER HOLDING CAPACITY	%	1.29	1.37	1.37	9.21
NEUTRALIZATION POTENTIAL (% $CaCO_3$)[)]	tons $CaCO_3$/ 1,000 tons material	13.58	12.76	12.76	11.51
TEXTURE		Loam	Sandy Loam	Sandy Loam	Clay Loam

231.200 Suitability of Topsoil Substitutes/Supplements

~~See Section 233.200.~~ Not applicable.

231.300 Testing of Topsoil Handling and Reclamation Procedures Regarding Revegetation

~~**4.6.4 Soil Testing**~~

The topsoil will be tested for need of nutrients and soil amendments following application and grading at the rate of one sample/acre. The depth of sampling should be the surface six inches of distributed topsoil. Parameters for testing will include plant available nitrogen, phosphorus and potassium. ~~prior to the first topsoil distribution effort.~~ Application will be on an as needed basis as determined by the tests. ~~Tests will not be repeated for subsequent topsoil distributions that may unless lack of revegetation success indicates a need to do so.~~

231.400 Construction, Use and Maintenance of Topsoil Storage Piles

See Section 234.

232 Topsoil and Subsoil Removal

232.100 Topsoil Removal and Segregation

Topsoil will be removed from the area to be disturbed as a separate layer and segregated.

232.200 Poor Topsoil

The soils on the site have been classified as fair to good for sustaining vegetation. Therefore, all available soil materials will be removed and stockpiled (refer to Section 222.400).

232.300 Thin Topsoil

Topsoil that is less than 6 inches thick will be removed with the immediately underlying unconsolidated materials and the mixture will be treated as salvageable topsoil.

232.400 Minor Disturbances Not Requiring Topsoil Removal

Small Structures. Soil will not be removed prior to construction ~~that would result in only minor disturbances. Such construction activity includes work~~ on small structures such as the installation of signs, and fence posts ~~lines, and etc.~~

~~**Vegetation.** The operator will not remove soil for minor disturbances where such activity will destroy vegetation or cause erosion.~~

232.500 Subsoil Segregation

As salvaged, subsoil will be segregated into a separate pile from the topsoil. ~~except In cases where the subsoil layer is thin (8 inches or less), the subsoil will be salvaged and stockpiles with the topsoil.~~

232.600 Timing

Vegetative cover that would interfere with the salvage of soil will be removed before surface disturbance takes place. Refer to Section 231.100 for additional information.

232.700 Topsoil and Subsoil Removal Under Adverse Conditions

Expansion - Soil horizons will be removed and stockpiled, except where natural conditions render operations hazardous or detrimental to soils outside the disturbed area. ~~**Conventional Machines.**~~ In localities where steep grades, adverse terrains, severe rockiness, limited depth of soils, or other adverse conditions exist that render soil removal activities using conventional machines hazardous, soils ~~will~~ may not be salvaged and stockpiled, following consultation with DOGM personnel.

233 Topsoil Substitutes and Supplements

~~Selected overburden materials may be used below the salvaged soils during reclamation operations, if sufficient soil materials are not available for the proposed reclamation activities. Equal portions of coal waste and subsoil may be used to create a blended cover material to be placed below topsoil/growth medium. Where overburden materials are used, the operator commits to demonstrating to the Division prior to salvaged soil emplacement that the overburden materials are non-toxic, non-acid forming, and non-combustible. Refer to Section 536.200 discussion of waste sampling/testing.~~ Not applicable.

234 Topsoil Storage ~~(Growth Medium)~~

Figure 5 is a drawing showing the soils surveyed, the test pit locations, the respective depth of topsoil and subsoil.

234.100 Topsoil Stockpiling ~~(Growth Medium)~~

The ~~growth medium~~ topsoil removed will be stockpiled for later use in reclamation operations when it is impractical to promptly redistribute the materials on regraded areas. Because the soil salvage quantities are estimated, the actual contours and corresponding cross-sections are approximate.

~~The term "growth medium" is used to describe a soil medium used for the support of plant growth and development.~~

The subsoil and topsoil stockpiles will be protected with a fence. Following the salvage of soils during Phases 1 the majority of the remaining soils salvaged will be used to reclaim the previous areas where waste rock has been stored i.e. Phase 3 salvaged topsoil and subsoil will be used to cover Phase 1 and 2, Phase 4 will be used to cover Phase 3, etc. .

~~It is anticipated that the piles will be constructed in horizontal lifts of 1.5 to 2.0 feet. Tracked equipment will be used to reduce compaction.~~ The stockpiles will be graded to a ~~maximum~~ slope ranging between of 2h:1v to 3h:1v,roughened, seeded and mulched to promote surface stabilization. The method of application of the mulch on the stockpiles will be by blower or by hand, the mulch will either be wood fiber, grass hay, straw or alfalfa hay, the anchoring method will be either crimping or chemical binder (Table 10, July 2008, Division's Soil Guidelines, pages 26 & 27). Since the piles will not have a flat horizontal surface the recommended application rate of 1 to 2 tons per acre will vary with the surface to receive the application, a minimum of 1 ton will be applied. The interim reclamation seed mix described in WRDS Chapter 3, Section 341.200, will be used for this purpose. Prior to September 2015, there is insufficient information as to what methods or treatments were used on the existing topsoil and subsoil stock piles.

~~The stockpiles will be kept isolated from the main area of the waste rock disposal site to protect the material from contaminants and unnecessary compaction that would interfere with vegetation.~~ A sign will be installed on the stockpiles to identify as a topsoil storage area or as a subsoil storage area. The stockpiles will be protected from wind and water erosion by being revegetated with a quick growing vegetative cover (interim reclamation seed mix, Section 341.200) and by installing berms around the stockpiles to help trap sediment coming off the stockpiles.

Lift #5 Expansion - ~~Growth~~ The ~~medium~~ topsoil/subsoil will be removed to a minimum depth of 18 inches in the approximately 0.54 acre area of the expansion. The ~~growth medium~~ topsoil will either be used immediately to reclaim a portion of the #5 lift or will be stockpiled on Topsoil Storage No. 2 to be used for reclamation in the future. ~~Growth~~ The ~~medium~~ topsoil to be removed is estimated to be 1,300 yds. The logs (Appendix II) from boring number B-1 located within the expansion area shows the topsoil to be 12 inches deep, however the area has been part of an undisturbed ditch and additional sediment has the potential of having been deposited in the area. Boring B-1 is located on the west side of the waste rock pile between the pile and undisturbed ditch. Boring B-1 will be covered with waste as part of the expansion planned for Lift # 5 in approximately 2014 (depending upon the quantity of waste produced and hauled).

234.200 Stockpiled Topsoil ~~(Growth Medium)~~

Stable Stockpile Site. Stockpiled materials will be placed on a stable site as described in Section 234.100.

Protection from Contaminants and Compaction. The stockpiles will be kept isolated from the main area of the waste rock disposal site to protect the material from contaminants and unnecessary compaction that would interfere with vegetation. ~~Stockpiled soil will be protected from contaminants and unnecessary compaction. To protect the soil from contaminants and unnecessary compaction that could interfere with vegetation, the stockpiles will be isolated from the main refuse pile area (Section 234.100). A sign designating "topsoil" will be installed on the stockpile.~~

The stockpile will be constructed in such a manner as to allow equipment access around the base of the stockpiles for repair of the surfaces and diversion structures as needed.

Furthermore, berms will be constructed around the stockpiles to ~~further~~ separate the soils from the materials stored on the site. The berm will be constructed as specified in Appendix VII (~~design drawing~~ Appendix C, Disturbed Berm Detail), ~~Chapters 5 and 7~~.

Wind and Water Erosion Protection. The stockpiles will be protected from wind and water erosion by prompt establishment and maintenance of a vegetative cover. Berms will be constructed around the stockpiles to help trap sediment runoff from the stockpiles. Refer to Section 242 .100 for additional protection information.

Topsoil Redistribution. A limited quantity of stockpiled soil may be distributed on the refuse pile to ~~determine~~ meet the quantity of soil cover necessary to fulfill revegetation reclamation requirements. The remainder of the stockpiled soil will not be moved until redistributed during reclamation operations unless approved by the Division.

234.300 Topsoil Stockpile Relocation

Stockpiled soil in jeopardy of being detrimentally affected in terms of its quantity and quality by refuse pile operations may be temporarily redistributed upon approval by the Division and modification of this M&RP.

Host Site. Soil relocation may occur provided that such action does not permanently adversely affect soil of the host site.

Topsoil Suitability. Stockpiled soil relocation may occur provided the material is retained in a condition more suitable for redistribution than if stockpiled.

240 RECLAMATION PLAN

241 General Requirements

Reclamation of the site (soil redistribution, amendments, and stabilization) is discussed in Sections 242, 243, and 244, respectively.

242 Soil Redistribution

~~4.4 Backfill Soil Stabilization, Compaction, Contouring & Grading~~

Historic Area - The fill area will be built up using waste rock generated during the mining operation at the SUFCO Mine. The waste rock will consist of shales, sandstones, mudstones, and some coal. Prior to fill placement, ~~all~~ vegetative cover will be removed from the area where fill is to be placed. Topsoil and subsoil will then be removed, stockpiled, reseeded and mulched. Fill will be placed in segments using trucks, loaders, other equipment and compaction equipment. These segments will vary in length and width~~, refer to Map 4 for dimensions~~. The first segment will be placed on the southeast side of the disposal area. Additional segments will be placed beginning on the east side and working to the west. The fill will be built up to approximate the final contours ~~shown on Map 2~~. The active area of the fill will consist of a pad where the haul road and compaction activities are taking place with an associated upslope and down slope. The upslope will be to the east adjacent to a previously established segment. The down slope will be to the west and will be the face of the present segment. As a segment is completed, it will be graded to blend into the contours ~~shown on Map 2~~. After grading, a layer of topsoil will be added and the completed segment will be seeded as described in the revegetation plan ~~of Section 4.6~~ and in accordance with the revegetation timetable~~ in Section 4.2.~~

~~4.5 Soil Preparation and Fertilization Plan~~

242.100 Soil Redistribution Practices

The stored soil will be redistributed after recontouring of the site has occurred during reclamation activities. The soil will be spread in a manner to provide a roughened surface so that seed and mulch can remain during germination and initial growth of the seedlings.

Topsoil redistribution will be accomplished when soil is dry or merely damp (not wet) to avoid excessive compaction. During reclamation, the berms and embankments that create the perimeter ditches and sediment pond will be pulled back to blend the undisturbed areas into the reclaimed refuse pile. Upon Phase II final reclamation, the banks of the sediment pond will be pushed over the existing pond residue and the site will be covered with topsoil.

Contemporaneous Reclamation: The topsoil and subsoil anticipated to be salvaged during Phases 1 thru 6 (2015) should be sufficient to allow the placement of four feet. However in the future, the applicant may demonstrate that less than four ~~two~~ feet of cover material over the refuse pile is sufficient to meet reclamation standards for bond release. The Division has previously approved 30" at the waste rock site as being sufficient to cover the placed waste and promote the establishment of vegetation. Historically, portions of the waste rock pile have received the 30" of topsoil and have revegetated well. To demonstrate that the 30" is sufficient for cover and revegetation additional information pertaining to a contemporaneous reclamation project will be provided to the Division for review and approval. ~~clarification of the project will be provided at that time.~~ ~~An area on the refuse pile will receive reclamation treatments contemporaneously to justify the decrease of required cover soils from four feet to two feet for final reclamation.~~

Soil Thickness: The topsoil will be distributed to the disturbed areas illustrated on Map 8. Soil ~~Growth medium~~ will be spread to a minimum depth of approximately 30 inches . The 30 inches will be made up of approximately 15 inches of topsoil and 15 inches of subsoil ~~Heavier~~ Deeper soil cover up to 48"(15 - 24" topsoil and 24 - 33" subsoil) will be applied, if necessary, to avoid plant toxicity problems.

Phases 1 - 6. It is planned that during the reclamation of Phases 1 thru 6 that approximately 30 inches of topsoil and 18 inches of subsoil (48") will be placed atop the waste rock piles. The four foot depth of placed soil could vary from 24 to 30 inches of topsoil and from 18 to 24 inches of subsoil, these amounts are dependent upon the actual quantity of soils salvaged during the construction of the site.

The remainder of the disturbed site area, not used for refuse storage will be covered with approximately 12 inches of topsoil ~~growth medium~~ (i.e. reclaimed roads, ditches, berms, etc. approximately 4.34 acres). The area and topsoil/subsoil cubic yards for each phase are shown on Plates 2A thru 2F.

The quantity of topsoil/subsoil placed during reclamation of will be determined by surveying the phased area prior to placement and post placement. The M&RP will be updated with as-built drawings, cross sections and a table(s) listing volumes of subsoil and topsoil stockpiles placed.

Historic - The first lift was covered with topsoil from the existing adjacent stockpile.

Expansion - Subsequent lifts will be covered with topsoil/subsoil ~~growth medium~~ from the next lift site. Sufficient topsoil/subsoil ~~/growth medium~~ will be placed in the long term storage stockpile to ensure minimum depth coverage of the final lift and the sediment pond area. The area of the phases of waste rock pile construction are noted in tables on Maps 2A - 2F.

Compaction. To prevent compaction of topsoil, soil-moving equipment will refrain from unnecessary operation over spread soil. ~~Front-end-loaders and other wheel-mounted equipment may be used to transport and dump soil.~~ When possible to minimize compaction, track-mounted equipment (e.g. bulldozers, trackhoes) will be used to spread the soil.

Erosion. Care will be exercised to ensure the stability of soil on graded slopes to guard against erosion during and after soil application. Erosion control measures will include but not be limited to extreme surface roughening (also known as pocking and gouging).

242.200 Regrading

Since the site has been disturbed by previous activities and will be used to permanently store coal mine waste, the area will not be returned to the original geometric configuration. Prior to soil redistribution, the disturbed area will be graded to meet the proposed final reclamation topography (Map 8).

The surface of the refuse pile will be left in a roughened state and in addition will be ripped prior to the application of soil. After the 1st lift of subsoil is placed, the surface of the refuse pile will be ripped again to a depth of approximately 12 inches in an effort to promote root penetration and to mix the top layer of the refuse with the subsoil. ~~Refer to Section 341.200 for further discussion of roughening methods.~~

The second type of surface consists of roads, perimeter ditches, and operational areas which may be compacted through their use. The surface will be ripped to a depth of approximately 1.5 to 2 feet with a ripper-equipped tractor or other appropriate equipment where possible to reduce surface compaction, to assure soil adherence, and promote root penetration. Following the ripping of the soils and the application of stockpiled soils, extreme roughening techniques will be applied. A backhoe or trackhoe will be used to create microbasins with an approximate depth of 18" and the width of the bucket (30" or less). Soil removed to form the microbasins will be dropped above the microbasin onto the soil surface.

242.300 Topsoil Redistribution on Impoundments and Roads

The sedimentation pond and embankment will be breached and reclaimed with the other surface disturbed areas. Similarly, reclamation of abandoned roads will also follow the same technique as for other disturbed areas.

243 Soil Nutrients and Amendments

Soil nutrients and amendments may be applied to the redistributed soil as necessary, to establish the vegetative cover. ~~The type and rate of application will be determined just prior to contemporaneous and final reclamation activities based on analyses of samples collected from the stockpiled soil materials. The soils will, at a minimum, be tested for pH, EC, total carbon, SAR, phosphorus, nitrate-nitrogen, and water holding capacity.~~ Refer ro Section 231.300 for additional detail.

In the event that the topsoil/subsoil piles are moved in conjunction with the pile expansion, organic matter growing on the soil will be incorporated into the piles when the soils are relocated. Nitrogen fertilization will be applied at the rate determined by need.

244 Soil Stabilization

244.100 Protection and Stabilization of Surface Areas

Reclaimed areas will be stabilized to control erosion by application of one or combinations of a mulch, extreme surface roughening, or other appropriate methods. Seeding will be accomplished using BTCA methods suitable for reclamation. Refer to Section 341.200 for a discussion of the seeding~~. Detailed~~ discussions regarding soil protection during and after final reclamation can be found in ~~Chapter 5~~ Sections 531,533 and 542.200 of this submittal. Methods of revegetation to be employed at final reclamation at this site are discussed in more detail in Chapter 3.

244.200 Mulch Application

Mulch will be applied as discussed previously in this chapter and for a .further discussion of revegetation practices to be utilized, see Chapter 3, Section 341.200 of the approved M&RP.. The method of application of the mulch will with be by blower or by hand, the mulch will either be wood fiber, grass hay, straw or alfalfa hay, the anchoring method will be either crimping or chemical binder (Table 10, July 2008, Division's Soil Guidelines, pages 26 & 27). Since the piles will not have a flat horizontal surface the recommended application rate of 1 to 2 tons per acre will vary with the surface to receive the application, a minimum of 1.5 ton per acre will be applied.

244.300 Rills and Gullies

Postmining Land Use and Revegetation. Rills and gullies that disrupt the postmining land use, contribute to the degradation of stream quality or reestablishment of vegetative cover will be regraded and seeded. The areas adjacent to any rills or gullies, which have been filled, regraded or otherwise stabilized, will be reseeded or stabilized accordingly. Should rills or gullies deeper than nine inches develop in areas that have had topsoil redistributed, such damage shall be corrected by hand repair to avoid excessive compaction. When rills and gullies are too large to handle with hand tools will be repaired following development of a plan in consultation with DOGM. These repaired areas shall be reseeded, also by hand, with the standard seed mixture on a schedule consistent with the proposed revegetation plan.

250 PERFORMANCE STANDARDS

251 Topsoil, Subsoil, and Topsoil Supplements Management

Topsoil, subsoil, and topsoil supplements shall be managed as outlined in Sections 230 and 240.

252 Stockpiled Topsoil and Subsoil

Stockpiled topsoil and subsoil will be managed according to plans outlined in Sections 230 and 240.

Estimated Area to Be Covered with Topsoil and Subsoil

(Refer to Section242.100 for additional information)

Phase	Area (approximate acres measured as horizontal distance)
1*	1.28
2	4.23
3	5.98
4	4.93
5	5.42
6	2.58

* Phase 1 acreage excludes roads, storage piles and sediment pond

CHAPTER 3

BIOLOGY

CHAPTER 3
BIOLOGY

310 INTRODUCTION

This chapter presents a description of the biological resources found in the Sufco Waste Rock Disposal Site and adjacent areas.

311 Vegetative, Fish and Wildlife Resources

Vegetative, fish, and wildlife resource conditions in and adjacent to the Waste Rock Disposal Site are discussed in Section 320 of this submittal and the approved M&RP.

312 Potential Impact to Vegetative, Fish and Wildlife Resources

Potential impacts to vegetative, fish, and wildlife resources and the associated mitigation plan are presented in Sections 330 and 340 of this chapter.

313 Description of Reclamation Plan

The reclamation plan used to restore the vegetative, fish and wildlife resources to a condition suitable for the postmining land use is presented in Section 340.

320 ENVIRONMENTAL DESCRIPTION

~~2.1 General Environmental Resources Summary~~

The environmental resources in the waste rock disposal area have been individually studied and are either presented in this document or are addressed in the main body of the M&RP.

The Permittee has attempted to provide pertinent and complete reports for each environmental study discipline through the use of independent consultants who are recognized as experts in their individual fields. It is the Permittee's intent that by so doing, the reviewing agencies will have available to them reliable data for their environmental analysis.

The initial geotechnical/hydrological analyses were contracted to Sergent, Hauskins and Beckwith (SHB). Drs. Stanley Welsh, Joseph Murdock, and Sheldon Nelson combined their efforts on the vegetative and soils requirements. Dr. Clyde Pritchett supervised the mammals study, and Dr. Clayton White concentrated on the birds with particular emphasis on the area's raptors. (These wildlife reports cover the general permit area which is adjacent to the proposed disposal site.) An extended opinion covering wildlife use has been provided by the Division of Wildlife Resource and is appended as Exhibit 2. Drs. Welsh, Nelson, Murdock, Pritchett, and White are all associated with the faculty of Brigham Young University. The cultural resource surveys were performed by Archeological-Environmental Research Corporation of Salt Lake City with Dr. Rick Hauck serving as project director. Copies of consultant reports not included previously in the M&RP are incorporated in this document.

The site contains no springs or perennial streams. Surface flow is limited to runoff from precipitation events and is minimal because of a small upslope drainage area. Sediment will be controlled by construction of ~~a~~ diversion ditches around the area to be disturbed and through the use of berms, and other sediment control devices such as silt fences . The active disposal area will be limited and will be protected by sediment control devices located in the immediate area~~.~~ ~~Topsoil will be salvaged and stored for distribution on newly filled areas. Revegetation is discussed in Section 4, Reclamation Plan.~~

321 Vegetation Information

This section contains the environmental descriptions of the vegetation for the waste rock site and adjacent areas.

321.100 Plant Communities Within the Proposed Permit Area

The site had been previously disturbed for the excavation of soils for the reconstruction of the county road which lies adjacent to the WRDS.

~~2.7 Vegetation~~

An analysis of the vegetative community at the waste rock disposal site (WRDS) was made by Drs. Welsh and Murdock in 1983. Their measurements included information on cover, productivity and shrub density for the disposal site. An amended copy of this report is included as Appendix IV. The range condition was evaluated by the SCS in 1987. A copy of their evaluation is included as Exhibit 3.

Expansion- The analysis of the vegetative communities for the WRDS expasion was performed by Mt. Nebo Scientific and is included in Appendix IV(A). Map 1 of the report shows the locations of the vegetative communities which include Sagebrush/Grass, Rabbitbrush/Sagebrush and Mountain Brush.

321.200 Land Productivity Prior to Mining

An analysis of the vegetative community at the waste rock disposal site was made by Drs. Welsh and Murdock in 1983. Their measurements included information on cover, productivity and shrub density for the disposal site. An amended copy of this report is included as Appendix IV. The range condition was evaluated by the SCS in 1987. A copy of their evaluation is included as Exhibit 3.

WRDS Expansion - Woody Species Density

Community	**WRDS**	**Reference Area**
	Individuals/Acre	
Sagebrush/Grass	3448	2943.6
Rabbitbrush/Sagebrush	1672.9	6168

Mountain Brush	3937	4092

The table information is complied from and additional information is located in a report prepared by Mt. Nebo Scientific, Appendix IV(A), "Vegetation & Sensitive Species of the Proposed Expansion at the Waste Rock Site".

322 Fish and Wildlife Information

A summary of the fish and wildlife resource information for the permit and adjacent areas is contained in Sections 322.100 through 322.300.

322.100 Level of Detail

The scope and level of detail within the approved M&RP are sufficient to design the protection and enhancement plan for wildlife and fish in the area. The disposal site contains no perennial or intermittent streams. The only surface flow in the area is in the form of occasional storm runoff. Consequently there has been no analysis made of the aquatic wildlife resources. ~~**2.8 Aquatic Wildlife Resources**~~

322.200 Site-specific Resource Information

~~**2.10 Mammals**~~

~~Refer to discussion of Section 2.9.~~

~~**2.9 Terrestrial Wildlife**~~

The disposal area is adjacent to the area investigated by Drs. Pritchett and White as reported in the appendices to the M&RP, Volume 6. A further evaluation of the wildlife use of the site has been provided by Wes Shields, Resource Analyst, DWR, Cedar City. A copy of Mr. Shields' report is included as Exhibit 2.

The area is probably used by wintering deer and elk and by several non-game species of birds and mammals. The small area which will be disturbed at the disposal site at any given time will result in minimal disruption to the wildlife community. Revegetation of those areas currently disturbed and the sediment pond water retained should help mitigate the impact.

Protection of the area wildlife will also be provided by the Applicant not using persistent pesticides unless approved in advance by the Division.

~~2.11~~ Raptors - The waste rock disposal site contains no suitable nesting sites for raptors. The area is probably part of the hunting territory for certain raptor species (See DWR letter appended as Exhibit 2.) The impact on the hunting activity of the raptors will be minimal since the area to be disturbed at any given time is small.

Expansion - In 2013 and 2014 the WRDS and immediate adjacent areas were part of the mine's annual raptor survey. The surveys are confidential and part of Sufco's annual reports to the UDOGM. No nests were found within the WRDS (T22S R4E, Section 18) during the surveys. Three active Redtailed Hawk nests were located during the 2013 survey, two in Section 17 and the other in Section 8. In the 2014 survey only one nest in Section 17 was active as was the nest in Section 8. An active Golden Eagle nest was located (2014) in Section 13, T22S R3E. The nests are within one mile of the WRDS site, however, the site has been active since 1991 and the country road within the same one mile radius has carried haul trucks since the 1940's. The activity in the area will be consistent with that of the last 24+ years.

Threatened and Endangered Plant and Wildlife Species. The WRDS does not support habitat for bats (very limited roosting habitat) or fish (water source). Information (Table 19) is located in a report prepared by Mt. Nebo Scientific, Appendix IV(A), "Vegetation & Sensitive Species of the Proposed Expansion at the Waste Rock Site". The State of Utah, Department of Natural Resources' biodiversity database specialist was consulted with regard to threatened, endangered or otherwise sensitive species in the area in 2013, findings from this research indicated no such species of animal or plant exists within a 2-mile radius of the site. The habitat available at the

WRDS does not meet the habitat requirements of the Yellow-Billed Cuckoo (Coccyzus Americanus) per the information provided by the State of Utah Natural Resources - Division of Wildlife Resources their UCDC description. "Habitat Requirements: Yellow-billed cuckoos are considered a riparian obligate and are usually found in large tracts of cottonwood/willow habitats with dense sub-canopies (below 10 m (33 ft))." The WRDS has no riparian habitat and does not have communities of cottonwoods or willows, therefore no impacts are anticipated.

Habitats of Unusually High Value. The permittee is not aware of habitats of unusually high value within the disturbed area boundary of the WRDS.

322.300 Fish and Wildlife Service Review

If requested, CFC authorizes the release of information pertaining to Section 322 and 333 to the U.S. Fish and Wildlife Service Regional and Field office for their review.

323 Maps and Aerial Photographs

Maps are contained within the approved M&RP and this application.

Location and Boundary of Proposed Reference Area - Reference areas have been designated for the WRDS, refer to report prepared by Mt. Nebo Scientific, Appendix IV(A), Map 1 of "Vegetation & Sensitive Species of the Proposed Expansion at the Waste Rock Site"

Vegetation Type and Plant Communities - Vegetative types and plant communities are outlined for the WRDS, on Map 1 in the report prepared by Mt. Nebo Scientific, Appendix IV(A), "Vegetation & Sensitive Species of the Proposed Expansion at the Waste Rock Site"

330 OPERATION PLAN

331 Measures Taken to Disturb the Smallest Practicable Area

For the proposed waste rock storage activities, only access structures and drainage controls required to maintain the waste rock pile or satisfy environmental or safety requirements will be built.

The WRDS expansion is divided into phases (Maps 2A - 2F), as the filling of each phase is completed it will receive either contemporaneous or final reclamation depending upon the future uses of the land and how the disturbed land ties into the next phase of waste placement. By constructing the expansion in phases the amount of disturbance not reclaimed will be limited to a small number of acres. Due to the sporadic nature of the filling process of a waste rock disposal site an exact time table for completion of each major step in the contemporaneous/final reclamation plan would be difficult. Phases and the sequence of the WRDS construction and reclamation are discussed in Chapter 5. Section 540 Contains a reclamation timetable.

Sections 341.200 describes the seed mixes to be used in final reclamation and interim reclamation. The interim seed mix will be planted to stabilize all areas not actively being utilized on the waste rock pile site. The practice will continue until final reclamation grading begins.

332 Description of Anticipated Impacts of Subsidence

No subsidence will occur in this area, as no subsurface extraction will occur.

333 Plan to Minimize Disturbances and Adverse Impacts.

Refer to the approved M&RP and to Sections 333.100 through 333.300 below.

Minimized Disturbance to Endangered or Threatened Species. CFC will apply all methods necessary to minimize disturbances or any adverse effects to threatened, endangered or species of special interest.

Species and Habitats. All species and habitats within the permit area will be protected to the best of CFC's ability.

Protective Measures. At WRDS protective measures include the intent for the disruption of habitat to be limited and with final reclamation the restoration to an improved state. The short-term goal of this revegetation plan is the immediate stabilization of the disturbed sites through erosion control. This objective will be achieved through controlled grading practices, proper seedbed preparation to encourage rapid plant establishment, inclusion of rapidly establishing species in the seed mixture to be planted, and mulch application.

Traffic Increase (2015). Vehicular traffic will not increase with the expansion of the WRDS. Truck carrying coal have historically used the road surrounding the WRDS at a rate of a truck every three minutes. With a change in coal clients, the number of trucks taking the eastern route (towards Emery, UT) has increase with the construction of the Quitchupah road and the western route (towards Salina, UT) towards the WRDS has decreased. The area of the WRDS has been surrounded by the paved county road at a minimum since the 1950's and the wildlife is accustom to the vehicular traffic.

340 RECLAMATION PLAN

See the approved M&RP reclamation plan for additional discussion as specified in this amendment.

341 Revegetation

The short-term goal of this revegetation plan is the immediate stabilization of the disturbed sites through erosion control. This objective will be achieved through controlled grading practices, proper seedbed preparation to encourage rapid plant establishment, inclusion of rapidly establishing species in the seed mixture to be planted, and mulch application.

The long-term goals are to establish useful, productive range and wildlife habitat. These goals will be attained through the selection and placement of desirable and productive plant species, and a commitment to monitor and maintain revegetated areas throughout the bond liability period.

Success of revegetation will be measured using statistically acceptable techniques for the determination of percent cover, shrub density and productivity. The baseline data will be used in evaluating the revegetation success. Since the area normally has less than 26.0 inches of annual precipitation, the liability period will be 10 years.

341.100 Schedule and Timetable

~~TABLE 4.6.3-1~~

REVEGETATION MONITORING SCHEDULE

Qualitative observations:

Reclamation type	1	2	3	4	5	6	7	8	9	10
Permanent reclamation	x	x	x	x	x	x	x	x	x	x

Quantitative observation:

Parameter	1	2	3	4	5	6	7	8	9	10
Cover		x	x		x			x	x	
Frequency		x	x		x			x	x	
Woody plant density		x	x		x			x	x	
Productivity								x	x	

341.200 Descriptions

~~4.6.1~~ **Species and Amount Per Acre**. After proper soil preparation, the seed mix ~~listed on Table 4.6.1-1~~ will be applied over the disturbed area. ~~The sediment pond topsoil, stockpiles will also use the seed mix listed on Table 4.6.1-1 except that the shrub seed will not be included.~~ The interim seed mix (grass and forb seeds only) will be used on the topsoil and subsoil stockpiles and any other areas requiring stabilization prior to final reclamation. ~~Since the area to be reseeded is relatively flat, the proposed seeding rate of 210.4 lbs per acre seems adequate.~~

~~TABLE 4.6.1-1~~
~~RECOMMENDED~~ SEED MIX
WASTE ROCK DISPOSAL SITE
SUFCO (~~ACT~~C/041/002)

Species	Rate # pls/acre
Grasses:	
Elymus lanceolatus Thickspike wheatgrass	3.0
Elymus smithii Western wheatgrass	3.0
Elymus spicatus Bluebunch wheatgrass	3.0
Bromus marginatus Mountain brome	3.0
Elymus cinereus Great Basin wildrye	2.0
Forbs:	
Archillea millefolium Western yarrow	0.1
Artemisia ludoviciana Louisiana wormwood	0.1
Linum perenne Blue flax	1.0
~~Melilotus officinalis~~ ~~Yellow sweetclover~~	~~1.0~~
Penstemon strictus Rocky Mountain Penstemon	0.5
Hedysarum boreale utahensis Utah Northern Sweetvetch	0.5
Shrubs:	
Amelanchier alnifolia Serviceberry	2.0
Artemisia tridentata var. pauciflora Mountain big sagebrush	0.2
Chrysothamnus nauseosus var. albicaulis Whitestem rubber rabbitbrush	0.5
Sambucus caerulea Blue elderberry	1.0
Symphoricarpos oreophilus Snowberry	1.0
Total	~~21~~ 20.9

NOTE~~: The rate of seeding is in pounds of pure live seed per acre; application will be by drilling, broadcasting or hydroseeding. The Division has determined that Melilotus officinalis meets the criteria of UMC 817.112.~~ Scientific names are adapted from Welsh et al., 1987. a Utah Flora. Me. Great Basin Naturalist 9: 1-894.

Since the area to be reseeded is relatively flat, the proposed seeding rate of ~~21.4~~ 20.9 lbs per acre seems adequate. Previous experience with reseeding attempts show that similar rates provide good revegetation success. The seed will be drilled where possible and broadcast as necessary on steep slopes or for touch-up effort. When broadcast seeding methods are used the seeding rate will be doubled to 41.8 lbs. per acre.

Method Used for Planting and Seeding. The waste rock pile site will be permanently reclaimed section-by-section. Refer to Chapter 5, Sections 536 and 540 for a discussion of the sequence of the construction and contemporaneous reclamation of the waste rock pile.

The area will be graded to final contours, and then ripped to relieve compaction. Ripping will be completed to a maximum depth of approximately 2 feet. Final ripping depths will be determined by the materials being ripped, to prevent incorporation of less desirable soil/rock into more productive materials.

Following ripping, stockpiled soil will be applied to the ripped surface and left in a extreme roughened state(pocked and gouged).

Soil samples will be collected and sent to the laboratory for analysis to determine if amendments are necessary. Soil nutrients are discussed further in Section 243. Nutrients will be applied in a single application. On slopes greater than 3:1, the rough, disturbed surface will be treated by traversing a dozer perpendicular to the slope contour to incorporate the nutrients.

Seeds will be broadcast and/or incorporated with a small amount of mulch and applied by hydroseeding equipment. Hydroseeding will be accomplished in two applications, the first being the application of the seed to the soil and the second an application of mulch and tackifier on top of the seed. When seed is broadcast the quantity of seed will be doubled and mulch (straw or other mulch product) when used will also be placed by hand.

Mulching Techniques. Organic mulch will be applied at the rate of 2000 pounds per acre and anchored with a tackifier when applied with hydroseeding equipment. When mulch is placed by hand it will be done in conjunction with broadcast seeding, using certified weed free straw or other weed free mulch such as wood fiber, wood cellulose, wood chips or bark as mulch. Because mulching might delay seed germination because the cover changes soil surface temperatures (Best Practices, USEPA). The use of mulch will be evaluated on a case by case basis while taking into consideration the "best practices" for mulching in place at the time of seeding.

Irrigation, Pest and Disease Control. No irrigation is planned and pesticides will not be used unless previously approved by the Division.

Measures Proposed for Revegetation Success. Refer to Section 356.

Greenhouse Studies, Field Trials or Other Equivalent Studies. Refer to Section 242 for information pertaining to a study of contemporaneous reclamation treatments used to provide justification for the reduction of cover necessary to comply with regulation R645-301-553.252.

342 Fish and Wildlife

342.100 Enhancement Measures

Enhancement measure to be used during the reclamation and post mining phase of operation to develop terrestrial habitat will include the establishment of vegetation for wildlife food and cover using the seed mix approved by DOGM. The pocking and gouging applied to the soils during reclamation will capture moisture for use by wildlife. Historically the sediment pond has collected and provided a water resource for large game species, small mammals and birds.

The WRDS contains no riparian, wetland or aquatic habitat, however the Skulumpah Reservoir repair and enhancement project completed (2014) by Sufco is in an area adjacent to the WRDS. Details of this project can be reviewed in the Earth Day award nomination package submitted to the Utah Division of Oil Gas and Mining board in 2015.

342.200 Plants Used for Wildlife Habitat

Nutritional Value. The nutritional value will be consistent with that of vegetation in the surrounding areas.

Cover. The goal is to establish plant species, which will provide sufficient cover for the wildlife of the area. There are no water sources within the waste rock pile permitted area to support fish.

Ability to Support and Enhance. Refer to the approved M&RP.

Cropland. Cropland is not a postmining land use.

Residential, Public Service and Industrial Land Use. No residential, industrial or public service use is planned at the present time.

350 PERFORMANCE STANDARDS

351 General Requirements

CFC commits to conduct all operations in accordance with the plans submitted in Sections R645-301-330 through R645-301-340 of the permit application.

352 Contemporaneous Reclamation

Reclamation activities prior to final reclamation will, to the extent feasible, be performed contemporaneously with waste rock storage operations. The soil stockpile and phases of the waste rock pile will be contemporaneously reclaimed, once it reaches final configuration. The soil storage area will receive interim seeding following the completion of soil stockpiling. The phases of pile outslope will be covered with soil and seeded with the final vegetation seed mix.

A portion of the waste rock pile will receive contemporaneous reclamation; the purpose will be to provide justification for the reduction of cover necessary to comply with regulation R645-301-553.252.

353 Revegetation: General Requirements

A vegetative cover will be established on all reclaimed areas to allow for the designated postmining land use of wildlife habitat and livestock grazing. Refer to Section 411 and the approved M&RP for additional information.

353.100 Vegetative Cover

The seed mix proposed for revegetation is intended to provide vegetative cover that will be diverse, effective, and permanent. The seed mixture was selected with respect to the climate, potential seedbed quality, erosion control, drought tolerance, and the mixture's ability for quick establishment and spreading.

Native Species. The reclamation vegetative mixture will be comprised of species indigenous to the area and capable of achieving the postmining land use as approved by the Division. Diversity of species should allow optimal utilization of plants by wildlife and domestic livestock.

The revegetative species will be purchased from suppliers who will certify their percentages of purity, germination, hard seed, and percentages of maximum weed seed content.

Extent of Cover. The vegetative cover will be at least equal in extent to the cover as determined by the reference area sampling as discussed in Section 341.200.

Stabilizing. The vegetative cover mixture is capable of stabilizing the soil surface from erosion.

353.200 Reestablished Plant Species

Seasonal Characteristics. The revegetation plant species will have the same growing season as the adjacent areas.

Self-generation. The reestablished plants are species capable of self-generation and plant succession.

Compatibility. The seed mix suggested for revegetation contains plants native to the area and compatible with the plant and animal species of the permit area.

Federal and Utah Laws or Regulations. The seed mixture purchased to revegetate the mine area will contain no poisonous or noxious plant as certified by the seed company. No species will be introduced in the area without being approved by the Division.

Vegetative Exception. CFC does not require vegetative exception at this time.

Cropland. The permit area contains no land designated as cropland.

354 Revegetation: Timing

CFC will follow the recommended guidelines for revegetation and planting during the first normal period of favorable planting conditions following replacement of the plant-growth medium. Seeding for final reclamation will be planted during the Fall months.

355 Revegetation: Mulching and Other Soil Stabilizing Practices

Refer to the approved M&RP.

356 Revegetation: Standards for Success

Revegetation success will be determined using ocular estimates of vegetative cover, with estimates made to the nearest percent. Plot size used previously was a 2 x 5 dm plot. However, plot size will be adjusted to fit the vegetation being measured, should the 2 x 5 dm plot size be judged not to be adequate. Shrub density will be determined by use of 9.6 square foot metal hoop. The woody plant species density will be 5000 plants per acre.

The level of confidence will continue to be 80% for shrublands, such as on the land in question, and 90% for grasslands. The revegetation monitoring schedule is shown on Table 4.6.3-1.

Sampling will be undertaken ~~on or about the first week of July each year~~ (as specified above), for each reclaimed waste rock segment, when the vegetation is at or near its peak of growth. Methodology will be consistent ~~from year to year~~, with plots randomly located each year; with the area to be surveyed divided into quadrants and a quarter of the plots placed randomly within each quadrant.

Reconnaissance survey and quantitative sampling will include the items noted in the Division's revegetation monitoring guidelines and in the Division's vegetation information guidelines for permanent program submissions for coal mines. For future reference, a copy of the Division's guidelines have been attached as Appendix VI.

The success criteria for cover, density and productivity will be determined based upon the values obtained from the reference area sampling.

The sampling methods to be used during reclamation will be specific to the requirements at the time of reclamation. Nonetheless, according to the currently approved UDOGM guidelines, these sampling methods would be used: sample adequacy, cover (line interception), density (belt transects or plots) and productivity (clipping and/or NRCS estimation). The Jaccard's Community Coefficient will be used to calculate acceptable plant similarity and diversity.

Success of Revegetation. The success standards for approval will be judged on the effectiveness of the vegetation for postmining land use, the extent of cover on the waste rock pile site compared to the extent of the cover of the reference area and the standards outlined in Section 353.

Reference areas have been designated for the WRDS, refer to report prepared by Mt. Nebo Scientific, Appendix IV(A), Map 1 of "Vegetation & Sensitive Species of the Proposed Expansion at the Waste Rock Site"

Sampling Techniques. CFC will comply with the standards for success, statistically valid sampling techniques for measuring success, and the approved methods outlined in the Division's "Vegetation Information Guidelines, Appendix A" for sampling.

Standards for Success. The standards for success will include criteria representative of undisturbed lands in the area of the permit and as discussed in Section 356.200.

356.200 Standards for Success

Standards of success will be applied in accordance with the approved postmining land use as described in this section.

Grazing Land or Pasture Land. The ground cover, stocking and production of living plants on the revegetated area will be at least equal to the reference area. Ground cover, production and stocking will be considered equal to the approved success standards when 90% of the success standard is accomplished.

Cropland. There is no area designated as cropland within the waste rock pile area.

Fish and Wildlife Habitat. The success of revegetation for fish (no water resources) and wildlife habitat will be determined on the basis of tree and shrub stocking and vegetative ground cover. Minimum stocking and planting arrangements will be those approved by the Division after consultation with other responsible fish and wildlife agencies, on the basis of local and regional conditions. Cover success will not be less than that required to achieve the approved postmining land use.

Prior to bond release, trees and shrubs on the revegetated site will be healthy and 80% of the plants will have been in place for 60% (6 years) of the applicable minimum period of responsibility.

Industrial, Commercial or Residential. The postmining land use for the permit area is not designated for industrial, commercial, or residential use.

Previously Disturbed Areas. The site parallels the county road and has been used as livestock open range, wildlife habitat, and soil excavation.

Siltation Structure Maintenance. Siltation structures will be maintained as discussed in the approved M&RP. For additional details on siltation structures, see Section 742 of this amendment.

Removal of Siltation Structures. The land on which siltation structures are located will be revegetated in accordance with the reclamation plan discussed in Sections 353 through 357.

357 Revegetation: Extended Responsibility Period

CFC will be responsible for the success of revegetation for a period of 10 years following seeding of the reclaimed area or upon Division bond release.

Extended Period Begins - The period of extended responsibility will begin the year after the disturbed area has been seeded.

Vegetative Parameters - Vegetation parameters will equal or exceed the approved success standard during the last 2 years of the responsibility period. The success standards are outlined in Section 356 of this amendment.

Husbandry Practices - CFC will comply with Division-approved husbandry practices which are normal conservation practices within the region of the mine. These practices may include disease, pest, and vermin control; and any pruning, reseeding, and transplanting required.

358 Protection of Fish, Wildlife and Related Environmental Values

There are no streams in the disposal area. Consequently, protection of fish is not a consideration.

The disposal activities shall be conducted in such a manner as to minimize the disturbance and adverse impact on wildlife. The area disturbed by roads and by placement of waste material will be kept at a minimum. Revegetation will be prompt to provide food and cover. No power lines or other such utilities are planned in the area.

Taking of Endangered or Threatened Species - The waste rock disposal site is not known to provide habitat for any threatened or endangered species. A letter from the Regional Resource

Analyst of the Division of Wildlife Resources confirming this opinion is included as Exhibit 2. The applicant will promptly report any threatened or endangered species in the permit area, or golden eagles not previously reported, to the Division.

CFC understands that there is no permission implied by these regulations for taking of endangered or threatened species, their nests, or eggs.

Replacement of Wetland and Riparian Vegetation - The site contains no wetland or riparian vegetation.

Manmade Wildlife Protection Measure - Barriers may include fencing around piles of growth medium, cable gate across access to roads and fencing around sediment ponds. The sediment pond will contain no hazardous concentrations of toxic-forming material.

CHAPTER 4

LAND USE

CHAPTER 4
LAND USE

410 LAND USE

~~**2.13 Land Use**~~

The waste rock disposal site is privately owned and is suitable primarily for summer range for cattle although the area has not been used as such in recent years. ~~Some land in the adjacent area is being subdivided as summer home building lots.~~

The waste rock disposal site is visible from a few of the summer home sites, however, the terrain is such that the disposal site is somewhat isolated. The visual impact is minimized by keeping the disturbed acreage small at any given time and by prompt revegetation of completed fill areas. Efforts will be made to use the disposal site during the week, thus avoiding an impact on weekend recreational use.

The visual impact will be only temporary in nature with the site being restored to an approximation of pre-mining conditions at the completion of mining activity.

~~**2.14 Community Infrastructure and Socioeconomics**~~

~~The waste disposal site is operated by personnel from the work force as currently proposed. No additional utilities or services will be required. Consequently, there will be no community infrastructure or socioeconomic impacts.~~

411 Environmental Description

A statement of the conditions and capabilities of the land to be affected by mining and reclamation operations follows in this section.

Premining Land Use. In preceding years the area has been utilized as open range for livestock and as wildlife habitat. Soil was borrowed from the area to repair the county road which is adjacent to the waste rock disposal site (WRDS).

411.110 Land Use Map and Narrative

The land use map would have limited information, due to the size of the site and since the storage area is adjacent to the County Road, lands under the jurisdiction of the Forest Service, lands under private ownership and lands owned by Canyon Fuel Company, LLC. Figure 1 and Map 1 provides surface ownership information. Figure 7 shows land use prior to the WRDS expansion in 2015 The uses included the waste rock disposal site(permitted in 1998), wildlife habitat and livestock open range.

411.120 Land Capability

The major plant communities in the area are identified in Section 321. No cultivated lands lie within the permit boundary, due to the limiting terrain and lack of water for irrigation.

411.130 Land Use Description

No industrial or municipal facilities are located on or immediately adjacent to the site. Farming of the area does not appear to have occurred in the past nor is it likely to occur in the future due to the poor quality of the soil and lack of available water resources.

The land uses adjacent to the site currently include a transportation corridor, cabins and recreational use of privately owned property, wildlife habitat and livestock range.

411.140 Cultural and Historic Resources Information

A cultural resources evaluation, conducted by Dr. F.R. Hauck of Archeological-Environmental Research Corporation, resulted in negative findings. A copy of Dr. Hauck's report is attached as Appendix I.

Cultural and historic literature and site evaluations of the area were performed by Senco-Phenix in 2014. A historical corral and discarded wood stove were located the survey, neither were recommended for nomination to the National Register of Historic Places. A copy of the reports is included in Confidential Appendix I(A) of this submittal.

Cultural and Historic Resource Maps. There are no cemeteries, public parks, or units of the National System of Trails or the Wild and Scenic Rivers System located within the site boundary.

CFC agrees to notify the Division and SHPO of previously unidentified cultural resources discovered in the course of operations. CFC also agrees to have any such cultural resources evaluated in terms of NRHP eligibility criteria. Protection of eligible cultural resources will be in accordance with Division and SHPO requirements. CFC will also instruct its employees that it is a violation of federal and state laws to collect individual artifacts or to otherwise disturb cultural resources.

411.200 Previous Mining Activity

CFC has no knowledge of the removal of coal or other minerals.

412 Reclamation Plan

412.100 Postmining Land Use Plan

The land will be returned to essentially the same condition as was found prior to usage as a waste rock disposal site. The land will remain a private holding and will continue to serve as winter range for big game animals.

It is anticipated that over time ~~the years some of~~ the surrounding land ~~will~~ may be subdivided into ~~5 acre~~ development lots for summer homes. Although there are currently no plans to ~~eventually~~ subdivide the waste rock disposal site, its final configuration will be compatible with this usage should such a decision be made.

CFC intends the postmining land use to be wildlife habitat and livestock grazing. Final reclamation activities, such as grading and seeding as detailed within this submittal and the approved M&RP, will be completed in a manner to allow land use comparable to the predisturbed conditions. The activities associated with the operation will follow accepted standards or proven techniques. Erosion hazards will be minimized and, where possible, eliminated. Reclamation will restore the land and vegetation to as near a natural and productive condition as possible.

412.200 Land Owner or Surface Manager Comments

Canyon Fuel Company, LLC owns the land on which the refuse pile Site is to be constructed.

412.300 Suitability and Capability

The Site will have fills containing excess spoils. The Site will be suitable for reclamation and revegetation. The reclaimed Site will be compatible with the surrounding topography and approved postmining land use. Refer to Chapter 5 for additional information pertaining to the storage of waste.

413 Performance Standards

The performance standards for the areas to be reclaimed for postmining land use are contained in this section.

Postmining Land Use. Postmining land uses are discussed in Section 412.100. The postmining lands will be reclaimed in a timely manner and capable of supporting such land uses (see Chapters 2, 3, 5, and 7).

Determining Premining Uses of Land. Postmining land uses will be as stated in Section 412.

Criteria for Alternative Postmining Land Uses. No alternative postmining land uses have been planned.

414 Alternative Land Use

No alternative postmining land uses have been planned.

420 AIR QUALITY

Air pollution at the disposal Site is expected to be minimal with the ~~only~~ potential ~~problem being that~~ of fugitive dust emissions. ~~An Air Quality Permit for these emissions was approved by the Bureau of Air Quality on April 1, 1988,~~ Sufco Mine made a request to the Division of Air Quality (DAQ) in 2011 to revise approval order BAQE-126-88 to increase the waste rock disposal activities from 10,000 tons per year to 40,000 tons per year at the waste rock disposal site. Following a review of the request, DAQ made the determination that the potential to emit (PTE) for each criteria pollutants were less than one ton per year for activities involving 40,000 tons per year, therefore DAQ chose to cancel the Approval Order and issued the small source registration on March 31, 2011.

The wet nature of the waste material helps to minimize the fugitive emissions ~~problem~~ as does the practice of disturbing only a small area ~~to be disturbed~~ at any given time. Also the area is not known to be subject to windy conditions. ~~However, to monitor potential fugitive dust problems, an observer from the mine staff has been trained and certified by the Bureau of Air Quality. This certification will be kept current during the summer season when the potential problem exists~~. Should observation indicate a need, fugitive dust emissions will be controlled through the use of water spray.

~~2.6~~ **Climate**. The climate at the proposed disposal Site is typical of subalpine areas in the central region of Utah. Summer seasons are generally short with considerable variation in temperature. Fall and Spring are erratic in nature with snow precipitation occurring as early as September and as late as June. Snow frequently remains on the ground from November until May.

A climatological summary for the climatological station at the SUFCO Mine is included in Volume 9 of the M&RP.

421 Air Quality Standards

Mining activities will be conducted in compliance with the requirements of the Federal Clean Air Act and the Utah Air Conservation Rules.

422 Compliance Efforts

Refer to the approved M&RP.

423 Monitoring Program

Refer to the approved M&RP.

424 Fugitive Control Plan for Production Rates Less than One Million Tons Per Year

Refer to the approved M&RP.

425 Additional Division Requirements

Refer to the approved M&RP.

CHAPTER 5

ENGINEERING

CHAPTER 5

ENGINEERING

510 INTRODUCTION

The activities associated with the construction and reclamation of the refuse pile will be designed, located, constructed, maintained, and reclaimed in accordance with the operation and reclamation plans.

511 General Requirements

This permit application includes descriptions of the proposed refuse pile area construction, maintenance, and reclamation operations together with the appropriate maps, plans, and cross sections. Potential environmental impacts as well as methods and calculations utilized to achieve compliance with the design criteria are also presented.

512 Certification

Where required by the regulations, cross sections and maps in this permit application have been prepared by or under the direction of, and certified by, qualified registered professional engineers, geologist or land surveyors. As appropriate, these persons were assisted by experts in the fields of hydrology, geology, biology, etc.

512.100 Cross Sections and Maps

The configuration of the waste rock pile and pile cross sections are provided on Historic Maps 2, 4 and Map Series 2, 3, 4, 5, 6, 7 and 8. ~~2, 3A, 3B, 4A and 4B of this submittal~~ .

512.200 Plans and Engineering Designs

Plans and engineering design's presented in this submittal were prepared by or under the direction of and certified by a qualified registered professional engineer.

Excess Spoil. No excess spoil will be generated from the refuse pile area.

Durable Rock Fills. No durable rock fills will exist in the refuse pile area.

Coal Mine Waste. If coal mine waste is generated by the Sufco Mine, it will be placed in the waste rock disposal site (WRDS).

Impoundments. A sedimentation pond impoundment was built at the refuse pile area in the late 1980's. The first sedimentation pond will be replaced by a second pond to be constructed in 2015/2016. (see Section 732).

Primary Roads. The access road to the refuse pile and the temporary road to construct the refuse pile are classified as primary roads.

Variance From Approximate Original Contour. CFC does not request a variance from the approximate original contour requirements of the regulations for this site. The proposed configuration of the site will comply with the post-mining land use and blend into the surrounding area.

513 Compliance with MSHA Regulations and MSHA Approvals

513.100 Coal Processing Waste Dams and Embankments

No coal processing waste dams or embankments will exist within the permit area.

513.200 Impoundments and Sedimentation Ponds

No impoundments or sedimentation ponds in the permit area meet the size criteria of 30 CFR 77.216(a).

513.300 Underground Development Waste, Coal Processing Waste, and Excess Spoil

Underground development waste and coal processing waste will be stored at the WRDS. No excess spoil will be generated or stored within the WRDS area.

513.400 Refuse Piles

The design of the pile will meet the requirements of MSHA, 30 CFR 77.124 and 30 CFR 77.215 in accordance with Section 536.900.

513.500 Underground Openings to the Surface

No underground openings will be present in this area.

513.600 Discharges to Underground Mines

No discharges to underground mines will occur at the WRDS.

513.700 Surface Coal Mining and Reclamation Activities

No surface coal mining and associated reclamation activities will occur in the WRDS area.

513.800 Coal Mine Waste Fires

Coal mine and underground development waste may have high moisture content. Controlled placement and compaction of the refuse materials will minimize the potential for spontaneous combustion or ignition of these materials. In the unlikely event that burning waste is found during the regular inspections of the refuse pile area, it will be separated and extinguished either by burying the burning materials or by using water sprays. Once extinguished, the material will be placed, compacted, and buried on the active refuse pile bench. If necessary, a long-term plan will be formulated in discussion with MSHA and the Division to extinguish existing fires and prevent future fires. ~~The applicant will help to prevent, control, and suppress fires in the waste rock pile(s).~~

514 Inspections

~~**3.2.8 Inspections**~~

~~The sediment pond, diversion ditches, and waste rock fill shall be inspected on at least a quarterly basis throughout construction by a qualified engineer. The sedimentation pond and waste rock fill will be inspected and certified in accordance with the requirements of the SMCRA regulations. Reports are to be provided to the mine office and the Division as to compliance with the project specifications.~~

514.100 Excess Spoil

Excess spoil will not be stored in this area.

514.200 Refuse Piles

During construction regular inspections (such as site preparation, foundation preparation, at various lifts during placement and compaction) will be made of the refuse piles by or under the direction of a registered professional engineer experienced in the construction of waste structures. Quarterly inspections of the piles will continue until final reclamation and release of the performance bond. ~~A certified report of inspection will be prepared by a qualified registered professional engineer and submitted to the Division.~~ A report of the inspection will be prepared by or under the direction of and certified by a registered professional engineer. The report will discuss the appearances of instability, structural weakness or other hazardous conditions and other aspects of the structure affecting stability. A copy of this report will be maintained at the mine site and submitted to DOGM in a timely manner.

514.300 Impoundments

Regular inspections were made during construction of the sedimentation pond(s) as well as upon completion of construction. These inspections will be made by or under the direction of a registered professional engineer experienced in the construction of similar earth and water structures.

Quarterly inspections of the sedimentation pond(s) will continue until removal of the structure or release of the performance bond. An annual certified report of inspection will be prepared by a qualified registered professional engineer and submitted to the Division. The report will discuss the appearances of instability, structural weakness or other hazardous conditions, depth of any impounded waters, existing storage capacity, and existing or required monitoring procedures, and other aspects of the structure affecting stability. A copy of this report will be maintained at the mine site.

515 Reporting and Emergency Procedures

515.100 Slides

A~~ny~~ slide or other damage at the disposal site which may have a potential adverse effect on public property, health, safety, or the environment will be reported to the Division by the fastest available means and will be remediated in compliance with Division instructions.

The "Waste Rock Pile Expansion, Slope Stability Analysis" located in Appendix II(A) contains the information pertaining to slides in Table 2, Summary of Slide Analysis, Attachment A, Slide Geometry and Output, Chapter 3 Introduction, Section 3.2 and 3.3 and results are discussed in Chapter 4. Settlement is part of the consideration incorporated in the program used for determining the potential for slides. Verification of material compaction by means of commitments in this permit should minimize settlement.

515.200 Impoundment Hazards

If the examination or inspection of an impoundment discloses that a potential hazard is associated with that impoundment that may have an adverse effect on the public, property, health, safety, or the environment, the Division will promptly be informed of the finding and of the emergency procedures formulated for public protection and remedial action. If adequate procedures cannot be formulated or implemented, the Division will be notified.

515.300 Temporary Cessation of Operations

Prior to a temporary cessation of operations within the permit area that will last for a period of 30 days or more or as soon as it is known that a temporary cessation will extend beyond 30 days, CFC will submit to the Division a notice of intention to cease or abandon operations. This notice will include:

A statement of the number of surface acres affected by mining operations in the permit area prior to cessation of operations,

A discussion of the extent and kind of reclamation activities which will have been accomplished prior to cessation of operations, and

An identification of the backfilling, regrading, revegetation, environmental monitoring, and water treatment activities that will continue during the temporary cessation.

520 OPERATION PLAN

521 General

521.100 Cross Sections and Maps

Existing Surface and Subsurface Facilities and Features. No buildings are located in and within 1000 feet of the WRDS. No surface or subsurface features are within, passing through or passing over the refuse pile area. An existing county road parallels the area.

Landowner, Right-of-Entry, and Public Interest. CFC is the current land owner of the property where the refuse pile is built. Refer to Chapter 1 for additional information.

Mining Sequence and Planned. This does not apply to this site (see Section 525).

Land Surface Configuration. Surface contours of undisturbed areas within the storage area are provided on Map Series 2, 4, 5 and 8 ~~3A, 3B, 4A and 4B~~ of this submittal. The hills surrounding the site range in elevation from 7600 to 8200, therefore the reclaimed elevation of the refuse pile of 7850 to 8,000 will blend with the surrounding area.

Surface Facilities. The surface facilities associated with the WRDS include: the refuse pile, temporary material/snow storage areas, soil stockpiles, access road, sedimentation pond(s), and drainage control structures (Refer to Map Series 2, 4, 7 and 8 ~~Maps 2, 4A, 4B, 5 and 7~~).

Transportation Facilities. A permanent road is not anticipated to be constructed, used, or maintained by CFC in the storage area. During construction of the pile, temporary access roads will be constructed and maintained. The temporary roads will be reclaimed and seeded with the permanent reclamation seed mix (Section 341of this amendment). Refer to Map Series 4 and 5 for the road locations.

Access to the site is via an adjacent county road. Access on the site is by a short haul road (less than l/4 mile in length). When no longer needed, the haul road will be promptly reclaimed. This haul road is shown in its initial location on Historic Map 2 ~~4~~. ~~Trucks will come down the county road in a westerly direction and exit down the ramp yielding to the uphill traffic lane. The truck will then proceed along the haulage road to the active fill area. In the fill area, the truck will be unloaded and return back up the haulage road and merge with any uphill traffic in the easterly lane.~~

521.200 Signs and Markers

Mine and Permit Identification Signs. A mine and permit identification sign will be displayed at the WRDS. This sign will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the bond is released for the site. The sign will contain the following information: Mine name, Company name, Company address and telephone number, MSHA identification number, and Permit identification number as obtained from the Division

Perimeter Markers. The perimeter of areas affected by surface operations will be clearly marked before beginning mining activities. The markers will be a design that can be easily seen and will be made of durable material, will conform to local regulations, and will be maintained until after the release of the bonds for the permit area. The extent of the disturbed area is marked with T-posts.

Buffer Zone Markers. Stream buffer zone markers are not required for this area.

Topsoil Markers. Markers will be placed on the soil stockpiles. These markers will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the release of the bonds for the permit area.

~~**3.2.7 Signs and Markers**~~

~~The site is properly posted with signs and markers The topsoil storage piles are labeled as such.~~

522 Coal Recovery

No coal recovery will be performed at this site.

523 Mining Methods

No mining will be performed at this site.

~~**3.5**~~ **Major Equipment List** -The waste rock will be loaded at the mine by a front-end loader or other available equipment. Transport to the disposal site will be by dump trucks. The waste rock will be spread and compacted by a self powered compactor of suitable size, a dozer of a suitable size, or with a large front-end loader. The equipment will vary according to the quantity of waste to be processed, hauled and compacted.

524 Blasting and Explosives

No explosives are to be used at this site.

525 Subsidence

Since no underground mining activity has occurred beneath the site, settlement of the fill will result only from the consolidation of the surface soils and elastic compression of the underlying bedrock. It is expected that total settlements on the order of 0.5 to l.0 inches will occur upon completion of the disposal area. Because no underground coal mining will occur beneath the WRDS there will be no effects on the site from coal mining related subsidence.

526 Mine Facilities

526.100 Mine Structures and Facilities

No buildings exist or are proposed at the WRDS, therefore, no existing buildings will be used in connection with or to facilitate this proposed coal mining and reclamation operation.

526.200 Utility Installation and Support Facilities

No utilities are to be installed at this site.

527 Transportation Facilities

527.100 Road Classification

No permanent roads are to be built in association with the construction of the refuse pile. A temporary road will be used to access the site. The access road to the refuse pile and the temporary road to construct the refuse pile are classified as primary roads. The operational typical road section is provided as Figure 6 of this submittal. Refer to Section 521.100 of this amendment for additional detail.

527.200 Description of Transportation Facilities

The road will gently slope toward Existing Ditch No. 2 which drains to the Existing Sediment Pond (Map 5A). The road does not cross a natural drainage. Specific design information for the hydrologic/sediment control structures is located in Appendix VII.

The road is approximately 16 feet wide and is constructed of compacted subsoil. The road will have a grade of <3% within the site (See cross-section Figure 6). The runoff from the road will flow into drainage ditches and then into the sediment pond.

During operations, the access road and temporary access road will be maintained using equipment which may be necessary to ensure compliance. Drainage ditches will be maintained to ensure proper functioning.

Accidental spillage of coal mine waste during haulage from the mine site to the refuse pile will be cleaned up and transported to the WRDS, in a timely manner.

If a catastrophic event's causes damage to access roads, the repair of the road/roads will begin as soon as practical following the catastrophic damage.

528 Handling and Disposal of Coal, Excess Spoil, and Coal Mine Waste

~~3.2.5 Methods of Waste Transport~~

Waste rock will be loaded into dump trucks at the mine site ~~using a front-end loader~~. ~~The trucks~~ and will transport the waste rock approximately 6.4 miles to the disposal site. Trucks will not be overloaded. Because of the ~~steep uphill grade and~~ damp nature of the waste rock, any wind losses will be minimal. If any spillage should occur in a route to the disposal site, it will be cleaned up and transported to the disposal site as soon as practical. Haulage to the disposal site will be on an intermittent basis. ~~Haulage and compaction activities will be scheduled during the week whenever possible.~~ Entrance to the waste rock disposal site ~~will be~~ is shown on Maps 4A and 5A.

Non-coal waste will not be deposited at the waste rock disposal site. Final disposal of non-coal wastes shall continue to be in an approved sanitary land fill. Durable rock type construction materials such as cinder block, concrete, however, will be deposited at the disposal site.

~~3.1.5~~ Acid and Toxic Forming Materials - Based on analyses of material that has been placed in the waste rock disposal site to date, no acid forming problems are anticipated. There is a potential for borderline toxicity problems from boron. Samples of the waste material will be collected quarterly and will be analyzed for acid or toxic forming potential. ~~All~~ Identified potential acid or toxic forming materials will be buried or otherwise treated.

Copies of laboratory reports on toxicity/acid-base accountability from representative waste samples are included in Volume 8 of the M&RP prior to 2005 and starting in 2005 will be included in the annual report.

529 Management of Mine Openings

No mine openings will be built in the area.

530 OPERATIONAL DESIGN CRITERIA AND PLANS

531 General

This section contains the general plans for the construction of the sediment control measures and general construction and maintenance of the refuse pile area. This site will be used by CFC to handle coal mine waste or underground development waste that may be generated by the Sufco Mine. Based on prior experience, the refuse materials anticipated to be generated by the mine will generally consist of shale with some sandstone, bone coal, and in limited quantities, sandstone from paleochannels. Sediment pond wastes from either the mine site or refuse area sediment pond will be stored in the refuse pile. Also, a portion of the site will be used as a temporary storage yard for mine materials and a place for disposal of excess snow.

During operations, the runoff from the site area will be treated through the use of sediment controls such as diversion ditches and berms, a sediment pond, and silt fences and/or straw bales. These structures will be constructed, to handle the site runoff, before the initial refuse is placed.

Sufco Waste Rock Site Expansion Construction Steps

Construction of waste rock pile will be completed in sequential phases according to plans and details as follows.

Existing vegetation will be removed, either stockpiled for removal, shredded or it will be burned, then the stripping and stockpiling of topsoil and subsoil of active phase will be done by using earth moving equipment such as loaders, scrapers, excavators and haul trucks. The contractor will utilize the most effective piece of equipment for the area of work. As the topsoil and subsoil is being removed, the phase under construction will be lower than the existing ground on the adjacent phase. Creating a containment ditch to allow for the runoff of the active phase to be collected and directed into the sediment pond.

Once the topsoil and subsoil has been removed (Sections 222 and 231), subgrade surface will be scarified and re-compacted to a minimum of 90% maximum density. Densities will be taken on subgrade at a minimum of one per 5000 square yards using a nuclear density gauge. Scarification will be done using earth moving equipment such as a grader, dozer or excavator. Compaction will be done utilizing the same type of equipment by wheel rolling the subgrade surface prior to any waste rock being placed. Water will be added to material as needed to obtain compaction.

Once subgrade has been scarified and compacted, waste rock will be delivered to the site using haul trucks such as 10 wheeled dump trucks and double trailer belly dumps. As the waste pile is being constructed a berm along the outside edge of the pile will be constructed to comply with MSHA regulations. In addition the berm will act as a diversion to direct on site water into the ditches and eventually into the sediment pond. As the waste rock is delivered on site, it will be handled and placed in its final position using earth moving equipment such as loaders, graders and dozers. The waste rock will be placed in +/-1 foot compacted lifts. As each layer is being constructed, it will be keyed into the adjacent slope at a minimum of 1 foot per lift or at a 1:1 keyed in slope (Map 3C). The material will be compacted to 95% of maximum laboratory compaction. To determine compaction, a nuclear density gauge will be used. When necessary due to the hydro carbons in the material, a density of the material may also be determined using a sand cone which will assist the nuclear density gauge results by providing an additional factor. Densities will be taken every 5,000 square yards per lift. Potholing down to each lift will be done if additional layers have been placed prior to density testing.

As the pile is constructed a 1:1 sideslope on the outside of the pile adjacent to the adjoining phases will remain. As the phase is completed, the top of the waste rock pile will be reclaimed by placing the designated depth of topsoil on the top of the pile. Once the topsoil is placed, the surface will be pocked and gouged using equipment with a maximum bucket width of 30 inches wide.
As construction from one phase to the other occurs, steps above will repeat.

532 Sediment Control

Sediment-control measures for the site area are described in detail in Sections 732 and 742 of this submittal. Runoff-control structures at the WRDS area have been designed to convey runoff in a non-erosive manner. Sediment yields in the permit area are minimized by, disturbing the smallest practicable area during the construction or modification of surface facilities and contemporaneously reclaiming areas suitable for such reclamation.

533 Impoundments

533.100 Slope Stability

New Pond- The only impoundment with an embankment that will be constructed, used, or maintained by CFC will be the sedimentation pond at the WRDS. This pond is an incised pond with an embankment consisting of native materials. A slope-stability analysis was performed on this pond embankment material and is provided in Appendix II(A). ~~According to this analysis, The soil properties used as input for *Slide* analyses were taken from the "EarthFax field investigation and laboratory testing results. In the interest of conservatism, soil properties and analyses were selected to provide worst-case estimates of geotechnical conditions at the refuse expansion site."~~

~~The calculated minimum factors of safety for the various scenarios described above are summarized in Table7 of the Waste Rock Pile Expansion Slope Stability Analysis, Appendix II(A). "As shown in this table, the minimum factor of safety for against slope failure of the refuse pile is expected to be 1.7. The minimum factor of safety for the topsoil and subsoil stockpile without ponded water is 1.7. The sedimentation pond embankment factor of safety, under rapid drawdown, is 1.3."~~

~~"The minimum acceptable factor of safety promulgated by the DOGM for the sedimentation pond embankment is 1.3 under steady-state seepage conditions (R645-301-533.110). This factor of safety applies to NRCS (1985) Class A embankments and those not meeting the criteria of MSHA 30 CFR Sec. 77.216(a). The proposed embankment classifies as a Class A embankment given its rural location, low ponded depth (feet) and low retention volume (less than 10 acre-feet). The calculated factor of safety of 1.3 is therefore considered acceptable and the embankment is expected to remain stable under the geometry and loading conditions."~~

Expansion Area - Text from Earthfax Engineering Group, LLC, Slope Stability Analysis, Appendix II(A)

Background Information. This slope stability investigation was performed by EarthFax Engineering Group, LLC (EarthFax). The investigation included the installation of 5 test pits to log soils and collect sufficient soil samples for geotechnical laboratory analysis. These test pits were excavated to an average depth of 6 feet based on the estimated salvage depths for topsoil and subsoil within the proximity. Soil samples were analyzed for grain size distribution, shear strength, and Atterberg Limits. Shear strengths were determined by direct shear tests conducted on samples that were remolded to the same dry density and moisture contents that were recorded in the field from nuclear density/moisture tests conducted by Jones & DeMille Engineering (see Table 1 and Attachment C). Descriptions of the soils encountered in the test pits, together with the results of these laboratory analyses, are provided in Attachments A-D.

The EarthFax field investigation generally encountered sandy lean clay, lean clay with sand, and silty sand in the native soils at the test pit locations shown on Figure 1, as detailed below:.

Lean CLAY with sand (Test Pits SMW-1 and SMW-3). The material contained 0.1 to 0.3% gravel, 18.7 to 26.1% sand, and 73.8 to 81% fines. According to the Atterberg Limits data, the liquid limit was 37-45, the plastic limit was 18 and the plastic index was 19-27. The angle of internal friction ranged from 40 to 29 degrees, and the cohesion intercept values ranged between 23 and 266 pounds per square foot ("psf"). The direct shear tests were conducted under consolidated, drained conditions.

Sandy lean CLAY (Test Pits SMW-2 and SMW-4). The material contained 0.3 to 9.8% gravel, 33.2 to 38.5% sand, and 51.7 to 66.4% fines. According to the Atterberg Limits data, the liquid limit was 32-36, the plastic limit was 17 and the plastic index was 15-19. The angle of internal friction ranged from 29 to 34 degrees, and the cohesion intercept values ranged between 162 and 265 psf. The direct shear tests were conducted under consolidated, drained conditions.

Silty SAND (Test Pit SMW-5). The material contained 9.3% gravel, 63% sand, and 27.7% fines. The angle of internal friction was 41 degrees and the cohesion intercept value was 49 psf. The direct shear tests were conducted under consolidated, drained conditions.

The sandy lean clay and lean clay with sand soils varied in depth and were encountered below the anticipated soil salvage depths. Additional detail on this investigation including test pit locations, detailed soil logs, and laboratory testing results can be found in the following subsections and attachments.

Evaluation Methods. Slope stability analyses were performed using the slope stability software *Slide 5.0 ("Slide")* by Rocscience. This program uses an iterative procedure to evaluate the factor of safety against rotational shear failure for tens of thousands of potential failure surfaces that may develop within a given slope. Each trial failure surface is discretized into small slices and the driving and resisting forces/moments are calculated for each according to Bishop's Simplified Method of Slices and Janbu Simplified Method of Slices. These forces are then summed over the entire failure surface to obtain a factor of safety defined as the sum of the resisting forces divided by the sum of the driving forces. Therefore, a factor of safety less that 1.0 indicates the potential for slope failure.

Sedimentation Pond Impoundment Embankment. It is our understanding that the sedimentation pond embankment is to be constructed with the following geometry:

Inner Slope. Maximum 16 feet tall at a 3H:1V slope

Crest. Minimum 12 feet wide

Outer Slope. Maximum 14 feet tall at a 2H:1V slope

The stability of the sedimentation pond embankment outer slope was analyzed under the steady-state seepage condition. This condition assumes the sedimentation pond is completely full of water with a phreatic surface fully developed within the embankment. The location of the phreatic surface was determined using *Slide's* finite-element seepage subprogram and assumed hydraulic conditions.

The stability of the sedimentation pond embankment inner slope was analyzed under a "rapid drawdown" condition. That is, it was assumed the pond is quickly drained such that the buttressing effect of the pond water is lost but pore pressures remain trapped within the embankment that had developed during the steady-state seepage condition, thus weakening the slope. This is the most critical condition for the inner slopes of the sedimentation pond embankment.

Stability analyses for the sedimentation pond embankment assumed that all native soils below the phreatic surface were fully saturated and weakened. For this analysis, the sedimentation pond embankment was modeled at the maximum dry density of the surface soil and should be constructed as such in the field. These are conservative assumptions since in reality the sedimentation pond will only be filled intermittently and with a finite quantity of water incapable of saturating all underlying soils.

Results. The soil properties used as input for *Slide* analyses are summarized in Table 3. As discussed above, these data are taken from the EarthFax field investigation and laboratory testing results. In the interest of conservatism, soil properties and analyses were selected to provide worst-case estimates of geotechnical conditions at the refuse expansion site. are expected to remain stable under the geometry and loading conditions presented herein.

The minimum acceptable factor of safety promulgated by the DOGM for the sedimentation pond embankment is 1.3 under steady-state seepage conditions (R645-301-533.110). This factor of safety applies to NRCS (1985) Class A embankments and those not meeting the criteria of MSHA 30 CFR Sec. 77.216(a). The proposed embankment classifies as a Class A embankment given its rural location, low ponded depth (5 feet), low retention volume (less than 20 acre-feet), and water elevation less than 20 feet from toe of embankment. The calculated factor of safety of 1.3 is therefore considered acceptable and the impoundment embankment is expected to remain stable under the geometry and loading conditions presented herein.

Engineering Practices. The results of this investigation apply to the slope geometries and soil conditions discussed above. If actual conditions differ from those assumed in this report, the stability of the waste rock pile, stockpile, and sedimentation pond embankment slope stability should be re-evaluated as necessary.

The following are current engineering practices specific to the design and construction of the sedimentation pond embankments:

1. The embankment should be placed on a well-prepared and compacted subgrade free from any organic soils, vegetation, debris, frozen soils, soft soils, or other deleterious materials (R645-533.220).
2. The embankments should be well keyed into, or otherwise secured to, the underlying subgrade and adjacent slopes.
3. Embankment soils should be compacted with an appropriate compactor to at least 95% of the Standard Proctor maximum dry density (ASTM D698) at ±2% of the soil's optimum moisture content. Compacted lifts should not exceed 8 inches.
4. It is recommended that topsoil be placed on the outer slope of constructed embankments and vegetation established in order to reduce the potential for erosion (R645-301-533.400). However, no trees, brush, or shrubs should be allowed to grow on the embankment. This can cause failure due to "piping" along root paths.
5. Embankments should be regularly inspected as promulgated by DOGM for signs of damage, erosion, and piping and repairs made as necessary.

Although not required by design the inside slope of the constructed pond embankment will be armoured with one foot of protective rock.

533.200 Foundation Considerations

During soil investigations, foundation conditions in the area of the proposed sedimentation pond were evaluated. Based on these investigations, no conditions were encountered which suggested that the materials in which the pond would be constructed would be unstable. The slope-stability analyses indicate that the pond embankments will also be stable under operating conditions. Detailed cross sections of the sedimentation pond are presented on Map 7 of this submittal.

533.300 Slope Protection

(Historic) The inslopes of the sedimentation pond and portions of the outslope disturbed by the spillway construction were revegetated following construction to minimize surface erosion and protect the embankments against sudden drawdown. The interim seed mix was used for these revegetation efforts (see Section 341.200 of this submittal). When required, pumping of the sedimentation pond, flow rates (and drawdown) will be controlled. Hence, it is unlikely that this drawdown will cause surface erosion of the embankment face.

533.400 Embankment Faces

(Historic) Embankment inslopes and portions of the outslopes were revegetated following construction of the sedimentation pond, as outlined in Section 533.300.

533.500 Highwalls

No highwalls will be located below the discharge lines of the sedimentation pond.

533.600 MSHA Criteria

The sedimentation ponds do~~es~~ not meet the size criteria of 30 CFR 216(a).

533.700 Pond Operation and Maintenance Plans

The sedimentation ponds have been designed as a total containment pond(s) to contain the 10-year, 24-hour storm event, and an adequate freeboard. Details of the design and the requirements for operation and maintenance of the pond(s) are presented in Chapter 7 of this submittal.

It is anticipated that the existing pond will not need to be removed from the site because of planned construction until Phase 6 (after 2020). The drainage from the waste rock site will be directed into the new pond once it is constructed during Phase 1 (2015/2016).

534 Roads

Location, Design, Construction, Reconstruction, Use, Maintenance, and Reclamation. No permanent roads will be constructed in the WRDS area. The refuse will be transported to the refuse pile area using the existing county road. A temporary access road between the refuse pile area and county road will be constructed to allow equipment access to the pile. The temporary road will be reclaimed. The temporary road will be maintained in accordance with the approved

M&RP. Refer to Section 527.200 for additional description of the transportation facilities.

The road access to the WRDS will be at the location shown on Map 5A. The first segment of the road will enter the site from the county turnaround located on the western edge of the WRDS. The first segment is approximately 235" long, the road then splits into an eastern segment which will allow the placement of refuse (approximately 975') and a segment going to the south which will access the new sediment pond and soil storage area (approximately 1200'). The lower portion of the road accessing the sediment pond will be temporary (approximately 645') and be used only during the construction of the new pond. Following the construction of the pond the southern end of the road will receive interim revegetation. Typical road design is provided as Figure 6.

Control of Damage to Public or Private Property. Roads will be designed in accordance with applicable county and State standards. By designing according to these standards, damage to public or private property will be minimized.

Road Surfacing. The temporary access road surface material will be compacted native subsoils. The characteristics of the substances used for road surfaces will be non-acid-and nontoxic-forming.

Environmental Protection and Safety. The design and construction of the temporary road will be in accordance with Section 5.3.4.2 of the approved M&RP.

535 Spoil

No spoil will be generated in the WRDS area.

536 Coal Mine Waste

Coal mine and underground development waste resulting from mining activities at the Sufco Mine will be disposed of at the refuse pile.

536.100 Design

~~3.3 Timing of Operation~~

Existing Piles - (Historic)Since the waste rock disposal area is relatively small and relatively small volumes of fill are placed annually, the fill will be constructed in segments. The original fill volume was estimated at 10,000 tons or 8,200 cubic yards per year. The average fill volume from 1996 through 2012 was 5,180 tons per year and ranged from 156 to 27,135 tons per year. At this projected rate, once the fill bench-slope configuration is established about 1.5 acres should be filled and reclaimed every six to nine years. The fill is expected to be completed in 2016. The waste rock disposal pile was surveyed in August 2005 and contains an estimated 163,748 tons of waste rock, at the end of 2012 there is estimated to be 199,700 tons of waste stored at the site. In 2013 the estimated available capacity remaining at the waste rock pile is 5,000 tons, the proposed expansion of Lift #5 will provide an estimated additional capacity of 40,000 tons. The maximum height of Lift #5 is estimated at 20 feet and will be adjusted lower if necessary for road visibility.

It should be noted that the active fill area will extend beyond the area shown for each year. This is best seen in cross-section G-G' of Figure 2 which shows the active fill areas in relation to the reclaimed area, topsoil removal area, and undisturbed area. Map 4V4 (historic map)has been revised to illustrate the current status of the reclaimed, active and undisturbed areas of the waste rock disposal area as of April 2013.

The following information is retained for historical record (prior to 2013 Site Expansion) { The fill area will eventually encompass about 8 acres and contain an estimated 204,700 tons of waste rock. Because of the irregularity of use, the fill will be constructed in segments envisioned to be about 300 feet long by 150 feet wide.} Reference Section 3.3 for additional information.

The following information is retained for historical record (prior to 2013 Site Expansion): { The 200 feet wide strips of waste will be placed beginning along the southern boundary and extend between the drainage diversion ditches. The eastern half of the disposal area will be completed first. The original Map 4V4 showed the areas that would be completed based on a waste rock volume of 10,000 tons per year. The average fill volume from 1996 through 2003 was 3,200 tons per year and ranged from 1,400 to 6,800 tons per year.}(Historic)

Following the completion of the construction on the Lift 5 expansion, the base (ground level) will be surveyed prior to the placement of waste. Beginning in the Fall of 2014 the volume of waste stored at the waste rock site will be estimated using the surveyed base. The volume will be presented in the annual report in 2016 and in the following years until the lift is full.

~~3.13~~**Stability of Fill** - (Historic)Static and pseudostatic stability analysis were performed on the rockfill by SHB assuming a critical surface propagating through both the in-situ soils and the fill, as well as through the fill alone. A maximum design embankment height of 20 feet was considered. Estimated strength parameters for the rock fill and in-situ soils are shown on the stability calculations sheets in Appendix C of the SHB report (Appendix II). Due to the open graded nature of the fill material, no pore pressure was assumed in the waste rock in the stability analysis.

The analyses performed by SHB indicate the likely deformation of the embankment structure during a seismic event would be sloughing of surface material. Deep-seated deformations would be a maximum of a few inches. Case history data indicates stability of rolled earth dams bearing on relatively stiff foundations have withstood extremely strong shaking ranging from 0.35g to 0.8g from earthquakes having magnitudes as large as 8.25. These data provide high confidence in the stability of the rockfill under similar extreme conditions.

A slope stability calculation using the fill configuration shown on Map 2 is included in Appendix III. The slope safety factor is 2.62. The slope stability and safety factor will be maintained throughout the expansion of Lift #5 and in the reconfiguration depicted on Map 2. (Historic)

~~3.1.4~~ **Waste Rock Fill Construction Criteria** - The waste rock generated at the mine at this time consists of a black to gray shale with some sandstone. Plasticity index, slake durability tests, and point load index tests performed on the present waste rock indicate it to be a sound, durable rock. It is anticipated that the waste rock will be flat, elongated pieces with a maximum size of 12 to 18 inches. The gradation of this material will most likely be coarse and poorly graded with a small percentage of sand size or smaller material.

Expansion - Text and Tables from Earthfax Engineering Group, LLC, Slope Stability Analysis, Appendix II(A), Tables, attachments and other information relative to the report can be reviewed in Appendix II(A)

BACKGROUND INFORMATION. This slope stability investigation was performed by EarthFax Engineering Group, LLC (EarthFax). The investigation included the installation of 5 test pits to log soils and collect sufficient soil samples for geotechnical laboratory analysis. These test pits were excavated to an average depth of 6 feet based on the estimated salvage depths for topsoil and subsoil within the proximity. Soil samples were analyzed for grain size distribution, shear strength, and Atterberg Limits. Shear strengths were determined by direct shear tests conducted on samples that were remolded to the same dry density and moisture contents that were recorded in the field from nuclear density/moisture tests conducted by Jones & DeMille Engineering (see Table 1 and Attachment C). Descriptions of the soils encountered in the test pits, together with the results of these laboratory analyses, are provided in Attachments A-D.

The EarthFax field investigation generally encountered sandy lean clay, lean clay with sand, and silty sand in the native soils at the test pit locations shown on Figure 1, as detailed below:

Lean CLAY with sand (Test Pits SMW-1 and SMW-3). The material contained 0.1 to 0.3% gravel, 18.7 to 26.1% sand, and 73.8 to 81% fines. According to the Atterberg Limits data, the liquid limit was 37-45, the plastic limit was 18 and the plastic index was 19-27. The angle of internal friction ranged from 40 to 29 degrees, and the cohesion intercept values ranged between 23 and 266 pounds per square foot ("psf"). The direct shear tests were conducted under consolidated, drained conditions.

Sandy lean CLAY (Test Pits SMW-2 and SMW-4). The material contained 0.3 to 9.8% gravel, 33.2 to 38.5% sand, and 51.7 to 66.4% fines. According to the Atterberg Limits data, the liquid limit was 32-36, the plastic limit was 17 and the plastic index was 15-19. The angle of internal friction ranged from 29 to 34 degrees, and the cohesion intercept values ranged between 162 and 265 psf. The direct shear tests were conducted under consolidated, drained conditions.

Silty SAND (Test Pit SMW-5). The material contained 9.3% gravel, 63% sand, and 27.7% fines. The angle of internal friction was 41 degrees and the cohesion intercept value was 49 psf. The direct shear tests were conducted under consolidated, drained conditions.

The sandy lean clay and lean clay with sand soils varied in depth and were encountered below the anticipated soil salvage depths. Additional detail on this investigation including test pit locations, detailed soil logs, and laboratory testing results can be found in the following subsections and attachments.

Refuse material to be placed at the site will originate as roof-fall and other rock materials removed from the SUFCO Mine. As part of this investigation, grain size distribution and angle of repose laboratory tests were conducted on the washed refuse material provided by Canyon Fuel Company. Results of these analyses are provided in Attachment B. This waste rock sample was obtained from a preparation plant laboratory reject material after a washing process which removes the majority of fines typically found within coal mine refuse.

According to the laboratory test analyses provided in Attachment B, the waste rock is angular with material sizes equivalent to about 91.9% gravel, 4.1% sand, and 4% fines. The material is classified as well graded, 3 inch minus grey gravel with a Unified Soil Classification of GW. The sample had an angle of repose of 33.6 degrees.

As indicated above, the sample used in this evaluation for analyses of engineering properties (i.e., the reject from a laboratory investigation of washability potential) was essentially devoid of fines, thereby resulting in a cohesionless sample. However, experience at other sites has indicated that the waste rock will not be devoid of fines, whether this waste rock is run-of-mine or the reject from a wash plant. Therefore, to estimate the cohesion intercept of the waste rock, the results of analyses conducted on waste rock from the former Castle Gate Coal Mine wash plant were reviewed (Golder Associates, 1978). Analyses of waste rock generated by the Dugout Canyon Mine were also reviewed (EarthFax, 1999). These investigations resulted in estimated cohesion intercepts of 800 and 490 pounds per square foot ("psf") for the Castle Gate and Dugout waste rock, respectively. To provide a conservative estimate of pile stability, the lower cohesion intercept of 490 psf was used for this evaluation. The results of laboratory analysis on the waste rock presented in this section are expected to be representative of the proposed waste rock pile.

EVALUATION METHODS. Slope stability analyses were performed using the slope stability software *Slide 5.0 ("Slide")* by Rocscience. This program uses an iterative procedure to evaluate the factor of safety against rotational shear failure for tens of thousands of potential failure surfaces that may develop within a given slope. Each trial failure surface is discretized into small slices and the driving and resisting forces/moments are calculated for each according to Bishop's Simplified Method of Slices and Janbu Simplified Method of Slices. These forces are then summed over the entire failure surface to obtain a factor of safety defined as the sum of the resisting forces divided by the sum of the driving forces. Therefore, a factor of safety less that 1.0 indicates the potential for slope failure.

The analysis discussed herein relied on soils data collected during the EarthFax field investigation, as this investigation encompassed the same general area as the proposed waste rock pile expansion. Long term stability analyses were performed for the coal mine waste refuse stockpile, spoils topsoil and subsoil stockpile, and the proposed sedimentation pond embankment (see Figure 1). Details on each of the slope-stability scenarios analyzed and soil properties used for these analyses are included in the following subsections.

Coal Mine Waste Refuse Stockpile. It is our understanding that the waste refuse stockpile will be constructed to a maximum height of 65 feet with a maximum side slope of 2 horizontal to 1 vertical ("2H:1V"). Depending on the location within the waste rock pile, the contact with underlying native soils varies in elevation while maintaining an average height of 62 feet. The engineering properties summarized in Chapter 2 were assumed for this evaluation.

Spoils Topsoil and Subsoil Stockpiles - It is our understanding that the topsoil and subsoil stockpile will be constructed to a maximum height of 25 feet with a maximum side slope of 2H:1V. Depending on the location within the topsoil and subsoil stockpile, the contact with underlying native soils varies in elevation. However, as a conservative measure, the maximum height of 25 feet was assumed for this elevation. Because the toe of a portion of the stockpile slope will coincide with the location of the sediment basin, analyses were performed for slope stability with and without ponded water at the toe of the stockpile.

The stability of the stockpile slope was analyzed under normal conditions for the sediment basin without water. This condition assumes the conservative variability (worst case scenario) of soils encompassing the stockpile. Because the underlying soils classify as similar soil types, both analyses were performed for the most critical soil type.

The stability of the stockpile slope with water in the sediment basin was also analyzed under the ponded condition. This condition assumes the sediment basin at the toe of the slope is completely full of water and the conservative variability of soils encompassing the stockpile. The effects of ponded water were determined using *Slide's* slope stability analysis and assumed hydraulic conditions. The conditions were modeled with a 2H:1V slope as this is the steepest slope observed in these soils along the edges of the topsoil and subsoil stockpile (see Figure 1).

RESULTS. The soil properties used as input for *Slide* analyses are summarized in Table 3. As discussed above, these data are taken from the EarthFax field investigation and laboratory testing results. In the interest of conservatism, soil properties and analyses were selected to provide worst-case estimates of geotechnical conditions at the refuse expansion site.

The calculated minimum factors of safety for the various scenarios described above are summarized in Table 2. As shown in this table, the minimum factor of safety for against slope failure of the coal mine waste refuse stockpile is expected to be 1.3 if the material is cohesionless and 1.7 under the assumed condition of reasonable cohesion. The minimum factor of safety for the spoils topsoil and subsoil stockpile with or without ponded water is 1.7. The sedimentation pond in-slope embankment factor of safety, under rapid drawdown, is 1.3. The minimum factor of safety associated with the sedimentation pond impoundment out-slope, assuming steady-state seepage, is also 1.3.

The minimum acceptable long-term static factor of safety promulgated by the Utah Division of Oil, Gas, and Mining ("DOGM") for coal mine waste refuse stockpiles is 1.5 (R645-301-536.110). The minimum calculated factor of safety 1.7 under the assumptions made above is therefore considered acceptable and slopes are expected to remain stable under the geometry and loading conditions presented herein.

The minimum acceptable factor of safety promulgated by the DOGM for the spoils topsoil and subsoil stockpiles is 1.5 (R645-301-535.110). The minimum calculated factor of safety 1.7 under the assumptions made above is therefore considered acceptable and slopes.

The following are current engineering practices specific to the design and construction of the coal mine waste refuse stockpile:

Material shall be placed in a controlled manner.

Although the lift thickness should not exceed 2 feet ± 10% (uncompacted), it may be advantageous to reduce this to facilitate drainage and improve condition. This should be evaluated by trial and error early in the operation.

New lifts should be placed only over waste rock has been properly compacted to provide a stable base for a new lift.

The dump surface should always be graded to facilitate drainage away from recently placed fill toward surface drainage courses. It may be advantageous to bulldoze shallow ditches at each lift elevation to improve surface drainage.

In the unlikely event that severe waste rock handling, placement and compaction problems are encountered, consideration should be given to temporarily flattening of dump face slope angles or utilizing artificial waste rock stabilization measure. Other measures may be considered on a case-by-case basis.

Sequencing and QA/QC Information. Additional information located in Section 531.

QA/QC information will be gathered and available for review upon request for the following:

Photo documentation of clearing and grubbing prior to refuse placement on each phased foundation;

Proof of testing lift thickness;

Results of compaction test(s) for each phased area, to meet Standard Proctor maximum dry density at +/- 2%;

Quarterly compaction tests, until waste placement phase is completed.

(Historic)Atterberg limits, slake durability, and point load index tests were performed on samples of waste rock from the mine. The results of these tests are also presented in Appendix B of the SHB report

~~3.4 Area Affected by Each Phase of Operation~~

The eastern half of the waste rock disposal site will be built up first. Once the eastern portion is to design height, the fill will be extended to the western boundary by extending the fill in segments. As each segment of the fill is brought to final design height, it will be contoured to the approximate contours ~~shown on Map 2.~~ Once this has been accomplished, topsoil will be distributed and revegetation will proceed as indicated in the Revegetation Plan contained in Section 4.6.(Historic)

New Piles (Phases 1 thru 6, 2015). The designs and their associated evaluations were based on the results of detailed foundation and laboratory analyses of soils at the site of the refuse pile. These results are presented in Appendix II(A) of this submittal.

According to this analysis, The soil properties used as input for *Slide* analyses were taken from the "EarthFax field investigation and laboratory testing results. In the interest of conservatism, soil properties and analyses were selected to provide worst-case estimates of geotechnical conditions at the refuse expansion site."

"The calculated minimum factors of safety for the various scenarios described above are summarized in Table 2 of the Waste Rock Pile Expansion Slope Stability Analysis, Appendix II(A). "As shown in this table, the minimum factor of safety for against slope failure of the refuse pile is expected to be 1.7"

"The minimum acceptable factor of safety promulgated by the Utah Division of Oil, Gas, and Mining ("DOGM") for coal mine waste rock stockpiles is 1.5 (R645-301-536.110). The minimum calculated factor of safety 1.7 under the assumptions made above is therefore considered acceptable and slopes are expected to remain stable under the geometry and loading conditions presented herein."

Based on the materials encountered in the WRDS area, the refuse pile can be constructed to an approximate height of 65 feet with 2H:1V outslopes on the native soils. Maps 2, 3A and 3B presents the proposed configuration of the refuse pile. Maps 8, 8A and 8 B show the reclamation topography and treatment for the refuse pile. The top of the reclaimed pile will be regraded to have an irregular plateau surface that drains toward the pile outslopes instead of draining only toward one side of the pile. Where possible the reclaimed slopes will be varied to blend into the shape of undisturbed areas. Outslopes of the reclaimed pile will be varied as much as possible to prevent long straight surfaces with uniform slopes.

Storage capacity of the pile is estimated to be approximately 938, 207 CY of refuse.

536.200 Waste Emplacement

~~3.2.6 Methods of Waste Placement~~

(Historic) The waste rock material shall be placed in horizontal lifts not to exceed three feet in thickness. The material shall be dumped from the haul trucks in such a manner that ~~any~~ precipitation falling on the piles can drain off the pad. The active pad area for waste placement will be sloped at approximately 2% toward the nearest drainage control structures ~~south and east~~ to promote drainage of precipitation off the pad area. The drainage control structures will direct the runoff to the sediment pond(s) for treatment unless specified differently. An interception ditch will be routed down the slope of the fill ~~from the southeast corner~~ of the active pad to the base of the fill where runoff will be collected by a ditch ~~No. 2~~. This interception ditch will be extended up the slope as each lift is completed.

The waste rock material shall be reworked with suitable sized, compaction equipment ~~which has a push blade~~ suitable for moving the material and leveling the lifts. When ~~the material is dry~~, necessary moisture will be added as required by the Air Quality Approval Order. This method will assist in achieving desired densities and prevent the formation of large voids. Additional compaction of each lift should be accomplished by routing the loaded trucks in a pattern over the lift surface in such a manner as to cover the ~~entire~~ area uniformly.

Loads of ~~noncemented~~, soft shale, clay spoil, or fine grained material (such as pond clean out material) shall be mixed with coarser graded loads in a controlled manner to limit concentrations of fine materials in the fill. ~~This is particularly true for sediment pond waste either from the minesite pond or the adjacent pond.~~

Due to the anticipated coarse, open graded nature of the waste rock material, most quality control work for the fill will have to be on a visual basis. Conventional in-place density tests will not give reliable results under these circumstances.

Intermittent construction slopes and the final exterior slopes of the fill should not be steeper than 2h:lv. Final slopes of the top surface of the waste rock area will be contoured to blend into the natural contour of the area. The final fill slope will be terraced on approximately 20 foot elevation increments ~~as shown in Map 2~~.

536.300 Excess Spoil Fills

No excess spoil fills will exist in the WRDS area.

536.400 Impounding Structures of Coal Mine Waste

No impounding structures built from coal mine waste will exist at the WRDS.

536.500 Disposal of Coal Mine Waste in Special Areas

CFC does not intend to dispose of coal mine waste in special areas.

536. 600 Underground Development Waste

Refer to Section 513.

536.700 Coal Processing Waste

Refer to Section 513.

536.800 Coal Processing Waste Banks, Dams and Embankments

CFC does not intend to construct waste banks, dams or embankments from coal processing waste. Hydrology information is located in Chapter 7 of this WRDS submittal.

536.900 Refuse Piles

Information pertaining to refuse piles and the WRDS are provided in the chapters of this WRDS document.

537 Regraded Slopes

537.100 Division Approval

No mining or reclamation activities will be conducted in the refuse pile permit area that require approval of the Division for alternative specifications or for steep cut slope.

537.200 Regrading of Settled and Revegetated Fills

Upon completion of the filling of the refuse pile, the site will be reclaimed. The refuse fill will be constructed in a prudent manner to ensure that the pile will be stable. Geotechnical analyses of the proposed configuration are presented in Appendix II(A).

540 RECLAMATION PLAN

541 General

~~4.1 Introduction~~

The operation of the waste rock disposal site is designed for minimal areal disturbance at any given time. The waste material will be placed in compacted lifts and will be covered with topsoil/~~growth~~ medium and revegetated. Routes required for access to active disposal areas will be revegetated as soon as practical. The final contours will be as shown on Map 2.

541.100 Commitment

Upon the permanent cessation of coal mining and reclamation operations at the WRDS, CFC will close, backfill, or otherwise permanently reclaim the affected areas in accordance with the R645 regulations and this reclamation plan.

541.200 Surface Coal Mining and Reclamation Activities

No surface coal mining and associated reclamation activities will be conducted in the permit area.

541.300 Underground Coal Mining and Reclamation Activities

No underground activities are planned for this site.

541.400 Environmental Protection Performance Standards

The plan presented herein is designed to meet the requirements of R645-301 and the environmental protection performance standards of the State Program.

542 Narratives, Maps, and Plans

542.100 Reclamation Timetable

~~**4.2 Time Table**~~

The waste rock disposal site will be used ~~on an infrequent basis~~ as required to dispose of rock generated during mining. ~~Because of the irregularity of use,~~ The fill will be constructed in segments of varying widths and lengths, ~~refer to Map 4 for dimensions~~. As segments are complete, they will be graded and vegetated ~~as set forth in Sections 4.4-4.6.~~ Final grading, topsoil application, seeding and other revegetation activities will be done in the Fall season when possible. ~~, preferably during late September or early October~~. ~~Refer to Section 3.3 for additional information.~~

A timetable for the completion of each major step in the reclamation plan follows. The first phase consists of regrading the remaining site disturbance, but the majority of the site will have already received contemporaneous reclamation. The process will continue with the placing of ~~growth~~ soil medium, surface roughening, and seeding (vegetating) the site. This phase will take approximately six (6) months to complete based on the number and anticipated types of construction equipment to be used, the number of operators and laborers necessary to complete the work, and the number of weather days (when work cannot take place) anticipated occurring. Work will be completed sooner if bad weather is not encountered. The second phase will be an approximate 10 month period where the success of the surface reclamation will be evaluated in relation to the surface roughening and the initial seeding success. If the surface roughening and/or initial reseeding (vegetation) does not appear, successful, additional seeding or reworking of portions of the reclaimed surface may be necessary.

After vegetation and monitoring requirements have been fulfilled, the sediment pond will be leveled, ~~this is expected to occur in 2026.~~ ~~This Phase II~~ This stage of reclamation will consist of dozing the embankment into the pond and reestablishing the ~~original~~ contour as shown on Map 2. Topsoil/~~growth~~ soil medium will be placed over the area from the dedicated stockpile prior to reseeding ~~according to Section 4.6.~~ The remaining monitoring bore holes will also be closed as part of ~~the Phase II~~ this stage of reclamation.

Reclamation Timetable*

Phase/Lift	Year Constructed	Contemporaneous Reclamation	Final Reclamation

	Planned	Actual	Planned	Planned
Lift 4			2015/2016	2016
Lift 5		2011-2016	2015/2016	2016
Existing Sediment Pond			2018	2020
Ph. 1 Access Rd.	2015		2018	2020+
Ph. 1 Topsoil Rd.	2015		2020+	2020+
Ph. 1 Sediment Pond	2015		2020+	2020+
Phase 2	2015		2018	2019
Phase 3	2018		2020+	2020+
Phase 4	2020		2020+	2020+
Phase 5	2020+		2020+	2020+
Phase 6	2020+		2020+	2020+

* Dates/year are estimated

\+ Beyond 2020

542.200 Plan - Backfilling, Soil Stabilization, Compacting, and Grading

Based on the proposed construction plans, the pile will be constructed so that the pile will be at final configuration when the disposal of waste is completed. Therefore, it is anticipated that little regrading will need to be conducted. The construction plans for the refuse pile area were designed to meet the objectives of maximizing refuse storage quantities and maintaining a geotechnically stable base. The primary features of this plan are:

Constructing a 2H to 1V outslope for the refuse pile;

Placement of soil;

Revegetation and mulching of the soiled site; and

Breaching and filling of the sedimentation pond with embankment materials.

Grading activities during operations will develop a pile with a final surface configuration approximating that defined by Map 8. Details regarding soil placement and revegetation following regrading are provided in Chapters 2 and 3, respectively.

Sedimentation Pond Removal and Interim Sediment Control. The existing sedimentation pond will be retained for as long as practical during reclamation, but at a minimum 2 years after the last augmented seeding. Because the pond is constructed as an incised structure, the pond reclamation will consist primarily of breaching the pond and pushing the embankment into the pond, ripping and ~~to~~ create a gentle slope. During reclamation the berm materials of the diversion ditches around the refuse pile will be pushed into the ditch and a free draining slope will be constructed to allow runoff from the pile site to enter the natural drainages. Once the sediment pond and ditch areas are adequately graded, the soil materials will be redistributed and revegetated in accordance with Chapters 2 and 3.

542.300 Final Surface Configuration Maps and Cross Sections

Final surface configuration maps and cross sections for the WRDS are provided on Map 8, 8A and 8B.

542.400 Removal of Temporary Structures

No surface structures are planned to be associated with the refuse pile operation.

542.500 Removal of Sedimentation Pond

Refer to Section 542.200 of this amendment.

542.600 Roads

The temporary access roads constructed during refuse pile construction activities will be reclaimed when no longer needed for access to the site. The surfacing material will be removed depending upon the materials condition or incorporated , the area will then be regraded, ripped, and the final reclamation seed mix will be applied as specified in Chapter 3.

542.700 Final Abandonment of Mine Openings and Disposal Areas

No mine openings or disposal areas will exist in this area. The abandonment of well openings is discussed in Sections 728.300 and 748 of Chapter 7.

542.800 Estimated Cost of Reclamation

Refer to the existing M&RP, Appendix 5-9. It is anticipated that the cost of reclamation of the refuse pile is adequately covered within the existing reclamation bond.

~~4.3 Cost Estimate for Performance Bond~~

~~The Surface Mining Control and Reclamation Act of 1977 requires the operator of a coal mine to file with the Office of Surface Mining, a bond payable to the regulatory authority in the amount equal to the estimated cost of completing the work described in the operator's reclamation plan. The purpose of the bond provision is to ensure the State of Utah that in the event of the operator being financially unable to reclaim the disturbed areas, such areas can and will be restored by the proper regulatory authority at no cost to state residents.~~

~~Reclamation will consist of grading and revegetating the waste rock disposal fill area, site, monitoring wells locations and removing the sediment pond(s) described in Section 4.6 Appendix III contains the calculations for reclamation costs. The permitted disturbed area acreage and actual disturbed area acreage and legal description of the permit area is provided in Chapter 1, Section 116 of the M&RP.~~

550 RECLAMATION DESIGN CRITERIA AND PLANS

551 Casing and Sealing of Underground Openings

No underground openings will exist in the area.

552 Permanent Features

552.100 Small Depressions

No small depressions will be created as part of the refuse pile construction and reclamation.

552.200 Permanent Impoundments

No permanent impoundments will be left following reclamation.

553 Backfilling and Grading

Reclamation design criteria and plans for the waste rock site are shown on the series of Maps 2, 3 and 8; and discussed in Sections 240, 340, 412, 540, and 760.

553.100 Disturbed Area Backfilling and Grading

Approximate Original Contour. As indicated earlier, the site of the WRDS is a previously disturbed site. The proposed configuration of the site will comply with the post-mining land use and blend into the surrounding area.

Based on the proposed plan, a portion of the existing ground surface will be raised by the construction of the refuse pile. Prior to placing refuse, the soils present on the site will be stripped and temporarily stored on the site. At contemporaneous and final reclamation, the stored soil will be redistributed and revegetated.

The reclaimed slopes of the refuse pile will have a similar shape to the slopes in the surrounding area, including concave slopes and slope breaks. The top of the reclaimed pile will be regraded to have an irregular plateau surface that drains toward all pile outslopes instead of draining only toward one side of the pile.

Erosion and Water Pollution. Sediment-control measures will be implemented during and following reclamation activities. ~~Prior to seeding, the areas with a slope steepness of 3H:1V or steeper will be roughened.~~ The final surface will consist of mounds and depressions capable of holding runoff. Refer to Sections 355 and 341 regarding erosion-control and revegetation.

During these activities temporary sediment controls may consist of installation of silt fences, berms, and/or straw bales, surface roughening, and reestablishment of the vegetative cover for the limited areas. As vegetation becomes established on the reclaimed surfaces, erosion potentials will be further minimized. By minimizing erosion, water pollution will also be precluded.

Post-Mining Land Use. The disturbed area will be reclaimed in a manner that supports the approved post-mining land use.

553.200 Spoil and Waste

Spoil. No spoil will be generated within the permit area of the WRDS.

Coal Processing Waste. No coal processing waste will be generated within the permit area. However, should coal from the CFC mines be processed at a washing facility, there is potential for the processing waste to be returned to the WRDS for disposal.

Selected overburden materials may be used below the salvaged soils during reclamation operations, if sufficient soil materials are not available for the proposed reclamation activities. Equal portions of coal waste and subsoil may be used to create a blended cover material to be placed below the topsoil. Where overburden materials are used, the operator commits to demonstrating to the Division prior to salvaged soil emplacement that the overburden materials are non-toxic, non-acid forming, and non-combustible. Refer to Section 536.200 discussion of waste sampling/testing.

Vegetation and organic material will be removed from the area receiving coal processing waste prior to placement. The topsoil on the area will be removed, segregated, stored and redistributed in accordance with Sections 230 and 240 of Chapter 2.

553.250 Refuse Piles

The WRDS is a previously disturbed area. The refuse pile surface will be prepared and the soil will be distributed and revegetated in accordance with the plans proposed in Chapters 2 and 3.

553.300 Exposed Coal Seams, Acid- and Toxic-Forming Materials, and Combustible Materials

No coal seams are present in the area.

553.400 Cut-and-Fill Terraces

No cut-and-fill terraces will be built at the site.

553.500 Highwalls From Previously Mined Areas

No highwalls exist or will be built at the WRDS.

553.600 Previously Mined Areas

The area has not been previously mined.

553.700 Backfilling and Grading - Thin Overburden

Backfilling and grading will occur during reclamation, as described in Sections 534.100 and 542.600.

553.800 Backfilling and Grading - Thick Overburden

Backfilling and grading will occur during reclamation, as described in Sections 534.100 and 542.600. The waste rock site does not require the use of spoil and waste materials to achieve a post mining slope or to return the area to approximate original contour.

553.900 Regrading of Settled and Revegetated Fills

No settled or revegetated fills currently or will exist at the storage site.

560 PERFORMANCE STANDARDS

Coal mining and reclamation operations at the WRDS will be conducted in accordance with the approved permit and the requirements of R645-301-510 through R645-301-553.

CHAPTER 6

GEOLOGY

CHAPTER 6

GEOLOGY AND ALLUVIAL VALLEY FLOOR

610 INTRODUCTION

611 General Requirements

The geologic resources are discussed in Sections 621 through 627 of this chapter.

612 Certification

A professional engineer has certified as required by the regulations the maps, plans, and cross-sections, presented in this chapter.

620 ENVIRONMENTAL DESCRIPTION

621 General Requirements

This section presents the regional and site-specific geologic information for the Waste Rock Disposal Site (WRDS).

622 Cross Sections, Maps and Plans

A geologic map of the WRDS is provided as Exhibit 7. Because of the limited areal extent of the WRDS, cross sections have not been provided.

623 Geologic Determinations

The information required by the Division to make a determination of the acid or toxic-forming characteristics of the site strata is presented in Section 6.2.4 of the approved M&RP.

The information required by the Division to make a determination as to whether the reclamation plan, described in Section 540, can be accomplished is presented in Section 6.2.4.

The information required to prepare the subsidence control program is addressed in Section 6.2.4.

624 Geologic Information

Regional Setting. ~~**2.2 Geology**~~

The bedrock, which underlies the site and is exposed immediately to the north and east of the site, consists of massive sandstone and sandy, carbonaceous claystone of the Price River Formation. The Price River Formation is part of the Mesaverde Group which is upper Cretaceous in age. The total thickness of the Price River Formation is about 700 feet, but the thickness below the site has not been determined. Local bedrock dips do not appear to exceed 10 degrees and no major faulting is apparent in the immediate site area. There has been no underground mining beneath the site. Runoff from the stockpile will be treated through the use of diversion ditches and a sediment pond. Therefore, no adverse impact on area surface or groundwater quality is anticipated.

As encountered in the seven boreholes and five backhoe test pits performed on site by Sergent, Hauskins & Beckwith (Appendix II), the Price River Formation is overlain by 4 to 30+ feet of unconsolidated colluvial material. This overburden consists of a soft to hard clay sequence with varying amounts of sand and silt. Subordinate units of argillaceous sand are also present in the colluvial deposit. The predominant clay units are normally gray to black in color, medium in plasticity, and firm to hard in consistency.

OBSERVATION WELL COMPLETION SUMMARY[a]

Well Number	Total Drilled Depth (ft)	Elev. Top of Casing (ft)	Casing Diameter (in)	Length of Perf. (ft)	Formation Monitored
WRDS B-3	29.5	7884.7	2	10	Price River
WRDS B-5	47.2	7960.15	2	10	Price River
WRDS B-6	46	7956.50	2	10	Price River

[(a)] See Figure 5 for well locations, wells drilled in 1983. Appendix II, Attachment A Sergent, Hauskins & Beckwith report.

