

CANYON FUEL COMPANY, LLC

DUGOUT CANYON MINE METHANE DEGASSIFICATION AMENDMENT Wells G-21, G-22 and Access Road

August 2008

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In C10070037 2008. Informing!
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CHAPTER 1

LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

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T13 S., R13 E., SLBM, Utah (Added to Permit Area in 2005, approximately 2,360 acres)

- Section 17: E1/2SW1/4, SW1/4SE1/4, E1/2E1/2W1/2SW1/4
- Section 20: E1/2W1/2, E1/2, E1/2E1/2W1/2W1/2
- Section 21: SW1/4NW1/4, SW1/4
- Section 28: NW1/4, N1/2SW1/4, SW1/4SW1/4
- Section 29: All
- Section 30: E1/2, E1/2W1/2

Waste Rock Storage Facility

T. 14 S., R. 12 E., SLBM, Utah (Approximately 26.8 acres)

Section 18: Portions of NE1/4, SW1/4 and SE1/4 of the NE1/4

All of Lease ML-42648, except the E1/2 of Section 8 and the NE1/4 of Section 17, is included within the Dugout Canyon Mine permit boundary. However, only the S1/2 SE1/4 of Section 9 from Lease ML-42649 is within the permit boundary. The ten acres described in UTU-76601 are also described in UTU-77985. The U.S. Department of Interior, Bureau of Land Management (BLM) right-of-way application UTU-76601 is included in Appendix 1-3.

The disturbed area encompasses 20.80 acres (Mine Facility area, including Gilson well pad and small substation), ~~30.4~~ 36.9 acres (G-2, G-3, G-4, G-5, G-6, G-7, G-9, G-10, G-11, G-12, G-13, G-14, G-15, G-16, G-17, G-18, G-19, G-21, G-22 (including access road) and G-31 Degas Well), 14.25 acres (AMV Road) 0.85 (Topsoil Stockpile), 1.8 acres (Leach field/pipeline area), 2.7 acres (Pace Canyon Fan Facility) and 26.8 acres (Refuse Pile area) totaling approximately ~~97.6~~ 104.1 acres. That acreage includes a pre- and post mining road with an area of 1.6 acres and 2.03 acres of undisturbed land within the mine facilities disturbed area and 11.2 acres within the refuse pile disturbed area.

The permit boundary encompasses approximately 9,511 acres which includes the following surface ownership and acreage: 10 acres in the BLM right-of-way, approximately 567 acres of other federal lands, 920 acres of state lands, and fee acreage of approximately 8,014 acres (Plate 1-1 and RA Plate 1-1).

Coal ownership acreage within the permit area includes approximately 2,844 acres of federal coal, approximately 5840 acres of state coal, and 827 acres of fee coal (Plate 1-2 and RA1-1B).

APPENDIX 5-6

Reclamation Bond Estimate

Bonding Calculations

Direct Costs

Subtotal Demolition and Removal	\$1,151,983.00	
Subtotal Backfilling and Grading	\$827,141.00	
Subtotal Revegetation	\$482,145.00	
Direct Costs	\$2,461,269.00	

Indirect Costs

Mob/Demob	\$246,127.00	10.0%
Contingency	\$123,063.00	5.0%
Engineering Redesign	\$61,532.00	2.5%
Main Office Expense	\$167,366.00	6.8%
Project Maignement Fee	\$61,532.00	2.5%
Subtotal Indirect Costs	\$659,620.00	26.8%

Total Cost	\$3,120,889.00	
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Escalation factor		0.016
Number of years		4
Escalation	\$204,582.00	

Reclamation Cost Escalated	\$3,325,471.00	
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Reclamation Cost (rounded to nearest \$1,000) 2010 Dollars	\$3,325,000.00	
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Bond in 2010 dollars	\$3,300,000.00	
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Difference Between Cost Estimate and Bond	-\$25,000.00	
Percent Difference	-0.75%	

Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost	
	Dugout Mine Vegetation																				151810
	Dugout Mine Refuse Pile																				104889
	Paco Canyon Fan Portal																				7231
	Degas Well G2																				6280
	Degas Well G3																				5179
	Degas Well G4																				4143
	Degas Well G5																				4143
	Degas Well G6																				5159
	Degas Well G7																				10350
	Degas Well G8																				8280
	Degas Well G9																				8482
	Degas Well G10																				8245
	Degas Well G11																				12574
	Degas Well G12																				8620
	Degas Well G13																				11535
	Degas Well G14																				9620
	Degas Well G15																				8394
	Degas Well G16																				8372
	Degas Well G17																				12574
	Degas Well G18																				13119
	Degas Well G19																				57891
	Degas Well G31																				17873
	AMV Road																				7873
	Degas Well G21																				48274.6
	Degas Well G22 & Access Road																				