Test Boring and Drill Hole Data (overburden removed). No additional test borings or drill holes are planned for the site.

Test Boring and Drill Hole Data (overburden not removed). No additional test borings or drill holes are planned for the site.

625 Additional Geologic Information

It is not anticipated that any additional geologic data will need to be collected for this site.

626 Sampling Waivers

A sampling waiver is not requested at this time for this site.

627 Description of the Overburden Thickness and Lithology

No mining will occur in this area. Therefore this regulation does not apply.

630 OPERATION PLAN

631 Casing and Sealing of Exploration Holes

No exploration holes exist or are planned for the site.

632 Subsidence Monitoring

Subsidence will not occur in this area (see Section 525).

640 PERFORMANCE STANDARDS

641 Exploration and Drill Holes

No exploration holes exist in the area or are any planned for the site.

642 Monuments and Surface Markers of Subsidence Monitoring Points

Subsidence will not occur in this area (see Section 525).

ALLUVIAL VALLEY FLOOR DETERMINATION

Alluvial Valley Floors. The disposal area has no Alluvial Valley Floors as defined by R645-302-320.

To determine the potential for an alluvial valley floor (AVF) to exist within the waste rock disposal site. Information within the WRDS chapters was evaluated. Including

- Geologic studies;
- Hydrologic studies;
- Land-use studies;
- Soils studies; and
- Vegetation studies.

The individual chapters outlined above should be consulted for more detailed information.

Agricultural Activities. As noted in Section 411 of WRDS amendment and the approved M&RP, the only agricultural activities which occur within the permit and adjacent areas are grazing of range land. No irrigated agriculture occurs within the permit and adjacent areas.

Flood Irrigation. No flood irrigation occurs within the WRDS disturbed area boundary or permit areas. According to Section 411.130 of this amendment and the approved M&RP, the nearest area of irrigated agriculture is located approximately 14 miles southwest of the WRDS.

CHAPTER 7

HYDROLOGY

CHAPTER 7

HYDROLOGY

710 INTRODUCTION

~~1.3 Disposal Site~~

The waste rock disposal site (WRDS) is located next to a paved county road that is presently used for access to the mine. Part of the site was previously disturbed for use as a borrow area for material to repair a slide on the county road in 1981. The site is situated between two natural drainages and, consequently, will cause only minimal disturbance to the existing drainages. The waste rock will be placed to fit in with the natural contour to the extent allowed. Drainage from the waste rock disposal area will be treated with a sediment pond(s), silt fences and other sediment controls. The drainage from the surrounding undisturbed area will be routed around the disturbed area when possible.

711 General Requirements

This chapter presents a description of:

Proposed operations and the potential impacts to the hydrologic balance;

Methods of compliance with design criteria and the calculations utilized to show compliance; and

Applicable hydrologic performance standards.

712 Certification

When required by regulation a qualified, registered professional engineer has certified maps, plans, and cross sections presented in this chapter.

713 Inspection

Impoundments will be inspected as required by Section 514.300.

720 ENVIRONMENTAL DESCRIPTION

721 General Requirements

This section presents a description of the pre-mining hydrologic resources within the permit and adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operation.

722 Cross Sections and Maps

722.100 Location and Extent of Subsurface Water

No seeps or springs are present within the boundary of the WRDS or in the immediate area.

722.200 Location of Surface Water Bodies

No surface water bodies lie within the WRDS boundary and there are no surface water bodies immediately adjacent to the WRDS.

722.300 Locations of Monitoring Stations

In five of the borings drilled under the direction of Sargent, Haskins and Beckwith (Appendix II), ~~PVC~~ observation wells were installed for the purpose of long term monitoring of the ground water conditions at the site. Refer to Figure 5 for monitoring well locations.

722.400 Location and Depth of Water Wells

No water-supply wells exist at the WRDS.

722.500 Surface Topography

Surface topographic features in the permit and adjacent areas are shown on the base map used for Map Series 2, 4~~A, 4B~~, 5, ~~5A~~ and 8.

723 Sampling and Analysis

Refer to Section 7.2.3 of the approved M&RP.

724 Baseline Information

Baseline data for the sampling of the groundwater water wells are located in Exhibit 6. No perennial or intermittent streams pass through the area. Surface flow is limited to storm and/or snow melt runoff, therefore no surface water baseline information was collected.

724.100 Groundwater Information

~~**2.3 Ground Water Hydrology**~~

No free ground water was encountered in the soils overlying the bedrock. Water was encountered in the bedrock formation. Original ground water levels in the observation wells are recorded below. ~~on the Well Completion Records which are included in Appendix A of the SHB report included as Appendix II.~~ Subsequent observation well level measurements are found on the Division's EDI data site. Activity at the disposal site will have no impact on the ground water system. Refer to Section 731.200 for additional information.

Depth to Groundwater. Water level measurements from the monitoring wells located on or immediately adjacent to the site indicate that water is found at a depth ranging from 23 to 48 feet below ground surface.

724.200 Surface Water Information

~~**2.4 Surface Water Hydrology**~~

Surface drainage of the immediate site area appears to be good. No existing springs are within the proposed waste rock disposal area; however, some spring activity is present to the north and east of the WRDS ~~forty acre parcel of property~~. ~~A cut section of the county road to the east of~~

~~the property has experienced some localized, shallow seated instability due to spring seepage in the cut slopes.~~

Drainage of the area to the north of the ~~proposed~~ currently filled area is directed by culverts through the county road embankment fills. The culverts are located to the east and west of the waste disposal area and discharge into natural channels. Some natural erosion is evident in the channels. However, at a point approximately half way along the south side of the disposal site, the channels fade into an open grassy area and becomes almost indiscernible. The lack of defined channels through the lower half of this down slope drainage area emphasizes the lack of significant surface flow in the recent past.

In 2014 the road drainage system was relocated to the outside of the county road, thus removing the road drainage from entering or flowing into the WRDS as described in the previous paragraph.

~~At the time the exploration was made, the surface of the site was firm and the drilling equipment experienced no problems.~~

The only impact on the surface water hydrology will be that associated with collection of the water from the disturbed area, routing of this water through the sedimentation pond and the routing of water from the undisturbed area around the waste disposal area . No perennial or intermittent streams pass through the area. Flow is limited to storm and/or snow melt runoff.

724.300 Geologic Information

Geologic information related to the WRDS and adjacent areas is presented in Chapter 6 of this submittal and the approved M&RP.

724.400 Climatological Information

Climatological information is discussed in Chapter 4.

724.500 Supplemental Information

The information pertinent to a determination of the probable hydrologic consequences of the constructing, maintaining, and reclaiming of the proposed refuse pile are presented in both this submittal and the approved M&RP.

724.600 Survey of Renewable Resource Lands

The existence and recharge of groundwater systems in the refuse pile and adjacent areas is discussed in Section 724.100 of this submittal and the approved M&RP.

724.700 Alluvial Valley Floor Requirements

Information regarding the presence or absence of alluvial valley floors in the permit and adjacent areas is presented in Chapter 6.

725 Baseline Cumulative Impact Area Information

The hydrologic and geologic information required for the Division to develop a Cumulative Hydrologic Impact Assessment is presented in the approved M&RP and this submittal under Chapters 6 and 7. Required information not available in these chapters is available from the Utah Divisions of Water Rights and Water Resources and from the U.S. Geological Survey and the U.S. Bureau of Land Management.

726 Modeling

No numerical groundwater or surface water modeling was conducted in support of this submittal.

727 Alternative Water Source Information

Not applicable.

728 Probable Hydrologic Consequences

728.100 Potential Impacts to Surface and Groundwater

Potential impacts of storing refuse and materials in this area on the quality and quantity of surface and groundwater flow may include:

Contamination from acid- or toxic- forming materials;
Increased sediment yield from disturbed areas;
Increased total dissolved solids concentrations;
Impacts to groundwater or surface water availability;
Hydrocarbon contamination from the use of hydrocarbons in the WRDS; and
Contamination of surface and groundwater from road salting activities.

These potential impacts are addressed in the following sections and in the approved M&RP.

728.200 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of the approved M&RP and this submittal. Baseline hydrologic information is presented in Sections 7.2.4 of the approved M&RP and UDOGM water database.

728.300 PHC Determination

Protection of Hydrologic Balance - There are no streams, springs or seeps within the fill area. Based on the consultant's report, no underdrains or rock core chimney drains will be required. Consequently, there will be no disruption of any underground aquifer.

The only surface flow in the area is that associated with storm or snow melt runoff. The disposal site lies between the natural runoff courses. Therefore, the only disruption of surface flow is that associated with directing surface runoff ~~from the undisturbed area~~ to the sedimentation pond. Discharge, if any, from the sedimentation pond is returned to the natural drainage.

The existing wells have been drilled and completed using techniques designed to prevent transfer between aquifers. Should additional wells be required, the hydrologic balance will continue to be protected through the use of approved construction methods. Upon abandonment, ~~all~~ water monitoring wells will be removed as described in this Section and in compliance with the Administrative Rules for Water Well Drillers as published by the Utah Division of Water Rights. Upon abandonment the shallow well casing pipes will be pulled from the ground or cut off a minimum of 5 feet below the surface and then buried.

~~Beyond these required diversions and well construction techniques, no additional effort is planned to protect the hydrologic balance.~~

Acid- or Toxic- Forming Materials. Refer to Section 731.300.

Sediment Yield. The potential impact of construction, maintenance, and reclamation of the refuse pile on sediment yield is an increase in sediment in the surface waters downstream from disturbed areas. Sediment-control measures (such as diversions, sediment pond, straw bales, etc.) will be installed to minimize this impact. These sediment control measures will be inspected and maintained to ensure that they remain in proper operating condition.

Various sediment-control measures will be implemented during reclamation as the vegetation becomes established. As discussed in Section 542.200 of this submittal, these measures will include maintenance of sediment pond, berms, and diversions in appropriate locations to minimize potential contributions of sediment to off-site areas. These measures will reduce the amount of erosion from the reclaimed areas, thereby precluding adverse impacts to the environment.

Once vegetation is adequately established, the berms will be pushed into the diversion ditches and revegetated in accordance with Chapter 2 and 3 of this submittal. Additionally, the sediment pond embankment will be breached and the outlet works of the sediment pond will be removed, thereby ensuring a positive drainage from the site area.

Potential Hydrocarbon Contamination. Diesel fuel, oils, greases, and other hydrocarbon products will not be stored at the site. Fuels, greases and other oils may leak from equipment during construction operations. These spills will be handled as specified in the approved M&RP.

Road Salting. No salting of roads will occur within the WRDS. Hence, this impact is not a significant concern. However, there is a potential for contribution of salt to the site from salt being applied under the direction of the county to the county road adjacent to the WRDS on three sides (east, west and north).

729 Cumulative Hydrologic Impact Assessment (CHIA)

A Cumulative Hydrologic Impact Assessment to include the permit and adjacent areas is to be prepared by the Division.

730 OPERATION PLAN

731 General Requirements

731.100 Hydrologic-Balance Protection

Groundwater Protection. The affect on groundwater in this area is expected to be minimal as discussed in Section 724.200. Groundwater will not be encountered or used during construction, maintenance, and reclamation of the WRDS. The monitoring wells that have been drilled in this area are used to aid in monitoring the potential impacts of the refuse pile.

Surface Water Protection. To protect the hydrologic balance, construction, maintenance, and reclamation operations will be conducted to handle earth materials and runoff in a manner that prevents, to the extent possible, additional contributions of suspended solids to stream flow outside the permit area, and otherwise prevents water pollution. Additionally, CFC will maintain adequate runoff- and sediment-control facilities to protect local surface waters.

During initial construction of the WRDS Expansion and prior to installation of the runoff- and sediment-control facilities, silt fences will be installed along the down gradient edge of the WRDS construction. These silt fences will be installed in accordance with the approved M&RP. If required for control of local erosion, straw-bale dikes may also be installed at the site during initial construction. The silt fences and straw-bale dikes will be periodically inspected, and accumulated sediment will be removed as needed to maintain functionality. Once the diversion ditches are installed, the silt fences and straw-bale dikes will be removed.

The initial placement of waste rock will take place in an area lower than the existing surrounding grade. The operator will construct the appropriate ditches adjacent to and upstream of the growing pile once the surface of the pile meets and exceeds the level of the surrounding existing ground surface. Prior to construction of the ditches, a temporary interim berm will be constructed upstream of the below-grade storage area to divert water to the sediment pond (Map 5A).

Once the runoff- and sediment-control facilities outlined in Section 732 have been installed, these structures will prevent additional contributions of suspended solids to streamflow outside the permit area. A description of sediment control following reclamation is presented in Sections 540 and 760 of this submittal. and the approved M&RP.

731.200 Water Monitoring

~~2.3 Ground Water Hydrology~~

No free ground water was encountered in the soils overlying the bedrock. Water was encountered in the bedrock formation. Original ground water levels in the observation wells are recorded below. ~~on the Well Completion Records which are included in Appendix A of the SHB report included as Appendix II.~~ Subsequent observation well level measurements are found on the Division's EDI data site. Activity at the disposal site will have no impact on the ground water system.

~~4.7.2 Ground Water Monitoring~~

In the monitoring wells, water quality and ground water levels were monitored monthly for the first six months to accelerate data collection. Thereafter, monitoring shall follow the "Groundwater Sampling Schedule" guidelines ~~in Table 4.7.2-1~~ and the parameter list ~~as shown on Table 4.7.2-2.~~ The adequacy of the operational parameter list was ~~will be~~ reviewed at the completion of baseline data collection.

There is no evidence that ground water in the area rises high enough to interfere with the ~~proposed~~ sediment pond(s). ~~While~~ The sample sites ~~are rather minimal, the~~ data show that the piezometric surface dips to the southwest as shown on Map 6. No seeps or springs have been identified to the west along the Salina Canyon. The ground water level slope to the southwest is verified by recent water level data taken in the wells. Well locations are shown on Figure 5.

Observation Well - Ground Water Level (Sergent, Hauskins & Beckwith's (SHB) **Report Appendix II)**

Well No.	**Sample Date**	**Water Level (Feet)**
3	9/14/83	23.6
	10/3/83	24.8
5	9/15/83	46.7
	10/3/83	48.5
6	9/14/83	37.9
	10/3/83	37
7	9/15/83	37.1
	10/3/83	44.5

~~TABLE 4.7.2-1~~

GROUND WATER SAMPLING SCHEDULE

	Baseline	Operational	Post Mining
Type of Sampling Site	Observation Wells	Observation Wells	Observation Wells
Field Measurements	Yes	Yes	Yes
Sampling Frequency	At least four samples per annum, at fixed monthly intervals.	Three samples per annum at fixed monthly intervals.	One sample per annum.
Sampling Duration	Two years (six months of data before approval of PAP) have ceased.	Three samples per annum at fixed monthly intervals.	Every year until termination of bonding.
Type of Data Collected and Reported	Water levels and water quality.	Water levels and water quality per operational parameters	Water levels and water quality per operational parameters
Comments	During the year preceding repermitting. One sample per baseline parameter.		

~~Monitoring data will be submitted to the division within 90 days of the end of each quarter.~~

~~TABLE 4.7.2-2~~

GROUND WATER BASELINE AND OPERATIONAL ~~AND POSTMINING~~ WATER QUALITY PARAMETER LIST

Field Measurements:

*	-	Water Levels or Flow
*	-	pH
*	-	Specific Conductivity (umhos/cm)
*	-	Temperature (C°)

Laboratory Measurements: (mg/l) (Major, minor ions and trace elements are to be analyzed in dissolved form only.)

*	-	Total Dissolved Solids
*	-	Total Hardness (as $CaCO_3$)
	-	Aluminum (Al)
	-	Arsenic (As)
	-	Barium (Ba)
*	-	Boron (B)
*	-	Carbonate (CO_3 -2)
*	-	Bicarbonate (HCO_3 -)
	-	Cadmium (Cd)
*	-	Calcium (Ca)
*	-	Chloride (CL-)
	-	Chromium (Cr)
	-	Copper (Cu)
	-	Fluoride (F-)
*	-	Iron (Fe)
	-	Lead (Pb)
*	-	Magnesium (Mg)
*	-	Manganese (Mn)
	-	Mercury (Hg)
	-	Molybdenum (Mo)
	-	Nickel (Ni)
	-	Nitrogen: Ammonia (NH_3)
	-	Nitrite (NO_2)

- Nitrate (NO_3 -)
- * - Potassium (K)
- Phosphate (PO_4 -3)
- * - Selenium (Se)
- * - Sodium (Na)
- * - Sulfate (SO_4 -2)
- Sulfide (S-)
- Zinc (Zn)

Sampling Period:

-Baseline

*Operational~~, Postmining~~

At the conclusion of site operation but prior to the removal of the sediment pond, water flowing into the pond will be monitored on a seasonal basis.

Monitoring Wells. As waste is placed around the casings of the monitoring wells, the casing will be extended so that monitoring of each well can continue until reclamation of the site or until the wells are abandoned.

~~**4.7.3 Water Quality**~~

~~Tabulated copies of water quality data collected to date may be found in Division's EDI data.~~
Water quality at the disposal site is saline with sulfate and chloride being the dominant contributors. Drill holes number B-3 ~~three~~ and B-6 ~~six~~ are currently the only holes below the road providing water quality data with quality at these holes being rather consistent. Drill holes number B-5, B-7, ~~five, seven,~~ and B-9 ~~nine~~ have not had either sufficient water or a recharge rate which would facilitate water quality sampling. Drill hole number B-8 ~~eight~~ located above the road appears to have tapped an aquifer which does not continue to the disposal site. This well has a total dissolved solids concentration of approximately 40% of that found in wells B-3 and B-6 and a recharge rate sufficient to preclude detectable draw-down with a bailer.

731.222 Point Source Discharge

The water collected and treated in the new (full containment) sediment pond (constructed 2015-2016) will be sampled should it discharge in accordance with R645-301-751. The sample will be analyzed for Total Iron, Total Dissolved Solids, Total Suspended Solid, pH and flow.

731.300 Acid- and Toxic-Forming Materials

Acid- or toxic forming materials are not expected to be produced from the mine. CFC commits to monitor materials produced and analyze them for acid- or toxic-forming materials. If materials are identified, they will be placed in the refuse pile and covered with 4 feet of non-acid, non-toxic, non-combustible materials. Copies of the toxicity/acid-base results from the samples collected are incorporated into the mine's Annual Report.

731.400 Transfer of Wells

The ground water monitoring wells, which exist at the site, will be abandoned following the reclamation of the site when no longer required for ground water monitoring. Therefore, no well transfers are required.

731.500 Discharges

No mines are located in the WRDS, thus no discharges to mines is possible.

731.600 Stream Buffer Zones

There are no streams within the WRDS area or immediately adjacent therefore there will not be constructed within 100 feet of a perennial stream. No stream channel diversions are planned and no buffer zone designation is necessary at this site.

731.700 Cross Sections and Maps

Maps ~~5,~~ 5A and Figure 5 shows the location of monitoring wells, and the proposed location of the diversion ditches and culverts and sediment pond associated with the WRDS. Appendix VII presents the design details of the sediment pond with appropriate cross sections of the pond and embankment (Map 7).

731.800 Water Rights and Replacement

No surface or groundwater sources with an associated water right are located within the WRDS boundary.

Water rights in the area adjacent to the disposal site: ~~are shown on Table 4.7.1-1~~. Right 95-1006 is identified in the Division of Water Rights documents as a pond used for stock watering under a 1879 priority. There is no evidence that this pond is currently in use.

The Exchange rights E 2118 and E 2119 were transferred from the Salina Trunk Canal for the purpose of supplying water to a recreational subdivision. A new well site was approved at a location, approximately 600 feet down drainage from the sedimentation pond. However, the well was drilled at a location approximately 1,000 feet east of the approved site. This well failed to deliver an adequate water supply and the site was abandoned. The water level in the abandoned well is at 228.8 feet. A new well has been drilled at a location N 1737 ft, E 1166 ft from the S 1/4 Cor of Sec 6, T 22 S, R 4 E, SLBM. An application is being processed to again transfer these water rights. This new well is far beyond a point of potential impact from the disposal site activity.

~~**TABLE 4.7.1-1**~~

AREA WATER RIGHTS

WATER USE CLAIM NO.	OWNER	SOURCE	FLOW (cfs)	PURPOSE OF USE	PERIOD OF USE
95-1006	USFS	Surface	510 units Livestock	Livestock Watering	6-1 to 10-5
E 2118	Howard W. Nielsen	Underground	0.046	Recreation	5-1 to 10-31
E 2119	Marlin Sorensen, Jr.	Underground	0.46	Recreation	3-15 to 10-15

LOCATION

95-1006 SE SW Sec 18, T 22 S, R 4 E, SLBM

E 2118 S 1820 ft W 240 Ft from N 4 Cor, Sec 18, T 22 S, R 4 E, SLBM

E 2119 S 1820 ft W 240 ft from N 4 Cor, Sec 18, T 22 S, R 4 E, SLBM

732 Sediment Control Measures

The sediment control measures within the WRDS have been designed to prevent additional contributions of sediment to stream flow or to runoff outside the permit area. In addition, they have been designed to meet applicable effluent limitations, and minimize erosion to the extent possible.

The structures to be used for the runoff-control plan for the permit area include disturbed and undisturbed area diversion channels, a sedimentation pond, berms, silt fences, and road diversions and culverts.

732.100 Siltation Structures

The siltation structure within the permit area is a sediment pond as described in Section 732.200. In addition to the sediment pond, a berm encircles the topsoil/subsoil stockpiles, providing treatment and total containment of the runoff from the stockpiles. Typical cross sections of the ditches, berm and containment area are located in Appendix VII.

732.200 Sedimentation Ponds

~~3.2.1 Sedimentation Pond~~

Existing Pond - A sedimentation pond was constructed down gradient from the rock fill area to control sediment removed from the disturbed areas by surface runoff. The pond was constructed prior to disturbing any other areas of the site. It will remain in place until the ~~waste rock disposal area has been completely reclaimed.~~ new pond is constructed as shown on Map 7 and described in Appendix VII.

~~**3.2.2 Operating Pond Requirements**~~

The sediment pond provides capacity in excess of requirements with present project conditions. The principle maintenance requirement will be sediment removal. When the sediment storage area is 60 percent full, which is at an average elevation of 7886.00 feet, sediment will ~~must~~ be removed from the pond.

The pond consists of an excavated storage basin. Suitable material removed from the excavation was used to construct an embankment on the downstream perimeter of the excavation to yield a maximum storage depth in the pond of 5.70 feet.

The embankment has a top width of I0 feet, a minimum height of 6.8 feet with exterior side slopes of 2.5h:Iv. The bottom of the pond was constructed at an elevation of 7885.00 feet.

In accordance with Section 73-5-12 of the Utah Code Annotated 1953, before commencing construction of the sediment pond for the project, written notice was given to the State Engineer, Division of Water Rights.

The embankment and excavated pond area was grubbed of the organic material and the topsoil removed and stored for future use. It is estimated that 24 inches of topsoil was removed from the area.

The top 9 inches of the grubbed and stripped area for sediment pond embankment construction was scarified and recompacted to 90 percent of the maximum dry density as determined by ASTM D1557 procedures. Moisture content during compaction was maintained at -1 to +3 percent of the optimum as determined by ASTM D1557.

Embankment fill material was placed in horizontal lifts not exceeding nine inches in thickness prior to compaction. Embankment material was compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557. Embankment material was free of organic material, and had a plasticity index as determined by ASTM D423 and D424 of not less than five. Waste rock was not used for embankment fill for the settling pond.

The embankment was constructed with interior and exterior slopes of 2.5h:lv. The top of the embankment was constructed at an elevation 7892.2 feet, providing 1.0 foot of freeboard above the maximum water surface and five percent for settlement. To prevent erosion, the exterior slopes were vegetated and the interior slopes covered with rip-rap and filter fabric in accordance with the recommendation presented in Section 5.3.3 of the SHB report.

The principal spillway consists of a 12 inch diameter corrugated metal pipe (CMP) with the inlet at an elevation of 7889.5 feet. A 36 inch CMP skimmer was placed around the inlet as shown on Section E-E' of Figure 1.

The CMP was placed at an average gradient of 4.4 percent through the embankment. Structural fill within 2.0 feet of the CMP was hand compacted to a dry density of at least 90 percent of ASTM D1557 at a moisture content of -1 to +3 percent of optimum. During placement and compaction of the fill along the CMP, the pipe was preloaded to prevent it from pushing up and out of alignment. Preload was maintained until at least 1/2 the pipe diameter had been placed and compacted. Two anti-seep collars with minimum dimensions of three feet high by three feet wide were placed around the CMP as shown in Figure 1. The anti-seep collars have water-tight connections to the CMP.

At the outlet of the principal pond spillway, a rip-rap apron was constructed as shown on Figure 1 to prevent damage to the downstream embankment slope.

Rip-rap conforms to the following gradation:

Size, Inches	Percent Passing
18	100
9	45-35
4	15-0

Rip-rap is hard, durable, and free from rocks having a maximum dimension three or more times greater than the minimum dimension of the particle.

Prior to rip-rap placement, a filter fabric ~~such as Phillips 66 SUPAC 5NP, Mirafi 140N, Dupont TYPAR 3401~~ or an approved equivalent, was placed on the prepared soil surface to prevent erosion and undermining of the rip-rap. A sand or 3/4 inch road base blanket was placed over the fabric to protect it from punctures during rip-rap placement.

~~2.4.2~~ Hydrologic Design Criteria of the Sedimentation Pond

Calculations of hydrologic design criteria are presented in Appendix III. Runoff volumes were calculated using SCS procedures.

The maximum capacity of the proposed sediment pond is 33,360 cubic feet. An ultimate sediment load based on 3 year loading was determined to be 9,148 cubic feet. Sediment volume is based on 0.0697 acre-foot per year for the 7.93 acres of disturbed area. In addition, a l0 year, 24 hour storm on the area would produce 21,792 cubic feet of runoff assuming no infiltration or collection. The total storage required for the reservoir is therefore 30,940 cubic feet. The additional storage volume is to allow for detention of a 10-year, 24-hour storm should the pond have water at the beginning of the storm.

The emergency spillway was designed to convey a 25 year, 24 hour flood flow through the pond safely with one foot of freeboard, assuming the pond was full at the beginning of the storm and no routing in the pond. The emergency spillway consists of a rip-rap lined ditch of trapezoidal cross-section. The side slopes are 3h:lv. The bottom width is 3 feet with a minimum depth of 0.75 feet. Rip-rap and filter blanket are in accordance with the recommendations in Appendix III. The crest elevation of the emergency spillway is 7890.70 feet.

The sedimentation pond will remain in a functional condition until the new sediment pond is constructed and operational ~~disposal site has been reclaimed and the revegetation effort deemed successful in accordance with the standards established in Section R645-301-356. At this point, the discharge structure will be removed, the site leveled to approximate original contours and the site revegetated using the same methods as previously used during reclamation of the disposal site.~~

~~3.2.3~~ **Decanting Impoundment** - A decanting impoundment was constructed down gradient from the sedimentation pond to be used for decanting of the sediment pond during sediment removal~~. It will remain must in place until the waste rock disposal area has been completely restored.~~ The impoundment consists of an excavated storage basin. Suitable material removed from the excavation was used to construct an embankment on the downstream perimeter of the excavation to yield a maximum storage depth in the impoundment of 2.0 feet.

The top of the embankment has a top width of 8 feet and was constructed at an elevation of 7881.25 feet, providing 1.0 feet of freeboard above the maximum water surface and five percent for settlement with interior and exterior side slopes of 2.5h:1v. The bottom of the impoundment was constructed at an elevation of 7878.00 feet.

The embankment and excavated impoundment area was grubbed of the organic material and the topsoil removed and stored for future use. It is estimated that 24 inches of topsoil was removed from the area. The decant impoundment construction followed the procedures described previously in the sediment pond requirements. ~~2.4.3~~ **Hydrologic Design Criteria of the Decanting Impoundment**

Calculations and Hydrologic design criteria are presented in Appendix III. Runoff volumes were calculated using SCS procedures.

The maximum capacity of the decanting impoundment is 5,048 cubic feet. An ultimate sediment load based on 3 year loading was determined to be 654 cubic feet. In addition, a 10 year, 24 hour storm on the area would produce 3,655 cubic feet of runoff assuming no infiltration. The total storage required for the impoundment is therefore, 4309 cubic feet.

The emergency spillway was designed to convey the 25 year, 24 hour flood flow from the sediment pond through the impoundment safely with one foot of freeboard, assuming the pond was full at the beginning of the storm and no routing in the pond. The emergency spillway consists of a rip-rap lined ditch of trapezoidal cross-section. The bottom width is 4.6 feet with a depth of 1.5 feet. Rip-rap and filter blanket are in accordance with the recommendations in

Appendix III. The crest elevation of the impoundment emergency spillway is 7880.25 feet. The decant impoundment will be removed during the expansion of the WRDS.

~~The top 9 inches of the grubbed and stripped area for embankment construction was scarified and recompacted to at least 90 percent of the maximum dry density as determined by ASTM D1557 procedures. Moisture content during compaction was maintained at -1 to +3 percent of the optimum as determined by ASTM D1557.~~

~~Embankment fill material was placed in horizontal lifts not exceeding nine inches in thickness prior to compaction. Embankment material was compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557.~~

~~Embankment material was free of organic material, and had a plasticity index as determined by ASTM D423 and D424 of not less than five. Waste rock was not used for embankment fill for the impoundment.~~

~~To prevent erosion, the interior and exterior slopes were vegetated. in accordance with the recommendation presented in Section 5.3.3 of the SHB report.~~

~~Rip-rap conforms to the following gradation:~~

~~Size, Inches~~	~~Percent Passing~~
~~18~~	~~100~~
~~9~~	~~45-35~~
~~4~~	~~15-0~~

~~Rip-rap is hard, durable, and free from rocks having a maximum dimension three or more times greater than the minimum dimension of the particle.~~

~~Prior to rip-rap placement, a filter fabric such as Phillips 66 SUPAC 5NP, Mirafi 140N, Dupont TYPAR 3401 or an approved equivalent, was placed on the prepared soil surface to prevent erosion and undermining of the rip-rap. A sand or 3/4 inch road base blanket could also be placed over the fabric to protect it from punctures during rip-rap placement.~~

New Pond - Reference Appendix VII and Map 7 for the hydrology information pertaining to the new pond.

"The average annual anticipated sediment yield from disturbed areas at the site was calculated using an assumed value of 0.1 acre-feet per acre per year from Section 7.4.2.2 of the SUFCO Mining and Reclamations Plan. The sediment yield from the undisturbed areas was 0.04 acre-feet per year from the study by Sergent, Hauskins, and Beckwith (1984).

The average annual sediment yield in acre-feet per acre for each watershed was multiplied by the watershed areas to find the annual volume of sediment yield from each area. The volumes for each watershed were summed to determine the total annual sediment yield draining into the sedimentation pond. The maximum calculated annual sediment yield for the area draining into the sedimentation pond is 4.22 acre-feet per year.

Sediment Pond Capacity - The sedimentation pond will retain runoff from a 10-year, 24-hour storm event from contributing watersheds (3.3 acre-feet) and one year of sediment yield (4.22 acre-feet), for a total of 7.52 acre-feet. The total designed capacity of the sedimentation pond is 10.01 acre-feet at the elevation of 7,841 feet.

Storm water discharge peak flows were estimated using SCS methodology and modeled via HEC-HMS version 3.3 for the 10-year 24-hour storm event. Proposed channels were sized for the design storm event using Bentley FlowMaster version V8i.

The sedimentation pond was designed according to Utah State Rule R645-301-742 and 743 to safely retain the 10-year 24-hour storm event and one year of predicted sediment yield. Riprap was sized to protect CC-1, DD-5 and UD-2 channels from potential erosion during the design storm event. The final proposed channel dimensions and riprap sizes are presented in Table 3 and Table 5. The detailed calculations are documented in Appendix A and Appendix B. Appendix C contains conveyance structure details (Appendix VII)."

Compliance Requirements. The sedimentation pond will be maintained until removal in accordance with the reclamation plan. When the pond is removed, the land will be revegetated in accordance with the reclamation plan defined in Section 540.

MSHA Requirements. MSHA requirements defined in 30 CFR 77.216 are not applicable since the sedimentation pond will not impound water or sediment to an elevation of 20 feet or more above the upstream toe of the structure. The pond will have a storage volume of less than 20 acre-feet.

732.300 Diversions

The objective of the runoff control plan is to isolate, to the maximum degree possible, storm water runoff from disturbed areas from that of undisturbed areas. A brief description for each proposed diversion structure follows.

Watersheds & Hydrologic Plan: The delineated watersheds are shown on Map 5 and described in Table 1 of the report in Appendix VII , the operational hydrology plan is shown on Map 5A. Peak flows and total runoff volumes for the site drainage are tabulated in Appendix A and in Table 2 of the report "Sufco Waste Rock Pile Hydrology", Jones & DeMille Engineering in Appendix VII.

Sufco Waste Rock Pile Hydrology", Jones & DeMille Engineering The areas contributing to the site runoff discharged to the sedimentation pond are the waste rock pile, topsoil/subsoil piles, disturbed areas, and sedimentation pond area. Runoff from the undisturbed watersheds will be safely conveyed around disturbed areas and the sedimentation pond as shown on Maps 5 and 5A (WRDS M&RP).

~~3.1.1 Runoff Control~~

~~Based on the size, configuration, and open graded structure of the waste rock fill and its location at the site, no underdrains or rock core chimney drains will be required. There were no springs or seeps within the proposed fill area at the time of the investigation which would require special treatment.~~

Runoff Control

~~All~~ surface precipitation falling directly on and infiltrating the underground development waste fill shall be channeled to a sedimentation pond ~~located down gradient from the toe of the disposal area fill~~. The active pad area for waste placement will be sloped at approximately 2% toward the nearest drainage control structures ~~south and east~~ to promote drainage of precipitation off the pad area. The drainage control structures will direct the runoff to the sediment pond(s) for treatment unless specified differently. An interception ditch will be routed down the slope of the fill ~~from the southeast corner~~ of the active pad to the base of the fill where runoff will be collected by a ditch ~~No. 2~~. ~~This interception ditch will be extended up the slope as each lift is completed. The pad area where waste rock placement active occurs will have a berm constructed around the outside edge about 2 ft high at a height to comply with MSHA requirements. This active pad area of waste rock placement will be sloped at about 2% to the east and south. Thus precipitation falling on the pad area will drain to the southeast corner where it will be routed down the slope of the fill~~. in an ~~interception ditch with a trapezoidal cross section. The bottom width of the ditch will be 2 ft with 1v:2h side slopes. Riprap with a~~ $\cancel{D_{50}}$ ~~of 10 inches will be used to line the ditch. This ditch will be a minimum of 0.7 ft deep, such that it can convey the 100 year, 6 hour event with 0.5 ft freeboard.~~ This configuration ~~will not allow any~~ should prevent the impounding of water on the surface of the fill. ~~Another interception ditch will be cut about 20 ft to~~

~~the west of the active fill slope. This ditch will have a triangular cross section with 1v:2h side slopes with a minimum depth of 0.9 ft. This interception ditch will route 100 year, 6 hour runoff to Ditch No. 2 which empties into the sedimentation pond.~~ Designs for these ~~temporary interception~~ ditches are in Appendix III, Engineering Calculations and in Appendix VII. The sedimentation pond is designed to handle the 10 year, 24 hour precipitation event. Design criteria for the sedimentation pond are presented in Appendices III and VII ~~Section 2.4.2.~~ .

~~All~~ Surface drainage from the areas above the site should be diverted around the disposal area. ~~from the point where it enters the site through the roadway embankment culverts.~~ Surface drainage from the county road above the site ~~must~~ will be controlled by a shoulder ditch and diverted away from the fill area. Design criteria for the site diversion ditches are presented in Appendices III and VII ~~Section 2.4.1~~

The sediment control measures at the waste rock disposal site are designed to adequately contain the sediment that is produced from the disturbed area. Surface water is collected from the undisturbed areas ~~which would drain into the disturbed area~~ and discharged below the disturbed area. Surface water collected within the disturbed area is collected and settled in the sedimentation pond(s) or the retention pond. No discharges to date have occurred from the sedimentation pond and none are expected ~~planned~~. ~~Thus, the impact of water collection to the surface water is the reduction of the amount of sediment and surface water available below the waste rock disposal site by that which is collected from the disturbed area and contained in the sedimentation pond.~~ No impact to surface water quality is expected. There were no springs or seeps within the proposed fill area at the time of the investigation which would require special treatment.

When the existing sedimentation pond is replaced Existing Diversion (ED)-1 and ED-2 channels will be reshaped to become a Combined Channel (CC)-1. CC-1 will channel runoff from DW-1 through Disturbed Culvert (DC)-1 into Diversion Ditch (DD)-5. DD-5 will convey the runoff from DW-1 and DW-2 to the new sedimentation pond. Runoff from DW-3 and DW-4 will follow the natural contours into the sediment pond inlet. DC-1 and DC-2 will remain during phased development but will be removed for the final reclamation of the site. DD-1 through DD-4 and DD-6 through DD-10 are designed to accept runoff from the largest watershed areas, but will exist and operate as required to convey runoff during the phased operations.

Undisturbed Watershed (UW)-1 and UW-2 runoff will be channeled around the sedimentation pond by UB-1, and will continue downstream of the site through the natural drainage. UW-3 and a portion of UW-4 will drain into UD-1 and through the level spreader to follow the existing terrain and be routed around the sedimentation pond, thereafter continuing through the natural drainage. A portion of UW-4 and UW-5 will flow through the natural drainage.

~~2.4.1~~ Diversion Ditches

Sergent, Hauskins & Beckwith's work on hydrology of the area was of an investigative nature. Subsequent designs of diversions used actual areas and runoff curve numbers that are believed to be more representative of the area. These calculations are included in Appendix III. A portion of these diversion ditches will be replaced during the waste rock expansion.

~~Diversion ditches are provided to direct runoff around the disturbed areas and sediment pond. Ditches will convey runoff from the disposal area to the sediment pond. These diversion ditches are shown on Map 2.~~

The maximum flow resulting from a 10 year, 24 hour storm was used as the design flow for each of the diversions. Ditches No. 1 and 2 conveying runoff to the sediment pond shall be trapezoidal shaped in cross-section. Both ditches have a bottom width of 12 inches and side slopes of 1:1 and are a nominal 16 inches deep. Ditch No. 2 is concrete lined, Ditch No. 1 is a dirt ditch with steep areas within the ditch being riprap lined. Ditch No. 1 was previously a concrete lined ditch, which will be broken up, left in place and covered with waste rock. This design will carry the 4.42 cfs of runoff expected from the disturbed area with 0.3 feet of freeboard. Design calculations are included in Appendix III.

Undisturbed drainage is routed around the disposal site and sediment pond using Diversions No. 1, 2, and 3 ~~as shown on Map 2.~~ ~~The drainage areas are shown on Map 3. Diversion No. 1 utilizes an existing culvert to convey part of the drainage area across the county road and onto an existing flood plain. This vegetated channel will adequately carry the runoff expected from the 0.19 square mile area. Another culvert will be used to collect the runoff from Area No. 2 and convey it across the county road. The diversion utilizes a vegetated ditch 0.90 feet deep and 19 feet wide of parabolic cross-section. Diversion No. 3 will route road runoff away from the facility. Design calculations for these diversions are included in Appendix III.~~

~~There will be no stream diversions in connection with the operation of the rock disposal site. Diversions ditches separating the disturbed and the undisturbed areas will be left in place at the conclusion of mining activities. Reclaiming these ditches would disturb the existing vegetation and would result in unnecessary soil and vegetation disturbance~~

732.400 Road Drainage

No permanent roads are to be built within the WRDS. Road drainage facilities will include diversion ditches and culverts. The road drainage diversion ditches and culverts for the WRDS are included in the list of diversions presented in Section 732.300 above. Additional road drainage design information is presented in Section 742.

The road drainage diversions will be maintained and repaired as needed. The culvert to be installed in the county road borrow ditch within the disturbed area is discussed in Section 742.300.

733 Impoundments

733.100 General Plans

Refer to Section 732.200.

Certification. The maps and cross sections of the sedimentation pond have been prepared by or under the direction of, and certified by a qualified, registered, professional engineer.

Maps and Cross Sections. The topography and cross sections for the sedimentation pond are provided on Map 7 of this submittal.

Narrative. A description of the sedimentation pond is presented in Sections 732.200 and 742 of this submittal.

Subsidence Survey Results. No underground coal mining will occur beneath the proposed sedimentation pond. Therefore, there will be no effects on the pond or pond embankment from subsidence.

Hydrologic Impact. The hydrologic and geologic information required to assess the hydrologic impacts of the proposed sedimentation pond are presented in Section 724 and Chapter 6 of this submittal and approved M&RP, respectively.

Design Plans and Construction Schedule. There are no additional structures proposed for the WRDS at this time. Any structures proposed in the future will not be constructed until the Division has approved the detailed design plan for the structure.

733.200 Permanent and Temporary Impoundments

Requirements. The sedimentation pond(s) has been designed using current, prudent engineering practices. Specific foundation design and construction criteria are presented in Chapter 5 of this submittal. Specific hydrologic design criteria for the pond are presented in

Section 743. The pond(s) will be inspected regularly based on the schedule contained in Section 514.300.

Permanent Impoundments. There are no permanent impoundment structures proposed for use in mining and reclamation operations within the permit and adjacent areas.

Temporary Impoundments. The Division's authorization is being sought for the construction of the sedimentation pond as a temporary impoundment at the WRDS as part of coal mining and reclamation operations.

Hazard Notifications. The sedimentation pond(s) will be examined for structural weakness and erosion in accordance with the schedule presented in Section 514.300. A report of these findings will be submitted to the Division as outlined in Section 514.300.

734 Discharge Structures

Discharge structures within the WRDS will consist of the emergency spillway on the sedimentation pond. The discharge structures will be constructed and maintained to comply with R645-301-744.

735 Disposal of Excess Spoil

There will be no excess spoil generated in the WRDS.

736 Coal Mine Waste

Coal mine waste generated by the Sufco Mine, will be stored and disposed of as described in Chapter 5 of this submittal.

737 Noncoal Mine Waste

Noncoal mine waste will be stored and disposed of as described in Chapter 5 of the approved M&RP.

738 Temporary Casing and Sealing of Wells

The groundwater monitoring well identified on Figure 5 will be operated and maintained as described in Section 748.

740 DESIGN CRITERIA AND PLANS

741 General Requirements

The site-specific plans incorporate design criteria for the control of drainage from disturbed and undisturbed areas.

742 Sediment Control Measures

742.100 General Requirements

Design. Sediment-control measures have been designed to:

Prevent additional contributions of sediment to stream flow or to runoff outside the permit area;

Meet the effluent limitations defined in Section 751 of this amendment; and

Minimize erosion to the extent possible.

Measures and Methods. Retention of sediment within the disturbed area;

Diversion of upstream runoff away from the disturbed area; and

Measures and methods such as silt fences, riprap, contemporaneous revegetation, vegetative sediment filters, sediment pond, and other measures that reduce overland flow velocities, reduce runoff volumes or trap sediment.

742.200 Siltation Structures

General Requirements. Additional contributions of suspended solids and sediment to runoff outside the permit area will be prevented to the extent possible using a sedimentation pond. The pond will be constructed before refuse pile construction operations begin. A qualified registered professional engineer will certify pond construction.

Sedimentation Ponds. The location of the sedimentation pond(s) is shown on Map 7 and described in Section 732.200. The pond will not be located within a perennial stream channel.

Sediment Removal. Sediment removal from the sedimentation pond will occur when the sediment level reaches the 60% clean-out level. **A marker will be built in the pond, designating the 60% sediment clean-out level.** The sediment will be disposed in the refuse pile as discussed in Section 526.100 and 732.200 of this M&RP.

New Pond Design Event. The sedimentation pond has been designed to contain runoff resulting from a 10-year, 24-hour event (3.3 acre-feet) and one year of predicted sediment yield (4.22 acre-feet).

New Pond Detention Time. The total design capacity for the sediment pond is 10.01 acre-feet.

New Pond Runoff Volume. The total runoff volue contributing to the sediment pond resulting from a 10-year 24-hour storm even for disturbed area DW-1 through DW-5 is approximately 3.3 acre-feet. The total runoff volume of the undisturbed areas conveyed around the pond is approximately 2.0 acre-feet.

Dewatering Device. Refer to Map 7 and Appendix VII.

Excessive Settlement. The sedimentation pond is to be incised in native material. Therefore, it is not expected that embankment settlement will be a significant concern. Stability analyses presented in Appendix II(A) indicate that the pond embankment will be stable under both normal and rapid drawdown conditions.

Embankment Material. The sedimentation pond inslope will be shaped to provide a 2H:1V slope. The sedimentation pond will be incised in native materials. The material to be used will be free of sod, large roots, and frozen soil. Materials that are disturbed during the inslope reshaping will be compacted.

Other Treatment Facilities. There are no other treatment facilities within the mine permit area.

Exemptions. No exemptions are being proposed at this time.

742.300 Diversions

General Requirements. The diversions within the WRDS will consist of drainage ditches and culverts. The diversions within the site area have been designed to minimize adverse impacts to the hydrologic balance, to prevent material damage outside the permit area, and to assure the safety of the public.

The diversions and diversion structures have been designed and will be constructed, maintained and used to:

Be stable; Provide protection against flooding and resultant damage to life and property;

Prevent, to the extent possible, additional contributions of suspended solids to stream flow outside the permit area; and comply with applicable local, state, and federal laws and regulations.

Expected life of diversion ditches and estimated year to be removed or buried by the expansion of waste into next phase as shown on Maps 2A thru 2F.

Diversion No.	Years In Operation (Estimated)*						
	2015	2016	2017	2018	2019	2020	
DD-1	X	X	X	X	X	X+	
DD-2	X	X	X	X			
DD-3				X	X	X	
DD-4						X+	
DD-5						+	
DD-6						+	
DD-7						+	
DD-8						+	
DD-9						+	
DD-10	X	X	X	X	X	X+	
+ = Beyond 2020	* = Based on Current Mine Plan(2015 version)						

The diversions within the WRDS will be removed when no longer needed. The diversions will be reclaimed in accordance with the reclamation plan defined in Chapter 5.

Diversion Berms. The diversion berms designs are shown in Appendix C of the hydrology report contained in Appendix VII. None of the berms have been designed specifically to convey runoff, therefore no calculations concerning the hydraulic characteristics of these berms are provided.

A temporary interim berm will be constructed to divert water away from the below grade waste rock storage area. This will remain in place until the waste rock fill reaches the level of the surrounding ground.

742.400 Road Drainage

No permanent roads are to be built in the WRDS. Runoff from the temporarily constructed road within the disturbed area will be treated by collection in the diversion ditches and sediment pond. None of these roads are located in the channel of an intermittent or perennial stream. Diversion ditches and culverts are described in Appendix VII.

743 Impoundments

Pertinent information regarding the sedimentation pond is presented in Sections 732.200 and 742.200.

744 Discharge Structures

Detailed information concerning the sedimentation pond discharge structure is presented in Section 732.200.

745 Disposal of Excess Spoil

There will be no excess spoil generated within the WRDS.

746 Coal Mine Waste

746.100 General Requirements

Coal mine waste will be placed in a controlled manner to minimize adverse effects of leachate in surface water runoff on surface and groundwater quality and quantity.

746.200 Refuse Piles

A description of the refuse pile is presented in Chapter 5 of this submittal.

746.300 Impounding Structures

No impounding structures within the WRDS will be constructed of coal mine waste or used to impound coal mine waste.

746.400 Return of Processing Waste to Abandoned Underground Workings

No coal processing waste will be generated at the WRDS.

747 Disposal of Noncoal Mine Waste

Disposal of noncoal mine waste is discussed in Chapter 5 of the approved M&RP.

748 Casing and Sealing of Wells

Each monitoring well has been cased, sealed, or otherwise managed, as approved by the Division, to prevent acid or other toxic drainage from entering ground or surface water, to minimize disturbance to the hydrologic balance, and to ensure the safety of people, livestock, fish and wildlife, and machinery in the site and adjacent area. The drill logs and completion diagrams for the wells are contained in Appendix II. Refer to Section 728.300 for additional information pertaining wells.

750 PERFORMANCE STANDARDS

The operations will be conducted to minimize disturbance to the hydrologic balance within the permit and adjacent areas, to prevent material damage to the hydrologic balance outside the permit area, and support approved post-mining land uses.

751 Water Quality Standards and Effluent Limitations

Discharges of water from disturbed areas will be in compliance with Utah and federal water quality laws and regulations and with effluent limitations for coal mining contained in 40 CFR Part 434.

752 Sediment Control Measures

The sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 760 of this submittal and the approved M&RP.

Siltation Structures and Diversions. Siltation structures and diversions will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 763 of this submittal and the approved M&RP.

Road Drainage. Runoff from temporary roads will be treated through siltation structures which will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 763 of this submittal and the approved M&RP.

753 Impoundments and Discharge Structures

Impoundments and discharge structures will be located, maintained, constructed and reclaimed as described in Sections 733, 734, 743, 745, and 760.

754 Disposal of Excess Spoil, Coal Mine Waste and Noncoal Mine Waste

Disposal areas for coal mine waste and noncoal mine waste will be located, maintained, constructed and reclaimed as described in Sections 736, 737, 746, 747, 760 and Chapter 5 of this submittal and the approved M&RP.

755 Casing and Sealing of Wells

The wells will be managed as described in Sections 551, 748 and 765 of this submittal.

760 RECLAMATION

761 General Requirements

A detailed reclamation plan for the WRDS is presented in Section 540. CFC will ensure that temporary structures are removed and reclaimed. Other than for restoration of natural drainage patterns, no permanent diversions are included in the reclamation plan.

762 Roads

No roads will be retained after reclamation of the site.

Restoring the Natural Drainage Patterns. Natural drainages will be restored during reclamation of the WRDS by removing the sediment pond and diversion ditches. As presented in Chapter 5, the existing topography will be altered by the construction of the refuse pile. This alteration will not significantly alter the natural drainage pattern of the area.

Reshaping Cut and Fill Slopes. Thr ough the use of contemporaneous reclamation, the fill slopes of the pile will be reclaimed as they are constructed. Section 540 describes the regrading process. The slopes will be shaped to be compatible with the post-mining land use and to complement the drainage pattern of the surrounding terrain.

763 Siltation Structures

Maintenance of Siltation Structures. The siltation structures will be maintained until removed in accordance with the approved reclamation plan. The sediment pond will be retained until at least 2 years after the last augmented seeding.

Removal of Siltation Structures. The land on which the siltation structure were located will be regraded and revegetated in accordance with the reclamation plan presented in Section 540 of this amendment.

764 Structure Removal

There will be no structures on the WRDS.

765 Permanent Casing and Sealing of Wells

When no longer required to monitor ground water levels in the area of the WRDS or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division. Permanent closure measures will be designed to prevent access.

CHAPTER 8

BONDING AND INSURANCE

CHAPTER 8
BONDING AND INSURANCE

810 BONDING DEFINITIONS AND DIVISION RESPONSIBILITIES

CFC will have on file with the Division a bond or bonds made payable to the Division for performance of all the requirements of the State Program associated with waste rock disposal site.

820 REQUIREMENT TO FILE A BOND

The disturbed area (58.5 acres) covered by the bond is outlined on Plate 2 of this amendment. The disturbed area and specific acres to be reclaimed are discussed in Section 340. The performance bond period is for the duration of the coal mining and reclamation operations including the extended period designated by the Division. The bond is in the form of a surety bond.

830 DETERMINATION OF BOND AMOUNT

The reclamation bond (direct and indirect costs) for the Waste Rock Disposal site is found in Appendix 5-9 of the M&RP. The bond coverage will be adjusted per the Division's determination of required bond coverage.

840 - 870 GENERAL TERMS AND CONDITIONS OF THE BOND

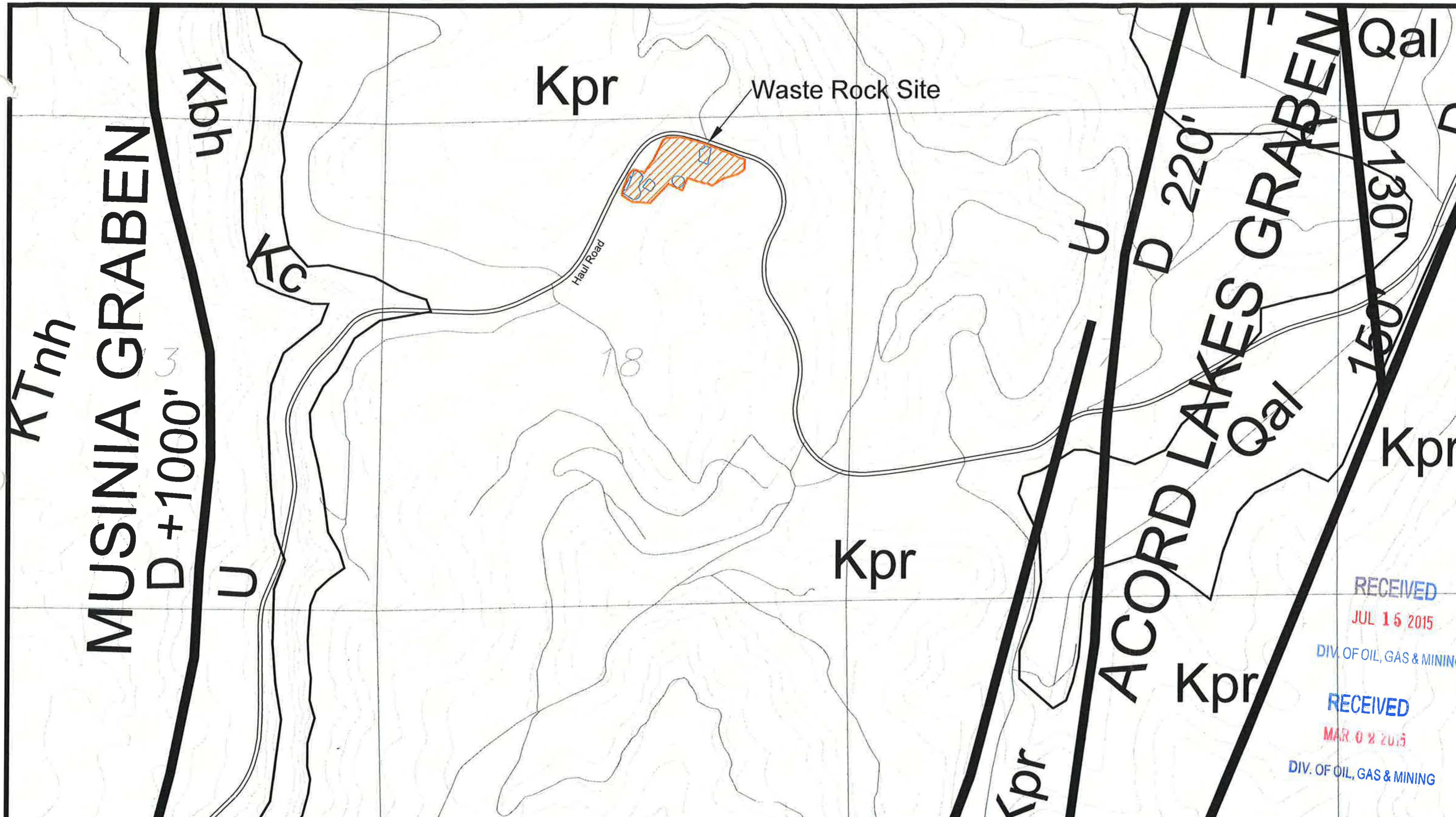
For the description and information pertaining to Sections 840 thru 870 refer to Chapter 8 of the approved M&RP.

880 REQUIREMENTS TO RELEASE PERFORMANCE BONDS

The applicant will comply with the requirements described in Section R645-301-880 of the Division regulations when applying for the release of performance bonds.

890 TERMS AND CONDITIONS FOR LIABILITY INSURANCE

A copy of current certificates of insurance are filed with the Division of Oil, Gas and Mining at the time of insurance renewal and a copy can be provided for review at the Canyon Fuel Company, LLC Sufco operation.



KTnh North Horn Formation
Kpr Price River Formation
Kc Castlegate Sandstone
Kbh Blackhawk Formation
Qal Alluvium

Fault
Formation Contact
Waste Rock Site

FEET
0' 1000' 2000' 3000'
SCALE

N

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 - Salina, UT 84654
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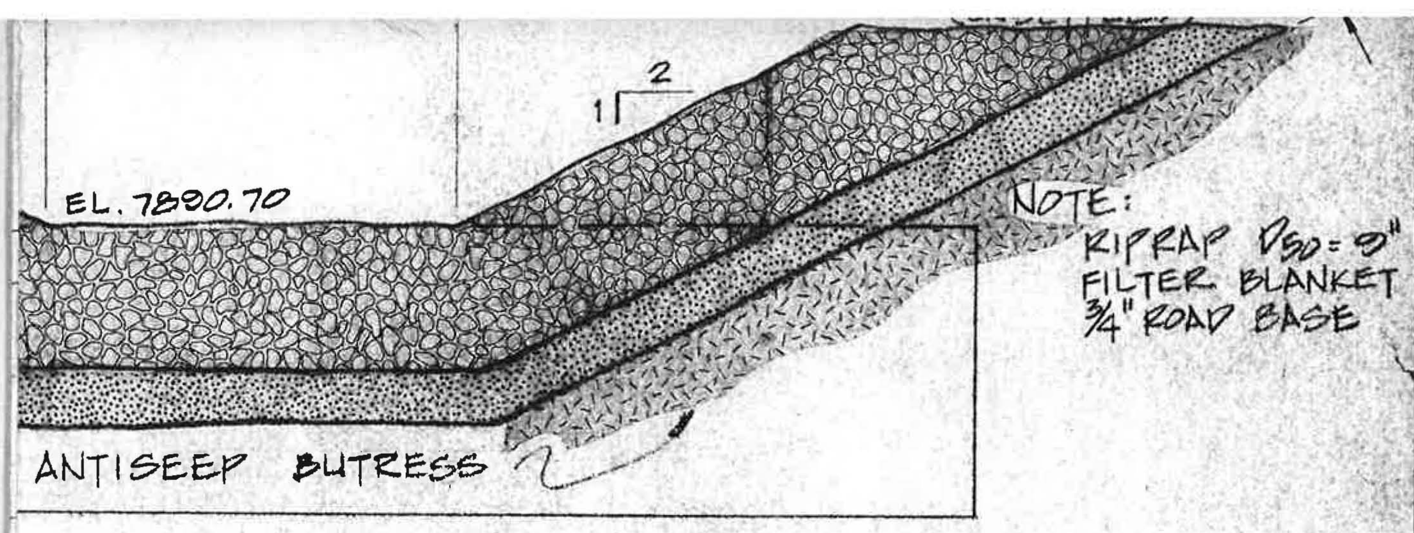
(435) 286-4499 Fax

SUFCO
WASTE ROCK SITE
GEOLOGY MAP

SCALE:	DATE:	DRAWN BY:	ENGINEER:	SHEET NO.
1"=1000'	2/20/15	MB	MB	EXHIBIT 7
CHECKED BY:	FILE NAME:			



CROSS-SECTION
GENCY SPILLWAY
: 1" = 2'-0"

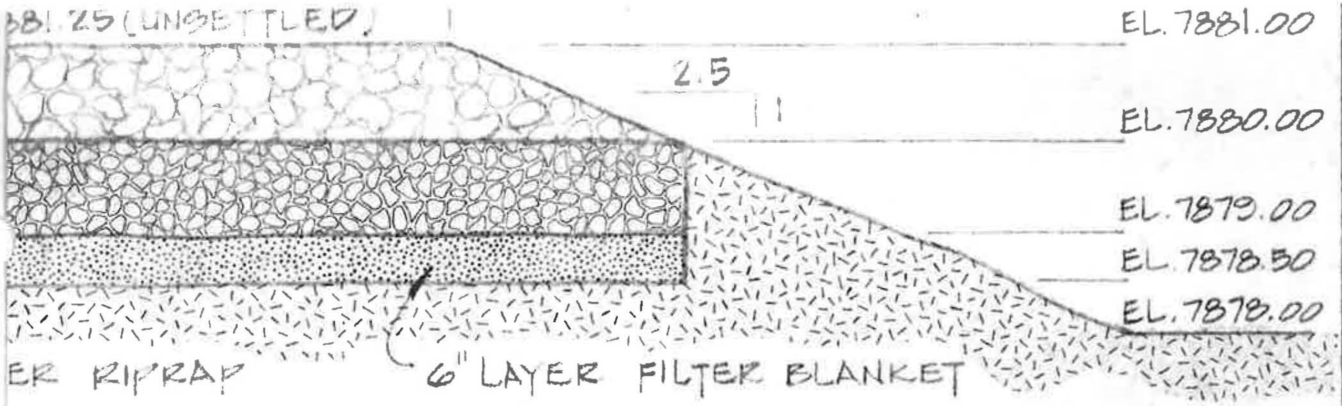
REGISTERED PROFESSIONAL ENGINEER
5369
WESLEY K.
SORENSEN
STATE OF UTAH

REVISIONS OR UP-DATES		
NO.	DATE	BY
1	4-20-88	W.K.S.
2	6-7-88	W.K.S.

Southern Utah Fuel Company — **MINE NO. 1**

UNDERGROUND DEVELOPMENT
WASTE DISPOSAL SITE
SEDIMENT POND DETAILS

DRAWN BY	DATE	SCALE
S.K.S.	NOV. 18, 87	AS SHOWN
CHECKED BY W.K.S.	DATE NOV. 18, 87	MATERIAL
TRACED	DATE	DRAWING NO. FIGURE 1
APPROVED	DATE	



REGISTERED PROFESSIONAL ENGINEER
5369
WESLEY K. SORENSEN
STATE OF UTAH

NOTE:
RIPRAP D_{50} = 9"
FILTER BLANKET
3/4" ROAD BASE

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
UNDERGROUND DEVELOPMENT WASTE DISPOSAL SITE - DETAILS	
DATE JUNE 7, 88	SCALE 1" = 2'-0"
DRAWN BY S.K.S.	DRAWING NO. FIGURE 1A

PROFESSIONAL ENGINEER
5369
WESLEY K.
SORENSEN

VOLUME CHART		
DESCRIPTION	ELEVATION	POND VOLUME
EMERGENCY SPILLWAY LEVEL	7890.7'	43,173 FT^3
PRIMARY SPILLWAY LEVEL	7889.50'	31,876 FT^3
DECANT LEVEL	7887.27'	15,393 FT^3
100% SEDIMENT VOLUME LEVEL	7885.47'	9,200 FT^3
60% SEDIMENT VOLUME LEVEL	7885.15'	5,490 FT^3

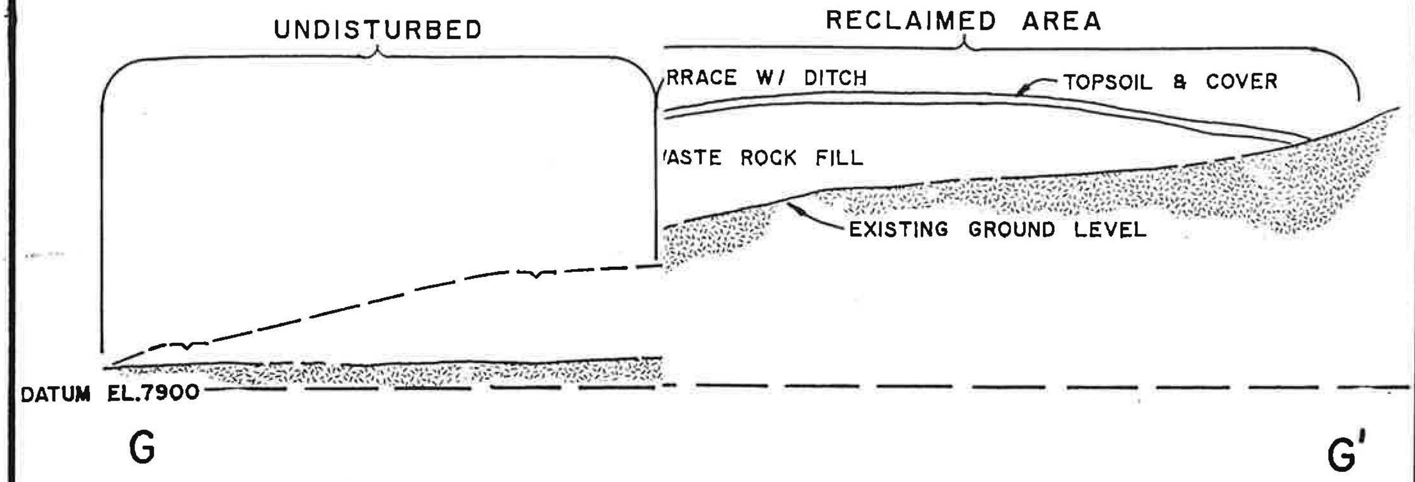
NOTE: ALL ELEVATIONS PLUS 7800.0'

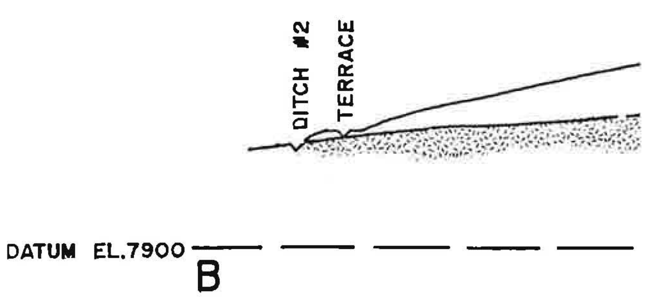
REVISIONS OR UP-DATES		
NO.	DATE	BY

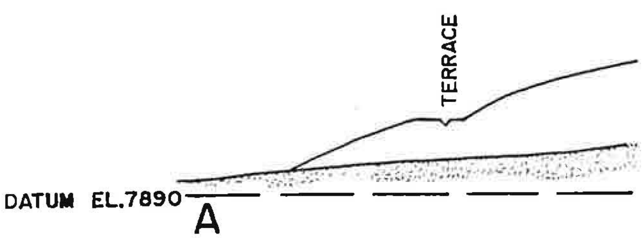
SOUTHERN UTAH FUEL CO.
MINE NUMBER ONE

UNDERGROUND DEVELOPMENT WASTE DISPOSAL SITE SEDIMENT POND AS BUILT VOLUME

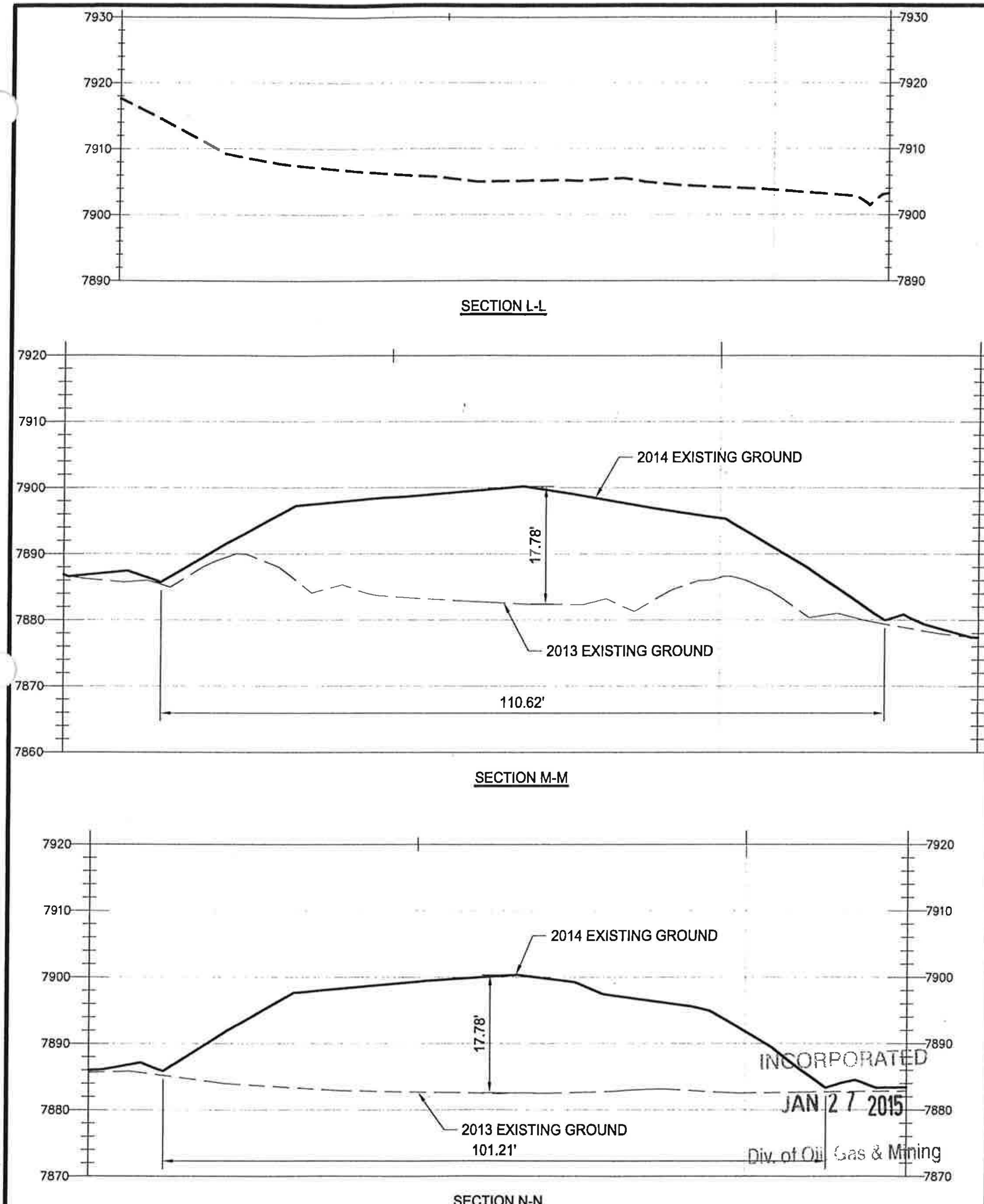
DRAWN BY S.K.S.	DATE NOV.21, '88	MATERIAL
CHECKED BY W.K.S.	DATE NOV.21, '88	SCALE 1" = 6'-0"
TRACED	DATE	DRAWING NO. FIGURE 1B
APPROVED	DATE	







SOUTHERN UTAH FUEL CO. **MINE NUMBER ONE**	
UNDERGROUND DEVELOPMENT WASTE DISPOSAL SITE CROSS - SECTIONS	
DATE NOV. 19, '87	SCALE 1" = 50'
DRAWN BY S.K.S.	DRAWING NO. FIGURE 2



Canyon Fuel Company, LLC
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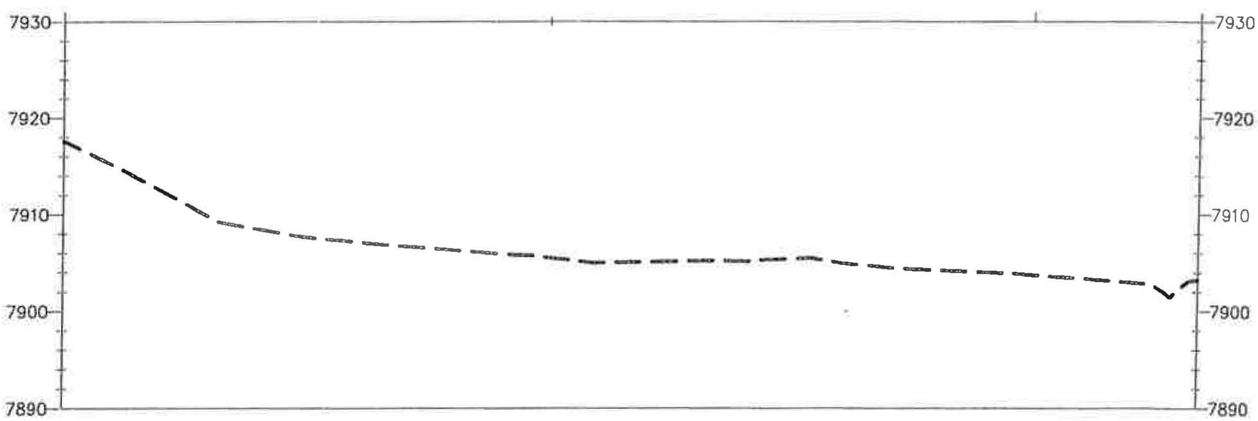
597 South SR 24 - Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

WASTE DISPOSAL SITE			SHEET NO.
CROSS SECTIONS			FIGURE 2A
SCALE: 1" = 20'	DATE: 11/12/2014	DRAWN BY: T.R.B.	
ENGINEER:	CHECKED BY: V.L.M.	PROJ: ####	
FILE NAME: H:\DRAWINGS\MRP\PLATES\WRDS Map2v7.dwg			



INCORPORATED

DEC 2 6 2013

Div. of Oil, Gas & Mining

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 - Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

WASTE DISPOSAL SITE			SHEET NO.
CROSS SECTION L-L			FIGURE 2A
SCALE: 1" = 20'	DATE: 11/18/2013	DRAWN BY: T.R.B.	
ENGINEER:	CHECKED BY: V.L.M.	PROJ: ####	
FILE NAME: H:\DRAWINGS\MRP\PLATES\WRDS Map2v6.dwg			

THIS PLAT ACCURATELY REPRESENTS THE SIZE AND VOLUME OF THE AS BUILT POND AS DETERMINED BY A SURVEY CONDUCTED ON MARCH 6, 1990.

REGISTERED PROFESSIONAL ENGINEER
#5369
WESLEY K. SORENSEN
STATE OF UTAH

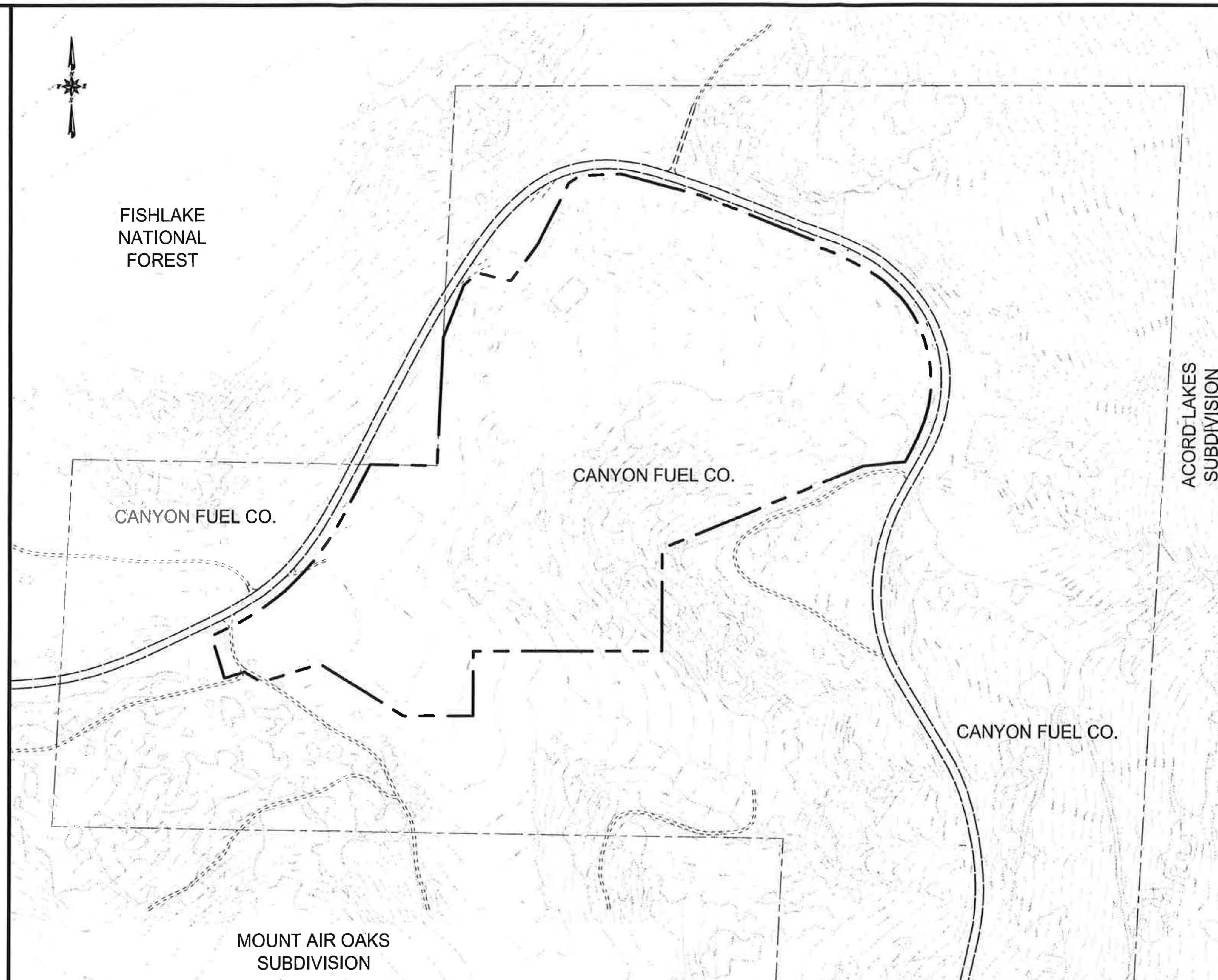
Wesley K Sorensen 3/27/90

WESLEY K. SORENSEN
P.E. NO. 5369
STATE OF UTAH

REVISIONS OR UP-DATES			SOUTHERN UTAH FUEL CO. MINE NUMBER ONE		
NO.	DATE	BY	UNDERGROUND DEVELOPMENT WASTE DISPOSAL SITE DECANT POND AS BUILT VOLUME		
			DRAWN BY S.K.S.	DATE 3-12-90	MATERIAL
			CHECKED BY J.M.B.	DATE 3-12-90	SCALE 1" = 2'-0"
			TRACED	DATE	DRAWING NO. FIGURE 3
			APPROVED W.K.S.	DATE 3-12-90	

LEGEND

- EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- OPERATIONAL GROUND INFERRED CONTOUR (40 FOOT)
- EXISTING ROAD
- EXISTING PAVED ROAD
- DISTURBED AREA BOUNDARY
- CANYON FUEL CO. PROPERTY BOUNDARY
- EXISTING TREELINE



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WASTE ROCK PILE

PROPERTY OWNERSHIP – DISTURBANCE AREA BOUNDARY LINE

SCALE: 1" = 400' | DATE: 6/23/2015 | DRAWN BY: J.A. | ENGINEER: L.F. | CHECKED BY: V.M

FILE NAME: H:\JD\Proj\1406-120\DWG\FIG_4 PROPERTY OWNERSHIP – DAB LINE.dwg | PROJ: 1406-120

REVISIONS

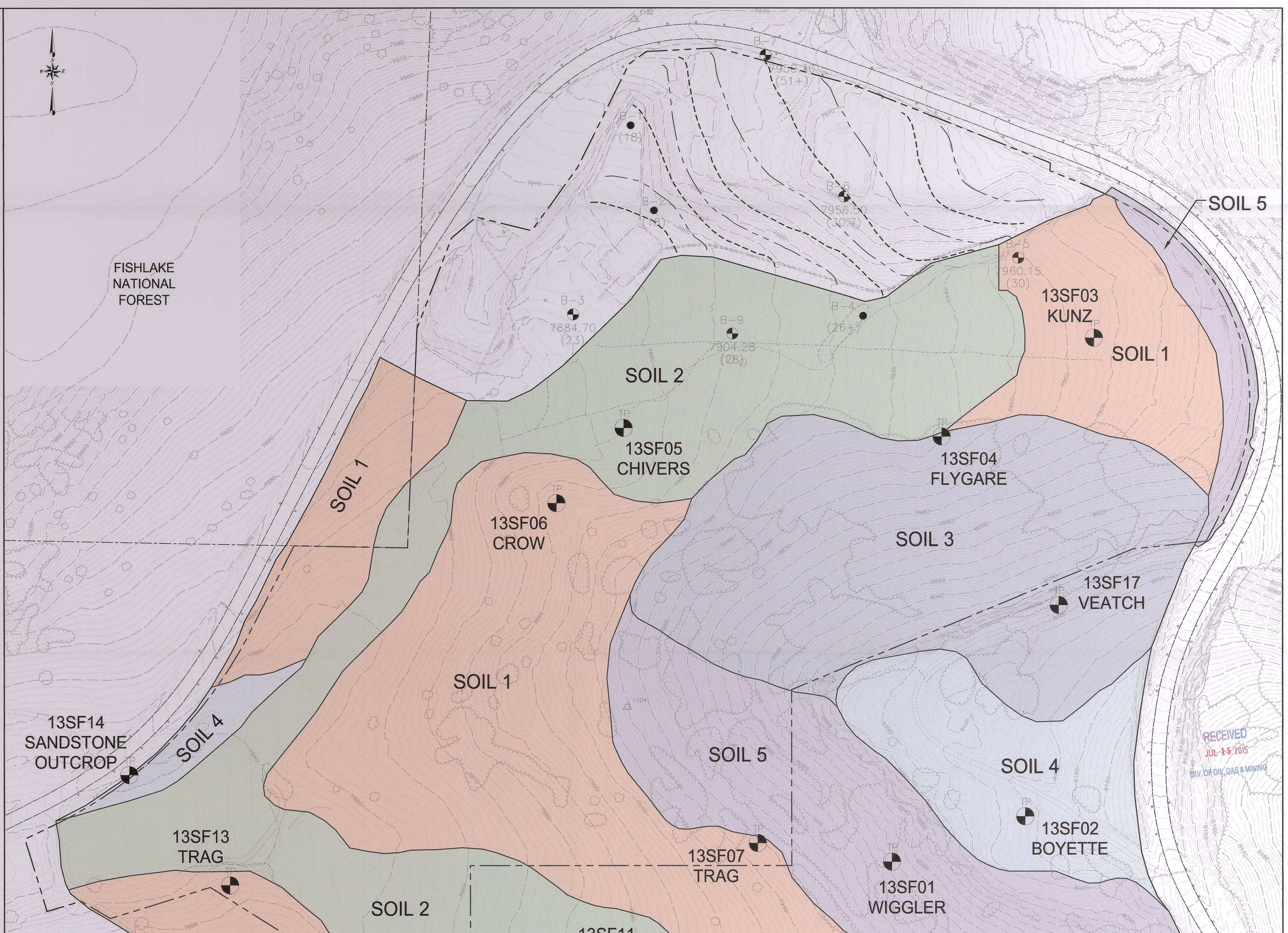
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	UPDEATE PLATE
2	9/4/2014	VM	JA	UPDATE PLATE

SHEET NO.

FIG. 4

LEGEND

- EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- SOIL-1, TOPSOIL-20", SUBSOIL-38" (KUNZ-TRAG-CROW)
- SOIL-2, TOPSOIL-35", SUBSOIL-33" (CHIVERS-KUNZ)
- SOIL-3, TOPSOIL-26", SUBSOIL-12" (TUNTSA-TRAG-ZILLION)
- SOIL-4, TOPSOIL-19", SUBSOIL-0" (BOYETT-VEATCH)
- SOIL-5, TOPSOIL-17", SUBSOIL-9" (WIGGLER-HELPER-TRAG)
- DISTURBED AREA BOUNDARY
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPERTY BOUNDARY
- EXISTING TREELINE
- B–? 7900.00 (30.0) MONITORING WELL WITH CAP ELEVATION (DEPTH TO CONSOLIDATED FORMATION)
- B–? (30.0) TEST BORE HOLE (DEPTH TO CONSOLIDATED FORMATION)
- TP SOIL TEST PIT



REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS

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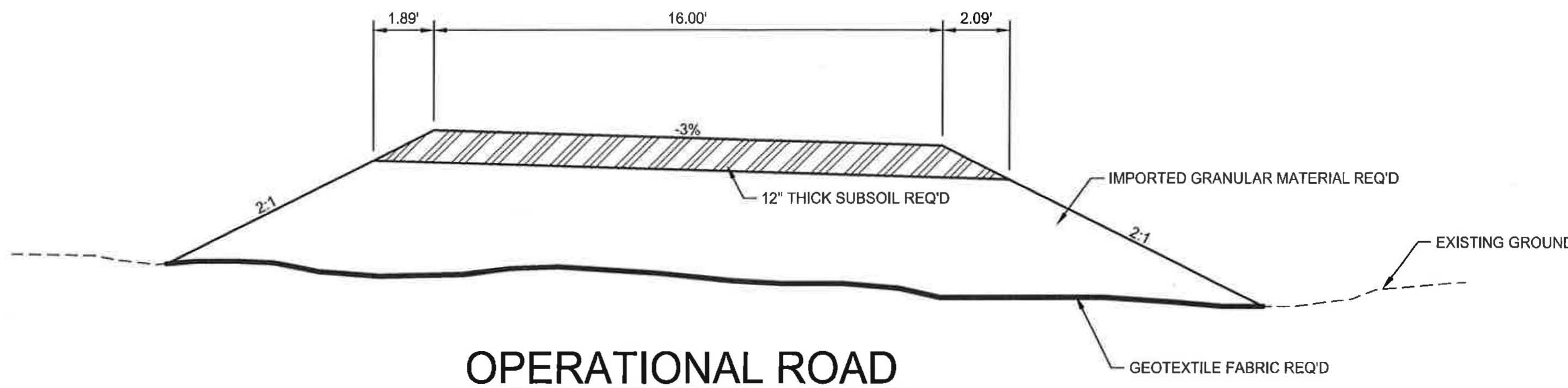
(435) 286–4499 Fax

WASTE ROCK PILE
SOILS MAP

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	6/24/2015	JA	LF / TH	VM	FIG. 5

SHT SET: 1406–120 | PROJECT NUMBER: 1406–120 | FILE NAME: H:\JD\Proj\1406–120\DWG\SHEET 11 SOILS.dwg



OPERATIONAL ROAD
TYPICAL SECTION NO. 1

Canyon Fuel Company, LLC
SUFCO Mine
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(435) 286-4880 Phone
(435) 286-4499 Fax

WASTE ROCK PILE

TYPICAL SECTION

SCALE:	DATE: 7/13/2015	DRAWN BY: J.A.	ENGINEER: L.F.	CHECKED BY: V.M
FILE NAME: H:\JD\Proj\1406-120\DWG\SHEET 9 OPERATIONAL details.dwg				PROJ: 1406-120

REVISIONS

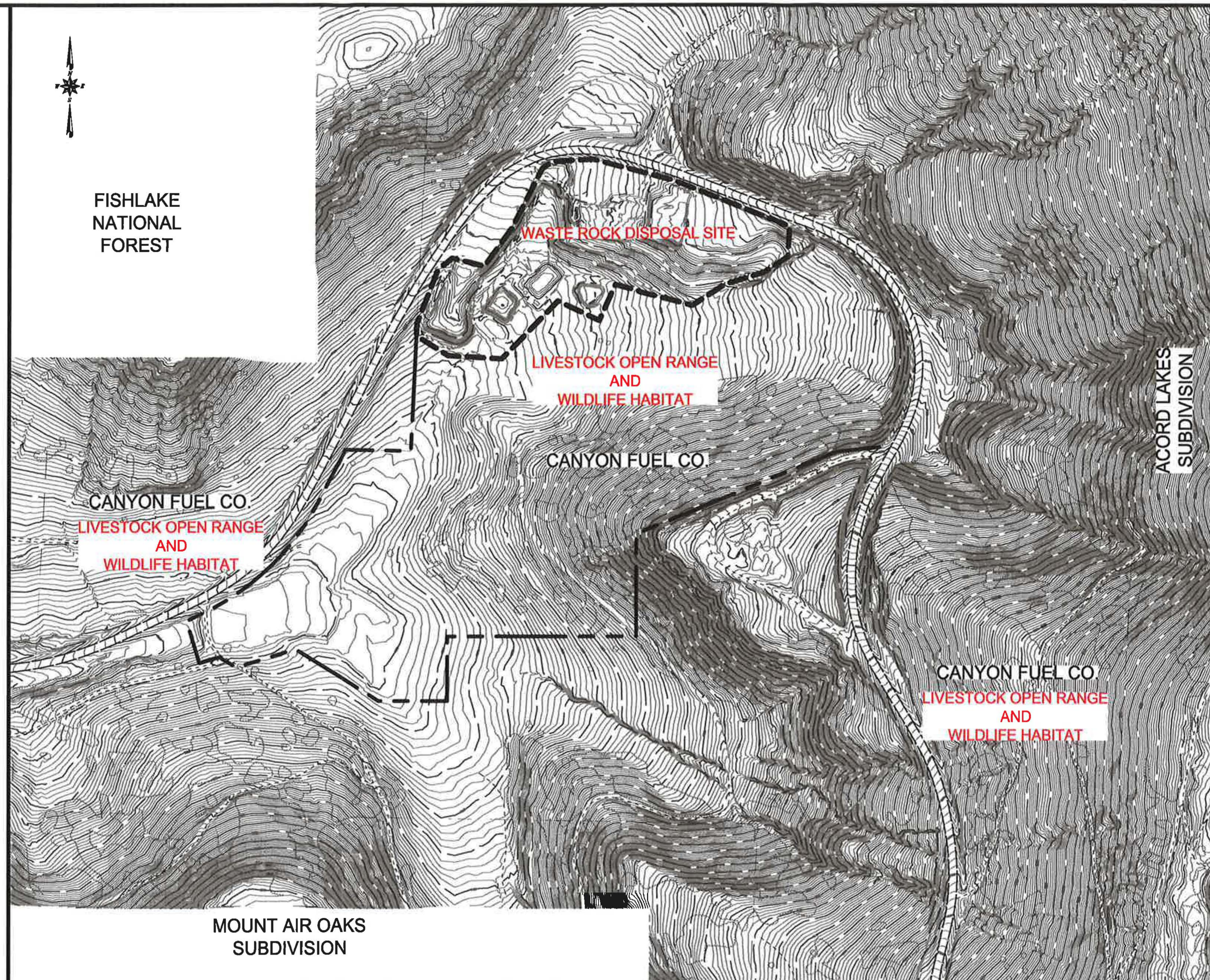
NO.	DATE	REQ. BY	DWG. BY	REMARKS

SHEET NO.

FIG. 6

LEGEND

- 8140 — EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- OPERATIONAL GROUND INFERRED CONTOUR (40 FOOT)
- EXISTING ROAD
- EXISTING PAVED ROAD
- DISTURBED AREA BOUNDARY
- CANYON FUEL CO. PROPERTY BOUNDARY
- EXISTING TREELINE



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(435) 286-4880 Phone
(435) 286-4499 Fax

WASTE ROCK PILE
LAND USE

SCALE: 1" = 400'	DATE: 7/13/2015	DRAWN BY: J.K.M.	ENGINEER:	CHECKED BY: V.M.
FILE NAME: H:\DRAWINGS\MAPSURF\WASTEROCK_SITE\dwg\WR LAND USE.dwg				PROJ:

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS

SHEET NO.

FIG. 7

Monroe: 7/13/2015 8:53 AM

SUFCO Mine
Waste Rock Pile Expansion
Slope Stability Analysis

Canyon Fuel Company
SUFCO Mine
Salina, Utah

June 2015

REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
9 Jul 2015
STATE OF UTAH

EarthFax Engineering Group, LLC.

Engineers / Scientists
www.earthfax.com

SUFCO Mine
Waste Rock Pile Expansion
Slope Stability Analysis

Canyon Fuel Company
SUFCO Mine
Salina, Utah

June 2015

EarthFax EarthFax Engineering Group, LLC.

Engineers / Scientists
www.earthfax.com

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LIST OF FIGURES

LIST OF ATTACHMENTS

SUFCO MINE
WASTE ROCK PILE EXPANSION
GEOTECHNICAL ANALYSIS

CHAPTER 1
INTRODUCTION

Canyon Fuel Company is planning the expansion of an existing waste rock pile. The site is located on Convulsion Road approximately 25 miles east of Salina, Utah. As shown in Figure 1, the proposed expansion will generally extend the existing refuse pile vertically and towards the south. To prevent adverse hydrologic impacts to the surrounding area, Canyon Fuel Company will construct additional runoff and sediment control facilities in the area, including berms, ditches, a sedimentation pond, and a sediment basin. In support of the site design, a slope stability analysis was performed for the site to confirm that the site expansion will be stable. The purpose of this report is to summarize the methods and findings of the slope stability analyses performed for the proposed SUFCO Mine waste rock site expansion.

CHAPTER 2
BACKGROUND INFORMATION

This slope stability investigation was performed by EarthFax Engineering Group, LLC (EarthFax). The investigation included the installation of 5 test pits to log soils and collect sufficient soil samples for geotechnical laboratory analysis. These test pits were excavated to an average depth of 6 feet based on the estimated salvage depths for topsoil and subsoil within the proximity. Soil samples were analyzed for grain size distribution, shear strength, and Atterberg Limits. Shear strengths were determined by direct shear tests conducted on samples that were remolded to the same dry density and moisture contents that were recorded in the field from nuclear density/moisture tests conducted by Jones & DeMille Engineering (see Table 1 and Attachment C). Descriptions of the soils encountered in the test pits, together with the results of these laboratory analyses, are provided in Attachments A-D.

The EarthFax field investigation generally encountered sandy lean clay, lean clay with sand, and silty sand in the native soils at the test pit locations shown on Figure 1, as detailed below:

- Lean CLAY with sand (Test Pits SMW-1 and SMW-3). The material contained 0.1 to 0.3% gravel, 18.7 to 26.1% sand, and 73.8 to 81% fines. According to the Atterberg Limits data, the liquid limit was 37-45, the plastic limit was 18 and the plastic index was 19-27. The angle of internal friction ranged from 40 to 29 degrees, and the cohesion intercept values ranged between 23 and 266 pounds per square foot ("psf"). The direct shear tests were conducted under consolidated, drained conditions.

- Sandy lean CLAY (Test Pits SMW-2 and SMW-4). The material contained 0.3 to 9.8% gravel, 33.2 to 38.5% sand, and 51.7 to 66.4% fines. According to the Atterberg Limits data, the liquid limit was 32-36, the plastic limit was 17 and the plastic index was 15-19. The angle of internal friction ranged from 29 to 34 degrees, and the cohesion intercept values ranged between 162 and 265 psf. The direct shear tests were conducted under consolidated, drained conditions.

- Silty SAND (Test Pit SMW-5). The material contained 9.3% gravel, 63% sand, and 27.7% fines. The angle of internal friction was 41 degrees and the cohesion intercept value was 49 psf. The direct shear tests were conducted under consolidated, drained conditions.

The sandy lean clay and lean clay with sand soils varied in depth and were encountered below the anticipated soil salvage depths. Additional detail on this investigation including test pit locations, detailed soil logs, and laboratory testing results can be found in the following subsections and attachments.

Refuse material to be placed at the site will originate as roof-fall and other rock materials removed from the SUFCO Mine. As part of this investigation, grain size distribution and angle of repose laboratory tests were conducted on the washed refuse material provided by Canyon Fuel Company. Results of these analyses are provided in Attachment B. This waste rock sample was obtained from a preparation plant laboratory reject material after a washing process which removes the majority of fines typically found within coal mine refuse.

According to the laboratory test analyses provided in Attachment B, the waste rock is angular with material sizes equivalent to about 91.9% gravel, 4.1% sand, and 4% fines. The material is classified as well graded, 3 inch minus grey gravel with a Unified Soil Classification of GW. The sample had an angle of repose of 33.6 degrees.

As indicated above, the sample used in this evaluation for analyses of engineering properties (i.e., the reject from a laboratory investigation of washability potential) was essentially devoid of fines, thereby resulting in a cohesionless sample. However, experience at other sites has indicated that the waste rock will not be devoid of fines, whether this waste rock is run-of-mine or the reject from a wash plant. Therefore, to estimate the cohesion intercept of the waste rock, the results of analyses conducted on waste rock from the former Castle Gate Coal Mine wash plant were reviewed (Golder Associates, 1978). Analyses of waste rock generated by the Dugout Canyon Mine were also reviewed (EarthFax, 1999). These investigations resulted in estimated cohesion intercepts of 800 and 490 pounds per square foot ("psf") for the Castle Gate and Dugout waste rock, respectively. To provide a conservative estimate of pile stability, the lower cohesion intercept of 490 psf was used for this evaluation. The results of laboratory analysis on the waste rock presented in this section are expected to be representative of the proposed waste rock pile.

CHAPTER 3
EVALUATION METHODS

Slope stability analyses were performed using the slope stability software *Slide 5.0 ("Slide")* by Rocscience. This program uses an iterative procedure to evaluate the factor of safety against rotational shear failure for tens of thousands of potential failure surfaces that may develop within a given slope. Each trial failure surface is discretized into small slices and the driving and resisting forces/moments are calculated for each according to Bishop's Simplified Method of Slices and Janbu Simplified Method of Slices. These forces are then summed over the entire failure surface to obtain a factor of safety defined as the sum of the resisting forces divided by the sum of the driving forces. Therefore, a factor of safety less that 1.0 indicates the potential for slope failure.

The analysis discussed herein relied on soils data collected during the EarthFax field investigation, as this investigation encompassed the same general area as the proposed waste rock pile expansion. Long term stability analyses were performed for the coal mine waste refuse stockpile, spoils topsoil and subsoil stockpile, and the proposed sedimentation pond embankment (see Figure 1). Details on each of the slope-stability scenarios analyzed and soil properties used for these analyses are included in the following subsections.

3.1 Coal Mine Waste Refuse Stockpile

It is our understanding that the waste refuse stockpile will be constructed to a maximum height of 65 feet with a maximum side slope of 2 horizontal to 1 vertical ("2H:1V"). Depending on the location within the waste rock pile, the contact with underlying native soils varies in elevation while maintaining an average height of 62 feet. The engineering properties summarized in Chapter 2 were assumed for this evaluation.

3.2 Spoils Topsoil and Subsoil Stockpiles

It is our understanding that the topsoil and subsoil stockpile will be constructed to a maximum height of 25 feet with a maximum side slope of 2H:1V. Depending on the location within the topsoil and subsoil stockpile, the contact with underlying native soils varies in elevation. However, as a conservative measure, the maximum height of 25 feet was assumed for this elevation. Because the toe of a portion of the stockpile slope will coincide with the location of the sediment basin, analyses were performed for slope stability with and without ponded water at the toe of the stockpile.

The stability of the stockpile slope was analyzed under normal conditions for the sediment basin without water. This condition assumes the conservative variability (worst case scenario) of soils encompassing the stockpile. Because the underlying soils classify as similar soil types, both analyses were performed for the most critical soil type.

The stability of the stockpile slope with water in the sediment basin was also analyzed under the ponded condition. This condition assumes the sediment basin at the toe of the slope is completely full of water and the conservative variability of soils encompassing the stockpile. The effects of ponded water were determined using *Slide's* slope stability analysis and assumed hydraulic conditions. The conditions were modeled with a 2H:1V slope as this is the steepest slope observed in these soils along the edges of the topsoil and subsoil stockpile (see Figure 1).

3.3 Sedimentation Pond Impoundment Embankment

It is our understanding that the sedimentation pond embankment is to be constructed with the following geometry:

- **Inner Slope**. Maximum 16 feet tall at a 3H:1V slope
- **Crest**. Minimum 12 feet wide
- **Outer Slope**. Maximum 14 feet tall at a 2H:1V slope

The stability of the sedimentation pond embankment outer slope was analyzed under the steady-state seepage condition. This condition assumes the sedimentation pond is completely full of water with a phreatic surface fully developed within the embankment. The location of the phreatic surface was determined using *Slide's* finite-element seepage subprogram and assumed hydraulic conditions.

The stability of the sedimentation pond embankment inner slope was analyzed under a "rapid drawdown" condition. That is, it was assumed the pond is quickly drained such that the buttressing effect of the pond water is lost but pore pressures remain trapped within the embankment that had developed during the steady-state seepage condition, thus weakening the slope. This is the most critical condition for the inner slopes of the sedimentation pond embankment.

Stability analyses for the sedimentation pond embankment assumed that all native soils below the phreatic surface were fully saturated and weakened. For this analysis, the sedimentation pond embankment was modeled at the maximum dry density of the surface soil and should be constructed as such in the field. These are conservative assumptions since in reality the sedimentation pond will only be filled intermittently and with a finite quantity of water incapable of saturating all underlying soils.

CHAPTER 4
RESULTS

The soil properties used as input for *Slide* analyses are summarized in Table 3. As discussed above, these data are taken from the EarthFax field investigation and laboratory testing results. In the interest of conservatism, soil properties and analyses were selected to provide worst-case estimates of geotechnical conditions at the refuse expansion site.

The calculated minimum factors of safety for the various scenarios described above are summarized in Table 2. As shown in this table, the minimum factor of safety for against slope failure of the coal mine waste refuse stockpile is expected to be 1.3 if the material is cohesionless and 1.7 under the assumed condition of reasonable cohesion. The minimum factor of safety for the spoils topsoil and subsoil stockpile with or without ponded water is 1.7. The sedimentation pond in-slope embankment factor of safety, under rapid drawdown, is 1.3. The minimum factor of safety associated with the sedimentation pond impoundment out-slope, assuming steady-state seepage, is also 1.3.

The minimum acceptable long-term static factor of safety promulgated by the Utah Division of Oil, Gas, and Mining ("DOGM") for coal mine waste refuse stockpiles is 1.5 (R645-301-536.110). The minimum calculated factor of safety 1.7 under the assumptions made above is therefore considered acceptable and slopes are expected to remain stable under the geometry and loading conditions presented herein.

The minimum acceptable factor of safety promulgated by the DOGM for the spoils topsoil and subsoil stockpiles is 1.5 (R645-301-535.110). The minimum calculated factor of safety 1.7 under the assumptions made above is therefore considered acceptable and slopes are expected to remain stable under the geometry and loading conditions presented herein.

The minimum acceptable factor of safety promulgated by the DOGM for the sedimentation pond embankment is 1.3 under steady-state seepage conditions (R645-301-533.110). This factor of safety applies to NRCS (1985) Class A embankments and those not meeting the criteria of MSHA 30 CFR Sec. 77.216(a). The proposed embankment classifies as a Class A embankment given its rural location, low ponded depth (5 feet), low retention volume (less than 20 acre-feet), and water elevation less than 20 feet from toe of embankment. The calculated factor of safety of 1.3 is therefore considered acceptable and the impoundment embankment is expected to remain stable under the geometry and loading conditions presented herein.

CHAPTER 5

ENGINEERING PRACTICES

The results of this investigation apply to the slope geometries and soil conditions discussed above. If actual conditions differ from those assumed in this report, the stability of the waste rock pile, stockpile, and sedimentation pond embankment slope stability should be re-evaluated as necessary.

The following are current engineering practices specific to the design and construction of the coal mine waste refuse stockpile:

- Material shall be placed in a controlled manner.
- Although the lift thickness should not exceed 2 feet ± 10%, it may be advantageous to reduce this to facilitate drainage and improve condition. This should be evaluated by trial and error early in the operation.
- New lifts should be placed only over waste rock has been properly compacted to provide a stable base for a new lift.
- The dump surface should always be graded to facilitate drainage away from recently placed fill toward surface drainage courses. It may be advantageous to bulldoze shallow ditches at each lift elevation to improve surface drainage.
- In the unlikely event that severe waste rock handling, placement and compaction problems are encountered, consideration should be given to temporarily flattening of dump face slope angles or utilizing artificial waste rock stabilization measure. Other measures may be considered on a case-by-case basis.

The following are current engineering practices specific to the design and construction of the sedimentation pond embankments:

- The embankment should be placed on a well-prepared and compacted subgrade free from any organic soils, vegetation, debris, frozen soils, soft soils, or other deleterious materials (R645-533.220).
- The embankments should be well keyed into, or otherwise secured to, the underlying subgrade and adjacent slopes.
- Embankment soils should be compacted with an appropriate compactor to at least 95% of the Standard Proctor maximum dry density (ASTM D698) at ±2% of the soil's optimum moisture content. Compacted lifts should not exceed 8 inches.
- It is recommended that topsoil be placed on the outer slope of constructed embankments and vegetation established in order to reduce the potential for erosion

(R645-301-533.400). However, no trees, brush, or shrubs should be allowed to grow on the embankment. This can cause failure due to "piping" along root paths.

- Embankments should be regularly inspected as promulgated by DOGM for signs of damage, erosion, and piping and repairs made as necessary.

CHAPTER 6
REFERENCES

EarthFax Engineering, Inc. 1999. Results of a foundation investigation and slope stability analysis for the proposed waste rock pile for the Dugout Canyon Mine. Letter report submitted to Mr. Chris Hansen of Canyon Fuel Company. November 10, 1999.

Golder Associates. 1978. *Design of a Coal Refuse Disposal System, Phase II; Detailed Design, School House Canyon Refuse Disposal Facility.* Design report for the proposed School House Canyon Refuse Dump Facility listed as Appendix 3.4B Mining & Reclamation Plan Permit No. ACT 007/004, Volume 3.

TABLE 1

In-Situ Density/Moisture Test Results of Test Pits

Test Pit	Test Depth	Probe Depth	Wet Density	Dry Density	% Moisture
SMW-1	3′	6″	94.1	82.1	14.7
SMW-1	5′	6″	98	89.7	9.3
SMW-2	6′	6″	114.8	104.5	9.9
SMW-3	6′	6″	117.8	104.9	12.3
SMW-4	8′	6″	122.5	104.6	17.9
SMW-5	5′	6″	117.4	113.3	3.6

In-situ densities tested by Jones & DeMille Engineering. No trench correction on in-situ tests.

TABLE 2

Summary of *Slide* Analysis

Condition/ Location	Minimum Factor of Safety	Minimum Acceptable Factor of Safety
Waste Rock Pile Cohesive Strength 0 psf	1.34	1.5
Waste Rock Pile Cohesive Strength 490 psf	1.73	1.5
Topsoil and Subsoil Stockpile No Ponded Water	1.73	-
Topsoil and Subsoil Stockpile Ponded Water	1.74	-
Sedimentation Pond Embankment Outslope with Steady-State Seepage	1.33	1.3
Sedimentation Pond Embankment Inslope with Rapid Drawdown	1.31	1.3

TABLE 3

Summary of Laboratory Test Results

Test Pit and Depth (Ft.)	Gradation (%)			Atterberg Limits			Direct Shear Test Values	
	Gravel	Sand	Fines	Liquid Limit	Plastic Index	Plastic Limit	Cohesive Strength (psf)	Angle of Internal Friction (degrees)
SMW-1 0-7 [(a)]	0.1	26.1	73.8	37	19	18	23	40
SMW-2 0-8 [(b)]	9.8	38.5	51.7	32	15	17	162	29
SMW-3 0-7 [(c)]	0.3	18.7	81	45	27	18	266	29
SMW-4 0-8 [(d)]	0.3	33.2	66.4	36	19	17	265	34
SMW-5 0-8 [(e)]	9.3	63.0	27.7	-	-	-	49	41
Waste Rock	91.9	4.1	4	-	-	-	0	33.6 (angle of repose)

(a) Lean CLAY with sand. Sample for direct shear test remolded to a dry density of 89.7 pcf at a moisture content of 9.3%, which were the result of a nuclear density/moisture test conducted at a 5' depth in the test pit. Direct shear test conducted under consolidated-drained (CD) unsaturated conditions with vertical effective pressures of 980, 490, and 240 psf.

(b) Sandy lean CLAY. Direct shear test samples remolded to a dry density of 104.5 pcf at a moisture content of 9.9%, which were the results of a nuclear tests conducted at a 6' depth in the test pit. Direct shear test conducted under consolidated-drained (CD) unsaturated conditions with vertical effective pressures of 350, 700, and 1400 psf.

(c) Lean CLAY with sand. Sample for direct shear test remolded to a dry density of 104.9 pcf at a moisture content of 12.3%, which were the results of a nuclear density/moisture test conducted at a 6' depth in the test pit. Direct shear test conducted under consolidated-drained (CD) unsaturated conditions with vertical effective pressures of 350, 700, and 1400 psf.

(d) Sandy lean CLAY. Direct shear test samples remolded to a dry density of 104.6 pcf at a moisture content of 17.9%, which were the results of a nuclear density/moisture test conducted at an 8' depth in the test pit. Direct shear test conducted under consolidated-drained (CD) unsaturated conditions with vertical effective pressures of 490, 980 and 1960 psf.

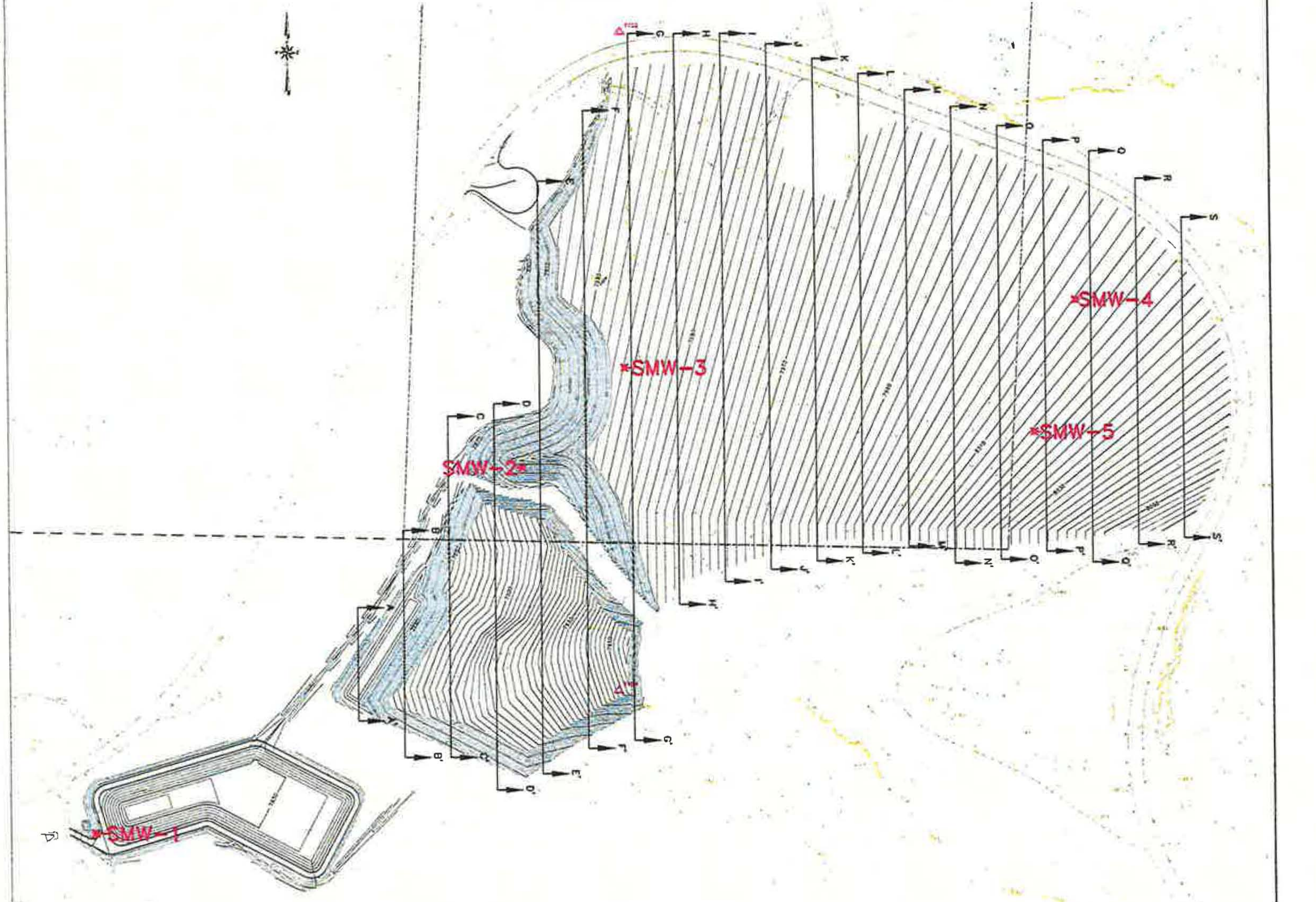
(e) Silty SAND. Direct shear test samples remolded to a dry density of 113.3 pcf at a moisture content of 3.6%, which were the result of a nuclear density/moisture test conducted at a 5' depth in the test pit. Direct shear test conducted under consolidated-drained (CD) unsaturated conditions with vertical effective pressures of 293, 586, and 1172 psf.

SUFCO MINE
WASTE ROCK DESIGN

INDEX OF DRAWINGS

LEGEND

- EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- 8140 — OPERATIONAL GROUND MAJOR CONTOUR (10 FOOT)
- OPERATIONAL GROUND MINOR CONTOUR (2 FOOT)
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- PROPERTY BOUNDARY
- EXISTING TREELINE
- A — A' OPERATIONAL CROSS SECTION LOCATION (SEE SHEETS 2 AND 3 FOR CROSS-SECTIONS)
- SMW-1 TEST PIT LOCATION



OPERATIONAL			
SOIL	CIVIL3D FILL	TOP/ SUBSOIL REMOVED	COMBINED FILL
PHASE 1	47,142	NA*	47,123
PHASE 2	149,583	26,175	180,760
PHASE 3	686,058	67,891	753,899
PHASE 4	464,546	54,597	518,143
PHASE 5	185,178	2,568	187,746
FINAL	19,871	NA	19,871
TOTAL	1,572,346	151,019	1,723,387

*TOP/SUB SOIL REMOVED TO CONSTRUCT SEDIMENTATION POND.

EarthFax Engineering, Inc.
Engineers/Scientists
EarthFax

0 50' 100'
1"=100'

BASE MAP PROVIDED BY DOWNE RESOURCE PARTNERS, LLC

REVISIONS: NO. | DATE | BY | DESCRIPTION | NO. | DATE | BY | DESCRIPTION

DRAWN BY: TAJ/SMF | CHECKED BY: TAJ | DATE: APRIL 2014
APPROVED BY: RBW | DWG DATA: G:\UD472

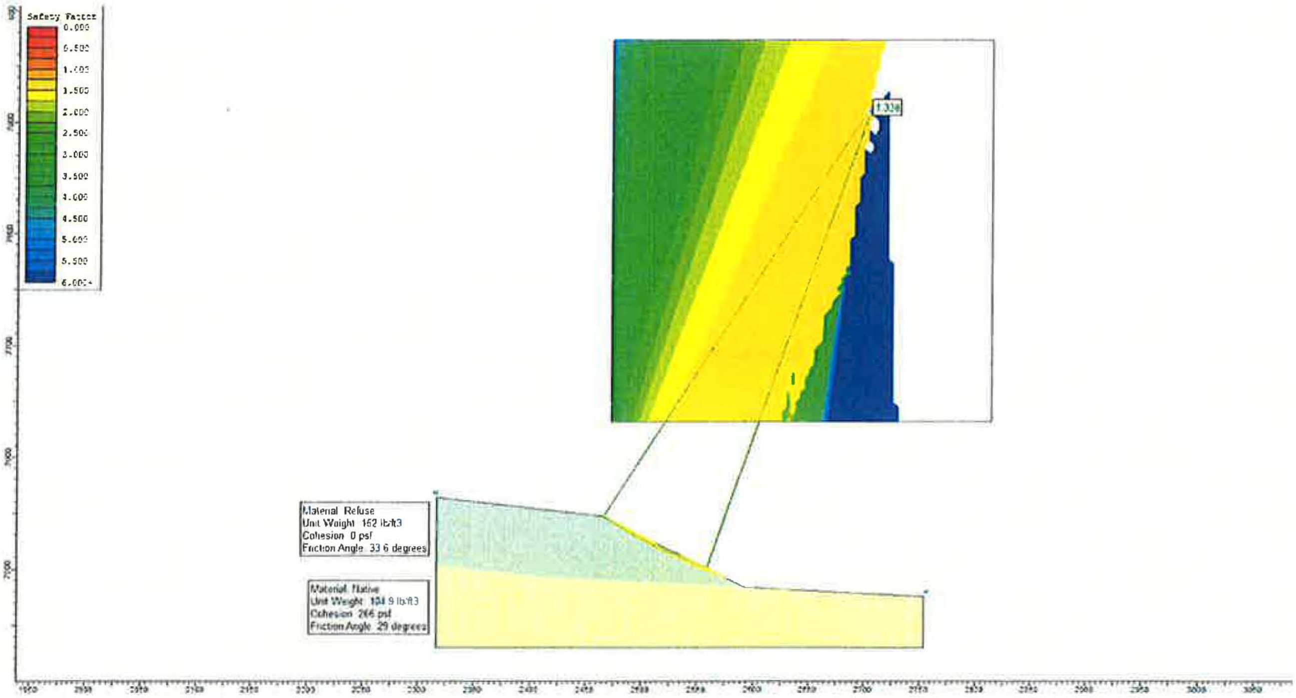
CANYON FUEL COMPANY
SUFCO MINE

GEOTECHNICAL INVESTIGATION
TEST PIT LOCATIONS

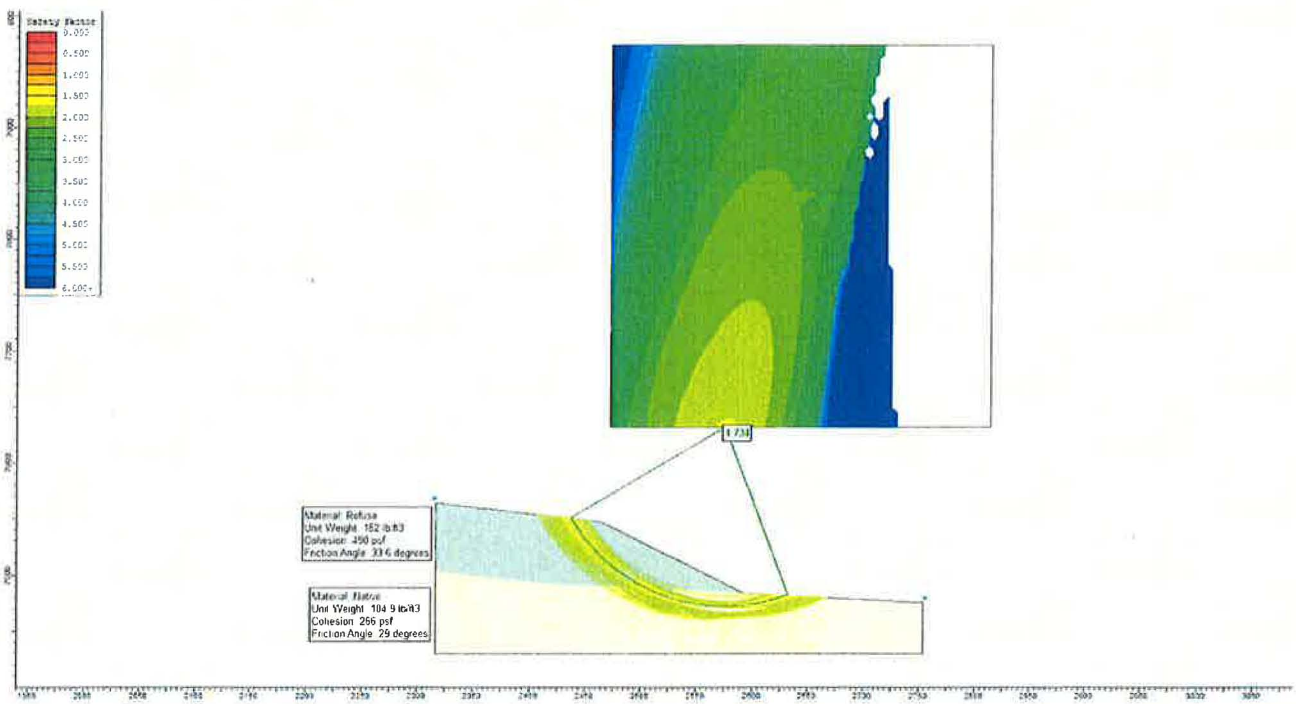
FIGURE 1

ATTACHMENT A

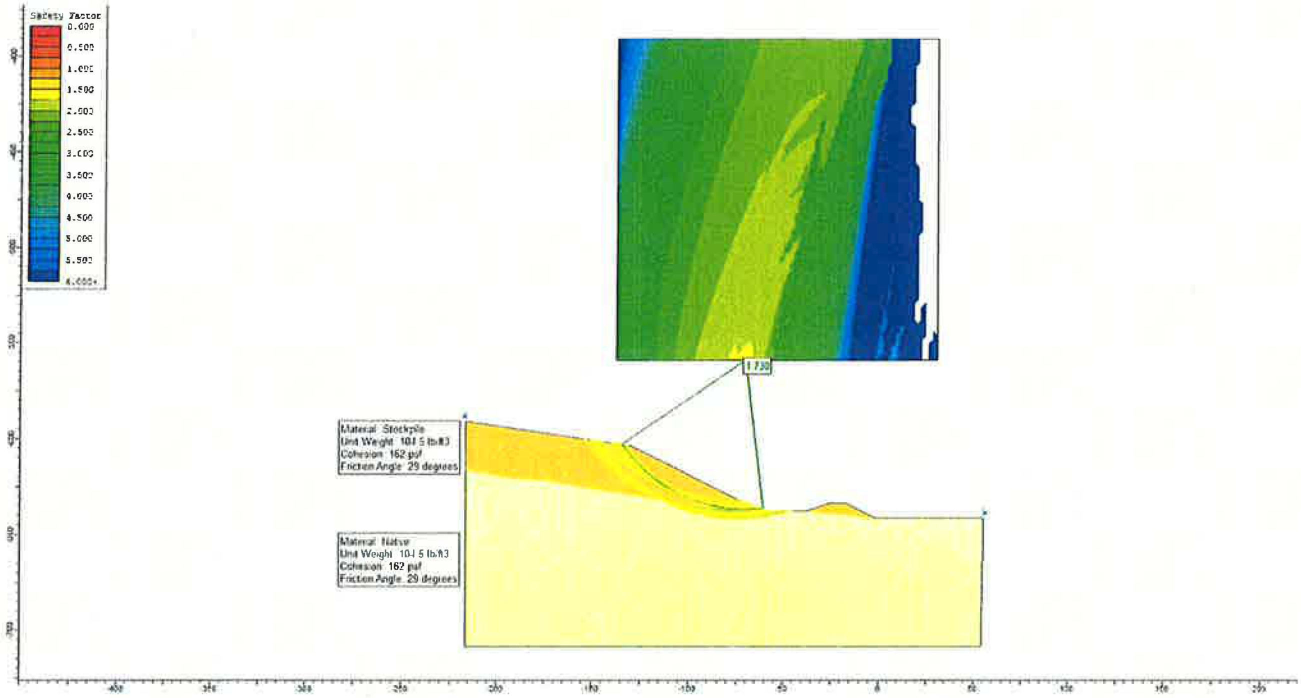
Slide Geometry and Output



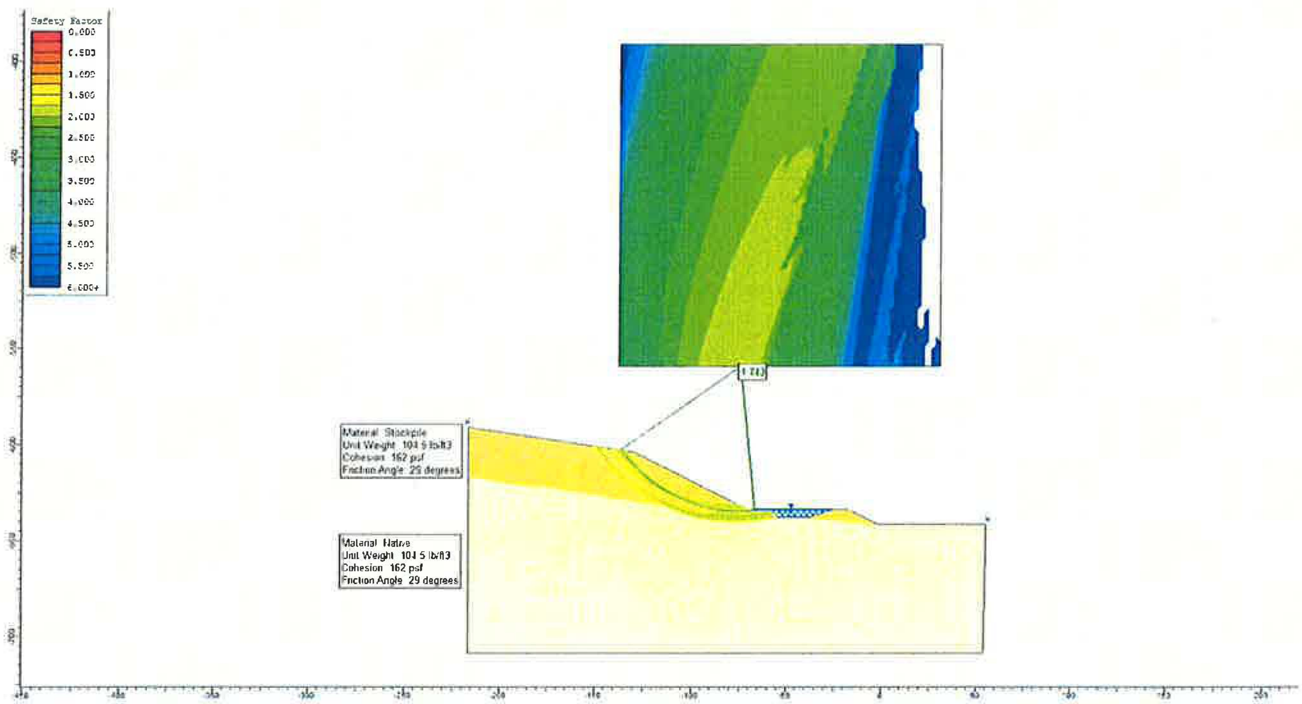
Refuse Pile Stability – Native Contact at Elevation 7938, Fill Height 61 feet (typical). Cohesive strength 0 psf.



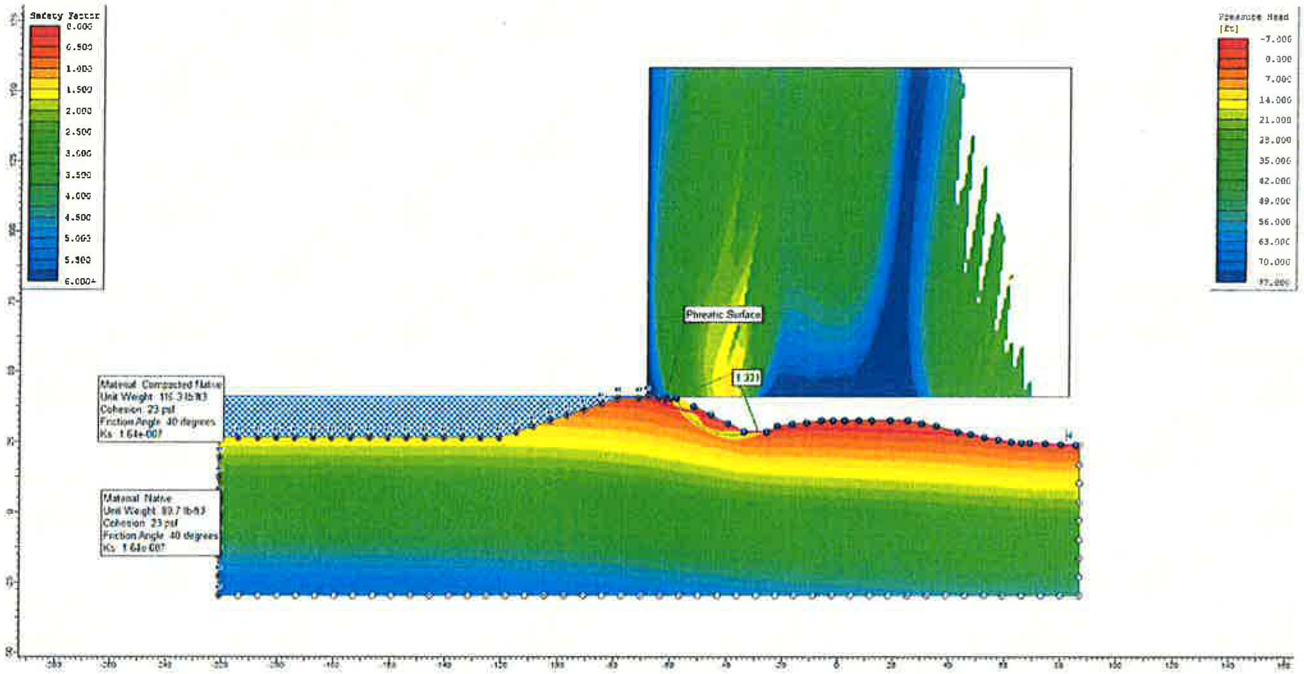
Refuse Pile Stability – Native Contact at Elevation 7938, Fill Height 61 feet (typical). Cohesive strength 490 psf.



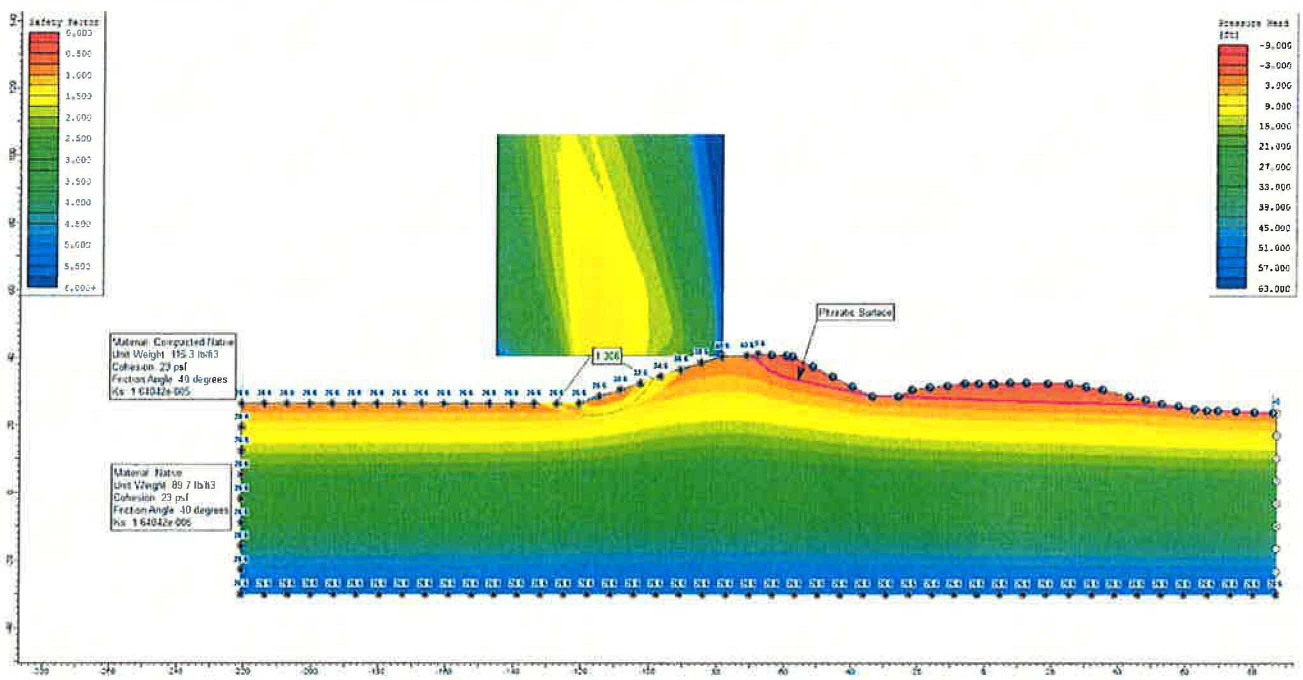
Topsoil and Subsoil Stockpile Stability – Native Contact at Elevation 7890, Fill Height 25 feet (no ponded water)



Topsoil and Subsoil Stockpile Stability – Native Contact at Elevation 7890, Fill Height 25 feet (ponded water)



Sedimentation Pond Embankment – Outslope with Steady-State Seepage



Sedimentation Pond Embankment – Inslope with Rapid Drawdown

ATTACHMENT B

IGES Soil Laboratory Test Results

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 and D2216)

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/2/2014
By: JDF

Sample Info.	Boring No.								
	Sample:	Waste Rock							
	Depth:								
Unit Weight Info.	Initial water volume (cc):	200.0							
	Final water volume (cc):	400.0							
	Sample volume, V (ft^3)	0.0071							
	Mass tare + wet soil (g)	493.16							
	Mass tare (g)	0.00							
	Moist soil, Ws (g)	493.16							
	Moist unit wt., γ_m (pcf)	153.93							
Water Content	Wet soil + tare (g)	867.13							
	Dry soil + tare (g)	857.86							
	Tare (g)	126.60							
Water Content, w (%)		**1.3**							
Dry Unit Wt., γ_d (pcf)		**152.0**							

Comments: Sample volume determined using water displacement.

Entered by: JDF
Reviewed: NB

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: **EarthFax Engineering, Inc.**
No: **M01292-018**
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: **SMW-1**
Sample:
Depth: **5'**
Description: Lean CLAY, grey

Preparation method: Wet
Liquid limit test method: Multipoint

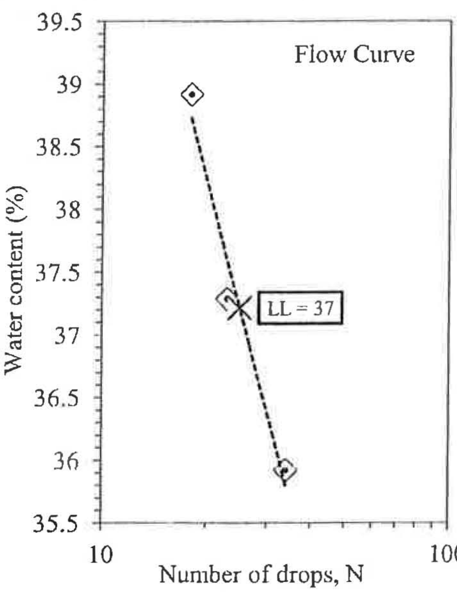
Plastic Limit

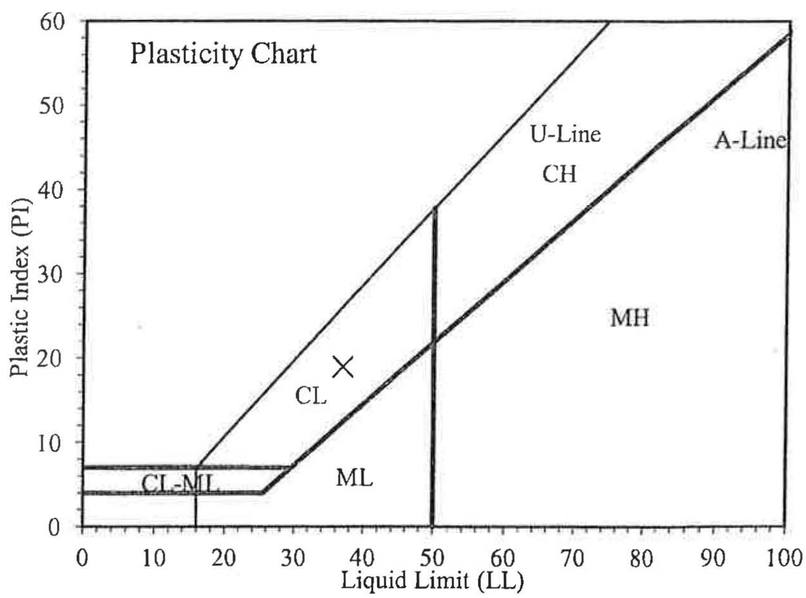
Determination No	1	2				
Wet Soil + Tare (g)	29.24	30.54				
Dry Soil + Tare (g)	28.03	29.21				
Water Loss (g)	1.21	1.33				
Tare (g)	21.39	21.87				
Dry Soil (g)	6.64	7.34				
Water Content, w (%)	18.22	18.12				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	23	18			
Wet Soil + Tare (g)	32.68	30.88	29.80			
Dry Soil + Tare (g)	29.81	28.46	27.57			
Water Loss (g)	2.87	2.42	2.23			
Tare (g)	21.82	21.97	21.84			
Dry Soil (g)	7.99	6.49	5.73			
Water Content, w (%)	35.92	37.29	38.92			
One-Point LL (%)		37				

Liquid Limit, LL (%)	**37**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**19**





Entered by: BRR
Reviewed: NB

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: SMW-2
Sample:
Depth: 8'
Description: Lean CLAY, brown

Preparation method: Wet
Liquid limit test method: Multipoint

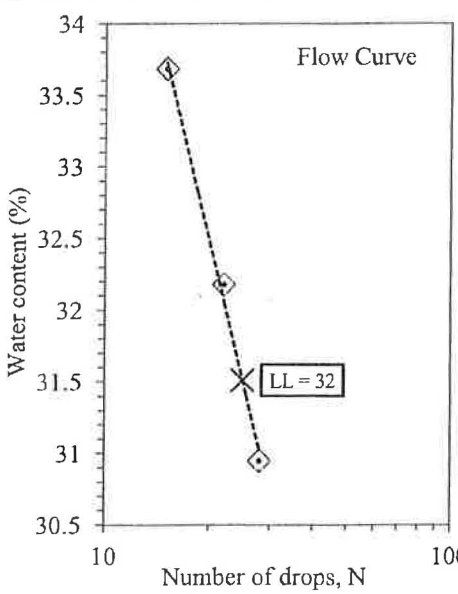
Plastic Limit

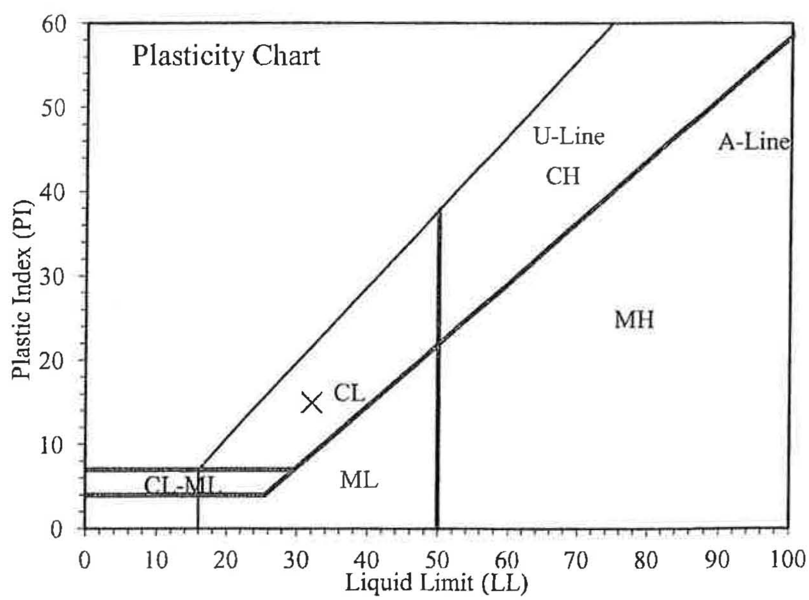
Determination No	1	2				
Wet Soil + Tare (g)	32.41	31.10				
Dry Soil + Tare (g)	30.87	29.74				
Water Loss (g)	1.54	1.36				
Tare (g)	21.95	21.96				
Dry Soil (g)	8.92	7.78				
Water Content, w (%)	17.26	17.48				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	22	15			
Wet Soil + Tare (g)	34.41	32.10	32.33			
Dry Soil + Tare (g)	31.51	29.68	29.78			
Water Loss (g)	2.90	2.42	2.55			
Tare (g)	22.14	22.16	22.21			
Dry Soil (g)	9.37	7.52	7.57			
Water Content, w (%)	30.95	32.18	33.69			
One-Point LL (%)	31	32				

Liquid Limit, LL (%)	**32**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**15**





Entered by: BRR
Reviewed: NJS

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

IGES

Project: **EarthFax Engineering, Inc.**
No: **M01292-018**
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: **SMW-3**
Sample:
Depth: **6-7'**
Description: Lean CLAY, brown

Preparation method: Wet
Liquid limit test method: Multipoint

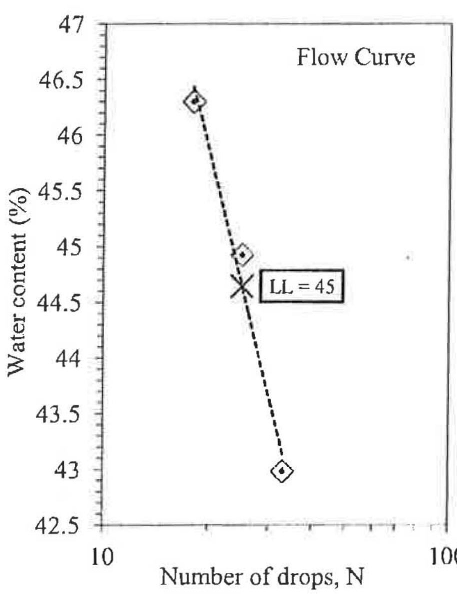
Plastic Limit

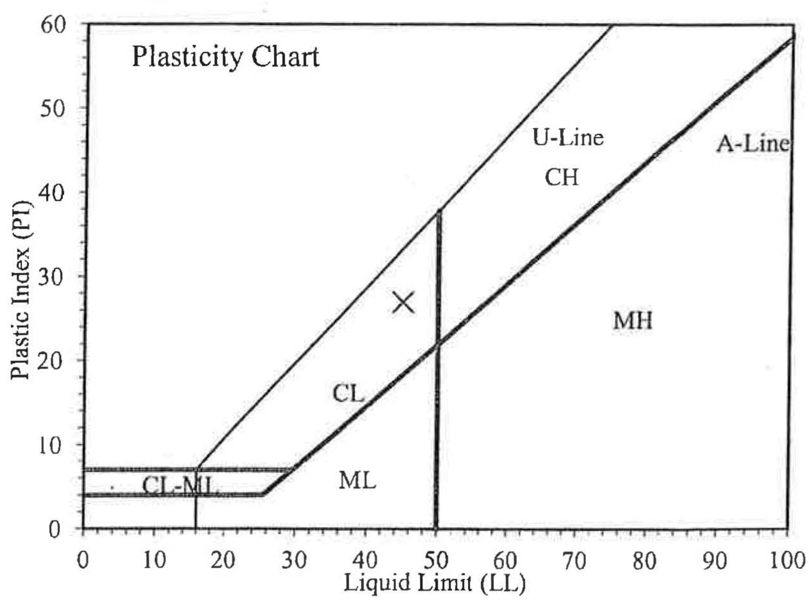
Determination No	1	2				
Wet Soil + Tare (g)	30.15	30.33				
Dry Soil + Tare (g)	28.85	29.07				
Water Loss (g)	1.30	1.26				
Tare (g)	21.69	21.88				
Dry Soil (g)	7.16	7.19				
Water Content, w (%)	18.16	17.52				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	25	18			
Wet Soil + Tare (g)	31.40	29.73	29.81			
Dry Soil + Tare (g)	28.49	27.25	27.43			
Water Loss (g)	2.91	2.48	2.38			
Tare (g)	21.72	21.73	22.29			
Dry Soil (g)	6.77	5.52	5.14			
Water Content, w (%)	42.98	44.93	46.30			
One-Point LL (%)		45				

Liquid Limit, LL (%)	**45**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**27**





Entered by: BRR
Reviewed: NB

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: **EarthFax Engineering, Inc.**
No: **M01292-018**
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: **SMW-4**
Sample:
Depth: **7.5-8'**
Description: Lean CLAY, brown

Preparation method: Wet
Liquid limit test method: Multipoint

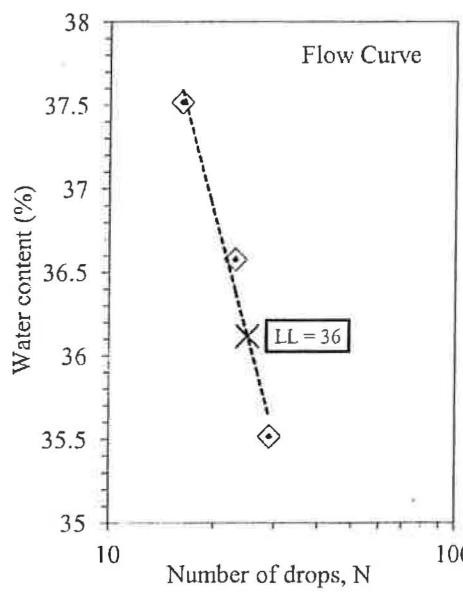
Plastic Limit

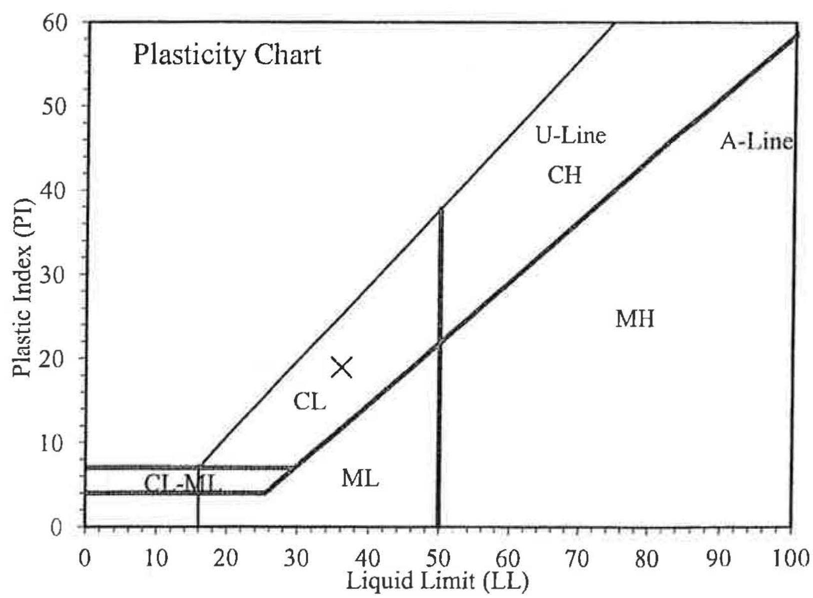
Determination No	1	2				
Wet Soil + Tare (g)	32.32	31.45				
Dry Soil + Tare (g)	30.80	30.12				
Water Loss (g)	1.52	1.33				
Tare (g)	21.83	22.22				
Dry Soil (g)	8.97	7.90				
Water Content, w (%)	16.95	16.84				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	29	23	16			
Wet Soil + Tare (g)	32.19	31.97	31.03			
Dry Soil + Tare (g)	29.59	29.34	28.49			
Water Loss (g)	2.60	2.63	2.54			
Tare (g)	22.27	22.15	21.72			
Dry Soil (g)	7.32	7.19	6.77			
Water Content, w (%)	35.52	36.58	37.52			
One-Point LL (%)	36	36				

Liquid Limit, LL (%)	**36**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**19**





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Reviewed: NB

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Rock Expansion Site
Date: 3/31/2014
By: BRR

Boring No.: SMW-5
Sample:
Depth: 5'
Description: Silty SAND, brown

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)

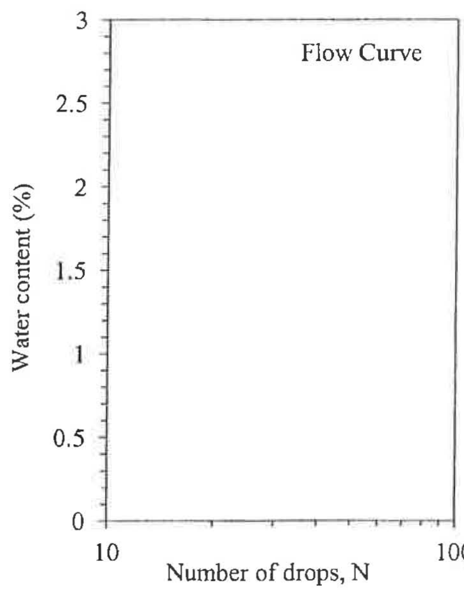
Plastic Limit

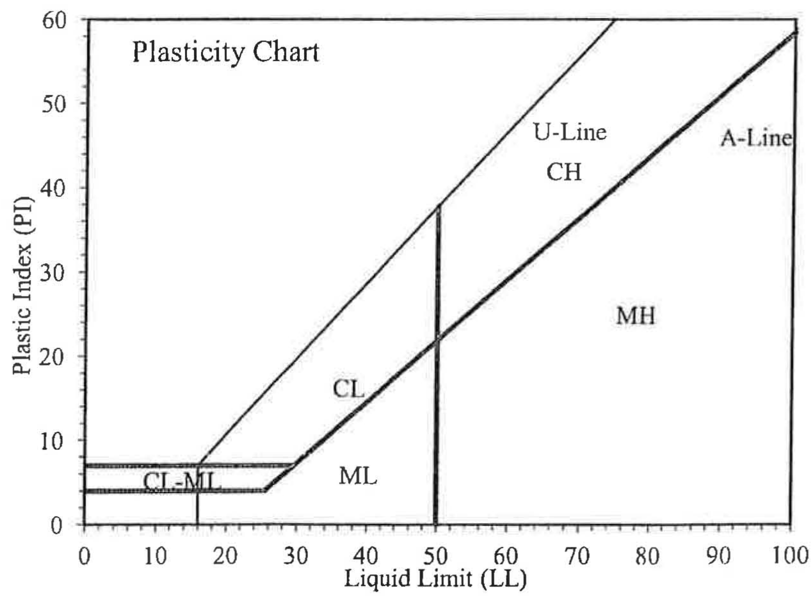
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by: BRR
Reviewed: NB

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Particle-Size Analysis of Soils *with hydrometer*
(ASTM D422)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: SMW-1
Sample:
Depth: 5'
Description: Lean CLAY with sand, grey

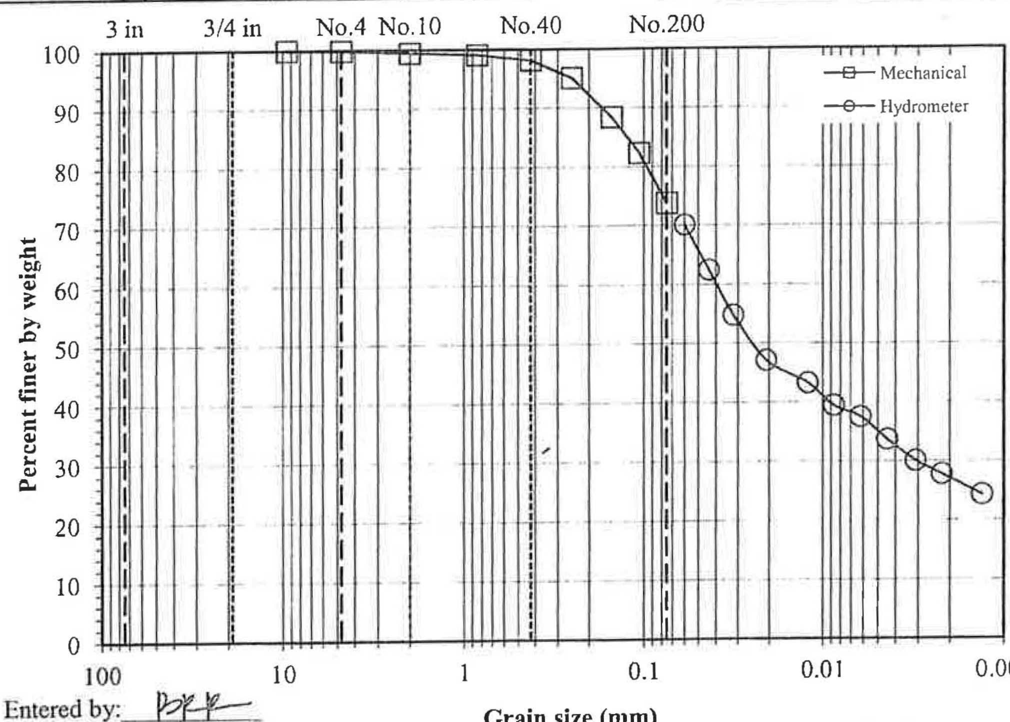
Split sieve:	Yes	
Split sieve:	#10	
	Moist	Dry
Total sample wt. (g):	484.00	475.66
+#10 Coarse fraction (g):	2.54	2.48
-#10 Split fraction (g):	52.79	51.88
Hydrometer fraction (g):	52.79	51.88
Split fraction:	0.995	

Water content data	C.F.(+#10)	S.F.(-#10)	Hyd.(-No.10)
Moist soil + tare (g):	194.84	66.05	66.05
Dry soil + tare (g):	193.66	65.55	65.55
Tare (g):	140.54	37.00	37.00
Water content (%):	2.22	1.75	1.75

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.65	Assumed	α:	1.00
Bulb No.	2		Hyd. fraction:	99.48
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	-	
3/8"	-	9.5	100.0	
No.4	0.46	4.75	99.9	
No.10	2.48	2	99.5	<=Split
No.20	0.18	0.85	99.1	
No.40	0.67	0.425	98.2	
No.60	2.27	0.25	95.1	
No.100	5.74	0.15	88.5	
No.140	8.95	0.106	82.3	
No.200	13.38	0.075	73.8	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	20.4	40	0.05995	70.18
1	20.4	36	0.04380	62.51
2	20.4	32	0.03193	54.84
5	20.4	28	0.02079	47.17
15	20.4	26	0.01217	43.33
30	20.4	24	0.00872	39.50
60	20.4	23	0.00621	37.58
120	20.4	21	0.00445	33.74
250	20.9	19	0.00310	30.12
482	22.3	17.5	0.00222	27.83
1415	20.9	16	0.00133	24.37



Gravel (%): 0.1
Sand (%): 26.1
Fines (%): 73.8

Entered by: BRR
Reviewed: NR

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Particle-Size Analysis of Soils *with hydrometer*
(ASTM D422)

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: SMW-2
Sample:
Depth: 8'
Description: Sandy lean CLAY, brown

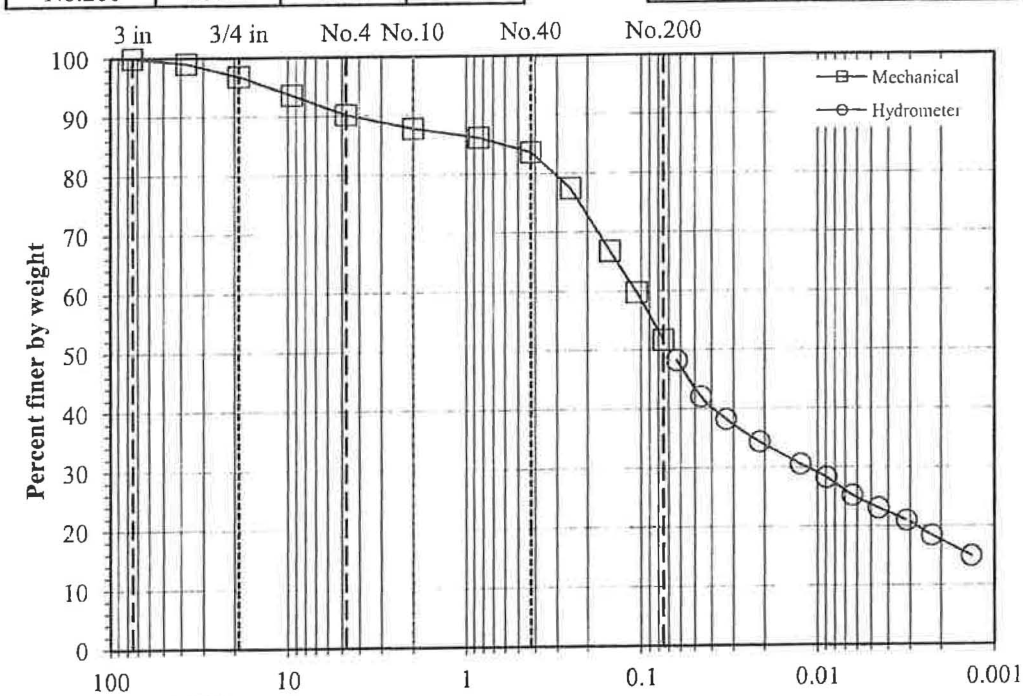
Split sieve:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	26128.38	23889.98
+3/8" Coarse fraction (g):	1582.83	1522.69
-3/8" Split fraction (g):	668.93	657.25
Hydrometer fraction (g):	58.30	57.02
Split fraction:	0.936	

Water content data	C.F.(+3/8")	S.F.(-3/8")	Hyd.(+No.10	Hyd.(-No.10)
Moist soil + tare (g):	2173.64	1075.65	203.15	75.69
Dry soil + tare (g):	2103.02	1007.96	201.78	74.84
Tare (g):	315.06	312.89	124.72	37.09
Water content (%):	3.95	9.74	1.78	2.25

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.65	Assumed	α:	1.00
Bulb No.	2		Hyd. fraction:	87.81
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	224.61	37.5	99.1	
3/4"	750.01	19	96.9	
3/8"	1522.69	9.5	93.6	<=Split
No.4	23.87	4.75	90.2	
No.10	40.83	2	87.8	<=Split hyd.
No.20	1.04	0.85	86.2	
No.40	2.70	0.425	83.7	
No.60	6.70	0.25	77.5	
No.100	13.62	0.15	66.8	
No.140	18.19	0.106	59.8	
No.200	23.43	0.075	51.7	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	19.3	35	0.06327	48.29
1	19.3	31	0.04611	42.13
2	19.3	28.5	0.03320	38.28
5	19.3	26	0.02136	34.43
15	19.4	23.5	0.01252	30.62
30	19.5	22	0.00893	28.34
60	19.6	20	0.00639	25.29
120	20	18.5	0.00454	23.12
250	20.6	17	0.00315	21.01
474	22.3	15	0.00227	18.50
1407	21	13	0.00135	14.98



Gravel (%): 9.8
Sand (%): 38.5
Fines (%): 51.7

Entered by: BKP
Reviewed: WJS

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Particle-Size Analysis of Soils *with hydrometer*
(ASTM D422)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: SMW-3
Sample:
Depth: 6-7'
Description: Lean CLAY with sand, brown

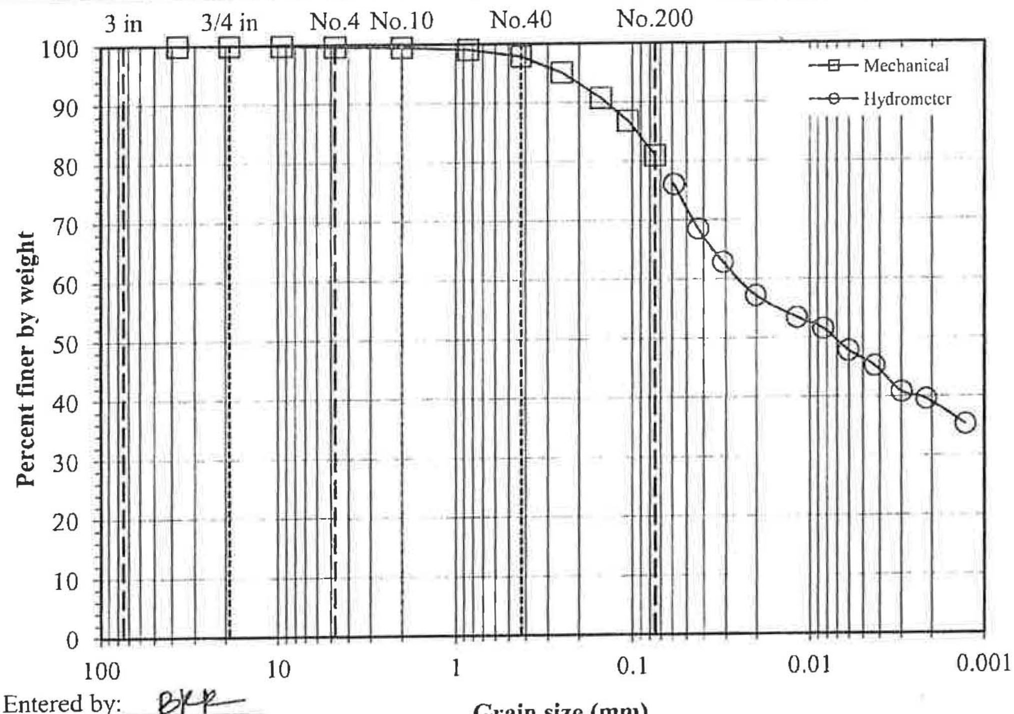
Split sieve:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	23699.09	21199.92
+3/8" Coarse fraction (g):	26.07	25.86
-3/8" Split fraction (g):	535.67	526.53
Hydrometer fraction (g):	54.09	52.73
Split fraction:	0.999	

Water content data	C.F.(+3/8")	S.F.(-3/8")	Hyd.(+No.10	Hyd.(-No.10)
Moist soil + tare (g):	149.72	613.46	149.37	68.07
Dry soil + tare (g):	149.51	560.81	149.00	67.31
Tare (g):	123.34	114.70	127.68	37.81
Water content (%):	0.80	11.80	1.74	2.58

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.65	Assumed	Intercept:	16.3
Bulb No.	2		α:	1.00
			Hyd. fraction:	99.55
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	100.0	
3/4"	8.15	19	100.0	
3/8"	25.86	9.5	99.9	<=Split
No.4	0.80	4.75	99.7	
No.10	1.71	2	99.6	<=Split hyd.
No.20	0.24	0.85	99.1	
No.40	0.86	0.425	97.9	
No.60	2.34	0.25	95.1	
No.100	4.65	0.15	90.8	
No.140	6.72	0.106	86.9	
No.200	9.84	0.075	81.0	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	19.1	44	0.05882	76.11
1	19.1	40	0.04307	68.56
2	19.1	37	0.03122	62.89
5	19.1	34	0.02021	57.23
15	19.2	32	0.01183	53.50
30	19.2	31	0.00843	51.61
60	19.3	29	0.00604	47.87
120	19.9	27.5	0.00428	45.29
250	20.6	25	0.00299	40.86
466	22.2	24	0.00216	39.63
1398	21	22	0.00128	35.36



Gravel (%): 0.3
Sand (%): 18.7
Fines (%): 81.0

Entered by: BKP
Reviewed: NB

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: SMW-4
Sample:
Depth: 7.5-8'
Description: Sandy lean CLAY, brown

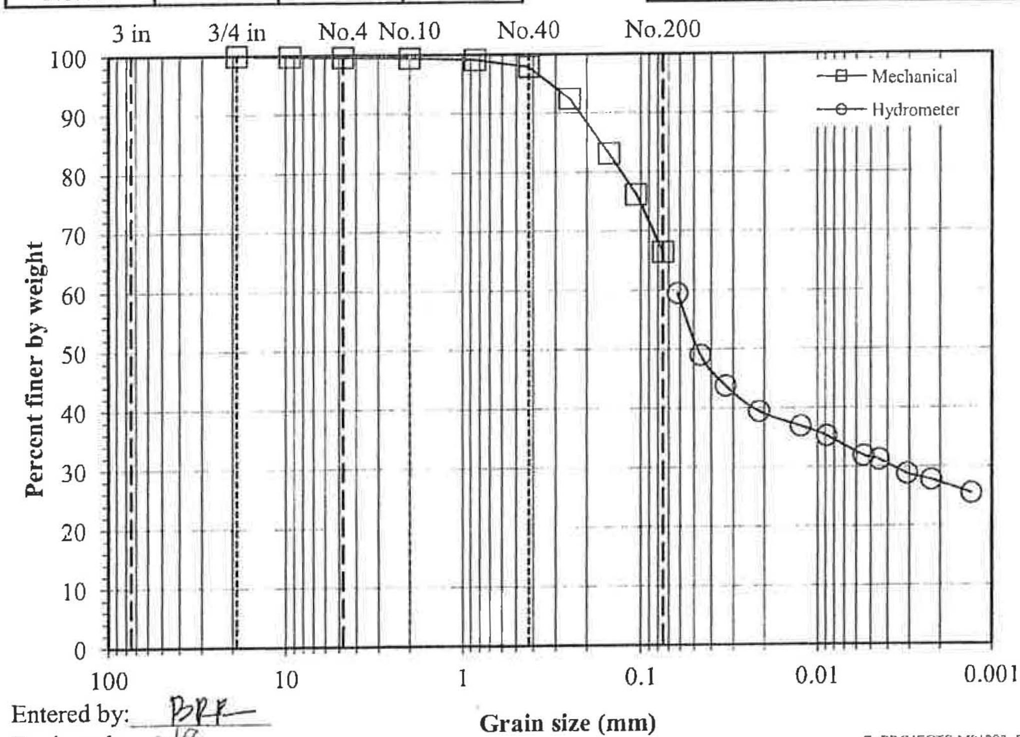
	Moist	Dry
Split sieve:	Yes	
Split sieve:	3/8"	
Total sample wt. (g):	23372.51	19637.69
+3/8" Coarse fraction (g):	34.69	32.75
-3/8" Split fraction (g):	357.66	350.14
Hydrometer fraction (g):	58.29	57.21
Split fraction:	0.998	

Water content data	C.F.(+3/8")	S.F.(-3/8")	Hyd.(+No.10	Hyd.(-No.10)
Moist soil + tare (g):	161.78	451.04	177.76	52.63
Dry soil + tare (g):	159.52	398.61	176.73	52.34
Tare (g):	121.27	123.25	128.75	36.95
Water content (%):	5.91	19.04	2.15	1.88

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
Gs:	2.65	Assumed	Intercept:	16.3
Bulb No.	2		α:	1.00
			Hyd. fraction:	99.46
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	100.0	
3/8"	32.75	9.5	99.8	<=Split
No.4	0.54	4.75	99.7	
No.10	1.30	2	99.5	<=Split hyd.
No.20	0.17	0.85	99.2	
No.40	0.88	0.425	97.9	
No.60	4.01	0.25	92.5	
No.100	9.37	0.15	83.2	
No.140	13.39	0.106	76.2	
No.200	18.99	0.075	66.4	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	18.7	38	0.06223	59.50
1	18.7	32	0.04611	49.07
2	18.7	29	0.03332	43.86
5	18.7	26.5	0.02144	39.51
15	18.9	25	0.01248	36.98
30	19.1	24	0.00886	35.32
80	19.4	22	0.00548	31.95
120	19.9	21.5	0.00446	31.27
250	20.5	20	0.00310	28.89
458	22.3	19	0.00225	27.84
1390	20.9	18	0.00132	25.57



Gravel (%): 0.3
Sand (%): 33.2
Fines (%): 66.4

Entered by: BRR
Reviewed: NB

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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: BRR

Boring No.: SMW-5
Sample:
Depth: 5'
Description: Silty SAND, brown

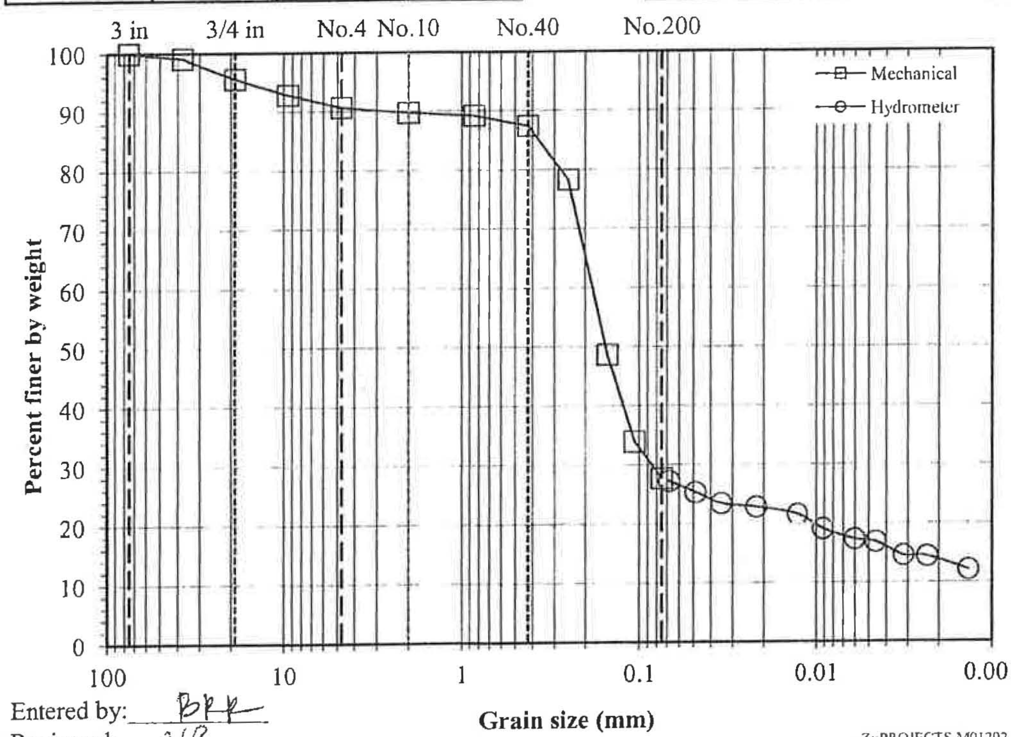
Split sieve:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	26744.16	25441.61
+3/8" Coarse fraction (g):	1861.37	1814.14
-3/8" Split fraction (g):	804.68	799.10
Hydrometer fraction (g):	71.78	71.52
Split fraction:	0.929	

Water content data	C.F.(+3/8")	S.F.(-3/8")	Hyd.(+No.10	Hyd.(-No.10)
Moist soil + tare (g):	2546.24	1118.69	301.48	62.19
Dry soil + tare (g):	2492.01	1082.93	300.94	62.10
Tare (g):	408.82	409.86	223.62	37.70
Water content (%):	2.60	5.31	0.70	0.37

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.1641
			Intercept:	16.3
Gs:	2.65	Assumed	α:	1.00
Bulb No.	2		Hyd. fraction:	89.79
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	224.74	37.5	99.1	
3/4"	1111.84	19	95.6	
3/8"	1814.14	9.5	92.9	<=Split
No.4	18.45	4.75	90.7	
No.10	26.49	2	89.8	<=Split hyd.
No.20	0.43	0.85	89.3	
No.40	1.85	0.425	87.5	
No.60	9.16	0.25	78.3	
No.100	32.75	0.15	48.7	
No.140	44.47	0.106	34.0	
No.200	49.44	0.075	27.7	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	18.6	25.5	0.06838	27.25
1	18.6	24	0.04884	25.37
2	18.6	22.5	0.03488	23.48
5	18.6	22	0.02213	22.86
15	18.7	21	0.01284	21.63
30	18.8	19	0.00919	19.14
70	19.3	17.5	0.00603	17.40
120	19.9	17	0.00459	16.94
250	20.6	15	0.00319	14.62
450	22.3	14.5	0.00234	14.46
1382	20.9	13	0.00137	12.19



Gravel (%): 9.3
Sand (%): 63.0
Fines (%): 27.7

Entered by: BRR
Reviewed: NB

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

IGES

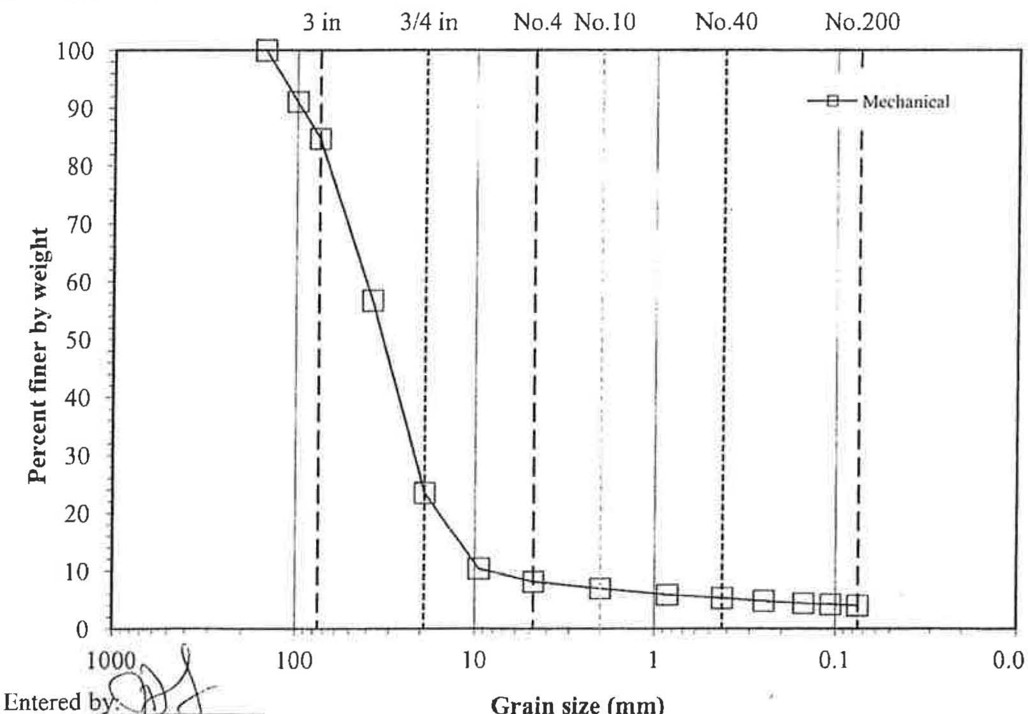
Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/4/2014
By: JDF

Boring No.:
Sample: Waste Rock
Depth:
Description: Grey gravel

Split:	Yes	
Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	55944.00	55319.95
+3/4" Coarse fraction (g):	42703.20	42313.63
-3/4" Split fraction (g):	1655.10	1625.79
Split fraction:	0.235	

Water content data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	2869.00	2118.10
Dry soil + tare (g):	2847.07	2088.79
Tare (g):	465.10	463.00
Water content (%):	0.9	1.8

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	100.0	
4"	4921.79	100	91.1	
3"	8479.63	75	84.7	
1.5"	23947.23	37.5	56.7	
3/4"	42313.63	19	23.5	←Split
3/8"	905.74	9.5	10.4	
No.4	1063.84	4.75	8.1	
No.10	1143.79	2	7.0	
No.20	1221.21	0.85	5.9	
No.40	1259.78	0.425	5.3	
No.60	1293.80	0.25	4.8	
No.100	1321.21	0.15	4.4	
No.140	1334.60	0.106	4.2	
No.200	1347.71	0.075	4.0	



Gravel (%): 91.9
Sand (%): 4.1
Fines (%): 4.0

Entered by: JDF
Reviewed: NB

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Classification of Soils for Engineering Purposes

(ASTM D2487)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion
Date: 4/11/2014
By: NB

Sample Info.								
Boring No.								
Sample:	SMW-1	SMW-2	SMW-3	SMW-4	SMW-5			
Depth:	5'	8'	6-7'	7.5-8'	5'			
Liquid Limit (%):	37	32	45	36	NP			
Plastic Limit (%):	18	17	18	17	NP			
Plastic Index (%):	19	15	27	19	NP			
Gravel (%):	0.1	9.8	0.3	0.3	9.3			
Sand (%):	26.1	38.5	18.7	33.2	63			
Fines (%):	73.8	51.7	81	66.4	27.7			
D_{60} (mm):								
D_{30} (mm):								
D_{10} (mm):								
Cu:								
Cc:								
Group Symbol:	**CL**	**CL**	**CL**	**CL**	**SM**			
Group Name:	**Lean CLAY with sand, grey**	**Sandy lean CLAY, brown**	**Lean CLAY with sand, brown**	**Sandy lean CLAY, brown**	**Silty SAND, brown**			

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Reviewed: [signature]

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

IGES

Project: EarthFax Engineering, Inc
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 3/27/2014
By: BRR

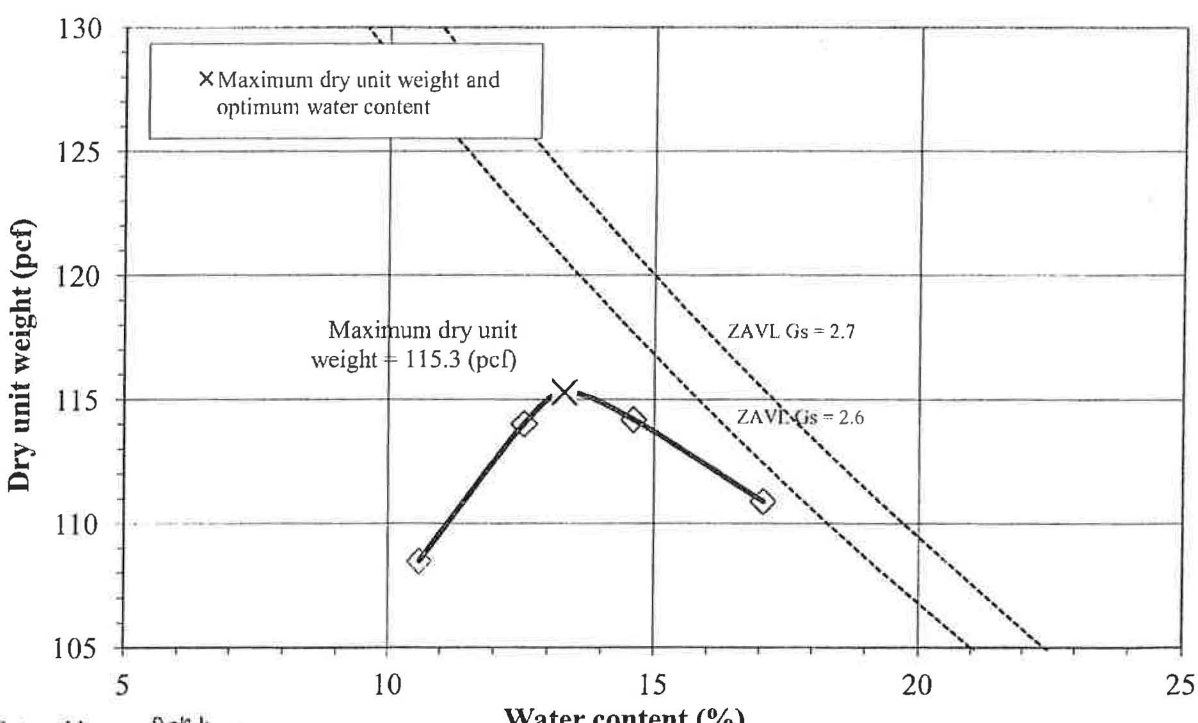
Boring No.: SMW-1
Sample:
Depth: 5.0'
Sample Description: Lean CLAY with sand, grey
Engineering Classification: CL
As-received water content (%): Not requested

Method: ASTM D1557 B
Mold Id. Inc 1
Mold volume (ft^3): 0.0333

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Optimum water content (%): 13.3
Maximum dry unit weight (pcf): 115.3

Point Number	+4%	+6%	+2%	As Is				
Wt. Sample + Mold (g)	6220.4	6204.6	6182.2	6056.2				
Wt. of Mold (g)	4244.4	4244.4	4244.4	4244.4				
Wet Unit Wt., γ_m (pcf)	130.9	129.8	128.3	120.0				
Wet Soil + Tare (g)	672.09	747.74	687.26	656.08				
Dry Soil + Tare (g)	602.19	657.38	626.34	604.97				
Tare (g)	123.55	127.84	140.99	122.75				
Water Content, w (%)	**14.6**	**17.1**	**12.6**	**10.6**				
Dry Unit Wt., γ_d (pcf)	**114.2**	**110.9**	**114.0**	**108.5**				



Entered by: BRR
Reviewed: NB

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Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/4/2014
By: JDF

Boring No.:
Sample: SMW-1
Depth: 5'
Sample Description: Lean CLAY with sand, grey
Sample type: Laboratory compacted
Dry unit weight 89.7 pcf
at 9.3 (%) w
Compaction specifications: Provided by client

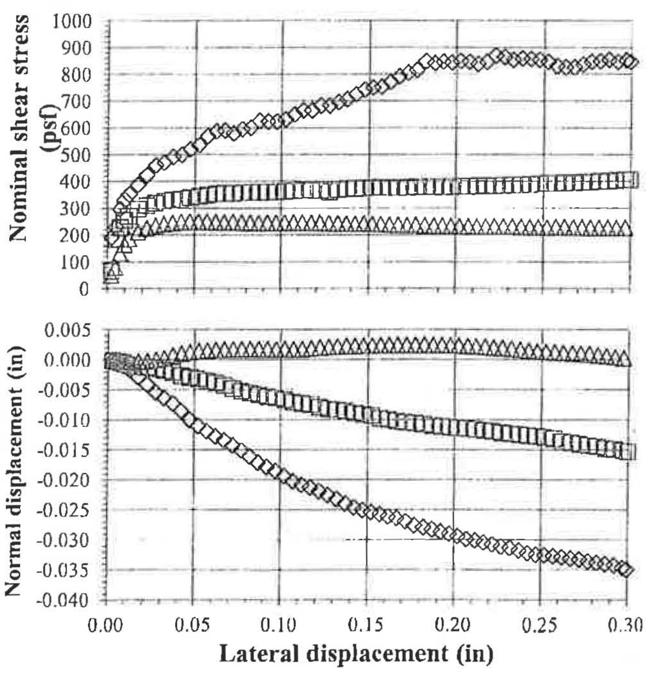
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0086
Specific gravity, Gs: 2.67 Assumed

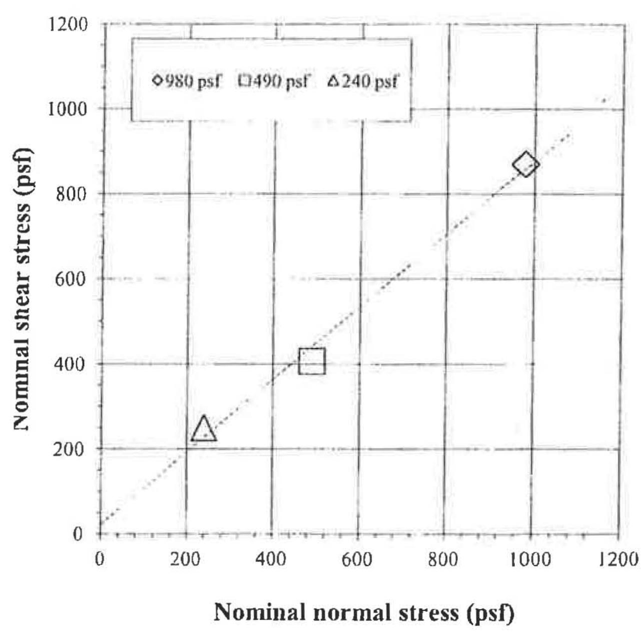
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	980		490		240	
Peak shear stress (psf)	870		406		250	
Lateral displacement at peak (in)	0.222		0.297		0.057	
Load Duration (min)	986		996		1008	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	1.0000	0.9918	1.0000	1.0222	1.0000	1.0296
Sample diameter (in)	2.416	2.416	2.416	2.416	2.416	2.416
Wt. rings + wet soil (g)	161.13	185.16	161.18	187.49	160.08	186.94
Wt. rings (g)	43.04	43.04	43.09	43.09	41.99	41.99
Wet soil + tare (g)	430.22		430.22		430.22	
Dry soil + tare (g)	403.78		403.78		403.78	
Tare (g)	118.09		118.09		118.09	
Water content (%)	9.3	31.5	9.3	33.6	9.3	34.1
Dry unit weight (pcf)	89.8	90.5	89.8	87.8	89.8	87.2
Void ratio, e, for assumed Gs	0.86	0.84	0.86	0.90	0.86	0.91
Saturation (%)*	28.9	100.0	28.9	100.0	28.9	100.0

ϕ' (deg)	40
c' (psf)	23

Average of 3 samples	Initial	Pre-shear
Water content (%)	9.3	33.1
Dry unit weight (pcf)	89.8	88.5

*Pre-shear saturation set to 100% for phase calculations





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Reviewed: NB

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-1
Depth: 5'

Nominal normal stress = 1000 psf			Nominal normal stress = 500 psf			Nominal normal stress = 200 psf		
Lateral Displacement	Nominal Shear Stress	Normal Displacement	Lateral Displacement	Nominal Shear Stress	Normal Displacement	Lateral Displacement	Nominal Shear Stress	Normal Displacement
(in.)	(psf)	(psf)	(in.)	(psf)	(psf)	(in.)	(psf)	(psf)
0.002	192	0.000	0.002	66	0.000	0.002	50	0.000
0.005	231	0.000	0.005	185	0.000	0.005	80	0.000
0.007	298	0.000	0.007	229	0.000	0.007	131	0.000
0.010	332	-0.001	0.010	255	-0.001	0.010	164	0.000
0.012	352	-0.002	0.012	272	-0.001	0.012	186	0.000
0.017	389	-0.003	0.017	297	-0.001	0.017	212	0.000
0.022	425	-0.004	0.022	310	-0.001	0.022	225	0.000
0.027	461	-0.005	0.027	319	-0.001	0.027	235	0.000
0.032	471	-0.006	0.032	327	-0.002	0.032	241	0.000
0.037	492	-0.007	0.037	332	-0.002	0.037	245	0.001
0.042	500	-0.008	0.042	336	-0.003	0.042	249	0.001
0.047	521	-0.010	0.047	341	-0.003	0.047	249	0.001
0.052	536	-0.011	0.052	345	-0.003	0.052	249	0.001
0.057	570	-0.012	0.057	349	-0.004	0.057	250	0.002
0.062	588	-0.013	0.062	354	-0.004	0.062	248	0.002
0.067	591	-0.013	0.067	356	-0.004	0.067	247	0.002
0.072	580	-0.014	0.072	356	-0.005	0.072	249	0.002
0.077	596	-0.015	0.077	358	-0.005	0.077	247	0.002
0.082	601	-0.016	0.082	360	-0.006	0.082	246	0.002
0.087	627	-0.017	0.087	361	-0.006	0.087	245	0.002
0.092	624	-0.018	0.092	360	-0.006	0.092	246	0.002
0.097	624	-0.018	0.097	362	-0.006	0.097	246	0.002
0.102	632	-0.019	0.102	364	-0.007	0.102	246	0.002
0.107	650	-0.020	0.107	366	-0.007	0.107	247	0.002
0.112	666	-0.021	0.112	367	-0.007	0.112	246	0.002
0.117	666	-0.021	0.117	368	-0.007	0.117	245	0.002
0.122	684	-0.022	0.122	368	-0.008	0.122	245	0.002
0.127	684	-0.023	0.127	361	-0.008	0.127	244	0.002
0.132	697	-0.023	0.132	371	-0.008	0.132	243	0.002
0.137	707	-0.024	0.137	373	-0.009	0.137	242	0.002
0.142	725	-0.025	0.142	374	-0.009	0.142	242	0.002
0.147	743	-0.025	0.147	376	-0.009	0.147	242	0.002
0.152	751	-0.025	0.152	377	-0.009	0.152	242	0.002
0.157	754	-0.026	0.157	377	-0.010	0.157	241	0.002
0.162	772	-0.026	0.162	377	-0.010	0.162	238	0.002
0.167	793	-0.026	0.167	377	-0.010	0.167	237	0.002
0.172	806	-0.027	0.172	378	-0.010	0.172	236	0.002
0.177	816	-0.028	0.177	379	-0.011	0.177	237	0.002
0.182	850	-0.028	0.182	380	-0.011	0.182	235	0.002
0.187	842	-0.028	0.187	380	-0.011	0.187	234	0.002
0.192	847	-0.029	0.192	380	-0.011	0.192	234	0.002
0.197	844	-0.029	0.197	380	-0.011	0.197	233	0.002
0.202	850	-0.029	0.202	381	-0.011	0.202	232	0.002
0.207	847	-0.030	0.207	381	-0.011	0.207	232	0.002
0.212	839	-0.030	0.212	383	-0.012	0.212	232	0.002
0.217	847	-0.030	0.217	383	-0.012	0.217	232	0.002
0.222	870	-0.031	0.222	385	-0.012	0.222	232	0.002
0.227	865	-0.031	0.227	385	-0.012	0.227	232	0.002
0.232	855	-0.031	0.232	386	-0.012	0.232	232	0.002
0.237	860	-0.032	0.237	387	-0.012	0.237	231	0.002
0.242	857	-0.032	0.242	389	-0.013	0.242	230	0.002
0.247	855	-0.032	0.247	391	-0.013	0.247	229	0.001
0.252	847	-0.033	0.252	392	-0.013	0.252	228	0.001
0.257	831	-0.033	0.257	393	-0.013	0.257	230	0.001
0.262	826	-0.033	0.262	395	-0.014	0.262	230	0.001
0.267	826	-0.033	0.267	396	-0.014	0.267	228	0.001
0.272	837	-0.033	0.272	397	-0.014	0.272	228	0.001
0.277	847	-0.034	0.277	399	-0.014	0.277	227	0.001
0.282	850	-0.034	0.282	401	-0.014	0.282	227	0.001
0.287	855	-0.034	0.287	402	-0.015	0.287	228	0.001
0.292	847	-0.034	0.292	404	-0.015	0.292	227	0.000
0.297	852	-0.035	0.297	406	-0.015	0.297	227	0.000
0.300	847	-0.035	0.300	406	-0.015	0.301	228	0.000

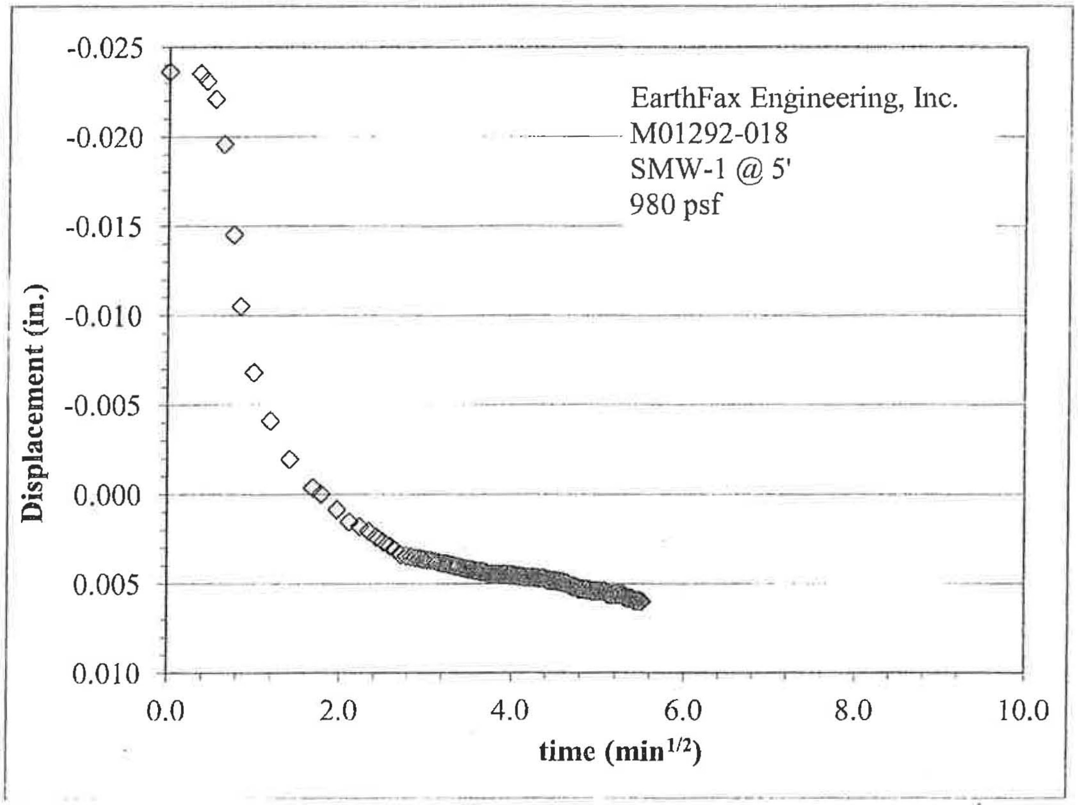
Direct Shear Test for Soils Under Drained Conditions

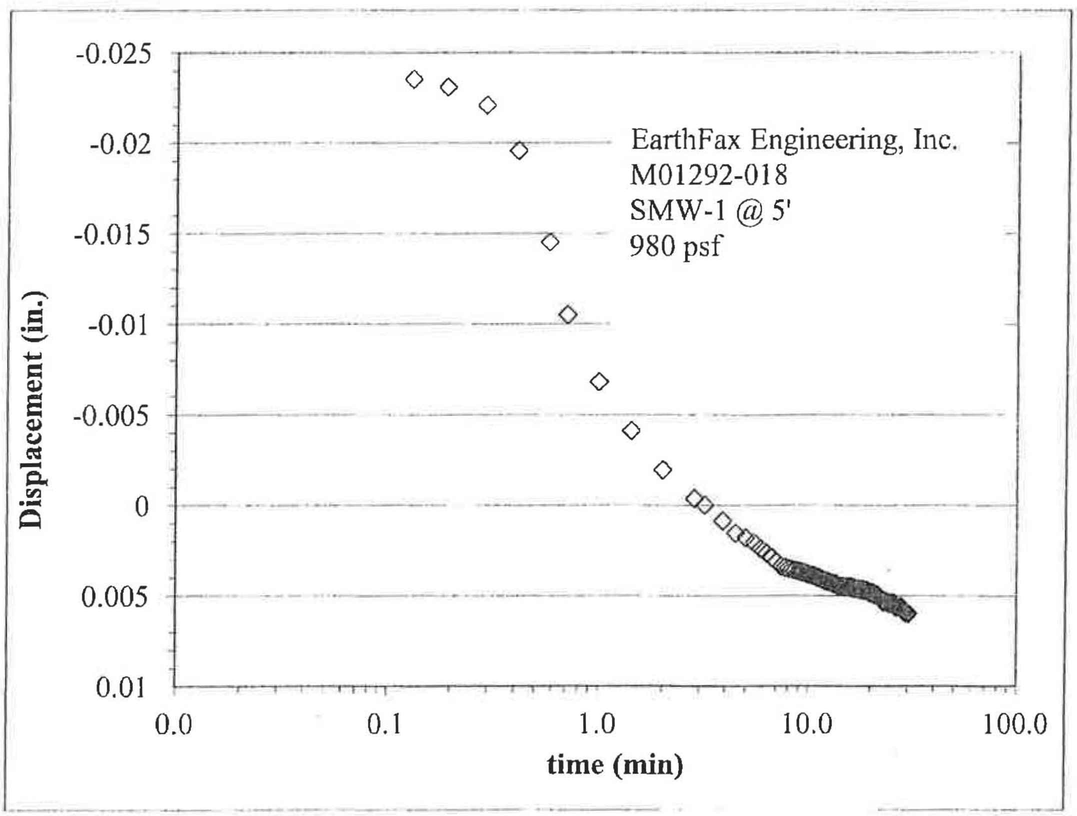
(ASTM D3080)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-1
Depth: 5'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/10/2014
By: JDF

Boring No.:
Sample: SMW-2
Depth: 8'
Sample Description: Sandy lean CLAY, brown
Sample type: Laboratory compacted
Dry unit weight 104.5 pcf
at 9.9 (%) w
Compaction specifications: Provided by client

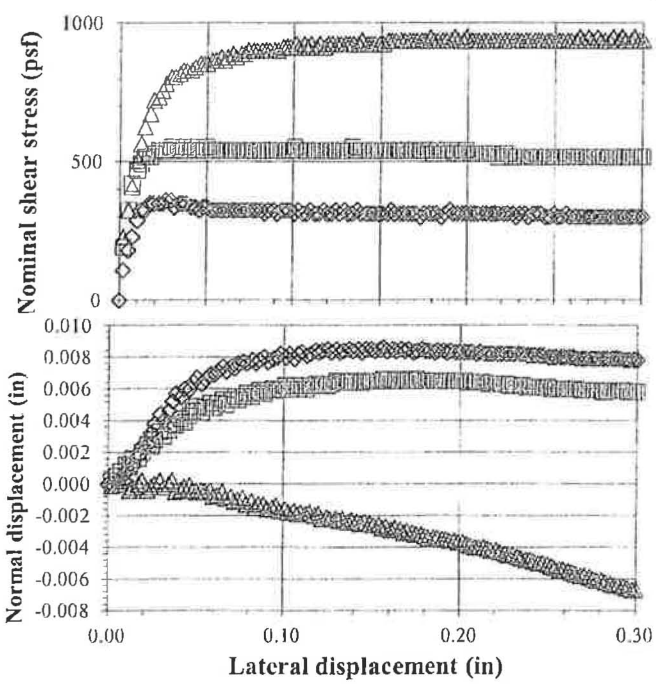
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0004
Specific gravity, Gs: 2.65 Assumed

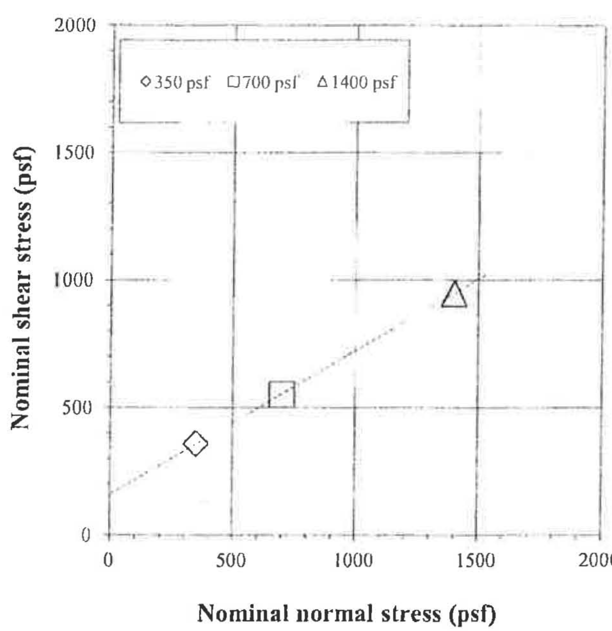
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	350		700		1400	
Peak shear stress (psf)	360		552		948	
Lateral displacement at peak (in)	0.026		0.029		0.178	
Load Duration (min)	5490		6727		8166	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	1.0000	1.0159	1.0000	1.0006	1.0000	1.0041
Sample diameter (in)	2.416	2.416	2.416	2.416	2.416	2.416
Wt. rings + wet soil (g)	181.41	197.87	180.45	195.76	180.97	196.54
Wt. rings (g)	43.08	43.08	42.12	42.12	42.64	42.64
Wet soil + tare (g)	301.29		301.29		301.29	
Dry soil + tare (g)	285.15		285.15		285.15	
Tare (g)	119.90		119.90		119.90	
Water content (%)	9.8	22.8	9.8	21.9	9.8	22.1
Dry unit weight (pcf)	104.7	103.0	104.7	104.6	104.7	104.2
Void ratio, e, for assumed Gs	0.58	0.60	0.58	0.58	0.58	0.59
Saturation (%)*	44.6	100.0	44.6	100.0	44.6	100.0

ϕ' (deg)	29
c' (psf)	162

Average of 3 samples	Initial	Pre-shear
Water content (%)	9.8	22.3
Dry unit weight (pcf)	104.7	104.0

*Pre-shear saturation set to 100% for phase calculations





Entered by: JDF
Reviewed: NS

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-2
Depth: 8'

Nominal normal stress = 350 psf			Nominal normal stress = 700 psf			Nominal normal stress = 1400 psf		
Lateral Displacement	Nominal Shear Stress	Normal Displacement	Lateral Displacement	Nominal Shear Stress	Normal Displacement	Lateral Displacement	Nominal Shear Stress	Normal Displacement
0.000	0	0.000	0.000	0	0.000	0.000	0	0.000
0.002	108	0.000	0.002	192	0.000	0.002	228	0.000
0.005	180	0.000	0.005	324	0.001	0.005	324	0.000
0.007	228	0.000	0.007	420	0.001	0.007	408	0.000
0.010	288	0.001	0.010	468	0.001	0.010	504	0.000
0.012	324	0.001	0.012	492	0.001	0.012	564	0.000
0.014	324	0.001	0.014	516	0.002	0.014	624	0.000
0.017	348	0.002	0.017	516	0.002	0.017	672	0.000
0.019	348	0.002	0.019	528	0.002	0.019	720	0.000
0.022	348	0.003	0.022	540	0.003	0.022	732	0.000
0.024	348	0.003	0.024	540	0.002	0.024	756	0.000
0.026	360	0.004	0.026	540	0.003	0.026	780	0.000
0.029	360	0.004	0.029	552	0.003	0.029	804	0.000
0.031	336	0.004	0.031	540	0.003	0.031	804	0.000
0.034	348	0.005	0.034	540	0.003	0.034	816	0.000
0.036	348	0.005	0.036	552	0.004	0.036	828	0.000
0.038	348	0.006	0.038	540	0.004	0.038	828	-0.001
0.041	336	0.006	0.041	552	0.004	0.041	828	0.000
0.043	336	0.006	0.043	540	0.004	0.043	840	0.000
0.046	324	0.006	0.046	540	0.004	0.046	852	0.000
0.048	336	0.006	0.048	540	0.005	0.048	852	0.000
0.050	336	0.007	0.050	552	0.005	0.050	852	-0.001
0.053	324	0.006	0.053	540	0.005	0.053	864	0.000
0.055	324	0.007	0.055	540	0.005	0.055	864	-0.001
0.058	324	0.007	0.058	540	0.005	0.058	876	0.000
0.060	324	0.007	0.060	540	0.005	0.060	864	-0.001
0.062	324	0.007	0.062	540	0.005	0.062	876	-0.001
0.065	324	0.007	0.065	540	0.005	0.065	888	-0.001
0.067	324	0.007	0.067	540	0.005	0.067	876	-0.001
0.070	324	0.007	0.070	540	0.005	0.070	888	-0.001
0.072	324	0.007	0.072	540	0.006	0.072	888	-0.001
0.074	324	0.008	0.074	540	0.005	0.074	900	-0.001
0.077	324	0.008	0.077	540	0.006	0.077	900	-0.001
0.079	324	0.008	0.079	540	0.006	0.079	900	-0.001
0.082	324	0.008	0.082	540	0.006	0.082	900	-0.001
0.084	312	0.008	0.084	540	0.006	0.084	900	-0.002
0.086	324	0.008	0.086	540	0.006	0.086	900	-0.001
0.089	324	0.008	0.089	540	0.006	0.089	900	-0.001
0.091	312	0.008	0.091	540	0.006	0.091	900	-0.002
0.094	324	0.008	0.094	540	0.006	0.094	912	-0.002
0.096	324	0.008	0.096	540	0.006	0.096	912	-0.001
0.098	324	0.008	0.098	540	0.006	0.098	912	-0.002
0.101	312	0.008	0.101	552	0.006	0.101	924	-0.002
0.103	324	0.008	0.103	540	0.006	0.103	912	-0.002
0.106	312	0.008	0.106	540	0.006	0.106	924	-0.002
0.108	312	0.008	0.108	540	0.006	0.108	912	-0.002
0.110	324	0.008	0.110	540	0.006	0.110	924	-0.002
0.113	312	0.008	0.113	540	0.006	0.113	912	-0.002
0.115	312	0.008	0.115	540	0.006	0.115	924	-0.002
0.118	324	0.008	0.118	540	0.006	0.118	912	-0.002
0.120	312	0.008	0.120	540	0.006	0.120	924	-0.002
0.122	312	0.008	0.122	540	0.006	0.122	924	-0.002
0.125	324	0.009	0.125	540	0.006	0.125	924	-0.002
0.127	312	0.008	0.127	540	0.006	0.127	924	-0.002
0.130	324	0.009	0.130	540	0.007	0.130	924	-0.002
0.132	312	0.008	0.132	540	0.006	0.132	924	-0.002
0.134	312	0.008	0.134	552	0.007	0.134	924	-0.002
0.137	324	0.009	0.137	540	0.006	0.137	924	-0.002
0.139	312	0.008	0.139	540	0.006	0.139	936	-0.002
0.142	312	0.009	0.142	540	0.007	0.142	924	-0.002
0.144	312	0.008	0.144	540	0.006	0.144	924	-0.003
0.146	312	0.009	0.146	540	0.007	0.146	924	-0.002
0.149	312	0.009	0.149	540	0.007	0.149	924	-0.003
0.151	312	0.008	0.151	540	0.007	0.151	924	-0.003
0.154	312	0.009	0.154	540	0.007	0.154	936	-0.003
0.156	324	0.009	0.156	540	0.007	0.156	936	-0.003

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-2
Depth: 8'

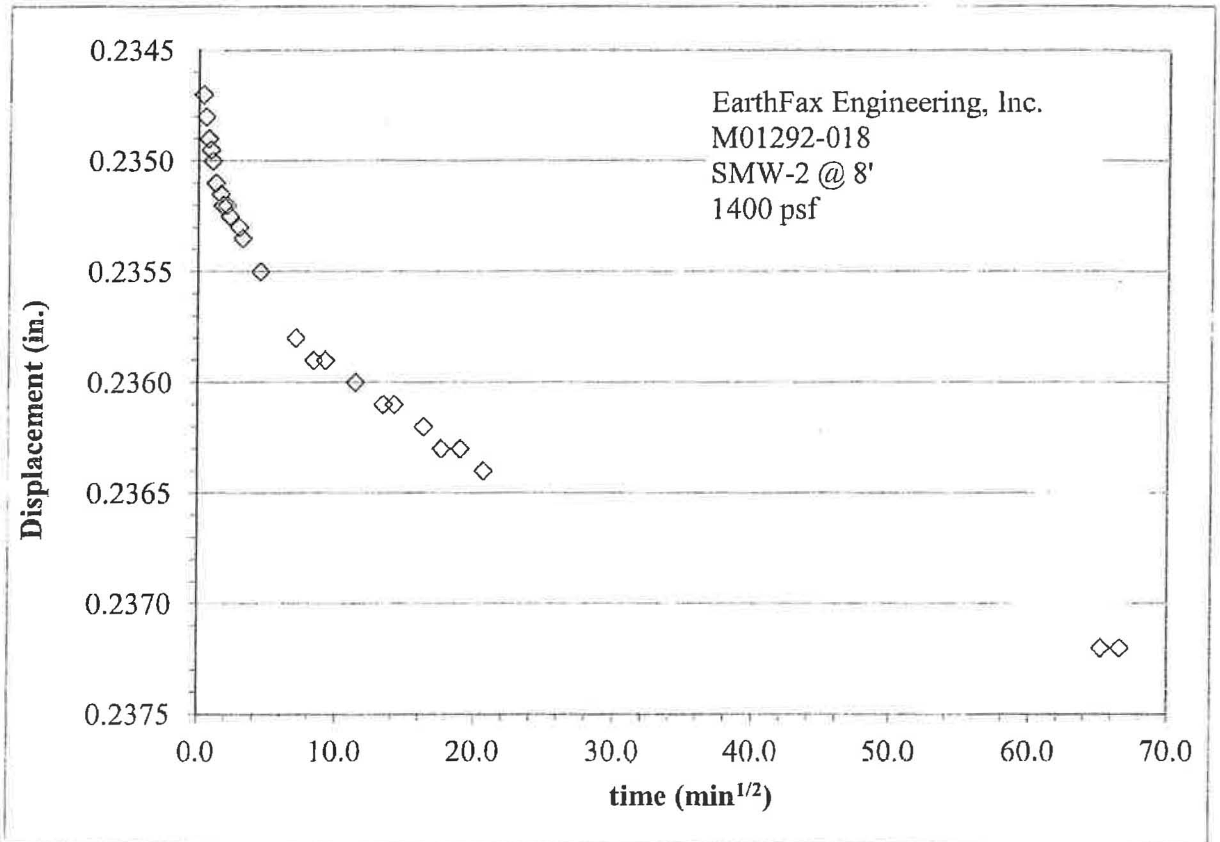
Nominal normal stress = 350 psf			Nominal normal stress = 700 psf			Nominal normal stress = 1400 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.158	312	0.008	0.158	540	0.007	0.158	936	-0.003
0.161	312	0.009	0.161	540	0.007	0.161	936	-0.003
0.163	312	0.008	0.163	540	0.007	0.163	936	-0.003
0.166	312	0.009	0.166	540	0.007	0.166	936	-0.003
0.168	312	0.008	0.168	540	0.007	0.168	936	-0.003
0.170	312	0.009	0.170	540	0.007	0.170	936	-0.003
0.173	300	0.008	0.173	540	0.007	0.173	936	-0.003
0.175	312	0.008	0.175	540	0.007	0.175	936	-0.003
0.178	312	0.009	0.178	540	0.007	0.178	948	-0.003
0.180	312	0.008	0.180	528	0.007	0.180	936	-0.003
0.182	312	0.008	0.182	540	0.007	0.182	936	-0.003
0.185	300	0.008	0.185	540	0.007	0.185	936	-0.003
0.187	312	0.008	0.187	528	0.007	0.187	936	-0.003
0.190	324	0.008	0.190	540	0.007	0.190	936	-0.004
0.192	312	0.008	0.192	528	0.007	0.192	948	-0.004
0.194	312	0.008	0.194	528	0.007	0.194	936	-0.004
0.197	312	0.008	0.197	528	0.007	0.197	936	-0.004
0.199	312	0.008	0.199	540	0.007	0.199	948	-0.004
0.202	312	0.008	0.202	528	0.007	0.202	936	-0.004
0.204	312	0.008	0.204	528	0.006	0.204	936	-0.004
0.206	312	0.008	0.206	528	0.006	0.206	936	-0.004
0.209	312	0.008	0.209	528	0.006	0.209	936	-0.004
0.211	312	0.008	0.211	528	0.006	0.211	936	-0.004
0.214	312	0.008	0.214	528	0.006	0.214	936	-0.004
0.216	312	0.008	0.216	528	0.006	0.216	936	-0.004
0.218	312	0.008	0.218	516	0.006	0.218	936	-0.004
0.221	312	0.008	0.221	528	0.006	0.221	936	-0.004
0.223	312	0.008	0.223	528	0.006	0.223	936	0.004
0.226	312	0.008	0.226	516	0.006	0.226	936	-0.004
0.228	300	0.008	0.228	516	0.006	0.228	936	-0.005
0.230	312	0.008	0.230	516	0.006	0.230	936	-0.005
0.233	312	0.008	0.233	516	0.006	0.233	936	-0.005
0.235	300	0.008	0.235	516	0.006	0.235	936	-0.005
0.238	312	0.008	0.238	516	0.006	0.238	936	-0.005
0.240	312	0.008	0.240	516	0.006	0.240	936	-0.005
0.242	312	0.008	0.242	516	0.006	0.242	936	-0.005
0.245	300	0.008	0.245	516	0.006	0.245	936	-0.005
0.247	300	0.008	0.247	516	0.006	0.247	936	-0.005
0.250	312	0.008	0.250	516	0.006	0.250	936	-0.005
0.252	300	0.008	0.252	516	0.006	0.252	936	-0.005
0.254	300	0.008	0.254	516	0.006	0.254	936	-0.005
0.257	312	0.008	0.257	516	0.006	0.257	936	-0.005
0.259	300	0.008	0.259	516	0.006	0.259	936	-0.005
0.262	300	0.008	0.262	516	0.006	0.262	936	-0.006
0.264	300	0.008	0.264	516	0.006	0.264	948	-0.006
0.266	300	0.008	0.266	516	0.006	0.266	936	-0.006
0.269	300	0.008	0.269	516	0.006	0.269	948	-0.006
0.271	300	0.008	0.271	516	0.006	0.271	936	-0.006
0.274	300	0.008	0.274	516	0.006	0.274	948	-0.006
0.276	300	0.008	0.276	516	0.006	0.276	936	-0.006
0.278	300	0.008	0.278	516	0.006	0.278	936	-0.006
0.281	300	0.008	0.281	516	0.006	0.281	936	-0.006
0.283	300	0.008	0.283	516	0.006	0.283	948	-0.006
0.286	300	0.008	0.286	516	0.006	0.286	936	-0.006
0.288	300	0.008	0.288	516	0.006	0.288	948	-0.006
0.290	300	0.008	0.290	516	0.006	0.290	936	-0.006
0.293	300	0.008	0.293	516	0.006	0.293	936	-0.007
0.295	300	0.008	0.295	516	0.006	0.295	948	-0.007
0.298	300	0.008	0.298	516	0.006	0.298	936	-0.007
0.300	300	0.008	0.300	516	0.006	0.300	936	-0.007

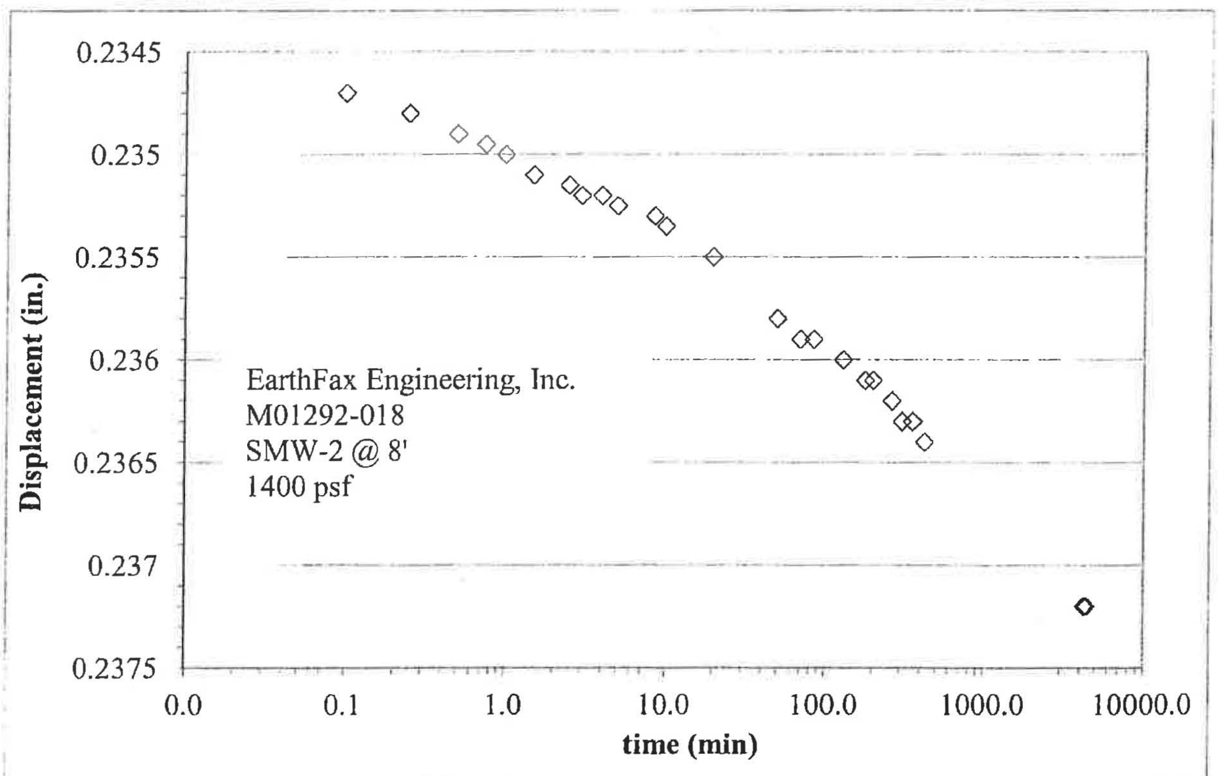
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-2
Depth: 8'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/8/2014
By: JDF

Boring No.:
Sample: SMW-3
Depth: 6-7'
Sample Description: Lean CLAY with sand, brown
Sample type: Laboratory compacted
Dry unit weight 104.9 pcf at 12.3 (%) w
Compaction specifications: Provided by client

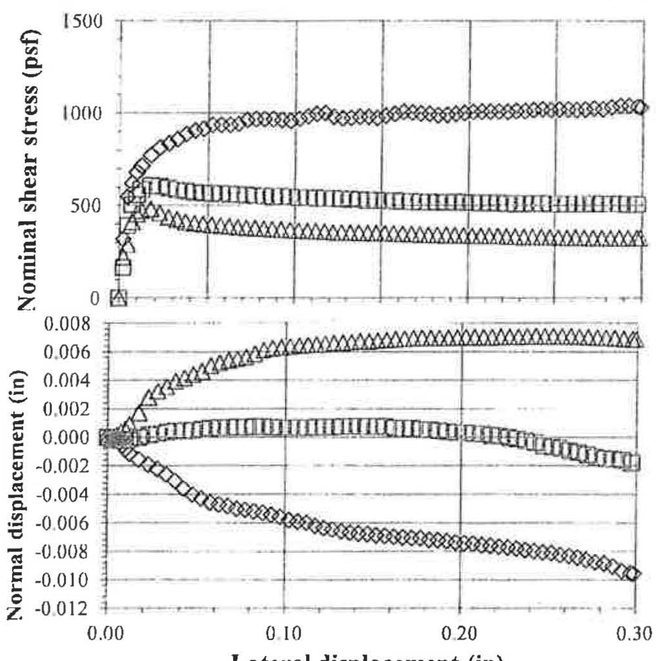
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0006
Specific gravity, Gs: 2.65 Assumed

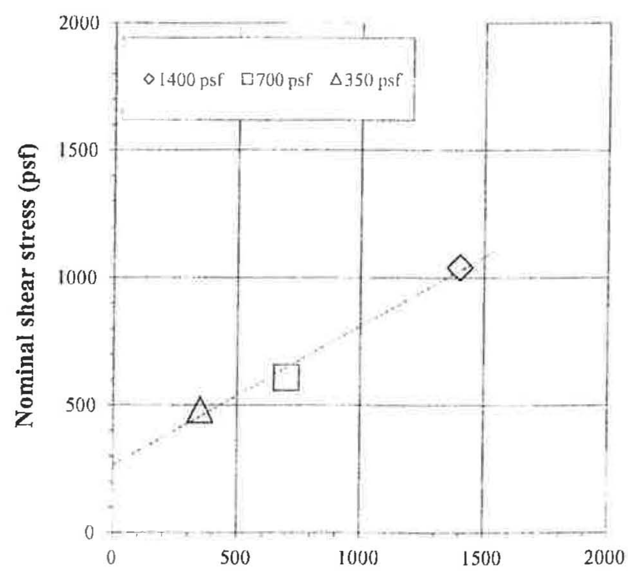
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	1400		700		350	
Peak shear stress (psf)	1041		608		482	
Lateral displacement at peak (in)	0.287		0.017		0.017	
Load Duration (min)	4056		4062		4075	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	1.0000	1.0041	1.0000	1.0148	1.0000	1.0196
Sample diameter (in)	2.416	2.416	2.416	2.416	2.416	2.416
Wt. rings + wet soil (g)	184.81	196.71	184.21	196.91	184.72	197.78
Wt. rings (g)	42.92	42.92	42.32	42.32	42.83	42.83
Wet soil + tare (g)	505.83		505.83		505.83	
Dry soil + tare (g)	463.03		463.03		463.03	
Tare (g)	127.29		127.29		127.29	
Water content (%)	12.7	22.2	12.7	22.8	12.7	23.1
Dry unit weight (pcf)	104.6	104.1	104.6	103.0	104.6	102.5
Void ratio, e, for assumed Gs	0.58	0.59	0.58	0.61	0.58	0.61
Saturation (%)*	58.1	100.0	58.1	100.0	58.1	100.0

φ' (deg)	29
c' (psf)	266

Average of 3 samples	Initial	Pre-shear
Water content (%)	12.7	22.7
Dry unit weight (pcf)	104.6	103.2

*Pre-shear saturation set to 100% for phase calculations





Entered by: JDF
Reviewed: NB

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Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-3
Depth: 6-7'