Ref.	Description	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swail Factor	Quantity	Unit	Cost
	Mine Belt BC-1 No 1																		19359
	Transfer Building No 2																		34970
	Fuel Belt BC 2 No3																		13812
	Stack Tubes 2 No4																		3973
	Head House 1 No 5																		6887
	Transfer Belt BC2 No 6																		8900
	Head House 2 No 7																		1632
	Reclaim Tunnel No 8																		33989
	Escape Tunnel 60 inch No 9																		12015
	Escape Tunnel 60 inch No 10																		963
	Truck Loading Belt BC 5 No 12																		31287
	Truck Loading and Scale No 13																		9946
	Bar House No 14																		25633
	Substation No 15																		138047
	Power Lines and Poles No 16																		1803
	Reclaiming Vail No 17																		1958
	Gasdon Vail No 18																		898
	Pump House No 19																		59875
	Paved Road No 20																		2708
	Water Tanks No 22																		141491
	Water TANK 72 inch No 21																		48216
	Rock Dust Bin No 23																		3097
	Fuel Tank and Fuel Station No 24																		1092
	Holding Tank No 25																		1615
	Ventilation Fan No 26																		331
	Magnet 27																		2280
	Water System 28																		491
	Sewage System 29																		73901
	Item 30 removed																		24724
	Storage Containers 31																		8900
	Gasdon Vail No 32																		5171
	Shop Building No 33																		5053
	Switch House No 34																		1035
	Portals No 35																		28000
	Storage Building No 38																		1785
	Sampling System No 37																		1335
	Shaker Storage Bin No 41																		822
	Substation No 2 No 42																		2954
	Gasdon Basins No 43																		982
	Papa Fan Cabinet																		2031
	Papa Fan Generator																		5200
	Papa Fan Portal																		9913
	Refines Site No 44																		12297
	Degase Vail C3																		7980
	Degase Vail C4																		7970
	Degase Vail C5																		11058
	Degase Vail C6																		8324
	Degase Vail C7																		12314
	Degase Vail G8																		11054
	Degase Vail G10																		2301
	Degase Vail G11																		9287
	Degase Vail G12																		9081
	Degase Vail G13																		13095
	Degase Vail G14																		12924
	Degase Vail G15																		11354
	Degase Vail G16																		10389
	Degase Vail G17																		10043
	Degase Vail G18																		21636
	Degase Vail G19																		13857
	Degase Vail G20																		27825
	AMV Road																		67996
	Degase Vail G21																		24340
	Degase Vail G22 & Road																		23534
																			1382933

Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Degas Well G-22 and Access Road	Front end loader	02315 424	1.43	/CY						7386							7386	CY	10562
	Grade and Backfill	Backfill Trench M	02315 610	1.58	/CY						430							430	CY	679
	Fill in Mud Pit																			
	Subtotal																			17241
	Pug Well Casing	Concrete Ready	03310 220	196	/CY						25							25	CY	4900
	Subtotal																			4900
	Spread Topsoil	Front end loader	02315 424	1.43	/CY						2103							2103	CY	3007
	Subtotal																			3007
	Fence (only pad)																			2067
	Remove Barbed Wire	Fencing Barbed	02220 220	1.59	/LF	1300												1300	FT	2067
	Subtotal																			2067
	Support	Pickup Rental	01 54 33 4	80.42	/day													5	day	402
	Foreman	Foreman Average	Foreman	\$59.90	/HR													32	hr	1917
	Subtotal																			2319
	Subtotal																			2319

Ref.	Description	Materials	Means Reference Number	Unit	Reference Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
	Degas Well G21																				
	Grade and Backfill	Front end loader 3 CY	02315 424	1.43 /CY								7059							7059	CY	10094
	Fill in Mud Pit	Backfill Trench Minimal H	02315 610	1.58 /CY								430							430	CY	679
	Subtotal																				10773
	Plug Well Casing	Concrete Ready Mix 8000	03310 220	198 /CY								25							25	CY	4900
	Subtotal																				4900
	Spread Topsoil	Front end loader 3 CY	02315 424	1.43 /CY								2718							2718	CY	3887
	Subtotal																				3887
	Fence																				
	Remove Barbed Wire	Fencing Barbed wire 3 st	02220 220	1.59 /LF			1950												1950	FT	3101
	Subtotal																				3101
	Support																				
	Pickup Truck	Pickup Rental	01 54 38 4	80.42 /day											24		hr		3	day	241
	Foreman	Foreman Average, Outside	Foreman	\$59.90 /HR											24		hr		24	hr	1438
	Subtotal																				1539
	Total																				24340

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~2007~~

CHAPTER 1

LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

Methane Degassification Amendment

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

111 Introduction

The degassification wells will be located on property owned by the Milton and Ardith Thayn Trust. The well locations are found in Table 1-1 and are shown in Figure 1-1.