Nominal normal stress = 1400 psf			Nominal normal stress = 700 psf			Nominal normal stress = 350 psf		
Lateral Displacement in	Nominal Shear Stress psf	Normal Displacement in	Lateral Displacement in	Nominal Shear Stress psf	Normal Displacement in	Lateral Displacement in	Nominal Shear Stress psf	Normal Displacement in
0.000	-3	0.000	0.000	2	0.000	0.000	2	0.000
0.002	321	0.000	0.002	166	0.000	0.002	221	0.000
0.005	549	0.000	0.005	392	0.000	0.005	289	0.000
0.007	622	0.000	0.007	507	0.000	0.007	412	0.000
0.010	681	-0.001	0.010	558	0.000	0.010	454	0.001
0.012	715	-0.001	0.012	587	0.000	0.012	473	0.001
0.017	772	-0.002	0.017	608	0.000	0.017	482	0.002
0.022	816	-0.002	0.022	605	0.000	0.022	460	0.003
0.027	837	-0.002	0.027	596	0.000	0.027	437	0.003
0.032	860	-0.003	0.032	586	0.000	0.032	425	0.004
0.037	888	-0.003	0.037	579	0.000	0.037	412	0.004
0.042	907	-0.004	0.042	572	0.000	0.042	405	0.004
0.047	917	-0.004	0.047	569	0.001	0.047	400	0.004
0.052	938	-0.004	0.052	566	0.001	0.052	395	0.005
0.057	938	-0.005	0.057	565	0.001	0.057	391	0.005
0.062	938	-0.005	0.062	562	0.001	0.062	388	0.005
0.067	943	-0.005	0.067	560	0.001	0.067	383	0.005
0.072	964	-0.005	0.072	557	0.001	0.072	381	0.006
0.077	969	-0.005	0.077	554	0.001	0.077	378	0.006
0.082	969	-0.005	0.082	552	0.001	0.082	375	0.006
0.087	969	-0.005	0.087	550	0.001	0.087	372	0.006
0.092	964	-0.005	0.092	549	0.001	0.092	370	0.006
0.097	958	-0.006	0.097	547	0.001	0.097	367	0.006
0.102	971	-0.006	0.102	544	0.001	0.102	364	0.006
0.107	984	-0.006	0.107	543	0.001	0.107	362	0.006
0.112	997	-0.006	0.112	541	0.001	0.112	362	0.006
0.117	1002	-0.006	0.117	540	0.001	0.117	359	0.007
0.122	982	-0.006	0.122	539	0.001	0.122	356	0.007
0.127	974	0.006	0.127	537	0.001	0.127	355	0.007
0.132	977	-0.007	0.132	534	0.001	0.132	354	0.007
0.137	982	-0.007	0.137	532	0.001	0.137	353	0.007
0.142	982	-0.007	0.142	529	0.001	0.142	352	0.007
0.147	977	-0.007	0.147	528	0.001	0.147	352	0.007
0.152	987	-0.007	0.152	527	0.001	0.152	351	0.007
0.157	997	-0.007	0.157	526	0.001	0.157	350	0.007
0.162	1008	-0.007	0.162	523	0.001	0.162	348	0.007
0.167	1005	-0.007	0.167	522	0.001	0.167	346	0.007
0.172	1000	-0.007	0.172	520	0.001	0.172	343	0.007
0.177	997	-0.007	0.177	520	0.001	0.177	342	0.007
0.182	989	-0.007	0.182	519	0.001	0.182	341	0.007
0.187	992	-0.007	0.187	519	0.000	0.187	340	0.007
0.192	997	-0.007	0.192	519	0.000	0.192	340	0.007
0.197	1002	-0.007	0.197	518	0.000	0.197	339	0.007
0.202	1008	-0.007	0.202	517	0.000	0.202	336	0.007
0.207	1010	-0.007	0.207	515	0.000	0.207	336	0.007
0.212	1010	-0.008	0.212	516	0.000	0.212	337	0.007
0.217	1010	-0.008	0.217	515	0.000	0.217	336	0.007
0.222	1008	-0.008	0.222	512	0.000	0.222	332	0.007
0.227	1013	-0.008	0.227	511	0.000	0.227	331	0.007
0.232	1013	-0.008	0.232	511	0.000	0.232	330	0.007
0.237	1018	-0.008	0.237	512	0.000	0.237	331	0.007
0.242	1021	-0.008	0.242	512	0.000	0.242	330	0.007
0.247	1018	-0.008	0.247	510	-0.001	0.247	329	0.007
0.252	1021	-0.008	0.252	510	-0.001	0.252	327	0.007
0.257	1021	-0.008	0.257	510	-0.001	0.257	325	0.007
0.262	1018	-0.008	0.262	510	-0.001	0.262	326	0.007
0.267	1021	-0.008	0.267	510	-0.001	0.267	325	0.007
0.272	1026	-0.009	0.272	511	-0.001	0.272	325	0.007
0.277	1023	-0.009	0.277	510	-0.001	0.277	324	0.007
0.282	1033	-0.009	0.282	509	-0.001	0.282	324	0.007
0.287	1041	-0.009	0.287	509	-0.002	0.287	325	0.007
0.292	1041	-0.009	0.292	507	-0.002	0.292	325	0.007
0.297	1036	-0.010	0.297	507	-0.002	0.297	325	0.007
0.299	1033	-0.010	0.298	507	-0.002	0.299	325	0.007

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

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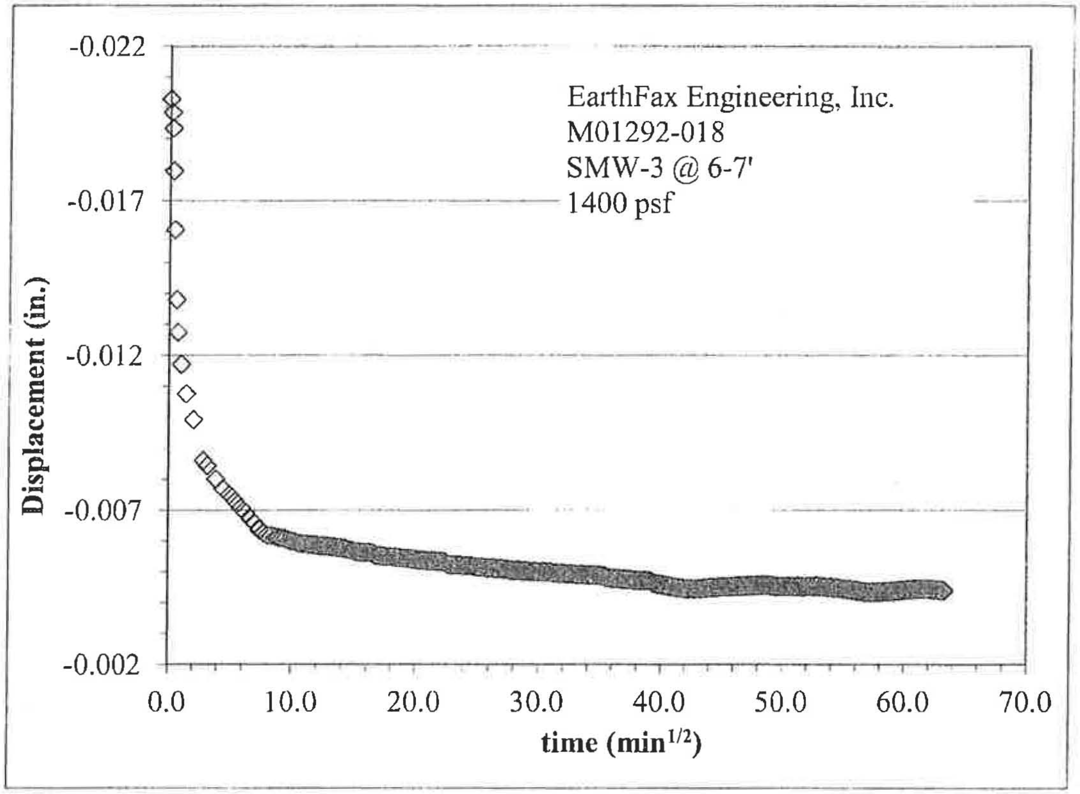
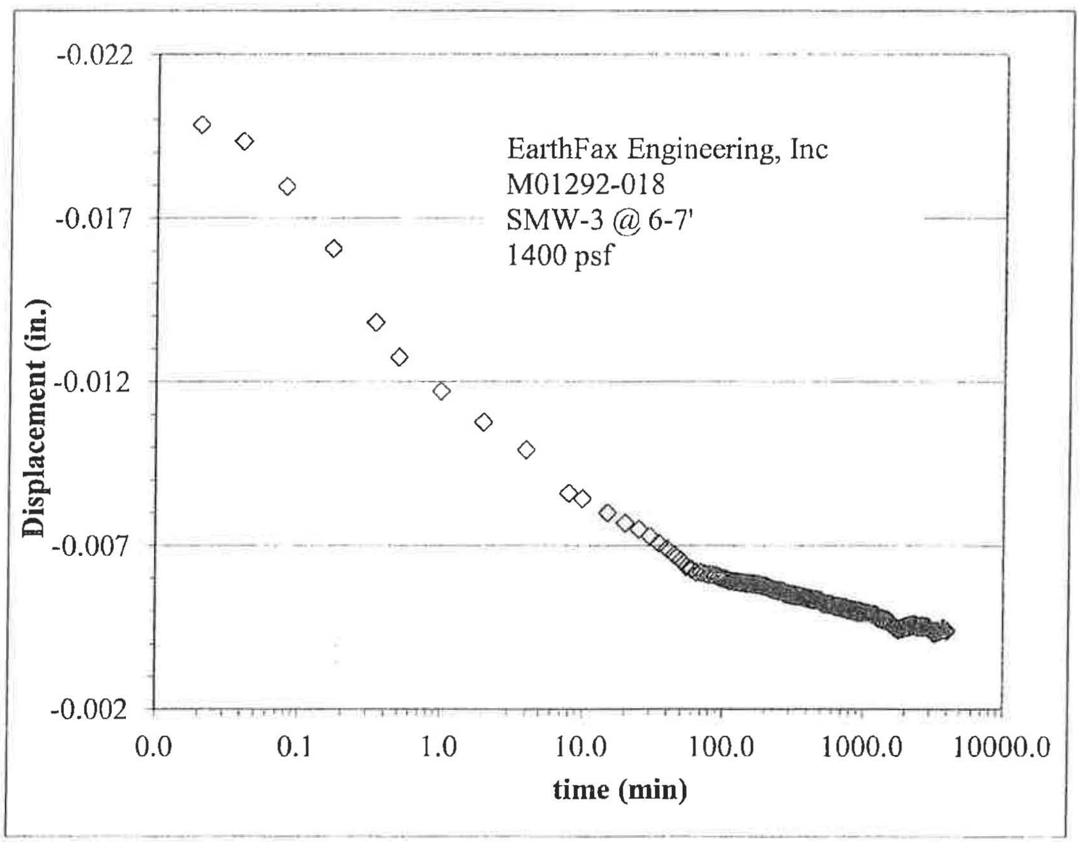
Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-3
Depth: 6-7'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/9/2014
By: JDF

Boring No.:
Sample: SMW-4
Depth: 8'
Sample Description: Sandy lean CLAY, brown
Sample type: Laboratory compacted
Dry unit weight 104.6 pcf
at 17.9 (%) w
Compaction specifications: Provided by client

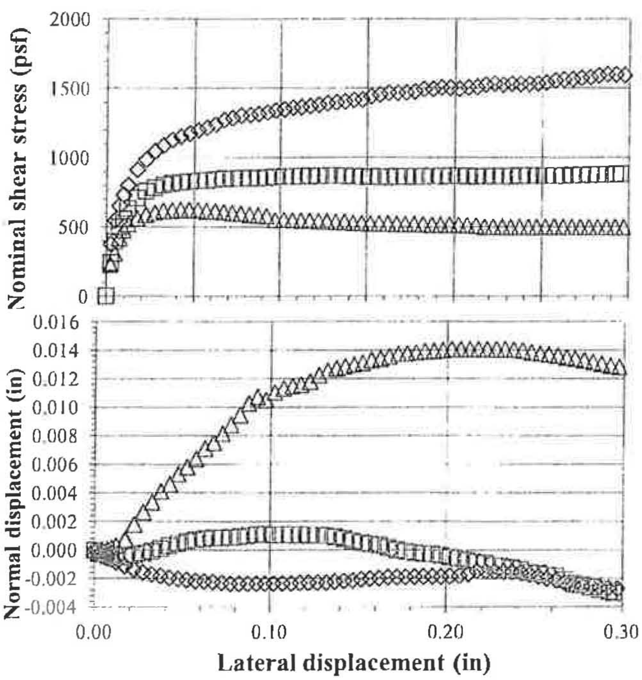
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0172
Specific gravity, Gs: 2.65 Assumed

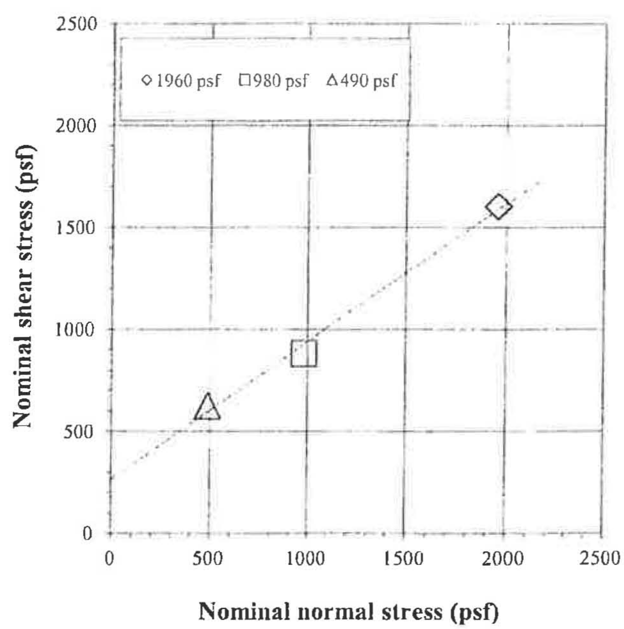
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	1960		980		490	
Peak shear stress (psf)	1603		882		626	
Lateral displacement at peak (in)	0.287		0.295		0.042	
Load Duration (min)	127		140		168	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	1.0000	0.9691	1.0000	0.9864	1.0000	0.9952
Sample diameter (in)	2.416	2.416	2.416	2.416	2.416	2.416
Wt. rings + wet soil (g)	193.58	196.37	191.60	195.69	191.56	196.31
Wt. rings (g)	45.04	45.04	43.06	43.06	43.02	43.02
Wet soil + tare (g)	298.33		298.33		298.33	
Dry soil + tare (g)	272.01		272.01		272.01	
Tare (g)	123.94		123.94		123.94	
Water content (%)	17.8	20.0	17.8	21.0	17.8	21.5
Dry unit weight (pcf)	104.8	108.1	104.8	106.2	104.8	105.3
Void ratio, e, for assumed Gs	0.58	0.53	0.58	0.56	0.58	0.57
Saturation (%)*	81.4	100.0	81.4	100.0	81.4	100.0

φ' (deg)	34
c' (psf)	265

Average of 3 samples	Initial	Pre-shear
Water content (%)	17.8	20.8
Dry unit weight (pcf)	104.8	106.5

*Pre-shear saturation set to 100% for phase calculations





Entered by: JDF
Reviewed: NHS

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Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-4
Depth: 8'

Nominal normal stress = 1960 psf			Nominal normal stress = 980 psf			Nominal normal stress = 490 psf		
Lateral Displacement	Nominal Shear Stress	Normal Displacement	Lateral Displacement	Nominal Shear Stress	Normal Displacement	Lateral Displacement	Nominal Shear Stress	Normal Displacement
in	psf	in	in	psf	in	in	psf	in
0.000	-5	0.000	0.000	5	0.000	0.000	-2	0.000
0.002	378	0.000	0.002	244	0.000	0.002	229	0.000
0.005	549	0.000	0.005	399	0.000	0.005	310	0.000
0.007	655	-0.001	0.007	502	0.000	0.007	419	0.000
0.010	733	-0.001	0.010	561	0.000	0.010	476	0.000
0.012	803	-0.001	0.012	635	0.000	0.012	522	0.000
0.017	914	-0.001	0.017	708	0.000	0.017	563	0.001
0.022	987	-0.001	0.022	759	0.000	0.022	589	0.002
0.027	1049	-0.002	0.027	785	0.000	0.027	603	0.003
0.032	1090	-0.002	0.032	802	0.000	0.032	618	0.003
0.037	1129	-0.002	0.037	814	0.000	0.037	618	0.004
0.042	1153	-0.002	0.042	823	0.000	0.042	626	0.005
0.047	1176	-0.002	0.047	829	0.000	0.047	622	0.005
0.052	1199	-0.002	0.052	834	0.001	0.052	623	0.006
0.057	1217	-0.002	0.057	839	0.001	0.057	616	0.006
0.062	1241	-0.002	0.062	845	0.001	0.062	616	0.007
0.067	1272	-0.002	0.067	850	0.001	0.067	608	0.008
0.072	1287	-0.002	0.072	851	0.001	0.072	602	0.008
0.077	1305	-0.002	0.077	854	0.001	0.077	596	0.009
0.082	1308	-0.002	0.082	854	0.001	0.082	588	0.009
0.087	1316	-0.002	0.087	855	0.001	0.087	584	0.010
0.092	1326	-0.002	0.092	859	0.001	0.092	579	0.011
0.097	1342	-0.002	0.097	862	0.001	0.097	549	0.011
0.102	1349	-0.002	0.102	865	0.001	0.102	550	0.011
0.107	1362	-0.002	0.107	866	0.001	0.107	549	0.011
0.112	1365	-0.002	0.112	866	0.001	0.112	546	0.011
0.117	1373	-0.002	0.117	868	0.001	0.117	545	0.012
0.122	1383	-0.002	0.122	870	0.001	0.122	542	0.012
0.127	1393	-0.002	0.127	872	0.001	0.127	541	0.012
0.132	1399	-0.002	0.132	872	0.001	0.132	537	0.013
0.137	1406	-0.002	0.137	869	0.001	0.137	535	0.013
0.142	1417	-0.002	0.142	866	0.001	0.142	530	0.013
0.147	1419	-0.002	0.147	865	0.001	0.147	528	0.013
0.152	1443	-0.002	0.152	864	0.001	0.152	526	0.013
0.157	1456	-0.002	0.157	863	0.000	0.157	524	0.013
0.162	1469	-0.002	0.162	861	0.000	0.162	524	0.013
0.167	1469	-0.002	0.167	864	0.000	0.167	522	0.014
0.172	1471	-0.002	0.172	863	0.000	0.172	521	0.014
0.177	1479	-0.002	0.177	865	0.000	0.177	520	0.014
0.182	1495	-0.002	0.182	865	0.000	0.182	519	0.014
0.187	1497	-0.002	0.187	866	0.000	0.187	516	0.014
0.192	1507	-0.002	0.192	866	0.000	0.192	516	0.014
0.197	1505	-0.002	0.197	869	0.000	0.197	515	0.014
0.202	1497	-0.002	0.202	869	0.000	0.202	514	0.014
0.207	1507	-0.002	0.207	868	-0.001	0.207	513	0.014
0.212	1510	-0.002	0.212	865	-0.001	0.212	511	0.014
0.217	1526	-0.001	0.217	866	-0.001	0.217	502	0.014
0.222	1533	-0.001	0.222	866	-0.001	0.222	502	0.014
0.227	1526	-0.001	0.227	866	-0.001	0.227	502	0.014
0.232	1533	-0.002	0.232	867	-0.001	0.232	501	0.014
0.237	1531	-0.002	0.237	870	-0.001	0.237	501	0.014
0.242	1531	-0.002	0.242	870	-0.001	0.242	499	0.014
0.247	1536	-0.002	0.247	871	-0.002	0.247	499	0.014
0.252	1541	-0.002	0.252	872	-0.002	0.252	499	0.014
0.257	1557	-0.002	0.257	872	-0.002	0.257	500	0.014
0.262	1564	-0.002	0.262	870	-0.002	0.262	501	0.014
0.267	1567	-0.002	0.267	874	-0.002	0.267	499	0.013
0.272	1575	-0.002	0.272	875	-0.002	0.272	500	0.013
0.277	1580	-0.003	0.277	877	-0.002	0.277	499	0.013
0.282	1593	-0.003	0.282	878	-0.003	0.282	500	0.013
0.287	1603	-0.003	0.287	879	-0.003	0.287	500	0.013
0.292	1601	-0.003	0.292	881	-0.003	0.292	500	0.013
0.297	1596	-0.003	0.295	882	-0.003	0.297	498	0.013
0.302	1593	-0.003				0.301	498	0.013

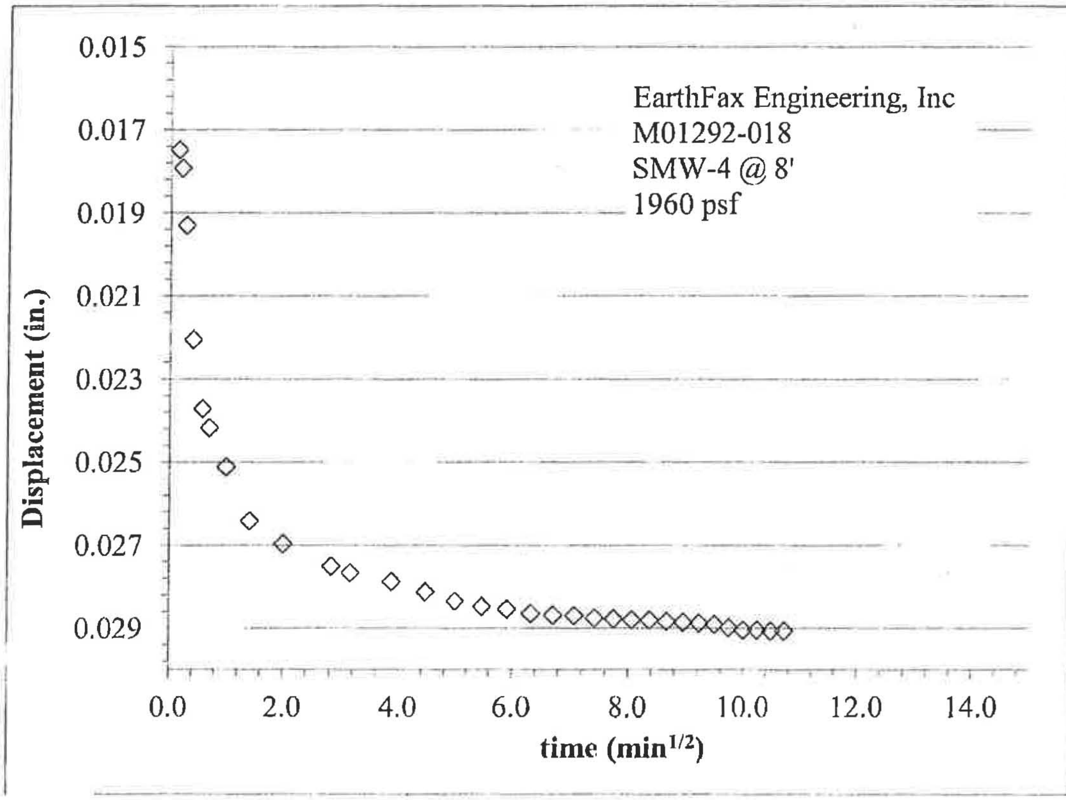
Direct Shear Test for Soils Under Drained Conditions

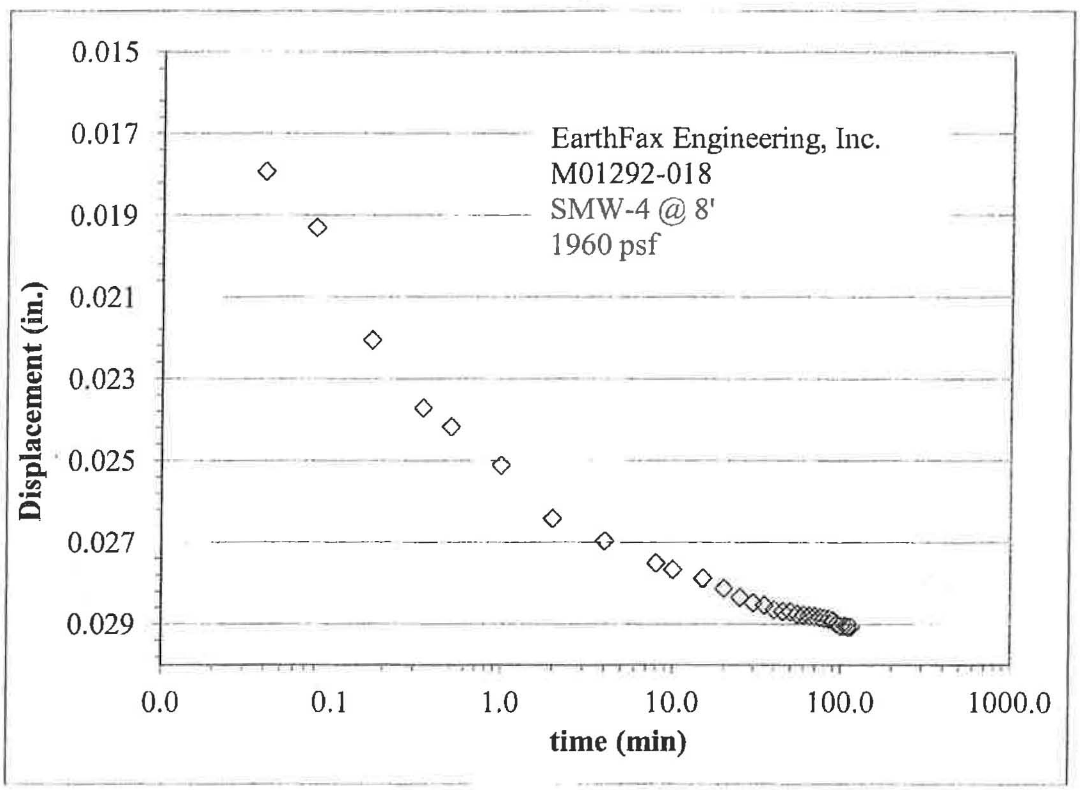
(ASTM D3080)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-4
Depth: 8'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/10/2014
By: JDF

Boring No.:
Sample: SMW-5
Depth: 5'
Sample Description: Silty SAND, brown
Sample type: Laboratory compacted
Dry unit weight 113.3 pcf
at 3.6 (%) w
Compaction specifications: Provided by client

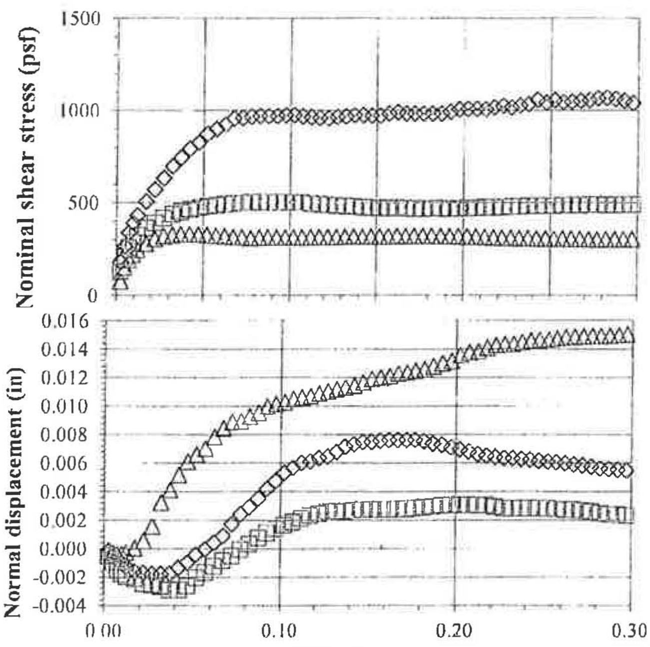
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0172
Specific gravity, Gs: 2.65 Assumed

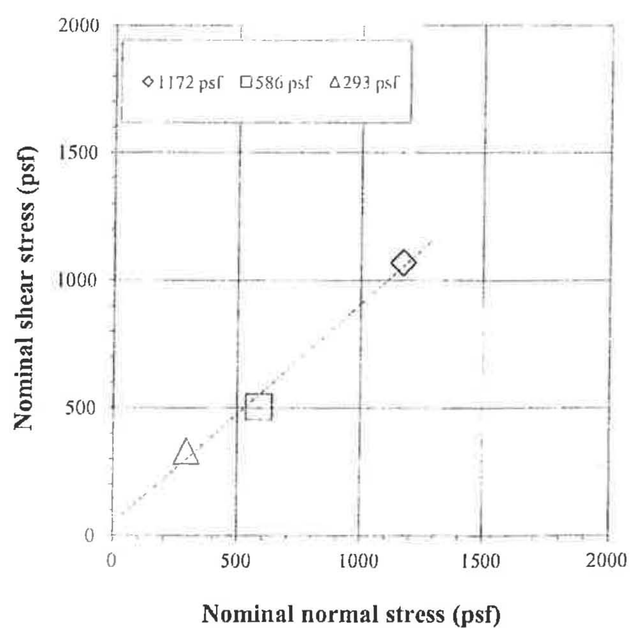
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	1172		586		293	
Peak shear stress (psf)	1070		506		331	
Lateral displacement at peak (in)	0.282		0.082		0.037	
Load Duration (min)	63		78		82	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	1.0000	0.9713	1.0000	0.9846	1.0000	0.9911
Sample diameter (in)	2.416	2.416	2.416	2.416	2.416	2.416
Wt. rings + wet soil (g)	185.90	202.40	184.45	201.95	184.65	202.64
Wt. rings (g)	44.52	44.52	43.07	43.07	43.27	43.27
Wet soil + tare (g)	453.55		453.55		453.55	
Dry soil + tare (g)	441.81		441.81		441.81	
Tare (g)	122.42		122.42		122.42	
Water content (%)	3.7	15.8	3.7	16.5	3.7	16.9
Dry unit weight (pcf)	113.3	116.6	113.3	115.0	113.3	114.3
Void ratio, e, for assumed Gs	0.46	0.42	0.46	0.44	0.46	0.45
Saturation (%)*	21.2	100.0	21.2	100.0	21.2	100.0

φ' (deg)	41
c' (psf)	49

Average of 3 samples	Initial	Pre-shear
Water content (%)	3.7	16.4
Dry unit weight (pcf)	113.3	115.3

*Pre-shear saturation set to 100% for phase calculations





Entered by: JDA
Reviewed: ND

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Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

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Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-5
Depth: 5'

Nominal normal stress = 1172 psf			Nominal normal stress = 586 psf			Nominal normal stress = 293 psf		
Lateral Displacement	Nominal Shear Stress	Normal Displacement	Lateral Displacement	Nominal Shear Stress	Normal Displacement	Lateral Displacement	Nominal Shear Stress	Normal Displacement
0.000	-10	0.000	0.000	-2	0.000	0.000	0	0.000
0.002	181	0.000	0.002	129	-0.001	0.002	75	0.000
0.005	267	0.000	0.005	205	-0.001	0.005	152	0.000
0.007	339	-0.001	0.007	257	-0.001	0.007	192	0.000
0.010	391	-0.001	0.010	289	-0.002	0.010	219	0.000
0.012	433	-0.001	0.012	325	-0.002	0.012	246	0.000
0.017	508	-0.002	0.017	364	-0.002	0.017	279	0.000
0.022	572	-0.002	0.022	393	-0.002	0.022	305	0.001
0.027	635	-0.002	0.027	419	-0.003	0.027	320	0.002
0.032	699	-0.002	0.032	440	-0.003	0.032	326	0.003
0.037	746	-0.002	0.037	451	-0.003	0.037	331	0.004
0.042	795	-0.001	0.042	467	-0.003	0.042	331	0.005
0.047	826	-0.001	0.047	475	-0.003	0.047	330	0.006
0.052	876	0.000	0.052	482	-0.002	0.052	326	0.007
0.057	901	0.000	0.057	489	-0.002	0.057	323	0.007
0.062	925	0.000	0.062	494	-0.001	0.062	320	0.008
0.067	958	0.001	0.067	498	-0.001	0.067	315	0.008
0.072	961	0.002	0.072	502	-0.001	0.072	315	0.009
0.077	969	0.002	0.077	504	0.000	0.077	309	0.009
0.082	971	0.003	0.082	506	0.000	0.082	313	0.009
0.087	971	0.004	0.087	504	0.001	0.087	315	0.010
0.092	971	0.004	0.092	504	0.001	0.092	314	0.010
0.097	977	0.005	0.097	504	0.001	0.097	314	0.010
0.102	977	0.005	0.102	502	0.002	0.102	314	0.010
0.107	969	0.006	0.107	502	0.002	0.107	313	0.011
0.112	964	0.006	0.112	497	0.002	0.112	315	0.011
0.117	961	0.006	0.117	493	0.002	0.117	315	0.011
0.122	958	0.006	0.122	490	0.002	0.122	315	0.011
0.127	966	0.006	0.127	487	0.003	0.127	315	0.011
0.132	969	0.007	0.132	484	0.003	0.132	317	0.011
0.137	977	0.007	0.137	482	0.003	0.137	319	0.011
0.142	977	0.007	0.142	477	0.003	0.142	317	0.011
0.147	974	0.007	0.147	476	0.003	0.147	319	0.012
0.152	974	0.008	0.152	474	0.003	0.152	318	0.012
0.157	984	0.008	0.157	473	0.003	0.157	320	0.012
0.162	992	0.008	0.162	475	0.003	0.162	321	0.012
0.167	984	0.008	0.167	472	0.003	0.167	320	0.012
0.172	984	0.008	0.172	471	0.003	0.172	321	0.012
0.177	984	0.008	0.177	471	0.003	0.177	321	0.012
0.182	984	0.008	0.182	472	0.003	0.182	321	0.013
0.187	984	0.007	0.187	472	0.003	0.187	320	0.013
0.192	995	0.007	0.192	471	0.003	0.192	320	0.013
0.197	1008	0.007	0.197	472	0.003	0.197	320	0.013
0.202	1010	0.007	0.202	474	0.003	0.202	318	0.014
0.207	1010	0.007	0.207	475	0.003	0.207	317	0.014
0.212	1008	0.007	0.212	477	0.003	0.212	315	0.014
0.217	1018	0.007	0.217	477	0.003	0.217	313	0.014
0.222	1026	0.006	0.222	478	0.003	0.222	311	0.014
0.227	1018	0.006	0.227	482	0.003	0.227	311	0.014
0.232	1028	0.006	0.232	483	0.003	0.232	310	0.014
0.237	1036	0.006	0.237	485	0.003	0.237	310	0.014
0.242	1059	0.006	0.242	485	0.003	0.242	307	0.015
0.247	1044	0.006	0.247	487	0.003	0.247	306	0.015
0.252	1057	0.006	0.252	486	0.003	0.252	305	0.015
0.257	1046	0.006	0.257	488	0.003	0.257	306	0.015
0.262	1049	0.006	0.262	489	0.003	0.262	306	0.015
0.267	1054	0.006	0.267	489	0.003	0.267	305	0.015
0.272	1057	0.006	0.272	492	0.003	0.272	304	0.015
0.277	1067	0.006	0.277	492	0.003	0.277	303	0.015
0.282	1070	0.006	0.282	491	0.003	0.282	304	0.015
0.287	1065	0.006	0.287	490	0.002	0.287	303	0.015
0.292	1054	0.006	0.292	492	0.002	0.292	304	0.015
0.297	1041	0.006	0.297	492	0.002	0.297	303	0.015
0.301	1036	0.005	0.301	493	0.002	0.301	305	0.015

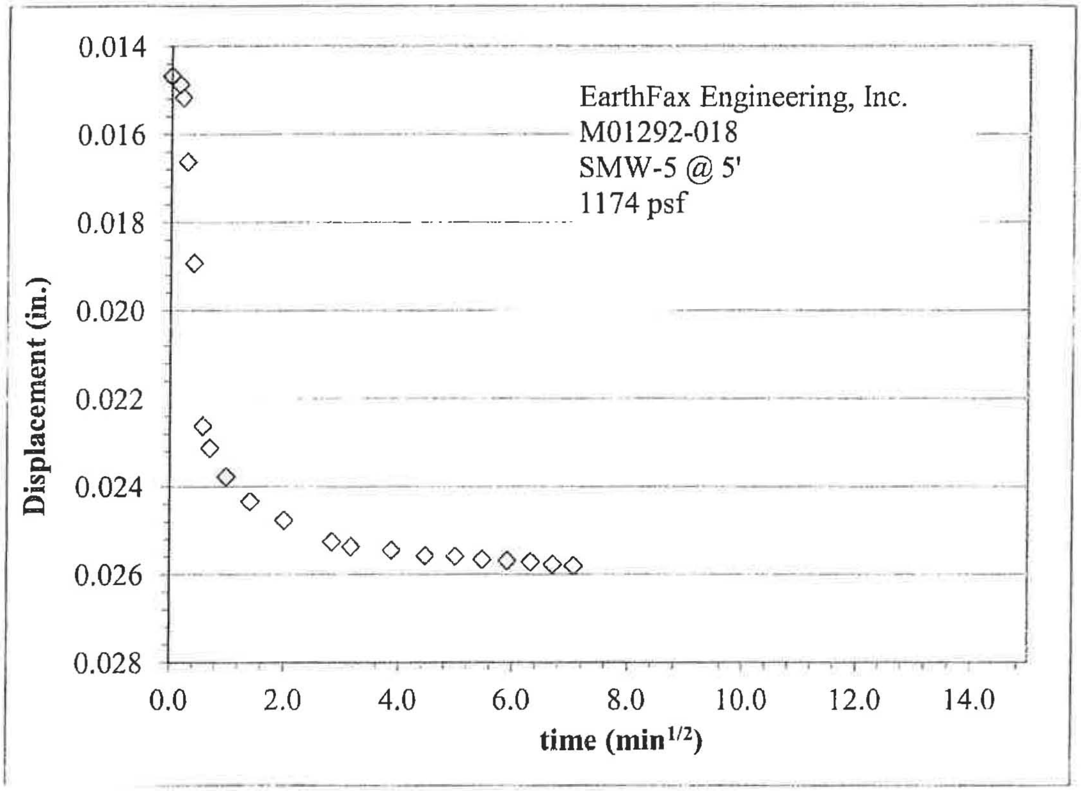
Direct Shear Test for Soils Under Drained Conditions

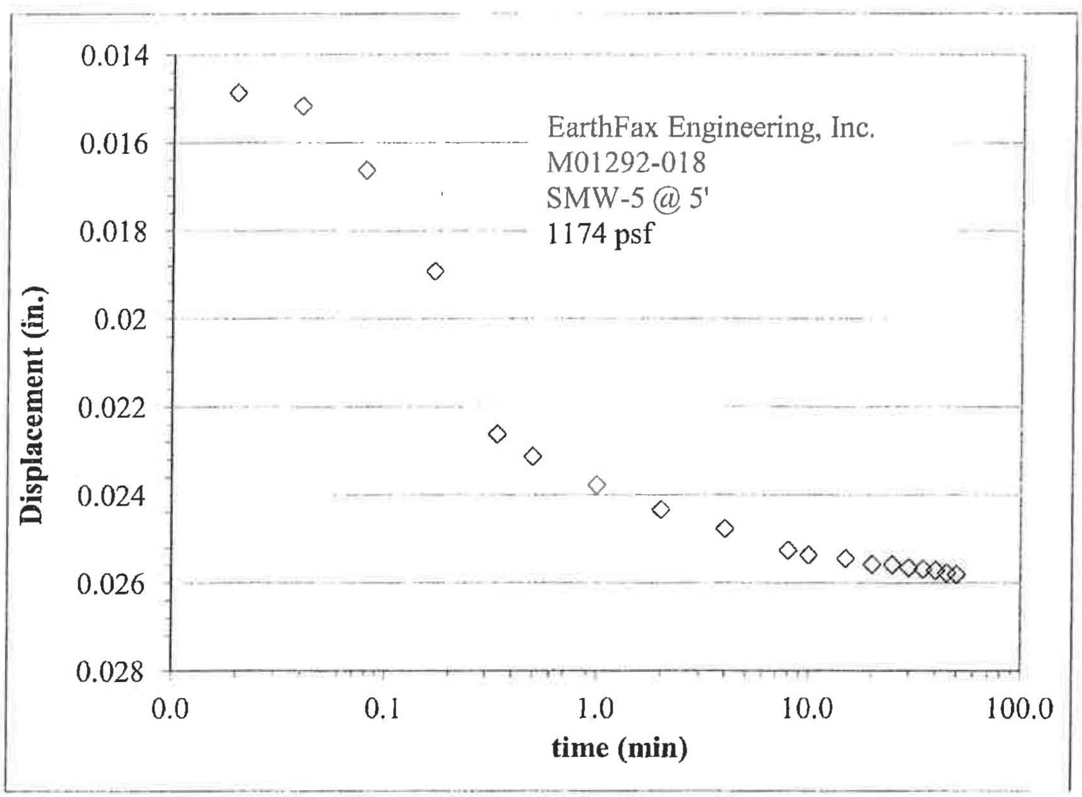
(ASTM D3080)

IGES

Project: EarthFax Engineering, Inc.
No: M01292-018
Location: Sufco Mine Waste Rock Expansion Site

Boring No.:
Sample: SMW-5
Depth: 5'





Angle of Repose

IGES

Project: **EarthFax Engineering, Inc.**
No: **M01292-018**
Location: Sufco Mine Waste Rock Expansion Site
Date: 4/1/2014
By: JDF

Boring No.:
Sample: **Waste Rock**
Depth:

Trial Number:	1	2	3
Measured Angle (°):	31.5	34.7	34.7

Average Angle of Repose (°) = 33.6

Entered by: JDF
Reviewed: NB

ATTACHMENT C

Jones and DeMille Engineering In Situ Nuclear Density Test Results

DENSITY REPORT

NUCLEAR MOISTURE DENSITY TEST DATA

Jones & DeMille Engineering

DATE: 03/18/2014

REPORT NUMBER:
For this day
√ 1

TECHNICIAN'S NAME: Warren M

PROJECT NAME: SUFCO, Canyon Fuel waste rock testing

PROJECT NUMBER: 1403-176

ENGINEER: Lyndon F
ENTER NAME

TROXLER NUMBER: 67280

STANDARD COUNT N(D)=: 2532
DENSITY

STANDARD COUNT N(M)=: 730
MOISTURE

MATERIAL: NATIVE

SOURCE: Waste rock expansion site

TEST RESULTS:

TEST STATION	OFFSET	REFERENCE/LIFT	PROB DEPTH	WET DENSITY	DRY DENSITY	%MOISTURE	%COMPACTION
Test hole SMW 1		3' depth	6"	94.1	82.1	14.7	
Test hole SMW 1		5' depth	6"	98.0	89.7	9.3	
Test hole SMW 2		6' depth	6"	114.8	104.5	9.9	
Test hole SMW 3		6' depth	6"	117.8	104.9	12.3	
Test hole SMW 5		5' depth	6"	117.4	113.3	3.6	
Test hole SMW 4		8' depth	6"	122.5	104.6	17.9	

COMMENTS: No trench correction on in place tests

EMAIL REPORT:

- fmaclean@earthfax.com; Heather.N@jonesanddemille.com

ATTACHMENT D

Test Pit Data Logs

Test Pit SMW-1

(Excavated and logged on March 18, 2014)

Depth (ft.)	Description
0-4	Silty SAND. Alluvium. Dry very fine grain topsoil. Organic matter. Pocket shear vane strength of 0.22 kg/cm^2. Dark grayish brown 10YR 4/2.
4-7	Sandy CLAY. Dry very fine grain. Organic matter. Pocket shear vane strength of 0.3 kg/cm^2. Dark yellowish brown 10YR 4/3.

Test Pit SMW-2

(Excavated and logged on March 18, 2014)

Depth (ft.)	Description
0-3	Silty CLAY. Moist cohesive soil. Organic matter. Pocket shear vane strength of 1.7 kg/cm^2. Dark yellowish brown 10YR 4/4.
3-8	Silty SAND. Alluvial banding. Dry very fine grain. Conglomerated. Pocket shear vane strength of 0.3 kg/cm^2. Dark brown 10YR 4/3.

Test Pit SMW-3

(Excavated and logged on March 18, 2014)

Depth (ft.)	Description
0-3	Sandy CLAY. Moist loose top soil. Organic matter. Pocket shear vane strength of 0.05 kg/cm^2. Very dark grayish brown 10YR 3/2.
3-8	Sandy CLAY. Blocky with white colored streaks. Dry, conglomerated. Pocket shear vane strength of 0.3 kg/cm^2. Dark grayish brown 10YR 4/2.

Test Pit SMW-4

(Excavated and logged on March 18, 2014)

Depth (ft.)	Description
0-2	Sandy CLAY. Moist top soil. Organic matter. Pocket shear vane strength of 0.225 kg/cm^2. Dark grayish brown 10YR 4/2.
2-5	Sandy CLAY. Moist cohesive soil. Pocket shear vane strength of 0.2 kg/cm^2. Very dark grayish brown 10YR 3/2.
5-7.5	Sandy CLAY. Moist cohesive soil. Pocket shear vane strength of 0.25 kg/cm^2. Very dark brown 10YR 2/2.
7.5-8	Sandy CLAY. Moist lean cohesive soil. Dry, very fine grain. Pocket shear vane strength of 0.3 kg/cm^2. Very dark grayish brown 10YR 3/2.

Test Pit SMW-5

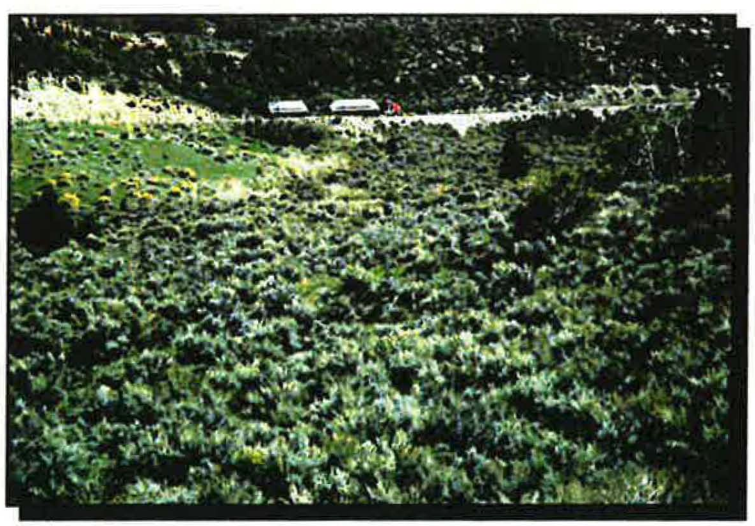
(Excavated and logged on March 18, 2014)

Depth (ft.)	Description
0-2	Sandy SILT. Moist top soil. Organic matter. Pocket shear vane strength of 0.65 kg/cm^2. Very dark grayish brown 10YR 3/2.
2-5	Silty SAND. Alluvial banding. Moist very fine grain. Pocket shear vane strength of 0.45 kg/cm^2. Dark yellowish brown 10YR 4/4.
5-7.5	Clayey SAND. Alluvial banding. Dry fine grain. Pocket shear vane strength of 0.25 kg/cm^2. Light yellowish brown 2.5YR 6/4.

Vegetation & Sensitive Species of the Proposed Expansion at the Waste Rock Site

for the
SUFCO Mine

in
Sevier County, Utah



Coal truck passing the SUFCO Waste Rock Study Area

Prepared by

MT. NEBO SCIENTIFIC, INC.
330 East 400 South, Suite 6
P.O. Box 337
Springville, Utah 84663
(801) 489-6937

Patrick D. Collins, Ph.D.

for

CANYON FUEL COMPANY, LLC
SUFCO MINE
597 South SR 24
Salina, Utah 84654

February 2014

Table of Contents

Introduction

Proposed Disturbance

Engineers at SUFCO have been planning to expand the mine's current Waste Rock Site to augment their coal mining operations in Sevier County, Utah. Prior to construction and disturbance to the existing plant communities within the boundaries of the expansion area, quantitative data were recorded to provide information about the baseline conditions of the vegetation.

Revegetation Success Standards

As required by applicable state and federal regulations, once a mining-related activity has run the course of its use and function, the site and land disturbances associated with it are subsequently reclaimed and revegetated. The restored plant communities must then achieve specific revegetation success standards. These standards are frequently derived by comparing similar plant communities, often adjacent to those being proposed for disturbance. These analogous communities, called the *reference areas*, are also quantitatively sampled prior to disturbance. The datasets of the areas are then compared to demonstrate their similarities (or differences). If they are approved as reference areas, the communities will again be compared to determine whether or not the restored communities meet specific revegetation success standards following final reclamation.

This document reports the results of sampling in the proposed disturbed areas of the expansion area as well as the reference areas for the Waste Rock Site. In addition, threatened, endangered and sensitive plant species were surveyed and addressed in the document.

Methods

Quantitative Sampling

Sample methods used for this study were performed in accordance with the vegetation guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM). Quantitative and qualitative data were recorded within the plant communities proposed for disturbance and their respective reference areas in September 2013 (see Map 1 at the end of the report). The GPS coordinates for all sample areas are provided below.

GPS COORDINATES FOR SAMPLE AREAS
FOR THE EXPANSION AREAS
AT SUFCO'S WASTE ROCK SITE
(UTM, ZONE 12S, NAD 27)

Sample Area	Waypoint Name	Coordinates (m)	Community Type
A	SufWRSa	456113E 4305344N	Proposed Disturbed Sagebrush/Grass
B	SufWRSb	456408E 4305366N	Proposed Disturbed Sagebrush/Grass
C	SufWRSc	456356E 4305728N	Proposed Disturbed Sagebrush/Grass
D	SufWRSd	456189E 4305526N	Proposed Disturbed Sagebrush/Grass
E	SufWRSe	456179E 4305389N	Proposed Disturbed Rabbitbrush/Sagebrush
F	SufWRSf	456014E 4305471N	Proposed Disturbed Rabbitbrush/Sagebrush
G	SufWRSg	456636E 4305351N	Proposed Disturbed Mountain Brush
H	SufWRSh	456490E 4305436N	Proposed Disturbed Mountain Brush
I	SufWRSi	456379E 4305675N	Proposed Disturbed Mountain Brush
J	SufWRSj	456472E 4305694N	Proposed Disturbed Mountain Brush
K	SufWRSk	456197E 4305198N	Sagebrush/Grass Reference Area
L	SufWRSl	456231E 4305209N	Rabbitbrush/Sagebrush Reference Area
M	SufWRSm	456371E 4305195N	Mountain Brush Reference Area

Sampling Design & Transect/Quadrat Placement

Vegetation sample transect lines were placed randomly within the boundaries of the proposed disturbed and reference areas. The transect placement technique was employed with the goal to adequately sample a representation of the entire site. Once the transects were established, quadrat locations for sampling were chosen using random numbers on the transect lines with the objective to record data without preconceived bias. The following data were then recorded.

Cover & Composition

Cover estimates were made using ocular methods with meter-square quadrats. Species composition, cover by species, and relative frequencies were also assessed from the quadrats. Additional information recorded on the raw data sheets were notes such as: slope, exposure, grazing use, disturbance and/or other appropriate notes. Plant species nomenclature follows *A Utah Flora* (Welsh et al., 2008).

Woody Species Density

Density of woody plant species for the proposed disturbed and reference areas were estimated using the point-quarter distance method. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. The number of individuals per acre was the end result of the calculations.

Sample Size & Adequacy

Sampling adequacy for cover and density was attempted by using the formula given below.

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

nMIN	= minimum adequate sample
t	= appropriate confidence t-value
s	= standard deviation
x	= sample mean
d	= desired change from mean

With the values used for "t" and "d" above, the goal was to meet appropriate sample adequacy values.

Statistical Analyses

Student's t-tests were employed to compare the total living covers and total woody species densities of the proposed disturbed areas with their respective reference areas.

Photographs

Color photographs of the sample areas were taken at the time of sampling and have been submitted with this report.

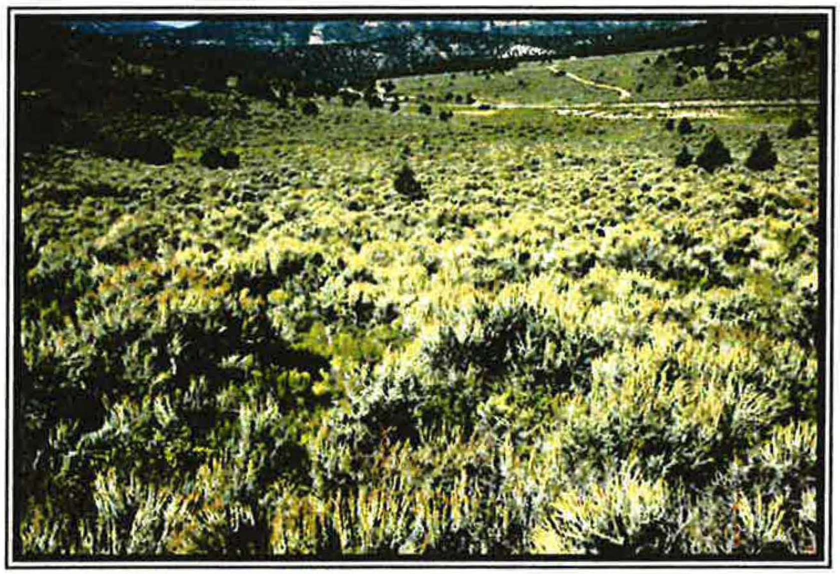
Threatened, Endangered & Sensitive Species

Prior to recording quantitative data on the plant communities, a sensitive plant species survey was conducted. To initiate the studies in the area, database searches and literature reviews were conducted for potential plant species that are known to be rare, endemic, threatened, endangered or otherwise sensitive in the general area. Additionally, the current list of federally protected species for Sevier County, Utah was reviewed along with potential habitats for these species in the areas proposed for disturbance.

Results

Proposed Disturbed Sagebrush/Grass Community

The Sagebrush/Grass Community was found in several areas within the Waste Rock Expansion site. Accordingly, sample transects were placed in several locations of this community throughout the study area [Sample Areas A, B, C, D (Map 1)]. As a method to more accurately represent all areas of the community, the datasets of all Sagebrush/Grass sample areas were combined for the summary tables.



Sagebrush/Grass (a collection of photographs of the sample areas later in the document)

The most common species by cover and frequency in this community, by far, were big sagebrush *(Artemisia tridentata* var. *tridentata*) and bluebunch wheatgrass (*Elymus spicatus*). Percent cover of big sagebrush was 19.88%, and its frequency value showed it occurred in 75.00% of the sample quadrats. Percent cover and frequency of bluebunch wheatgrass were 19.38% and 85.00%, respectively. These values, as well as the results for all other species encountered in the samples, are shown in Table 1.

The total living cover in the Sagebrush/Grass areas was estimated at 69.13%, where 68.00% of it came from understory and only 1.13% from overstory cover (Table 2 A). Composition of the combined data indicated that 53.57% of the understory cover were shrubs, 39.32% grasses and 7.11% forbs (Table 2-B).

The total woody species density for the Sagebrush/Grass Community was estimated at 3,448 plants per acre. The most important species for this parameter by quite a wide margin was big sagebrush, however, other important woody species included snowberry (*Symphoricarpos oreophilus*), viscid rabbitbrush (*Chrysothamnus viscidiflorus*), Vasey's sagebrush (*Artemisia tridentata* var. *vaseyana*) and bitterbrush (*Purshia tridentata*). Density values for all species have been provided on Table 3.

Sagebrush/Grass Reference Area

The reference area chosen to represent future revegetation success standards [Sample Area K (Map 1)] was also dominated by many of the same species as the proposed disturbed area described above. Big sagebrush and bluebunch wheatgrass were again the clear dominates by cover and frequency and were nearly equally represented; the former had a cover and frequency of 21.83% and 76.67% and the latter 22.67% and 86.67%, respectively. For a list of all species found in the samples refer to Table 4.

Sagebrush/Grass Reference Area

The total living cover for this reference area was estimated at 67.67% (Table 5-A). Composition of the total living cover was calculated at 47.57% grasses, 44.08% shrubs and 8.35% forbs (Table 5-B).

Total density of woody species was estimated at 2,944 individuals per acre – the most common were big sagebrush, followed distantly by snowberry, Vasey's sagebrush, viscid rabbitbrush and bitterbrush (Table 6).

Proposed Disturbed Rabbitbrush/Sagebrush Community

Another community type proposed for disturbance, a Rabbitbrush/Sagebrush Community [Sample Areas E, F (Map 1)], was historically probably quite similar to the Sagebrush/Grass Communities described above. It appears this community has been disturbed previously, which could have been the result of heavy grazing or stock handling pressure, and was later re-seeded with plant species that included some non-natives. This community was greatly dominated by crested wheatgrass (*Agropyron cristatum*), but rubber rabbitbrush (*Chrysothamnus nauseosus*) and big sagebrush were also important components as shown by cover and frequency values (Table 7). Reviewing Table 7 also suggests less diversity in this community when compared to the undisturbed Sagebrush/Grass Community above.

Rabbitbrush/Sagebrush

The total living cover in the community was estimated at 81.50% (Table 8-A); composition consisted of only grasses at 58.73% and shrubs at 41.27% (Table 8-B).

Woody species density totaled 1,673 plants per acre and was dominated with nearly equal densities of rubber rabbitbrush and big sagebrush (Table 9).

Rabbitbrush/Sagebrush Reference Area

The reference area chosen to represent future revegetation success standards [Sample Area L (Map 1)] was also dominated by some of the same species as the proposed disturbed area described above. For example, crested wheatgrass was also the most common species by cover and frequency (27.33% cover with a frequency of 70.00%) followed distantly, and nearly equally represented, by two rabbitbrush species (viscid and rubber rabbitbrush). Viscid rabbitbrush had a cover and frequency of 12.17% and 46.67% and rubber rabbitbrush was 11.83% and 43.33%, respectively. For a list of all species found in the samples refer to Table 10.

The total living cover for this reference area was estimated at 78.83% (Table 11-A). Composition of the understory cover was calculated at 47.96% grasses, 42.91% shrubs and 9.13% forbs (Table 11-B).

Total density of woody species here was estimated at 6,168 individuals per acre; the most common shrubs were rubber rabbitbrush, viscid rabbitbrush, snowberry and big sagebrush (Table 12).

Rabbitbrush/Sagebrush Reference Area

Proposed Disturbed Mountain Brush Community

While mapping the plant communities in the expansion area it was evident that there was a host of shrubland communities located within the study site – some of which were dominated by alder-leaf mountain-mahogany (*Cercocarpus montanus*), others by Utah serviceberry (*Amelanchier utahensis*), and still others by Gambel's oak (*Quercus gambelii* var. *gambelii*). There were also plant communities that appeared to have equal amounts of two or more of these woody species. Finally, there was one area that appeared to be a typical aspen (*Populus tremuloides*) community, but closer scrutiny suggested it was on the fringes of those communities described above (e.g. Gamble's oak and sagebrush were also major components within the community).

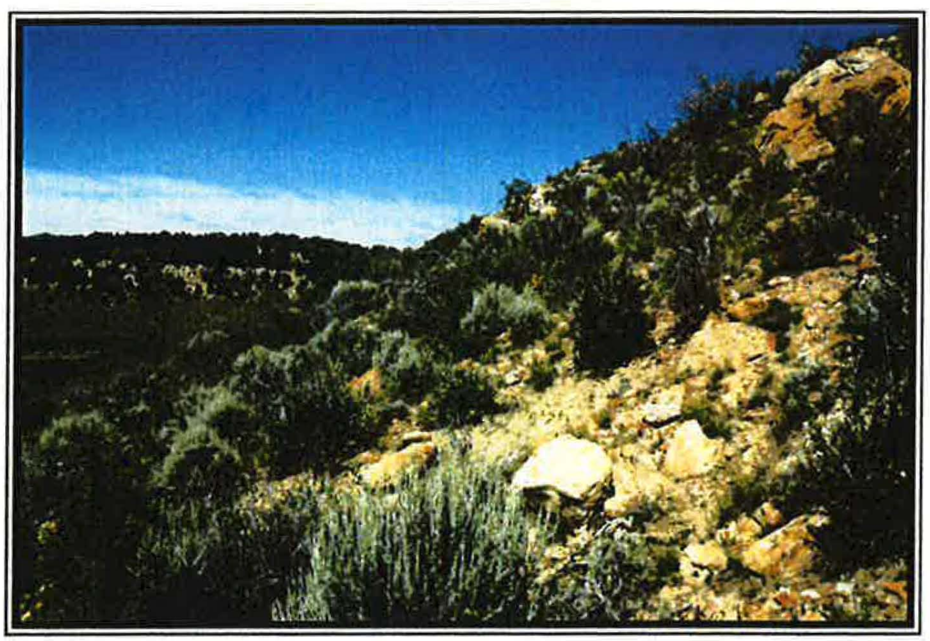
Mountain Brush

Rather than trying to separate all these communities into distinct types, it seemed prudent and more practical to place them into one community type called "Mountain Brush". Since they seemed to be more of a 'continuum' of each other, results from this logic should provide a meaningful baseline dataset for future revegetation planning. With this in mind, although the communities were sampled separately [Sample Areas G, H, I, J (Map 1)], the data were later combined or "lumped" to reflect averages or intermediate values of the variations between the community types.

According to cover and frequency values the most important plant species in the proposed disturbed Mountain Brush Community were alder-leaf mountain mahogany, bluebunch wheatgrass, Vasey's sagebrush, Gambel's oak, Utah serviceberry and snowberry (Table 13).

The total living cover of the community was estimated at 66.70%, which was comprised of 57.90% understory and 8.80% overstory cover (Table 14-A). The composition of the understory cover was comprised of 62.05% trees/shrubs, 29.93% grasses and 8.02% forbs (Table 14-B).

The mean total woody species density of the sample areas was estimated at 3,937 individuals per acre (Table 15). The most important species for this parameter were alder-leaf mountain-mahogany, Gambel's oak, Vasey's sagebrush, snowberry, Utah serviceberry and aspen.



Mountain Brush

Mountain Brush Reference Area

A reference area was chosen that seemed to be intermediate or transitional to most of the communities described in the proposed disturbed Mountain Brush Communities above [Sample Areas M (Map 1)].

Mountain Brush Reference Area

The most common species in the Mountain Brush Reference Area by cover and frequency were alder-leaf mountain-mahogany, Sandberg's bluegrass (*Poa secunda*), Gambel's oak, Utah serviceberry and Vasey's sagebrush (Table 16).

The total living cover for this reference area was estimated at 63.33% (Table 17-A). Composition of the understory cover was calculated at 73.62% trees/shrubs, 22.82% grasses and 3.56% forbs (Table 17-B).

Total density of woody species was estimated at 4,092 individuals per acre; the most common were alder-leaf mountain-mahogany, followed by Gambel's oak, Vasey's sagebrush, Utah serviceberry and snowberry (Table 18).

Mountain Brush Reference Area

The next several pages present the data summary tables referenced above. Included after the tables are the follow report sections:

- Community Comparisons
- Discussion about Threatened, Endangered & Sensitive Species
- Summary & Discussion

Data Summary Tables

Table 1: Waste Rock Site Expansion Areas at the SUFCO Mine. Cover and Frequency by Plant Species (2013).

Proposed Disturbed Sagebrush/Grass Sample Areas: A, B, C, D (combined)			n=40
	Mean Percent	**Standard Deviation**	**Percent Frequency**
OVERSTORY			
Amelanchier utahensis	0.75	3.46	5.00
Juniperus osteosperma	0.38	2.34	2.50
UNDERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	0.50	3.12	2.50
Artemisia tridentata var. tridentata	19.88	15.10	75.00
Artemisia tridentata var. vaseyana	2.25	6.98	10.00
Chrysothamnus nauseosus	0.75	3.27	5.00
Chrysothamnus viscidiflorus	6.50	10.14	35.00
Gutierrezia sarothrae	0.25	1.56	2.50
Juniperus osteosperma	0.63	3.90	2.50
Purshia tridentata	2.63	7.58	12.50
Symphoricarpos oreophilus	3.00	7.48	17.50
FORBS			
Achillea millefolium	0.50	3.12	2.50
Antennaria dimorpha	0.75	4.68	2.50
Artemisia ludoviciana	0.25	1.56	2.50
Castilleja sp.	0.38	2.34	2.50
Cirsium sp.	0.50	2.45	5.00
Eriogonum racemosa	0.25	1.56	2.50
Machaeranthera grindelioides	0.38	1.32	7.50
Penstemon watsonii	2.00	4.72	17.50
GRASSES			
Agropyron cristatum	4.88	9.58	27.50
Bromus inermis	0.50	2.18	5.00
Elymus spicatus	19.38	12.71	85.00
Poa secunda	1.88	5.88	10.00

Table 2: Waste Rock Site Expansion Areas at the SUFCO Mine. Total Cover and Composition (2013).

Proposed Disturbed Sagebrush/Grass Sample Areas: A, B, C, D (combined)		n=40
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	1.13	4.11
Understory (U)	68.00	10.23
Litter	16.93	8.31
Bareground	11.73	8.94
Rock	3.35	2.36
O + U	69.13	9.61
B. % COMPOSITION		
Trees/Shrubs	53.57	18.81
Forbs	7.11	11.25
Grasses	39.32	16.08

Table 3: Waste Rock Site Expansion Areas at the SUFCO Mine. Woody Species Density (2013).

Proposed Disturbed Sagebrush/Grass Sample Areas: A, B, C, D (combined)	n=40
SPECIES	**Individuals/Acre**
Amelanchier utahensis	43.10
Artemisia tridentata var. tridentata	1917.98
Artemisia tridentata var. vaseyana	280.15
Chrysothamnus nauseosus	64.65
Chrysothamnus viscidiflorus	387.91
Juniperus osteosperma	64.65
Purshia tridentata	193.95
Symphoricarpos oreophilus	474.11
Tetradymia canescens	21.55
TOTAL	**3448.05**

Table 4: Waste Rock Site Expansion Areas at the SUFCO Mine. Cover and Frequency by Plant Species (2013).

Sagebrush/Grass Reference Area Sample Area: K			n=30
	Mean Percent	**Standard Deviation**	**Percent Frequency**
TREES & SHRUBS			
Artemisia tridentata var. tridentata	21.83	15.99	76.67
Artemisia tridentata var. vaseyana	2.00	7.48	6.67
Chrysothamnus viscidiflorus	1.00	5.39	3.33
Mahonia repens	1.00	2.00	20.00
Symphoricarpos oreophilus	4.17	9.04	23.33
FORBS			
Cirsium sp.	2.83	4.22	36.67
Eriogonum racemosa	2.00	3.32	30.00
Lupinus argenteus	0.67	2.13	10.00
GRASSES			
Agropyron cristatum	5.17	11.22	26.67
Bromus inermis	0.33	1.80	3.33
Elymus elymoides	0.67	3.59	3.33
Elymus spicatus	22.67	13.15	86.67
Poa secunda	3.33	7.11	20.00

Table 5: Waste Rock Site Expansion Areas at the SUFCO Mine. Total Cover and Composition (2013).

Sagebrush/Grass Reference Area Sample Area: K		n=30
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Total Living Cover	67.67	8.83
Litter	21.33	6.94
Bareground	8.63	7.39
Rock	2.37	1.87
B. % COMPOSITION		
Shrubs	44.08	17.89
Forbs	8.35	8.41
Grasses	47.57	18.94

Table 6: Waste Rock Site Expansion Areas at the SUFCO Mine. Woody Species Density (2013).

Sagebrush/Grass Reference Area Sample Area: K	n=30
SPECIES	**Individuals/Acre**
Artemisia tridentata var. tridentata	2305.84
Artemisia tridentata var. vaseyana	220.77
Chrysothamnus viscidiflorus	171.71
Purshia tridentata	24.53
Symphoricarpos oreophilus	220.77
TOTAL	**2943.62**

Table 7: Waste Rock Site Expansion Areas at the SUFCO Mine. Cover and Frequency by Plant Species (2013).

Proposed Disturbed Rabbitbrush/Sagebrush Sample Areas: E, F (combined)			n=30
	Mean Percent	**Standard Deviation**	**Percent Frequency**
TREES & SHRUBS			
Artemisia tridentata var. tridentata	12.67	15.26	43.33
Chrysothamnus nauseosus	14.83	19.43	46.67
Chrysothamnus viscidiflorus	6.00	10.98	26.67
Symphoricarpos oreophilus	0.33	1.80	3.33
FORBS			
GRASSES			
Agropyron cristatum	38.50	23.31	86.67
Elymus spicatus	9.17	13.61	36.67

Table 8: Waste Rock Site Expansion Areas at the SUFCO Mine. Total Cover and Composition (2013).

Proposed Disturbed Rabbitbrush/Sagebrush Sample Areas: E, F (combined)		n=30
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Total Living Cover	81.50	8.48
Litter	12.17	7.47
Bareground	4.70	4.37
Rock	1.63	1.02
B. % COMPOSITION		
Shrubs	41.27	20.88
Forbs	0.00	0.00
Grasses	58.73	20.88

Table 9: Waste Rock Site Expansion Areas at the SUFCO Mine. Woody Species Density (2013).

Proposed Disturbed Rabbitbrush/Sagebrush Sample Areas: E, F (combined)	n=30
SPECIES	**Individuals/Acre**
Artemisia tridentata var. tridentata	655.24
Chrysothamnus nauseosus	669.18
Chrysothamnus viscidiflorus	278.83
Symphoricarpos oreophilus	69.71
TOTAL	**1672.96**

Table 10: Waste Rock Site Expansion Areas at the SUFCO Mine. Cover and Frequency by Plant Species (2013).

Rabbitbrush/Sagebrush Reference Area Sample Area: L			n=30
	Mean Percent	**Standard Deviation**	**Percent Frequency**
TREES & SHRUBS			
Artemisia tridentata var. tridentata	2.00	5.42	13.33
Artemisia tridentata var. vaseyana	0.67	2.81	6.67
Chrysothamnus nauseosus	11.83	15.94	43.33
Chrysothamnus viscidiflorus	12.17	16.87	46.67
Symphoricarpos oreophilus	6.50	7.21	53.33
Rosa woodsii	0.33	1.25	6.67
FORBS			
Achillea millefolium	2.50	6.02	16.67
Cirsium sp.	0.17	0.90	3.33
Erigeron sp.	1.67	6.24	6.67
Iva axillaris	1.67	4.35	13.33
Penstemon watsonii	1.17	4.41	6.67
GRASSES			
Agropyron cristatum	27.33	23.16	70.00
Elymus smithii	3.00	12.95	6.67
Elymus spicatus	6.00	12.07	23.33
Poa pratensis	1.50	5.65	6.67
Poa secunda	0.33	1.80	3.33

Table 11: Waste Rock Site Expansion Areas at the SUFCO Mine. Total Cover and Composition (2013).

Rabbitbrush/Sagebrush Reference Area Sample Area: L		n=30
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Total Living Cover	78.83	8.91
Litter	13.73	8.28
Bareground	6.17	5.13
Rock	1.27	0.77
B. % COMPOSITION		
Shrubs	42.91	24.00
Forbs	9.13	14.69
Grasses	47.96	23.80

Table 12: Waste Rock Site Expansion Areas at the SUFCO Mine. Woody Species Density (2013).

Rabbitbrush/Sagebrush Reference Area Sample Area: L	n=30
SPECIES	**Individuals/Acre**
Artemisia tridentata var. tridentata	1079.41
Chrysothamnus nauseosus	2313.02
Chrysothamnus viscidiflorus	1387.81
Rosa woodsii	102.80
Symphoricarpos oreophilus	1285.01
TOTAL	**6168.04**

Table 13: Waste Rock Site Expansion Areas at the SUFCO Mine. Cover and Frequency by Plant Species (2013).

Proposed Disturbed Mountain Brush Sample Areas: G, H, I, J (combined)			n=50
	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	0.30	2.10	2.00
Cercocarpus montanus	0.30	2.10	2.00
Populus tremuloides	2.60	7.09	12.00
Quercus gambelii	5.60	9.88	24.00
UNDERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	6.00	12.37	24.00
Artemisia tridentata var. tridentata	0.90	3.70	6.00
Artemisia tridentata var. vaseyana	6.20	10.42	30.00
Cercocarpus montanus	11.50	15.07	44.00
Chrysothamnus nauseosus	0.30	2.10	2.00
Populus tremuloides	0.90	3.96	6.00
Purshia tridentata	0.50	3.50	2.00
Quercus gambelii	5.60	13.14	18.00
Rosa woodsii	0.20	1.40	2.00
Symphoricarpos oreophilus	4.20	8.96	6.00
FORBS			
Achillea millefolium	1.00	4.24	6.00
Erigeron engelmannii	0.20	1.40	2.00
Lupinus argenteus	1.90	4.68	16.00
Machaeranthera grindelioides	0.40	1.69	6.00
Penstemon watsonii	0.60	2.37	6.00
Taraxacum officinale	0.20	1.40	2.00
GRASSES			
Bromus carinatus	0.20	1.40	2.00
Elymus canadensis	2.20	10.50	6.00
Elymus salinus	2.60	6.73	16.00
Elymus spicatus	8.00	10.82	44.00
Poa secunda	3.90	8.38	22.00
Stipa hymenoides	0.40	2.80	2.00

Table 14: Waste Rock Site Expansion Areas at the SUFCO Mine. Total Cover and Composition (2013).

Proposed Disturbed Mountain Brush Sample Areas: G, H, I, J (combined)		n=50
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	8.80	11.56
Understory (U)	57.90	10.40
Litter	19.76	11.99
Bareground	12.66	10.12
Rock	9.68	9.13
O + U	66.70	12.51
B. % COMPOSITION		
Trees/Shrubs	62.05	24.74
Forbs	8.02	15.11
Grasses	29.93	20.08

Table 15: Waste Rock Site Expansion Areas at the SUFCO Mine. Woody Species Density (2013).

Proposed Disturbed Mountain Brush Sample Areas: G, H, I, J (combined)	n=50
SPECIES	**Individuals/Acre**
Amelanchier utahensis	354.33
Artemisia tridentata var. tridentata	78.74
Artemisia tridentata var. vaseyana	531.50
Ceratoides lanata	39.37
Cercocarpus montanus	1259.85
Chrysothamnus nauseosus	78.74
Juniperus osteosperma	19.69
Pinus edulis	19.69
Populus tremuloides	295.28
Purshia tridentata	59.06
Quercus gambelii	767.72
Rosa woodsii	39.37
Symphoricarpos oreophilus	393.70
TOTAL	**3937.03**

Table 16: Waste Rock Site Expansion Areas at the SUFCO Mine. Living Cover and Frequency by Plant Species (2013).

Mountain Brush Reference Area Sample Area: M			n=30
	Mean Percent	**Standard Deviation**	**Percent Frequency**
OVERSTORY			
Juniperus osteosperma	0.67	3.59	3.33
Pinus edulis	1.00	3.00	10.00
Quercus gambelii	2.33	6.80	13.33
UNDERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	5.67	9.37	33.33
Artemisia tridentata var. tridentata	2.00	8.43	6.67
Artemisia tridentata var. vaseyana	5.00	8.37	33.33
Cercocarpus montanus	19.17	20.58	60.00
Chrysothamnus viscidiflorus	0.33	1.80	3.33
Gutierrezia sarothrae	0.33	1.80	3.33
Penstemon watsonii	1.50	3.20	20.00
Pinus edulis	3.33	8.79	13.33
Quercus gambelii	5.83	11.26	23.33
Symphoricarpos oreophilus	0.50	1.98	6.67
FORBS			
Antennaria dimorpha	0.50	1.98	6.67
Erigeron sp.	0.33	1.80	3.33
Juniperus osteosperma	1.00	5.39	3.33
Machaeranthera grindelioides	0.33	1.80	3.33
Tetradymia canescens	0.00	0.00	3.33
GRASSES			
Bromus carinatus	1.33	7.18	3.33
Elymus spicatus	4.83	9.17	26.67
Poa secunda	6.33	8.46	46.67
Stipa hymenoides	1.00	5.39	3.33

Table 17: Waste Rock Site Expansion Areas at the SUFCO Mine.
Total Cover and Composition (2013).

Mountain Brush Reference Area Sample Area: M		n=30
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	4.00	7.68
Understory (U)	59.33	8.73
Litter	15.17	9.70
Bareground	9.17	4.30
Rock	16.33	11.90
O + U	63.33	6.87
B. % COMPOSITION		
Trees/Shrubs	73.62	20.29
Forbs	3.56	9.99
Grasses	22.82	19.03

Table 18: Waste Rock Site Expansion Areas at the SUFCO Mine. Woody Species Density (2013).

Mountain Brush Reference Area Sample Area: M	
SPECIES	**Individuals/Acre**
Amelanchier utahensis	477.41
Artemisia tridentata var. tridentata	102.30
Artemisia tridentata var. vaseyana	511.51
Cercocarpus montanus	1568.63
Chrysothamnus viscidiflorus	68.20
Gutierrezia sarothrae	34.10
Juniperus osteosperma	136.40
Pinus edulis	170.50
Quercus gambelii	716.11
Symphoricarpos oreophilus	238.70
Tetradymia canescens	68.20
TOTAL	**4092.07**

Community Comparisons

When the **total living cover** of the Proposed Disturbed Sagebrush/Grass Community was compared to the Sagebrush/Grass Reference Area, the difference was not statistically significant (Figure 1).

Figure 1. A statistical comparison (Student's t-tests) of the **total living cover** between the Proposed Disturbed and Reference Areas of the Waste Rock Site.

	$\bar{x}$	s	n	t	df	SL
Sagebrush/Grass						
Proposed Disturbed (Sample Areas A,B,C,D)	69.13 (o+u)	9.61	40			
Reference Area (Sample Area K)	67.67	8.83	30			
t-test				0.6510	68	N.S.

$\bar{x}$ = mean
s = standard deviation
n = sample size
t = Student's t-value
df = degrees of freedom
n/a = not applicable

p = probability
SL= Significance Level
N.S.=Non-Significant
u = understory
o = overstory

Also, when the **woody species densities** between these two communities were compared statistically, results from a Student's t-test also suggested that the difference was non-significant (Figure 2).

Figure 2. A statistical comparison (Student's t-tests) of the **woody species density** between the Proposed Disturbed and Reference Areas of the Waste Rock Site.

	$\bar{x}$	s	n	t	df	SL
Sagebrush/Grass						
Proposed Disturbed (Sample Areas A,B,C,D)	3448.05	1172.92	40			
Reference Area (Sample Area K)	2943.63	1154.60	30			
t-test				1.7925	68	N.S.

$\bar{x}$ = mean
s = standard deviation
n = sample size
t = Student's t-value
df = degrees of freedom

p = probability
SL= Significance Level
N.S.=Non-Significant

Next, when the **total living cover** value of the Proposed Disturbed Rabbitbrush/Sagebrush Community was compared with the Rabbitbrush/Sagebrush Reference Area, the difference was again non-significant (Figure 3).

Figure 3. A statistical comparison (Student's t-tests) of the **total living cover** between the Proposed Disturbed and Reference Areas of the Waste Rock Site.

	$\bar{x}$	s	n	t	df	SL
Rabbitbrush/Sagebrush						
Proposed Disturbed (Sample Areas E, F)	81.50	8.48	30			
Reference Area (Sample Area L)	78.83	8.91	30			
t-test				1.1889	58	N.S.

$\bar{X}$ = mean
s = standard deviation
n = sample size
t = Student's t-value
df = degrees of freedom
n/a = not applicable

p = probability
SL= Significance Level
N.S.=Non-Significant

However, when the **woody species densities** of these two areas were compared, the difference was significant statistically (Figure 4).

Figure 4. A statistical comparison (Student's t-tests) of the **woody species density** between the Proposed Disturbed and Reference Areas of the Waste Rock Site.

	$\bar{x}$	s	n	t	df	SL
Rabbitbrush/Sagebrush						
Proposed Disturbed (Sample Areas E, F)	6168.04	2017.02	30			
Reference Area (Sample Area L)	1672.96	801.92	30			
t-test				11.3428	58	p<.01

$\bar{X}$ = mean
s = standard deviation
n = sample size
t = Student's t-value
df = degrees of freedom

p = probability
SL= Significance Level
N.S.=Non-Significant

Next, when the **total living cover** of the Proposed Disturbed Mountain Brush Community was compared to its reference area, the difference was once again non-significant statistically (Figure 5).

Figure 5. A statistical comparison (Student's t-tests) of the **total living cover** between the Proposed Disturbed and Reference Areas of the Waste Rock Site.

	$\bar{x}$	s	n	t	df	SL
Mountain Brush						
Proposed Disturbed (Sample Areas G,H,I,J)	66.70 (o+u)	12.51	50			
Reference Area (Sample Area M)	63.33	6.87	30			
t-test				1.3557	78	N.S.

$\bar{X}$ = mean
s = standard deviation
n = sample size
t = Student's t-value
df = degrees of freedom
n/a = not applicable
p = probability
SL= Significance Level
N.S.=Non-Significant
P-J = Pinyon-Juniper
u = understory
o = overstory

Finally, when the **woody species density** of the Proposed Disturbed Mountain Brush Community was compared to the Mountain Brush Reference Area, the difference was statistically non-significant (Figure 6).

Figure 6. A statistical comparison (Student's t-tests) of the **woody species density** between the Proposed Disturbed and Reference Areas of the Waste Rock Site.

	$\bar{x}$	s	n	t	df	SL
Mountain Brush						
Proposed Disturbed (Sample Areas G,H,I,J	3937.13	1535.74	50			
Reference Area (Sample Area M)	4092.07	2402.10	30			
t-test				0.3523	78	N.S.

$\bar{X}$ = mean
s = standard deviation
n = sample size
t = Student's t-value
df = degrees of freedom
p = probability
SL= Significance Level
N.S.=Non-Significant

Threatened, Endangered & Sensitive Species

A table of federally listed threatened, endangered and candidate species for Sevier County, Utah has been provided below (Table 19). The table also includes the status of the species, along with site-specific notes about the area proposed for disturbance and the probabilities of their occurrences in the study area.

Table 19: Federally listed threatened, endangered and candidate species for Sevier County, Utah (last updated January 12, 2012).

ENDANGERED		SITE-SPECIFIC NOTES
Sclerocactus wrightiae	Wright fishhook cactus	Wright's fishhook cactus is known to be present primarily in salt desert habitats on Mancos Shale, Dakota, Morrison, Summerville and Entrada Sandstone formations. This habitat is not present in the study area. Consequently, there will be no impact to this species as a result of expansion of the waste rock site.
THREATENED		
Astragalus montii	Heliotrope milkvetch	This species is known to occur only in Flagstaff Limestone, a formation that is not present at the waste rock site. There should be no impact to this species as a result of proposed expansion.
Townsendia aprica	Last chance townsendia	Although this species can be found in pinyon-juniper communities and this community is relatively close to the study area, it most commonly occurs on clay and clay-silt exposures on the Mancos Shale formation. This formation is not found in the study area. There should be no impact to this species as a result of proposed expansion.
Lynx canadensis	Canada lynx	State of Utah, Division of Wildlife Resources (DWR) distribution maps show that the general area on the Wasatch Plateau in Sevier County may be "critical habitat" for this species. The Canada lynx range extends from Canada and Alaska south to Maine, the Rocky Mountains, and also to the Great Lakes region. DWR biologists state that, *although sightings of the Canada lynx in Utah over the past twenty years are exceedingly rare, the USDA Forest Service recently announced that Canada lynx hair was*

Table 19: Federally listed threatened, endangered and candidate species for Sevier County, Utah (last updated January 12, 2012).

		found in the Manti-La Sal National Forest during 2002. The preferred habitat of the Canada lynx is montane coniferous forest, where it often hunts snowshoe hares. Coniferous forests do not exist at the study area. Consequently, there will be no impact to this species as a result of expansion of the waste rock site.
CANDIDATE		
Centrocercus urophasianus	Greater sage-grouse	Greater sage-grouse inhabit sagebrush zones in Utah's mountain valleys and foothills. There is no brooding or winter habitat for this species shown on the DWR database maps at or near the study area. Utah's Conservation Plan for Greater Sage-grouse (February 14, 2013) shows areas near, but outside the study area to have "Opportunity Area" habitats for the sage-grouse in this portion of the Parker Mtn-Emery Sage-Grouse Management Area (SGMA). No leks have been mapped near the site. Consequently, there should be no impact to this species as a result of expansion of the waste rock site.
Cynomys parvidens	Utah prairie-dog	Habitat for this prairie-dog does not exist in the study area. Consequently, there will be no impact to this species as a result of the proposed waste rock expansion.
EXTIRPATED		
Ursus arctos	Brown (grizzly) bear	The brown (grizzly) bear was extirpated from Utah in the 1920s. It probably once occurred in the Wasatch Plateau. Even though the brown bear may have been present in the general area historically, suitable habitat for the brown bear at or near the study area is questionable. There will be no impact to this species as a result of the proposed waste rock expansion.

The State of Utah, Department of Natural Resources' biodiversity database specialist was consulted with regard to threatened, endangered or otherwise sensitive species in the mine area in 2013. Findings for this research indicated no such species, plant or animal, were found within a 2-mile radius of the mine site.

Additionally, GIS data and shape files from the State of Utah, Division of Wildlife Resources (DWR), Utah Conservation Data Center (UCDC) database were consulted for potential habitats of sensitive species. This database suggested there could be general habitat for one sensitive mammal in the Wasatch Plateau area, the big free-tailed bat *(Nyctinomops macrotis)*. Below is some descriptive information provided by DWR.

> *"The big free-tailed bat occurs in the western United States, as well as in much of Latin America. The species is rare in Utah, occurring primarily in the southern half of the state, although individuals may rarely occur in northern Utah. The big free-tailed bat is included on the Utah Sensitive Species List."*
>
> *"The big free-tailed bat prefers rocky and woodland habitats, where roosting occurs in caves, mines, old buildings, and rock crevices. The species is typically active year-round, spending summers in temperate North America and migrating to warmer areas in North America and South America for the winter."*

Although there are woodlands in the expansion area, there is no or very little of the roosting habitat described above. Based on that fact and the rareness of the species, it is unlikely the proposed expansion project would impact this species.

Summary & Discussion

Quantitative sampling has been conducted in those plant communities that have the potential of being impacted by construction of proposed expansion areas of SUFCO's Waste Rock Site. Additionally, similar plant communities outside the expansion area were also sampled with the goal to find appropriate revegetation success standards when the site is reclaimed in the future. These communities are called *reference areas.*

Statistical comparisons between the means of the proposed disturbed and reference areas (Figures 1 through 6), suggested that nearly all differences were non-significant. When the mean **total living covers** for the Proposed Disturbed Sagebrush/Grass, Rabbitbrush/ Sagebrush and Mountain Brush Communities were compared with their reference areas, there were no statistically significant differences. This suggests that the reference areas chosen may be appropriate to be used for revegetation success standards for living cover at the time of final reclamation.

Additionally, when statistics were used to make comparisons to their respective reference areas, the mean total **woody species densities** of the Proposed Disturbed Sagebrush/Grass and Mountain Brush Communities had differences were also non-significant. The one exception was that the total density of the Proposed Disturbed Sagebrush/Rabbitbrush Community was significantly greater than its reference area. As mentioned, these communities were probably not in their native condition – they have been somewhat altered by previous activities unrelated to mining. State R645 regulations require lands previously disturbed "*and that are remined by or otherwise redisturbed by coal mining and reclamation operations, at a minimum the vegetative cover will be not less than the ground cover that existed before redisturbance and will be adequate to control erosion*". A discussion regarding this site as well as other suggestions for revegetation success standards are provided below.

Because they match so closely, it seems appropriate that the reference areas could be used for final revegetation success standards for total living cover values. Regarding the woody species densities, however, it has been suggested at other future reclamation sites that perhaps the high woody species density values in some of the native plant communities are a result of domestic livestock and wildlife grazing pressure which often selects for the herbaceous species over the woody plants. Consequently, after consultations with the DWR biologists, sometimes less woody species density values may provide more opportunity for increased forb and grass species establishment that could provide greater species diversity in the summer range for the resident wildlife species as well as domestic livestock. Consequently, a pre-set woody species value of 2,000 plants per acre may be a more appropriate recommendation for a revegetation standard for the proposed disturbed Rabbitbrush/Sagebrush as well as the Sagebrush/Grass sites at the Waste Rock Site. Subject to approval by biologists from the State of Utah, Division of Oil, Gas and Mining (DOGM), revegetation success standards for each area are shown on Table 20.

Table 20: Summary of revegetation recommended success standards for the expansion area of the Waste Rock Site at the SUFCO Mine.

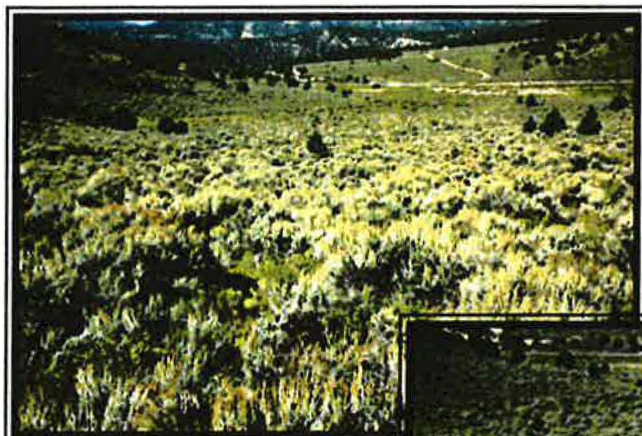
PROPOSED DISTURBED AREA	COVER	DENSITY	DIVERSITY
Sagebrush/Grass	Sagebrush Reference Area	2,000 plants/acre	Sagebrush Reference Area
Rabbitbrush/Sagebrush	Rabbitbrush/Sagebrush Reference Area	2,000 plants/acre	Rabbitbrush/Sagebrush Reference Area
Mountain Brush	Mountain Brush Reference Area	Mountain Brush Reference Area	Mountain Brush Reference Area

Finally, with relation to the success standards described above, there is one very important consideration for final reclamation and revegetation planning – this is the final post-mining topography. If the final slopes, aspects and elevations deviate greatly from the current, pre-disturbance topography (and they probably will), thought should be given to what community types and the extent of them should be created at specific locations on the reclaimed land.

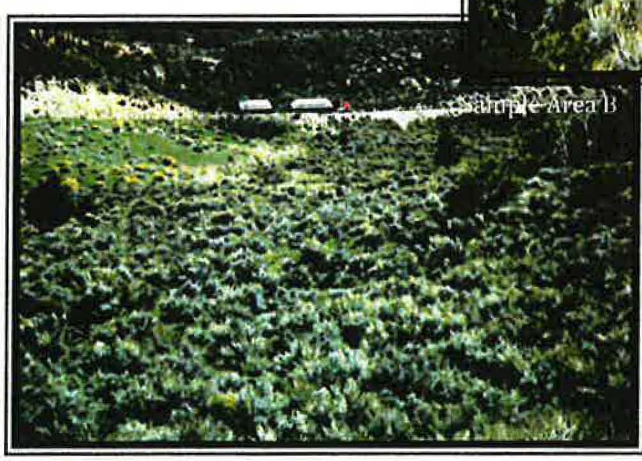
Color Photographs of the Sample Areas

Proposed Disturbed Sagebrush/Grass Community

Sample Area A

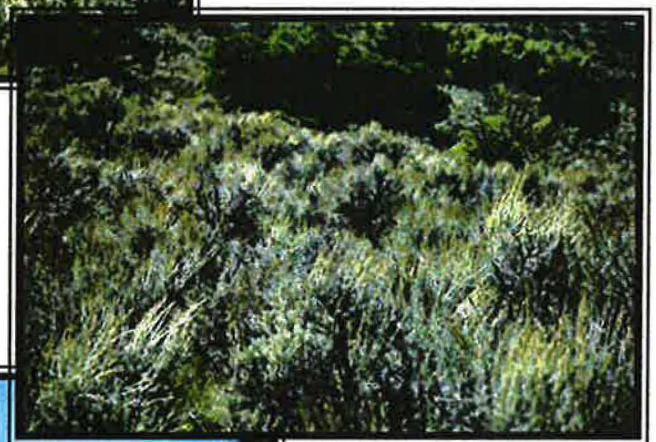


Sample Area B

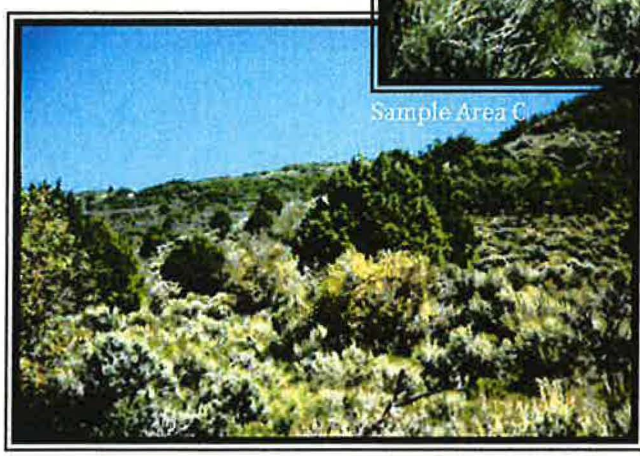


Sample Area C

Sample Area C



Sample Area C



Sample Area D

Sample Area D

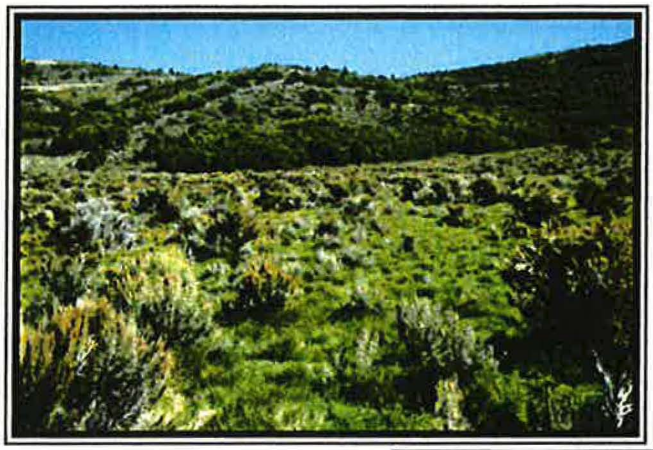
Proposed Disturbed Rabbitbrush/Sagebrush Community

Sample Area E

Sample Area E

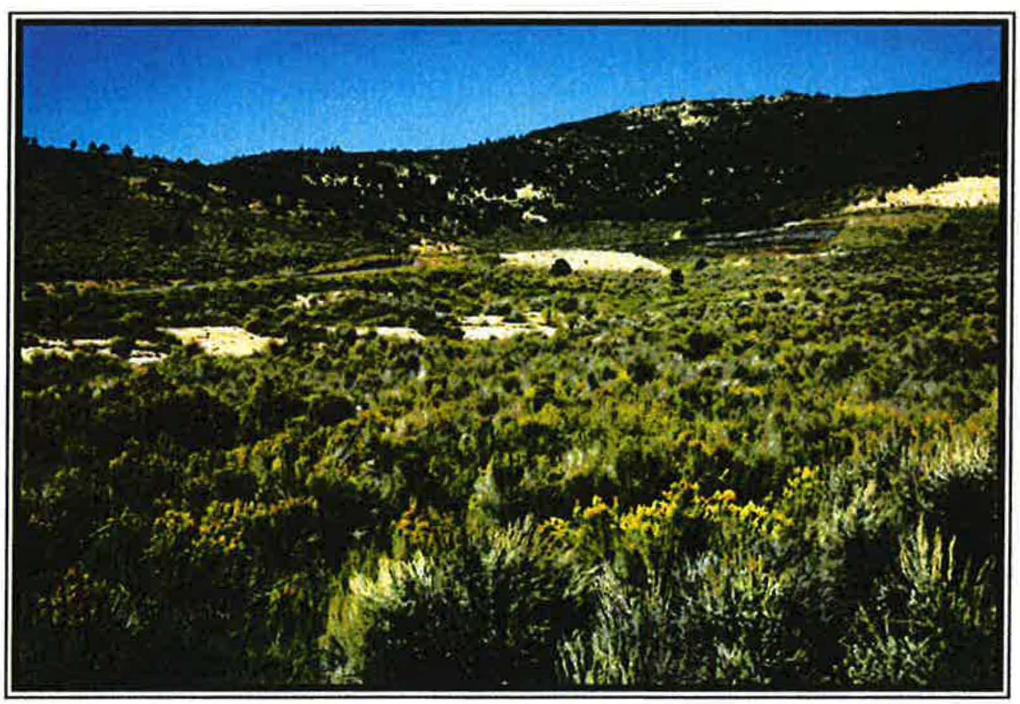
Sample Area E

Sample Area E



Sample Area E

Sample Area F



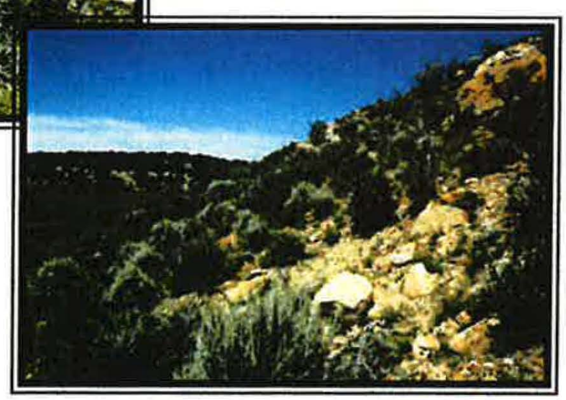
Sample Area F

Proposed Disturbed Mountain Brush Community

Sample Area G

Sample Area G

Sample Area H



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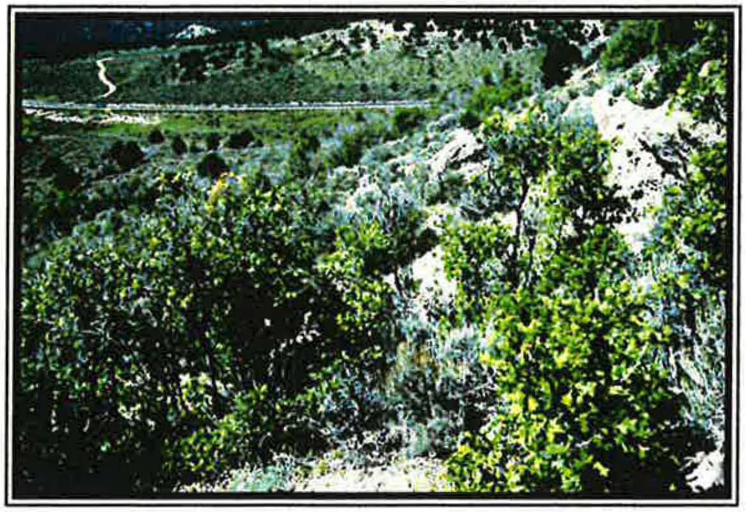
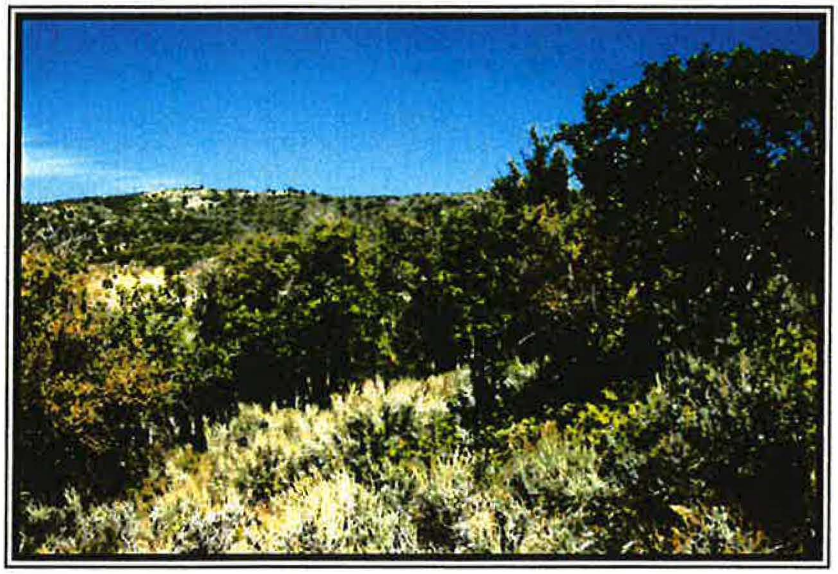


Sample Area H

Sample Area H

Sample Area I



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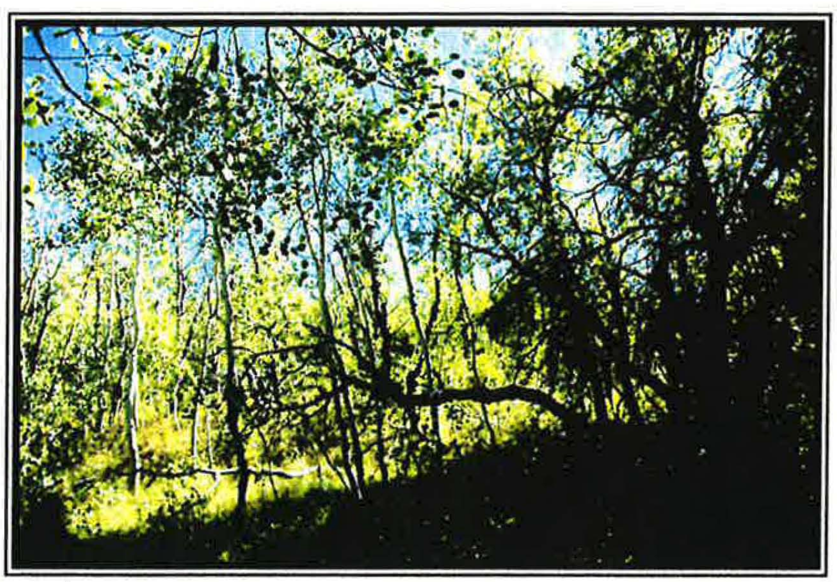
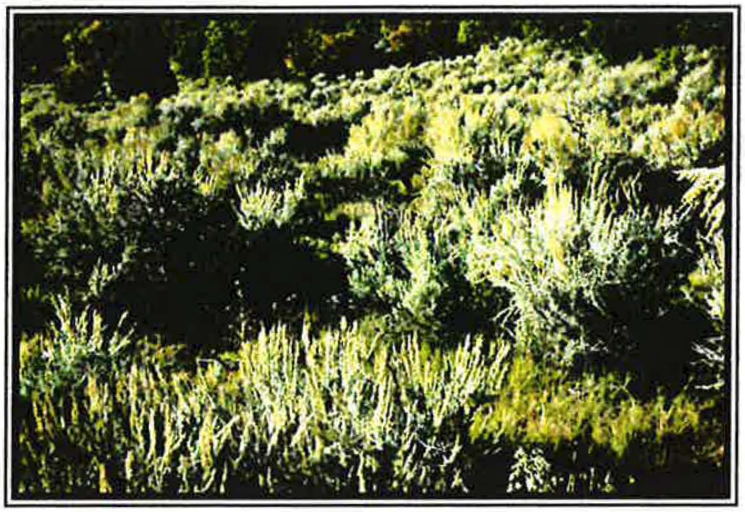
Sample Area J



Sample Area J

Sagebrush/Grass Reference Area



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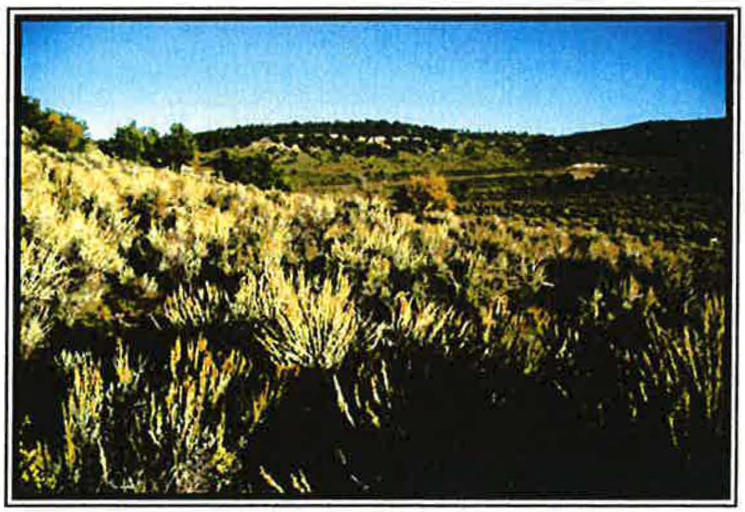
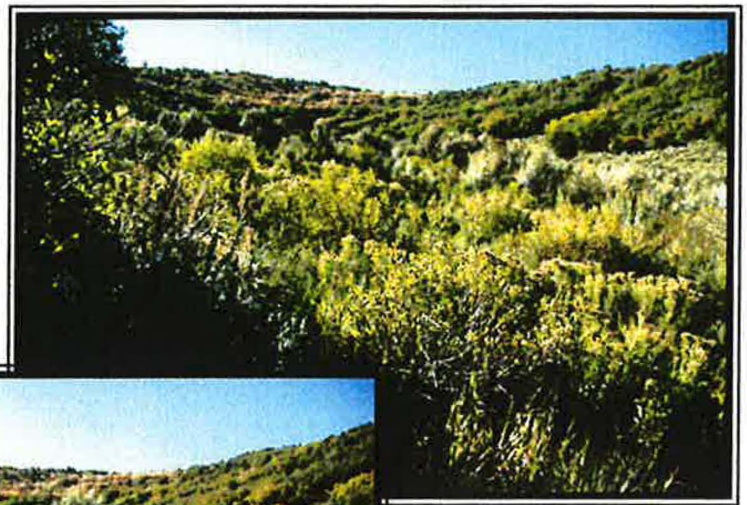


Sample Area K

Sample Area K

Rabbitbrush/Sagebrush Reference Area



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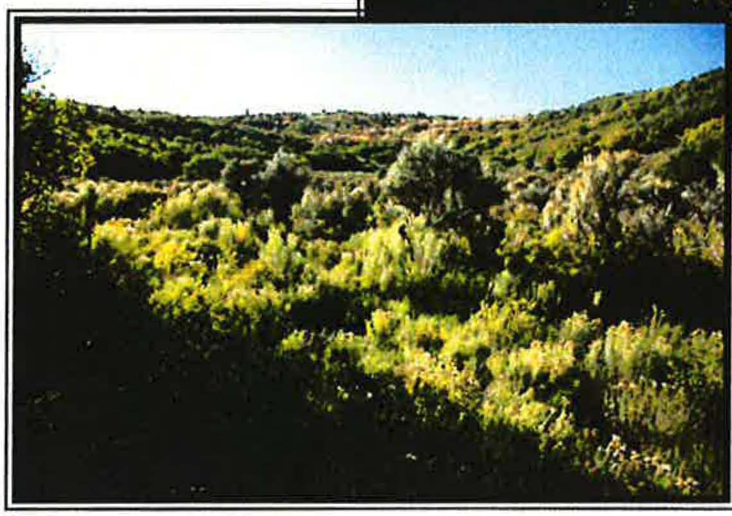

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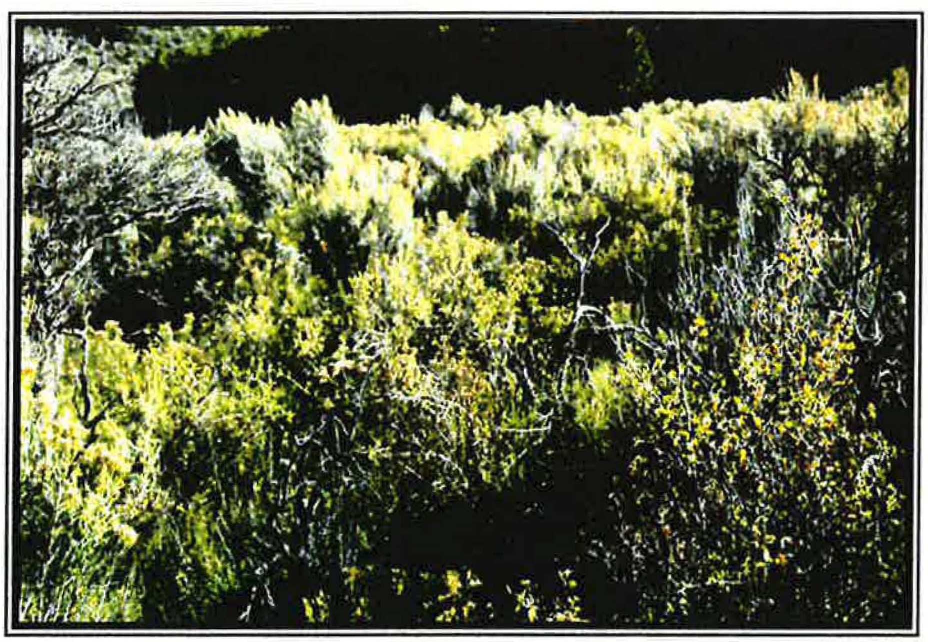
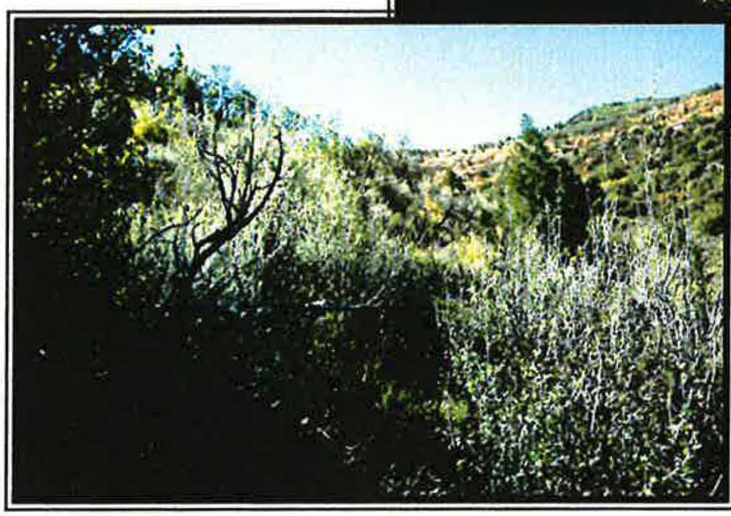


Sample Area L

Mountain Brush Reference Area

Sample Area M



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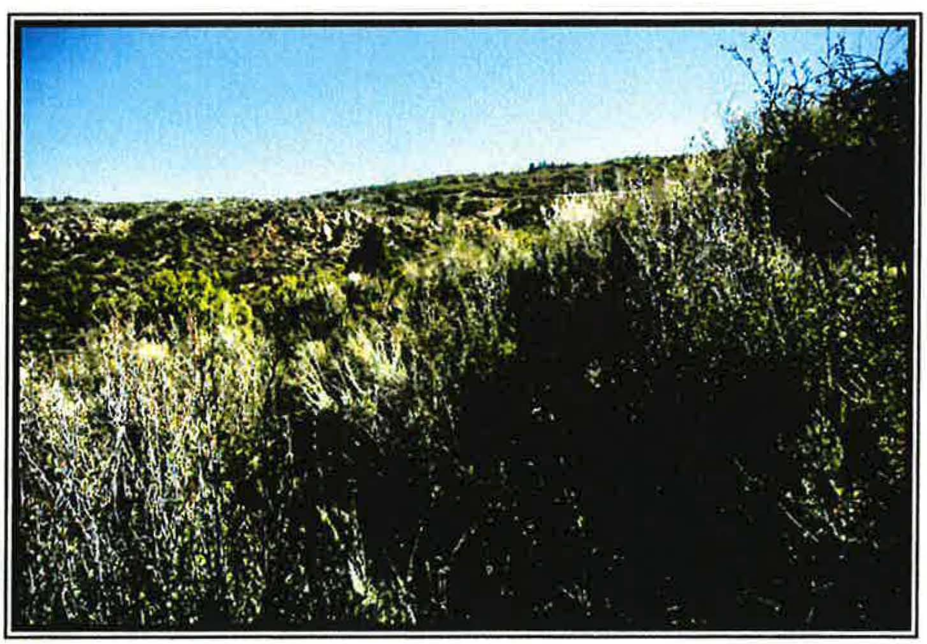
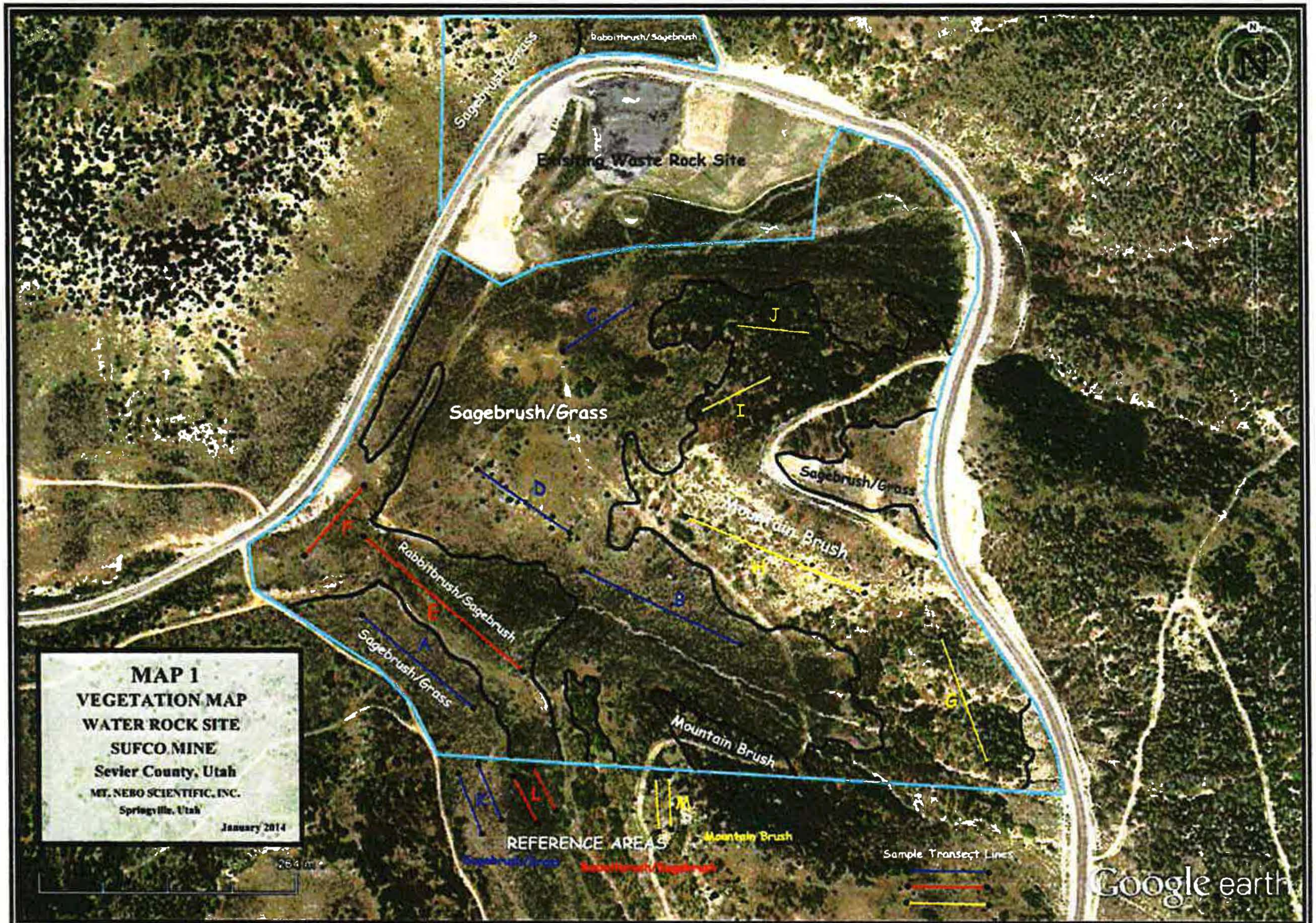


Sample Area M


Sample Area M


Sample Area M


Sample Area M


MAP 1
VEGETATION MAP
WATER ROCK SITE
SUFCO MINE
Sevier County, Utah
MT. NEBO SCIENTIFIC, INC.
Springville, Utah
January 2014
Existing Waste Rock Site
Rabbitbrush/Sagebrush
Sagebrush/Grass
Sagebrush/Grass
Sagebrush/Grass
Rabbitbrush/Sagebrush
Sagebrush/Grass
Mountain Brush
Mountain Brush
A
B
C
D
E
F
G
H
I
J
K
L
M
REFERENCE AREAS
Mountain Brush
Sample Transect Lines
N
Google earth

Order 2 Soil Survey

for the

Proposed Expansion
of the
Existing Waste Rock Area
at the
SUFCO Mine

Located East of Salina, Utah

Prepared for

SUFCO Mine

By

Long Resource Consultants, Inc.
Morgan, Utah

January 26, 2014

Table of Contents

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Section One

Purpose of Soil Survey

The purpose of this soil survey was to identify topsoil and subsoil sources within a proposed expansion of the existing waste rock disposal site operated by Southern Utah Fuel Company (SUFCO). This soil survey was prepared so that SUFCO could identify soil properties (e.g. depths, textures, chemistry, rock fragment content, and other soil conditions) that may impact: salvage, stockpiling, and replacement of topsoil and subsoil; and successful long term reclamation.

Project Area

The proposed SUFCO Waste Rock Expansion Area is located on private land approximately 19.6 miles east southeast of Salina, Utah. The proposed project expansion is located in Section 18, Township 22 South, Range 4 East, Salt Lake Base Meridian. The Convulsion Mine Road borders the proposed project area on the west, north, and east. The general location of the soil survey area is shown in Figure 1.

Elevation ranges from approximately 7,835 feet in the southwest corner of the project area to 8,183 in the southeast corner.

Vegetation is dominated by basin big sagebrush and mountain big sagebrush. Gambel oak and quaking aspen dominate the north and westerly facing slopes. Grasses include bluegrass, crested wheatgrass, fescue, and thickspike wheatgrass.

Climate

Climate data for the *Proposed Waste Rock Expansion Area* is of limited availability. PRISM (GIS data for maximum air temperature, minimum air temperature, and average annual precipitation were downloaded from the Geospatial Data Gateway (USDA 2014a). This estimated data is based on 30 year averages, which are updated annually. The average annual maximum air temperature is 54^{o}F and the average annual minimum air temperature is 29^{o}F, based on current PRISM data. The average annual air temperature is 42^{o}F (based on the average maximum and minimum PRISM values). The average annual precipitation is 17 to 18 inches, based on current PRISM data. These estimated annual temperature and precipitation averages reflect the taxonomic classification of the soils and the existing vegetation.

The soil moisture regime is ustic and the soil temperature regime is frigid (Fishlake NF 2013).

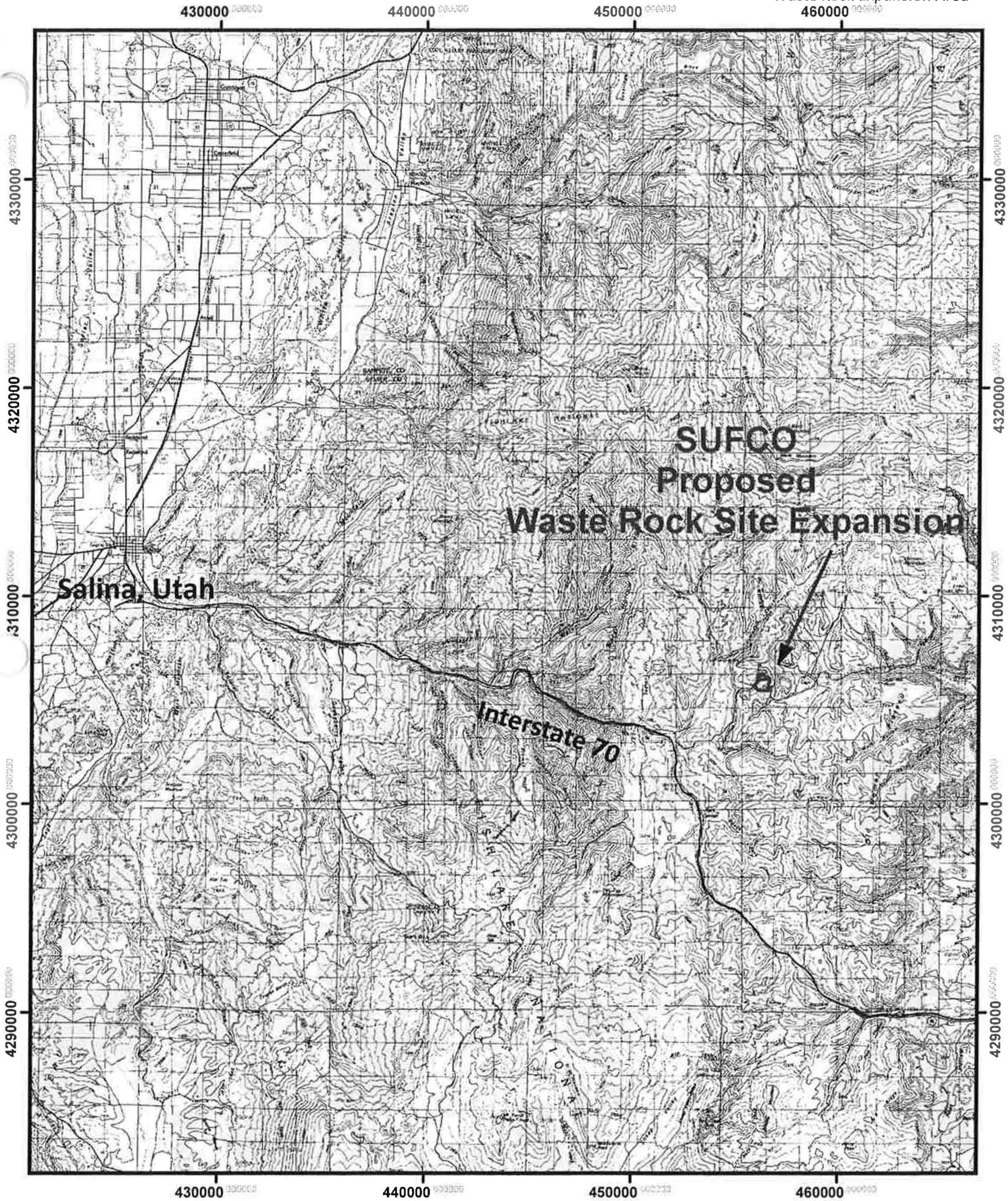

Figure 1. General Location of SUFCO Waste Rock Expansion Soil Surveu Area

Salain, UT 100K Topo Map Jan 26, 2014 1 inch = 20,000 feet UTM NAD83 Zone 12N meters

Order 3 Soil Survey

An order 3 soil survey has been conducted in the vicinity of the *Proposed Expansion of the Existing Waste Rock Soil Survey* area by the Fishlake National Forest (Fishlake 2013). This soil survey is in progress and has not been published (subject to change by the Fishlake National Forest). Soils were classified to the taxonomic family in this survey. Family names were not assigned. This order 3 survey is based on landforms and vegetation. Table 1 lists the order 3 soil survey soil map units delineated by the Fishlake National Forest within the *Proposed Expansion of the Existing Waste Rock Soil Survey* area. Figure 2 contains the Fishlake National Forest order 3 soil survey.

Table 1. Fishlake National Forest soil map units delineated within the Proposed Expansion of the Existing Waste Rock Soil Survey area (Fishlake 2013).

Map Unit	Slope Range	Pct	Taxonomic family[1]	Physiogrpahic Setting	Vegetation
	%	%			
29	10-40	65 25	Typic Argiustolls, lo-skeletal, mix, super, frigid Pachic Argiustolls, fi-loamy, mix, super, frigid	Mountain sides	Mtn shrubs & grasses
30D	3-25	40 40	Pachic Argiustolls fine, mix, super, frigid Pachic Argiustolls fine-loamy, mix, super, frigid	High mtn summits, sideslopes, benches, & valleys	Mtn big sage & grasses
65	25-65	50 25 15	Typic Argiustolls lo-skel, mix, super, frigid Lithic Haplustepts lo-skel, mix, super, frigid Typic Haplocalcids fi-loamy, mix, super, frigid	Ridgetops & mountainsides	Oakbrush & mtn shrubs
70	15-60	40 20 20	Lithic Ustorthents lo-skel, mix, super, calc, frigid Typic Argiustolls fi-loamy, mix super, frigid Rock Outcrops	Mountainsides, structural benches	Curleaf mtn mahogany, pinyon-juniper, & oakbrush
92	3-15	40 20	Ustic Haplargids fine, mix, super, frigid Ustic Torriorthents fine, mix, super, frigid	Plateau tops & sideslopes, high mtn meadows	Mountain big sage with grasses

1. The *Keys to Soil Taxonomy* edition was not specified.

The soils, physiographic settings, and vegetation described in the Fishlake National Forest (NF) soil survey are similar to those identified in this survey with the following exceptions:

- Birchleaf (or alderleaf) is the dominant variety of mountain mahogany, rather than the curleaf listed by the Fishlake NF survey;
- The dominant soil textural family is fine-loamy, rather than loamy-skeletal listed by the Fishlake NF survey; and
- Extent of fine textured soils is much less than described by the Fishlake NF survey.

Figure 2. Fishlake National Forest, Order 3 Soil Survey

Waste Rock Soil Survey Area
Fishlake NF Soil Survey

NAIP 2011 Aerial Photography Jan 26, 2014 1 inch = 400 feet UTM NAD83 Zone 12N meters

How this Soil Survey was Made

This soil survey was made in accordance with the guidelines for an order 2 soil survey as detailed in the *Soil Survey Manual* (NRCS 1993). Soils were classified to the taxonomic family using the *Keys to Soil Taxonomy, Eleventh Edition* (NRCS 2010). The dominant soil sub-groups identified in the *Proposed Waste Rock Expansion Soil survey* area are Typic Haplustalfs, Typic Argiustolls, Pachic Haplustolls, Pachic Argiustolls, Typic Ustorthents, and Oxyaquic Argiustolls.

Field Evaluation of Soils

Sixteen soil profile descriptions were described in the *Proposed Expansion of the Existing Waste Rock Soil Survey* area during September and early October 2013. These profiles were examined and sampled in hand dug and backhoe pits. Soil profile depths ranged from 16 to 78 inches(42 to 200 cm). Hand dug pits were dug to a minimum depth of 40 inches (100 cm) or a restrictive layer (e.g. sandstone or shale). Representative samples of each soil horizon were placed in soil profile boxes for later examination. Standard NRCS soil profile log sheets were completed at each location using the methods detailed in the *Field Book for Describing and Sampling Soils, version 3.0* (Schoenberger et. al., 2012).

The location of each soil profile was recorded with a Garmin GPSMap 62st. The coordinate system was UTM NAD83 Zone 12N. Location data was transferred from the Garmin into ARCMap shapefiles using DNRGPS software (MDNR 2012).

Each soil profile description was digitized using Pedon PC software version 5.1 (NRCS 2012). These soil profile descriptions are contained in Appendix A. Photographs of each soil profile location in the *Proposed Expansion of the Existing Waste Rock Soil Survey* are in Appendix B. Photographs of each soil profile box are in Appendix C.

Analysis of Soils

Representative samples of each soil horizon were collected during the field examination and submitted for laboratory analysis by Inter Mountain Labs in Sheridan, Wyoming. Each of the soil samples were analyzed for the parameters outlined by the Utah Division of Oil Gas and Mining (DOGM) in *Guidelines for Management of Topsoil and Overburden* (DOGM, 2005), Table 2. Results of the laboratory analysis are in Appendix D.

Table 2. Soil analysis parameters for topsoil and overburden (Utah DOGM, 2005).

Topsoil Suitability Parameters	
Paste pH	Nitrate (as N)
Saturation percent	Soluble Boron
Electrical Conductivity (ECe)	Organic Matter Percent
Soluble Na, K, Mg, and Ca	$CaCO_3$ Percent
Sodium Adsorption Ratio	Soluble Selenium
Particle Size Analysis (% very fine sand, sand, silt, and clay)	Total Organic Carbon (TOC) percent

Prime Farmland

A prime farmland assessment was conducted by the Soil Conservation Service (Allgood 1987) for the "...Waste Rock Disposal Site, Convulsion Canyon."

This assessment determined that, "The property located in the NW 1/4 of the NE 1/4 of Section 18, Township 22 South, Range 4 East does not meet the criteria for prime farmland."

"The main reasons these soils do not qualify are the steep slopes on which both soils occur, and the cobbly surface of the Freece soil."

Section Two

Soil Map Units

Soils in the proposed SUFCO waste rock expansion area were identified by five distinct soil map units. The area covered by these soil map unit is shown in table 3. The components of each map unit are listed in Table 4. The order 2 soil survey map is in Figure 3.

Table 3. Soil map units in the order 2 soil survey in the *Proposed Waste Rock Expansion Area*.

Map Unit Symbol	Map Unit Name	Plane Acres
1	Kunz - Trag - Crow families complex, 4 to 24 percent slopes	33.7
2	Chivers - Kunz families complex, 2 to 15 percent slopes	17.3
3	Tuntsa - Trag - Zillion families association, 15 to 40 percent slopes	20.9
4	Boyett - Veatch families complex, 3 to 28 percent slopes	7.0
5	Wiggler - Helper - Trag families complex, 15 to 60 percent slopes	12.2
Total		91.1

Soil drainage is well drained in each soil map unit, unless otherwise specified.

Soil Map Unit 1

The *Kunz - Trag - Crow families complex* is dominated by very deep soils (greater than 60 inches) with argillic horizons (illuvial clay accumulation). This map unit consists of 45 percent Kunz family soils on footslopes, 35 percent Trag family soils on backslopes, and 15 percent Crow family soils on convex ridges. Also included are 5 percent Wiggler family soils and other similar soils. The approximate slope range is 4 to 24 percent.

Kunz family soils are located on alluvial valley sideslopes and alluvial fan toeslopes. They formed in alluvium from sandstone and shale. They are very deep and have an argillic horizon (illuvial clay accumulation). Secondary carbonates are present in the lower part of the argillic horizon. Vegetation on these soils consists of basin big sagebrush, rabbitbrush, mountain snowberry, and crested wheatgrass. The approximate slope range for Kunz soils in map unit 1 is 4 to 20 percent. Soil profile 13SF03 is representative of Kunz soils in map unit 1.

Trag family soils are located on alluvial fans. They are very deep, have a dark surface (mollic), and have an argillic horizon (illuvial clay accumulation). Secondary carbonates are present in the lower part of the argillic horizon. Vegetation on these soils consists of mountain big sagebrush, mountain snowberry, rabbitbrush, crested wheatgrass, and bluegrass. The approximate slope range for Trag soils in map unit 1 is 4 to 24 percent. Soil profile 13SF09 is representative of Trag soils in map unit 1.

Crow soils are located on convex mountain ridges and alluvial fans. They very deep and have a fine textured argillic horizon (illuvial clay accumulation). Secondary carbonates are present in the lower part of the soil profile. Vegetation on these soils consists of mountain big sagebrush antelope bitterbrush, bluegrass, thickspike wheatgrass, showy phlox, and Utah serviceberry. The approximate slope range for Crow soils in map unit 1 is 4 to 18 percent. Soil profile 13SF06 is representative of Crow soils in map unti 1.

This map unit is a good source of topsoil and subsoil.

Soil Map Unit 2

The *Chivers - Kunz famlies complex* is dominated by very deep soils with argillic horizons (illuvial clay accumulation). This map unit consists of 50 percent Chivers family soils on gently sloping concave footslopes and 40 percent Kunz family soils on gently to strongly sloping linear footslopes. Also included in this map unit are 10 percent Trag family soils on strongly sloping backslopes, and other similar soils. The approximate slope range is 2 to 15 percent.

Chivers family soils are located in the concave mountain valley bottom. These soils formed in alluvium from sandstone and shale. They have a dark surface (mollic) and an argillic horizon (illuvial clay accumulation). They are moderately well drained and have aquic soil conditions within 1 meter (40 inches) of the soil surface. Redox mottles were observed between 84 and 200 cm below the surface in representative soil profile 13SF05. The depth of these redox mottles is deeper than that which is required for a hydric soil (USACE 2008). Vegetation on these soils consists of basin big sagebrush, rabbitbrush, crested wheatgrass, Utah serviceberry, mountain snowberry, wild rose, and bottlebrush squirreltail. The approximate slope range for Chivers family soils in map unit is 2 to 12 percent.

Kunz family soils are located on the footslopes of alluvial fans. They are very deep and well drained. Kunz soils formed in slope alluvium from sandstone and shale. They have an argillic horizon (illuvial clay accumulation). Secondary carbonates have accumulated in the lower part of the argillic. Vegetation on Kunz family soils consists of Basin big sagebrush, bluegrass, fescue, crested wheatgrass, rabbitbrush, and mountain snowberry. The approximate slope range for Kunz family soils in this map unit is 5 to 15 percent. Soil profile 13SF11 is representative of Kunz family soils in map unit 2.

This map unit is a good source of topsoil and subsoil.

Table 4. Soil map unit composition for order 2 soil survey of SUFCO proposed waste rock expansion area.

Map Unit	Pct	Soil Family	Taxonomic classification	Profile	Vegetation	Setting
1	Kunz - Trag - Crow families complex, 4 to 24 percent slopes					
	45	Kunz	Typic Haplustalf fine-loamy, mixed, superactive, frigid	13SF03	Basin Big Sage	Footslopes
	35	Trag	Typic Argiustoll, fine-loamy, mixed, superactive, frigid	13SF09	Mtn Big Sage	Backslopes
	15	Crow	Typic Haplustalf fine, mixed, super, frigid	13SF06	Bitterbrush	convex ridges
	5	Wiggler	Typic Ustorthent loamy, mixed super, calc., frigid, shallow		Birchleaf	Steep convex south slopes
2	Chivers - Kunz families complex, 2 to 15 percent slopes					
	50	Chivers	Oxyaquic Argiustoll fine-loamy, mixed, superactive, frigid	13SF05	Basin Big Sage	Concave toeslopes
	40	Kunz	Typic Haplustalf fine-loamy, mixed, superactive, frigid	13SF11	Basin Big Sage	Footslopes
	10	Trag	Typic Argiustoll, fine-loamy, mixed, superactive, frigid		Mtn Big Sage	Backslopes
3	Tuntsa - Trag - Zillion families association, 15 to 40 percent slopes					
	45	Tuntsa	Pachic Haplustoll coarse-loamy, mixed, superactive, frigid	13SF08	Oak	N. concave footslopes
	25	Trag	Typic Argiustoll fine-loamy, mixed, superactive, frigid	13SF10	Mtn Big Sage	North convex backslopes
	20	Zillion	Pachic Argiustoll loamy-skel, mixed, superactive	13SF04	Aspen Thicket	N. concave toeslopes
	10	Veatch	Typic Haplustoll loamy-skeletal, mixed, superactive, frigid		Oak	North convex ridges
4	Boyett - Veatch families complex, 3 to 28 percent slopes					
	70	Boyett	Typic Haplustalf coarse-loamy, mixed, superactive, frigid	13SF02	Mtn Big Sage	Structural bench
	20	Veatch	Typic Haplustoll loamy-skeletal, mixed, superactive, frigid		Oak	North convex ridges
	5	Wiggler	Typic Ustorthent loamy, mixed super, calc., frigid, shallow		Birchleaf	Steep convex south slopes
	5	Sandstone Outcrops				Free face

Table 4. continued.

Map Unit	Pct	Soil Family	Taxonomic classification	Profile	Vegetation	Setting
5	Wiggler - Helper - Trag families complex, 15 to 50 percent slopes					
	50	Wiggler	Typic Ustorthent loamy, mixed super, calc., frigid, shallow	13SF01	Birchleaf	Steep convex south slopes
	20	Helper	Typic Haplustept fine-loamy, mixed, superactive, frigid	13SF16	Utah juniper	Steep concave south slopes
	20	Trag	Typic Argiustoll, fine-loamy, mixed, superactive, frigid	13SF15	Mtn Big Sage	Concave backslopes
	5	Tuntsa	Pachic Haplustoll coarse-loamy, mixed, superactive, frigid		Oak	North concave footslopes
	5	Sandstone Outcrops				Free face

Soil Map Unit 3

The *Tuntsa - Trag - Zillion families complex* is dominated by very deep soils on north facing slopes. This map unit consists of 45 percent Tuntsa family soils on concave north to west facing footslopes, 25 percent Trag family soils on north to west facing convex backslopes, and 20 percent Zillion family soils on north facing concave toeslopes. Also included in this map unit are 10 percent Veatch family soils and other similar soils. The approximate slope range is 15 to 40 percent.

Tuntsa family soils are located on concave mountain sideslopes. They formed in slope alluvium and colluvium from sandstone and conglomerate. They are very deep and have a thick dark surface (pachic). These soils are coarse textured and contain large amounts of sandstone cobbles, stones, and boulders in the lower portions of the soil profile. Secondary carbonates are present in the lower part of the soil profile. Vegetation on these soils consists of Gambel oak, mountain snowberry, mountain big sagebrush, and thickspike wheatgrass. The approximate slope range for Tuntsa family soils in this map unit is 20 to 40 percent. Soil profile 13SF08 is representative of Tuntsa family soils in map unit 3.

Trag family soils are located on convex mountain side slopes. They formed in mixed slope alluvium from sandstone and shale. They are very deep, have a dark surface (mollic), and have an argillic horizon (illuvial clay accumulation). Secondary carbonates are present in the lower part of the soil profile. Cobles or stones are present in the lower portions of some Trag family profiles. Vegetation on these soils consists of mountain big sagebrush, Utah serviceberry, birchleaf mountain mahogany, and Rocky mountain juniper. The approximate slope range for Trag family soils in this map unit is 25 to 35 percent. Soil profile 13SF10 is representative of Trag family soils in map unit 3.

Zillion family soils are located on concave mountain footslopes. They formed in slope alluvium and colluvium from sandstone and shale. They are very deep and have a thick dark surface (pachic), and an argillic horizon (illuvial clay accumulation). These soils are skeletal (greater than 35 percent rock fragments) and contain large amounts of gravels, cobbles, and stones. Vegetation on these soils consists of Quaking aspen thickets, rabbitbrush, thickspike wheatgrass, and mountain snowberry. The approximate slope range for Zillion soils in this map unit is 15 to 30 percent. Soil profile 13SF04 is representative of Zillion family soils in map unit 3.

This map unit is a moderate source of topsoil and subsoil. The presence of cobbles, stones, and boulders will be limiting to topsoil and subsoil salvage.

Soil Map Unit 4

The *Boyett - Veatch families complex* is dominated by moderately deep soils (20 to 40 inches or 50 to 100 cm) over sandstone. This map unit consists of 70 percent Boyett family soils and 20 percent Veatch family soils. Also included in this map unit are 5 percent Wiggler family soils, 5 percent sandstone outcrops, and other similar soils. This map unit occurs on the structural bench on the east side of the soil survey area and in the southwest corner of the survey area.

Boyett family soils formed in sandstone residuum. They are coarse textured and have an argillic horizon (illuvial clay accumulation). Vegetation on these soils consists of mountain big sagebrush, fescue, bluegrass, Utah serviceberry, and birchleaf mountain mahogany. The approximate slope range for Boyett family soils in this map unit is 3 to 15 percent. Soil profile 13SF02 is representative of Boyett family soils in map unit 4.

Veatch family soils are on north facing mountain sideslopes and ridges. They formed in sandstone residuum. They are moderately deep, have a dark surface (mollic). Vegetation on these soils consists of mountain big sagebrush, fescue, bluegrass, Utah serviceberry, Gambel oak, and birchleaf mahogany. The approximate slope range for Veatch soils in this map unit is 12 to 28 percent. Soil profile 13SF17 is representative of Veatch soils in map unit 4.

This map unit contains limited amounts of topsoil and subsoil due to the depth to sandstone.

Soil Map Unit 5

The *Wiggler - Helper - Trag* familis complex is dominated by shallow and moderately deep soils on steep to very steep south facing slopes. This map unit consists 50 percent Wiggler family soils on steep convex slopes, 20 percent Helper family soils on steep concave slopes, and 20 percent Trag family soils on concave backslopes. Also included in this map unit are 5 percent Tuntsa family soils, 5 percent sandstone outcrops, and other similar soils.

Wiggler family soils are located on steep to very steep south facing mountain sideslopes. They formed in sandstone colluvium over shale residuum. Vegetation on these soils consists of birchleaf mountain mahogany, mountain big sagebrush, and Indian ricegrass. The depth to shale is less than 20 inches (50 cm). The approximate slope for Wiggler family soils in map unit 5 is 30 to 60 percent. Soil profile 13SF01 is representative of Wiggler family soils in map unit 5.

Helper family soils are located on steep mountain hillslopes. They formed in moderately deep (20 to 40 inches or 50 to 100 cm) sandstone colluvium and residuum. Vegetation on these soils consists of mountain big sagebrush, antelope bitterbrush, thickspike wheatgrass, Indian ricegrass, Utah serviceberry, a few scattered Utah juniper, rabbitbrush, and cactus. The approximate slope range for Helper family soils in map unit 5 is 25 to 40 percent. Soil profile 13SF16 is representative of Helper family soils in map unit 5.

Trag family soils are located on moderately steep to steep mountain sideslopes. They formed in slope alluvium. These soils are deep to very deep with a dark surface (mollic) and an argillic horizon (illuvial clay accumulation). Secondary carbonates are present in the lower part of the argillic horizon. Vegetation consists of mountain big sagebrush, antelope bitterbrush, bluegrass, thickspike wheatgrass, fescue, cactus, arrowleaf balsamroot, scattered Utah junipers, small clumps of Gambel oak, and rabbitbrush. Soil profile 13SF15 is representative of Trag family soils in map unit 5.

This map unit contains limited amounts of topsoil and subsoil due to shallow to moderately deep soil depths and steep to very steep slopes. The deeper pockets of salvageable topsoil and subsoil are located in the Trag family soil areas.

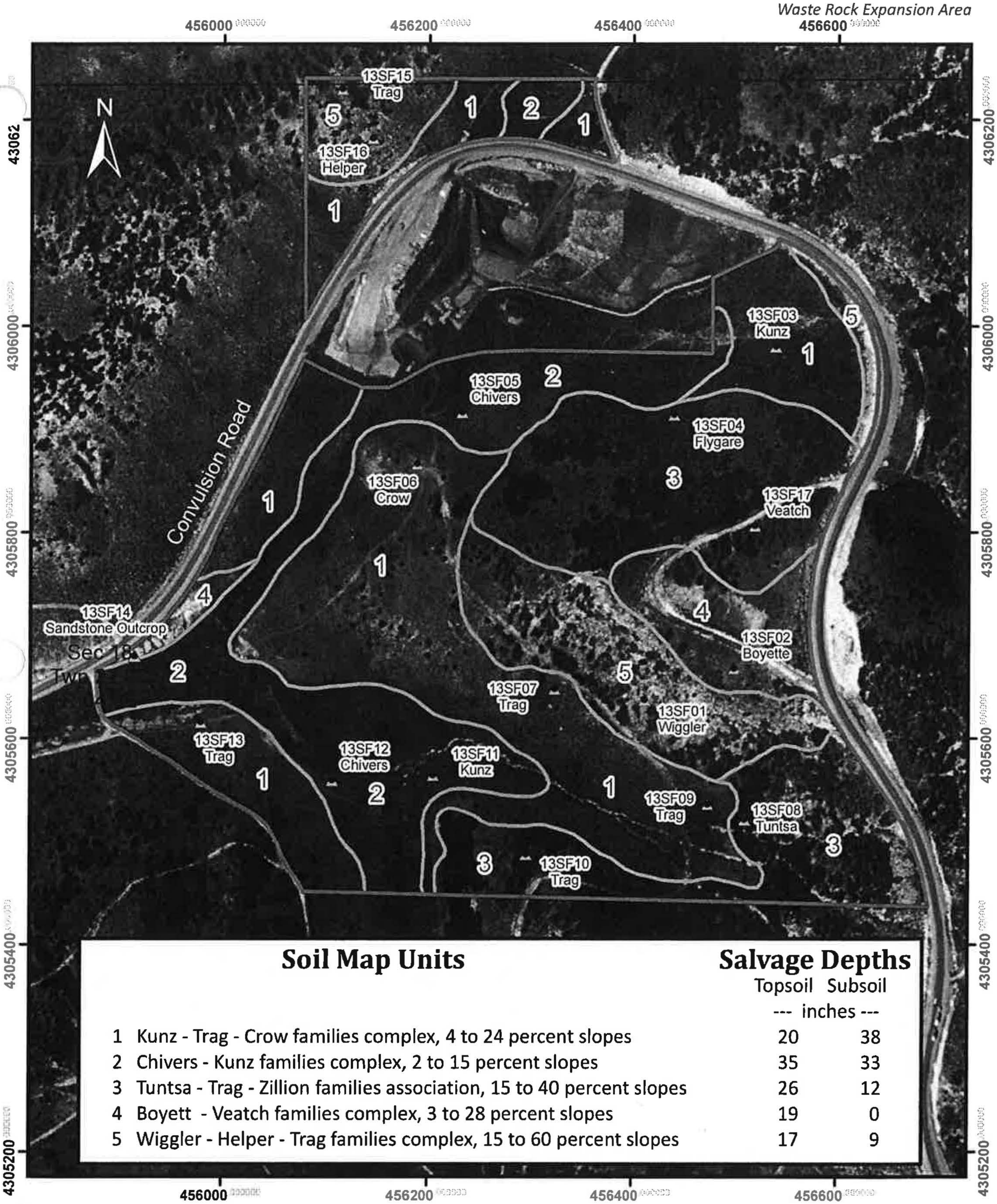

Figure 3. SUFCO Proposed Waste Rock Expansion Area, Order 2 Soil Survey

NAIP 2011 Aerial Photography Jan 26, 2014 1 inch = 400 feet UTM NAD83 Zone 12N meters

▲ Waste Rock Soil Pit
Waste Rock Soil Survey Area
Waste Rock Soil Map Units

Section Three

Soil Families

Sixteen soil profile descriptions were collected in SUFCO's proposed waste rock expansion area during September and early October 2013. These soil descriptions identified ten soil families. The taxonomic classification (NRCS 2010) and soil family (NRCS 2014b) for each of these profiles is listed in Table 5. One miscellaneous landform note (rock outcrop) was also identified with a location number. Soil profile descriptions are in Appendix A.

Table 5. Taxonomic classification and soil family for soil profiles described within the SUFCO's proposed waste rock expansion area.

Soil Profile	Soil Family	Taxonomic Classification[2]
13SF01	Wiggler	Typic Ustorthent loamy, mixed super, calc., frigid, shallow
13SF02	Boyett	Typic Haplustalf coarse-loamy, mixed, superactive, frigid
13SF03	Kunz	Typic Haplustalf fine-loamy, mixed, superactive, frigid
13SF04	Zillion	Pachic Argiustoll loamy-skeletal, mixed, superactive, frigid
13SF05	Chivers	Oxyaquic Argiustoll fine-loamy, mixed, superactive, frigid
13SF06	Crow	Typic Haplustalf fine, mixed, superactive, frigid
13SF07	Trag	Typic Argiustoll, fine-loamy, mixed, superactive, frigid
13SF08	Tuntsa	Pachic Haplustoll coarse-loamy, mixed, superactive, frigid
13SF09	Trag	Typic Argiustoll, fine-loamy, mixed, superactive, frigid
13SF10	Trag	Typic Argiustoll, fine-loamy, mixed, superactive, frigid
13SF11	Kunz	Typic Haplustalf fine-loamy, mixed, superactive, frigid
13SF12	Chivers similar	Oxyaquic Haplustalf fine-loamy, mixed, superactive, frigid
13SF13	Trag	Typic Argiustoll fine-loamy, mixed, superactive, frigid
13SF14		Sandstone outcrop
13SF15	Trag	Typic Argiustoll, fine-loamy, mixed, superactive, frigid
13SF16	Helper	Typic Haplustept fine-loamy, mixed, superactive, frigid
13SF17	Veatch	Typic Haplustoll loamy-skeletal, mixed, superactive, frigid

1. Soil family name chosen from established soil series that most closely fits soil in this soil survey (NRCS 2014a).
2. Taxonomic classification based on Keys to Soil Taxonomy, Eleventh Edition (NRCS 2010).

Section Four

Topsoil and Subsoil Salvage Guidelines

The suitability of the topsoil and subsoil was evaluated using the field data, lab data, and the criteria set forth by the Utah Division of Oil, Gas, and Mining in Guidelines for Management of Topsoil and Overburden (DOGM 2005), Table 6.

Table 5. Soil suitability and unsuitability criteria (Utah DOGM, 2005).

Criteria	Good	Fair	Poor	Unacceptable
Topsoil Suitability				
Saturation %	25 to 55	≥56 to 80	<25 or >80	
pH	6.5 to 8.2	6.0 to 6.4	5.5 to 6.0	<5.5
		8.2 to 8.5	8.6 to 9.0	>9.0
EC (mS/cm 25°C)	0 to 4	4 to 8	8 to 15	>15
SAR	0 to 4	5 to 10	10 to 14	>14
$CaCO_3$ %	<15	15 to 30	>30	
Texture	sl, l, sil, scl, vfsl, fsl	cl, sicl, sc, ls, lfs	sic, s, sc, c, cos, fs, vfs	g, vcos
Total Organic Carbon	<10%			≥10%
Available Water Capacity (in/in)	>0.10 moderate	0.05 to 0.10 low	<0.05 very low	
K factor	<0.37	0.37	>0.37	
Overburden Suitability				
	UNACCEPTABLE			
Soluble Selenium	≥ 0.15 mg/kg	Unacceptable level in rooting zone (top 4 feet of fill) and/or ephemeral drainages.		
	≥ 0.10 mg/kg	Unacceptable level for top 4 feet in surface-water impoundments or intermittent/perennial drainages including 100 year flood plain.		
Available Boron	≥ 5.0 mg/kg			

Soil Features

No significant soil limitations were identified in the laboratory analysis. Soil horizons with Fair or Poor suitabilities (DOGM 2005) are highlighted in Table D-1 in Appendix D.

Saturation Percent

Saturation percents were in either the *Good* or *Fair* categories, except for one horizon. The surface horizon (0 to 13 cm) of soil profile 13SF10 had a saturation percent of 118 percent. The percent clay is only 22 percent, but the organic matter is 11.1 percent. This limitation can be mitigated when the material is mixed with more suitable materials during salvage operations.

Soil pH

The majority of the soil pH values were in the *Good* category. Two were in the *Fair* category with soil pH values of 6.3 and 6.4. A lower soil horizon (57 to 112 cm) in soil profile 13SF06 had a soil pH of 8.6 which is in the *Poor* category. This limitation can be mitigated when the material is mixed with more suitable materials during salvage operations.

Electrical Conductivity

All of the electrical conductivity values were within the *Good* category.

Sodium Adsorption Ratio

The majority of the sodium adsorption ratio (SAR) values were in the *Good* category. Four soil horizons were in the *Fair* category. The soil horizons with Fair values are in the lower portions of soil profiles 13SF06 and 13SF12. These limitations can be mitigated when the material is mixed with more suitable materials during salvage operations.

Texture

The majority of the soil horizons had textures in either the *Good* or *Fair* categories. Two horizons had a Poor soil texture (sand and silty clay). These limitations can be mitigated if the material is mixed with more suitable materials during salvage operations.

Available Water Capacity

Available water capacity (AWC) was estimated for each soil horizon with the Soil Water Characteristics model (Saxton 2012). This model estimates AWC using the percent sand, percent clay, percent organic matter, electrical conductivity, and field estimated percent gravels. Low AWC attributes to droughty soil conditions during reclamation.

The majority of the estimated available water capacities are in either the *Good* or *Fair* categories. Six of the soil horizons have estimated AWC in the *Poor* category (less than 0.05 inches per inch). Estimated AWC values in the *Poor* category can be attributed to either: clay percents less than 5 percent (13SF10 and 13SF13); or field estimated rock fragment content of 45 percent or greater (13SF01, 13SF04, and 13SF08). Soils with *Poor* AWC due to high rock fragment content should not be salvaged for use as topsoil or subsoil, unless estimated quantities are limiting.

K Factor

All but two of the K factors calculated by Inter Mountain Labs are within the *Good* category. Two soil horizons (13SF10 65 to 112cm and 13SF13 8 to 18cm) have calculated K factors of 0.38 which is in the Poor category. K factors are considered to be Poor, if they are greater than 0.37 (DOGM 2005). These two soil horizons are very close to being rated as *Fair* and are of limited extent compared to the amount of *Good* materials. These limitations can be mitigated if the material is mixed with more suitable materials during salvage operations.

Soluble Boron

None of the soluble boron values exceeded 1 ppm, which is significantly less than the 5 ppm suitability limit established by Utah DOGM (DOGM 2005).

Soluble Selenium

All of the soluble selenium values were non-detectable (less than 0.02 ppm).

Total Organic Carbon

All of the total organic carbon values were less than the 10 percent level established by Utah DOGM as *Unacceptable* (DOGM 2005). The surface horizon (0 to 13 cm) in soil profile 13SF10 had a total organic carbon value of 9.0 percent. This soil horizon also has an organic matter content of 11.1 percent.

Rock Fragments

The NRCS guidelines for determination of suitability for *Construction Material - Reclamation* (NRCS 2013) were used to evaluate the suitability of topsoil and subsoil based on the field estimated quantities of cobbles and stones. The criteria for cobbles and stones are listed in Table 6. These guidelines were established to evaluate the upper 72 inches of the soil, but for the purposes of this soil survey the criteria for cobbles and stones was applied to each individual soil horizon.

Table 6. Criteria used for determining suitability of reclamation material based on estimated rock fragment content (NRCS 2013).

Evaluation Parameter	Limiting	Somewhat Limiting	Not Limiting	Limitation Description
Cobble Content [1, 2]	> 50%	> 25% to ≤ 50%	≤ 25%	Too Cobbly
Stone Content [2, 3]	> 15%	> 5% to ≤ 15%	≤ 5%	Too Stony

1. Excessive stones (rock fragments > 10 inch in size) can interfere with construction equipment.
2.Values are for weight percent (estimated).

Estimated Topsoil and Subsoil Salvage Depths

The separation between topsoil was based on soil colors and substantial decreases in the organic matter content. Estimated salvage depths for topsoil and subsoil meet the Good and Fair criteria established by Utah DOGM (DOGM 2005) and will be suitable for reclamation. Topsoil generally contains more organic matter and soil nutrients which will enhance final reclamation. Table 7 lists the estimated topsoil and subsoil salvage depths for each soil profile.

Table 7. Estimated topsoil and subsoil salvage depths for soil profiles.

Soil Profile	Soil Family	Estimated Topsoil Salvage Depth	Estimated Subsoil Salvage Depth	Limiting Feature(s)
		Inches	*inches*	
13SF01	Wiggler	17	0	Shallow depth to shale
13SF02	Boyett	22	0	Depth to sandstone
13SF03	Kunz	15	52	Decreased AWC in the subsoil
13SF04	Zillion	18	28	Too stony in lower soil profile
13SF05	Chivers	33	46	Organic matter decreases in subsoil
13SF06	Crow	14	44	Fine textures in upper subsoil
13SF07	Trag	24	45	Organic matter decreases in subsoil
13SF08	Tuntsa	33	0	Too stony (boulders) in subsoil
13SF09	Trag	28	41	Increased secondary carbonates in subsoil
13SF10	Trag	13	31	Too cobbly in bottom of soil profile
13SF11	Kunz	25	44	Increased secondary carbonates in subsoil
13SF12	Chivers	67	0	No significant changes in soil profile
13SF13	Trag	16	18	Secondary carbonates and depth to shale
13SF14	Sandstone	0	0	Sandstone outcrop
13SF15	Trag	40	0	Depth of soil description
13SF16	Helper	11	17	Droughty subsoil; depth to sandstone
13SF17	Veatch	13	0	Low AWC; flagstones; depth to sandstone

Table 8 lists the average estimated salvage depths for each soil family. These estimated salvage depths for each soil family should be expected to vary within the soil survey area. Salvage of topsoil and subsoil should be monitored.

Table 8. Estimated average topsoil and subsoil salvage depths for each soil family.

Soil Family	Estimated Average Topsoil Salvage Depth	Estimated Average Subsoil Salvage Depth	Limiting Feature(s)
	Inches	*Inches*	
Boyett	22	0	Depth to sandstone
Chivers	50	23	
Crow	14	44	Increased clay content in upper subsoil
Zillion	18	28	Too stony in bottom of soil profile
Helper	11	17	Droughty subsoil; depth to sandstone
Kunz	20	48	Secondary carbonates and decreased AWC in subsoil
Sandstone	0	0	
Trag	24	27	Cobbles in subsoil and depth to sandstone
Tuntsa	33	0	Too stony (boulders) in subsoil
Veatch	13	0	Low AWC; flagstones; depth to sandstone
Wiggler	17	0	Low AWC; flagstones; depth to sandstone

Estimated topsoil and subsoil salvage depths for each soil map unit based on weighted averages are listed in Table 9.

Table 9. Estimated topsoil and subsoil for each soil map unit based on weighted averages.

Map Unit	Percent	Soil Family	Topsoil Depth[1]	Weighted Topsoil Depth[3]	Subsoil Depth[2]	Weighted Subsoil Depth[3]
	%		*inches*	*inches*	*inches*	*inches*
1	Kunz - Trag - Crow families complex, 6 to 18 percent slopes					
	45	Kunz	20	9.0	48	21.6
	35	Trag	24	8.4	27	9.5
	15	Crow	14	2.1	44	6.6
	5	Wiggler	17	0.9	0	0.0
	Weighted Cumulative Depths			20		38
2	Chivers - Kunz families complex, 2 to 15 percent slopes					
	50	Chivers	50	25.0	23	11.5
	40	Kunz	20	8.0	48	19.2
	10	Trag	24	2.4	27	2.7
	Weighted Cumulative Depths			35		33
3	Tuntsa - Trag - Zillion families association, 15 to 40 percent slopes					
	45	Tuntsa	33	14.9	0	0.0
	25	Trag	24	6.0	27	6.8
	20	Zillion	18	3.6	28	5.6
	10	Veatch	13	1.3	0	0.0
	Weighted Cumulative Depths			26		12
4	Boyett - Veatch families complex, 3 to 28 percent slopes					
	70	Boyette	22	15.4	0	0.0
	20	Veatch	13	2.6	0	0.0
	5	Wiggler	17	0.9	0	0.0
	5	Sandstone Outcrops		0.0	0	0.0
	Weighted Cumulative Depths			19		0
5	Wiggler - Helper - Trag families complex, 15 to 50 percent slopes					
	50	Wiggler	17	8.5	0	0.0
	20	Helper	11	2.2	17	3.4
	20	Trag	24	4.8	27	5.4
	5	Tuntsa	33	1.7	0	0.0
	5	Sandstone	0	0.0	0	0.0
	Weighted Cumulative Depths			17		9

1. Topsoil salvage depth based on average for soil family, from Table 8.
2. Subsoil salvage depth based on average for soil family, from Table 8.
3. Weighted salvage depth calculated by multiplying average depth for topsoil or subsoil by percent in map unit.

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Appendix A

Soil Profile Descriptions

The soil profile descriptions contained in this appendix were collected during September and early October 2013. All soil profiles were examined and described by Robert Long, Certified Professional Soil Scientist (CPSS #02346). The following soil profiles were collected from hand dug soil pits:

13SF01 13SF02 13SF15 13SF16

Soil profile 13SF14 delineated sandstone outcrop and 13SF17 was a road cut.

The remaining soil profiles were dug with a backhoe.

Profile descriptions were collected as outlined in the *Field Book for Describing and Sampling Soils, version 3.0* (Schoenberger et. al. 2012).

Soils were classified using *Keys to Soil Taxonomy, Eleventh Edition* (NRCS 2010).

Soil profile descriptions were entered into a project database using *Pedon PC* software (NRCS 2012) for evaluation and comparison of profiles. *Pedon PC* was also used to produce the standardized profile descriptions contained in this appendix.

Laboratory data for the following parameters was also entered into the *Pedon PC* database and included in these profile descriptions: paste pH; electrical conductivity (ECe); USDA soil texture (including percent sand, silt, and clay), percent calcium carbonate. Laboratory analysis data in Appendix D of this report.

SOIL PROFILE DESCRIPTION 13SF01

Pedon ID: 13SF01
Description Date: 9/19/2013
Describer: Robert Long

Soil Name As Correlated: Wiggler family
Current Taxonomic Class: Loamy, mixed, superactive, calcareous, frigid, shallow Typic Ustorthents

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456411E, 4305638N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: mountain slope
Geomorphic Component: Center third of mountainflank
Profile Pos: Backslope
Slope: 52 percent
Elevation: 2442 meters (8011.8 feet)
Aspect: 214°
Shape: up/down: Linear; **across:** Convex

Drainage: Well drained
Runoff: High
Erosion: Class 2 - Rill erosion

Primary Earth Cover: Shrub cover

> **Existing Vegetation:** CEMOG - birchleaf mountain mahogany (*Cercocarpus montanus var. glaber*); ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); ACHY - Indian ricegrass (*Achnatherum hymenoides*)

Surface Fragments: 10 percent subangular gravels, b percent subangular sandstone cobbles, 10 percent subangular sandstone stones, 10 percent subangular sandstone boulders, 5 percent subangular sandstone channers, and 2 percent subangular sandstone flagstones.
Parent Materials: colluvium derived from sandstone over residuum weathered from shale

Bedrock: Moderately cemented calcareous shale at 42 centimeters (16.5 inches)
Particle Size Control Section: 25 to 42 centimeters (9.8 to 16.5 inches)

Diagnostic Features: Paralithic contact: 42 centimeters (16.5 inches)
Restrictions: Paralithic bedrock: 42 centimeters (16.5 inches)

A --- 0 to 10 centimeters (0 to 3.9 inches); light yellowish brown (2.5Y 6/4) dry, loam; light olive brown (2.5Y 5/4) moist; 47 percent sand; 28 percent silt; 25 percent clay; moderate medium platy parting to moderate medium granular structure; very friable, slightly hard, slightly sticky, moderately plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 5 percent subangular sandstone gravels; electrical conductivity of 0.36 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; clear smooth boundary; CaCO3 2.6 Percent.

C --- 10 to 42 centimeters (3.9 to 16.5 inches); light olive brown (2.5Y 5/3) dry, gravelly sandy clay loam; olive brown (2.5Y 4/3) moist; 70 percent sand; 10 percent silt; 20 percent clay; structure; friable, hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and many very fine roots throughout; common very fine interstitial pores; 20 percent shale parachanners and 30 percent subangular sandstone gravels; electrical conductivity of 0.36 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; clear smooth boundary; CaCO3 4 Percent.

Cr --- 42 centimeters (16.5 inches); Shale- soft.

SOIL PROFILE DESCRIPTION 13SF02

Pedon ID: 13SF02
Description Date: 9/19/2013
Describer: Robert Long

Soil Name As Correlated: Boyett family
Current Taxonomic Class: Coarse-loamy, mixed, superactive, frigid Typic Haplustalfs

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456498E, 4305669N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: structural bench
Geomorphic Component: Mountaintop
Profile Pos: Summit
Slope: 3 percent
Elevation: 2471 meters (8107 feet)
Aspect: 268°
Shape: up/down: Linear; **across:** Linear

Drainage: Well drained
Runoff: Medium
Erosion: Class 1 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); FESTU - fescue (*Festuca*); POA - bluegrass (*Poa*); AMUT - Utah serviceberry (*Amelanchier utahensis*); CEMOG - birchleaf mountain mahogany (*Cercocarpus montanus var. glaber*)

Surface Fragments: 3 percent subangular sandstone gravels and 2 percent subangular sandstone channers.
Parent Materials: residuum weathered from sandstone
Bedrock: Strongly cemented sandstone at 56 centimeters (22 inches)
Particle Size Control Section: 11 to 56 centimeters (4.3 to 22 inches)
Diagnostic Features: Argillic horizon: 26 to 56 centimeters (10.2 to 22 inches) and Lithic contact: 56 centimeters (22 inches)
Restrictions: Lithic bedrock: 56 centimeters (22 inches)

A --- 0 to 11 centimeters (0 to 4.3 inches); light yellowish brown (10YR 6/4) dry, sandy loam; brown (10YR 5/3) moist; 63 percent sand; 24 percent silt; 13 percent clay; weak medium subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine interstitial pores; 2 percent subangular sandstone gravels; electrical conductivity of 0.3 mmhos/cm; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; clear smooth boundary; $CaCO_3$ 1 Percent.

Bt1 --- 11 to 26 centimeters (4.3 to 10.2 inches); light yellowish brown (10YR 6/4) dry, sandy loam; brown (10YR 5/3) moist; 60 percent sand; 26 percent silt; 14 percent clay; moderate medium subangular blocky structure; friable, slightly hard, slightly sticky, slightly plastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 10 percent (few) clay films between sand grains; electrical conductivity of 0.31 mmhos/cm; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; clear smooth boundary; $CaCO_3$ 0.9 Percent.

Bt2 --- 26 to 56 centimeters (10.2 to 22 inches); light yellowish brown (10YR 6/4) dry, sandy loam; yellowish brown (10YR 5/4) moist; 57 percent sand; 25 percent silt; 18 percent clay; moderate medium prismatic parting to strong medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 50 percent (many) clay films between sand grains; electrical conductivity of 0.21 mmhos/cm; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; abrupt smooth boundary; $CaCO_3$ 0.9 Percent.

R --- 56 centimeters (22 inches); Sandstone.

SOIL PROFILE DESCRIPTION 13SF03

Pedon ID: 13SF03
Description Date: 9/25/2013
Describer: Robert Long

Soil Name As Correlated: Kunz family
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Typic Haplustalfs

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456538E, 4305981N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: valley
Geomorphic Component: Base Slope
Profile Pos: Footslope
Slope: 9 percent
Elevation: 2424 meters (7952.8 feet)
Aspect: 294°
Shape: up/down: Concave; **across:** Concave

Drainage: Well drained
Runoff: Medium
Erosion: Class 1 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRT - basin big sagebrush (*Artemisia tridentata ssp. tridentata*); SYOR2 - mountain snowberry (*Symphoricarpos oreophilus*); AGCR - crested wheatgrass (*Agropyron cristatum*); CHRYS9 - rabbitbrush (*Chrysothamnus*)

Surface Fragments: 5 **Surface Fragments:** 3 percent subangular sandstone gravels.
Parent Materials: alluvium derived from sandstone and shale
Particle Size Control Section: 38 to 88 centimeters (15 to 34.6 inches)
Diagnostic Features: Argillic horizon: 38 to 170 centimeters (15 to 66.9 inches) and Secondary carbonates: 74 to 170 centimeters (29.1 to 66.9 inches)

Oi --- 0 to 1 centimeter (0 to 0.4 inches); (10YR) dry; (10YR) moist; Leaves & Twigs.

A1 --- 1 to 14 centimeters (0.4 to 5.5 inches); yellowish brown (10YR 5/4) dry, sandy loam; brown (10YR 4/3) moist; 60 percent sand; 23 percent silt; 17 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, slightly sticky, slightly plastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; electrical conductivity of 0.35 mmhos/cm by EC meter, saturated paste; slightly effervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; clear smooth boundary; $CaCO_3$ 5.2 Percent.

A2 --- 14 to 38 centimeters (5.5 to 15 inches); brown (10YR 5/3) dry, sandy loam; dark brown (10YR 3/3) moist; 60 percent sand; 25 percent silt; 15 percent clay; weak medium subangular blocky structure; very firm, slightly hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; electrical conductivity of 0.28 mmhos/cm by EC meter, saturated paste; very slightly effervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; clear smooth boundary; $CaCO_3$ 5.1 Percent.

2Bt1 --- 38 to 59 centimeters (15 to 23.2 inches); brown (10YR 5/3) dry, sandy loam; dark grayish brown (10YR 4/2) moist; 71 percent sand; 15 percent silt; 14 percent clay; weak medium prismatic parting to moderate medium subangular blocky structure; friable, hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 45 percent (common) clay films on all faces of peds; electrical conductivity of 0.31 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; clear smooth boundary; $CaCO_3$ 3.1 Percent.

2Bt2 --- 59 to 74 centimeters (23.2 to 29.1 inches); brown (10YR 5/3) dry, sandy loam; dark grayish brown (10YR 4/2) moist; 63 percent sand; 20 percent silt; 17 percent clay; moderate medium prismatic parting to strong medium subangular blocky structure; friable, hard, slightly sticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 60 percent (many) clay films on all faces of peds; electrical conductivity of 0.34 mmhos/cm by EC meter, saturated paste; very slightly effervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; gradual smooth boundary; $CaCO_3$ 2.9 Percent.

2Btk1 --- 74 to 94 centimeters (29.1 to 37 inches); grayish brown (10YR 5/2) dry, sandy clay loam; dark grayish brown (10YR 4/2) moist; 57 percent sand; 23 percent silt; 20 percent clay; moderate medium prismatic parting to moderate medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 40 percent (common) clay films on all faces of peds; 2 percent (common) fine threadlike masses of carbonate in matrix; electrical conductivity of 0.32 mmhos/cm by EC meter, saturated paste; very slightly effervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; gradual smooth boundary; CaCO3 2.8 Percent.

2Btk2 --- 94 to 145 centimeters (37 to 57.1 inches); grayish brown (10YR 5/2) dry, sandy clay loam; dark grayish brown (10YR 4/2) moist; 58 percent sand; 22 percent silt; 20 percent clay; moderate medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 30 percent (common) clay films on all faces of peds; 6 percent (common) fine threadlike masses of carbonate in matrix; electrical conductivity of 0.3 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; gradual smooth boundary; CaCO3 3.4 Percent.

2Btk3 --- 145 to 150 centimeters (57.1 to 59.1 inches); brown (10YR 5/3) dry, sandy loam; dark grayish brown (10YR 4/2) moist; 58 percent sand; 23 percent silt; 19 percent clay; moderate medium subangular blocky structure; very friable, hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 15 percent (few) clay films on all faces of peds; 12 percent (common) fine threadlike masses of carbonate in matrix; 5 percent subrounded sandstone gravels; electrical conductivity of 0.39 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; CaCO3 5.5 Percent.

SOIL PROFILE DESCRIPTION 13SF04

Pedon ID: 13SF04
Description Date: 9/25/2013
Describer: Robert Long

Soil Name As Correlated: Zillion family
Current Taxonomic Class: Loamy-skeletal, mixed, superactive, frigid Typic Argiustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456440E, 4305915N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 18 East of the 29 Meridian

Landscape: mountains
Landform: mountain slope
Geomorphic Component: Lower third of mountainflank
Profile Pos: Footslope
Slope: 23 percent
Elevation: 2417 meters (7929.8 feet)
Aspect: 344°
Shape: up/down: Concave; **across:** Linear

Drainage: Well drained
Runoff: Low
Erosion: None - deposition

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: POTR5 - quaking aspen (*Populus tremuloides*); CHRYS9 - rabbitbrush (*Chrysothamnus*); ELLAL - thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*); SYORO - mountain snowberry (*Symphoricarpos oreophilus var. oreophilus*)

Surface Fragments: 7 percent subangular sandstone stones and 2 percent subangular sandstone boulders.
Parent Materials: slope alluvium derived from sandstone and shale
Particle Size Control Section: 77 to 118 centimeters (30.3 to 46.5 inches)
Diagnostic Features: Mollic epipedon: 2 to 46 centimeters (0.8 to 18.1 inches), Albic horizon: 46 to 77 centimeters (18.1 to 30.3 inches) and Argillic horizon: 77 to 118 centimeters (30.3 to 46.5 inches)

Oi --- 0 to 2 centimeters (0 to 0.8 inches); Leaves & Twigs.

A1 --- 2 to 16 centimeters (0.8 to 6.3 inches); brown (10YR 5/3) dry, very cobbly sandy loam; very dark grayish brown (10YR 3/2) moist; 71 percent sand; 16 percent silt; 13 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine interstitial pores; 5 percent subangular sandstone stones, 20 percent subangular sandstone cobbles and 20 percent subangular sandstone gravels; electrical conductivity of 0.34 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; gradual smooth boundary; $CaCO_3$ 1.8 Percent.

A2 --- 16 to 46 centimeters (6.3 to 18.1 inches); brown (10YR 5/3) dry, very cobbly sandy loam; very dark grayish brown (10YR 3/2) moist; 71 percent sand; 16 percent silt; 13 percent clay; weak medium subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; common very coarse roots throughout, common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine interstitial pores; 5 percent subangular sandstone stones, 25 percent subangular sandstone cobbles and 15 percent subangular sandstone gravels; electrical conductivity of 0.26 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; abrupt smooth boundary; $CaCO_3$ 1.1 Percent.

E --- 46 to 77 centimeters (18.1 to 30.3 inches); very pale brown (10YR 7/3) dry, very gravelly sandy loam; light yellowish brown (10YR 6/4) moist; 69 percent sand; 17 percent silt; 14 percent clay; moderate medium prismatic parting to strong medium subangular blocky structure; friable, very hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 10 percent subangular sandstone stones, 10 percent subangular sandstone cobbles and 30 percent subangular sandstone gravels; electrical conductivity of 0.32 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; clear smooth boundary; $CaCO_3$ 0.6 Percent.

Bt --- 77 to 118 centimeters (30.3 to 46.5 inches); yellow (10YR 7/6) dry, very stony sandy clay loam; yellowish brown (10YR 5/6) moist; 58 percent sand; 18 percent silt; 24 percent clay; strong medium prismatic parting to strong medium subangular blocky structure; friable, very hard, slightly sticky, slightly plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 80 percent (many) clay films on all faces of peds; 15 percent subangular sandstone stones, 10 percent subangular sandstone cobbles and 15 percent subangular sandstone gravels; electrical conductivity of 0.22 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; neutral, pH 7.3, pH meter; clear smooth boundary; $CaCO_3$ 0.9 Percent.

C --- 118 to 150 centimeters (46.5 to 59.1 inches); very pale brown (10YR 7/4) dry, very stony sandy loam; light yellowish brown (10YR 6/4) moist; 75 percent sand; 13 percent silt; 12 percent clay; moderate medium subangular blocky structure; friable, very hard, nonsticky, nonplastic; common very fine roots throughout; common very fine tubular pores; 20 percent subangular sandstone stones, 15 percent subangular sandstone cobbles and 10 percent subangular sandstone gravels; electrical conductivity of 0.25 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; $CaCO_3$ 0.6 Percent.

SOIL PROFILE DESCRIPTION 13SF05

Pedon ID: 13SF05
Description Date: 9/25/2013
Describer: Robert Long

Soil Name As Correlated: Chivers family
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Oxyaquic Argiustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456232E, 4305917N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: valley
Geomorphic Component: Mountainbase
Profile Pos: Toeslope
Slope: 11 percent
Elevation: 2399 meters (7870.7 feet)
Aspect: 283°
Shape: up/down: Concave; **across:** Linear

Drainage: Moderately well drained
Runoff: Low
Erosion: Class 1 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRT - basin big sagebrush (*Artemisia tridentata ssp. tridentata*); ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); CHRYS9 - rabbitbrush (*Chrysothamnus*); AGCR - crested wheatgrass (*Agropyron cristatum*); AMUT - Utah serviceberry (*Amelanchier utahensis*); SYOR2 - mountain snowberry (*Symphoricarpos oreophilus*); ELEL5 - bottlebrush squirreltail (*Elymus elymoides*)

Surface Fragments: none.
Parent Materials: alluvium derived from sandstone and shale
Particle Size Control Section: 64 to 114 centimeters (25.2 to 44.9 inches)
Diagnostic Features: Mollic epipedon: 0 to 84 centimeters (0 to 33.1 inches), Argillic horizon: 64 to 200 centimeters (25.2 to 78.7 inches) and Aquic conditions: 84 to 200 centimeters (33.1 to 78.7 inches)

A1 --- 0 to 11 centimeters (0 to 4.3 inches); dark grayish brown (10YR 4/2) dry, sandy loam; very dark brown (10YR 2/2) moist; 77 percent sand; 15 percent silt; 8 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; noneffervescent by HCl, 1 normal; slightly acid, pH 6.5, pH meter; gradual smooth boundary; $CaCO_3$ 0.9 Percent.

A2 --- 11 to 28 centimeters (4.3 to 11 inches); dark grayish brown (10YR 4/2) dry, sandy loam; very dark grayish brown (10YR 3/2) moist; 64 percent sand; 21 percent silt; 15 percent clay; weak medium subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; noneffervescent by HCl, 1 normal; neutral, pH 6.9, pH meter; clear smooth boundary; $CaCO_3$ 0.8 Percent.

BA --- 28 to 64 centimeters (11 to 25.2 inches); grayish brown (10YR 5/2) dry, sandy loam; very dark grayish brown (10YR 3/2) moist; 61 percent sand; 24 percent silt; 15 percent clay; weak medium prismatic parting to moderate medium subangular blocky structure; friable, hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 25 percent (common) clay films on all faces of peds; noneffervescent by HCl, 1 normal; neutral, pH 7.1, pH meter; clear smooth boundary; $CaCO_3$ 0.8 Percent.

Bt1 --- 64 to 84 centimeters (25.2 to 33.1 inches); grayish brown (10YR 5/2) dry, loam; very dark grayish brown (10YR 3/2) moist; 46 percent sand; 30 percent silt; 24 percent clay; moderate medium prismatic parting to strong medium subangular blocky structure; firm, very hard, slightly sticky, slightly plastic; common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 40 percent (common) clay films on all faces of peds; noneffervescent by HCl, 1 normal; neutral, pH 7, pH meter; clear smooth boundary; $CaCO_3$ 1 Percent.

Bt2 --- 84 to 110 centimeters (33.1 to 43.3 inches); light yellowish brown (2.5Y 6/3) dry, clay loam; light olive brown (2.5Y 5/3) moist; 42 percent sand; 25 percent silt; 33 percent clay; 5 percent medium prominent brownish yellow (10YR 6/6) mottles (moist); moderate medium prismatic parting to strong medium subangular blocky structure; firm, very hard, moderately sticky, moderately plastic; common very fine roots throughout; common very fine tubular pores; 70 percent (many) clay films on all faces of peds; noneffervescent by HCl, 1 normal; neutral, pH 6.9, pH meter; clear smooth boundary; $CaCO_3$ 1.2 Percent.

Bt3 --- 110 to 156 centimeters (43.3 to 61.4 inches); pale yellow (2.5Y 7/3) dry, sandy clay loam; light yellowish brown (2.5Y 6/4) moist; 45 percent sand; 28 percent silt; 27 percent clay; 30 percent very coarse prominent brownish yellow (10YR 6/8) mottles (moist); moderate medium subangular blocky structure; friable, very hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 50 percent (many) clay films on all faces of peds; noneffervescent by HCl, 1 normal; neutral, pH 7, pH meter; clear wavy boundary; CaCO3 1.2 Percent.

Bt4 --- 156 to 200 centimeters (61.4 to 78.7 inches); pale yellow (2.5Y 7/4) dry, sandy clay loam; light yellowish brown (2.5Y 6/4) moist; 56 percent sand; 21 percent silt; 23 percent clay; 20 percent coarse prominent brownish yellow (10YR 6/8) mottles (moist); moderate medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine interstitial pores; noneffervescent by HCl, 1 normal; neutral, pH 7.2, pH meter; CaCO3 1.2 Percent.

SOIL PROFILE DESCRIPTION 13SF06

Pedon ID: 13SF06
Description Date: 9/25/2013
Describer: Robert Long

Soil Name As Correlated: Crow family
Current Taxonomic Class: Fine, mixed, superactive, frigid Typic Haplustalfs

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456188E, 4305867N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: alluvial fan
Geomorphic Component: Crest
Profile Pos: Backslope
Slope: 16 percent
Elevation: 2402 meters (7880.6 feet)
Aspect: 224°
Shape: up/down: Convex; **across:** Convex

Drainage: Well drained
Runoff: Medium
Erosion: Class 4 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); PURSH - bitterbrush (*Purshia*); POA - bluegrass (*Poa*); ELLAL - thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*); PHLOX - Phlox (*Phlox*); AMELA - serviceberry (*Amelanchier*)

Surface Fragments: 20 percent subrounded sandstone gravels, 20 percent subrounded quartzite gravels, 5 percent subrounded sandstone cobbles, and 5 percent subangular sandstone flagstones.
Parent Materials: alluvium
Particle Size Control Section: 36 to 86 centimeters (14.2 to 33.9 inches)
Diagnostic Features: Argillic horizon: 36 to 112 centimeters (14.2 to 44.1 inches) and Secondary carbonates: 57 to 180 centimeters (22.4 to 70.9 inches)

A --- 0 to 14 centimeters (0 to 5.5 inches); olive yellow (2.5Y 6/6) dry, clay loam; light olive brown (2.5Y 5/6) moist; 25 percent sand; 37 percent silt; 38 percent clay; weak medium subangular blocky parting to moderate medium granular structure; friable, hard, moderately sticky, moderately plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 5 percent subangular sandstone gravels; electrical conductivity of 0.18 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; neutral, pH 7.1, pH meter; clear smooth boundary; CaCO3 2 Percent.

BA --- 14 to 36 centimeters (5.5 to 14.2 inches); olive yellow (2.5Y 6/6) dry, clay loam; light olive brown (2.5Y 5/6) moist; 25 percent sand; 43 percent silt; 32 percent clay; moderate medium subangular blocky structure; friable, hard, moderately sticky, moderately plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; electrical conductivity of 0.26 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; neutral, pH 7.2, pH meter; clear smooth boundary; CaCO3 2.2 Percent.

Bt --- 36 to 57 centimeters (14.2 to 22.4 inches); 97 percent light yellowish brown (2.5Y 6/3) dry and 3 percent olive yellow (2.5Y 6/6) dry, silty clay; 97 percent olive brown (2.5Y 4/3) moist and 3 percent light olive brown (2.5Y 5/6) moist; 10 percent sand; 45 percent silt; 45 percent clay; moderate medium prismatic parting to strong medium subangular blocky structure; firm, very hard, very sticky, very plastic; common fine roots throughout and common very fine roots throughout; 60 percent (many) clay films on all faces of peds; electrical conductivity of 0.31 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; Peds in Bt are coated with soil from BA horizon that enters Bt when the soil dries and cracks. These thin discontinuous coatings comprise about 3 percent of Bt soil color; clear smooth boundary; Field Measured CaCO3 2.5 Percent.

Btk --- 57 to 112 centimeters (22.4 to 44.1 inches); pale yellow (2.5Y 8/4) dry, silty clay loam; light yellowish brown (2.5Y 6/4) moist; 17 percent sand; 50 percent silt; 33 percent clay; strong coarse prismatic parting to strong medium angular blocky structure; firm, very hard, moderately sticky, moderately plastic; common very fine roots throughout; 70 percent (many) clay films on all faces of peds; 25 percent (many) coarse masses of carbonate on vertical faces of peds; electrical conductivity of 0.62 mmhos/cm by EC meter, saturated paste; slightly effervescent by HCl, 1 normal; strongly alkaline, pH 8.6, pH meter; clear smooth boundary; CaCO3 6.1 Percent.

Bk --- 112 to 180 centimeters (44.1 to 70.9 inches); light yellowish brown (2.5Y 6/3) dry, very gravelly silt loam; light olive brown (2.5Y 5/3) moist; 28 percent sand; 50 percent silt; 22 percent clay; moderate medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 5 percent (common) medium threadlike masses of carbonate in matrix and 10 percent (common) medium masses of carbonate in matrix; 5 percent subangular sandstone stones, 10 percent subangular sandstone cobbles and 40 percent subangular sandstone gravels; electrical conductivity of 2.96 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; $CaCO_3$ 10.8 Percent.

SOIL PROFILE DESCRIPTION 13SF07

Pedon ID: 13SF07
Description Date: 9/26/2013
Describer: Robert Long

Soil Name As Correlated: Trag family
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Oxyaquic Argiustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456323E, 4305649N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: mountain slope
Geomorphic Component: Center third of mountainflank
Profile Pos: Backslope
Slope: 23 percent
Elevation: 2418 meters (7933.1 feet)
Aspect: 183°
Shape: up/down: Convex; **across:** Linear

Drainage: Well drained
Runoff: Medium
Erosion: Class 1 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); SYOR2 - mountain snowberry (*Symphoricarpos oreophilus*); POA - bluegrass (*Poa*)

Surface Fragments: 5 percent subrounded sandstone gravels, 5 percent subrounded quartzite gravels, and 2 percent subangular sandstone boulders.
Parent Materials: slope alluvium
Particle Size Control Section: 138 to 63 centimeters (54.3 to 24.8 inches)
Diagnostic Features: Mollic epipedon: 0 to 28 centimeters (0 to 11 inches), Argillic horizon: 28 to 93 centimeters (11 to 36.6 inches) and Secondary carbonates: 93 to 175 centimeters (36.6 to 68.9 inches)

A --- 0 to 13 centimeters (0 to 5.1 inches); brown (10YR 5/3) dry, sandy loam; dark brown (10YR 3/3) moist; 72 percent sand; 13 percent silt; 15 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine interstitial pores; 5 percent subrounded quartzite gravels and 5 percent subrounded sandstone gravels; noneffervescent by HCl, 1 normal; neutral, pH 6.9, pH meter; clear smooth boundary; $CaCO_3$ 1.2 Percent.

Bt1 --- 13 to 28 centimeters (5.1 to 11 inches); brown (10YR 5/3) dry, sandy loam; dark brown (10YR 3/3) moist; 67 percent sand; 15 percent silt; 18 percent clay; moderate medium subangular blocky structure; very friable, slightly hard, nonsticky, slightly plastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 15 percent (few) clay films on all faces of peds; 5 percent subrounded sandstone gravels; noneffervescent by HCl, 1 normal; neutral, pH 7, pH meter; clear wavy boundary; $CaCO_3$ 0.9 Percent.

Bt2 --- 28 to 60 centimeters (11 to 23.6 inches); yellowish brown (10YR 5/4) dry, sandy clay loam; dark yellowish brown (10YR 4/4) moist; 67 percent sand; 13 percent silt; 20 percent clay; moderate medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 30 percent (common) clay films on all faces of peds; 3 percent subrounded sandstone gravels; noneffervescent by HCl, 1 normal; neutral, pH 7.1, pH meter; clear smooth boundary; $CaCO_3$ 1.1 Percent.

Bt3 --- 60 to 93 centimeters (23.6 to 36.6 inches); pale brown (10YR 6/3) dry, sandy loam; dark yellowish brown (10YR 4/4) moist; 65 percent sand; 16 percent silt; 19 percent clay; moderate medium prismatic parting to strong medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 45 percent (common) clay films on all faces of peds; 2 percent subrounded sandstone gravels; noneffervescent by HCl, 1 normal; neutral, pH 7, pH meter; clear smooth boundary; $CaCO_3$ 1.1 Percent.

Bk1 --- 93 to 146 centimeters (36.6 to 57.5 inches); pale yellow (2.5Y 7/4) dry, sandy clay loam; light yellowish brown (2.5Y 6/4) moist; 59 percent sand; 21 percent silt; 20 percent clay; moderate medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 2 percent (very few) carbonate coats on bottom surfaces of rock fragments; 5 percent subrounded sandstone gravels; very slightly effervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; gradual smooth boundary; $CaCO_3$ 1.2 Percent.

Bk2 --- 146 to 175 centimeters (57.5 to 68.9 inches); pale yellow (2.5Y 7/4) dry, sandy clay loam; light yellowish brown (2.5Y 6/4) moist; 56 percent sand; 21 percent silt; 23 percent clay; weak medium subangular blocky structure; very friable, hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 4 percent (very few) carbonate coats on bottom surfaces of rock fragments; 4 percent (common) fine threadlike masses of carbonate in matrix; 10 percent subrounded sandstone gravels; slightly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; $CaCO_3$ 1.9 Percent.

SOIL PROFILE DESCRIPTION 13SF08

Pedon ID: 13SF08
Description Date: 9/26/2013
Describer: Robert Long

Pedon Notes: There is not enough clay increase between the Bw and Bt for the Bt to be an argillic. Horizon classified as a Bt due to the observation of clay films. There is not enough carbonates for a calcic horizon.

Soil Name As Correlated: Tuntsa family
Current Taxonomic Class: Coarse-loamy, mixed, superactive, frigid Pachic Haplustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456509E, 4305522N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: mountain slope
Geomorphic Component: Upper third of mountainflank
Profile Pos: Footslope
Slope: 37 percent
Elevation: 2442 meters (8011.8 feet)
Aspect: 295°
Shape: up/down: Concave; **across:** Concave

Drainage: Well drained
Runoff: Low
Erosion: None - deposition

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: QUGA - Gambel oak (*Quercus gambelii*); SYOR2 - mountain snowberry (*Symphoricarpos oreophilus*); ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); ELLAL - thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*)

Surface Fragments: none.
Parent Materials: slope alluvium derived from sandstone
Particle Size Control Section: 32 to 107 centimeters (12.6 to 42.1 inches)
Diagnostic Features: Mollic epipedon: 7 to 83 centimeters (2.8 to 32.7 inches), Cambic horizon: 21 to 83 centimeters (8.3 to 32.7 inches) and Secondary carbonates: 83 to 185 centimeters (32.7 to 72.8 inches)

Oi --- 0 to 7 centimeters (0 to 2.8 inches); Leaves & Twigs.

A --- 7 to 21 centimeters (2.8 to 8.3 inches); brown (10YR 5/3) dry, sandy loam; dark brown (10YR 3/3) moist; 68 percent sand; 18 percent silt; 14 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, nonsticky, nonplastic; common very coarse roots throughout, common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine interstitial pores; 5 percent subangular sandstone gravels; electrical conductivity of 0.34 mmhos/cm by EC meter, saturated paste; by HCl, 1 normal; neutral, pH 7.2, pH meter; gradual smooth boundary; $CaCO_3$ 1.1 Percent.

Bw --- 21 to 46 centimeters (8.3 to 18.1 inches); brown (10YR 5/3) dry, sandy loam; dark brown (10YR 3/3) moist; 65 percent sand; 19 percent silt; 16 percent clay; weak medium subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; common very coarse roots throughout, common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 5 percent subangular sandstone gravels; electrical conductivity of 0.25 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.5, pH meter; clear wavy boundary; $CaCO_3$ 0.7 Percent.

Bt --- 46 to 83 centimeters (18.1 to 32.7 inches); brown (10YR 5/3) dry, sandy loam; dark brown (10YR 3/3) moist; 64 percent sand; 19 percent silt; 17 percent clay; moderate medium subangular blocky structure; friable, hard, slightly sticky, nonplastic; common very coarse roots throughout, common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 5 percent (few) carbonate coats on all faces of peds and 15 percent (few) clay films between sand grains; 10 percent subangular sandstone gravels; electrical conductivity of 0.27 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.4, pH meter; clear smooth boundary; $CaCO_3$ 0.7 Percent.

Bk --- 83 to 116 centimeters (32.7 to 45.7 inches); light olive brown (2.5Y 5/3) dry, very bouldery sandy loam; olive brown (2.5Y 4/4) moist; 66 percent sand; 19 percent silt; 15 percent clay; moderate medium subangular blocky structure; friable, hard, slightly sticky, nonplastic; common very coarse roots throughout, common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 5 percent (common) fine threadlike masses of carbonate in matrix; 35 percent subangular sandstone boulders and 5 percent subangular sandstone gravels; electrical conductivity of 0.26 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; clear wavy boundary; $CaCO_3$ 1.1 Percent.

2Bk1 --- 116 to 149 centimeters (45.7 to 58.7 inches); brown (10YR 5/3) dry, very bouldery sandy loam; dark grayish brown (10YR 4/2) moist; 71 percent sand; 17 percent silt; 12 percent clay; moderate medium subangular blocky structure; friable, hard, slightly sticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 2 percent (common) fine threadlike masses of carbonate in matrix; 60 percent subangular sandstone boulders and 5 percent subangular sandstone gravels; electrical conductivity of 0.25 mmhos/cm by EC meter, saturated paste; very slightly effervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; clear smooth boundary; $CaCO_3$ 1.2 Percent.

2Bk2 --- 149 to 185 centimeters (58.7 to 72.8 inches); pale yellow (2.5Y 8/3) dry, extremely bouldery sandy loam; light yellowish brown (2.5Y 6/4) moist; 74 percent sand; 11 percent silt; 15 percent clay; moderate medium subangular blocky structure; friable, very hard, slightly sticky, nonplastic; common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 5 percent (few) carbonate coats on bottom surfaces of rock fragments; 2 percent (common) fine threadlike masses of carbonate in matrix; 60 percent subangular sandstone boulders and 5 percent subangular sandstone gravels; electrical conductivity of 0.24 mmhos/cm by EC meter, saturated paste; very slightly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; $CaCO_3$ 0.9 Percent.

SOIL PROFILE DESCRIPTION 13SF09

Pedon ID: 13SF09
Description Date: 9/26/2013
Describer: Robert Long

Soil Name As Correlated: Trag family

Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Typic Argiustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456473E, 4305537N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: alluvial fan
Geomorphic Component: Upper third of mountainflank
Profile Pos: Backslope
Slope: 14 percent
Elevation: 2438 meters (7998.7 feet)
Aspect: 283°
Shape: up/down: Linear; **across:** Linear

Drainage: Well drained
Runoff: Medium
Erosion: Class 1 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRT - basin big sagebrush (*Artemisia tridentata ssp. tridentata*); ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); SYOR2 - mountain snowberry (*Symphoricarpos oreophilus*); CHRYS9 - rabbitbrush (*Chrysothamnus*); AGCR - crested wheatgrass (*Agropyron cristatum*); POA - bluegrass (*Poa*)

Surface Fragments: 5 percent subangular sandstone gravels.
Parent Materials: alluvium derived from sandstone
Particle Size Control Section: 11 to 61 centimeters (4.3 to 24 inches)
Diagnostic Features: Mollic epipedon: 0 to 29 centimeters (0 to 11.4 inches), Argillic horizon: 11 to 175 centimeters (4.3 to 68.9 inches) and Secondary carbonates: 72 to 175 centimeters (28.3 to 68.9 inches)

A --- 0 to 11 centimeters (0 to 4.3 inches); brown (10YR 5/3) dry, sandy loam; dark brown (10YR 3/3) moist; 59 percent sand; 22 percent silt; 19 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, slightly sticky, slightly plastic; common medium roots, common fine roots and many very fine roots; common very fine interstitial pores; 5 percent subangular sandstone gravels; electrical conductivity of 0.21 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; neutral, pH 6.9, pH meter; clear smooth boundary; CaCO3 1.3 Percent.

Bt1 --- 11 to 29 centimeters (4.3 to 11.4 inches); brown (10YR 5/3) dry, loam; dark brown (10YR 3/3) moist; 50 percent sand; 28 percent silt; 22 percent clay; moderate medium prismatic parting to moderate medium subangular blocky structure; very friable, hard, slightly sticky, slightly plastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 15 percent (few) clay films between sand grains and 25 percent (common) clay films on all faces of peds; 5 percent subangular sandstone gravels; electrical conductivity of 0.27 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; gradual smooth boundary; CaCO3 2.1 Percent.

Bt2 --- 29 to 72 centimeters (11.4 to 28.3 inches); yellowish brown (10YR 5/4) dry, sandy loam; brown (10YR 4/3) moist; 58 percent sand; 24 percent silt; 18 percent clay; moderate medium prismatic parting to strong medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common coarse roots, common medium roots, common fine roots and common very fine roots; common very fine tubular pores; 15 percent (few) clay films between sand grains and 35 percent (common) clay films on all faces of peds; 3 percent subangular sandstone gravels; electrical conductivity of 0.36 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; clear wavy boundary; CaCO3 1.4 Percent.

Btk1 --- 72 to 114 centimeters (28.3 to 44.9 inches); pale brown (10YR 6/3) dry, sandy clay loam; brown (10YR 5/3) moist; 50 percent sand; 26 percent silt; 24 percent clay; strong medium prismatic parting to strong medium angular blocky structure; friable, very hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 2 percent (very few) carbonate coats on bottom surfaces of rock fragments and 55 percent (many) clay films on all faces of peds; 12 percent (common) medium threadlike masses of carbonate in matrix; 5 percent subangular sandstone gravels; electrical conductivity of 0.33 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; gradual smooth boundary; CaCO3 5 Percent.

Btk2 --- 114 to 175 centimeters (44.9 to 68.9 inches); light brownish gray (10YR 6/2) dry, sandy clay loam; grayish brown (10YR 5/2) moist; 49 percent sand; 27 percent silt; 24 percent clay; moderate medium prismatic parting to moderate medium subangular blocky structure; friable, very hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 3 percent (very few) carbonate coats on bottom surfaces of rock fragments and 35 percent (common) clay films on all faces of peds; 22 percent (many) fine threadlike masses of carbonate in matrix; 10 percent subangular sandstone gravels; electrical conductivity of 0.29 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; CaCO3 7.9 Percent.

SOIL PROFILE DESCRIPTION 13SF10

Pedon ID: 13SF10
Description Date: 9/26/2013
Describer: Robert Long

Pedon Notes: Carbonates are sufficient in Bk for a calcic, because the percent clay is less than 18 percent.

Soil Name As Correlated: Trag family
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Typic Argiustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456295E, 4305489N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: mountain slope and mountain
Geomorphic Component: Lower third of mountainflank
Profile Pos: Backslope
Slope: 25 percent
Elevation: 2432 meters (7979 feet)
Aspect: 351°
Shape: up/down: Linear; **across:** Convex

Drainage: Well drained
Runoff: High
Erosion: Class 2 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: CEMOG - birchleaf mountain mahogany (*Cercocarpus montanus var. glaber*); AMUT - Utah serviceberry (*Amelanchier utahensis*); ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); JUSC2 - Rocky Mountain juniper (*Juniperus scopulorum*)

Surface Fragments: 10 percent subrounded sandstone gravels and 5 percent subrounded quartzite gravels
Parent Materials: slope alluvium derived from sandstone and shale over residuum weathered from calcareous sandstone
Particle Size Control Section: 13 to 63 centimeters (5.1 to 24.8 inches)

Diagnostic Features: Mollic epipedon: 0 to 34 centimeters (0 to 13.4 inches), Argillic horizon: 13 to 112 centimeters (5.1 to 44.1 inches), Secondary carbonates: 65 to 180 centimeters (25.6 to 70.9 inches) and Calcic horizon: 112 to 180 centimeters (44.1 to 70.9 inches)

A --- 0 to 13 centimeters (0 to 5.1 inches); brown (10YR 4/3) dry, loam; dark brown (10YR 3/3) moist; 44 percent sand; 34 percent silt; 22 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, slightly sticky, slightly plastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and many very fine roots throughout; common very fine tubular pores; 5 percent subrounded sandstone gravels; electrical conductivity of 0.29 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; neutral, pH 6.8, pH meter; clear wavy boundary; $CaCO_3$ 2.6 Percent.

Bt --- 13 to 34 centimeters (5.1 to 13.4 inches); brown (10YR 5/3) dry, clay loam; dark brown (10YR 3/3) moist; 22 percent sand; 47 percent silt; 31 percent clay; moderate medium prismatic parting to strong medium angular blocky structure; friable, hard, moderately sticky, moderately plastic; common very coarse roots throughout, common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 60 percent (many) clay films on all faces of peds; 2 percent subrounded sandstone gravels; electrical conductivity of 0.15 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly acid, pH 6.4, pH meter; gradual smooth boundary; $CaCO_3$ 2.2 Percent.

Bt --- 34 to 65 centimeters (13.4 to 25.6 inches); yellow (10YR 7/6) dry, clay loam; brownish yellow (10YR 6/6) moist; 26 percent sand; 43 percent silt; 31 percent clay; strong medium prismatic parting to strong medium angular blocky structure; friable, hard, moderately sticky, moderately plastic; common very coarse roots throughout, common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 70 percent (many) clay films on all faces of peds; electrical conductivity of 0.16 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly acid, pH 6.3, pH meter; clear smooth boundary; $CaCO_3$ 2.3 Percent.

Btk --- 65 to 112 centimeters (25.6 to 44.1 inches); very pale brown (10YR 7/4) dry, loam; yellowish brown (10YR 5/4) moist; 47 percent sand; 39 percent silt; 14 percent clay; moderate medium prismatic parting to strong medium angular blocky structure; friable, hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 45 percent (common) clay films on all faces of peds; 20 percent (many) fine threadlike masses of carbonate in matrix; 5 percent subrounded sandstone gravels; electrical conductivity of 0.26 mmhos/cm by EC meter, saturated paste; violently effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; clear smooth boundary; $CaCO_3$ 3.7 Percent.

Bk2 --- 112 to 180 centimeters (44.1 to 70.9 inches); light brownish gray (10YR 6/2) dry, extremely cobbly sand; grayish brown (10YR 5/2) moist; 88 percent sand; 9 percent silt; 3 percent clay; weak medium subangular blocky structure; friable, very hard, nonsticky, nonplastic; common very fine roots throughout; common very fine interstitial pores; 7 percent (few) carbonate coats on bottom surfaces of rock fragments; 25 percent (many) medium spherical masses of carbonate in matrix; 60 percent angular sandstone cobbles and 10 percent angular sandstone gravels; electrical conductivity of 0.24 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 8.1, pH meter; $CaCO_3$ 7.4 Percent.

SOIL PROFILE DESCRIPTION 13SF11

Pedon ID: 13SF11
Description Date: 9/26/2013
Describer: Robert Long

Soil Name As Correlated: Kunz family
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Typic Haplustalfs

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456204E, 4305565N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: valley
Landform: alluvial fan
Geomorphic Component: Mountainbase
Profile Pos: Toeslope
Slope: 12 percent
Elevation: 2407 meters (7897 feet)
Aspect: 290°
Shape: up/down: Linear; **across:** Linear

Drainage: Well drained
Runoff: Low
Erosion: Class 1 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRT - basin big sagebrush (*Artemisia tridentata ssp. tridentata*); POA - bluegrass (*Poa*); FESTU - fescue (*Festuca*); AGCR - crested wheatgrass (*Agropyron cristatum*); CHRYS9 - rabbitbrush (*Chrysothamnus*); SYOR2 - mountain snowberry (*Symphoricarpos oreophilus*)

Surface Fragments: none
Parent Materials: alluvium derived from sandstone and shale
Particle Size Control Section: 38 to 88 centimeters (15 to 34.6 inches)
Diagnostic Features: Argillic horizon: 38 to 155 centimeters (15 to 61 inches) and Secondary carbonates: 64 to 175 centimeters (25.2 to 68.9 inches)

A --- 0 to 18 centimeters (0 to 7.1 inches); pale brown (10YR 6/3) dry, loam; brown (10YR 4/3) moist; 50 percent sand; 34 percent silt; 16 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine interstitial pores; electrical conductivity of 0.35 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.4, pH meter; clear smooth boundary; CaCO3 3.1 Percent.

BA --- 18 to 38 centimeters (7.1 to 15 inches); pale brown (10YR 6/3) dry, loam; dark yellowish brown (10YR 4/4) moist; 46 percent sand; 36 percent silt; 18 percent clay; moderate medium subangular blocky structure; very friable, hard, slightly sticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; electrical conductivity of 0.31 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; clear smooth boundary; CaCO3 4 Percent.

Bt --- 38 to 64 centimeters (15 to 25.2 inches); brown (10YR 5/3) dry, loam; brown (10YR 4/3) moist; 44 percent sand; 34 percent silt; 22 percent clay; moderate medium prismatic parting to strong medium angular blocky structure; friable, hard, slightly sticky, slightly plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 55 percent (many) clay films on all faces of peds; electrical conductivity of 0.27 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; clear smooth boundary; CaCO3 2.6 Percent.

Btk1 --- 64 to 105 centimeters (25.2 to 41.3 inches); light brownish gray (10YR 6/2) dry, clay loam; grayish brown (10YR 5/2) moist; 36 percent sand; 34 percent silt; 30 percent clay; moderate medium prismatic parting to strong medium angular blocky structure; firm, very hard, moderately sticky, moderately plastic; common fine roots throughout and common very fine roots throughout; 65 percent (many) clay films on all faces of peds; 8 percent (common) fine threadlike masses of carbonate in matrix; electrical conductivity of 0.26 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; clear wavy boundary; CaCO3 5.2 Percent.

Btk2 --- 105 to 155 centimeters (41.3 to 61 inches); pale yellow (2.5Y 7/3) dry, loam; light olive brown (2.5Y 5/3) moist; 44 percent sand; 33 percent silt; 23 percent clay; moderate medium prismatic parting to moderate medium angular blocky structure; friable, very hard, slightly sticky, slightly plastic; common very fine roots throughout; 60 percent (many) clay films on all faces of peds; 15 percent (common) medium spherical masses of carbonate in matrix; electrical conductivity of 0.21 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; gradual smooth boundary; CaCO3 6.5 Percent.

Bk --- 155 to 175 centimeters (61 to 68.9 inches); pale yellow (2.5Y 7/3) dry, loam; light olive brown (2.5Y 5/3) moist; null percent sand; null percent silt; 25 percent clay; moderate medium subangular blocky structure; friable, hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 2 percent (very few) carbonate coats on bottom surfaces of rock fragments; 10 percent (common) medium spherical masses of carbonate in matrix; 5 percent subangular sandstone gravels; electrical conductivity of 0.51 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; $CaCO_3$ 8.2 Percent.

SOIL PROFILE DESCRIPTION 13SF12

Pedon ID: 13SF12
Description Date: 9/26/2013
Describer: Robert Long

Pedon Notes: This soil is similar to Chivers, but it does not have a mollic epipedon. Soil moisture appears to be perching on top of the 3Btk3 clay loam. There are no redox features in the 3Btk3 horizon.

Soil Name As Correlated: Chivers similar
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Oxyaquic Haplustalfs

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456105E, 4305560N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: valley
Geomorphic Component: Mountain base
Profile Pos: Toeslope
Slope: 3 percent
Elevation: 2397 meters (7864.2 feet)
Aspect: 326°
Shape: up/down: Linear; **across:** Concave

Drainage: Poorly drained
Runoff: Low
Erosion: None - deposition

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: AGCR - crested wheatgrass (*Agropyron cristatum*); CHRYS9 - rabbitbrush (*Chrysothamnus*); ARTRT - basin big sagebrush (*Artemisia tridentata ssp. tridentata*); SYOR2 - mountain snowberry (*Symphoricarpos oreophilus*)

Surface Fragments: none
Parent Materials: alluvium derived from sandstone and shale
Particle Size Control Section: 34 to 84 centimeters (13.4 to 33.1 inches)
Diagnostic Features: Aquic conditions: 15 to 145 centimeters (5.9 to 57.1 inches), Argillic horizon: 34 to 170 centimeters (13.4 to 66.9 inches) and Secondary carbonates: 60 to 170 centimeters (23.6 to 66.9 inches)

A --- 0 to 15 centimeters (0 to 5.9 inches); grayish brown (2.5Y 5/2) dry, silty clay loam; olive brown (2.5Y 4/3) moist; 18 percent sand; 48 percent silt; 34 percent clay; weak medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, moderately sticky, moderately plastic; common fine roots throughout and common very fine roots throughout; common very fine tubular pores; strongly effervescent by HCl, 1 normal; slightly alkaline, pH 7.5, pH meter; clear smooth boundary; $CaCO_3$ 8.8 Percent.

2BA --- 15 to 34 centimeters (5.9 to 13.4 inches); pale yellow (2.5Y 7/3) dry, sandy loam; light olive brown (2.5Y 5/3) moist; 56 percent sand; 26 percent silt; 18 percent clay; 5 percent fine prominent brownish yellow (10YR 6/6) mottles; moderate medium subangular blocky structure; very friable, slightly hard, nonsticky, slightly plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; slightly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; clear smooth boundary; $CaCO_3$ 4.5 Percent.

2Bt --- 34 to 60 centimeters (13.4 to 23.6 inches); pale yellow (2.5Y 7/4) dry, loam; light yellowish brown (2.5Y 6/4) moist; 46 percent sand; 33 percent silt; 21 percent clay; 12 percent medium prominent yellow (10YR 7/6) mottles; moderate medium prismatic parting to moderate medium single grain structure; friable, hard, slightly sticky, slightly plastic; common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 15 percent (few) clay films between sand grains and 30 percent (common) clay films on all faces of peds; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 8.1, pH meter; clear smooth boundary; $CaCO_3$ 4.7 Percent.

3Btk1 --- 60 to 90 centimeters (23.6 to 35.4 inches); pale brown (10YR 6/3) dry, loam; brown (10YR 5/3) moist; 42 percent sand; 32 percent silt; 26 percent clay; 10 percent medium distinct yellow (10YR 7/6) mottles; strong medium prismatic parting to strong medium angular blocky structure; firm, very hard, slightly sticky, slightly plastic; common fine roots throughout and common very fine roots throughout; 40 percent (common) clay films on all faces of peds; 4 percent (common) fine threadlike masses of carbonate in matrix; very slightly effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; gradual smooth boundary; $CaCO_3$ 4.5 Percent.

3Btk2 --- 90 to 145 centimeters (35.4 to 57.1 inches); brown (10YR 5/3) dry, silt loam; dark gray (10YR 4/1) moist; 28 percent sand; 55 percent silt; 17 percent clay; 5 percent fine prominent yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to strong medium angular blocky structure; friable, very hard, nonsticky, nonplastic; common fine roots throughout and common very fine roots throughout; 60 percent (many) clay films on all faces of peds; 12 percent (common) fine threadlike masses of carbonate in matrix; slightly effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; clear smooth boundary; $CaCO_3$ 2.5 Percent.

3Btk3 --- 145 to 170 centimeters (57.1 to 66.9 inches); pale brown (10YR 6/3) dry, clay loam; dark gray (10YR 4/1) moist; 33 percent sand; 38 percent silt; 29 percent clay; moderate medium subangular blocky structure; friable, very hard, slightly sticky, slightly plastic; common very fine roots throughout; common very fine tubular pores; 40 percent (common) clay films between sand grains; 6 percent (common) fine threadlike masses of carbonate in matrix; 5 percent subangular sandstone gravels; strongly effervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; $CaCO_3$ 3.1 Percent.

SOIL PROFILE DESCRIPTION 13SF13

Pedon ID: 13SF13
Description Date: 9/26/2013
Describer: Robert Long

Pedon Notes: Soil moisture appears to be perching on top of the hard shale bedrock. Redox mottles are present, but only a very limited amount. Shale bedrock was hard enough to make digging with a small backhoe difficult. Depth to bedrock will limit the amount of subsoil that can be salvaged in this area. The fine textured Btk makes this soil also similar to the Crow family. The average percent clay for the control section is 34.

Soil Name As Correlated: Trag family
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Typic Argiustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 455978E, 4305617N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: structural bench
Geomorphic Component: Mountainbase
Profile Pos: Footslope
Slope: 7 percent
Elevation: 2396 meters (7860.9 feet)
Aspect: 24°
Shape: up/down: Concave; **across:** Linear

Drainage: Somewhat poorly drained
Runoff: Medium
Erosion: Class 1 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); PUTR2 - antelope bitterbrush (*Purshia tridentata*); AGCR - crested wheatgrass (*Agropyron cristatum*)

Surface Fragments: 5 percent subrounded sandstone gravels
Parent Materials: residuum weathered from calcareous shale
Bedrock: Calcareous shale at 86 centimeters (33.9 inches)
Particle Size Control Section: 18 to 61 centimeters (7.1 to 24 inches)

Diagnostic Features: Mollic epipedon: 0 to 18 centimeters (0 to 7.1 inches), Argillic horizon: 18 to 61 centimeters (7.1 to 24 inches), Aquic conditions: 61 to 86 centimeters (24 to 33.9 inches), Secondary carbonates: 61 to 86 centimeters (24 to 33.9 inches) and Lithic contact: 86 to 101 centimeters (33.9 to 39.8 inches)
Restrictions: Lithic bedrock: 86 to 101 centimeters (33.9 to 39.8 inches)

A1 --- 0 to 8 centimeters (0 to 3.1 inches); brown (10YR 5/3) dry, sandy loam; dark brown (10YR 3/3) moist; 52 percent sand; 31 percent silt; 17 percent clay; weak medium platy parting to moderate medium granular structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and many very fine roots throughout; common very fine tubular pores; 5 percent subrounded sandstone gravels; electrical conductivity of 0.26 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; neutral, pH 6.7, pH meter; clear smooth boundary; CaCO3 0.9 Percent.

A2 --- 8 to 18 centimeters (3.1 to 7.1 inches); brown (10YR 5/3) dry, loam; dark brown (10YR 3/3) moist; 45 percent sand; 44 percent silt; 11 percent clay; weak medium subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 5 percent subrounded sandstone gravels; electrical conductivity of 0.24 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; neutral, pH 7, pH meter; clear smooth boundary; CaCO3 1.1 Percent.

Bt --- 18 to 40 centimeters (7.1 to 15.7 inches); yellow (10YR 7/6) dry, clay loam; light yellowish brown (10YR 6/4) moist; 32 percent sand; 38 percent silt; 30 percent clay; strong medium prismatic parting to strong medium angular blocky structure; firm, very hard, moderately sticky, moderately plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 70 percent (many) clay films; electrical conductivity of 0.33 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; neutral, pH 7.3, pH meter; clear wavy boundary; CaCO3 1.7 Percent.

Btk --- 40 to 61 centimeters (15.7 to 24 inches); 98 percent pale yellow (2.5Y 7/3) dry and 2 percent yellow (10YR 7/6) dry, clay loam; 98 percent light olive brown (2.5Y 5/3) moist and 2 percent light yellowish brown (10YR 6/4) moist; 30 percent sand; 31 percent silt; 39 percent clay; moderate medium prismatic parting to strong medium angular blocky structure; firm, very hard, very sticky, very plastic; common very fine roots throughout; common very fine tubular pores; 60 percent (many) clay films; 5 percent (common) fine masses of carbonate in matrix; electrical conductivity of 0.22 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; thin discontinuous coatings of soil from the overlying Bt horizon cover about 2 percent of the ped surface area in the Btk; clear smooth boundary; CaCO3 6.9 Percent.

Bk --- 61 to 86 centimeters (24 to 33.9 inches); white (2.5Y 8/1) dry, clay loam; light brownish gray (2.5Y 6/2) moist; 34 percent sand; 31 percent silt; 35 percent clay; 2 percent fine prominent brownish yellow (10YR 6/6) mottles (moist); moderate medium subangular blocky structure; friable, very hard, moderately sticky, moderately plastic; common very fine roots throughout; 25 percent (many) coarse masses of carbonate in matrix; electrical conductivity of 0.26 mmhos/cm by EC meter, saturated paste; violently effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; clear smooth boundary; $CaCO_3$ 12 Percent.

R --- 86 to 101 centimeters (33.9 to 39.8 inches); Hard Shale.

SOIL PROFILE DESCRIPTION 13SF14

Pedon ID: 13SF14
Description Date: 9/26/2013
Describer: Robert Long

Site Notes: Text: Sandstone outcrop

UTM: 455913E, 4305681N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: structural bench

SOIL PROFILE DESCRIPTION 13SF15

Pedon ID: 13SF15
Description Date: 10/3/2013
Describer: Robert Long

Soil Name As Correlated: Trag family
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Typic Argiustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456114E, 4306231N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: mountain slope
Geomorphic Component: Upper third of mountainflank
Profile Pos: Shoulder
Slope: 34 percent
Elevation: 2460 meters (8070.9 feet)
Aspect: 144°
Shape: up/down: Convex; **across:** Convex

Drainage: Well drained
Runoff: High
Erosion: Class 3 - Rill erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); PUTR2 - antelope bitterbrush (*Purshia tridentata*); ELLAL - thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*); POSE - Sandberg bluegrass (*Poa secunda*); FESTU - fescue (*Festuca*); BASA3 - arrowleaf balsamroot (*Balsamorhiza sagittata*); JUOS - Utah juniper (*Juniperus osteosperma*); CHRYS9 - rabbitbrush (*Chrysothamnus*); QUGA - Gambel oak (*Quercus gambelii*); OPUNT - pricklypear (*Opuntia*)

Surface Fragments: 2 percent subangular sandstone gravels, 2 percent subangular sandstone cobbles, and 2 percent subangular sandstone stones.
Parent Materials: residuum weathered from sandstone
Particle Size Control Section: 21 to 71 centimeters (8.3 to 28 inches)
Diagnostic Features: Mollic epipedon: 0 to 21 centimeters (0 to 8.3 inches), Argillic horizon: 21 to 102 centimeters (8.3 to 40.2 inches) and Secondary carbonates: 52 to 102 centimeters (20.5 to 40.2 inches)

A --- 0 to 21 centimeters (0 to 8.3 inches); grayish brown (10YR 5/2) dry, sandy loam; very dark grayish brown (10YR 3/2) moist; 56 percent sand; 28 percent silt; 16 percent clay; moderate medium subangular blocky parting to moderate medium granular structure; very friable, hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; noneffervescent by HCl, 1 normal; neutral, pH 7.3, pH meter; clear smooth boundary; CaCO3 1 Percent.

Bt --- 21 to 52 centimeters (8.3 to 20.5 inches); brown (10YR 5/3) dry, loam; dark grayish brown (10YR 4/2) moist; 46 percent sand; 33 percent silt; 21 percent clay; strong medium prismatic parting to strong medium angular blocky structure; friable, very hard, slightly sticky, slightly plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 70 percent (many) clay films on all faces of peds; noneffervescent by HCl, 1 normal; neutral, pH 7, pH meter; gradual smooth boundary; CaCO3 1.1 Percent.

Btk --- 52 to 102 centimeters (20.5 to 40.2 inches); pale brown (10YR 6/3) dry, loam; brown (10YR 4/3) moist; 44 percent sand; 31 percent silt; 25 percent clay; moderate medium prismatic parting to strong medium subangular blocky structure; friable, very hard, slightly sticky, slightly plastic; common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 40 percent (common) clay films on all faces of peds; 3 percent (common) fine masses of carbonate in matrix; very slightly effervescent by HCl, 1 normal; neutral, pH 6.6, pH meter; CaCO3 1.3 Percent.

SOIL PROFILE DESCRIPTION 13SF16

Pedon ID: 13SF16
Description Date: 10/3/2013
Describer: Robert Long

Soil Name As Correlated: Helper family
Current Taxonomic Class: Fine-loamy, mixed, superactive, frigid Typic Haplustepts

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456144E, 4306183N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 South, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: mountain slope
Geomorphic Component: Upper third of mountainflank
Profile Pos: Backslope
Slope: 31 percent
Elevation: 2440 meters (8005.2 feet)
Aspect: 127°
Shape: up/down: Convex; **across:** Convex

Drainage: Well drained
Runoff: High
Erosion: Class 2 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); PUTR2 - antelope bitterbrush (*Purshia tridentata*); ELLAL - thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*); ACHY - Indian ricegrass (*Achnatherum hymenoides*); AMUT - Utah serviceberry (*Amelanchier utahensis*); JUOS - Utah juniper (*Juniperus osteosperma*); CHRYS9 - rabbitbrush (*Chrysothamnus*); OPUNT - pricklypear (*Opuntia*)

Surface Fragments: 15 percent subangular sandstone gravels, 5 percent subangular sandstone cobbles, 10 percent subangular sandstone, 5 percent subangular sandstone boulders, 5 percent subangular sandstone channers, and 10 percent subangular sandstone flagstones.
Parent Materials: colluvium derived from sandstone and shale over residuum weathered from calcareous sandstone
Bedrock: Sandstone
Particle Size Control Section: 25 to 72 centimeters (9.8 to 28.3 inches)

Diagnostic Features: Cambic horizon: 11 centimeters (4.3 inches) and Lithic contact: 72 centimeters (28.3 inches)
Restrictions: Lithic bedrock: 72 centimeters (28.3 inches)

A --- 0 to 11 centimeters (0 to 4.3 inches); light yellowish brown (2.5Y 6/3) dry, loam; light olive brown (2.5Y 5/3) moist; 42 percent sand; 34 percent silt; 24 percent clay; moderate medium platy parting to moderate medium granular structure; very friable, hard, slightly sticky, slightly plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 1 percent subangular sandstone boulders, 10 percent subangular sandstone stones, 2 percent subangular sandstone cobbles and 10 percent subangular sandstone gravels; electrical conductivity of 0.21 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; clear smooth boundary; CaCO3 1.5 Percent.

Bw --- 11 to 29 centimeters (4.3 to 11.4 inches); light yellowish brown (2.5Y 6/4) dry, sandy clay loam; light olive brown (2.5Y 5/4) moist; 54 percent sand; 22 percent silt; 24 percent clay; moderate medium prismatic structure; friable, hard, slightly sticky, slightly plastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 45 percent (common) clay films on all faces of peds; 5 percent subangular sandstone gravels; electrical conductivity of 0.27 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.4, pH meter; abrupt smooth boundary; CaCO3 1 Percent.

2C --- 29 to 72 centimeters (11.4 to 28.3 inches); pale yellow (2.5Y 8/2) dry, sandy loam; light gray (2.5Y 7/2) moist; 76 percent sand; 12 percent silt; 12 percent clay; single grain and massive; loose, soft, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; many very fine interstitial pores; electrical conductivity of 0.22 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; clear smooth boundary; CaCO3 0.6 Percent.

2R --- 72 centimeters (28.3 inches); Sandstone.

SOIL PROFILE DESCRIPTION 13SF17

Pedon ID: 13SF17
Description Date: 10/3/2013
Describer: Robert Long

Soil Name As Correlated: Veatch family
Current Taxonomic Class: Loamy-skeletal, mixed, superactive, frigid Typic Haplustolls

County or Parish: UT041 - Sevier
State or Territory: UT - Utah
UTM: 456518E, 4305807N -- Datum NAD83, Zone 12
Legal Description: Section 18, Township 22 south, Range 4 East of the 29 Meridian

Landscape: mountains
Landform: structural bench
Geomorphic Component: Mountaintop
Profile Pos: Shoulder
Slope: 27 percent
Elevation: 2465 meters (8087.3 feet)
Aspect: 341°
Shape: up/down: Convex; **across:** Linear

Drainage: Well drained
Runoff: Low
Erosion: Class 1 - Sheet erosion

Primary Earth Cover: Shrubby rangeland
Existing Vegetation: AMUT - Utah serviceberry (*Amelanchier utahensis*); ARTRV - mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*); ELLAL - thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*); SYOR2 - mountain snowberry (*Symphoricarpos oreophilus*); QUGA - Gambel oak (*Quercus gambelii*)

Surface Fragments: 10 percent subangular sandstone gravels and 5 percent subangular sandstone channers
Parent Materials: residuum weathered from sandstone
Bedrock: Sandstone at 57 centimeters (22.4 inches)
Particle Size Control Section: 25 to 57 centimeters (9.8 to 22.4 inches)
Diagnostic Features: Mollic epipedon: 0 to 18 centimeters (0 to 7.1 inches), Cambic horizon: 18 to 32 centimeters (7.1 to 12.6 inches) and Lithic contact: 57 centimeters (22.4 inches)
Restrictions: Lithic bedrock: 57 centimeters (22.4 inches)

A --- 0 to 18 centimeters (0 to 7.1 inches); brown (10YR 5/3) dry, gravelly sandy loam; dark brown (10YR 3/3) moist; 54 percent sand; 35 percent silt; 11 percent clay; moderate medium subangular blocky parting to moderate medium granular structure; very friable, slightly hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine tubular pores; 5 percent subangular sandstone channers and 10 percent subangular sandstone gravels; electrical conductivity of 0.37 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; clear smooth boundary; $CaCO_3$ 3.1 Percent.

Bw --- 18 to 32 centimeters (7.1 to 12.6 inches); pale brown (10YR 6/3) dry, very channery sandy loam; brown (10YR 4/3) moist; 60 percent sand; 30 percent silt; 10 percent clay; structure; very friable, slightly hard, nonsticky, nonplastic; common coarse roots throughout, common medium roots throughout, common fine roots throughout and common very fine roots throughout; common very fine interstitial pores; 15 percent subangular sandstone flagstones and 40 percent subangular sandstone channers; electrical conductivity of 0.36 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.4, pH meter; clear smooth boundary; $CaCO_3$ 1.2 Percent.

C --- 32 to 57 centimeters (12.6 to 22.4 inches); very pale brown (10YR 7/4) dry, very flaggy loamy sand; yellowish brown (10YR 5/4) moist; 77 percent sand; 18 percent silt; 5 percent clay; single grain and massive; very friable, hard, nonsticky, nonplastic; common very fine roots throughout; common very fine interstitial pores; 30 percent subangular sandstone flagstones and 25 percent sandstone channers; electrical conductivity of 0.23 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; abrupt smooth boundary; $CaCO_3$ 1.2 Percent.

R --- 57 centimeters (22.4 inches); Castlegate Sandstone.

Appendix B

Soil Profile and Location Photographs

Photo B - 1. Soil profile location 13SF01, Wiggler family, looking upslope to the northwest.

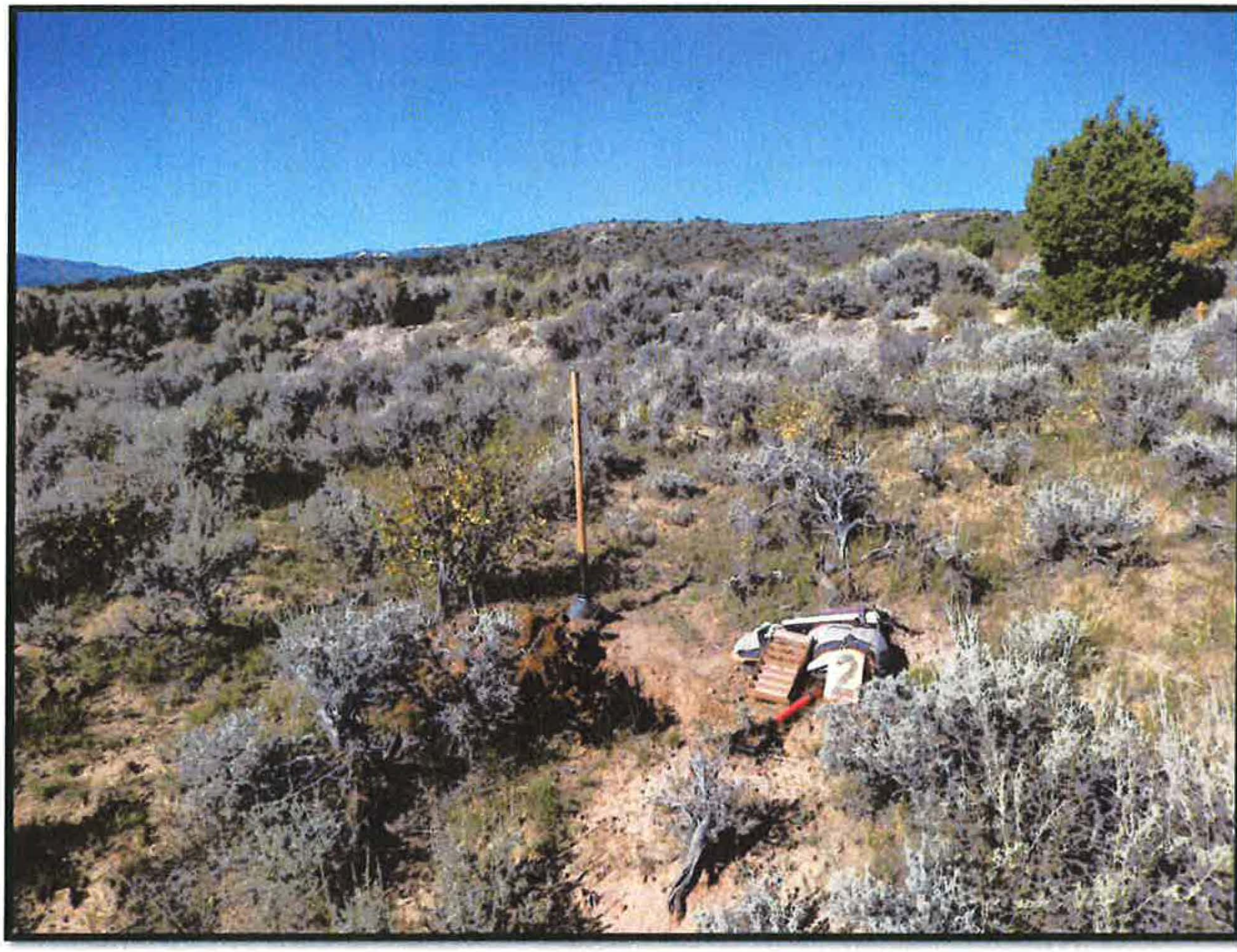

Photo B - 2. Soil profile location 13SF02, Boyett family, looking north.

Photo B - 3. Soil profile location 13SF03, Kunz family, looking south southeast.

Photo B - 4. Soil profile 13SF03, Kunz family.

Photo B - 5. Soil profile 13SF04, Zillion family.

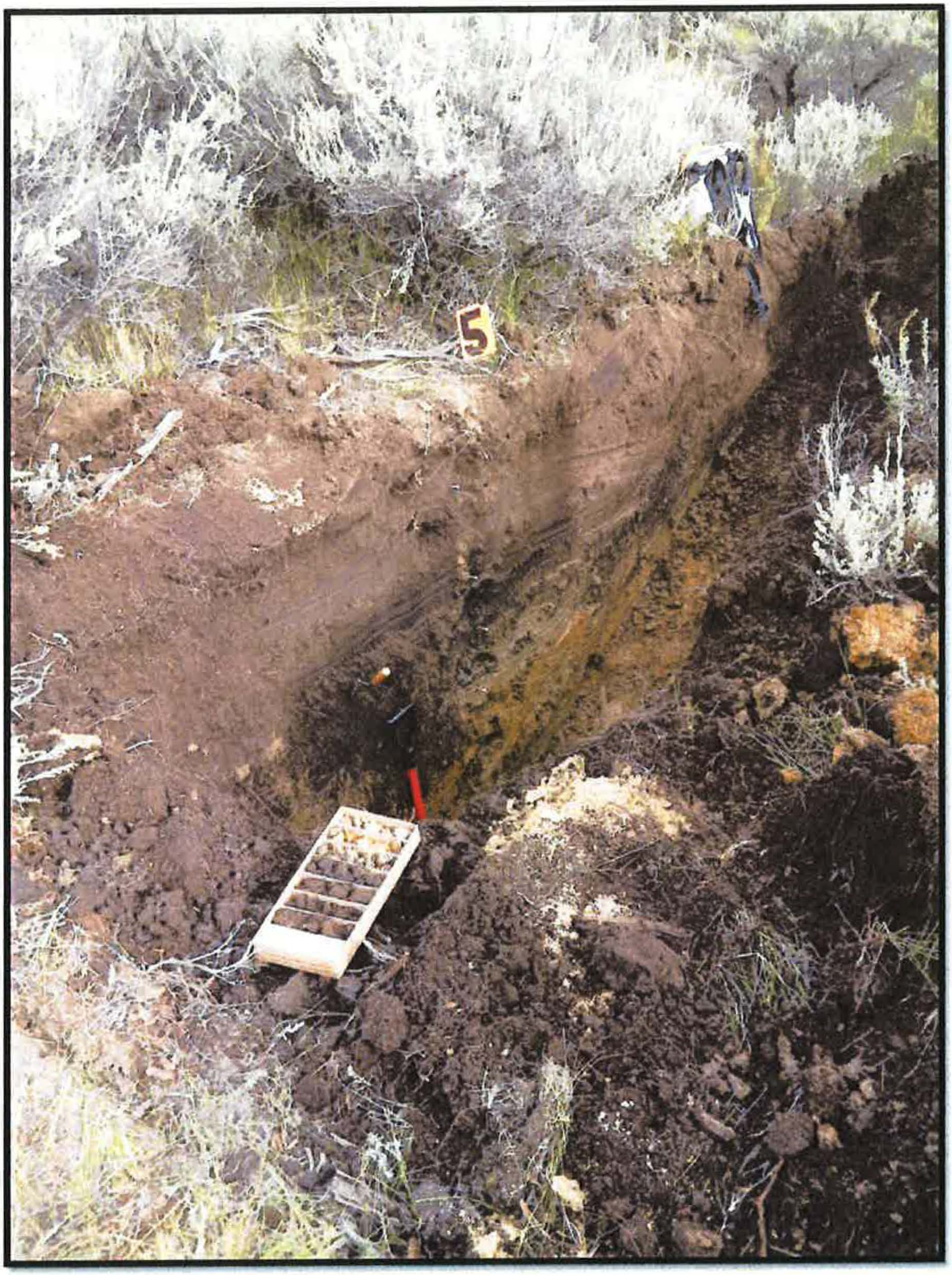

Photo B - 6. Soil profile 13SF05, Chivers family.

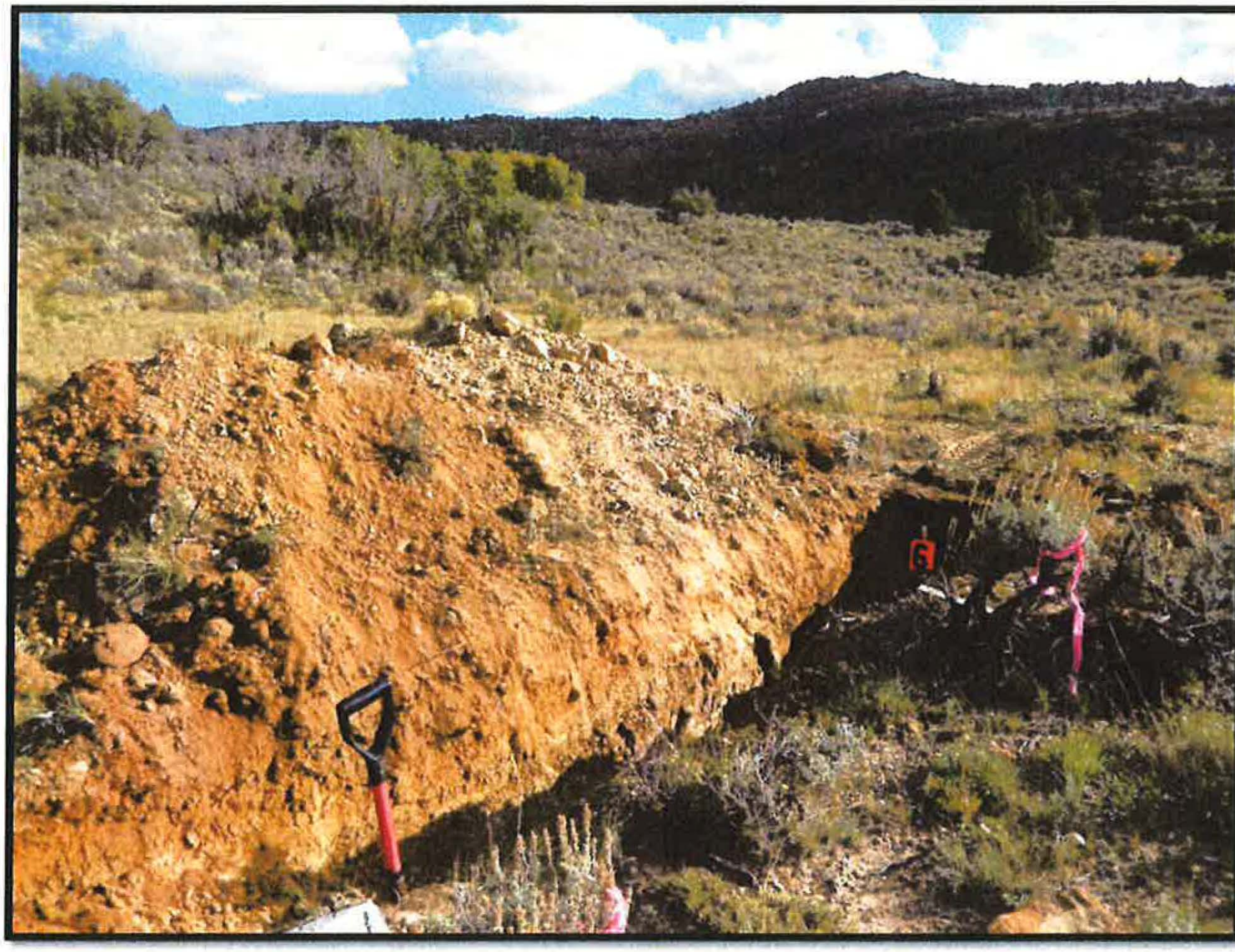

Photo B - 7. Soil profile location 13SF06, Crow family, looking south southeast.

Photo B - 8. Soil profile 13SF06, Crow family. Small amounts of soil from the BA horizon has migrated into the Bt horizon (upper argillic) when the soil dries and cracks, resulting in thin discontinuous coatings on peds in the Bt.

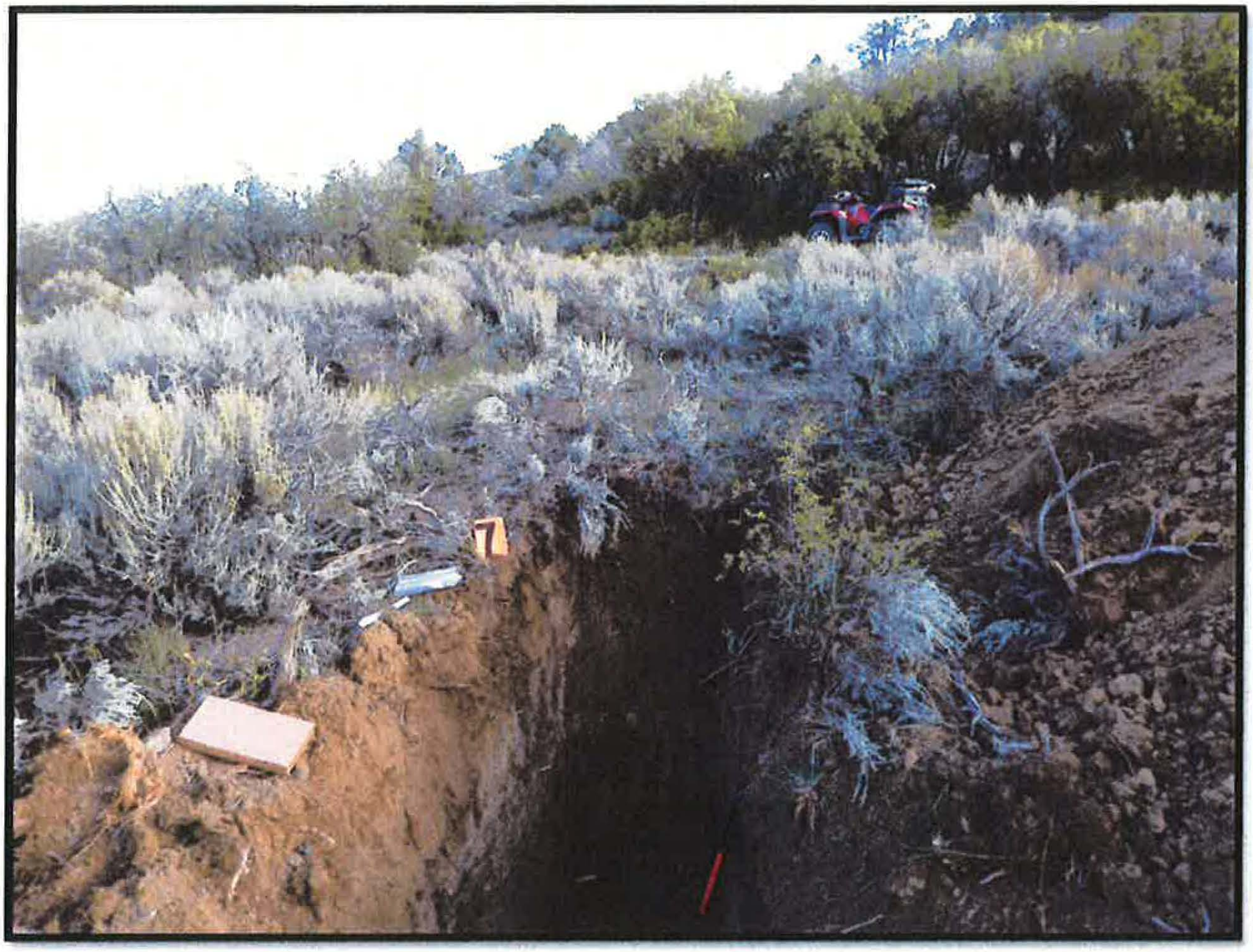

Photo B - 9. Soil profile location 13SF07, Trag family, looking north.

Photo B - 10. Soil profile 13SF07, Trag family.

Photo B - 11. Soil profile location 13SF08, Tuntsa family, looking upslope to the east.

Photo B - 12. Soil profile 13SF08, Tuntsa family. Large boulders are on the lower left and right in photo (scrap marks on rock from backhoe).

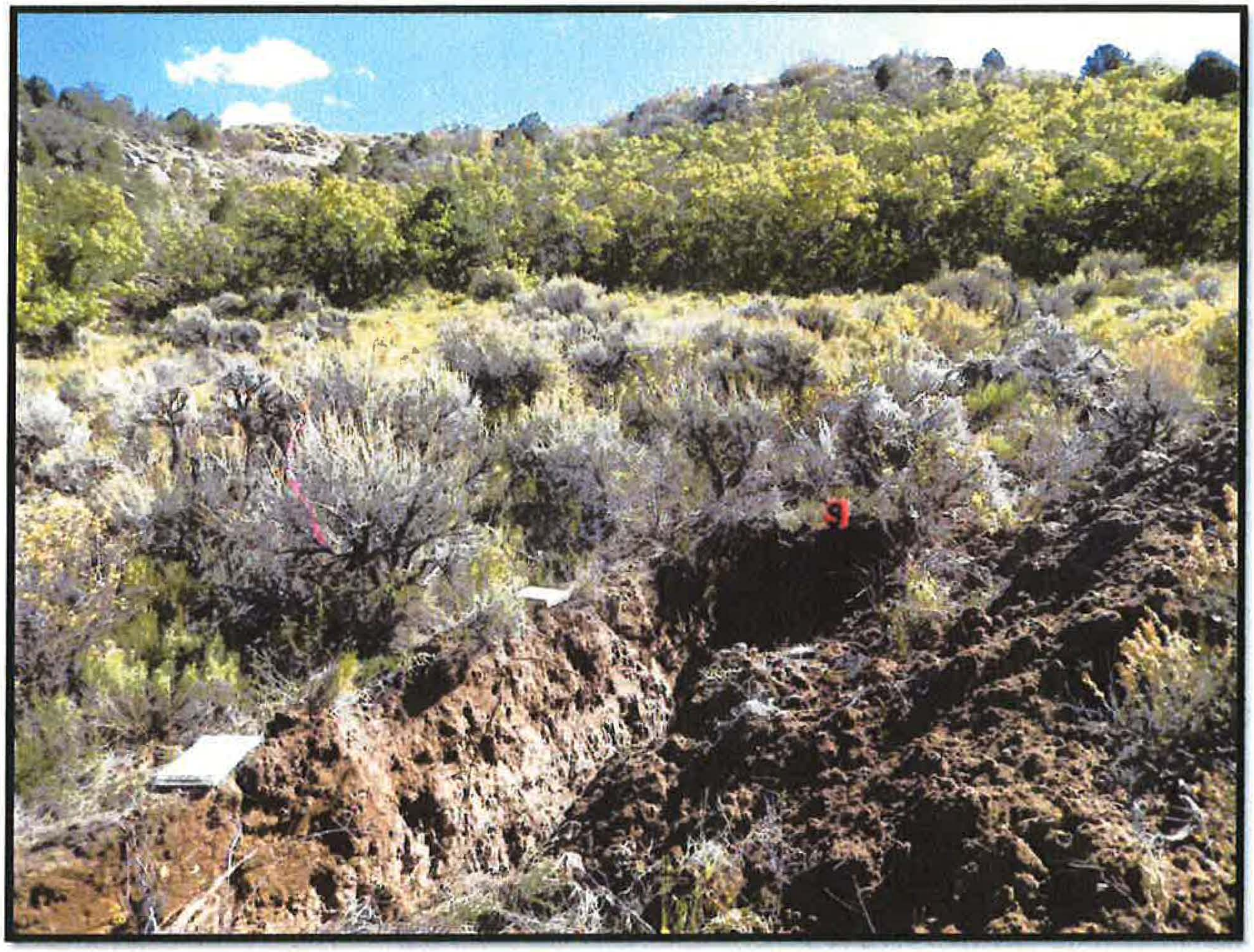

Photo B - 13. Soil profile location 13SF09, Trag family, looking upslope to the east. Soil profile location 13SF08 is in Gambel oak beyond sagebrush.

Photo B - 14. Soil profile 13SF09, Trag family.

Photo B - 15. Soil profile location 13SF10, Trag family, looking upslope to the south.

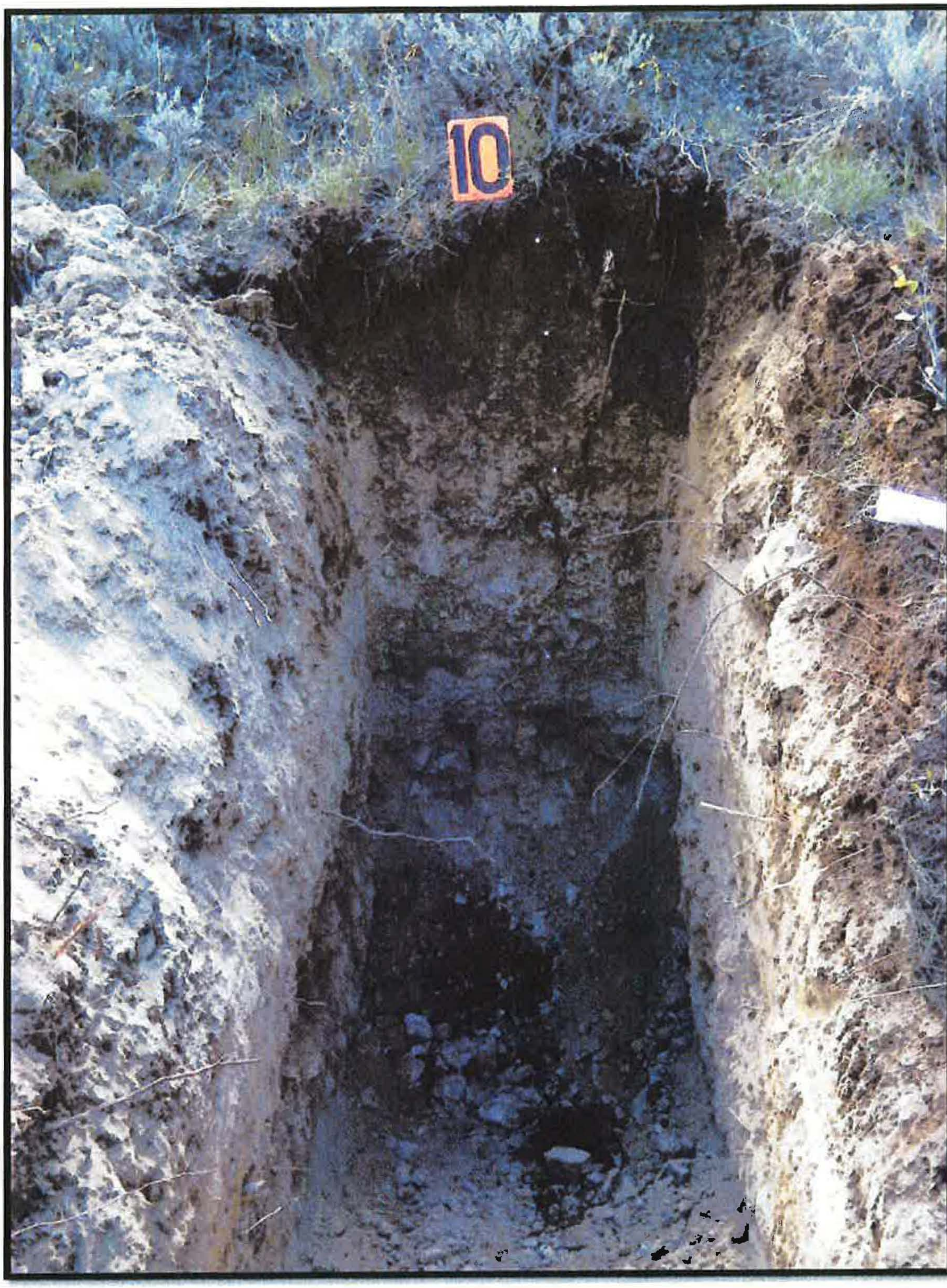

Photo B - 16. Soil profile 13SF10, Trag family.

Photo B - 17. Soil profile location 13SF11, Kunz family, looking west.

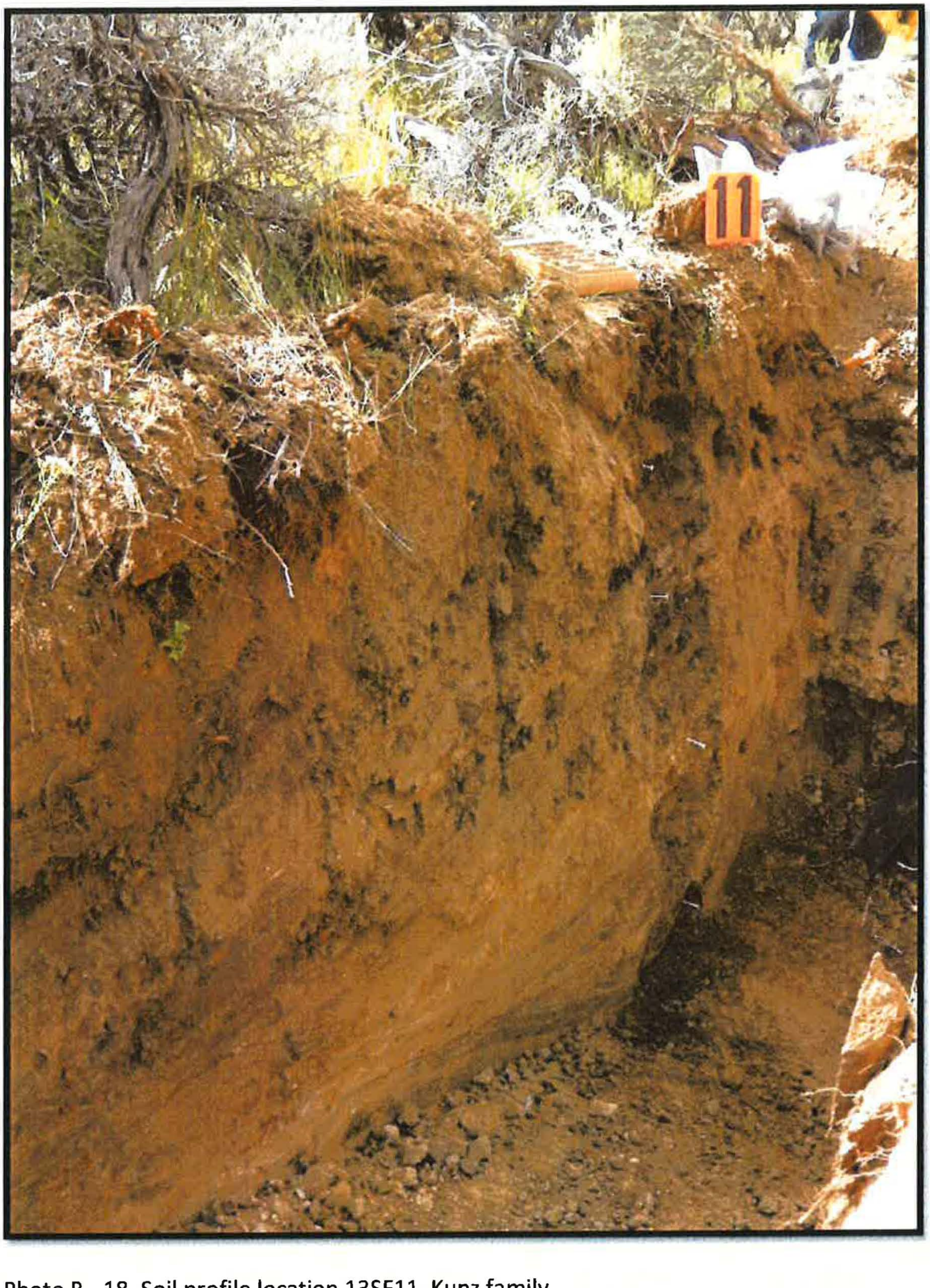

Photo B - 18. Soil profile location 13SF11, Kunz family.

Photo B - 19. Soil profile location 13SF12, Chivers family similar, looking southwest.

Photo B - 20. Soil profile 13SF12, Chivers family similar.

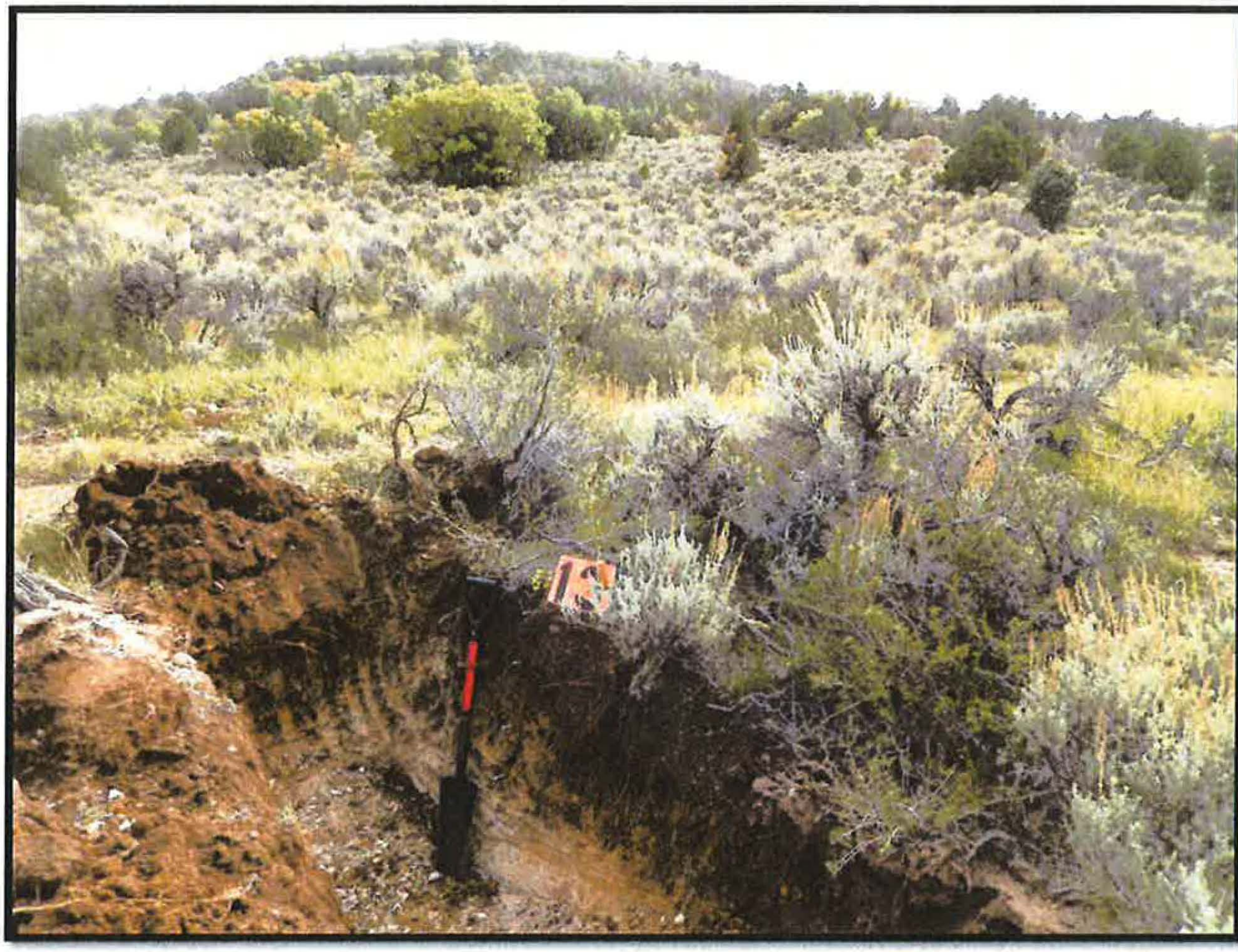

Photo B - 21. Soil profile location 13SF13, Trag family, looking south.

Photo B - 22. Soil profile 13SF13, Trag family.

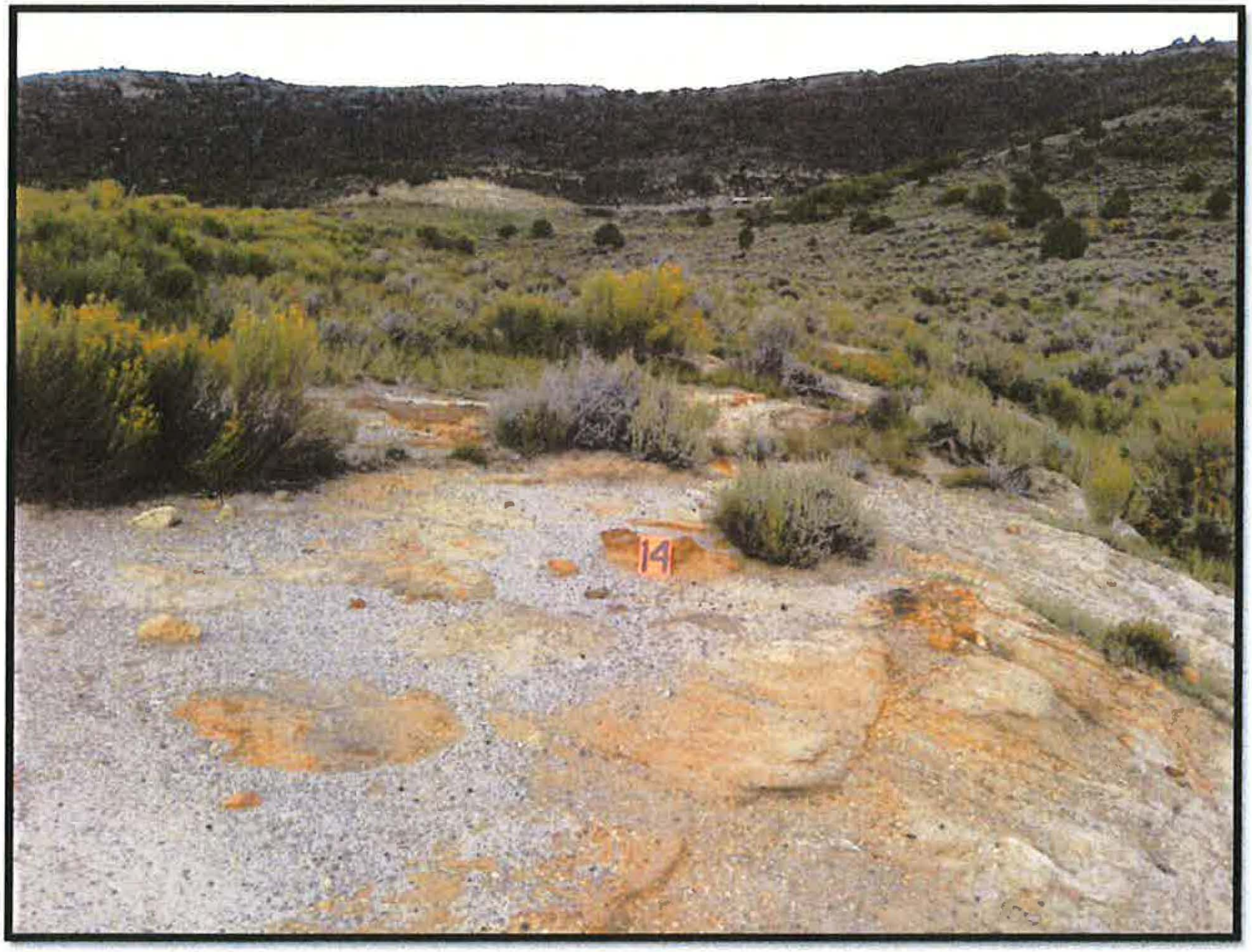

Photo B - 23. Soil profile location 13SF14, sandstone outcrop.

Photo B - 24. Soil profile location 13SF15, Trag family, looking upslope to the north.

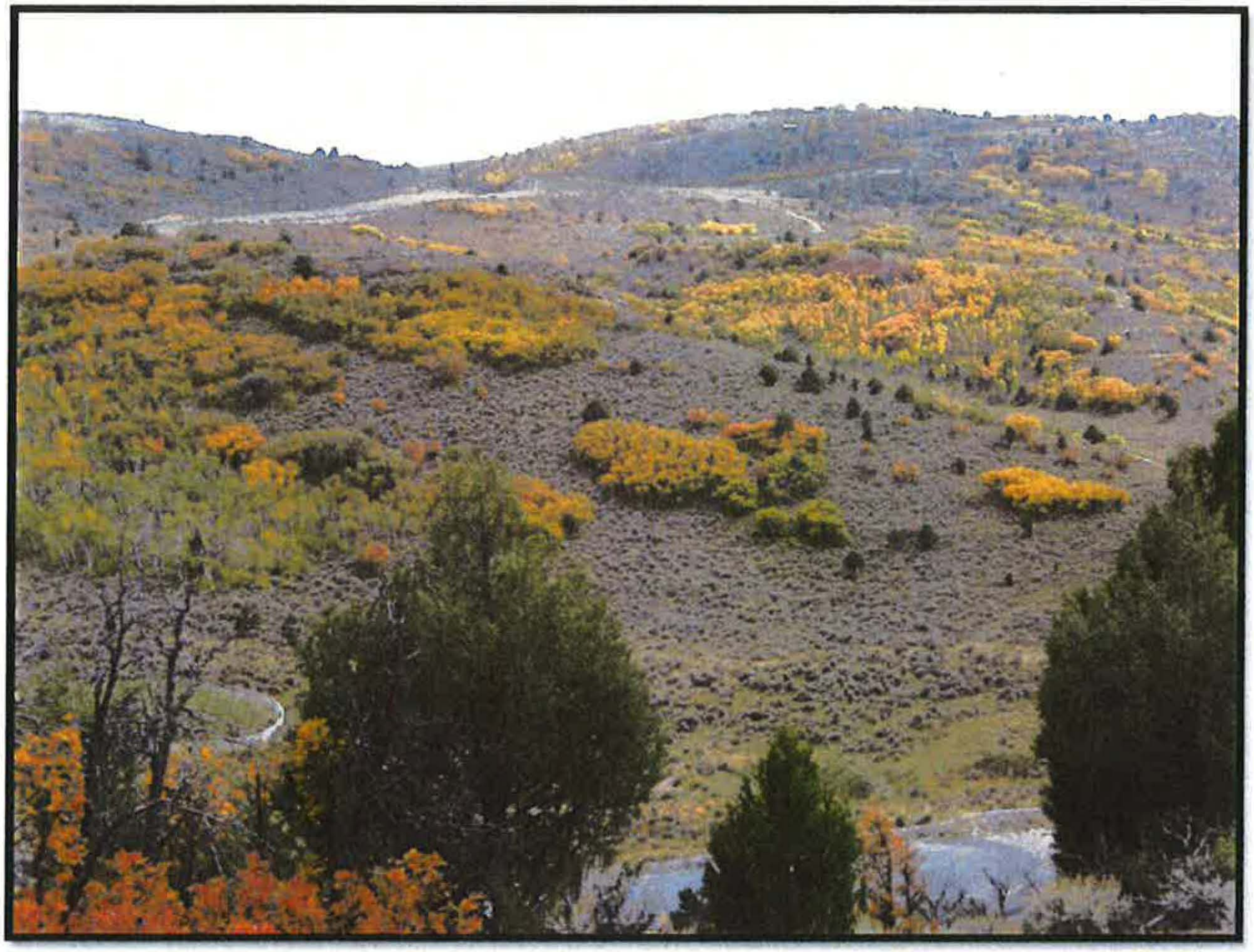

Photo B - 25. Looking east southeast from soil profile location 13SF15. Convulsion Canyon road is in lower foreground. Profile 13SF04, Zillion family, was located in aspen on left. Profile 13SF05, Chivers family was located in basin big sage on valley bottom between hillslope and roadway. Profile 13SF08, Tuntsa family, was located in Gambel oak to the right of center.

Photo B - 26. Looking southeast from profile location 13SF15.

Photo B - 27. Soil profile location 13SF16, Helper family, looking north.

Photo B - 28. Soil profile location 13SF17, Veatch family, looking east southeast.

Appendix C

Soil Profile Box Photos

Photo C - 1. Soil profile 13SF01, Wiggler family,

Typic Ustorthent loamy, mixed superactive, calcareous, frigid, shallow.

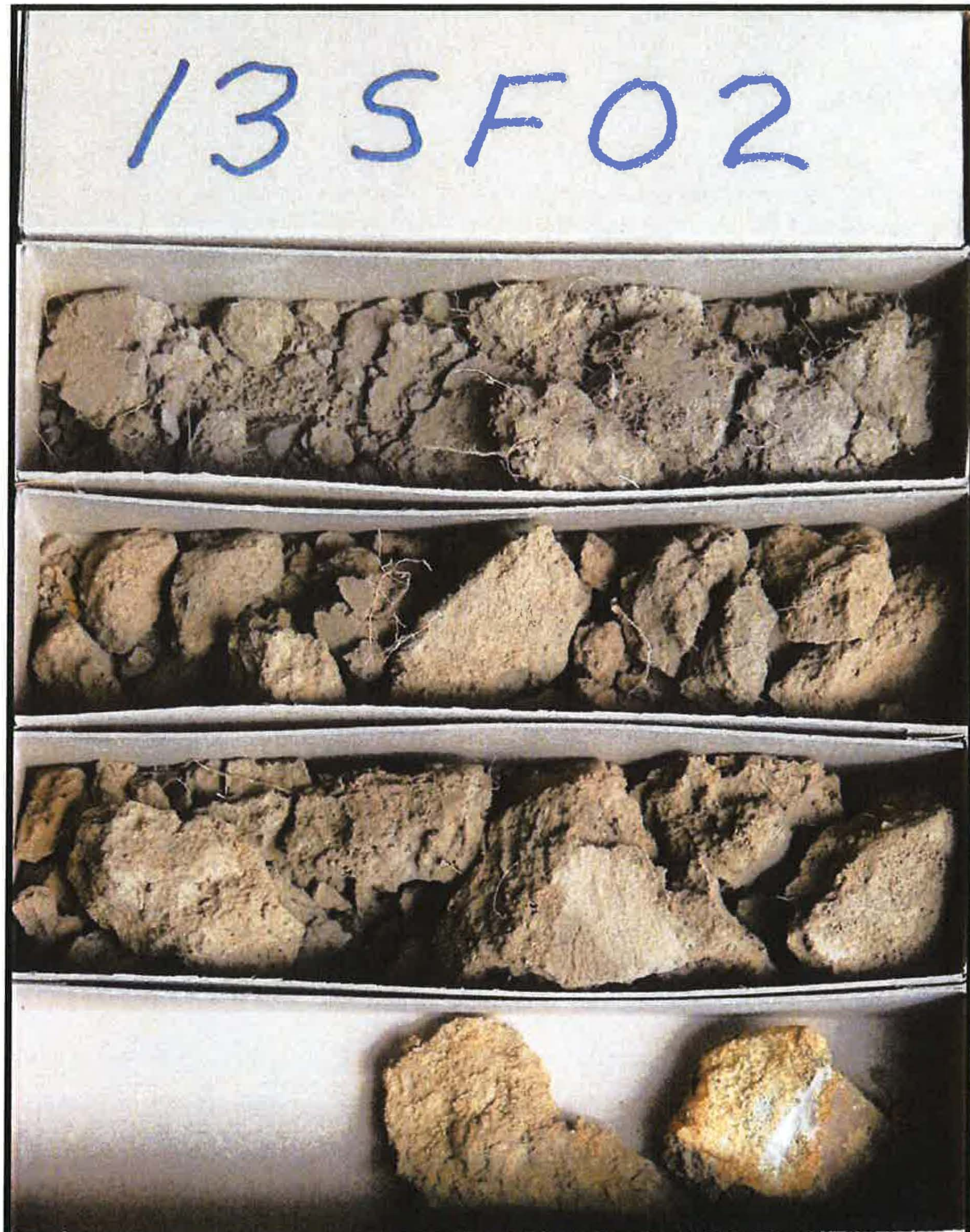

Photo C - 2. Soil profile 13SF02, Boyett family

Typic Haplustalf coarse-loamy, mixed, superactive, frigid

Photo C - 3. Soil profile 13SF03, Kunz family

Typic Haplustalf fine-loamy, mixed, superactive, frigid

Photo C - 4. Soil profile 13SF04, Zillion family

Pachic Argiustoll loamy-skeletal, mixed, superactive, frigid

Photo C - 5. Soil profile 13SF05, Chivers family

Oxyaquic Argiustoll fine-loamy, mixed, superactive, frigid

Redox mottles are present in Bt2, Bt3, and Bt4 (bottom 3 trays).

Photo C - 6. Soil profile 13SF06, Crow family

Typic Haplustalf fine, mixed, superactive, frigid

Thin discontinuous coatings of soil from BA horizon (second tray from top) are on peds in Bt horizon (third tray from top).

Photo C - 7. Soil profile 13SF07, Trag family

Typic Argiustoll, fine-loamy, mixed, superactive, frigid

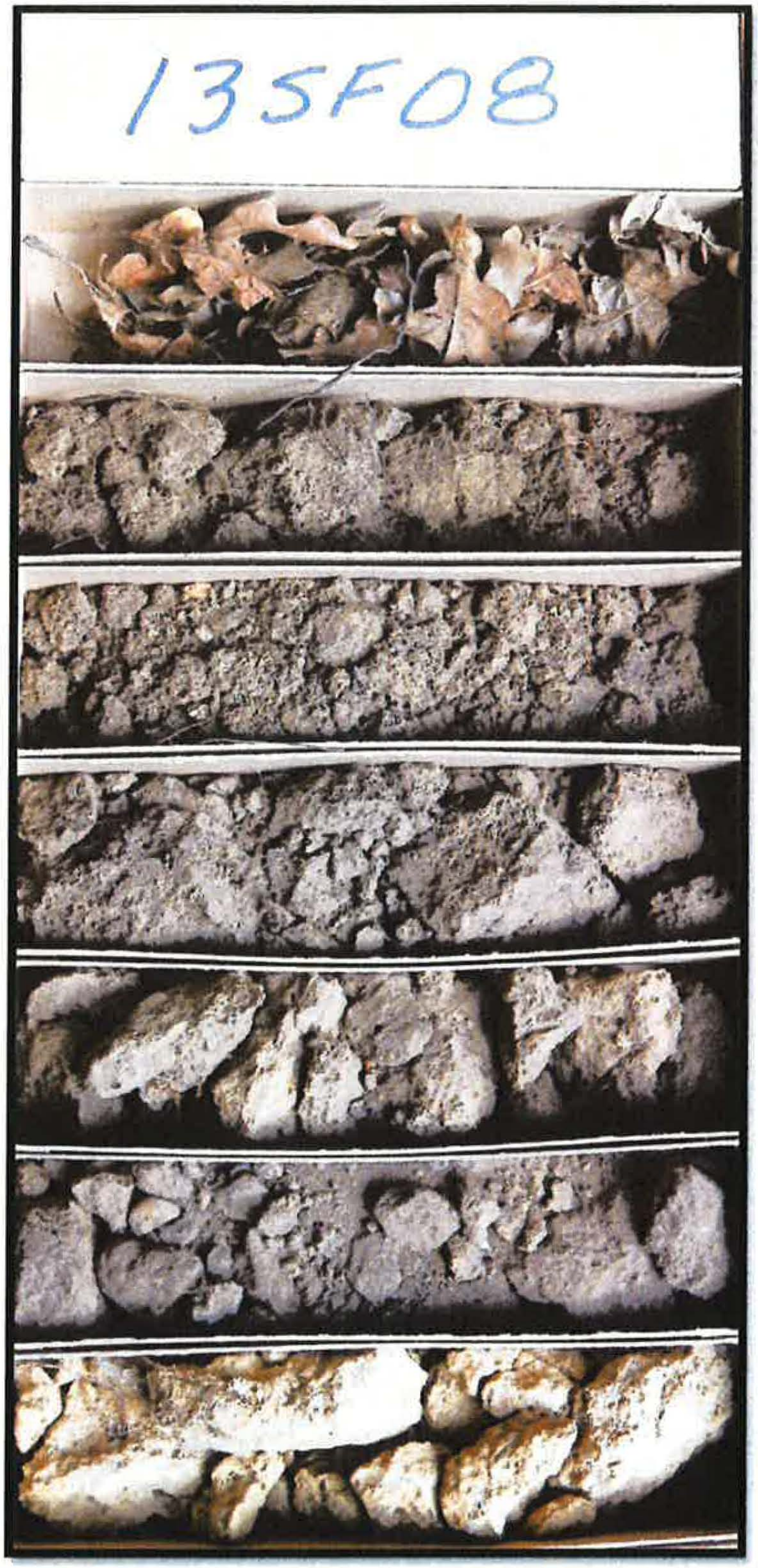

Photo C - 8. Soil profile 13SF08, Tuntsa family

Pachic Haplustoll coarse-loamy, mixed, superactive, frigid

Photo C - 9. Soil profile 13SF09, Trag family

Typic Argiustoll, fine-loamy, mixed, superactive, frigid

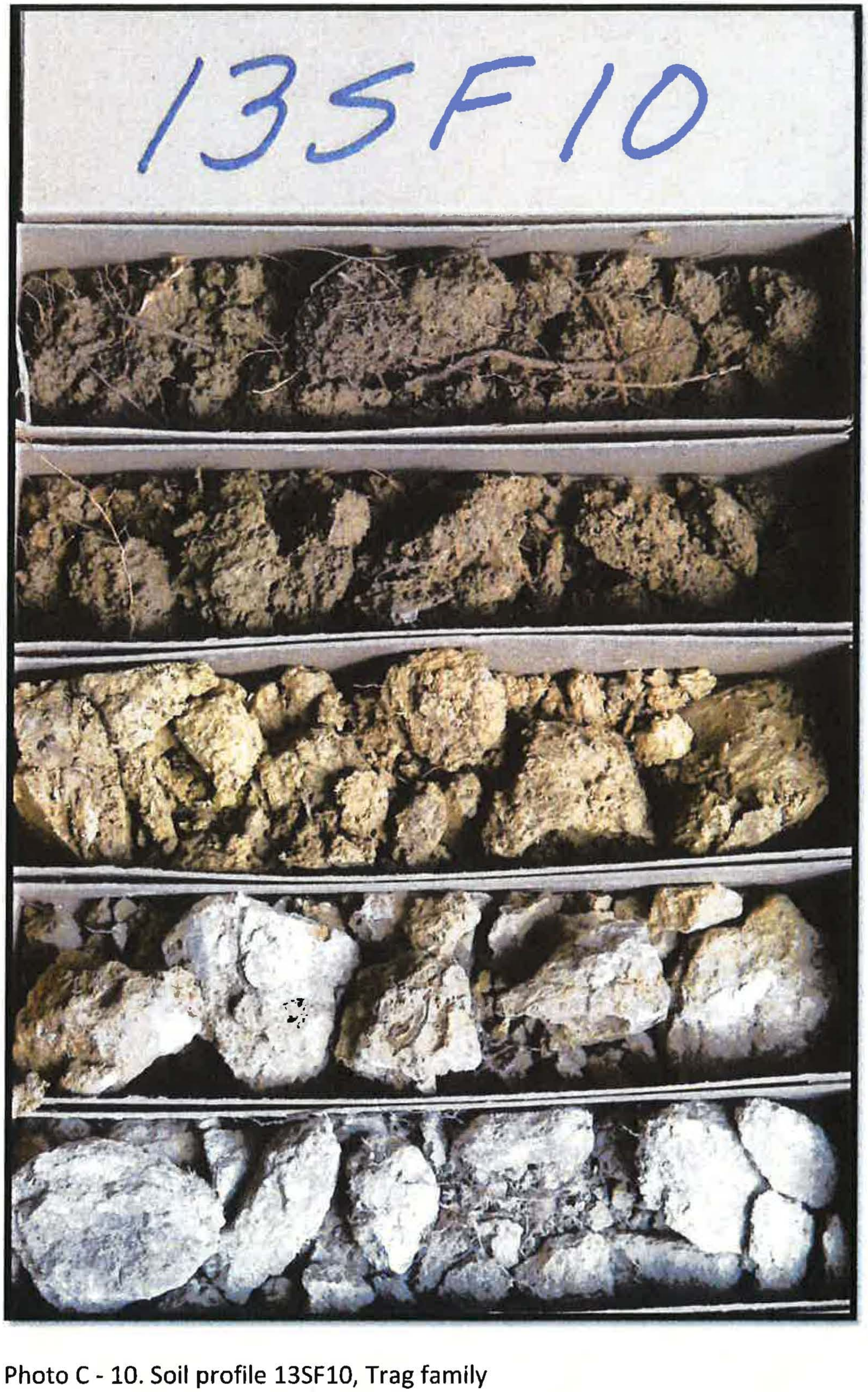

Photo C - 10. Soil profile 13SF10, Trag family

Typic Argiustoll, fine-loamy, mixed, superactive, frigid

Photo C - 11. Soil profile 13SF11, Kunz family

Typic Haplustalf fine-loamy, mixed, superactive, frigid

Photo C - 12. Soil profile 13SF12, Chivers family similar

Oxyaquic Haplustalf fine-loamy, mixed, superactive, frigid

Redox mottles were observed in the 2BA, 2Bt, 3BTk1, and Btk2 horizons (trays 2 thru 4).

Photo C - 13. Soil profile 13SF13, Trag family

Typic Argiustoll fine-loamy, mixed, superactive, frigid

Peds in the 2Btk horizon (tray 4 from the top) are covered with a few thin discontinuous coatings from the overlying 2Bt horizon.

A few redox mottles (2 percent or less) were observed in the 2Bk horizon (tray 5 from the top) due to soil moisture perching on top of the underlying shale (tray 5).

Photo C - 14. Soil profile location 13SF14 was sandstone outcrop. No box sample collected or photo available.

Photo C - 15. Soil Profile 13SF15, Trag family

Typic Argiustoll fine-loamy, mixed, superactive, frigid

Photo C - 16. Soil profile 13SF16, Helper family

Typic Haplustept fine-loamy, mixed, superactive, frigid

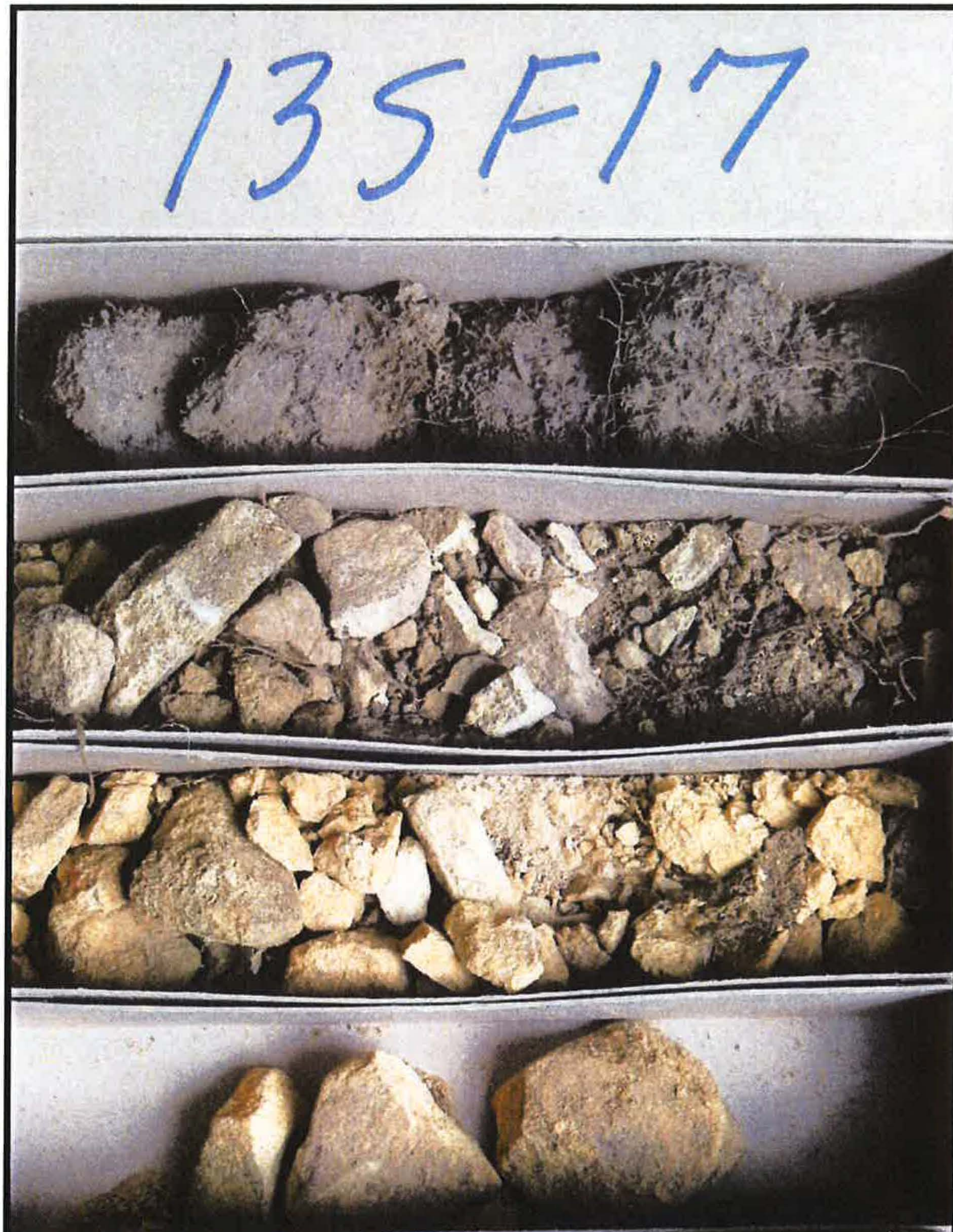

Photo C - 17. Soil profile 13SF17, Veatch family

Typic Haplustoll loamy-skeletal, mixed, superactive, frigid

Appendix D

Laboratory Analysis

Table D-1. Summary of soil sample analysis and determination of soil suitabilty.

Sample	Begin Depth	End Depth	Saturation[1]	pH[1]	Electrical Conductivity[1]	Organic Matter[1]	SAR[1]	CO3[1]	Texture[1]	Available Water Capicity[2]	K factor[3]	Boron[1]	Selenium[1]	Total Organic Carbon[1]
	cm	cm	%	s.u.	dS/m	%		%		in/in		ppm	ppm	%
13SF01	0	10	48.3	7.7	0.36	2.0	0.30	2.6	Loam	0.12	0.22	0.31	<0.02	0.9
13SF01	10	42	54.1	7.9	0.36	1.5	0.45	4.0	Sandy Clay Loam	0.04	0.25	0.53	<0.02	0.5
13SF02	0	11	40.7	7.6	0.30	3.0	0.21	1.0	Sandy Loam	0.10	0.14	0.21	<0.02	1.0
13SF02	11	26	44.8	7.6	0.31	1.6	0.34	0.9	Sandy Loam	0.10	0.20	0.19	<0.02	0.6
13SF02	26	56	36.8	7.7	0.21	0.7	0.47	0.9	Sandy Loam	0.10	0.20	0.17	<0.02	0.6
13SF03	1	14	43.5	7.6	0.35	4.5	0.20	5.2	Sandy Loam	0.11	0.15	0.30	<0.02	1.8
13SF03	14	38	39.5	7.8	0.28	2.5	0.22	5.1	Sandy Loam	0.11	0.24	0.30	<0.02	0.8
13SF03	38	59	34.6	8.0	0.31	1.6	0.26	3.1	Sandy Loam	0.08	0.22	0.37	<0.02	0.7
13SF03	59	74	42.5	7.8	0.34	2.2	0.27	2.9	Sandy Loam	0.10	0.20	0.29	<0.02	0.9
13SF03	79	94	42.2	7.8	0.32	2.9	0.28	2.8	Sandy Clay Loam	0.11	0.23	0.29	<0.02	1.1
13SF03	94	145	44.0	7.7	0.30	1.9	0.22	3.4	Sandy Clay Loam	0.10	0.24	0.33	<0.02	0.9
13SF03	145	170	45.4	8.0	0.39	1.3	0.42	5.5	Sandy Loam	0.10	0.22	0.41	<0.02	0.6
13SF04	2	16	41.8	7.6	0.34	4.1	0.17	1.8	Sandy Loam	0.09	0.18	0.46	<0.02	1.9
13SF04	16	46	35.8	7.7	0.26	2.5	0.23	1.1	Sandy Loam	0.05	0.22	0.28	<0.02	1.0
13SF04	46	77	29.9	7.6	0.32	0.1	0.28	0.6	Sandy Loam	0.04	0.32	0.14	<0.02	0.1
13SF04	77	118	33.9	7.3	0.22	0.3	0.30	0.9	Sandy Clay Loam	0.05	0.24	0.13	<0.02	<0.1
13SF04	118	150	30.2	7.7	0.25	<0.1	0.34	0.6	Sandy Loam	0.04	0.31	0.13	<0.02	<0.1
13SF05	0	11	40.7	6.5	0.21	3.5	0.27	0.9	Sandy Loam	0.08	0.21	0.33	<0.02	2.7
13SF05	11	28	39.7	6.9	0.20	1.9	0.32	0.8	Sandy Loam	0.09	0.24	0.23	<0.02	1.2
13SF05	28	64	36.6	7.1	0.21	2.0	0.28	0.8	Sandy Loam	0.10	0.23	0.17	<0.02	0.7
13SF05	64	84	36.9	7.0	0.29	1.8	0.49	1.0	Loam	0.12	0.27	0.19	<0.02	0.6
13SF05	84	110	43.4	6.9	0.22	0.5	0.51	1.2	Clay Loam	0.12	0.25	0.18	<0.02	0.1
13SF05	110	156	41.8	7.0	0.26	0.5	0.59	1.2	Sandy Clay Loam	0.12	0.29	0.23	<0.02	0.1
13SF05	156	200	37.8	7.2	0.26	0.3	0.91	1.0	Sandy Clay Loam	0.10	0.27	0.17	<0.02	<0.1
13SF06	0	14	48.7	7.1	0.18	1.2	0.50	2.0	Clay Loam	0.13	0.26	0.34	<0.02	0.5
13SF06	14	36	46.3	7.2	0.26	0.5	1.03	2.2	Clay Loam	0.15	0.32	0.33	<0.02	0.2
13SF06	36	57	58.5	7.7	0.31	0.5	2.15	2.5	Silty Clay	0.14	0.30	0.27	<0.02	<0.1
13SF06	57	112	49.9	8.6	0.62	0.6	4.94	6.1	Silty Clay Loam	0.16	0.35	0.41	<0.02	<0.1
13SF06	112	180	45.3	7.7	2.96	0.3	6.67	10.8	Silty Loam	0.07	0.33	0.38	<0.02	<0.1

Table D-1. Summary of soil sample analysis and determination of soil suitabilty.

Sample	Begin Depth	End Depth	Saturation[1]	pH[1]	Electrical Conductivity[1]	Organic Matter[1]	SAR[1]	CO3[1]	Texture[1]	Available Water Capicity[2]	K factor[3]	Boron[1]	Selenium[1]	Total Organic Carbon[1]
	cm	cm	%	s.u.	dS/m	%		%		in/in		ppm	ppm	%
13SF07	0	13	41.4	6.9	0.25	2.2	0.29	1.2	Sandy Loam	0.07	0.22	0.38	<0.02	1.0
13SF07	13	28	41.7	7.0	0.18	1.0	0.28	0.9	Sandy Loam	0.08	0.24	0.19	<0.02	0.5
13SF07	28	60	37.5	7.1	0.15	0.7	0.40	1.1	Sandy Clay Loam	0.08	0.28	0.22	<0.02	0.5
13SF07	60	93	40.3	7.0	0.18	0.2	0.42	1.1	Sandy Loam	0.08	0.26	0.14	<0.02	0.1
13SF07	93	146	51.7	7.7	0.30	0.3	0.67	1.2	Sandy Clay Loam	0.09	0.32	0.18	<0.02	<0.1
13SF07	146	175	46.6	8.0	0.22	0.2	0.54	1.9	Sandy Clay Loam	0.09	0.29	0.24	<0.02	<0.1
13SF08	7	21	53.8	7.2	0.34	4.7	0.33	1.1	Sandy Loam	0.10	0.14	0.50	<0.02	2.3
13SF08	21	46	42.7	7.5	0.25	3.1	0.32	0.7	Sandy Loam	0.09	0.15	0.44	<0.02	1.3
13SF08	46	83	42.3	7.4	0.27	1.9	0.36	0.7	Sandy Loam	0.08	0.17	0.52	<0.02	0.8
13SF08	83	116	40.7	7.6	0.26	1.4	0.25	1.1	Sandy Loam	0.05	0.24	0.28	<0.02	0.6
13SF08	116	149	33.2	7.8	0.25	1.7	0.30	1.2	Sandy Loam	0.05	0.23	0.29	<0.02	0.8
13SF08	149	185	33.8	8.0	0.24	0.1	0.32	0.9	Sandy Loam	0.03	0.27	0.25	<0.02	0.1
13SF09	0	11	40.5	6.9	0.21	3.6	0.21	1.3	Sandy Loam	0.11	0.15	0.44	<0.02	1.7
13SF09	11	29	47.4	7.6	0.27	3.3	0.25	2.1	Loam	0.12	0.19	0.27	<0.02	1.3
13SF09	29	72	50.8	7.6	0.36	2.4	0.33	1.4	Sandy Loam	0.10	0.19	0.28	<0.02	0.9
13SF09	72	114	50.3	7.8	0.33	2.2	0.22	5.0	Sandy Clay Loam	0.11	0.25	0.43	<0.02	1.0
13SF09	114	175	45.5	8.0	0.29	1.8	0.31	7.9	Sandy Clay Loam	0.11	0.25	0.28	<0.02	0.7
13SF10	0	13	118	6.8	0.29	11.1	0.20	2.6	Loam	0.15	0.00	0.37	<0.02	9.0
13SF10	13	34	58.9	6.4	0.15	1.3	0.33	2.2	Clay Loam	0.15	0.33	0.32	<0.02	0.6
13SF10	34	65	51.5	6.3	0.16	0.9	0.44	2.3	Clay Loam	0.15	0.32	0.37	<0.02	0.1
13SF10	65	112	54.5	7.9	0.26	0.5	0.24	3.7	Loam	0.12	0.38	0.27	<0.02	<0.1
13SF10	112	180	52.1	8.1	0.24	<0.1	0.46	7.4	Sand	0.02	0.30	0.15	<0.02	<0.1
13SF11	0	18	60.4	7.4	0.35	5.2	0.18	3.1	Loam	0.14	0.19	0.42	<0.02	3.1
13SF11	18	38	45.4	7.8	0.31	2.5	0.25	4.0	Loam	0.13	0.27	0.43	<0.02	0.7
13SF11	38	64	50.5	7.9	0.27	3.0	0.24	2.6	Loam	0.13	0.22	0.27	<0.02	1.3
13SF11	64	105	51.1	7.9	0.26	3.4	0.33	5.2	Clay Loam	0.14	0.23	0.27	<0.02	1.2
13SF11	105	155	48.4	7.8	0.21	1.7	0.42	6.5	Loam	0.13	0.24	0.45	<0.02	0.6
13SF11	155	175	63.4	7.7	0.51	5.2	1.01	8.2	Loam	0.13	0.20	0.24	<0.02	3.1

Table D-1. Summary of soil sample analysis and determination of soil suitabilty.

Sample	Begin Depth	End Depth	Saturation[1]	pH[1]	Electrical Conductivity[1]	Organic Matter[1]	SAR[1]	CO3[1]	Texture[1]	Available Water Capicity[2]	K factor[3]	Boron[1]	Selenium[1]	Total Organic Carbon[1]
	cm	cm	%	s.u.	dS/m	%		%		in/in		ppm	ppm	%
13SF12	0	15	63.4	7.5	0.30	4.9	0.36	8.8	Silty Clay Loam	0.16	0.25	0.40	<0.02	2.6
13SF12	15	34	38.0	8.0	0.30	1.7	2.17	4.5	Sandy Loam	0.11	0.18	0.47	<0.02	0.7
13SF12	34	60	38.6	8.1	0.29	1.7	3.18	4.7	Loam	0.13	0.26	0.37	<0.02	0.7
13SF12	60	90	48.8	7.9	0.45	3.8	5.11	4.5	Loam	0.14	0.18	0.79	<0.02	1.8
13SF12	90	145	55.9	7.9	0.47	4.2	3.68	2.5	Silty Loam	0.18	0.28	0.68	<0.02	1.5
13SF12	145	170	48.7	7.8	1.06	2.7	4.15	3.1	Clay Loam	0.14	0.27	0.45	<0.02	0.9
13SF13	0	8	45.0	6.7	0.26	4.3	0.37	0.9	Sandy Loam	0.12	0.19	0.38	<0.02	3.0
13SF13	8	18	46.9	7.0	0.24	2.3	0.41	1.1	Loam	0.13	0.38	0.61	<0.02	1.3
13SF13	18	40	57.2	7.3	0.33	1.9	0.23	1.7	Clay Loam	0.14	0.27	0.39	<0.02	0.8
13SF13	40	61	48.7	7.9	0.22	1.7	0.23	6.9	Clay Loam	0.13	0.21	0.40	<0.02	0.5
13SF13	61	86	42.8	7.9	0.26	1.4	0.22	12.0	Clay Loam	0.13	0.24	0.30	<0.02	<0.1
13SF15	0	21	39.8	7.3	0.18	1.6	0.24	1.0	Sandy Loam	0.11	0.23	0.14	<0.02	0.8
13SF15	21	52	39.9	7.0	0.14	1.7	0.44	1.1	Loam	0.13	0.24	0.18	<0.02	0.8
13SF15	52	102	43.8	6.6	0.11	1.1	0.38	1.3	Loam	0.12	0.23	0.25	<0.02	0.3
13SF16	0	11	41.5	7.6	0.21	2.4	0.28	1.5	Loam	0.10	0.23	0.24	<0.02	1.0
13SF16	11	29	48.7	7.4	0.27	1.4	0.36	1.0	Sandy Clay Loam	0.10	0.29	0.27	<0.02	0.7
13SF16	29	72	36.3	7.7	0.22	0.1	0.36	0.6	Sandy Loam	0.06	0.32	0.18	<0.02	0.1
13SF17	0	18	60.9	7.7	0.37	4.5	0.14	3.1	Sandy Loam	0.11	0.23	0.70	<0.02	3.1
13SF17	18	32	54.6	7.4	0.36	2.8	0.19	1.2	Sandy Loam	0.06	0.25	0.53	<0.02	1.3
13SF17	32	57	35.4	7.7	0.23	0.6	0.17	1.2	Loamy Sand	0.03	0.34	0.22	<0.02	0.4

Utah DOGM soil suitability/unsuitability evaluations (DOGM 2005).

Good | Fair | Poor | Unacceptable

1. Value determined by laboratory analysis.
2. Available water capacity (AWC) determined by *Soil Water Characteristics* model (Saxton 2009).
3. K factor calculated by *Inter-Mountain Labs* .

Inter-Mountain Labs
Your Environmental Monitoring Partner
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Date: 12/11/2013

CLIENT: Canyon Fuel Company, LLC.
Project: Waste Rock Expansion
Lab Order: S1310280

CASE NARRATIVE

Report ID: S1310280001

Samples 13SF01, 13SF02, 13SF03, 13SF04, 13SF05, 13SF06, 13SF07, 13SF08, 13SF09, 13SF10, 13SF11, 13SF12, 13SF13, 13SF15, 13SF16, and 13SF17 were received on October 18, 2013.

Samples were analyzed using the methods outlined in the following references:

U.S.E.P.A. 600/2-78-054 "Field and Laboratory Methods Applicable to Overburden and Mining Soils", 1978
American Society of Agronomy, Number 9, Part 2, 1982
USDA Handbook 60 "Diagnosis and Improvement of Saline and Alkali Soils", 1969
Wyoming Department of Environmental Quality, Land Quality Division, Guideline No. 1, 1984
New Mexico Overburden and Soils Inventory and Handling Guideline, March 1987
State of Utah, Division of Oil, Gas, and Mining: Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, April 1988
Montana Department of State Lands, Reclamation Division: Soil, Overburden, and Regraded Spoil Guidelines, December 1994
State of Nevada Modified Sobek Procedure
Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition

All Quality Control parameters met the acceptance criteria defined by EPA and Inter-Mountain Laboratories except as indicated in this case narrative.

Due to technician error, we lost some sample for S1310280-057 (13SF11, 155-175cm) and because of this, there was not enough sample to conduct texture analysis.

Reviewed by: Karen A Secor

Karen Secor, Soil Lab Supervisor

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Soil Analysis Report

Canyon Fuel Company, LLC.
397 South 800 West
Salina, UT 84654

Report ID: S1310280001

oject: Waste Rock Expansion
te Received: 10/18/2013

Date Reported: 12/11/2013
Work Order: S1310280

ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical Conductivity dS/m	Organic Matter %	PE Calcium meq/L	PE Magnesium meq/L	PE Potassium meq/L	PE Sodium meq/L	SAR
10280-001	13SF01	0-10	7.7	48.3	0.36	2.0	2.44	0.77	0.15	0.38	0.30
10280-002	13SF01	10-42	7.9	54.1	0.36	1.5	2.77	0.80	0.07	0.60	0.45
10280-003	13SF02	0-11	7.6	40.7	0.30	3.0	2.08	0.65	0.25	0.24	0.21
10280-004	13SF02	11-26	7.6	44.8	0.31	1.6	2.06	0.73	0.22	0.40	0.34
10280-005	13SF02	26-56	7.7	36.8	0.21	0.7	1.16	0.44	0.10	0.42	0.47
10280-006	13SF03	1-14	7.6	43.5	0.35	4.5	2.59	0.47	0.36	0.24	0.20
10280-007	13SF03	14-38	7.8	39.5	0.28	2.5	2.25	0.41	0.29	0.25	0.22
10280-008	13SF03	38-59	8.0	34.6	0.31	1.6	2.56	0.42	0.18	0.31	0.26
10280-009	13SF03	59-74	7.8	42.5	0.34	2.2	2.62	0.56	0.14	0.34	0.27
10280-010	13SF03	79-94	7.8	42.2	0.32	2.9	2.62	0.42	0.16	0.35	0.28
10280-011	13SF03	94-145	7.7	44.0	0.30	1.9	2.57	0.50	0.18	0.27	0.22
10280-012	13SF03	145-170	8.0	45.4	0.39	1.3	2.91	0.67	0.21	0.56	0.42
10280-013	13SF04	2-16	7.6	41.8	0.34	4.1	2.36	0.51	0.42	0.20	0.17
10280-014	13SF04	16-46	7.7	35.8	0.26	2.5	1.80	0.34	0.30	0.24	0.23
10280-015	13SF04	46-77	7.6	29.9	0.32	0.1	2.31	0.55	0.24	0.33	0.28
10280-016	13SF04	77-118	7.3	33.9	0.22	0.3	1.39	0.38	0.12	0.28	0.30
10280-017	13SF04	118-150	7.7	30.2	0.25	<0.1	1.53	0.47	0.08	0.34	0.34
10280-018	13SF05	0-11	6.5	40.7	0.21	3.5	1.24	0.29	0.31	0.24	0.27
10280-019	13SF05	11-28	6.9	39.7	0.20	1.9	1.16	0.30	0.45	0.27	0.32
10280-020	13SF05	28-64	7.1	36.6	0.21	2.0	1.11	0.28	0.46	0.24	0.28

se results apply only to the samples tested.

eviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

reviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

ellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

viewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Soil Analysis Report

Canyon Fuel Company, LLC.
397 South 800 West
Salina, UT 84654

Report ID: S1310280001

ɔject: Waste Rock Expansion
ıte Received: 10/18/2013

Date Reported: 12/11/2013
Work Order: S1310280

ID	Sample ID	Depths cm	Sand %	Silt %	Clay %	Texture	Very Fine Sand %	Boron ppm	Nitrate (as N) ppm	CO3 %	Selenium ppm
10280-001	13SF01	0-10	47.0	28.0	25.0	Loam	16.5	0.31	2.0	2.6	<0.02
10280-002	13SF01	10-42	70.0	10.0	20.0	Sandy Clay Loam	26.5	0.53	0.6	4.0	<0.02
10280-003	13SF02	0-11	63.0	24.0	13.0	Sandy Loam	15.1	0.21	1.0	1.0	<0.02
10280-004	13SF02	11-26	60.0	26.0	14.0	Sandy Loam	12.7	0.19	1.1	0.9	<0.02
10280-005	13SF02	26-56	57.0	25.0	18.0	Sandy Loam	12.2	0.17	0.6	0.9	<0.02
10280-006	13SF03	1-14	60.0	23.0	17.0	Sandy Loam	20.1	0.30	4.3	5.2	<0.02
10280-007	13SF03	14-38	60.0	25.0	15.0	Sandy Loam	23.9	0.30	<0.1	5.1	<0.02
10280-008	13SF03	38-59	71.0	15.0	14.0	Sandy Loam	27.1	0.37	0.6	3.1	<0.02
10280-009	13SF03	59-74	63.0	20.0	17.0	Sandy Loam	21.8	0.29	0.6	2.9	<0.02
10280-010	13SF03	79-94	57.0	23.0	20.0	Sandy Clay Loam	20.3	0.29	0.5	2.8	<0.02
10280-011	13SF03	94-145	58.0	22.0	20.0	Sandy Clay Loam	18.3	0.33	0.3	3.4	<0.02
10280-012	13SF03	145-170	58.0	23.0	19.0	Sandy Loam	20.1	0.41	0.6	5.5	<0.02
10280-013	13SF04	2-16	71.0	16.0	13.0	Sandy Loam	28.4	0.46	<0.1	1.8	<0.02
10280-014	13SF04	16-46	71.0	16.0	13.0	Sandy Loam	29.2	0.28	0.4	1.1	<0.02
10280-015	13SF04	46-77	69.0	17.0	14.0	Sandy Loam	28.3	0.14	<0.1	0.6	<0.02
10280-016	13SF04	77-118	58.0	18.0	24.0	Sandy Clay Loam	19.5	0.13	<0.1	0.9	<0.02
10280-017	13SF04	118-150	75.0	13.0	12.0	Sandy Loam	33.8	0.13	<0.1	0.6	<0.02
10280-018	13SF05	0-11	77.0	15.0	8.0	Sandy Loam	30.2	0.33	7.5	0.9	<0.02
10280-019	13SF05	11-28	64.0	21.0	15.0	Sandy Loam	20.3	0.23	1.7	0.8	<0.02
10280-020	13SF05	28-64	61.0	24.0	15.0	Sandy Loam	21.3	0.17	0.5	0.8	<0.02

se results apply only to the samples tested.

reviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

reviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

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viewed by: Karen A Secor

Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company, LLC.
397 South 800 West
Salina, UT 84654

Report ID: S1310280001
Date Reported: 12/11/2013
Work Order: S1310280

ject: Waste Rock Expansion
te Received: 10/18/2013

ID	Sample ID	Depths cm	Total Carbon %	TOC %
10280-001	13SF01	0-10	1.2	0.9
10280-002	13SF01	10-42	1.0	0.5
10280-003	13SF02	0-11	1.2	1.0
10280-004	13SF02	11-26	0.7	0.6
10280-005	13SF02	26-56	0.7	0.6
10280-006	13SF03	1-14	2.5	1.8
10280-007	13SF03	14-38	1.4	0.8
10280-008	13SF03	38-59	1.1	0.7
10280-009	13SF03	59-74	1.3	0.9
10280-010	13SF03	79-94	1.4	1.1
10280-011	13SF03	94-145	1.3	0.9
10280-012	13SF03	145-170	1.3	0.6
10280-013	13SF04	2-16	2.1	1.9
10280-014	13SF04	16-46	1.2	1.0
10280-015	13SF04	46-77	0.2	0.1
10280-016	13SF04	77-118	0.2	<0.1
10280-017	13SF04	118-150	0.1	<0.1
10280-018	13SF05	0-11	2.8	2.7
10280-019	13SF05	11-28	1.3	1.2
10280-020	13SF05	28-64	0.8	0.7

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eviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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Karen Secor, Soil Lab Supervisor

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ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical Conductivity dS/m	Organic Matter %	PE Calcium meq/L	PE Magnesium meq/L	PE Potassium meq/L	PE Sodium meq/L	SAR
10280-021	13SF05	64-84	7.0	36.9	0.29	1.8	1.44	0.43	0.19	0.47	0.49
10280-022	13SF05	84-110	6.9	43.4	0.22	0.5	1.14	0.33	0.09	0.43	0.51
10280-023	13SF05	110-156	7.0	41.8	0.26	0.5	1.32	0.37	0.08	0.54	0.59
10280-024	13SF05	156-200	7.2	37.8	0.26	0.3	1.03	0.28	0.06	0.74	0.91
10280-025	13SF06	0-14	7.1	48.7	0.18	1.2	1.02	0.35	0.04	0.42	0.50
10280-026	13SF06	14-36	7.2	46.3	0.26	0.5	1.24	0.55	0.03	0.98	1.03
10280-027	13SF06	36-57	7.7	58.5	0.31	0.5	1.02	0.40	0.04	1.81	2.15
10280-028	13SF06	57-112	8.6	49.9	0.62	0.6	1.21	0.56	0.03	4.65	4.94
10280-029	13SF06	112-180	7.7	45.3	2.96	0.3	19.7	14.3	0.09	27.5	6.67
10280-030	13SF07	0-13	6.9	41.4	0.25	2.2	1.37	0.34	0.14	0.27	0.29
10280-031	13SF07	13-28	7.0	41.7	0.18	1.0	1.26	0.28	0.10	0.25	0.28
10280-032	13SF07	28-60	7.1	37.5	0.15	0.7	0.98	0.26	0.06	0.31	0.40
10280-033	13SF07	60-93	7.0	40.3	0.18	0.2	1.03	0.33	0.05	0.34	0.42
10280-034	13SF07	93-146	7.7	51.7	0.30	0.3	1.59	0.57	0.02	0.69	0.67
10280-035	13SF07	146-175	8.0	46.6	0.22	0.2	1.14	0.41	0.02	0.47	0.54
10280-036	13SF08	7-21	7.2	53.8	0.34	4.7	1.60	0.51	1.15	0.34	0.33
10280-037	13SF08	21-46	7.5	42.7	0.25	3.1	1.41	0.33	0.43	0.30	0.32
10280-038	13SF08	46-83	7.4	42.3	0.27	1.9	1.75	0.43	0.29	0.38	0.36
10280-039	13SF08	83-116	7.6	40.7	0.26	1.4	1.66	0.36	0.22	0.25	0.25
10280-040	13SF08	116-149	7.8	33.2	0.25	1.7	1.59	0.34	0.18	0.30	0.30

se results apply only to the samples tested.

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Karen Secor, Soil Lab Supervisor

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ID	Sample ID	Depths cm	Sand %	Silt %	Clay %	Texture	Very Fine Sand %	Boron ppm	Nitrate (as N) ppm	CO3 %	Selenium ppm
10280-021	13SF05	64-84	46.0	30.0	24.0	Loam	16.9	0.19	<0.1	1.0	<0.02
10280-022	13SF05	84-110	42.0	25.0	33.0	Clay Loam	14.3	0.18	<0.1	1.2	<0.02
10280-023	13SF05	110-156	45.0	28.0	27.0	Sandy Clay Loam	15.1	0.23	<0.1	1.2	<0.02
10280-024	13SF05	156-200	56.0	21.0	23.0	Sandy Clay Loam	15.9	0.17	<0.1	1.0	<0.02
10280-025	13SF06	0-14	25.0	37.0	38.0	Clay Loam	9.4	0.34	0.3	2.0	<0.02
10280-026	13SF06	14-36	25.0	43.0	32.0	Clay Loam	7.6	0.33	0.2	2.2	<0.02
10280-027	13SF06	36-57	10.0	45.0	45.0	Silty Clay	2.5	0.27	<0.1	2.5	<0.02
10280-028	13SF06	57-112	17.0	50.0	33.0	Silty Clay Loam	3.0	0.41	0.1	6.1	<0.02
10280-029	13SF06	112-180	28.0	50.0	22.0	Silty Loam	3.8	0.38	0.2	10.8	<0.02
10280-030	13SF07	0-13	72.0	13.0	15.0	Sandy Loam	31.6	0.38	3.5	1.2	<0.02
10280-031	13SF07	13-28	67.0	15.0	18.0	Sandy Loam	29.0	0.19	0.3	0.9	<0.02
10280-032	13SF07	28-60	67.0	13.0	20.0	Sandy Clay Loam	30.4	0.22	<0.1	1.1	<0.02
10280-033	13SF07	60-93	65.0	16.0	19.0	Sandy Loam	28.7	0.14	<0.1	1.1	<0.02
10280-034	13SF07	93-146	59.0	21.0	20.0	Sandy Clay Loam	26.6	0.18	<0.1	1.2	<0.02
10280-035	13SF07	146-175	56.0	21.0	23.0	Sandy Clay Loam	24.1	0.24	<0.1	1.9	<0.02
10280-036	13SF08	7-21	68.0	18.0	14.0	Sandy Loam	28.1	0.50	2.1	1.1	<0.02
10280-037	13SF08	21-46	65.0	19.0	16.0	Sandy Loam	22.7	0.44	1.4	0.7	<0.02
10280-038	13SF08	46-83	64.0	19.0	17.0	Sandy Loam	21.6	0.52	<0.1	0.7	<0.02
10280-039	13SF08	83-116	66.0	19.0	15.0	Sandy Loam	24.7	0.28	<0.1	1.1	<0.02
10280-040	13SF08	116-149	71.0	17.0	12.0	Sandy Loam	25.9	0.29	<0.1	1.2	<0.02

se results apply only to the samples tested.
eviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
reviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
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viewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Soil Analysis Report

Canyon Fuel Company, LLC.
397 South 800 West
Salina, UT 84654

Report ID: S1310280001

oject: Waste Rock Expansion
ite Received: 10/18/2013

Date Reported: 12/11/2013
Work Order: S1310280

ID	Sample ID	Depths cm	Total Carbon %	TOC %
10280-021	13SF05	64-84	0.7	0.6
10280-022	13SF05	84-110	0.3	0.1
10280-023	13SF05	110-156	0.3	0.1
10280-024	13SF05	156-200	<0.1	<0.1
10280-025	13SF06	0-14	0.8	0.5
10280-026	13SF06	14-36	0.5	0.2
10280-027	13SF06	36-57	0.3	<0.1
10280-028	13SF06	57-112	0.8	<0.1
10280-029	13SF06	112-180	1.4	<0.1
10280-030	13SF07	0-13	1.1	1.0
10280-031	13SF07	13-28	0.6	0.5
10280-032	13SF07	28-60	0.6	0.5
10280-033	13SF07	60-93	0.3	0.1
10280-034	13SF07	93-146	0.2	<0.1
10280-035	13SF07	146-175	0.3	<0.1
10280-036	13SF08	7-21	2.4	2.3
10280-037	13SF08	21-46	1.4	1.3
10280-038	13SF08	46-83	0.9	0.8
10280-039	13SF08	83-116	0.7	0.6
10280-040	13SF08	116-149	0.9	0.8

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viewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain Labs

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ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical Conductivity dS/m	Organic Matter %	PE Calcium meq/L	PE Magnesium meq/L	PE Potassium meq/L	PE Sodium meq/L	SAR
10280-041	13SF08	149-185	8.0	33.8	0.24	0.1	1.40	0.37	0.20	0.30	0.32
10280-042	13SF09	0-11	6.9	40.5	0.21	3.6	1.17	0.37	0.24	0.19	0.21
10280-043	13SF09	11-29	7.6	47.4	0.27	3.3	1.90	0.48	0.27	0.27	0.25
10280-044	13SF09	29-72	7.6	50.8	0.36	2.4	2.33	0.46	0.27	0.39	0.33
10280-045	13SF09	72-114	7.8	50.3	0.33	2.2	2.29	0.52	0.18	0.26	0.22
10280-046	13SF09	114-175	8.0	45.5	0.29	1.8	1.88	0.54	0.08	0.34	0.31
10280-047	13SF10	0-13	6.8	118	0.29	11.1	1.66	0.67	0.34	0.22	0.20
10280-048	13SF10	13-34	6.4	58.9	0.15	1.3	0.86	0.32	0.04	0.25	0.33
10280-049	13SF10	34-65	6.3	51.5	0.16	0.9	0.80	0.29	0.02	0.32	0.44
10280-050	13SF10	65-112	7.9	54.5	0.26	0.5	1.76	0.51	0.03	0.25	0.24
10280-051	13SF10	112-180	8.1	52.1	0.24	<0.1	1.12	0.77	0.02	0.45	0.46
10280-052	13SF11	0-18	7.4	60.4	0.35	5.2	2.47	0.58	0.41	0.23	0.18
10280-053	13SF11	18-38	7.8	45.4	0.31	2.5	2.39	0.44	0.31	0.29	0.25
10280-054	13SF11	38-64	7.9	50.5	0.27	3.0	2.16	0.33	0.24	0.27	0.24
10280-055	13SF11	64-105	7.9	51.1	0.26	3.4	1.77	0.40	0.14	0.34	0.33
10280-056	13SF11	105-155	7.8	48.4	0.21	1.7	1.25	0.43	0.09	0.39	0.42
10280-057	13SF11	155-175	7.7	63.4	0.51	5.2	3.11	0.64	0.32	1.39	1.01
10280-058	13SF12	0-15	7.5	63.4	0.30	4.9	2.23	0.48	0.27	0.42	0.36
10280-059	13SF12	15-34	8.0	38.0	0.30	1.7	1.13	0.42	0.21	1.91	2.17
10280-060	13SF12	34-60	8.1	38.6	0.29	1.7	0.69	0.26	0.14	2.19	3.18

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viewed by: Karen A Secor

Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company, LLC.
397 South 800 West
Salina, UT 84654

Report ID: S1310280001

oject: Waste Rock Expansion
Date Reported: 12/11/2013
ite Received: 10/18/2013
Work Order: S1310280

ID	Sample ID	Depths cm	Sand %	Silt %	Clay %	Texture	Very Fine Sand %	Boron ppm	Nitrate (as N) ppm	CO3 %	Selenium ppm
10280-041	13SF08	149-185	74.0	11.0	15.0	Sandy Loam	32.9	0.25	<0.1	0.9	<0.02
10280-042	13SF09	0-11	59.0	22.0	19.0	Sandy Loam	16.8	0.44	1.5	1.3	<0.02
10280-043	13SF09	11-29	50.0	28.0	22.0	Loam	15.7	0.27	0.4	2.1	<0.02
10280-044	13SF09	29-72	58.0	24.0	18.0	Sandy Loam	17.0	0.28	0.5	1.4	<0.02
10280-045	13SF09	72-114	50.0	26.0	24.0	Sandy Clay Loam	13.3	0.43	0.3	5.0	<0.02
10280-046	13SF09	114-175	49.0	27.0	24.0	Sandy Clay Loam	17.9	0.28	0.1	7.9	<0.02
10280-047	13SF10	0-13	44.0	34.0	22.0	Loam	18.4	0.37	6.2	2.6	<0.02
10280-048	13SF10	13-34	22.0	47.0	31.0	Clay Loam	7.5	0.32	<0.1	2.2	<0.02
10280-049	13SF10	34-65	26.0	43.0	31.0	Clay Loam	8.6	0.37	<0.1	2.3	<0.02
10280-050	13SF10	65-112	47.0	39.0	14.0	Loam	17.1	0.27	0.3	3.7	<0.02
10280-051	13SF10	112-180	88.0	9.0	3.0	Sand	39.8	0.15	<0.1	7.4	<0.02
10280-052	13SF11	0-18	50.0	34.0	16.0	Loam	15.1	0.42	0.1	3.1	<0.02
10280-053	13SF11	18-38	46.0	36.0	18.0	Loam	16.0	0.43	0.7	4.0	<0.02
10280-054	13SF11	38-64	44.0	34.0	22.0	Loam	12.4	0.27	0.3	2.6	<0.02
10280-055	13SF11	64-105	36.0	34.0	30.0	Clay Loam	11.4	0.27	0.2	5.2	<0.02
10280-056	13SF11	105-155	44.0	33.0	23.0	Loam	13.4	0.45	0.5	6.5	<0.02
10280-057	13SF11	155-175						0.24	0.4	8.2	<0.02
10280-058	13SF12	0-15	18.0	48.0	34.0	Silty Clay Loam	7.1	0.40	0.6	8.8	<0.02
10280-059	13SF12	15-34	56.0	26.0	18.0	Sandy Loam	16.5	0.47	0.2	4.5	<0.02
10280-060	13SF12	34-60	46.0	33.0	21.0	Loam	15.1	0.37	<0.1	4.7	<0.02

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viewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

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Soil Analysis Report

Canyon Fuel Company, LLC.

397 South 800 West
Salina, UT 84654

Report ID: S1310280001

Date Reported: 12/11/2013

Work Order: S1310280

ject: Waste Rock Expansion

te Received: 10/18/2013

ID	Sample ID	Depths cm	Total Carbon %	TOC %
10280-041	13SF08	149-185	0.2	0.1
10280-042	13SF09	0-11	1.8	1.7
10280-043	13SF09	11-29	1.5	1.3
10280-044	13SF09	29-72	1.1	0.9
10280-045	13SF09	72-114	1.6	1.0
10280-046	13SF09	114-175	1.7	0.7
10280-047	13SF10	0-13	9.3	9.0
10280-048	13SF10	13-34	0.9	0.6
10280-049	13SF10	34-65	0.4	0.1
10280-050	13SF10	65-112	0.3	<0.1
10280-051	13SF10	112-180	0.8	<0.1
10280-052	13SF11	0-18	3.5	3.1
10280-053	13SF11	18-38	1.2	0.7
10280-054	13SF11	38-64	1.6	1.3
10280-055	13SF11	64-105	1.8	1.2
10280-056	13SF11	105-155	1.4	0.6
10280-057	13SF11	155-175	4.1	3.1
10280-058	13SF12	0-15	3.6	2.6
10280-059	13SF12	15-34	1.3	0.7
10280-060	13SF12	34-60	1.3	0.7

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Karen Secor, Soil Lab Supervisor

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Salina, UT 84654

Report ID: S1310280001

ject: Waste Rock Expansion

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ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical Conductivity dS/m	Organic Matter %	PE Calcium meq/L	PE Magnesium meq/L	PE Potassium meq/L	PE Sodium meq/L	SAR
10280-061	13SF12	60-90	7.9	48.8	0.45	3.8	0.92	0.29	0.13	3.98	5.11
10280-062	13SF12	90-145	7.9	55.9	0.47	4.2	1.08	0.33	0.11	3.09	3.68
10280-063	13SF12	145-170	7.8	48.7	1.06	2.7	3.77	1.01	0.31	6.41	4.15
10280-064	13SF13	0-8	6.7	45.0	0.26	4.3	1.15	0.38	0.43	0.32	0.37
10280-065	13SF13	8-18	7.0	46.9	0.24	2.3	1.55	0.38	0.30	0.41	0.41
10280-066	13SF13	18-40	7.3	57.2	0.33	1.9	2.30	0.68	0.21	0.28	0.23
10280-067	13SF13	40-61	7.9	48.7	0.22	1.7	1.54	0.49	0.14	0.23	0.23
10280-068	13SF13	61-86	7.9	42.8	0.26	1.4	1.66	0.59	0.08	0.23	0.22
10280-069	13SF15	0-21	7.3	39.8	0.18	1.6	1.15	0.37	0.12	0.21	0.24
10280-070	13SF15	21-52	7.0	39.9	0.14	1.7	0.65	0.22	0.06	0.29	0.44
10280-071	13SF15	52-102	6.6	43.8	0.11	1.1	0.46	0.17	0.05	0.22	0.38
10280-072	13SF16	0-11	7.6	41.5	0.21	2.4	1.36	0.40	0.10	0.26	0.28
10280-073	13SF16	11-29	7.4	48.7	0.27	1.4	1.43	0.42	0.05	0.35	0.36
10280-074	13SF16	29-72	7.7	36.3	0.22	0.1	1.26	0.38	0.05	0.32	0.36
10280-075	13SF17	0-18	7.7	60.9	0.37	4.5	2.57	0.65	0.73	0.18	0.14
10280-076	13SF17	18-32	7.4	54.6	0.36	2.8	3.48	0.81	0.44	0.27	0.19
10280-077	13SF17	32-57	7.7	35.4	0.23	0.6	2.17	0.49	0.19	0.20	0.17

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ID	Sample ID	Depths cm	Sand %	Silt %	Clay %	Texture	Very Fine Sand %	Boron ppm	Nitrate (as N) ppm	CO3 %	Selenium ppm
10280-061	13SF12	60-90	42.0	32.0	26.0	Loam	13.3	0.79	0.4	4.5	<0.02
10280-062	13SF12	90-145	28.0	55.0	17.0	Silty Loam	7.5	0.68	0.4	2.5	<0.02
10280-063	13SF12	145-170	33.0	38.0	29.0	Clay Loam	10.5	0.45	0.3	3.1	<0.02
10280-064	13SF13	0-8	52.0	31.0	17.0	Sandy Loam	19.7	0.38	7.0	0.9	<0.02
10280-065	13SF13	8-18	45.0	44.0	11.0	Loam	18.0	0.61	0.5	1.1	<0.02
10280-066	13SF13	18-40	32.0	38.0	30.0	Clay Loam	8.6	0.39	0.2	1.7	<0.02
10280-067	13SF13	40-61	30.0	31.0	39.0	Clay Loam	9.0	0.40	0.2	6.9	<0.02
10280-068	13SF13	61-86	34.0	31.0	35.0	Clay Loam	10.8	0.30	<0.1	12.0	<0.02
10280-069	13SF15	0-21	56.0	28.0	16.0	Sandy Loam	16.5	0.14	0.4	1.0	<0.02
10280-070	13SF15	21-52	46.0	33.0	21.0	Loam	12.4	0.18	<0.1	1.1	<0.02
10280-071	13SF15	52-102	44.0	31.0	25.0	Loam	11.5	0.25	0.1	1.3	<0.02
10280-072	13SF16	0-11	42.0	34.0	24.0	Loam	14.3	0.24	0.9	1.5	<0.02
10280-073	13SF16	11-29	54.0	22.0	24.0	Sandy Clay Loam	22.9	0.27	0.3	1.0	<0.02
10280-074	13SF16	29-72	76.0	12.0	12.0	Sandy Loam	37.0	0.18	0.2	0.6	<0.02
10280-075	13SF17	0-18	54.0	35.0	11.0	Sandy Loam	20.5	0.70	1.6	3.1	<0.02
10280-076	13SF17	18-32	60.0	30.0	10.0	Sandy Loam	24.0	0.53	<0.1	1.2	<0.02
10280-077	13SF17	32-57	77.0	18.0	5.0	Loamy Sand	35.1	0.22	0.7	1.2	<0.02

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ID	Sample ID	Depths cm	Total Carbon %	TOC %
10280-061	13SF12	60-90	2.3	1.8
10280-062	13SF12	90-145	1.8	1.5
10280-063	13SF12	145-170	1.3	0.9
10280-064	13SF13	0-8	3.1	3.0
10280-065	13SF13	8-18	1.4	1.3
10280-066	13SF13	18-40	1.0	0.8
10280-067	13SF13	40-61	1.3	0.5
10280-068	13SF13	61-86	1.3	<0.1
10280-069	13SF15	0-21	0.9	0.8
10280-070	13SF15	21-52	0.9	0.8
10280-071	13SF15	52-102	0.5	0.3
10280-072	13SF16	0-11	1.2	1.0
10280-073	13SF16	11-29	0.8	0.7
10280-074	13SF16	29-72	0.2	0.1
10280-075	13SF17	0-18	3.4	3.1
10280-076	13SF17	18-32	1.4	1.3
10280-077	13SF17	32-57	0.5	0.4

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Karen Secor, Soil Lab Supervisor

SUFCO WASTE ROCK PILE HYDROLOGY

JULY 2015

PREPARED FOR:
SUFCO Mine

PROFESSIONAL ENGINEER
No. 348930
KERRY
ROBERT
BENSON
STATE OF UTAH

7-10-2015

PREPARED BY:

Jones & DeMille Engineering

1-800-748-5275
Project #: 1406-120

RICHFIELD ▪ PRICE ▪ MANTI ▪ ROOSEVELT ▪ AMERICAN FORK ▪ ST. GEORGE

SUFCO WASTE ROCK PILE HYDROLOGY

JULY 2015

PREPARED FOR:

SUFCO Mine

PREPARED BY:

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1. HYDROLOGY INTRODUCTION

The purpose of this hydrologic evaluation is to quantify the storm water runoff peak flows and volumes for the 10-year 24-hour storm according to the Utah Division of Oil, Gas, and Mining requirement R645-301-742&743. The results are then used in the hydraulic evaluation below to design the storm water conveyance (e.g., channels, culverts, etc. and sedimentation structures to meet or exceed the runoff flows and volumes.

The U.S. Soil Conservation Service (SCS) Curve Number (CN) methodology, as defined in the National Engineering Handbook (NRCS, 2004), was selected to estimate peak flows and hydrographs at the project site. The CN values used were obtained from a previous study "Geotechnical/Hydrological Investigation Report Waste Rock Disposal Site" by Sergent, Hauskins, and Beckwith (1984) located in Appendix II, Volume 3, Waste Rock Disposal Site (WRDS M&RP). In selecting CN values, the waste rock pile is assumed to have no vegetation due to it being a disturbed area. Some contemporaneous reclamation may occur as the site is developed; however, the operational hydrologic design conservatively assumes no contemporaneous reclamation will occur. Therefore the disturbed areas excluding the pond were assigned a CN value of 90, previously reclaimed areas were assigned a CN value of 80, and undisturbed areas were assigned a CN of 65. The sedimentation pond area was assigned a CN value of 98 due to the potential for the pond to contain water during a storm event. The Sevier County gravel pull off area directly northwest of the waste rock pile was assigned a CN value of 80.

Following SCS methodology, the Watershed Lag Method estimates the initial abstraction (I_a), maximum retention (S), and lag time (lg) using the following equations (NRCS, 2004).

$$I_a = 0.2S$$

$$S = \frac{1000}{CN} - 10$$

$$Lg = \frac{L^{0.8}(S+1)^{0.7}}{1900\sqrt{Y}}$$

where:

I_a = initial abstraction (in)
CN = Curve Number
L = watercourse length (ft.)
S = maximum retention (in)
Lg = lag time (hr)
Y = average drainage basin slope (%)

Table 1 lists the parameters for the drainages.

Table 1. Hydrology Parameters

Drainage Basin	Area (ft^2)	Area (acres)	Area (mi^2)	Length (ft)	Slope (%)	CN	S (in)	Initial Abstraction (in)	Lag Time (hr)	Lag Time (min)	Tc (hr)	Tc (min)
DW-1	1373964	31.5	0.049	1650	9.0	90.00	1.1	0.2	0.1	7	0.2	11
DW-2	272336	6.3	0.010	525	20.8	80.00	2.5	0.5	0.0	2	0.1	4
DW-3	54266	1.2	0.002	180	9.5	80.00	2.5	0.5	0.0	2	0.0	3
DW-4	70375	1.6	0.003	515	9.5	80.00	2.5	0.5	0.1	4	0.1	6
DW-5	68097	1.6	0.002	1	0.0	98.00	0.2	0.0	0.2	11	0.3	19
UW-1	56889	1.3	0.002	200	6.0	80.00	2.5	0.5	0.0	2	0.1	4
UW-2	325816	7.5	0.012	340	10.0	65.00	5.4	1.1	0.1	4	0.1	6
UW-3	443875	10.2	0.016	920	18.0	65.00	5.4	1.1	0.1	6	0.2	11
UW-4	3153906	72.4	0.113	1040	23.0	65.00	5.4	1.1	0.1	6	0.2	10
UW-5	5770022	132.5	0.207	2000	27.0	65.00	5.4	1.1	0.2	10	0.3	16

HEC-HMS version 3.3 was used to calculate the storm water discharge for the design storm. The design storm, 10-year 24-hour, depth of 1.92 inches was used at the project location and taken from the National Oceanic and Atmospheric Administration (NOAA) ATLAS 14, Point Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/ut_pfds.html, also in Appendix A). Site watershed areas and average slopes were calculated from a 2-foot contour interval topographic map provided by SUFCO Mine using AutoCAD 2014 software. Additionally, the Water Hollow Ridge and Accord Lakes USGS topographic maps with 40- foot contour were used in areas not within the SUFCO topographic map.

HEC-HMS runoff calculations were performed for the site with a design storm of a standard 24 hour duration as required by the SCS method and the SCS Type II distribution was selected based on the project site location. The HEC-HMS model input and results are included in Appendix A.

2. OPERATIONAL HYDROLOGY

The delineated operational watersheds are shown on Map 5 located in the WRDS M&RP. The operational hydrology plan is shown on Map 5A. Peak flows and total runoff volumes for the site drainage subareas are tabulated in Appendix A and in Table 2.

Table 2. Disturbed Watershed Parameters

Hydrologic Element	Basin Identifier	Peak Discharge (CFS)	Volume (Acre-Feet)
DW*-1	Waste Rock Pile	37.5	2.7
DW-2	Topsoil/Subsoil Pile	4.0	0.3
DW-3	Onsite Disturbed Area	0.8	0.1
DW-4	Onsite Disturbed Area	1.2	0.1
DW-5	Sedimentation Pond	1.9	0.2
Outfall**	Outfall	45.4	3.3

Disturbed Watershed** * Outfall is total runoff flows and volumes from subareas**

The areas contributing to the site runoff discharged to the sedimentation pond are the waste rock pile, topsoil/subsoil piles, disturbed areas, and sedimentation pond area. Runoff from the undisturbed watersheds will be conveyed around disturbed areas and the sedimentation pond as shown on Maps 5 and 5A (WRDS M&RP).

When the existing sedimentation pond is replaced, Existing Diversion (ED)-1 and ED-2 channels will be reshaped to become a Combined Channel (CC)-1. CC-1 will channel runoff from DW-1 through Disturbed Culvert (DC)-1 into Diversion Ditch (DD)-10. DD-10 will convey the runoff from DW-1 and DW-2 to the new sedimentation pond. Runoff from DW-3 and DW-4 will follow the natural contours into the sediment pond inlet. DC-1 and DC-2 will remain during phased development but will be removed for final reclamation of the site. DD-1 through DD-9 are designed to accept runoff from the largest watershed areas, but will exist and operate as required to convey runoff during the phased operations.

Undisturbed Watershed (UW)-1 and UW-2 runoff will be channeled around the sedimentation pond by UB-1, and will continue downstream of the site through the natural drainage. UW-3 and a portion of UW-4 will drain into UD-1 and through the level spreader to follow the existing terrain and be routed around the sedimentation pond, thereafter continuing through the natural drainage. A portion of UW-4 and UW-5 will flow through the natural drainage.

2.1. PHASED HYDROLOGY

DW-1 will be constructed in phases as shown on Map 4A thru Map 4F. Phase 6 is not part of DW-1 but Phase 1 – 5 are subareas of watershed DW-1. For each phase operation a drainage ditch (Disturbed Ditch Detail) will be located at the lowest elevation contour of the phased boundary to contain and transport all runoff to the sediment pond (DD-1 thru DD-9). Table 3 shows the hydrologic parameters for each Phase area.

Table 3. Phase Watershed Hydrologic Parameters

Drainage Basin	Area (ft^2)	Area (acres)	Area (mi^2)	Length (ft)	Slope (%)	CN	S (in)	Initial Abstraction (in)	Lag Time (hr)	Lag Time (min)	Tc (hr)	Tc (min)
PH-1	268958	6.2	0.0096	2400	9.0	90	1.1	0.2	0.1	9	0.2	15
PH-2	184079	4.2	0.0066	610	9.0	90	1.1	0.2	0.1	3	0.1	5
PH-3	190830	4.4	0.0068	590	9.0	90	1.1	0.2	0.0	3	0.1	5
PH-4	200548	4.6	0.0072	730	9.0	90	1.1	0.2	0.1	3	0.1	6
PH-5	185118	4.2	0.0066	620	9.0	90	1.1	0.2	0.1	3	0.1	5
PH-6	38548	0.9	0.0014	440	6.0	90	1.1	0.2	0.0	3	0.1	5

The total runoff volume for all phase areas is 39.80 CFS. DD-2 thru DD-4 will report to DD-1 and DD-5 thru DD-9 will report to CC-1. DD-1 will report to CC-1. The HEC-HMS volume and peak flow summary can be found in Appendix A.

3. HYDRAULIC EVALUATION

This hydraulic evaluation was conducted to determine adequate design parameters for the construction of storm water conveyances (berms and channels) and the sedimentation pond. Channel sizing was conducted using the Flow Master software from Bentley, Inc. The hydraulic calculations can be found in Appendix B.

3.1. CHANNEL SIZING

The riprap cross-section for CC-1 has a 36 inch bottom width with 2H:1V sides and a 24 inch overall depth shown in Appendix B and Appendix C. The CC-1 cross-section will be used for DD-5 which flows into the sedimentation pond. CC-1 will convey the required 37.5 cubic feet per second (CFS) from DW-1. DD-10 will convey the required 45.4 CFS from CC-1 and DW-2 thru DW-4 and with at least 6 inches of freeboard.

The drainage ditch conveying runoff from the largest contributing area (DD-1) was used as the design criteria for ditches DD-1 thru DD-9. Approximately 31.0 CFS from 23.6 acres of DW-1 report to DD-1. Ditches DD-1 thru DD-4 and DD-5 thru DD-9 will be 12 inches deep, have a 3 foot bottom width and 2H:1V sides slopes.

DB-1 and DB-2 are berms designed to convey runoff from the top soil pile to DC-4. Flow from DC-4 will report to DD-10. The berm will be constructed 1.25 feet tall with 2H:1V sides slopes creating a v-shaped ditch with the existing pile, providing 6 inches of freeboard.

UB-1 will have 2H:1V side slopes, with a depth of 12 inches and 6 inches of free board. UD-1 is designed as a riprap channel with a 12 inch bottom width, 2H:1V sides slopes and 12 inches deep.

The channel design calculations are included in Appendix B and summarized in Table 4. Designs for ED-1, ED-2, and Ditch No. 2 are discussed in Section 2.4.1 of the WRDS M&RP.

Table 4. Channel Design Criteria

Channel Designation	Design slope (ft./ft.)	Cross Section	Side Slope	Bottom Width (Feet)	Normal Depth (Feet)	Channel Depth (Feet)	Manning's n	Lining
CC-1	0.058	Trapezoidal	2H:1V	3	1.38	2.00	0.069	Riprap
DD-10	0.036	Trapezoidal	2H:1V	3	1.70	2.00	0.069	Riprap
DD-1, DD-2, DD-3, DD-4, DD-5, DD-6, DD-7, DD-8, DD-9	0.090	Trapezoidal	2H:1V	3	0.54	1.00	0.020	Earth
DB-1, DB-2	0.030	Berm	2H:1V	-	0.75	1.25	0.035	Earth
UD-1	0.108	Trapezoidal	2H:1V	1	0.13	1.00	0.060	Riprap
UB-1	0.036	Berm	2H:1V	-	0.16	1.00	0.045	Earth

Table 5 shows the designed culverts and the flows required for the sizing calculations. The "Max Flow" column represents flow rates from a culvert running at capacity while the "Required Flow" column represents flow rates from the design storm runoff. DC-1 and DC-2 are similarly sized to enable the area flow to pass through either. DC-3 will convey runoff from disturbed ditches excluding DD-5 and CC-1 and will be sized using the runoff flow from DW-1. UC-3 is oversized to accommodate runoff from storm events larger than the designed storm because of the size of the undisturbed area from which it will convey runoff. UC-4 discharges treated water into an existing natural drainage.

Table 5. Culvert Criteria

Culvert	Required Flow (CFS)	Size (inches)	Max Flow (CFS)
DC-1	37.5	30	53.5
DC-2	37.5	30	53.5
DC-3	37.5	30	66.7
DC-4	4.0	12	21.1
UC-3	5.2	24	60.0
UC-4	50.6	36	161.5

3.2. RIPRAP SIZING

Riprap lining is used to limit the erosion in earthen channels. The following calculations were conducted to determine an applicable size for the rock riprap to line the channels on this site.

Water depth, channel velocity, bend radius, and channel width were determined by using available channel cross sections and gradient information and applying open channel flow hydraulic calculations.

Riprap size was determined using the average size of the methods listed:

Maynord

$$d_{30} = SF \times Cs \times Ct \times Cv \times D \times \left(\left(\frac{\gamma}{\gamma_s - \gamma} \right)^{0.5} \times \frac{V}{(K1 * g * D)^{0.5}} \right)^{2.5}$$

$$Cv = 1.283 - 0.2 \times log\left(\frac{R}{W}\right)$$

$$K1 = \left(1 - \frac{\sin^2 \theta}{\sin^2 \Phi}\right)^{0.5}$$

$D = average\ water\ depth\ in\ channel$ (ft)

$SF = safety\ factor = 1.2$

$Cv = velocity\ correction\ factor$

$Ct = thickness\ coefficient$

$Cs = stability\ coefficient$

$K1 = side\ slope\ correction$

$V = local\ depth\ averaged\ velocity, (ft/s)$

$g = acceleration\ due\ to\ gravity$

$\gamma = unit\ weight\ of\ water, (pcf)$

$\gamma_s = unit\ weight\ of\ stone, (pcf)$

$\theta = angle\ of\ rock\ from\ the\ horizontal$

$\Phi = angle\ of\ repose$

$R = centerline\ bend\ radius$

$W = water\ surface\ width$

USBR

$$d_{50} = 0.043\, V_a^{\,2.06}$$

$V_a = average\ channel\ velocity\ (ft/s)$

Isbash

$$d_{50} = \frac{V_a^{\,2}}{2 \times g \times C^2 \times (G_s - 1)}$$

$V_a = average\ channel\ velocity\ (ft/s)$

$g = acceleration\ due\ to\ gravity$

$C = 0.86\ for\ high\ and\ 1.2\ for\ low\ tyrbulence\ zones$

$G_s = specific\ gravity\ of\ stone$

HEC-11

$$d_{50} = d_{50}{}' \times C_f \times C_s$$

$$d'_{50} = 0.001 \times \frac{V_a^{\,3}}{K^{1.5} \times D^{0.5}}$$

$$C_f = \left(\frac{SF}{1.2}\right)^{1.5}$$

$$C_s = \frac{2.12}{(G_s - 1)^{1.5}}$$

$V_a = average\ channel\ velocity\ (ft/s)$

$$K = side\ slope\ correction\ factor\ = \left(1 - \frac{\sin^2\theta}{\sin^2\varphi}\right)^{0.5}$$

$D = average\ water\ depth\ in\ channel$ (ft)

$\theta = angle\ of\ side\ slope\ to\ horizontal$

$\varphi = angle\ of\ repose\ for\ stone$

$SF = safety\ factor = 1.5$

$G_s = specific\ gravity\ of\ stone$

ASCE

$$d_{50} = \left(\frac{6W_{50}}{\pi \times \gamma_s}\right)^{0.333}$$

$$W_{50} = weight\ of\ stone\ (lbs) of\ diameter\ d_{50} = 0.000041 \frac{G_s V_x{}^6}{(G_s - 1)^3 \cos^3(\theta)}$$

$G_s = specific\ gravity\ of\ stone$

$V_x = \frac{4}{3}\ V_a\ for\ impinging\ flows\ and \frac{2}{3} V_a for\ tangential\ flows$

$V_a = average\ channel\ velocity\ (ft/s)$

$\gamma_s = unit\ weight\ of\ stone, (pcf)$

$\theta = angle\ of\ side\ slope\ to\ horizontal$

Based upon the proceeding equations, the average channel depth, velocity, and discharge were used in the calculations. The results are shown in Table 6. The resulting calculated d_{50} riprap size ranges from 1.0 to 5.2 inches. For the final design, a d_{50} = 6 inches was selected for CC-1, DD-10 and UD-1. Although it may be an over design for the smaller channels it will make constructability simpler. See Appendix B for riprap calculations.

An 8" layer of riprap will be placed on the inside bank of the sediment pond to prevent any erosion from possible wave action.

Table 6. Riprap Size

Reach	Flow Rate (ft^3/s)	Velocity (ft/s)	Slope (%)	Channel Width (ft)	Side Slope H:V	D_{50} (in)
CC-1	37.5	5.4	5.8	3	2:1	5.2
DD-5	45.4	5.3	3.6	3	2:1	4.3
UD-1	0.3	2.4	10.8	1	2:1	1.0

4. RUNOFF VOLUME

The total runoff volume contributing to the sedimentation pond resulting from a 10-year 24-hour storm event for disturbed areas DW-1 through DW-5 is approximately 3.3 acre-feet. The total runoff volume of undisturbed areas conveyed around the pond is approximately 2.0 acre-feet.

5. SEDIMENT VOLUME

The average annual anticipated sediment yield from disturbed areas at the site was calculated using an assumed value of 0.1 acre-feet per acre per year from Section 7.4.2.2 of the SUFCO Mining and Reclamations Plan. The sediment yield from the undisturbed areas was 0.04 acre-feet per year from the study by Sergent, Hauskins, and Beckwith (1984).

The average annual sediment yield in acre-feet per acre for each watershed was multiplied by the watershed areas to find the annual volume of sediment yield from each area. The volumes for each watershed were summed to determine the total annual sediment yield draining into the sedimentation pond. The maximum calculated annual sediment yield for the area draining into the sedimentation pond is 4.22 acre-feet per year.

5.1. SEDIMENT POND CAPACITY

The sedimentation pond will retain runoff from a 10-year, 24-hour storm event from contributing watersheds (3.3 acre-feet) and one year of sediment yield (4.22 acre-feet), for a total of 7.52 acre-feet. The total designed capacity of the sedimentation pond is 10.01 acre-feet at the elevation of 7,841 feet.

6. CONCLUSIONS

Storm water discharge peak flows were estimated using SCS methodology and modeled via HEC-HMS version 3.3 for the 10-year 24-hour storm event. Proposed channels were sized for the design storm event using Bentley FlowMaster version V8i.

The sedimentation pond was designed according to Utah State Rule R645-301-742 and 743 to safely retain the 10-year 24-hour storm event and one year of predicted sediment yield. Riprap was sized to protect CC-1, DD-10 and UD-1 channels from potential erosion during the design storm event. The final proposed channel dimensions and riprap sizes are presented in Table 3 and Table 5. The detailed calculations are documented in Appendix A and Appendix B. Appendix C contains conveyance structure details.

APPENDIX A. HYDROLOGLY CALCULATIONS

A.1. HYDROLOGY PARAMETERS

Precipitation Frequency Data Server

NOAA Atlas 14, Volume 1, Version 5
Location name: Salina, Utah, US*
Coordinates: 38.9017, -111.5017
Elevation: 7965 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

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	0.133 (0.117 0.154)	0.172 (0.151 0.199)	0.239 (0.208 0.274)	0.294 (0.254 0.340)	0.381 (0.321 0.440)	0.457 (0.378 0.531)	0.544 (0.440 0.636)	0.644 (0.508 0.761)	0.804 (0.605 0.971)	0.950 (0.690 1.17)
10-min	0.203 (0.178 0.234)	0.262 (0.230 0.303)	0.364 (0.317 0.417)	0.448 (0.386 0.518)	0.580 (0.488 0.670)	0.696 (0.575 0.808)	0.828 (0.670 0.968)	0.981 (0.773 1.16)	1.22 (0.920 1.48)	1.45 (1.05 1.78)
15-min	0.251 (0.220 0.290)	0.325 (0.286 0.376)	0.451 (0.392 0.517)	0.556 (0.479 0.642)	0.719 (0.606 0.830)	0.862 (0.713 1.00)	1.03 (0.830 1.20)	1.22 (0.958 1.44)	1.52 (1.14 1.83)	1.79 (1.30 2.21)
30-min	0.338 (0.297 0.390)	0.437 (0.385 0.506)	0.608 (0.528 0.696)	0.748 (0.645 0.864)	0.969 (0.816 1.12)	1.16 (0.960 1.35)	1.38 (1.12 1.61)	1.64 (1.29 1.93)	2.04 (1.54 2.47)	2.41 (1.75 2.97)
60-min	0.419 (0.367 0.483)	0.542 (0.476 0.626)	0.752 (0.654 0.862)	0.926 (0.799 1.07)	1.20 (1.01 1.38)	1.44 (1.19 1.67)	1.71 (1.38 2.00)	2.03 (1.60 2.39)	2.53 (1.90 3.05)	2.99 (2.17 3.68)
2-hr	0.516 (0.455 0.584)	0.653 (0.577 0.741)	0.874 (0.766 0.992)	1.07 (0.931 1.22)	1.38 (1.17 1.57)	1.65 (1.38 1.89)	1.96 (1.60 2.27)	2.33 (1.85 2.71)	2.90 (2.21 3.45)	3.43 (2.52 4.16)
3-hr	0.586 (0.530 0.657)	0.739 (0.667 0.830)	0.954 (0.859 1.07)	1.15 (1.02 1.29)	1.44 (1.27 1.63)	1.71 (1.47 1.93)	2.02 (1.71 2.31)	2.38 (1.97 2.74)	2.96 (2.37 3.49)	3.49 (2.71 4.18)
6-hr	0.754 (0.689 0.828)	0.938 (0.862 1.03)	1.16 (1.07 1.28)	1.36 (1.24 1.50)	1.64 (1.47 1.81)	1.88 (1.67 2.08)	2.17 (1.91 2.43)	2.51 (2.17 2.84)	3.10 (2.61 3.57)	3.63 (2.98 4.24)
12-hr	0.958 (0.880 1.04)	1.19 (1.09 1.29)	1.45 (1.33 1.59)	1.68 (1.53 1.84)	1.99 (1.80 2.18)	2.24 (2.01 2.47)	2.50 (2.22 2.77)	2.83 (2.48 3.17)	3.44 (2.86 3.90)	4.00 (3.40 4.59)
24-hr	1.09 (0.995 1.19)	1.35 (1.24 1.48)	1.67 (1.53 1.82)	1.92 (1.76 2.10)	2.29 (2.08 2.50)	2.57 (2.33 2.81)	2.86 (2.59 3.14)	3.16 (2.84 3.48)	3.58 (3.17 3.95)	4.04 (3.43 4.64)
2-day	1.28 (1.19 1.39)	1.59 (1.47 1.73)	1.96 (1.81 2.13)	2.27 (2.10 2.46)	2.71 (2.48 2.94)	3.06 (2.79 3.33)	3.43 (3.10 3.74)	3.81 (3.42 4.17)	4.36 (3.86 4.80)	4.79 (4.19 5.30)
3-day	1.42 (1.31 1.55)	1.76 (1.63 1.92)	2.17 (2.01 2.37)	2.52 (2.32 2.74)	3.02 (2.76 3.28)	3.42 (3.11 3.72)	3.84 (3.46 4.18)	4.28 (3.83 4.68)	4.90 (4.33 5.40)	5.40 (4.71 5.98)
4-day	1.56 (1.44 1.71)	1.94 (1.79 2.12)	2.39 (2.20 2.61)	2.78 (2.55 3.02)	3.33 (3.04 3.62)	3.77 (3.43 4.11)	4.24 (3.82 4.63)	4.74 (4.23 5.19)	5.45 (4.80 6.00)	6.02 (5.24 6.67)
7-day	1.91 (1.76 2.10)	2.38 (2.18 2.61)	2.93 (2.69 3.21)	3.38 (3.10 3.71)	4.00 (3.65 4.39)	4.49 (4.07 4.92)	5.00 (4.50 5.49)	5.52 (4.94 6.08)	6.23 (5.51 6.90)	6.79 (5.95 7.56)
10-day	2.23 (2.04 2.46)	2.78 (2.54 3.06)	3.42 (3.12 3.76)	3.93 (3.57 4.32)	4.62 (4.18 5.08)	5.15 (4.64 5.68)	5.70 (5.11 6.30)	6.25 (5.57 6.93)	6.99 (6.15 7.78)	7.56 (6.60 8.46)
20-day	3.06 (2.77 3.38)	3.80 (3.44 4.20)	4.66 (4.21 5.14)	5.32 (4.81 5.88)	6.19 (5.57 6.84)	6.84 (6.13 7.56)	7.49 (6.68 8.30)	8.13 (7.22 9.02)	8.97 (7.90 10.0)	9.60 (8.39 10.7)
30-day	3.78 (3.44 4.15)	4.69 (4.28 5.16)	5.72 (5.21 6.29)	6.51 (5.92 7.15)	7.55 (6.84 8.29)	8.31 (7.51 9.14)	9.07 (8.16 9.99)	9.82 (8.78 10.8)	10.8 (9.57 12.0)	11.5 (10.1 12.8)
45-day	4.78 (4.34 5.28)	5.94 (5.39 6.57)	7.23 (6.56 7.99)	8.22 (7.43 9.07)	9.48 (8.54 10.5)	10.4 (9.36 11.5)	11.3 (10.1 12.6)	12.2 (10.9 13.6)	13.4 (11.8 14.9)	14.3 (12.5 16.0)
60-day	5.68 (5.19 6.24)	7.09 (6.47 7.79)	8.62 (7.87 9.48)	9.77 (8.89 10.7)	11.2 (10.2 12.3)	12.3 (11.1 13.5)	13.3 (12.0 14.7)	14.3 (12.8 15.8)	15.6 (13.8 17.3)	16.5 (14.6 18.4)

[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

http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_printpage.html?lat=38.9017&lon=-111.5017&data=depth&units=english&series=pds[1/7/2014 9:57:43 AM]

A.2. HEC-HMS CALCULATIONS

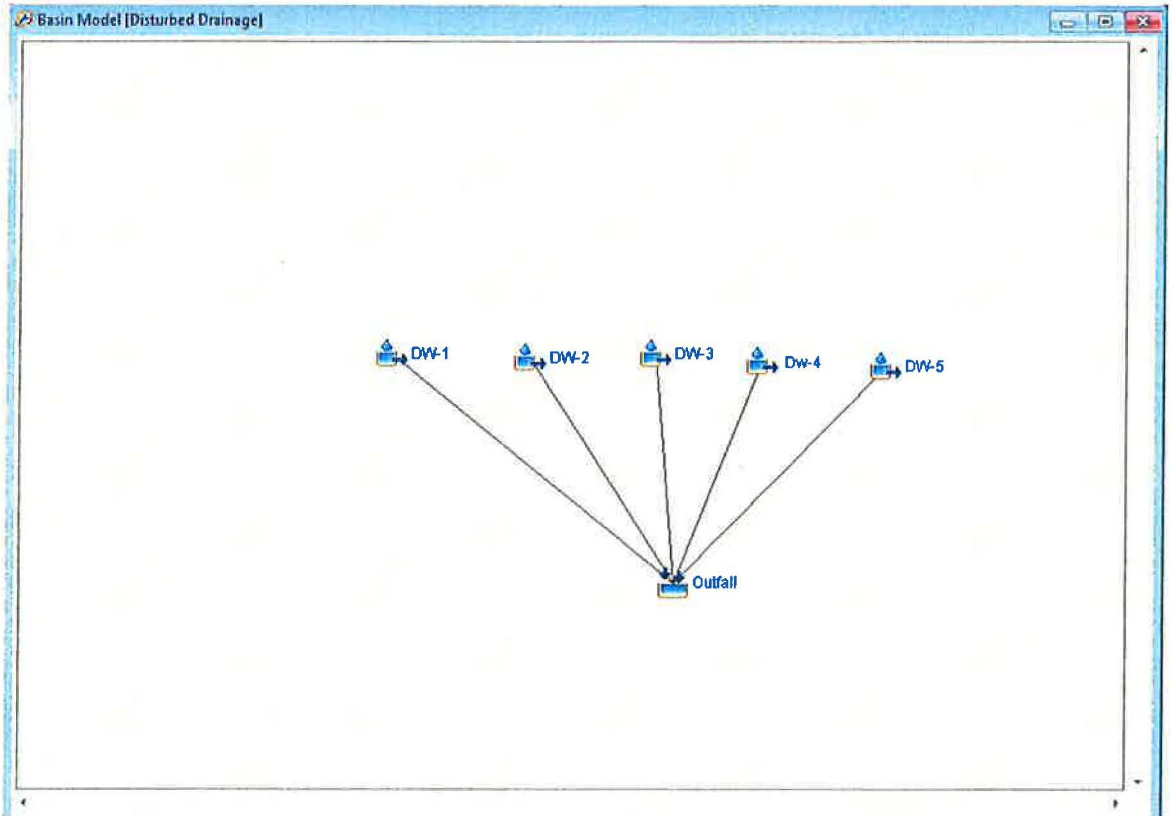


Table A 1. Global Summary Results for Disturbed Drainage, 10yr 24-hr Storm Event

Catchment	Area (MI2)	Peak Discharge (CFS)	Volume (AC-FT)
DW-1	0.049	37.5	2.7
DW-2	0.010	4.0	0.3
DW-3	0.002	0.8	0.1
DW-4	0.003	1.2	0.1
DW-5	0.002	1.9	0.2
Outfall*	0.066	45.4	3.3

***Outfall is total runoff flows and volumes from subareas**

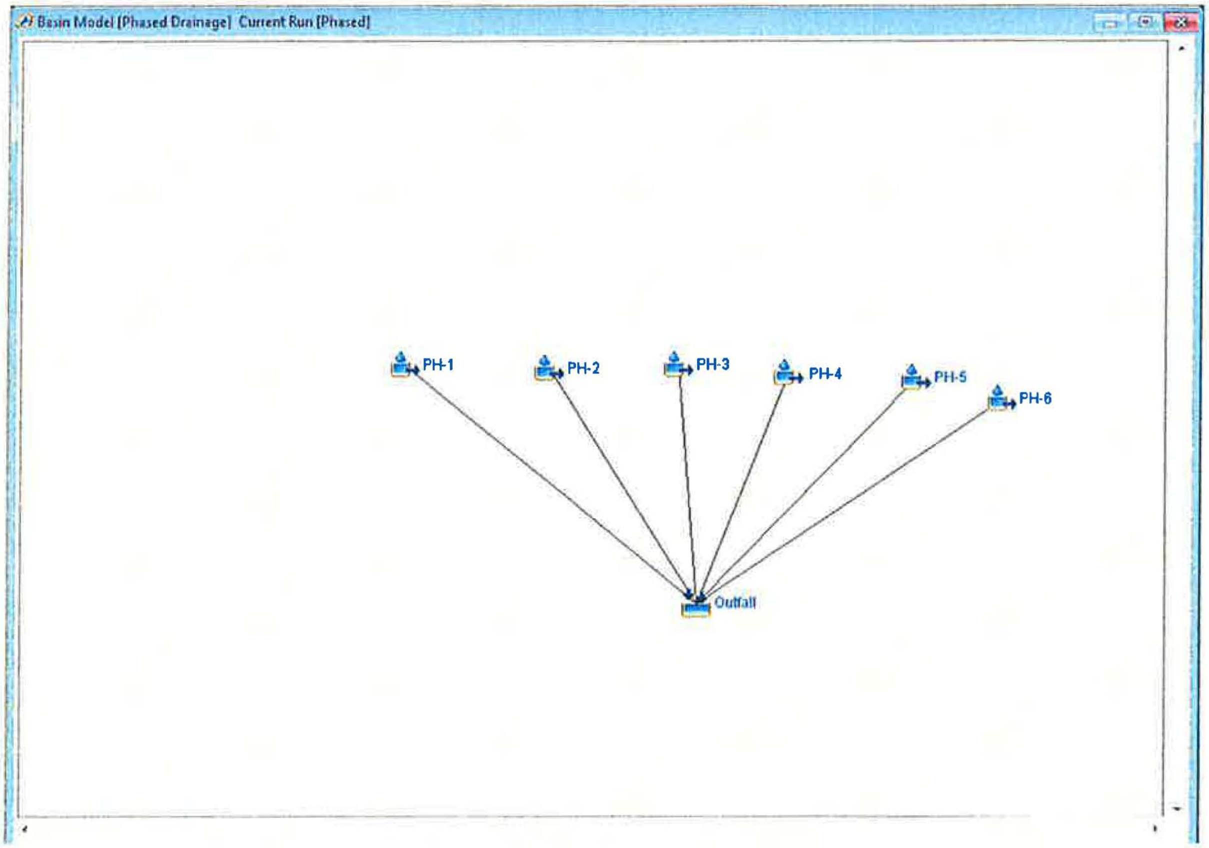


Table A 2. Global Summary Results for Phase Subbasins, 10yr 24-hr Storm Event

Catchment	Area (MI2)	Peak Discharge (CFS)	Volume (AC-FT)
PH-1	0.0096	8.28	0.54
PH-2	0.0066	7.27	0.37
PH-3	0.0068	7.49	0.38
PH-4	0.0072	7.93	0.40
PH-5	0.0066	7.27	0.37
PH-6	0.0014	1.54	0.08
Outfall*	0.0383	39.80	2.13

*Outfall is totol runoff flows and volumes from subareas

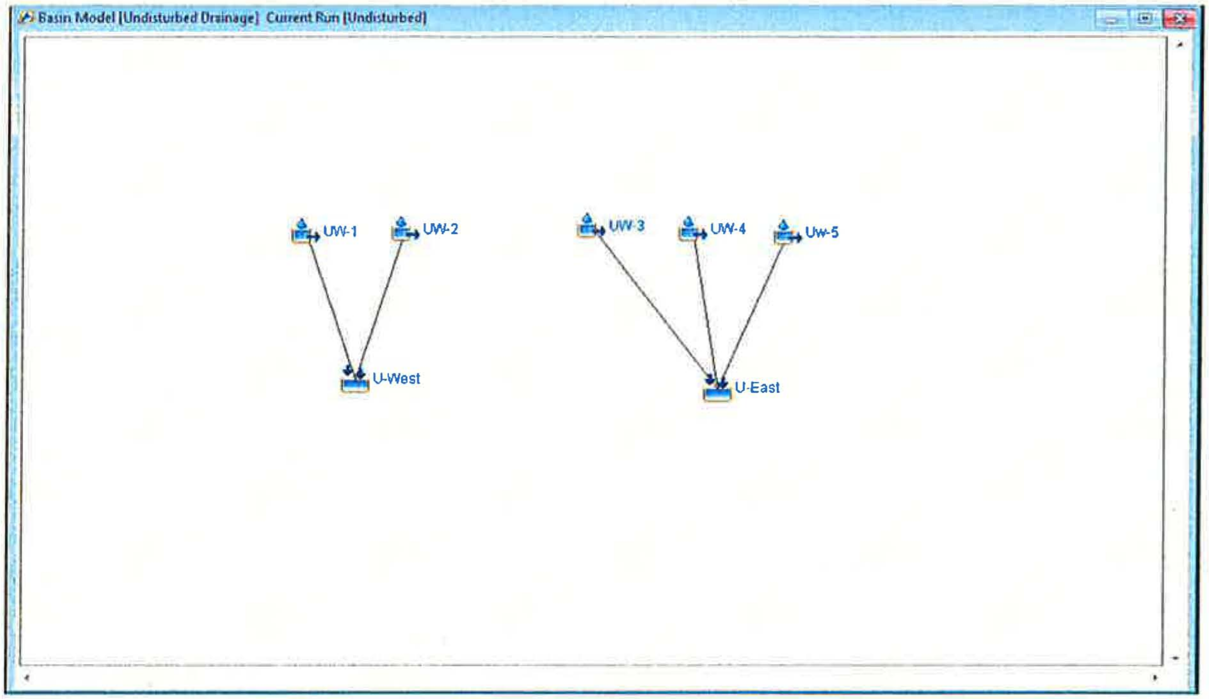


Table A 3. Global Summary Results for Undisturbed Drainage, 10yr 24-hr Storm Event

Catchment	Area (MI2)	Peak Discharge (CFS)	Volume (AC-FT)
UW-1	0.002	0.8	0.1
UW-2	0.012	0.2	0.1
U-West	0.014	1.0	0.1
UW-3	0.016	0.3	0.1
UW-4	0.113	1.8	0.7
UW-5	0.207	3.2	1.2
U-East	0.336	5.2	1.9

APPENDIX B. HYDRAULICS

B.1. CHANNEL SIZING

Cross Section for CC-1

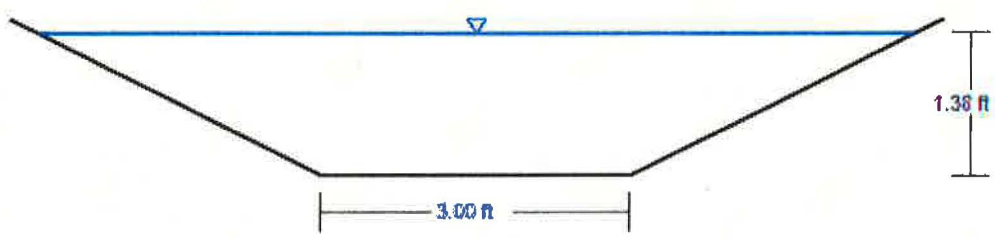
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.069	
Channel Slope	0.05800	ft/ft
Normal Depth	1.38	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	37.50	ft^3/s

Cross Section Image



Cross Section for DD-10

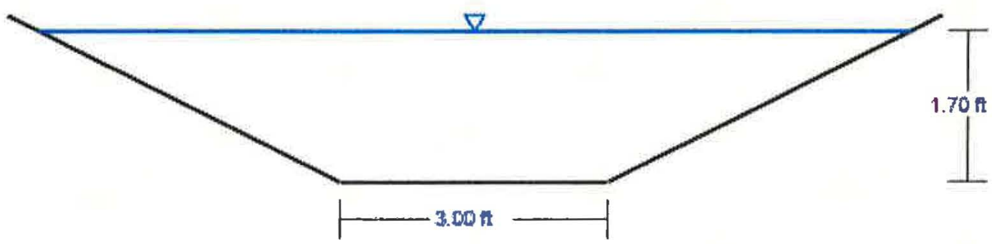
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.069	
Channel Slope	0.03600	ft/ft
Normal Depth	1.70	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	45.40	ft³/s

Cross Section Image



Cross Section for DD-1 - DD-9

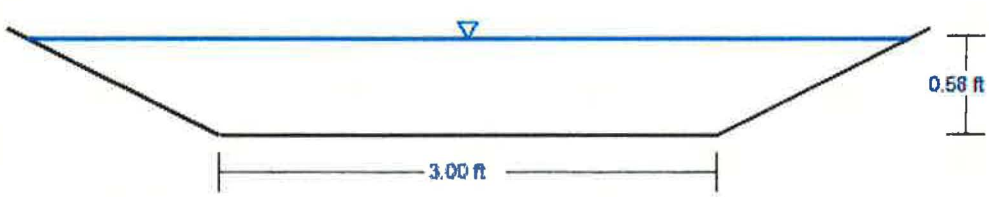
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.020	
Channel Slope	0.09000	ft/ft
Normal Depth	0.58	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	31.00	ft³/s

Cross Section Image



Cross Section for DB-1, DB-2

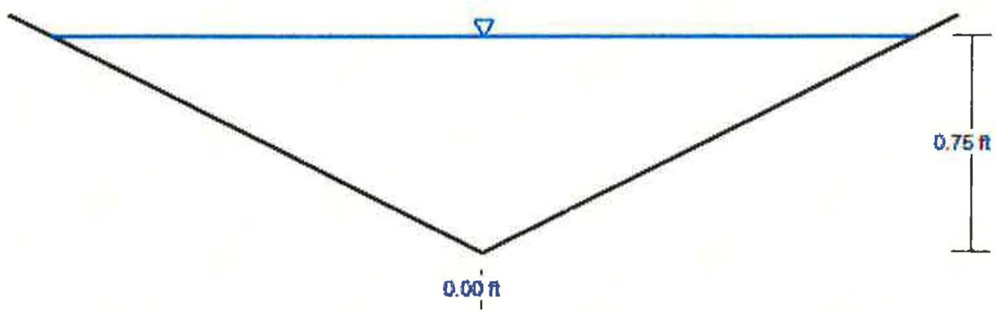
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.03000	ft/ft
Normal Depth	0.75	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	0.00	ft
Discharge	4.00	ft³/s

Cross Section Image



Cross Section for UB-1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.045	
Channel Slope	0.03600	ft/ft
Normal Depth	0.16	ft
Left Side Slope	62.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Discharge	1.00	ft³/s

Cross Section Image

Cross Section for UD-1

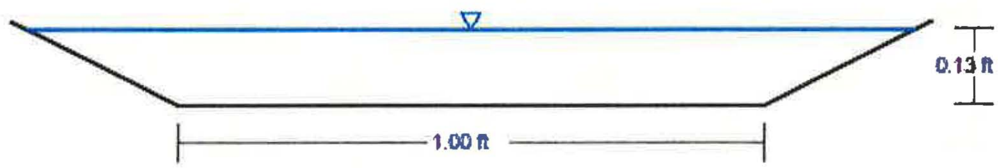
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.060	
Channel Slope	0.10800	ft/ft
Normal Depth	0.13	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	1.00	ft
Discharge	0.30	ft³/s

Cross Section Image



B.2. RIPRAP SIZING

Table B 1. Riprap Sizing for CC-1

Riprap Sizing Calculations
CC-1 22-Jan-15

Method	Estimated Riprap Size	
	d_{50} (ft)	d_{50} (in)
Maynord	0.35	4.20
USBR	0.45	5.41
Isbash	0.47	5.59
HEC-11	0.43	5.20
ASCE	0.48	5.71
Average Value	**0.44**	**5.22**

Modify Sheet as necessary

USER INPUT			
d (ft) =	1.4	average water depth in channel (ft)	
V (ft/s) =	5.8	average channel velocity (fps)	
r (ft) =	250.0	average bend radius (ft.)	
w (ft.) =	5.0	average channel width (ft.)	
g =	32.2	gravitational constant (ft./s^2)	
θ =	26.6	angle of side slope to horizontal	
Φ =	40.0	angle of repose for angular riprap	
γ =	62.4	unit weight of water (lb./ft^3)	
γ_s =	156.0	unit weight of stone (lb./ft^3)	
Y_{max}	2.0	ft.	
Q =	37.5	cfs	
$Q_{channel}$ =	80.7	cfs	
d_{50} =	0.8	inches	existing channel
d_{50} =	21.2	mm	

Table B 2. Riprap sizing for DD-5

Riprap Sizing Calculations

DD-10

22-Jan-15

Method	Estimated Riprap Size	
	d_{50} (ft.)	d_{50} (in)
Maynord	0.29	3.47
USBR	0.38	4.51
Isbash	0.39	4.68
HEC-11	0.32	3.87
ASCE	0.40	4.78
Average Value	**0.36**	**4.26**

Modify Sheet as necessary

USER INPUT			
d (ft.) =	1.5	average water depth in channel (ft.)	
V (ft./s) =	5.3	average channel velocity (fps)	
r (ft.) =	150.0	average bend radius (ft.)	
w (ft.) =	5.0	average channel width (ft.)	
g =	32.2	gravitational constant (ft./s^2)	
θ =	26.6	angle of side slope to horizontal	
Φ =	40.0	angle of repose for angular riprap	
γ =	62.4	unit weight of water (lb./ft^3)	
γ_s =	156.0	unit weight of stone (lb./ft^3)	
Y_{max}	2.0	ft.	
Q =	45.4	cfs	
$Q_{channel}$ =	80.7	cfs	
d_{50} =	0.8	inches	existing channel
d_{50} =	21.2	mm	

Table B 3. Riprap sizing for UD-1

Riprap Sizing Calculations

UD-1 22-Jan-15

Method	Estimated Riprap Size	
	d_{50} (ft.)	d_{50} (in)
Maynord	0.06	0.78
USBR	0.07	0.87
Isbash	0.08	0.95
HEC-11	0.10	1.19
ASCE	0.08	0.97
Average Value	**0.08**	**0.95**

Modify Sheet as necessary

USER INPUT			
d (ft.) =	0.1	average water depth in channel (ft.)	
V (ft./s) =	2.4	average channel velocity (fps)	
r (ft.) =	150.0	average bend radius (ft.)	
w (ft.) =	1.5	average channel width (ft.)	
g =	32.2	gravitational constant (ft./s^2)	
θ =	26.6	angle of side slope to horizontal	
Φ =	40.0	angle of repose for angular riprap	
γ =	62.4	unit weight of water (lb./ft^3)	
γ_s =	156.0	unit weight of stone (lb./ft^3)	
Y_{max}	1.0	ft.	
Q =	0.3	cfs	
$Q_{channel}$ =	24.5	cfs	
d_{50} =	0.8	inches	existing channel
d_{50} =	21.2	mm	

B.3. CULVERT SIZING

Cross Section for DC-1, DC-2

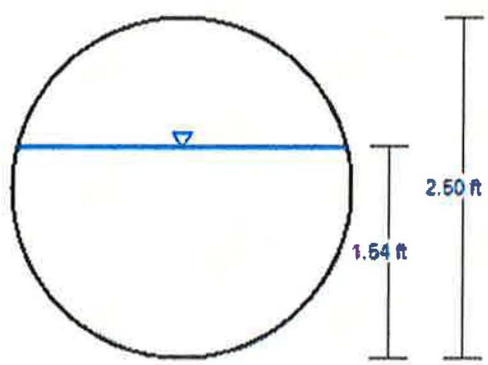
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.05800	ft/ft
Normal Depth	1.54	ft
Diameter	2.50	ft
Discharge	37.50	ft^3/s

Cross Section Image



Cross Section for DC-3

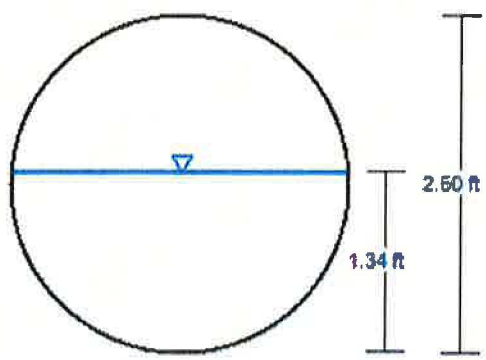
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.09000	ft/ft
Normal Depth	1.34	ft
Diameter	2.50	ft
Discharge	37.50	ft³/s

Cross Section Image



Cross Section for DC-4

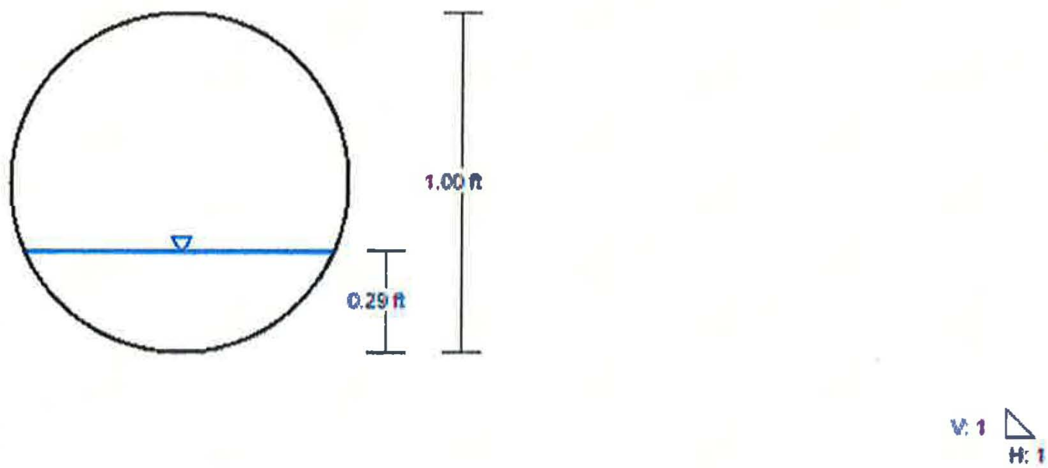
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.30000	ft/ft
Normal Depth	0.29	ft
Diameter	1.00	ft
Discharge	4.00	ft³/s

Cross Section Image



Cross Section for UC-3

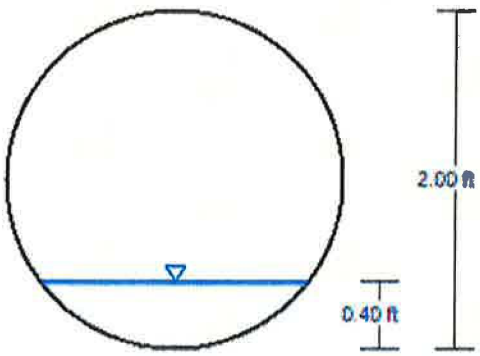
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.06000	ft/ft
Normal Depth	0.40	ft
Diameter	2.00	ft
Discharge	5.20	ft³/s

Cross Section Image



Cross Section for UC-4

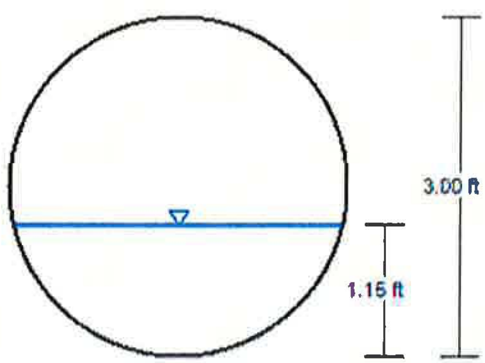
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

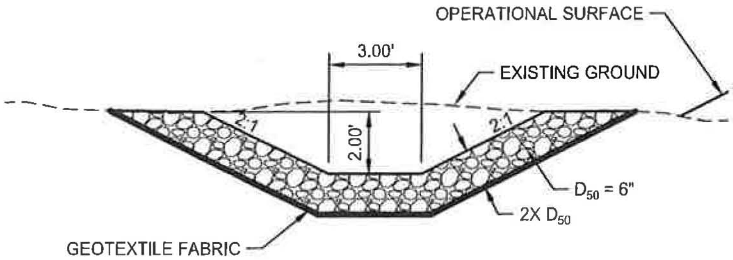
Roughness Coefficient	0.012	
Channel Slope	0.05000	ft/ft
Normal Depth	1.15	ft
Diameter	3.00	ft
Discharge	50.60	ft³/s

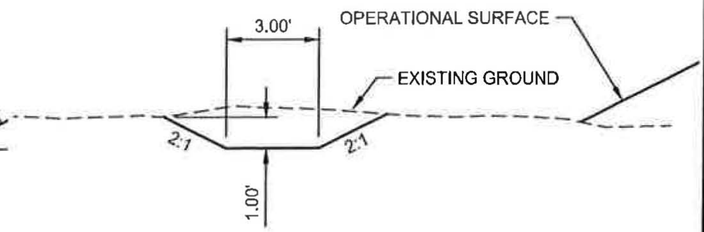
Cross Section Image



V: 1

APPENDIX C. CONVEYANCE STRUCTURES DETAILS



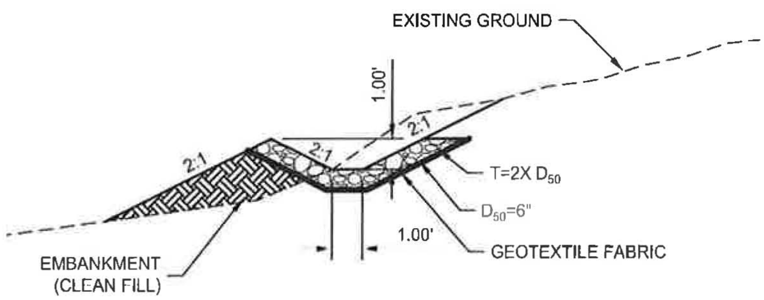


DISTURBED DITCH DETAIL

USE ON DITCHES DD-1, DD-2, DD-3, DD-4, DD-5, DD-6, DD-7, DD-8 & DD-9

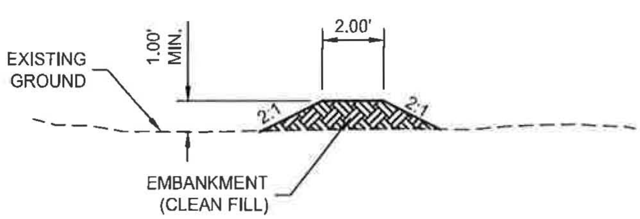
DISTURBED DITCH RIPRAP DETAIL

USE ON DITCHES CC-1 & DD-10



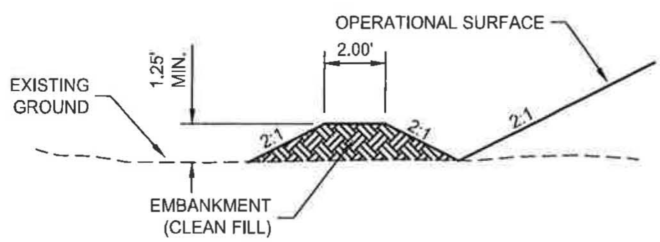
UNDISTURBED DITCH DETAIL

USE ON DITCH UD-1



UNDISTURBED BERM DETAIL

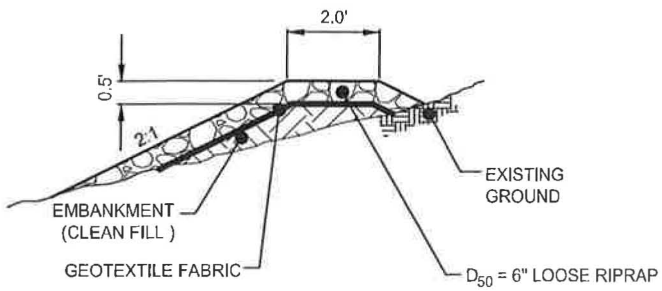
USE ON BERMS UB-1



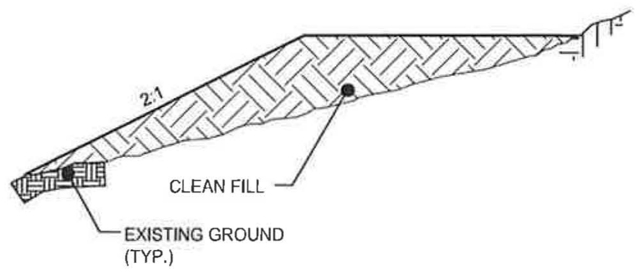
DISTURBED BERM DETAIL

USE ON BERMS DB-1 & DB-2

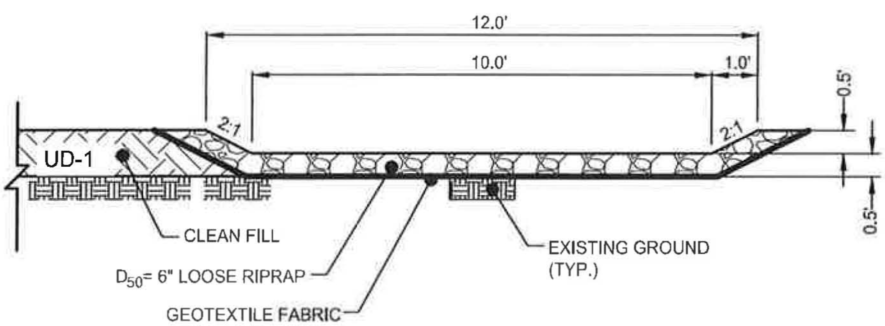
Appendix VII



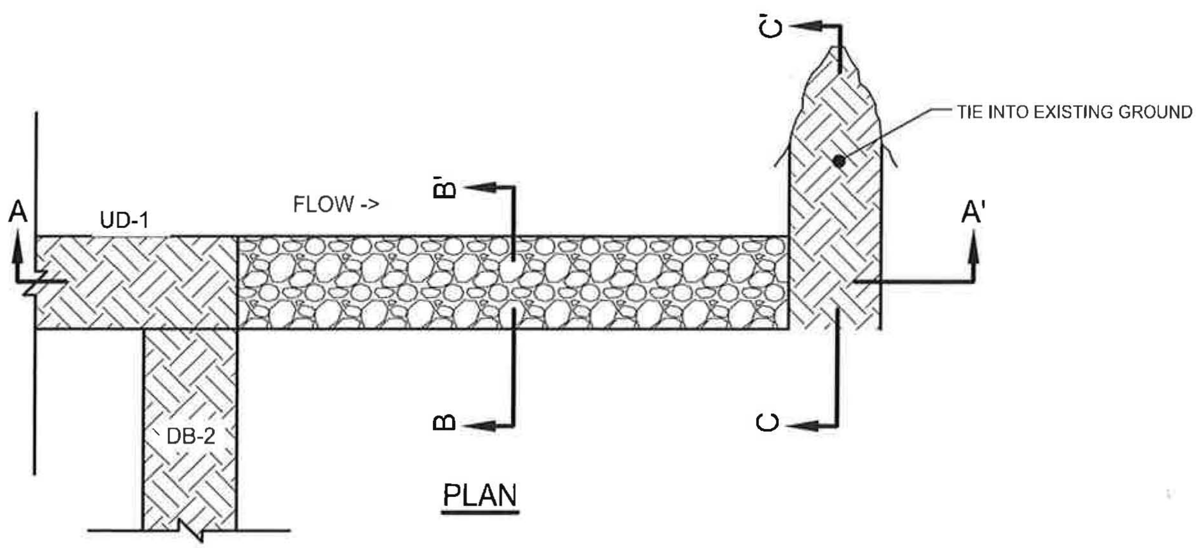
SECTION B-B'



SECTION C-C'



SECTION A-A'

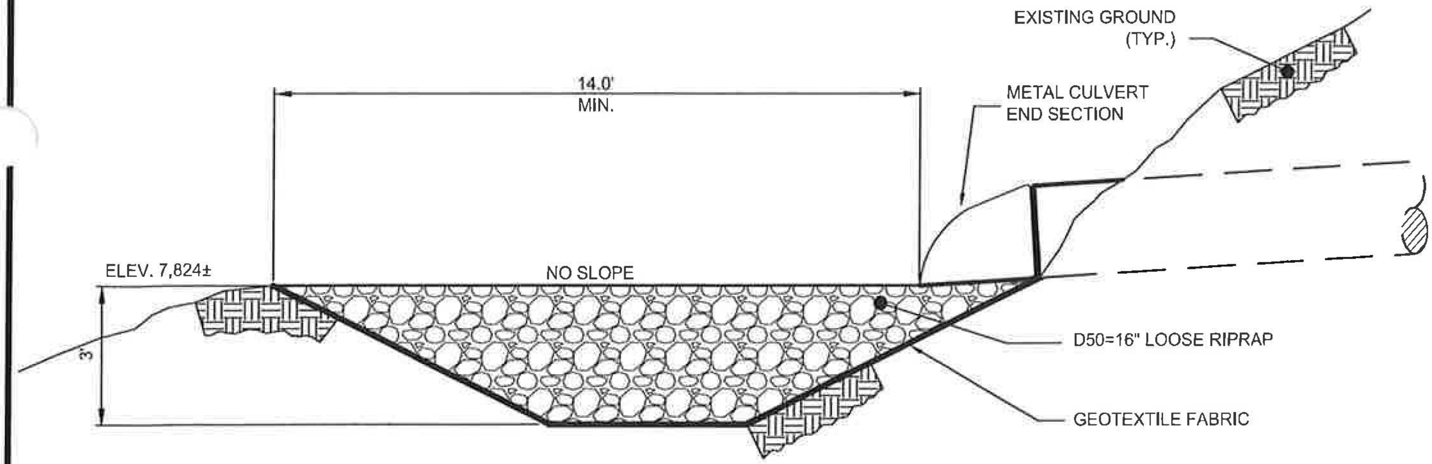


PLAN

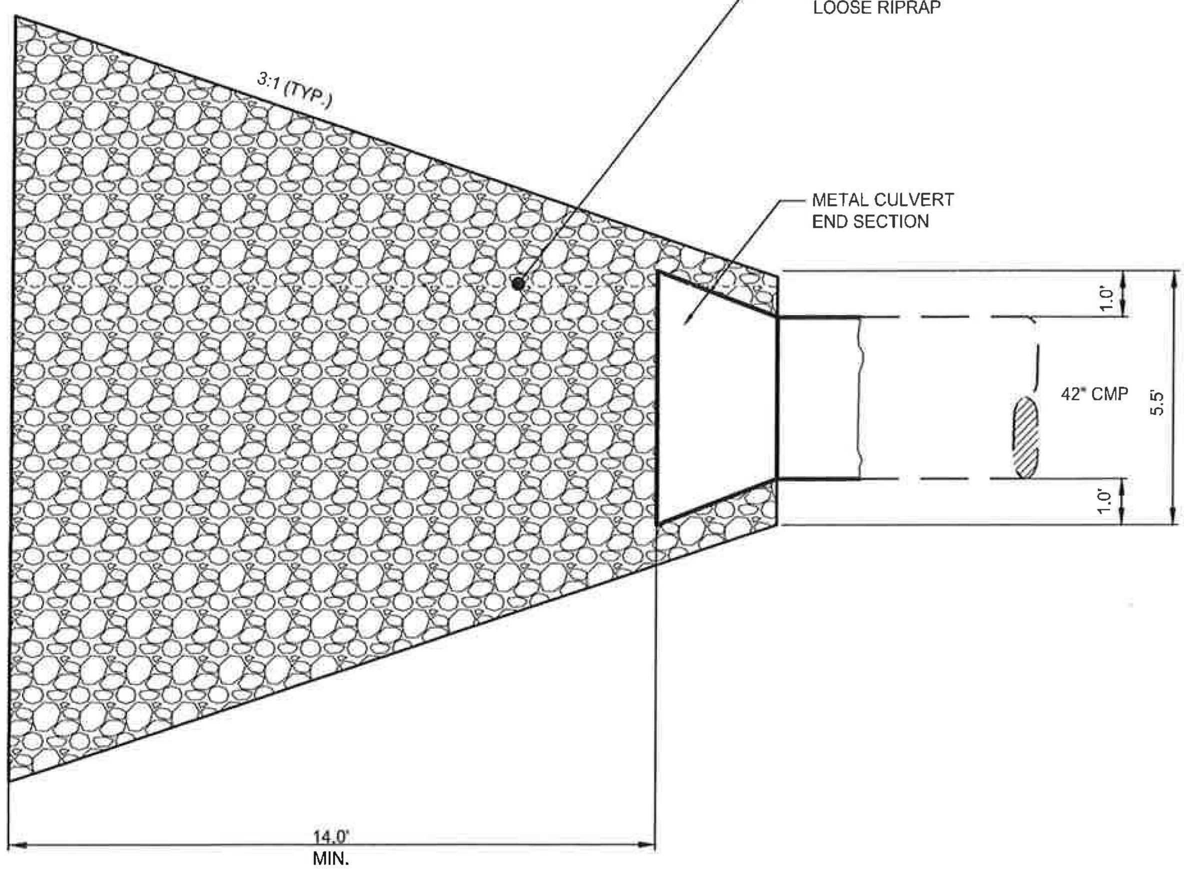
LEVEL SPREADER DETAIL

NO SCALE

Appendix VII



SECTION

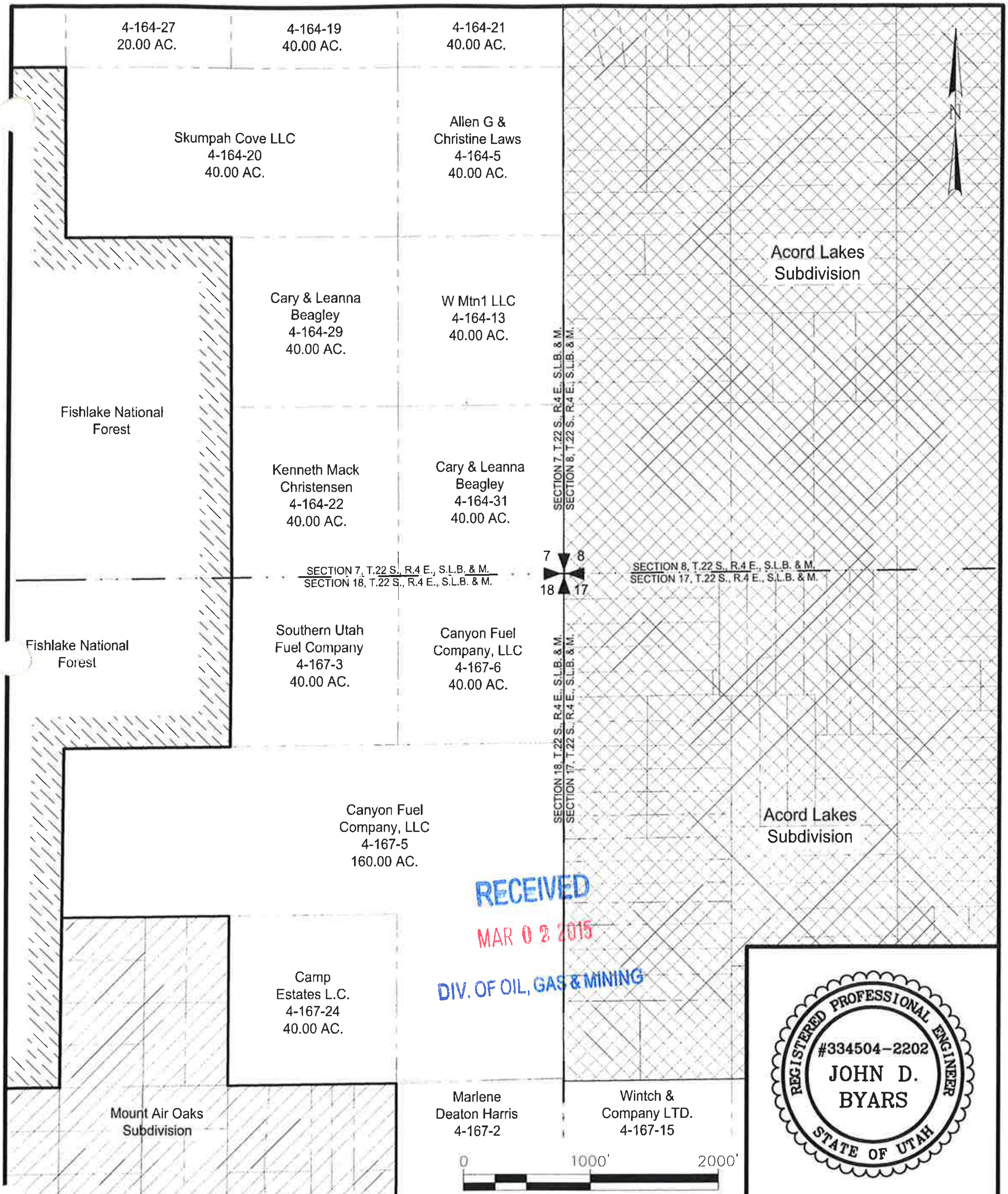


PLAN

UC-4 OUTFALL DETAIL

NO SCALE

Appendix VII



Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 - Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

Underground Development Waste Disposal Site – Property Ownership

SCALE: 1" = 1000'	DATE: 6/2/2014	DRAWN BY: K.B.B.	SHEET NO. Map1
ENGINEER: J.D.B.	CHECKED BY: K.B.B.	PROJ:	
FILE NAME: H:\DRAWINGS\MRP\PLATES\WRDS MAP1v2.dwg			

Sufco Waste Rock Topsoil / Subsoil

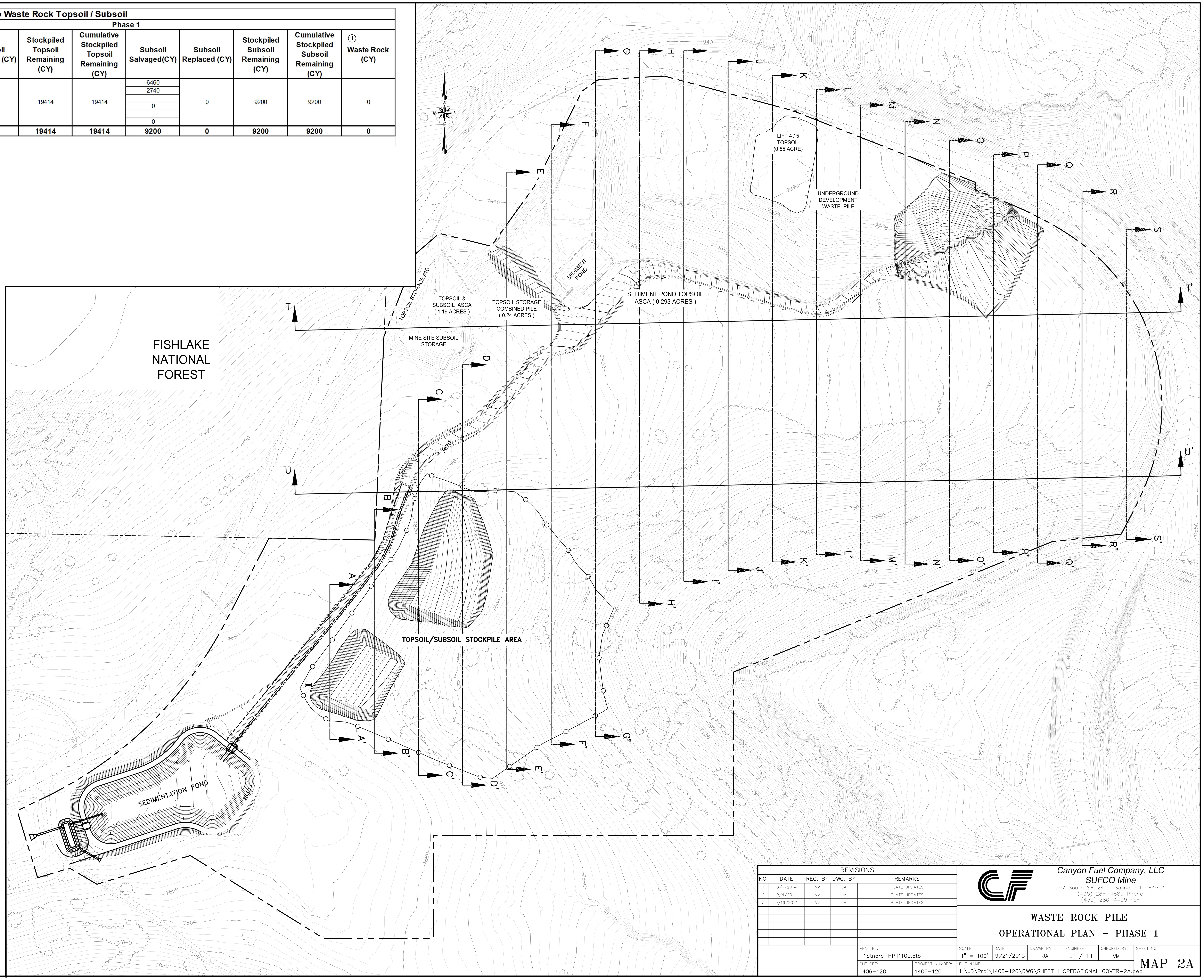
*Soil Type	Topsoil (Inches)	Subsoil (Inches)	Phase 1									
			Area (SF)	Topsoil Salvaged (CY)	Topsoil Replaced (CY)	Stockpiled Topsoil Remaining (CY)	Cumulative Stockpiled Topsoil Remaining (CY)	Subsoil Salvaged(CY)	Subsoil Replaced (CY)	Stockpiled Subsoil Remaining (CY)	Cumulative Stockpiled Subsoil Remaining (CY)	① Waste Rock (CY)
1	20	38	55080	3400	5086	19414	19414	6460	0	9200	9200	0
2	35	33	158297	17100				2740				
3	26	12										
4	19	0	8526	500				0				
5	17	9										
Rehandled Soils	30	0	37800	3500				0				
Total				**24500**	**5086**	**19414**	**19414**	**9200**	**0**	**9200**	**9200**	**0**

***See Fig. 5 for Soil Type Map**

NOTE:

1 SEE MAPS 4A - 4F FOR DIMENSIONS OF SOIL STORAGE STOCKPILES.

② THERE WILL BE NO WASTE ROCK PLACEMENT IN PHASE 1.
PHASE 1 WILL BE ONLY ROADWAY AND SEDIMENT POND CONSTRUCTION.



LEGEND

- EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- OPERATIONAL GROUND MAJOR CONTOUR (5 FOOT)
- OPERATIONAL GROUND MINOR CONTOUR (1 FOOT)
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- EXISTING TREELINE
- OPERATIONAL CROSS SECTION LOCATION (SEE MAP 3A, MAP 3B AND MAP 3C FOR CROSS-SECTIONS)

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

WASTE ROCK PILE
OPERATIONAL PLAN – PHASE 1

PEN TBL:	SHT SET:	PROJECT NUMBER:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1406–120	1406–120	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 2A

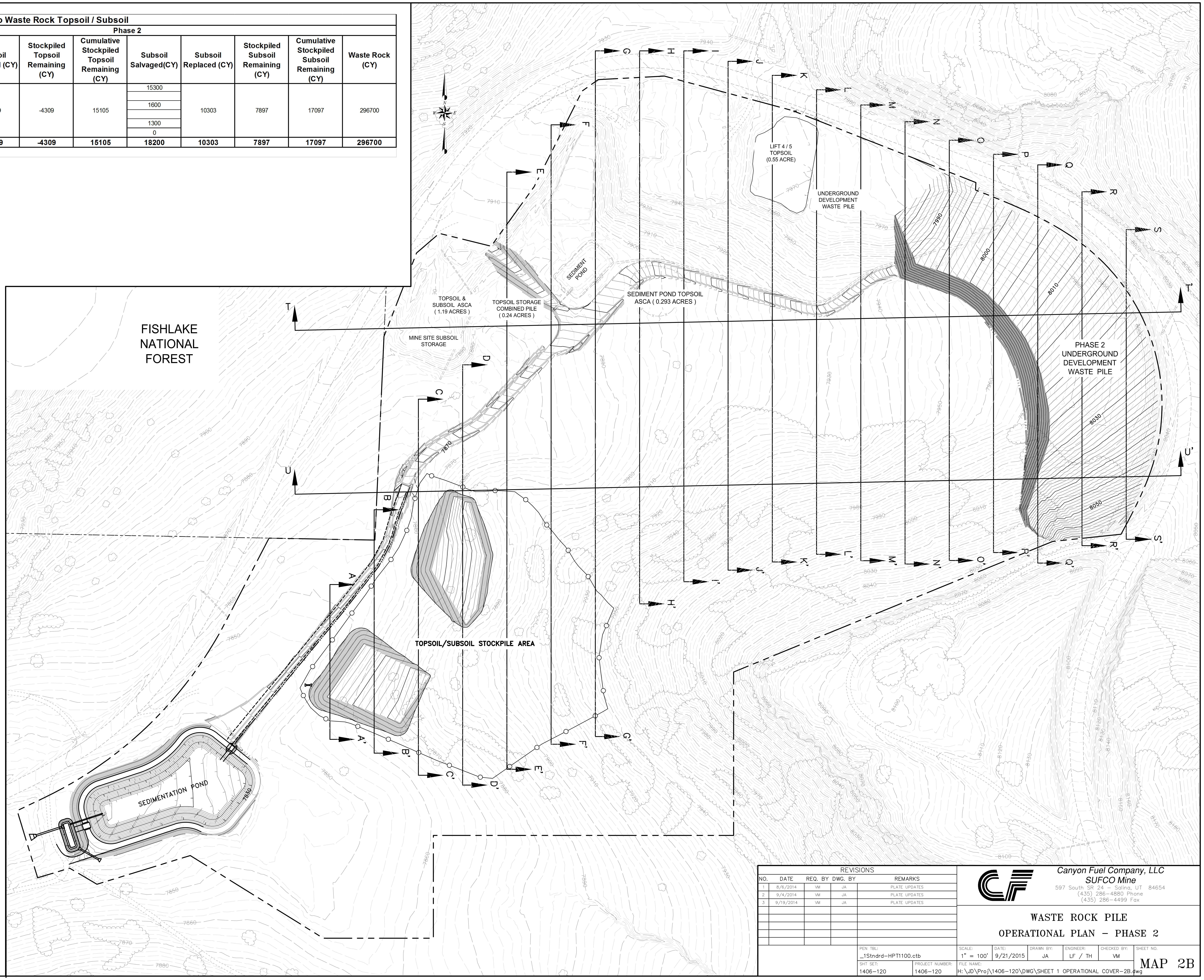
FILE NAME: H:\JD\Proj\1406–120\DWG\SHEET 1 OPERATIONAL COVER–2A.dwg

Sufco Waste Rock Topsoil / Subsoil

*Soil Type	Topsoil (Inches)	Subsoil (Inches)	Phase 2									
			Area (SF)	Topsoil Salvaged (CY)	Topsoil Replaced (CY)	Stockpiled Topsoil Remaining (CY)	Cumulative Stockpiled Topsoil Remaining (CY)	Subsoil Salvaged(CY)	Subsoil Replaced (CY)	Stockpiled Subsoil Remaining (CY)	Cumulative Stockpiled Subsoil Remaining (CY)	Waste Rock (CY)
1	20	38	106920	6600	16809	-4309	15105	15300	10303	7897	17097	296700
2	35	33										
3	26	12	42369	3400				1600				
4	19	0										
5	17	9	47647	2500				1300				
Rehandled Soils	30	0	0	0				0				
Total				**12500**	**16809**	**-4309**	**15105**	**18200**	**10303**	**7897**	**17097**	**296700**

***See Fig. 5 for Soil Type Map**

NOTE:
1 SEE MAPS 4A - 4F FOR DIMENSIONS OF SOIL STORAGE STOCKPILES.



LEGEND

- EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- OPERATIONAL GROUND MAJOR CONTOUR (5 FOOT)
- OPERATIONAL GROUND MINOR CONTOUR (1 FOOT)
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- EXISTING TREELINE
- OPERATIONAL CROSS SECTION LOCATION (SEE MAP 3A, MAP 3B AND MAP 3C FOR CROSS-SECTIONS)

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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WASTE ROCK PILE
OPERATIONAL PLAN – PHASE 2

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-HPT1100.ctb	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 2B

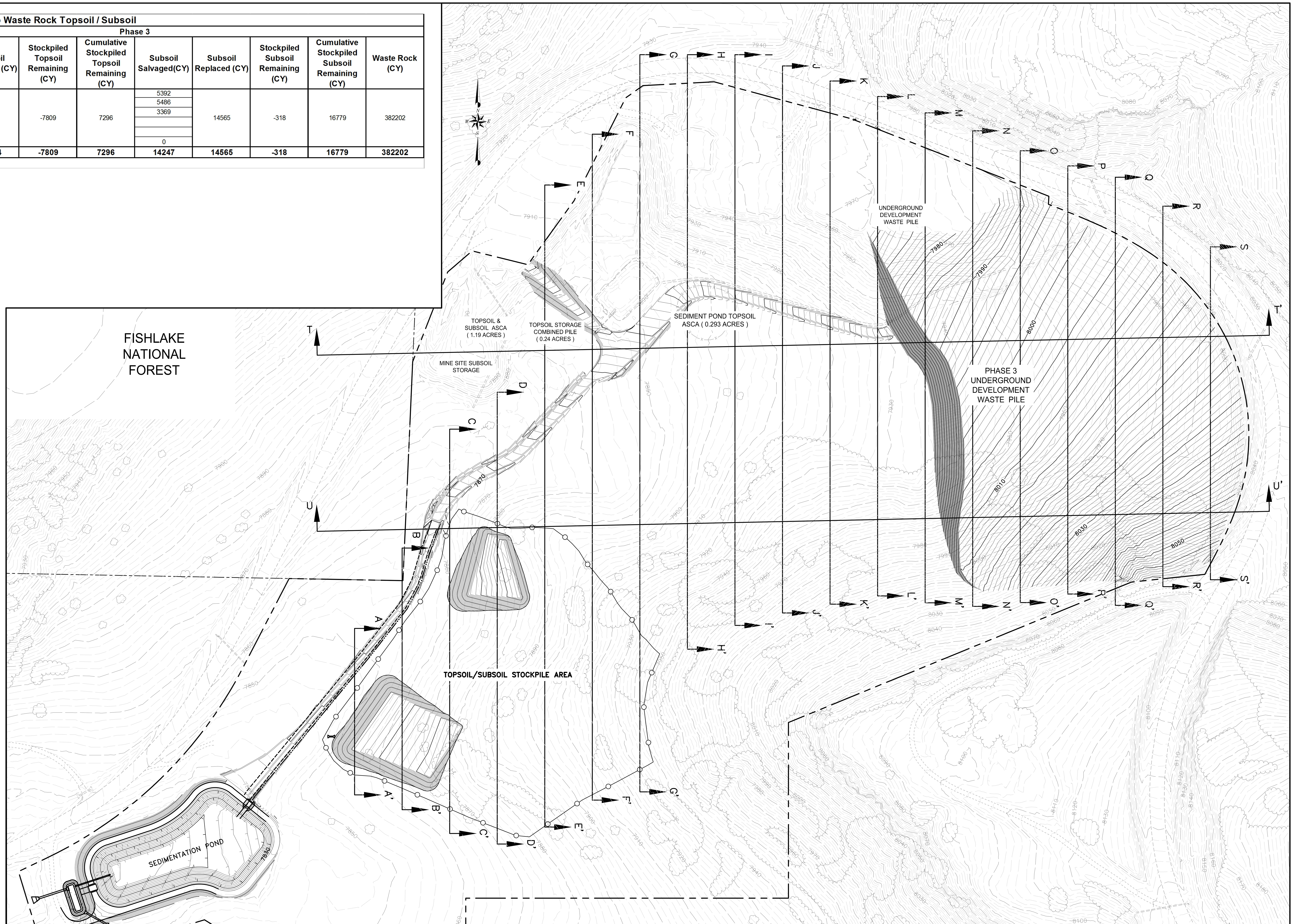
SHT SET: 1406-120
PROJECT NUMBER: 1406-120
FILE NAME: H:\JD\Proj\1406-120\DWG\SHEET 1 OPERATIONAL COVER-2B.dwg

Sufco Waste Rock Topsoil / Subsoil												
			Phase 3									
*Soil Type	Topsoil (Inches)	Subsoil (Inches)	Area (SF)	Topsoil Salvaged (CY)	Topsoil Replaced (CY)	Stockpiled Topsoil Remaining (CY)	Cumulative Stockpiled Topsoil Remaining (CY)	Subsoil Salvaged(CY)	Subsoil Replaced (CY)	Stockpiled Subsoil Remaining (CY)	Cumulative Stockpiled Subsoil Remaining (CY)	Waste Rock (CY)
1	20	38	45978	2838	23764	-7809	7296	5392	14565	-318	16779	382202
2	35	33	53858	5818				5486				
3	26	12	90961	7299				3369				
4	19	0										
5	17	9										
Rehandled Soils	30	0	25897	2398				0				
Total				**15955**	**23764**	**-7809**	**7296**	**14247**	**14565**	**-318**	**16779**	**382202**

***See Fig. 5 for Soil Type Map**

NOTE:

1 SEE MAPS 4A - 4F FOR DIMENSIONS OF SOIL STORAGE STOCKPILES.



LEGEND

EXISTING GROUND MAJOR CONTOUR (10 FOOT)

EXISTING GROUND MINOR CONTOUR (2 FOOT)

OPERATIONAL GROUND MAJOR CONTOUR (5 FOOT)

OPERATIONAL GROUND MINOR CONTOUR (1 FOOT)

EXISTING ROAD

EXISTING PAVED ROAD

PROPOSED ANCILLARY ROAD

EXISTING CULVERT

PROPOSED CULVERT

TOPSOIL / SUBSOIL STORAGE BOUNDARY

PROPOSED DITCH

DISTURBED AREA BOUNDARY

PROPERTY BOUNDARY

EXISTING TREELINE

OPERATIONAL CROSS SECTION LOCATION (SEE MAP 3A, MAP 3B AND MAP 3C FOR CROSS-SECTIONS)

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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WASTE ROCK PILE

OPERATIONAL PLAN – PHASE 3

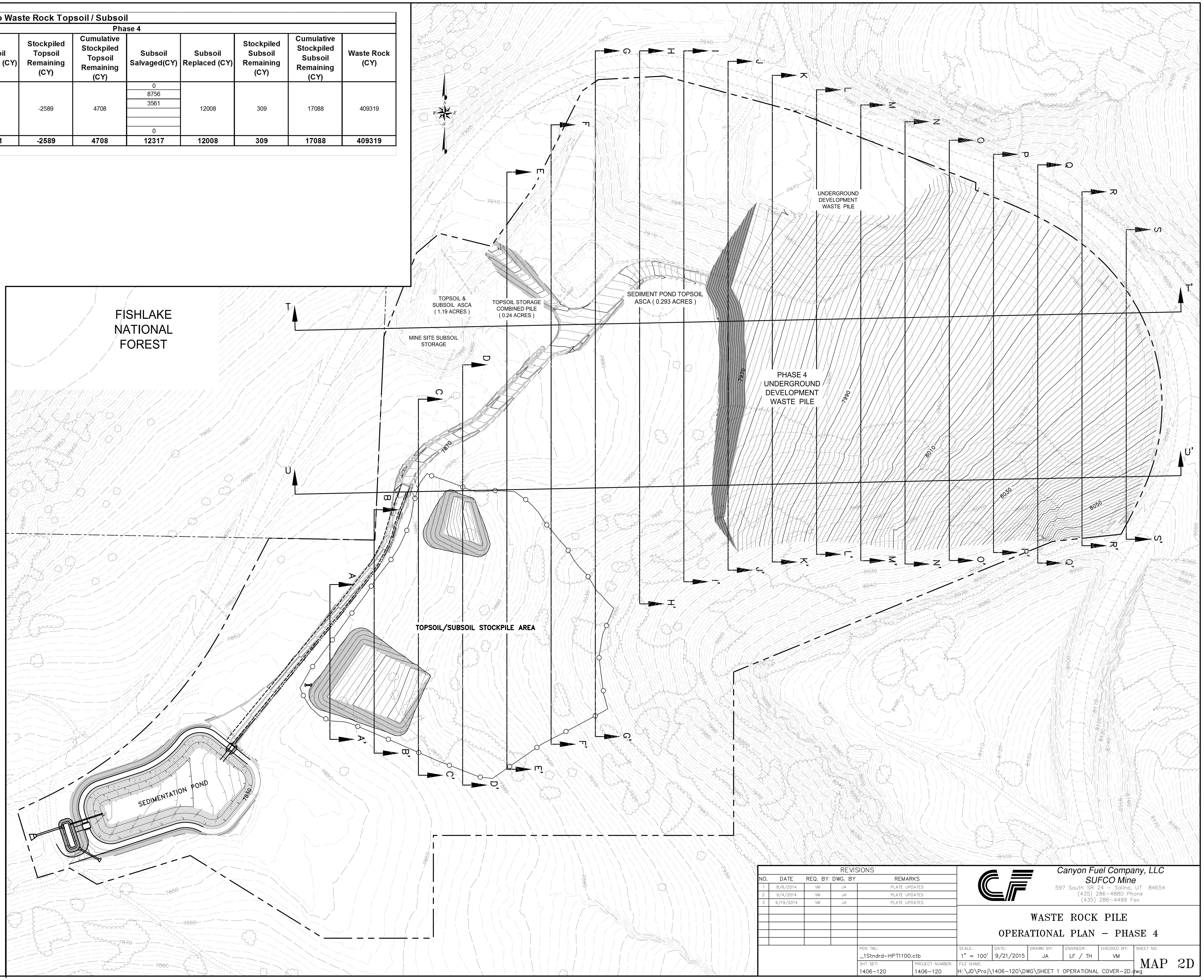
PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 2C

SHT SET: 1406–120 | PROJECT NUMBER: 1406–120 | FILE NAME: H:\JD\Proj\1406–120\DWG\SHEET 1 OPERATIONAL COVER–2C.dwg

Sufco Waste Rock Topsoil / Subsoil													
			Phase 4										
Soil Type	Topsoil (Inches)	Subsoil (Inches)	Area (SF)	Topsoil Salvaged (CY)	Topsoil Replaced (CY)	Stockpiled Topsoil Remaining (CY)	Cumulative Stockpiled Topsoil Remaining (CY)	Subsoil Salvaged(CY)	Subsoil Replaced (CY)	Stockpiled Subsoil Remaining (CY)	Cumulative Stockpiled Subsoil Remaining (CY)	Waste Rock (CY)
1	20	38		0				0				
2	35	33	85964	9286				8756				
3	26	12	96154	7716	19591	-2589	4708	3561	12008	309	17088	409319
4	19	0										
5	17	9										
Rehandled Soils	30	0	36023	3335				0				
Total				**17002**	**19591**	**-2589**	**4708**	**12317**	**12008**	**309**	**17088**	**409319**

***See Fig. 5 for Soil Type Map**

NOTE:
1 SEE MAPS 4A - 4F FOR DIMENSIONS OF SOIL STORAGE STOCKPILES.



LEGEND

- EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- OPERATIONAL GROUND MAJOR CONTOUR (5 FOOT)
- OPERATIONAL GROUND MINOR CONTOUR (1 FOOT)
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- EXISTING TREELINE
- OPERATIONAL CROSS SECTION LOCATION (SEE MAP 3A, MAP 3B AND MAP 3C FOR CROSS-SECTIONS)

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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WASTE ROCK PILE
OPERATIONAL PLAN – PHASE 4

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 2D

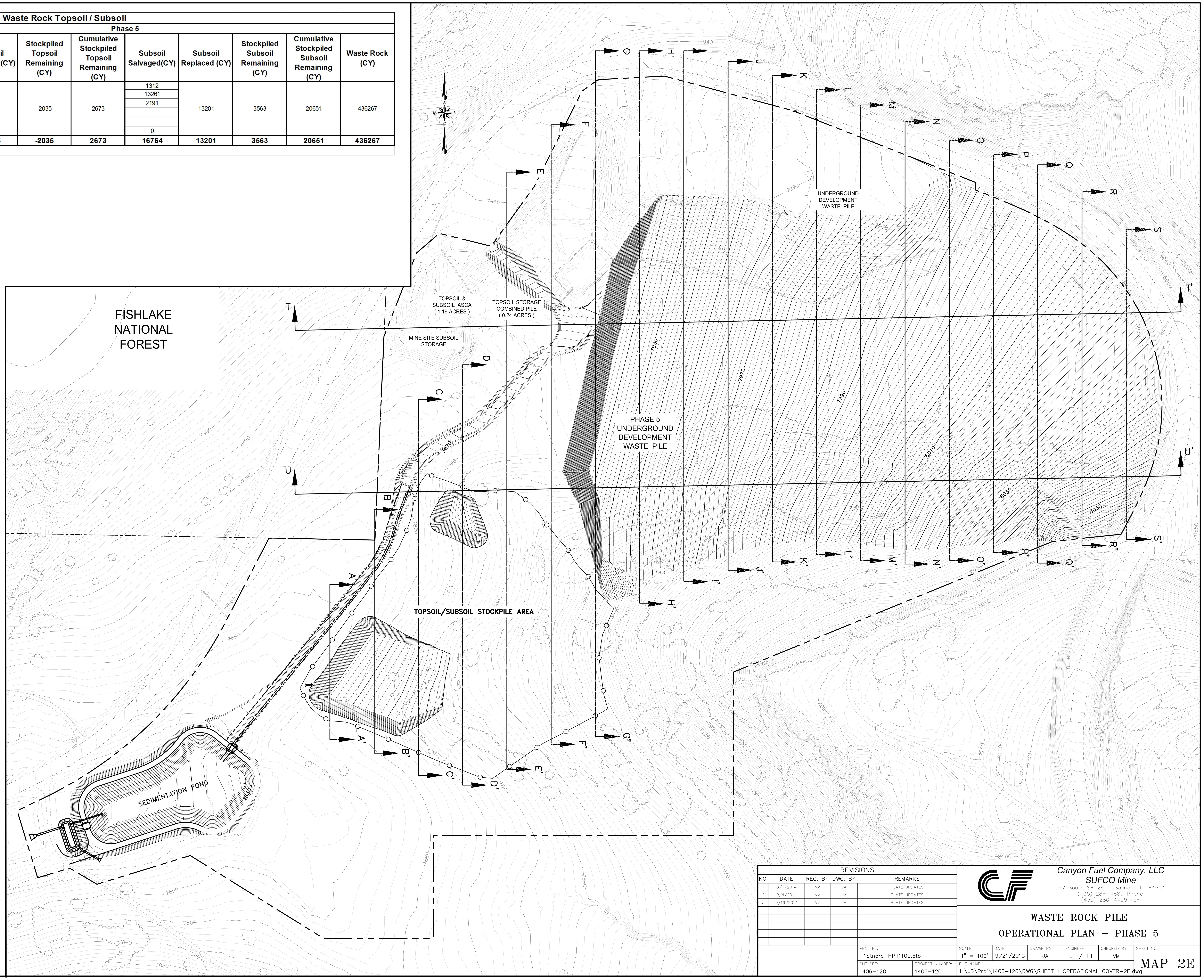
SHT SET: 1406–120 | PROJECT NUMBER: 1406–120 | FILE NAME: H:\JD\Proj\1406–120\DWG\SHEET 1 OPERATIONAL COVER–2D.dwg

Sufco Waste Rock Topsoil / Subsoil												
			Phase 5									
Soil Type	Topsoil (Inches)	Subsoil (Inches)	Area (SF)	Topsoil Salvaged (CY)	Topsoil Replaced (CY)	Stockpiled Topsoil Remaining (CY)	Cumulative Stockpiled Topsoil Remaining (CY)	Subsoil Salvaged(CY)	Subsoil Replaced (CY)	Stockpiled Subsoil Remaining (CY)	Cumulative Stockpiled Subsoil Remaining (CY)	Waste Rock (CY)
1	20	38	11185	690	21538	-2035	2673	1312	13201	3563	20651	436267
2	35	33	130199	14065				13261				
3	26	12	59163	4748				2191				
4	19	0										
5	17	9										
Rehandled Soils	30	0	36112	3344				0				
Total				**19503**	**21538**	**-2035**	**2673**	**16764**	**13201**	**3563**	**20651**	**436267**

***See Fig. 5 for Soil Type Map**

NOTE:

1 SEE MAPS 4A - 4F FOR DIMENSIONS OF SOIL STORAGE STOCKPILES.



LEGEND

- 8140 — EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- 8140 — OPERATIONAL GROUND MAJOR CONTOUR (5 FOOT)
- OPERATIONAL GROUND MINOR CONTOUR (1 FOOT)
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- EXISTING TREELINE
- A A' OPERATIONAL CROSS SECTION LOCATION (SEE MAP 3A, MAP 3B AND MAP 3C FOR CROSS-SECTIONS)

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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WASTE ROCK PILE

OPERATIONAL PLAN – PHASE 5

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 2E

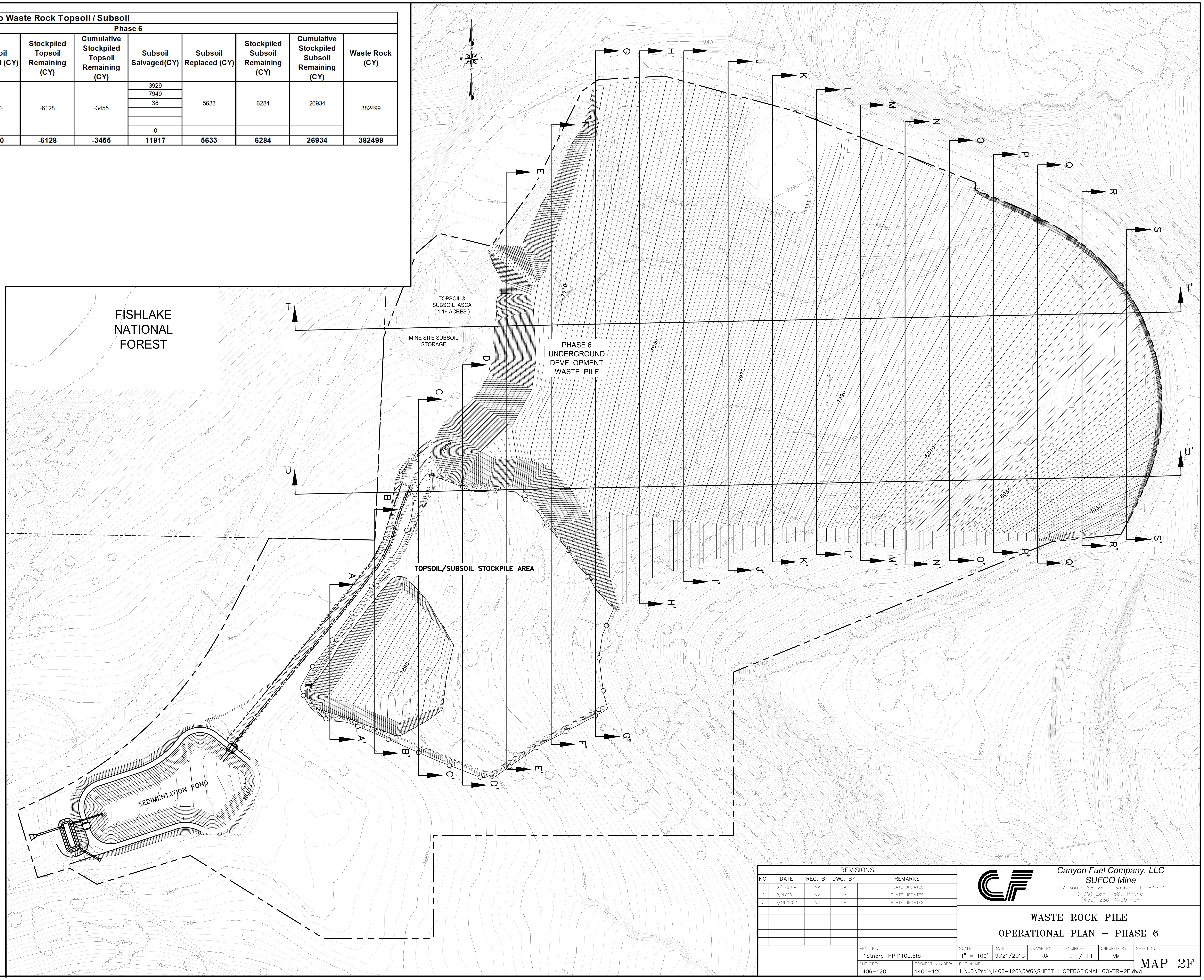
SHT SET: 1406–120 PROJECT NUMBER: 1406–120 FILE NAME: H:\JD\Proj\1406–120\DWG\SHEET 1 OPERATIONAL COVER–2E.dwg

Sufco Waste Rock Topsoil / Subsoil

Soil Type	Topsoil (Inches)	Subsoil (Inches)	Phase 6									
			Area (SF)	Topsoil Salvaged (CY)	Topsoil Replaced (CY)	Stockpiled Topsoil Remaining (CY)	Cumulative Stockpiled Topsoil Remaining (CY)	Subsoil Salvaged(CY)	Subsoil Replaced (CY)	Stockpiled Subsoil Remaining (CY)	Cumulative Stockpiled Subsoil Remaining (CY)	Waste Rock (CY)
1	20	38	33498	2068	16710	-6128	-3455	3929	5633	6284	26934	382499
2	35	33	78048	8431				7949				
3	26	12	1037	83				38				
4	19	0										
5	17	9										
Rehandled Soils	30	0	0	0				0				
Total				**10582**	**16710**	**-6128**	**-3455**	**11917**	**5633**	**6284**	**26934**	**382499**

***See Fig. 5 for Soil Type Map**

NOTE:
1 SEE MAPS 4A - 4F FOR DIMENSIONS OF SOIL STORAGE STOCKPILES.



LEGEND

- 8140 EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- 8140 OPERATIONAL GROUND MAJOR CONTOUR (5 FOOT)
- OPERATIONAL GROUND MINOR CONTOUR (1 FOOT)
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- EXISTING TREELINE
- A A' OPERATIONAL CROSS SECTION LOCATION (SEE MAP 3A, MAP 3B AND MAP 3C FOR CROSS-SECTIONS)

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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WASTE ROCK PILE
OPERATIONAL PLAN – PHASE 6

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-HPT1100.ctb	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 2F

SHT SET: 1406-120 | PROJECT NUMBER: 1406-120 | FILE NAME: H:\JD\Proj\1406-120\DWG\SHEET 1 OPERATIONAL COVER-2F.dwg

EXPLANATION

DISTURBED AREA BOUNDARY
PERMIT AREA BOUNDARY/PROPERTY LINE
DIKE BOUNDARY
STORAGE PILE BOUNDARY
FINAL CONTOUR WITH 10' – 15' TERRACE AND DITCH
FINAL CONTOUR WITH NO TERRACE
SILT FENCE
B-2 7100.0' (30) WATER MONITORING WELL WITH CAP ELEVATION (DEPTH TO CONSOLIDATED FORMATION)
B-4 (18) TEST BORE HOLE (DEPTH TO CONSOLIDATED FORMATION)
DIVERSION DITCH

RECEIVED
JUL 15 2015
DIV. OF OIL, GAS & MINING

JOHN D. BYARS
STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

NOTE:
PERMIT/PROPERTY BOUNDARY IS NW1/4 NE1/4 SECTION 18, T22S, R4E, SLB&M

50 0 50

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS
4	4/10/2013	M.L.D.	K.B.B.	
5	8/5/2013	V.M.	T.R.B.	
6	11/13/2014	V.M.	T.R.B.	
7	9/16/2014	V.M.	T.R.B.	
8	12/8/2014	V.M.	T.R.B.	Added Sec Lines M & N, changed linetypes

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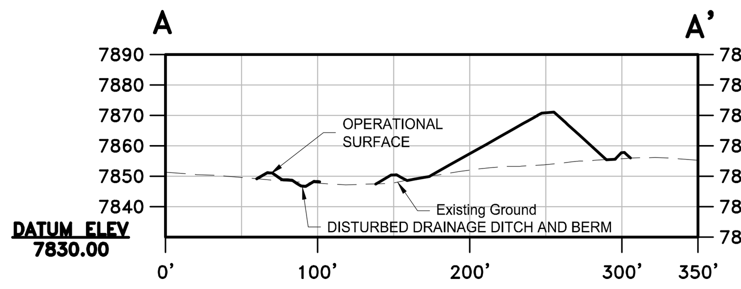
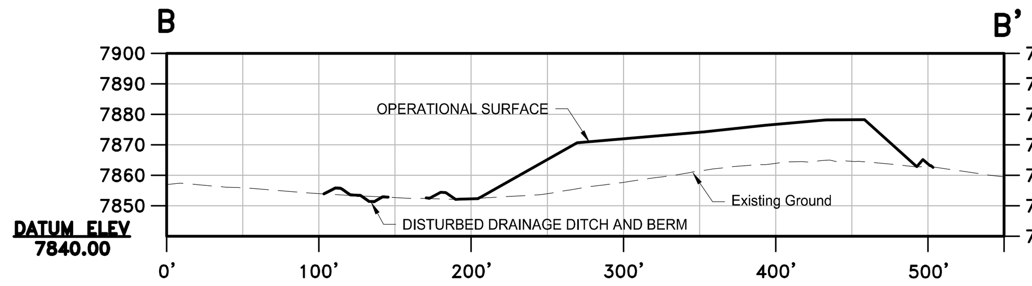
UNDERGROUND DEVELOPMENT WASTE DISPOSAL SITE PLAN

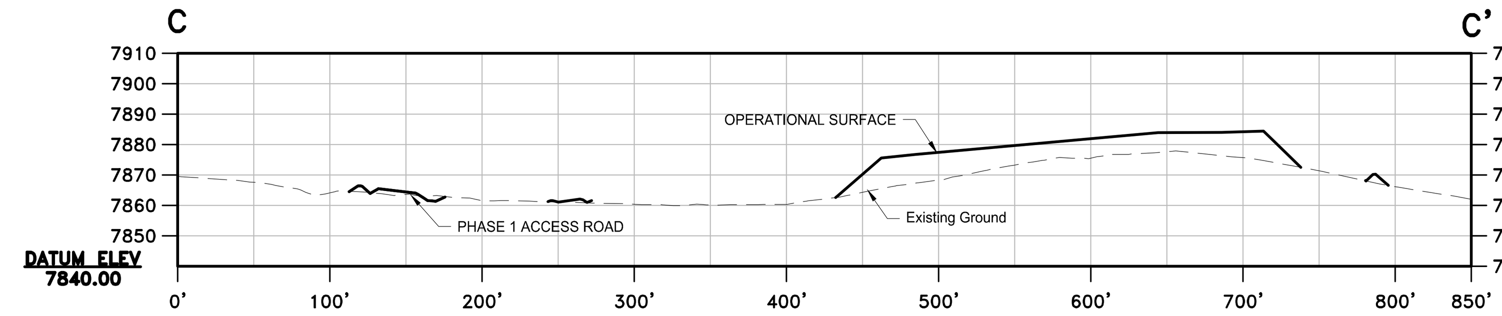
PEN TBL: Plate Map 7.ctb	SCALE: 1" = 50'	DATE: 7/9/2015	DRAWN BY: S.K.S./T.R.B.	ENGINEER:	CHECKED BY: V.M.	SHEET NO. MAP 2v8 HISTORIC
SHT SET: ####	PROJECT NUMBER: ####	FILE NAME: H:\DRAWINGS\MRP\PLATES\WRDS Map2v8.dwg				



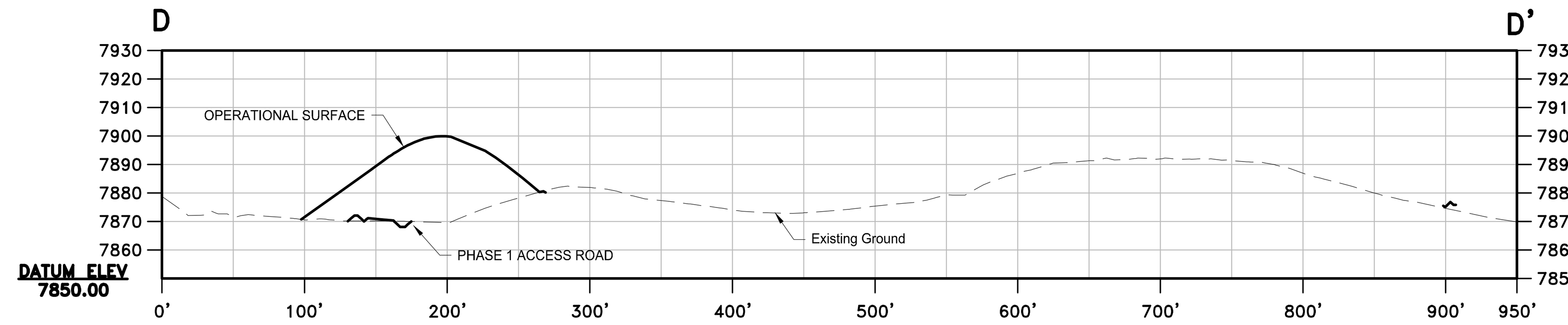
SECTION A-A'



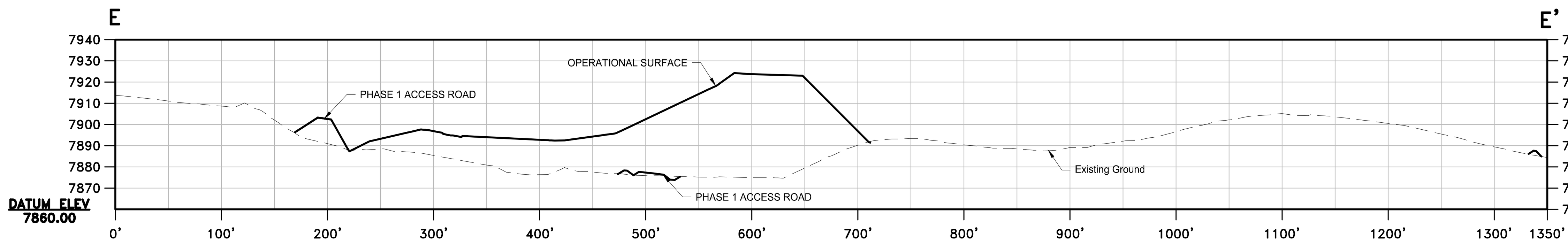
SECTION B-B'



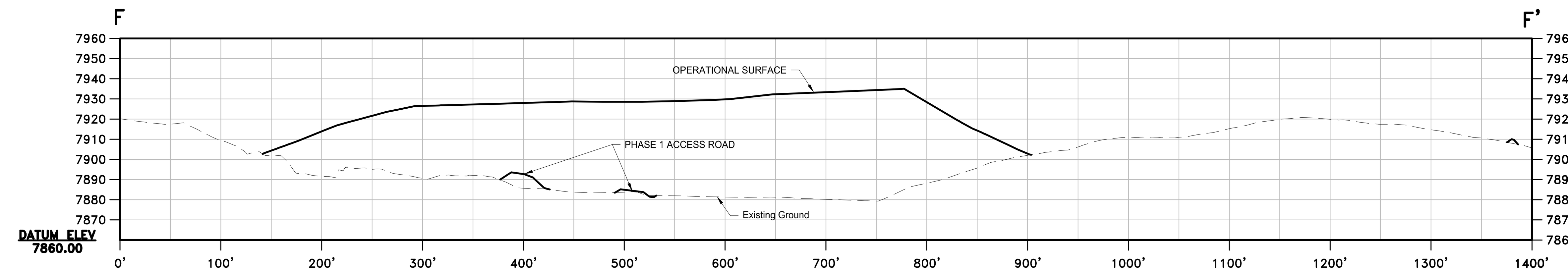
SECTION C-C'



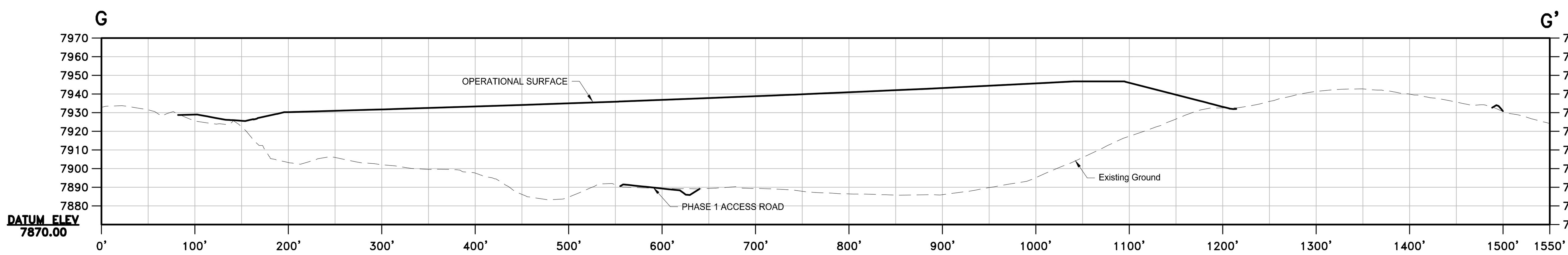
SECTION D-D'



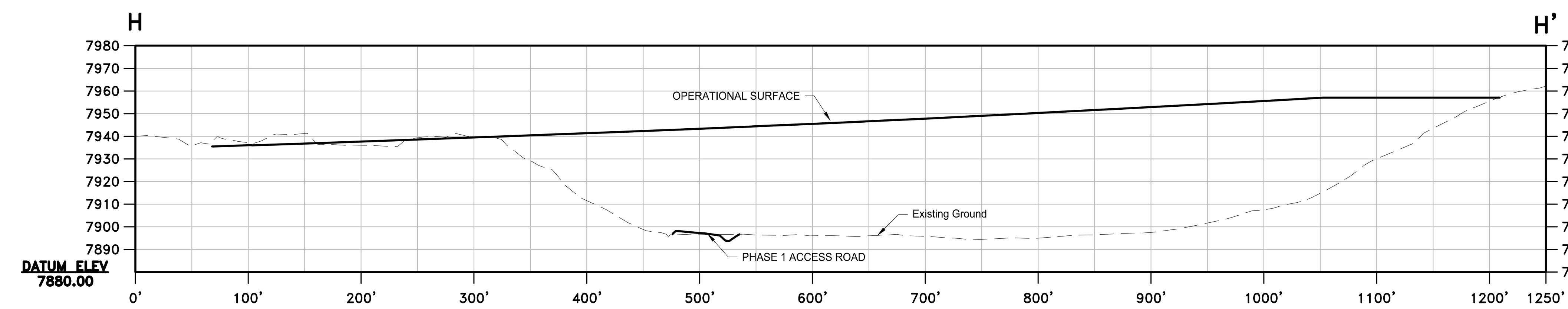
SECTION E-E'



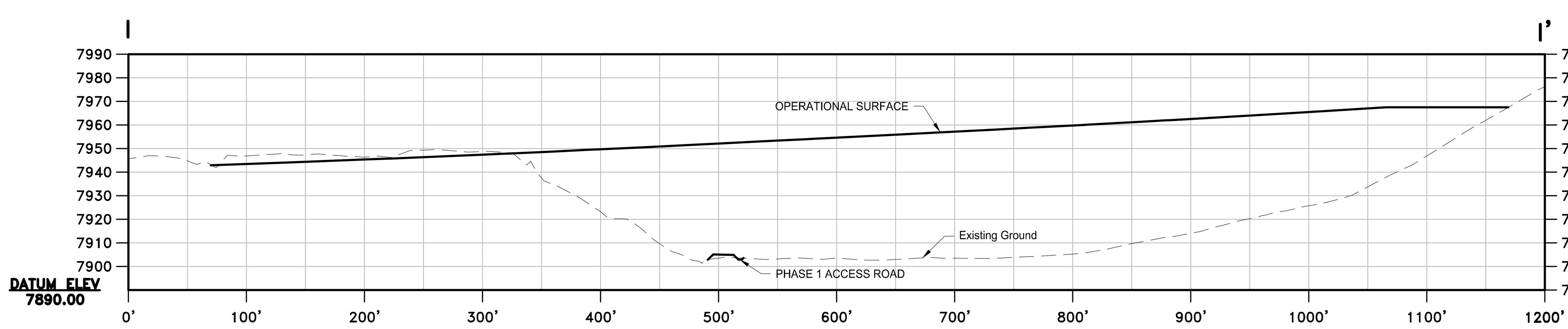
SECTION F-F'



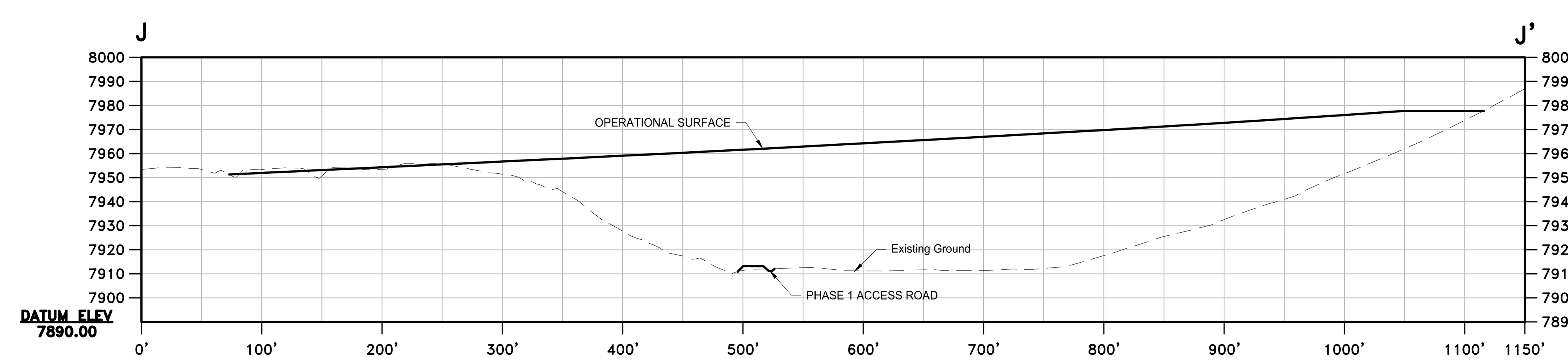
SECTION G-G'



SECTION H-H'



SECTION I-I'



SECTION J-J'

LEGEND

EXISTING GROUND SURFACE

OPERATIONAL SURFACE

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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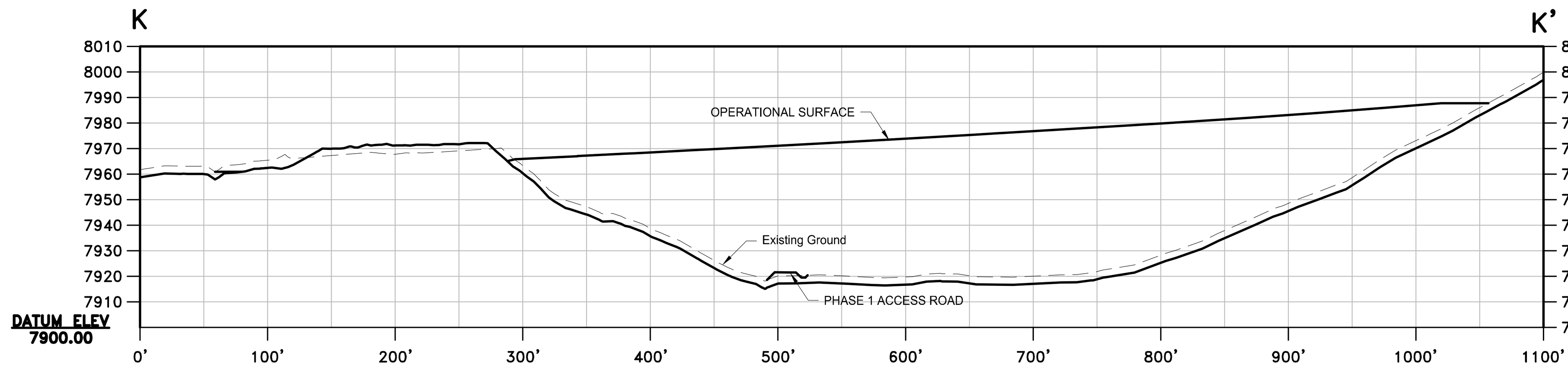
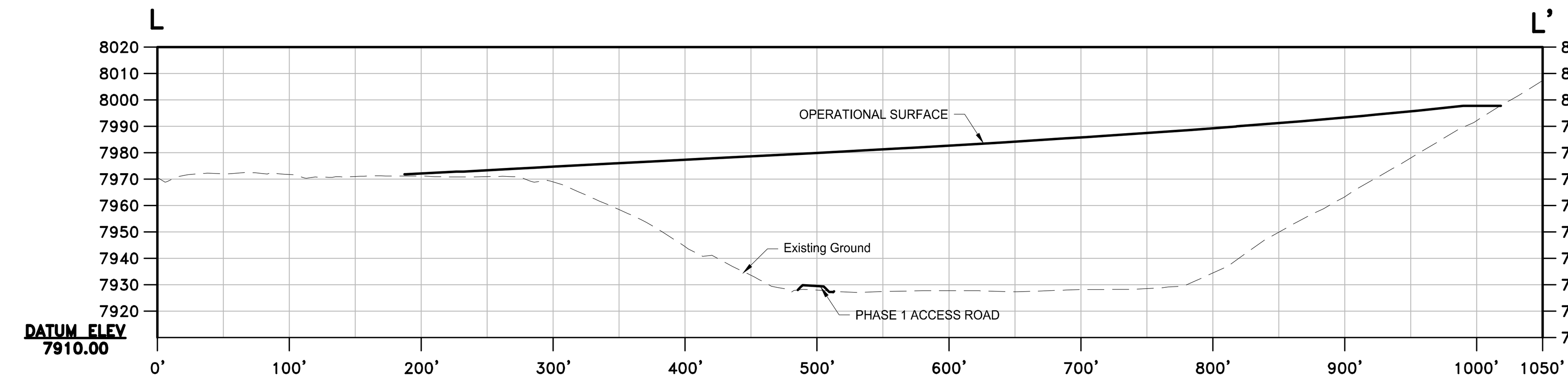
WASTE ROCK PILE
OPERATIONAL CROSS SECTIONS

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 3A

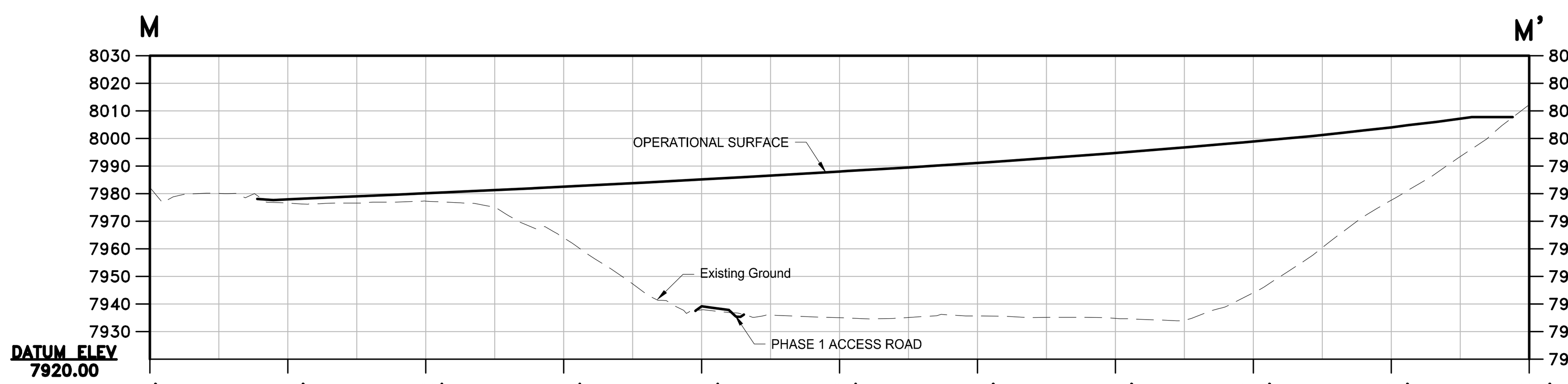
SHT SET:	PROJECT NUMBER:	FILE NAME:
1406–120	1406–120	H:\JD\Proj\1406–120\DWG\SHEET 2 OPERATIONAL SECTIONS.dwg



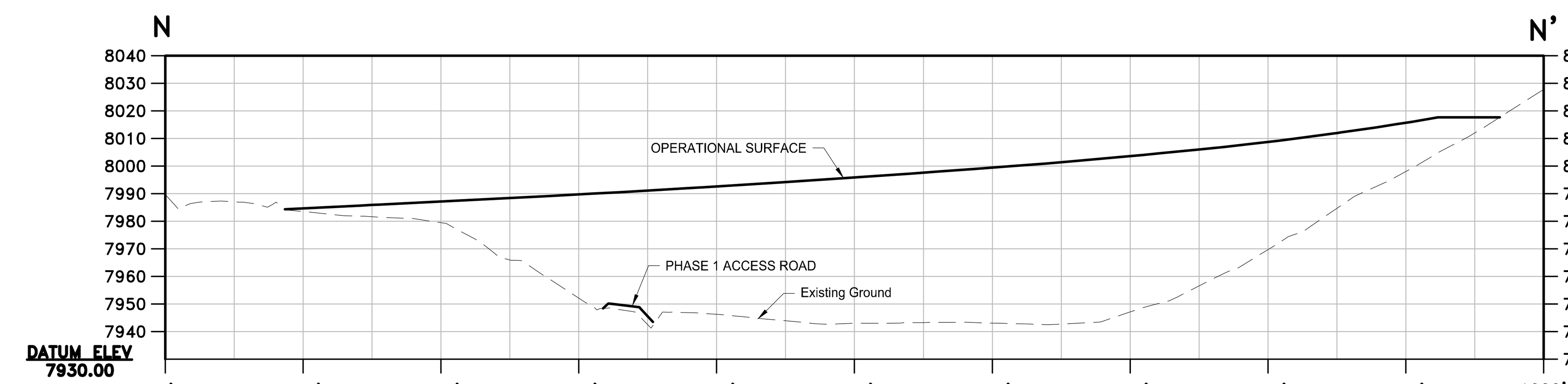
SECTION K–K'



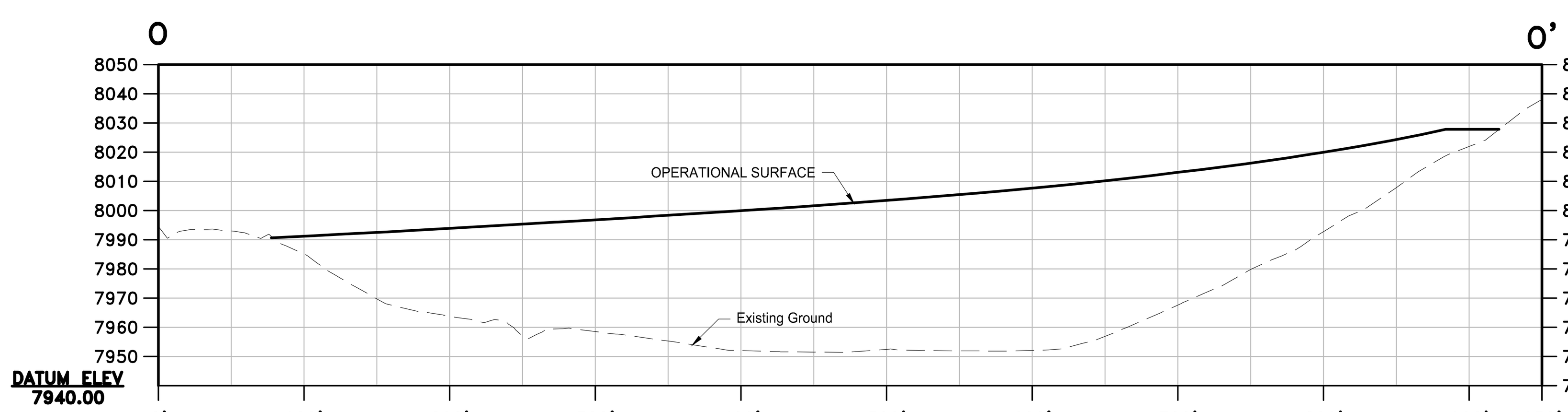
SECTION L–L'



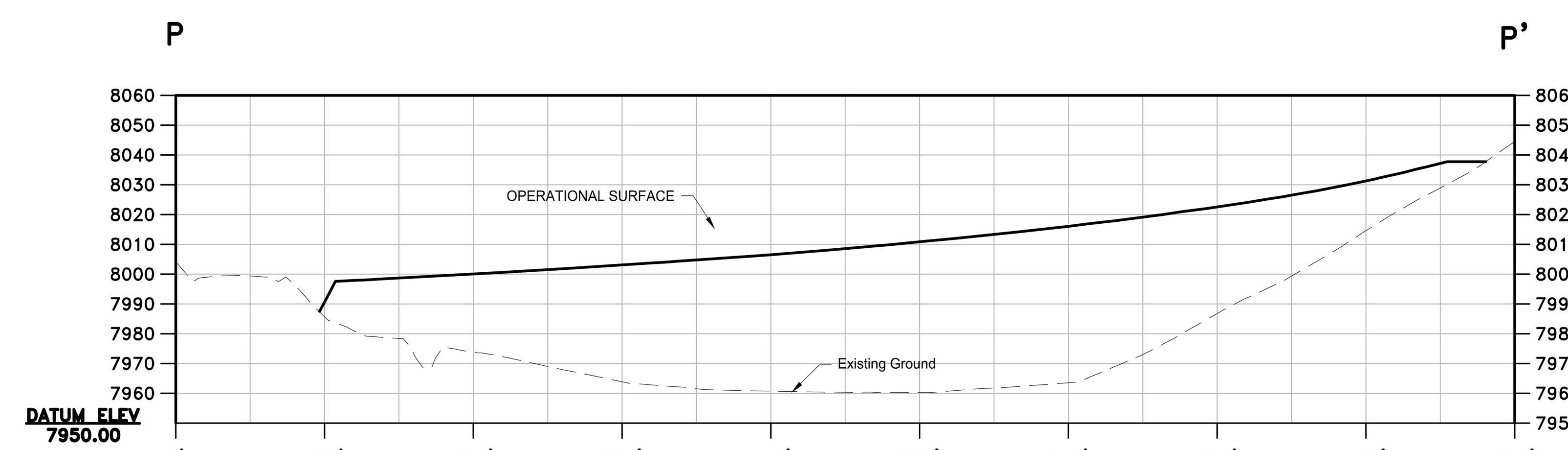
SECTION M–M'



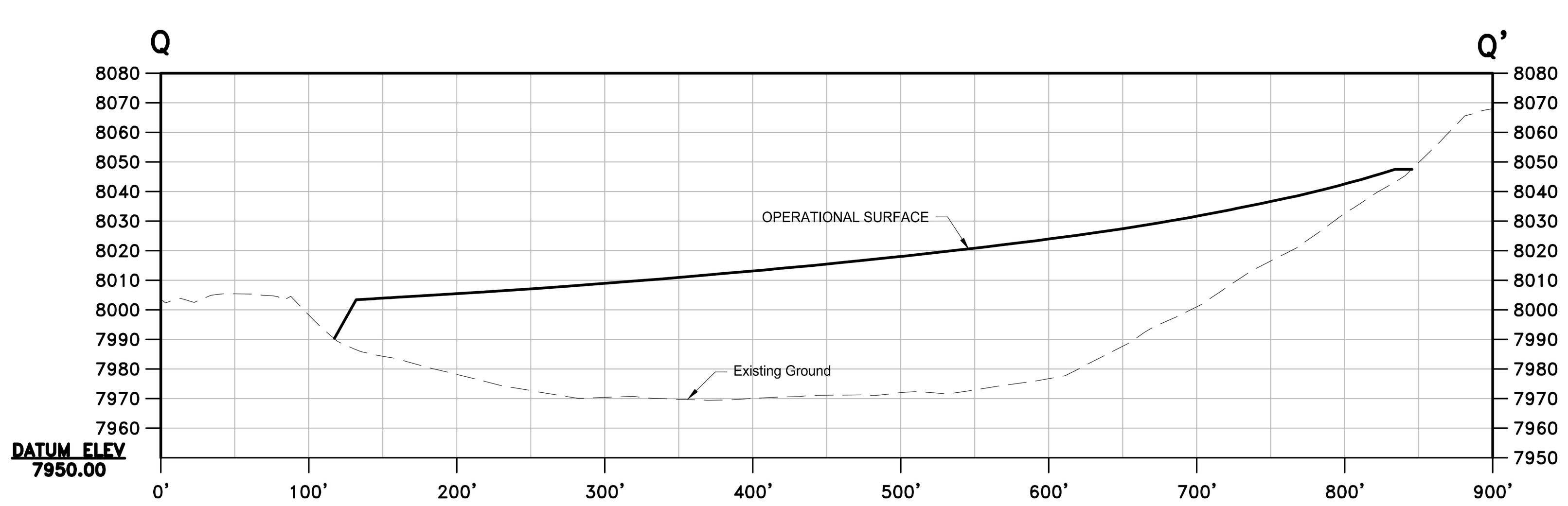
SECTION N–N'



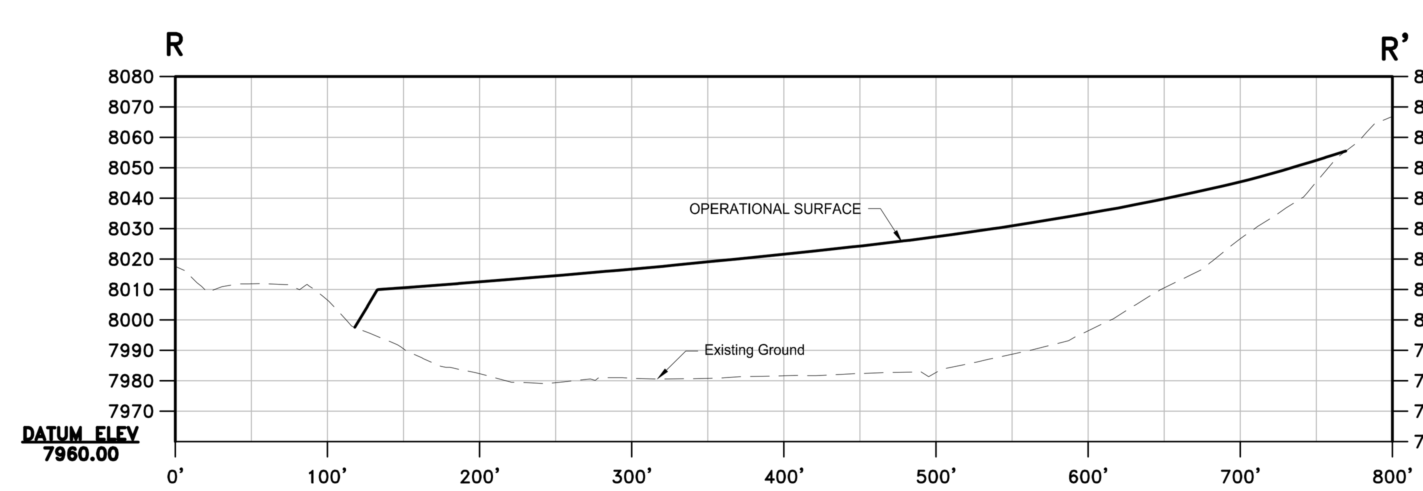
SECTION O–O'



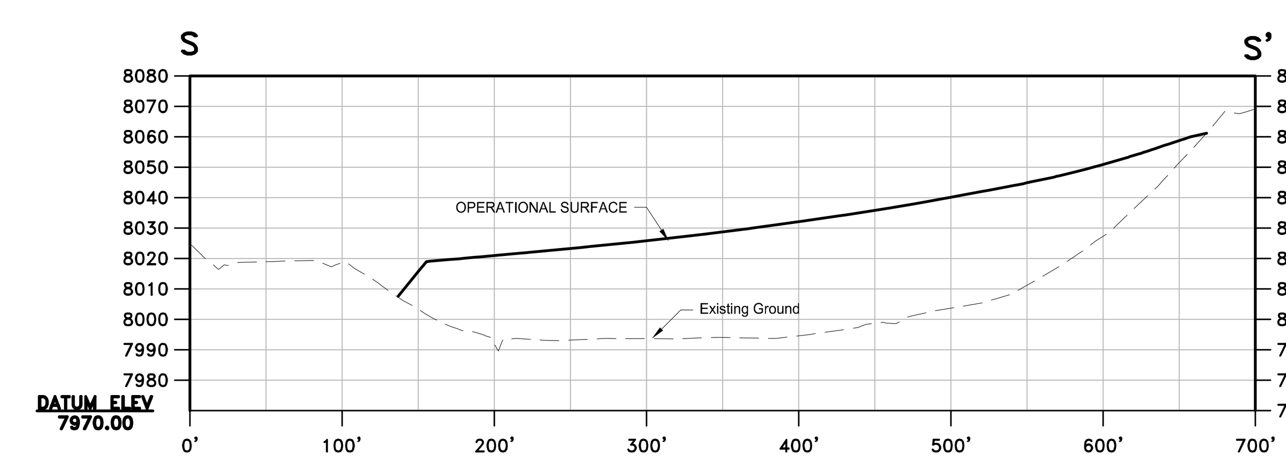
SECTION P–P'



SECTION Q–Q'



SECTION R–R'



SECTION S–S'

LEGEND

— — — — EXISTING GROUND SURFACE

——— OPERATIONAL SURFACE

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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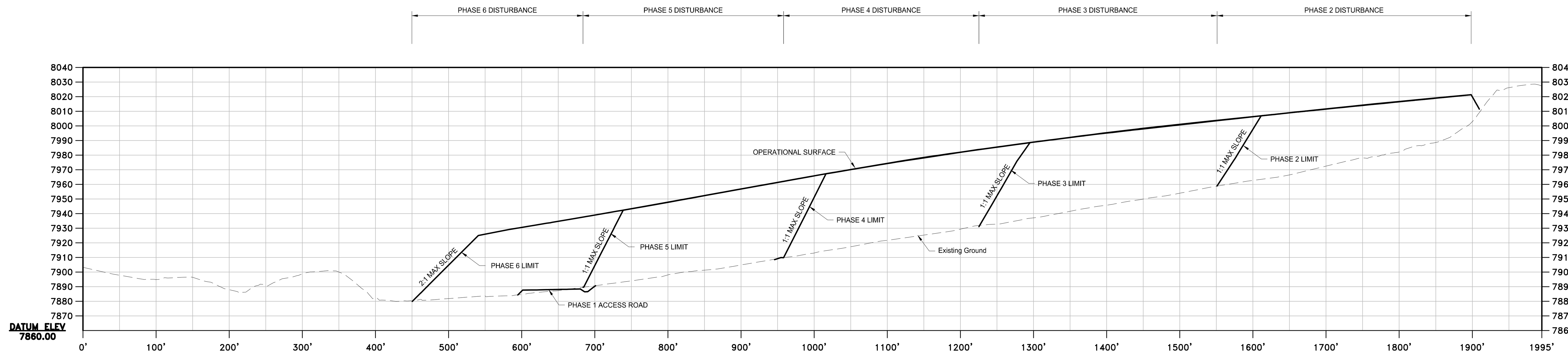
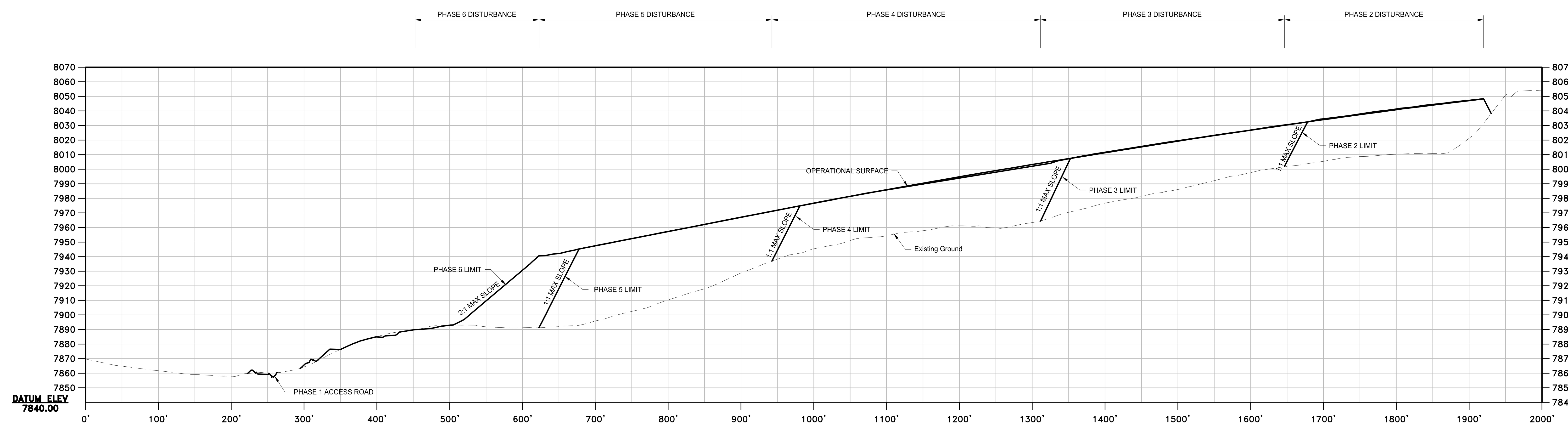
WASTE ROCK PILE
OPERATIONAL CROSS SECTIONS

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 3B

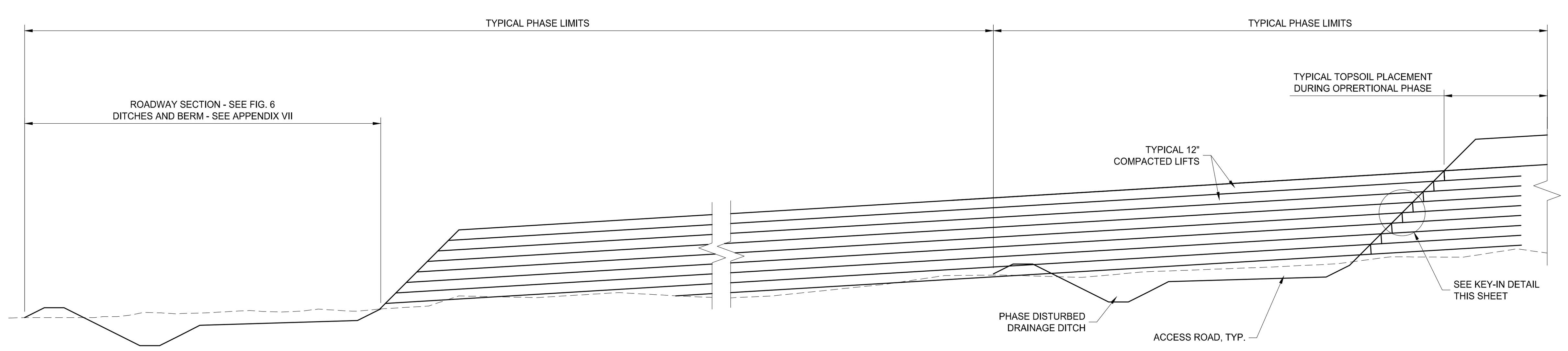
SHT SET:	PROJECT NUMBER:	FILE NAME:
1406–120	1406–120	H:\JD\Proj\1406–120\DWG\SHEET 3 OPERATIONAL SECTIONS.dwg

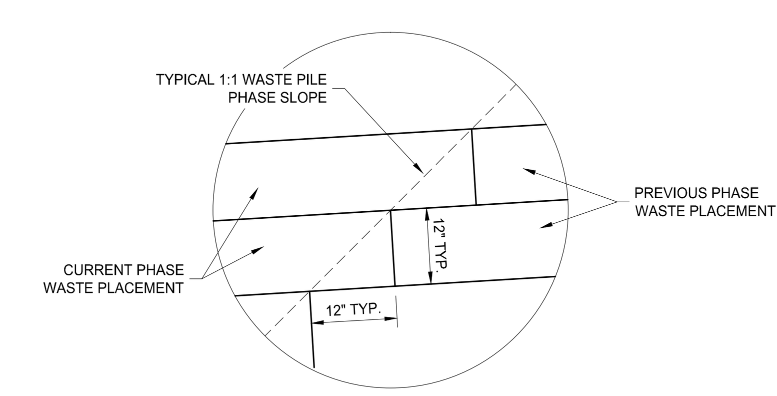


SECTION T–T'



SECTION U–U'





SLOPE KEY-IN DETAIL

TYPICAL WASTE PLACEMENT
AND KEY-IN DETAIL

LEGEND

— — — — EXISTING GROUND SURFACE

———— OPERATIONAL SURFACE

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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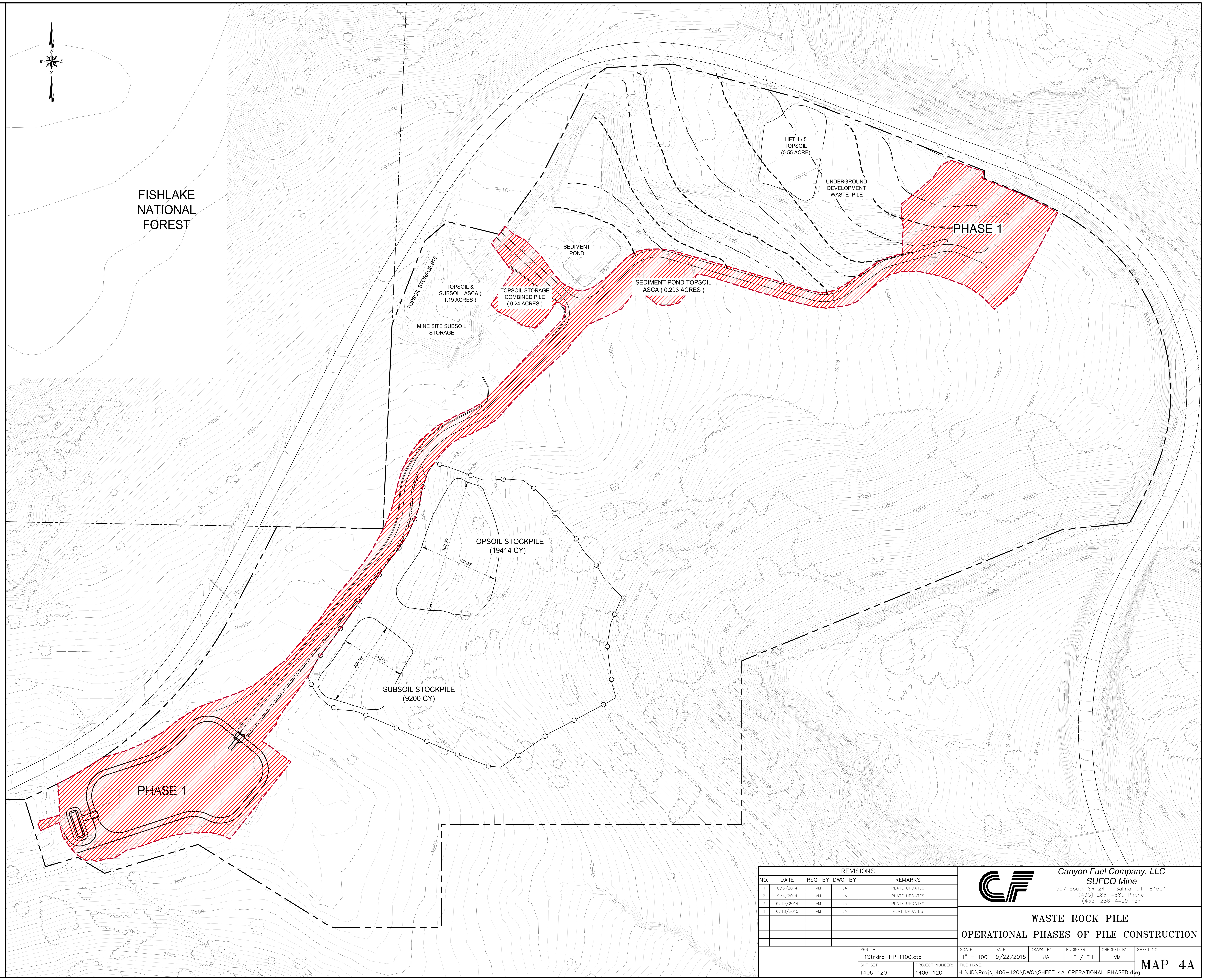
WASTE ROCK PILE
OPERATIONAL CROSS SECTIONS

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/21/2015	JA	LF / TH	VM	MAP 3C

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406–120	1406–120	H:\JD\Proj\1406–120\DWG\SHEET 4 OPERATIONAL SECTIONS.dwg

LEGEND

- EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- PROPOSED PHASE 1
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- PROPOSED DRAINAGE BERM
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- EXISTING TREELINE



REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES
4	6/18/2015	VM	JA	PLAT UPDATES

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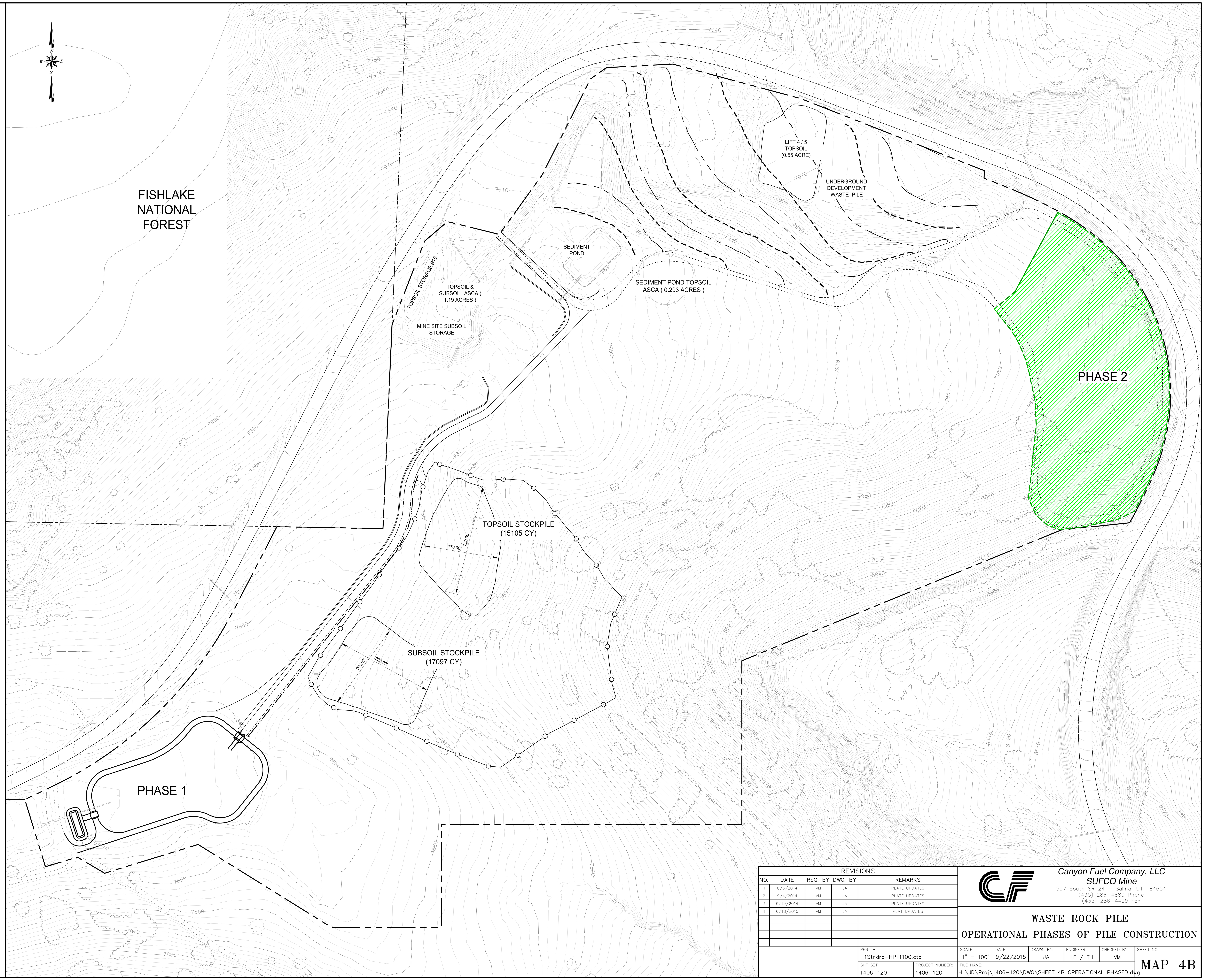
WASTE ROCK PILE
OPERATIONAL PHASES OF PILE CONSTRUCTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/22/2015	JA	LF / TH	VM	MAP 4A

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406–120	1406–120	H:\JD\Proj\1406–120\DWG\SHEET 4A OPERATIONAL PHASED.dwg

LEGEND

- 8140 — EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- PROPOSED PHASE 2
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- PROPOSED DRAINAGE BERM
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- EXISTING TREELINE



REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES
4	6/18/2015	VM	JA	PLAT UPDATES

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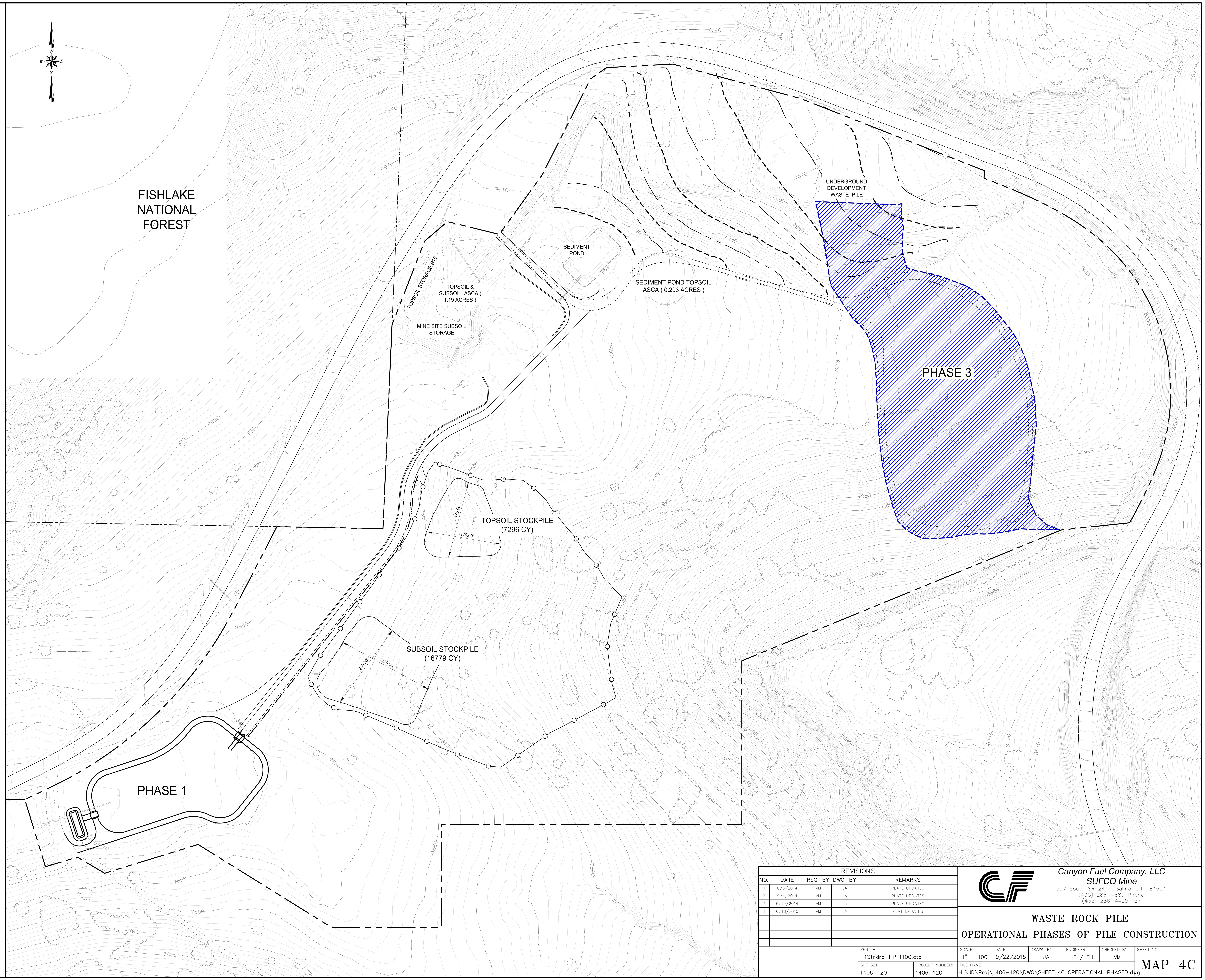
WASTE ROCK PILE
OPERATIONAL PHASES OF PILE CONSTRUCTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/22/2015	JA	LF / TH	VM	MAP 4B

SHT SET: 1406–120 | PROJECT NUMBER: 1406–120 | FILE NAME: H:\JD\Proj\1406–120\DWG\SHEET 4B OPERATIONAL PHASED.dwg

LEGEND

8140	EXISTING GROUND MAJOR CONTOUR (10 FOOT)
	EXISTING GROUND MINOR CONTOUR (2 FOOT)
	PROPOSED PHASE 3
	EXISTING ROAD
	EXISTING PAVED ROAD
	PROPOSED ROAD
	PROPOSED ANCILLARY ROAD
	EXISTING CULVERT
	PROPOSED CULVERT
	PROPOSED DRAINAGE BERM
	PROPOSED DITCH
	DISTURBED AREA BOUNDARY
	PROPERTY BOUNDARY
	TOPSOIL / SUBSOIL STORAGE BOUNDARY
	EXISTING TREELINE



REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES
4	6/18/2015	VM	JA	PLAT UPDATES

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WASTE ROCK PILE
OPERATIONAL PHASES OF PILE CONSTRUCTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/22/2015	JA	LF / TH	VM	MAP 4C

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406–120	1406–120	H:\JD\Proj\1406–120\DWG\SHEET 4C OPERATIONAL PHASED.dwg

LEGEND

- 8140 — EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- PROPOSED PHASE 4
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- PROPOSED DRAINAGE BERM
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- EXISTING TREELINE

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES
4	6/18/2015	VM	JA	PLAT UPDATES

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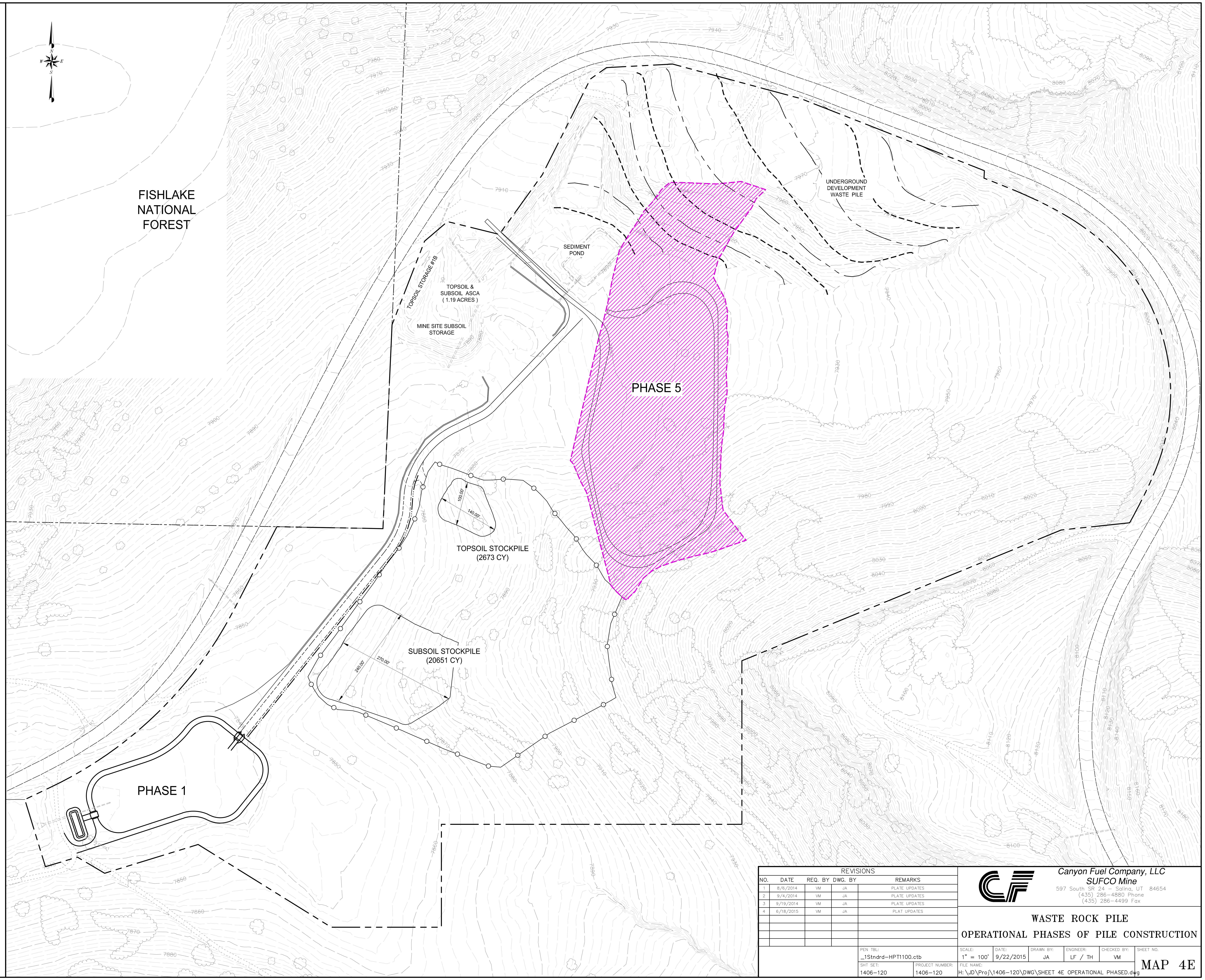
WASTE ROCK PILE
OPERATIONAL PHASES OF PILE CONSTRUCTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/22/2015	JA	LF / TH	VM	MAP 4D

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406–120	1406–120	H:\JD\Proj\1406–120\DWG\SHEET 4D OPERATIONAL PHASED.dwg

LEGEND

- 8140 — EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- PROPOSED PHASE 5
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- PROPOSED DRAINAGE BERM
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- EXISTING TREELINE



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NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES
4	6/18/2015	VM	JA	PLAT UPDATES

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WASTE ROCK PILE
OPERATIONAL PHASES OF PILE CONSTRUCTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-HPT1100.ctb	1" = 100'	9/22/2015	JA	LF / TH	VM	MAP 4E

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406-120	1406-120	H:\JD\Proj\1406-120\DWG\SHEET 4E OPERATIONAL PHASED.dwg

LEGEND

- EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- PROPOSED PHASE 6
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING CULVERT
- PROPOSED CULVERT
- PROPOSED DRAINAGE BERM
- PROPOSED DITCH
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- TOPSOIL / SUBSOIL STORAGE BOUNDARY
- EXISTING TREELINE

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES
4	6/18/2015	VM	JA	PLAT UPDATES

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WASTE ROCK PILE
OPERATIONAL PHASES OF PILE CONSTRUCTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	9/22/2015	JA	LF / TH	VM	MAP 4F

SHT SET: 1406–120
PROJECT NUMBER: 1406–120
FILE NAME: H:\JD\Proj\1406–120\DWG\SHEET 4F OPERATIONAL PHASED.dwg

EXPLANATION

DIKE BOUNDARY

STORAGE PILE BOUNDARY

DISTURBED AREA BOUNDARY

PERMIT AREA BOUNDARY/PROPERTY LINE

SILT FENCE

B-2 7100.0' (30) WATER MONITORING WELL WITH CAP ELEVATION (DEPTH TO CONSOLIDATED FORMATION)

B-4 (18) TEST BORE HOLE (DEPTH TO CONSOLIDATED FORMATION)

DIVERSION DITCH

NOTE:
PERMIT/PROPERTY BOUNDARY IS NW1/4 NE1/4 SECTION 18, T22S, R4E, SLB&M

JOHN D. BYARS
STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

50 0 50

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/31/2005	M.L.D.		
2	4/10/2013	M.L.D.	K.B.B.	
3	5/20/2013	V.M.	T.R.B.	
4	11/13/2013	V.M.	T.R.B.	

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UNDERGROUND DEVELOPMENT WASTE DISPOSAL SITE OPERATIONS PLAN

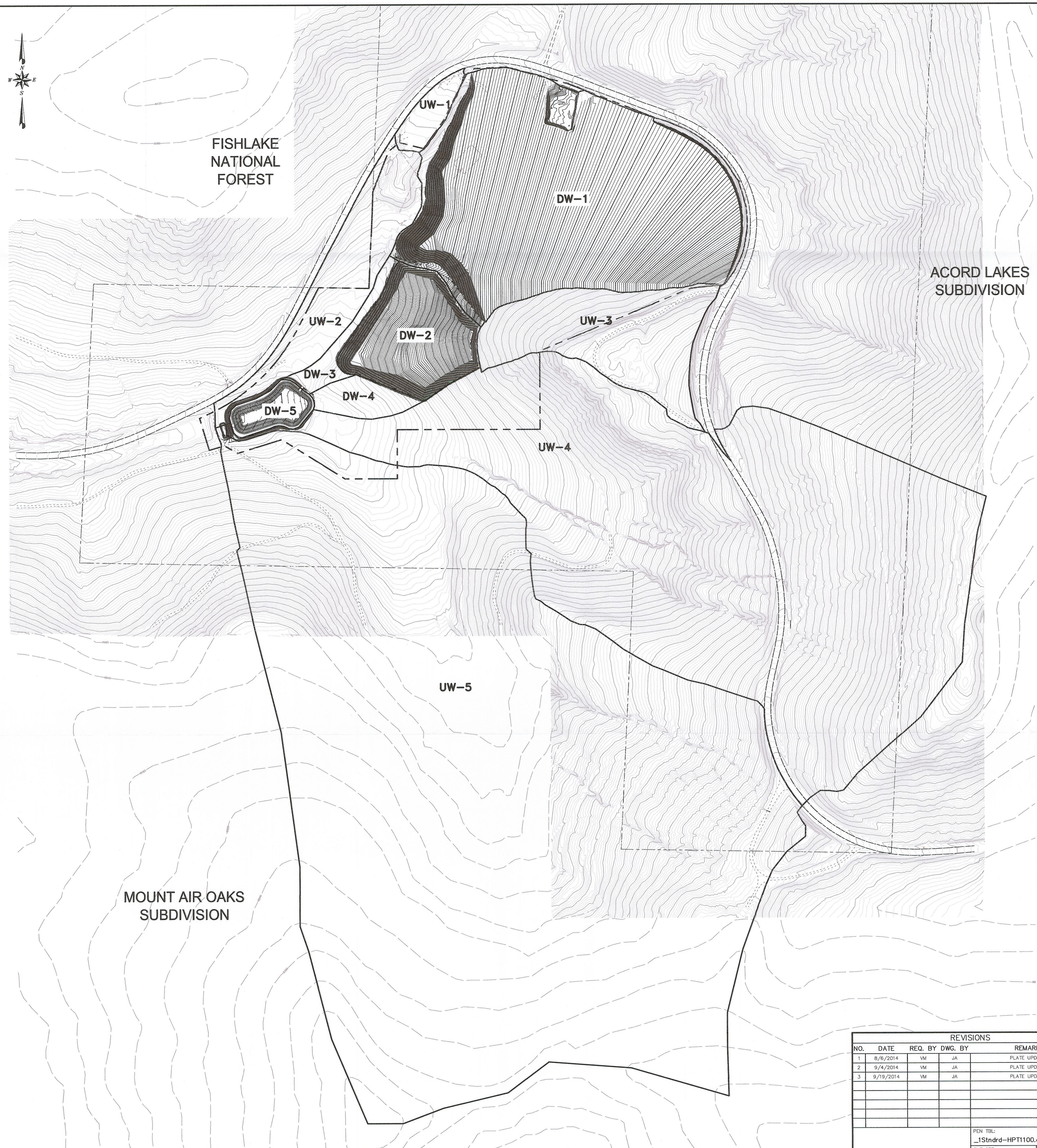
PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
Plate Map 7.ctb	1" = 50'	5/21/2015	S.K.S./T.R.B.		V.M.	MAP 4v4 HISTORIC

SHT SET: #### PROJECT NUMBER: ####

FILE NAME: H:\DRAWINGS\MRP\PLATES\WRDS MAP4v4.dwg

LEGEND

- 8140 — EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- OPERATIONAL GROUND INFERRED CONTOUR (40 FOOT)
- OPERATIONAL WATERSHED BOUNDARY
- **DW–2** DISTURBED WATERSHED DESIGNATION
- **UW–2** UNDISTURBED WATERSHED DESIGNATION
- EXISTING ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- EXISTING TREELINE



REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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WASTE ROCK PILE
OPERATIONAL WATERSHED PLAN

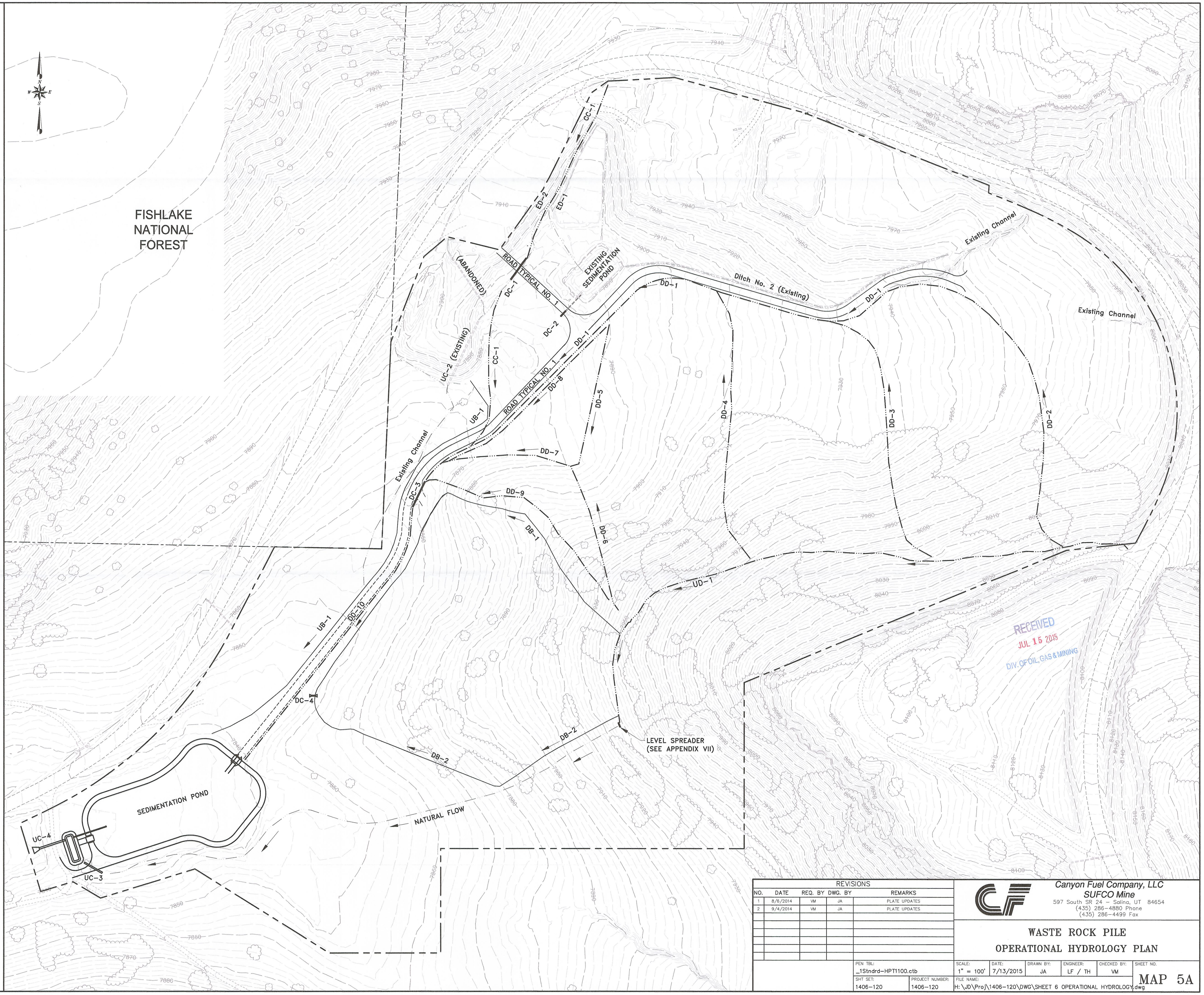
PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 250'	7/7/2015	JA	LF / TH	VM	MAP 5

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406–120	1406–120	H:\JD\Proj\1406–120\DWG\SHEET 7 OPERATIONAL WATERSHED.dwg

LEGEND

- 8140 — EXISTING GROUND MAJOR CONTOUR (10 FOOT)
- EXISTING GROUND MINOR CONTOUR (2 FOOT)
- DISTURBED/UNDISTURBED AREA BERM (DB-_/UB-_)
- UNDISTURBED AREA DITCH (UD-_)
- DISTURBED AREA DITCH (DD-_)
- UNDISTURBED AREA CULVERT (UC-_)
- DISTURBED AREA CULVERT (DC-_)
- UNDISTURBED AREA CATCH BASIN (UCB-_)
- EXISTING CULVERT
- PROPOSED OPERATIONAL ROAD
- PROPOSED ANCILLARY ROAD
- EXISTING ROAD
- EXISTING PAVED ROAD
- DISTURBED AREA BOUNDARY
- PROPERTY BOUNDARY
- EXISTING TREELINE
- DRAINAGE FLOW DIRECTION

NOTES:
1. SEE MAP 5 FOR LARGER WATERSHEDS.
2. SEE APPENDIX VII FOR BERM, DITCH, AND CULVERT DETAILS.



REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES

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WASTE ROCK PILE
OPERATIONAL HYDROLOGY PLAN

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-HPT1100.ctb	1" = 100'	7/13/2015	JA	LF / TH	VM	MAP 5A

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406-120	1406-120	H:\JD\Proj\1406-120\DWG\SHEET 6 OPERATIONAL HYDROLOGY.dwg

WILL REMAIN AS PART
OF EXISTING PERMIT

-N-

WATER MONITORING WELLS
WITH COLLAR ELEVATION

TOPOGRAPHIC MAP

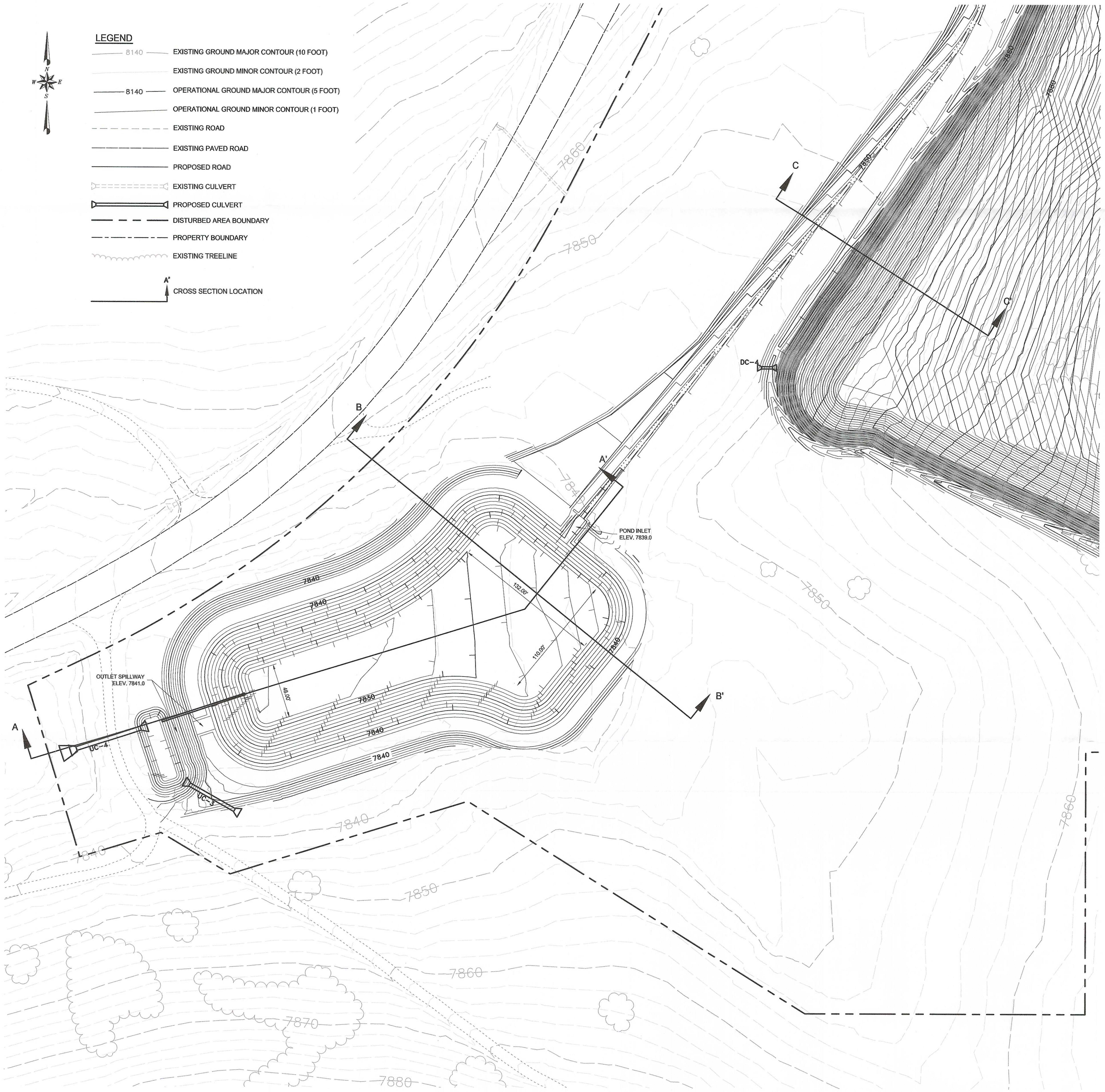
SCALE 1" = 50'

CONTOUR INTERVAL 2'

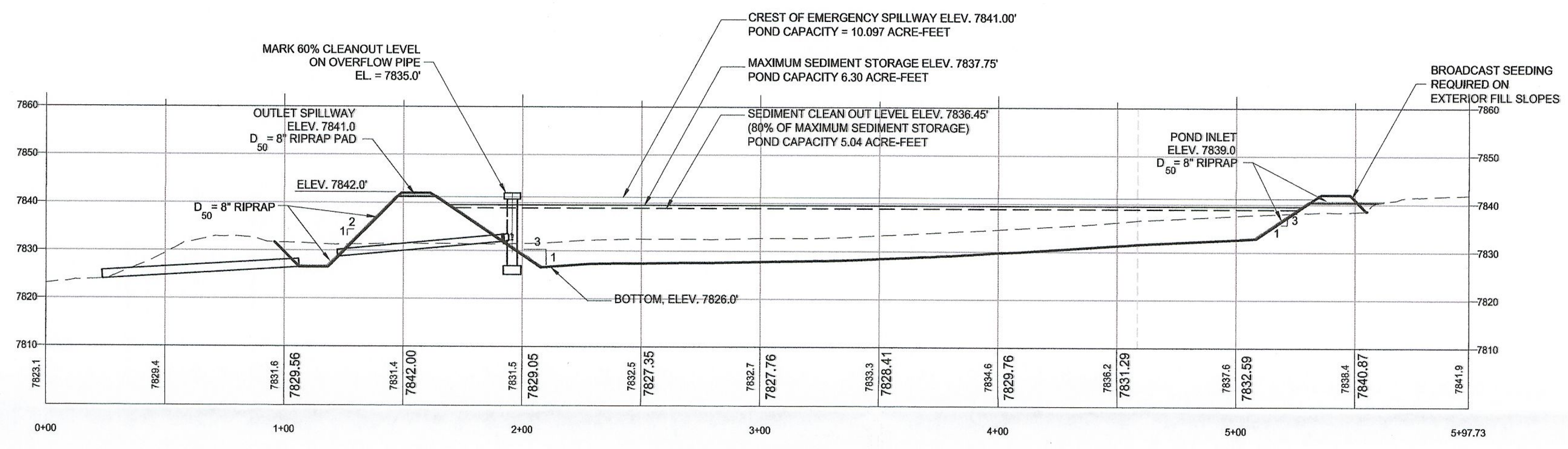
0 50 100

Compiled by
Western Air Maps, Inc.
Lenexa, Kansas

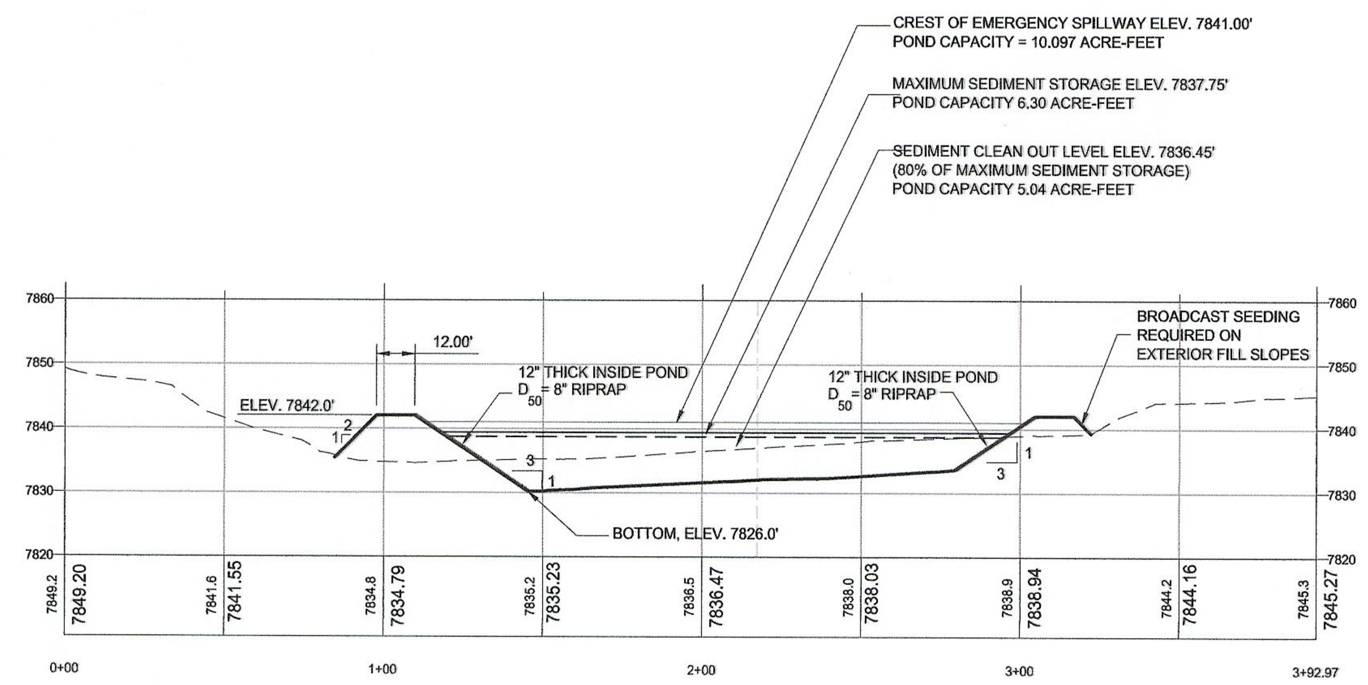
SOUTHERN UTAH FUEL CO. **MINE NUMBER ONE**		
STRIKE AND DIP OF POTENTIOMETRIC SURFACE		
DRAWN BY S.K.S.	DATE 3-28-88	MATERIAL
CHECKED BY W.K.S.	DATE 3-28-88	SCALE 1" = 50'
TRACED	DATE	DRAWING NO. MAP 6
APPROVED	DATE	



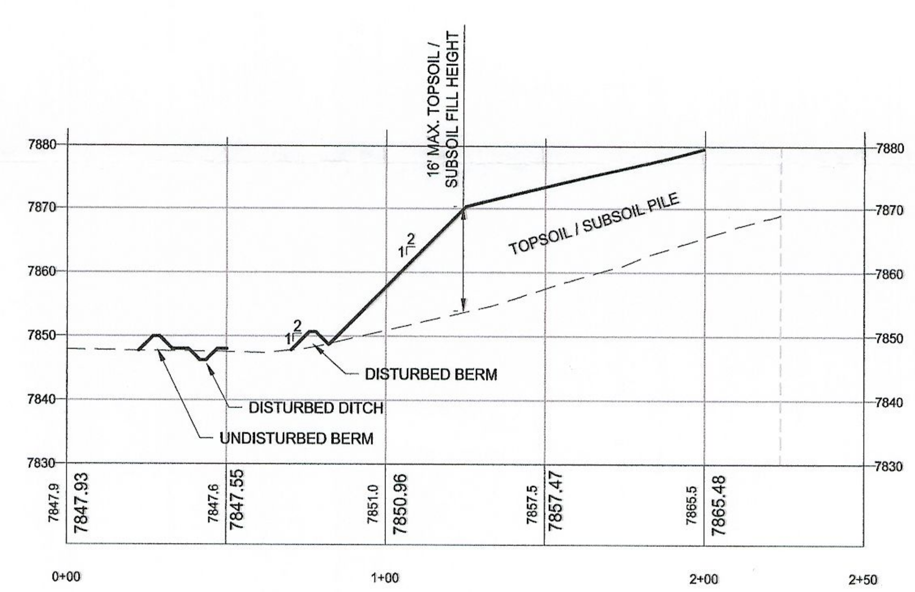
PLAN
HORZ: 1"=50'



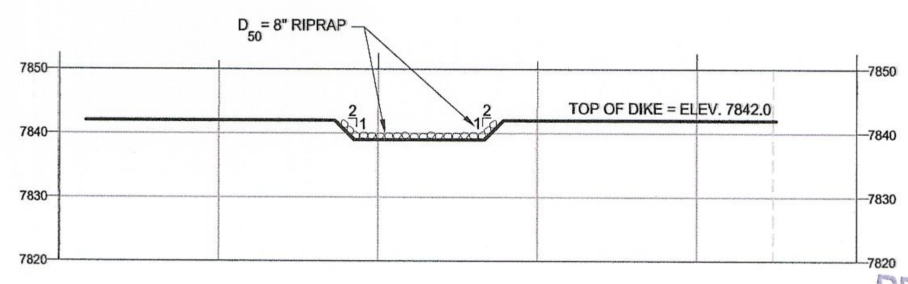
POND SECTION A - A'
PROFILE VERTICALLY EXAGGERATED X 2



POND SECTION B - B'
PROFILE VERTICALLY EXAGGERATED X 2



BASIN SECTION C - C'
PROFILE VERTICALLY EXAGGERATED X 2



POND INLET / OUTLET DETAIL
PROFILE VERTICALLY EXAGGERATED X 2

NOTE:
SEDIMENTATION POND WILL TREAT 100-YR, 6-HR STORM WITH SEDIMENT STORAGE.

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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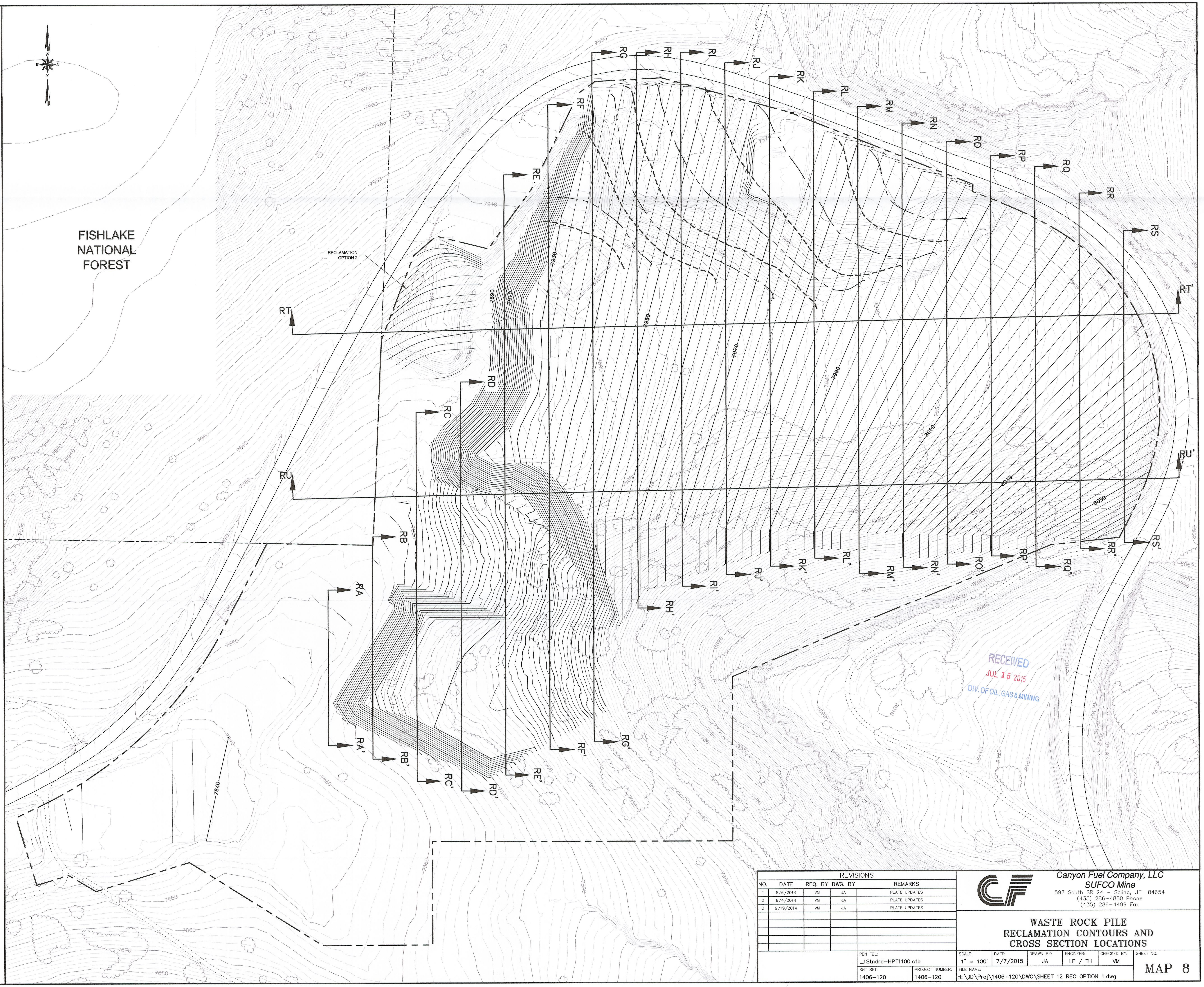
WASTE ROCK PILE SEDIMENTATION POND AND SEDIMENT BASIN WITH SECTIONS

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-HPT1100.ctb	1" = 50'	6/24/2015	JA	LF / TH	VM	MAP 7

SHT SET: 1406-120 · PROJECT NUMBER: 1406-120 · FILE NAME: H:\JD\Proj\1406-120\DWG\SHEET 10 SED POND.dwg

LEGEND

8140	EXISTING GROUND MAJOR CONTOUR (10 FOOT)
	EXISTING GROUND MINOR CONTOUR (2 FOOT)
8140	RECLAMATION GROUND MAJOR CONTOUR (10 FOOT)
	RECLAMATION GROUND MINOR CONTOUR (2 FOOT)
	EXISTING ROAD
	EXISTING PAVED ROAD
	EXISTING CULVERT
	DISTURBED AREA BOUNDARY
	PROPERTY BOUNDARY
	EXISTING TREELINE
RA RA'	RECLAMATION CROSS-SECTION LOCATION (SEE MAP 8A, MAP 8B AND MAP 8C FOR CROSS-SECTIONS)



REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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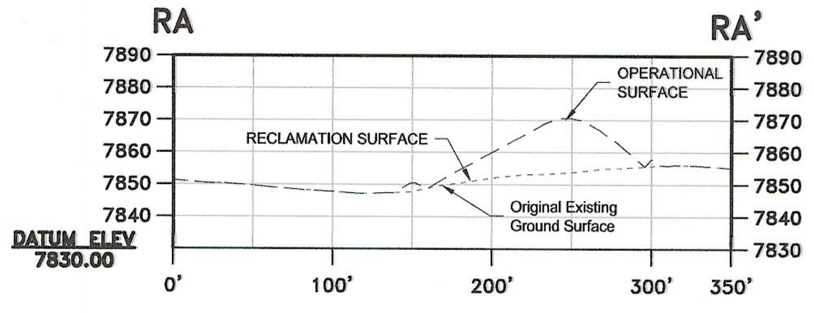
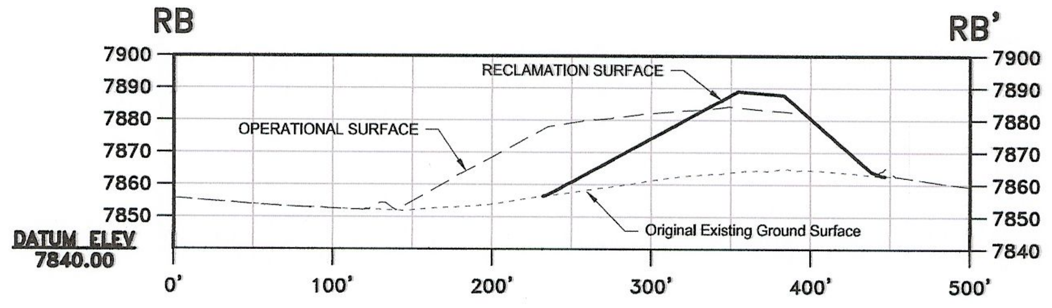
WASTE ROCK PILE RECLAMATION CONTOURS AND CROSS SECTION LOCATIONS

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-HPT1100.ctb	1" = 100'	7/7/2015	JA	LF / TH	VM	MAP 8

SHT SET: 1406-120 | PROJECT NUMBER: 1406-120 | FILE NAME: H:\JD\Proj\1406-120\DWG\SHEET 12 REC OPTION 1.dwg



SECTION RA–RA'



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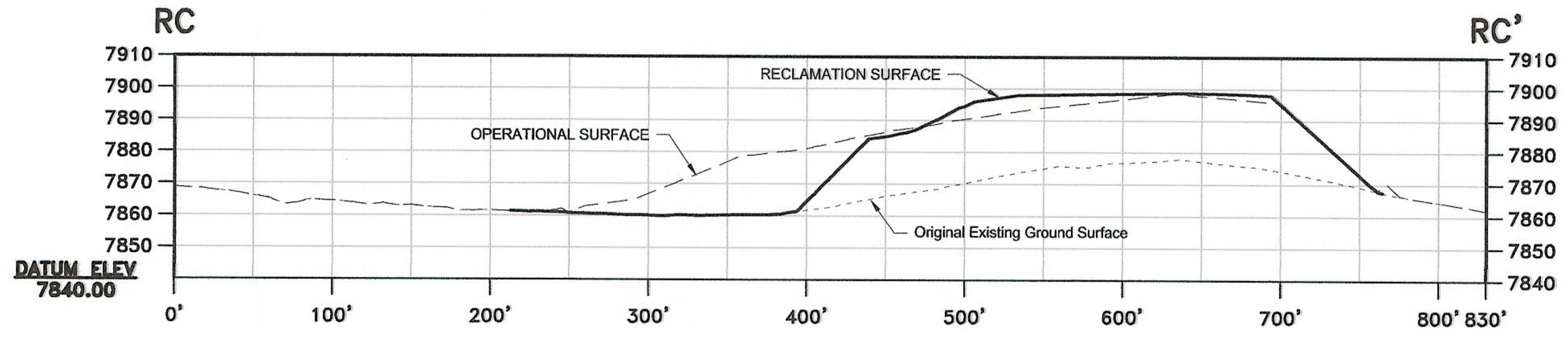

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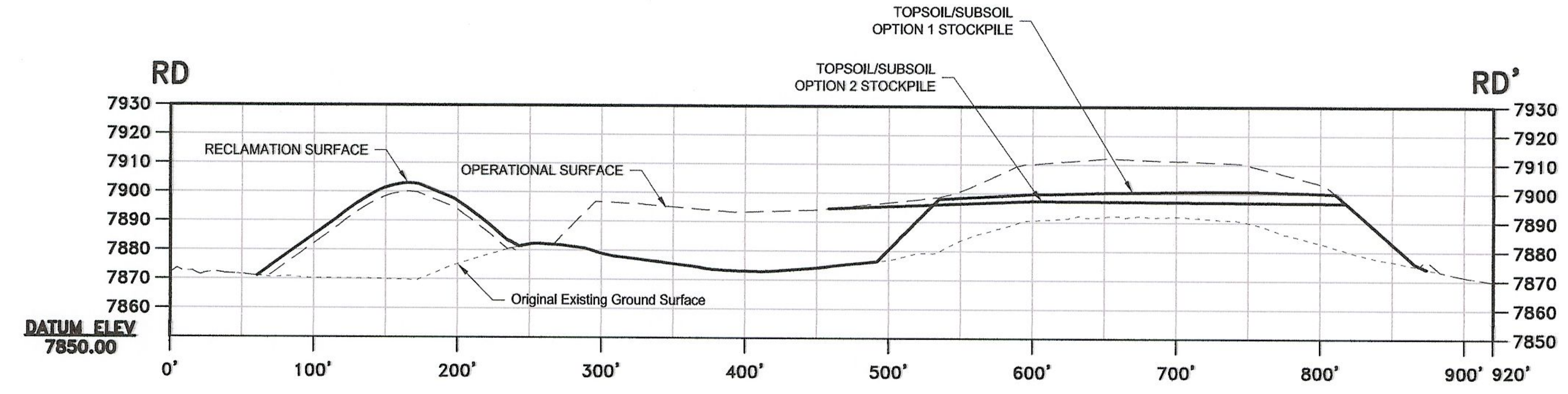

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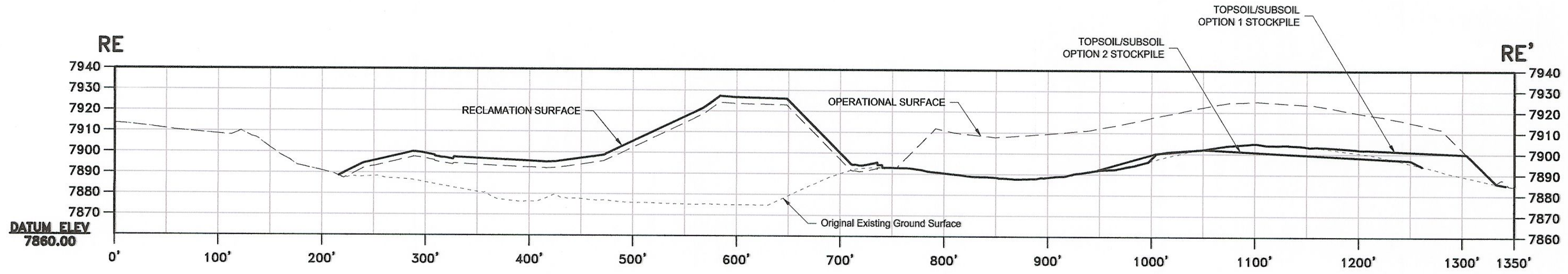
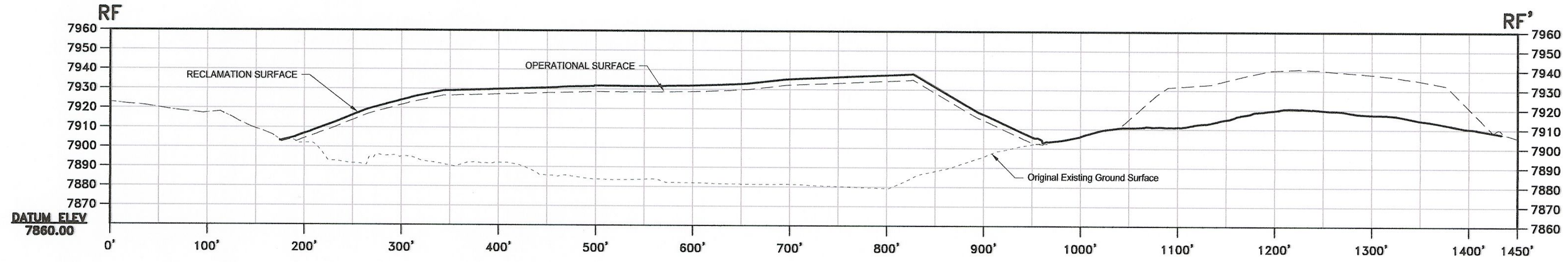


SECTION RE–RE'



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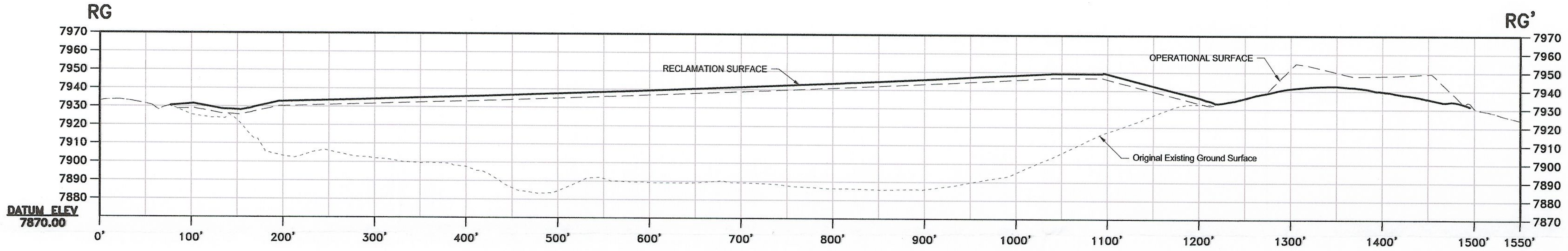
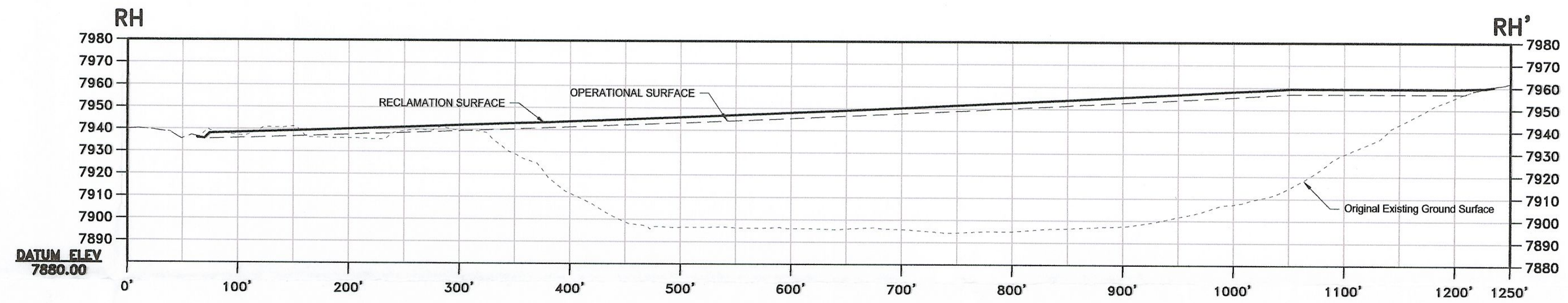
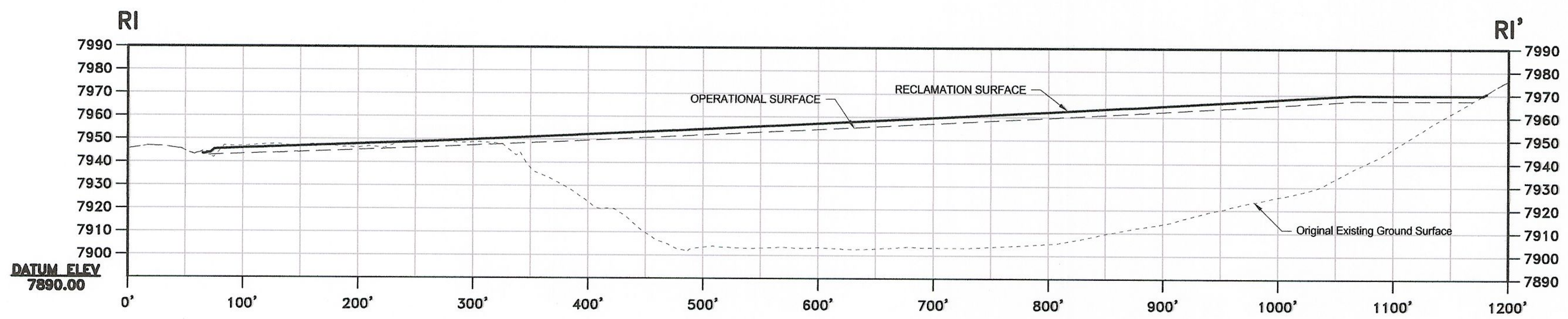


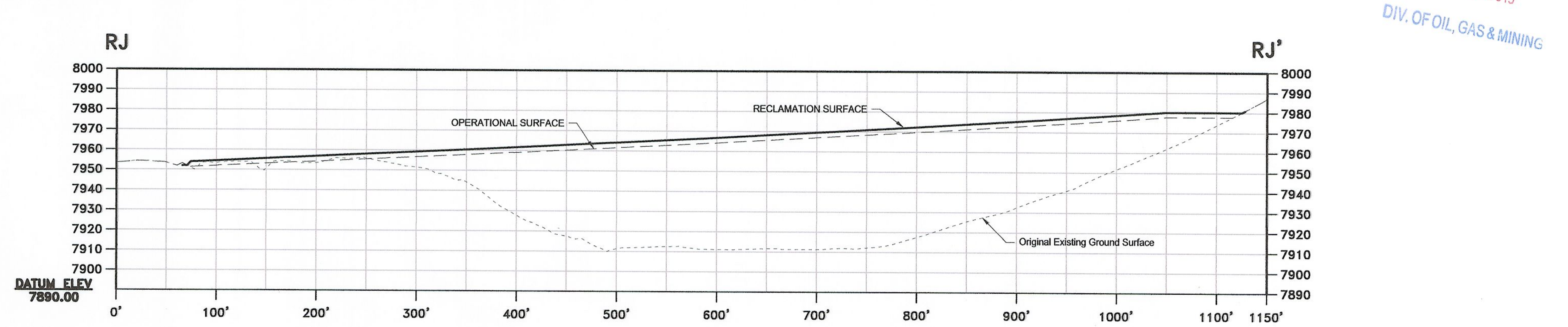
SECTION RG–RG'



SECTION RH–RH'



SECTION RI–RI'



SECTION RJ–RJ'

RECEIVED
JUL 15 2015
DIV. OF OIL, GAS & MINING

LEGEND

ORIGINAL EXISTING GROUND SURFACE

OPERATIONAL SURFACE

RECLAMATION SURFACE

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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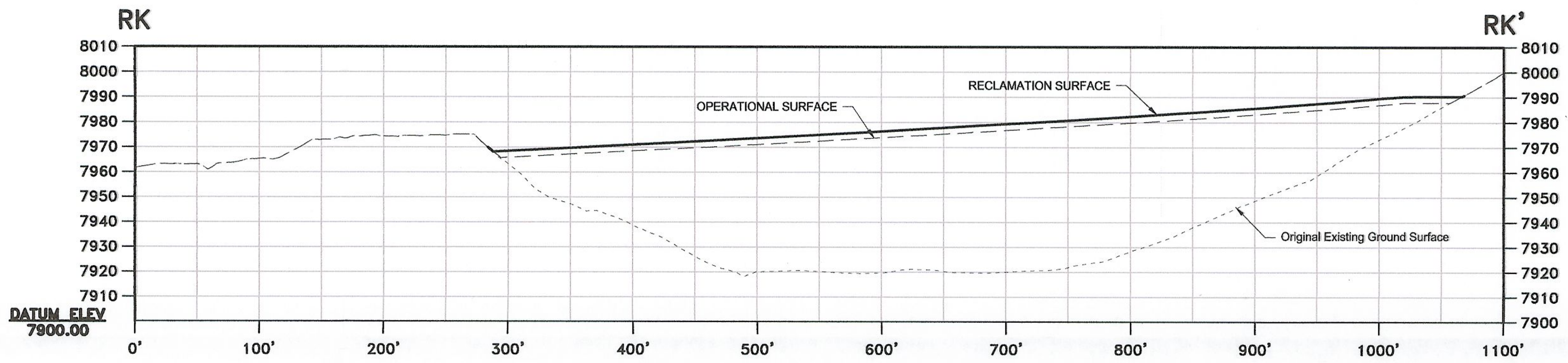
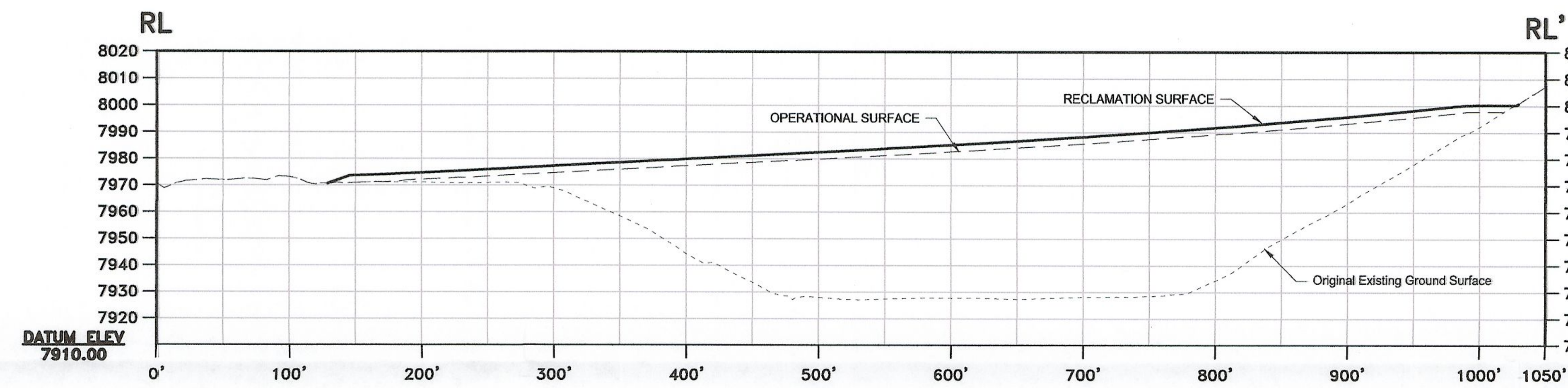
WASTE ROCK PILE
RECLAMATION CROSS-SECTIONS

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-HPT1100.ctb	1" = 100'	7/7/2015	JA	LF / TH	VM	MAP 8A

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406-120	1406-120	H:\JD\Proj\1406-120\DWG\SHEET 14 RECLAMATION SECTIONS.dwg



SECTION RK–RK'



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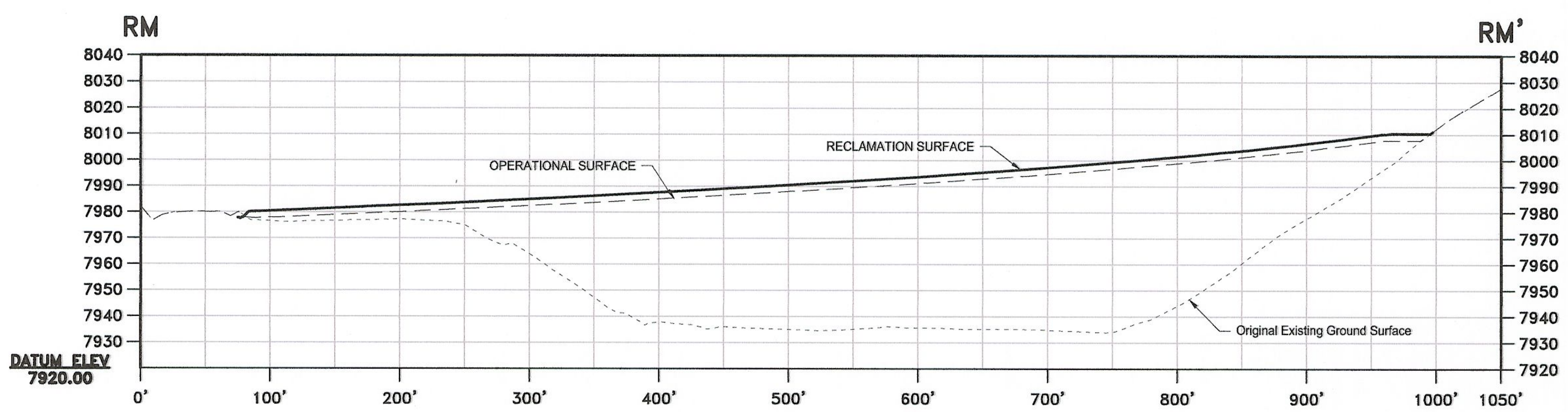

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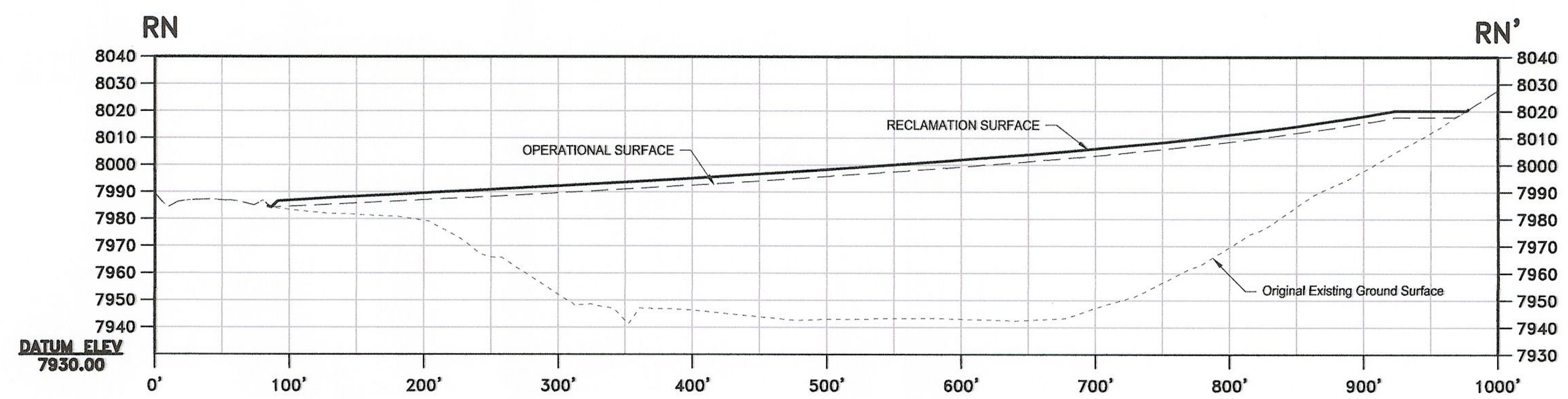

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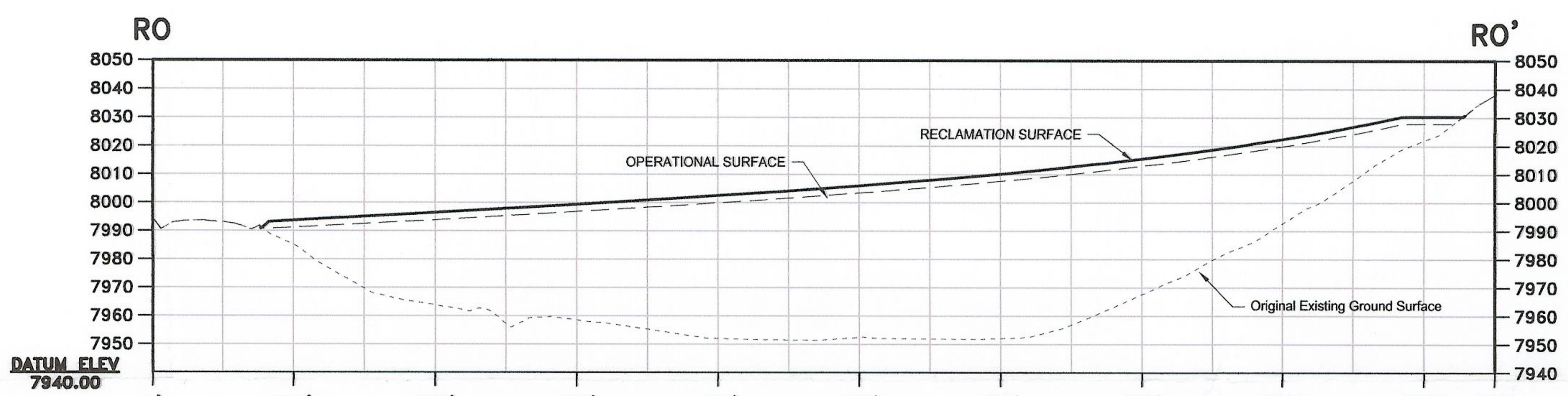
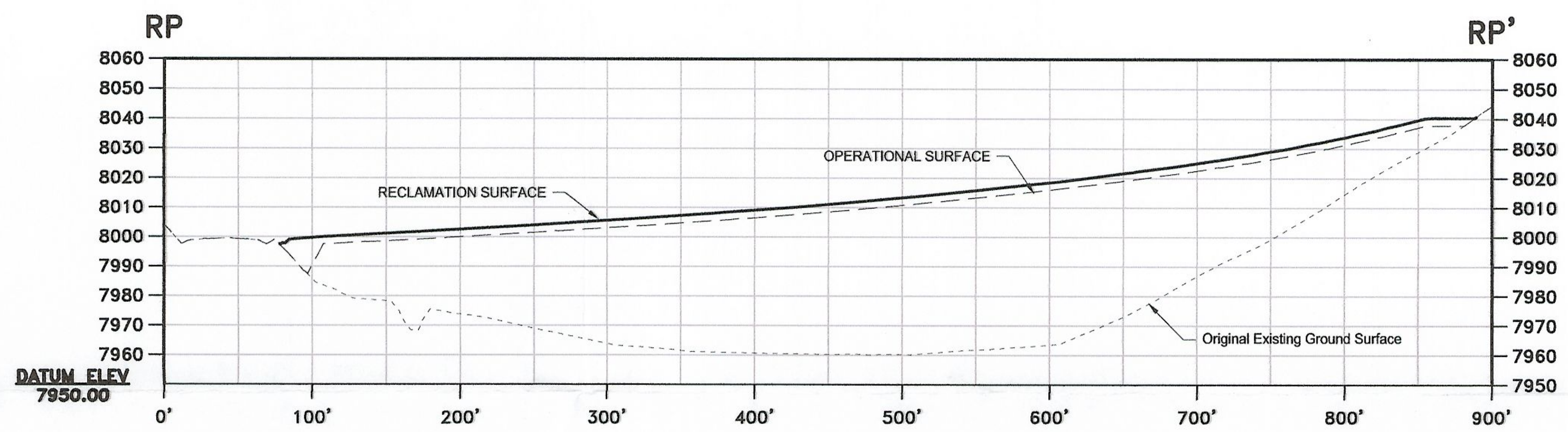


SECTION RO–RO'



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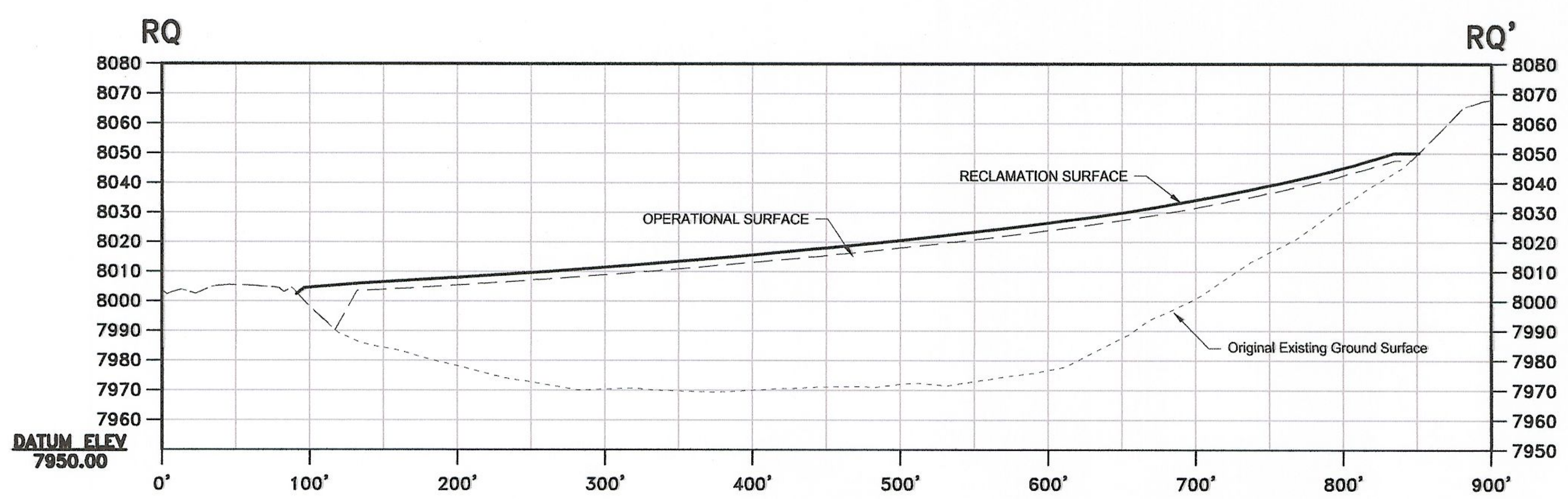
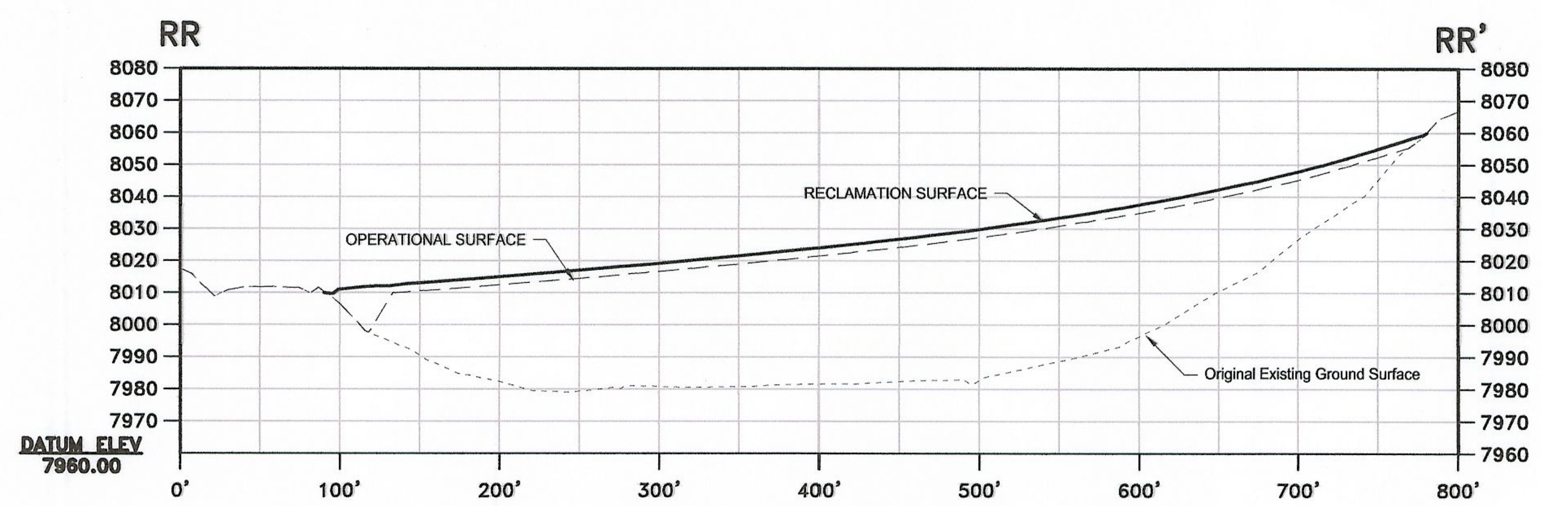
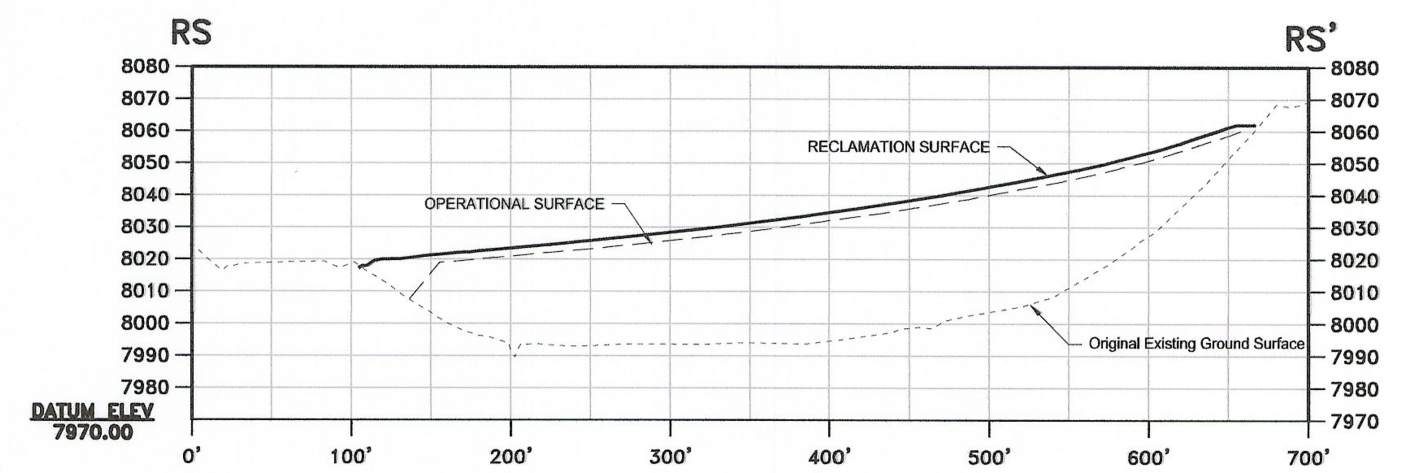


SECTION RQ–RQ'



SECTION RR–RR'



SECTION RS–RS'

LEGEND

- ORIGINAL EXISTING GROUND SURFACE (dotted)
- OPERATIONAL SURFACE (dashed)
- RECLAMATION SURFACE (solid)

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

WASTE ROCK PILE
RECLAMATION CROSS–SECTIONS

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd–HPT1100.ctb	1" = 100'	7/7/2015	JA	LF / TH	VM	MAP 8B

SHT SET:	PROJECT NUMBER:	FILE NAME:
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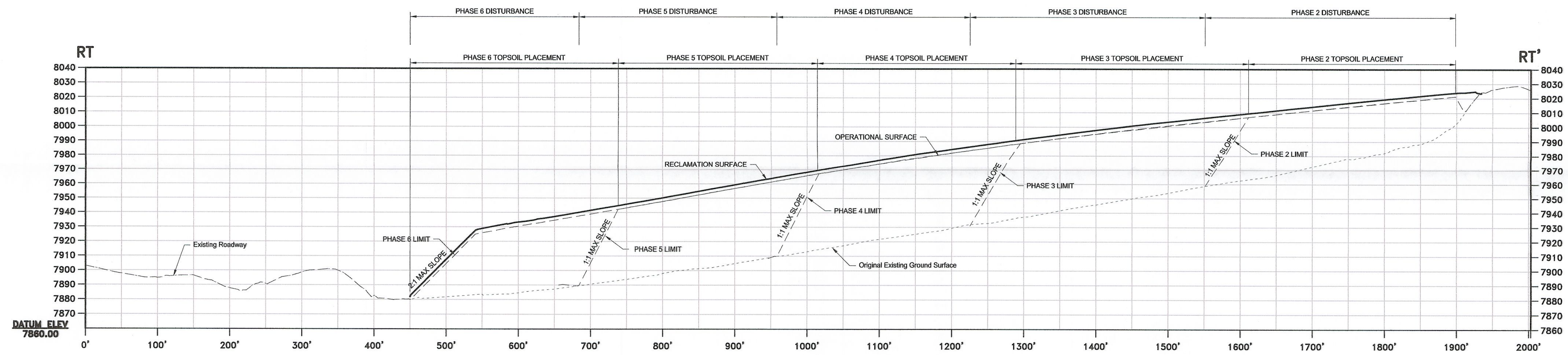
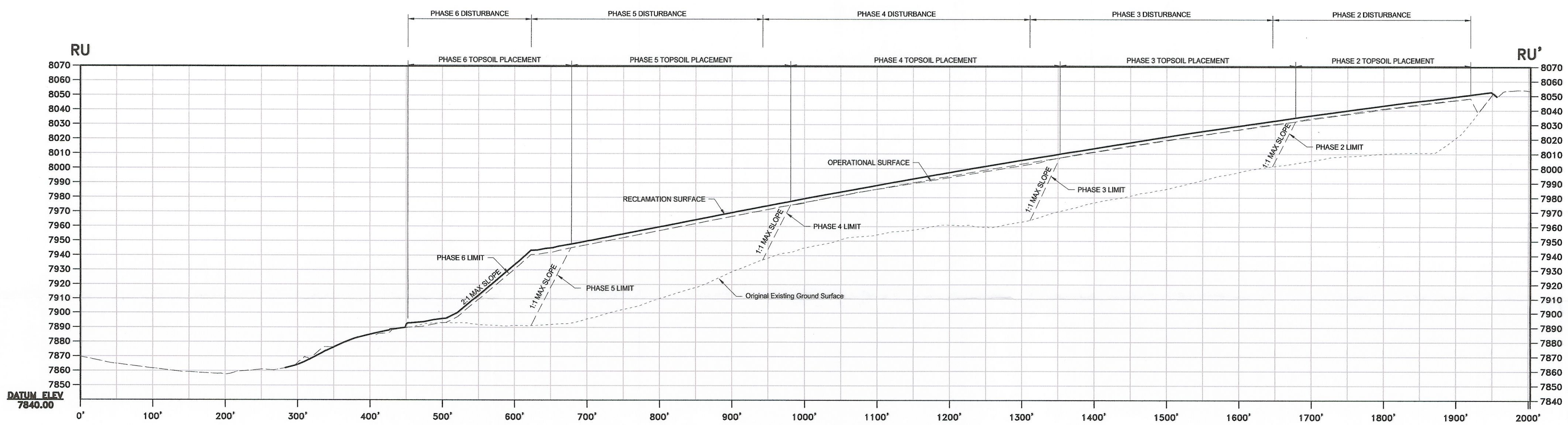


SECTION RT–RT'



SECTION RU–RU'

LEGEND

- ORIGINAL EXISTING GROUND SURFACE
- OPERATIONAL SURFACE
- RECLAMATION SURFACE

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	8/6/2014	VM	JA	PLATE UPDATES
2	9/4/2014	VM	JA	PLATE UPDATES
3	9/19/2014	VM	JA	PLATE UPDATES

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WASTE ROCK PILE
RECLAMATION CROSS-SECTIONS

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-HPT1100.ctb	1" = 100'	7/7/2015	JA	LF / TH	VM	MAP 8C

SHT SET:	PROJECT NUMBER:	FILE NAME:
1406-120	1406-120	H:\JD\Proj\1406-120\DWG\SHEET 14 RECLAMATION SECTIONS.dwg

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