112 Identification of Interests

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

112.100 Business Entity

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

112.200 Applicant and Operator

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

112.300 Officers of the Applicant

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

TABLE 1-1

Degas Well Locations
Pine Canyon, Utah Quadrangle, Salt Lake Meridian

Hole Number	Section	Township and Range
G-1	Portion of N1/2SE1/4NW1/4 Section 24	Township 13 South, Range 12 East
G-2	Portion of N1/2SW1/4NE1/4 Section 24	Township 13 South, Range 12 East
G-3	Portion of N1/2SW1/4NW1/4 Section 19	Township 13 South, Range 13 East
G-4	Portion of N1/2NE1/4NW1/4 Section 24	Township 13 South, Range 12 East
G-5	Portion of N1/2NW1/4NE1/4 Section 24	Township 13 South, Range 12 East
G-6	Portion of S1/2SW1/4NW1/4 Section 18	Township 13 South, Range 13 East
G-7	Portion of SW1/4NE1/4SE1/4 Section 24	Township 13 South, Range 12 East
G-8	Portion of NE1/4NE1/4NE1/4 Section 26	Township 13 South, Range 12 East
G-9	Portion of NW1/4NW1/4SW1/4 Section 21	Township 13 South, Range 13 East
G-10	Portion of NE1/4NE1/4SE1/4 Section 20	Township 13 South, Range 13 East
G-11	Portion of NE1/4SE1/4SW1/4 Section 20	Township 13 South, Range 13 East
G-12	Portion of SE1/4NW1/4SW1/4 Section 20	Township 13 South, Range 13 East

G-13	Portion of NW1/4NE1/4SE1/4 Section 19	Township 13 South, Range 13 East
G-14	Portion of SW1/4SW1/4SE1/4 Section 17	Township 13 South, Range 13 East
G-15	Portion of NW1/4SE1/4NE1/4 Section 19	Township 13 South, Range 13 East
G-16	Portion of SW1/4SE1/4SE1/4 Section 18	Township 13 South, Range 13 East
G-17	Portion of SE1/4NW1/4SE1/4 Section 18	Township 13 South, Range 13 East
G-18	Portion of NE1/4SE1/4NW1/4 Section 20	Township 13 South, Range 13 East
G-19	Portion of SW1/4NW1/4SE1/4 Section 20	Township 13 South, Range 13 East
G-21	Portion of SW1/4NW1/4SE1/4 Section 17	Township 13 South, Range 13 East
G-22 Access Road	Portion of NE1/4SE1/4SE1/4 Section 18 Portions of SE1/4 Section 18	Township 13 South, Range 13 East Township 13 South, Range 13 East
G-31	Portion of NW1/4SW1/4NW1/4 Section 20	Township 13 South, Range 13 East
AMV Road	Portion of S1/2NW1/4 Section 20 Portion of SW1/4SW1/4NE1/4 Section 20	Township 13 South, Range 13 East

112.400 Coal Mining and Reclamation Operation Owned or Controlled

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

112.500 Legal or Equitable Owner of the Surface and Mineral Properties

The legal and equitable owner of the surface and mineral properties to be affected by this operation during the duration of the permit period are list below.

Milton & Ardith Thayn Trust
7730 East US Highway 6
Sunnyside Star Route
Price, Utah 84501

United States of America
State of Utah, Department of Interior
Bureau of Land Management
Price Field Office
125 South 600 West
Price, Utah 84501

State of Utah
School and Institutional
Trust Lands Administration
675 East 500 South
Salt Lake City, Utah 84102-2818

Gil L. Conover
450 So. State
Ferron, Utah 84523

112.600 Owners of Record of Property Contiguous to Proposed Permit Area

Owners of record for surface and mineral properties contiguous to the proposed permit area are list below.

United States of America
Department of Interior
Bureau of Land Management

State of Utah
School and Industrial
Trust Lands Administration

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~2007~~

Price Field Office
125 South 600 West
Price, Utah 84501

675 East 500 South
Salt Lake City, Utah 84102-2818

George and Alice Conover, Et Al
2701 Georgia Way
Sandy, Utah 84092

KFJ Ranch Partnership
C/O Kerwin Jensen
Cleveland, Utah 84518

J. George Conover
275 West Main
Ferron, Utah 84523

Gil L. Conover
450 So. State
Ferron, Utah 84523

112.700 MSHA Numbers

Refer to the same section of the approved M&RP.

112.800 Interest In Contiguous Lands

Canyon Fuel Company, LLC has no interest in contiguous lands other than those currently owned as shown on Plate 1-1 of the approved M&RP.

112.900 Certification of Submittal Information

No information has changed in the approved M&RP because of this submittal. Refer to the same section of the approved M&RP.

113 Violation Information

Refer to the same section of the General Chapter 1 for Canyon Fuel Company, LLC prepared for

the Dugout Canyon Mine, Soldier Canyon Mine and Banning Loadout operations.

114 Right-of-Entry Information

Refer to the same section of the approved M&RP.

See Table 1-2 for disturbed acreage for each well site. The disturbed acres will be added to the total disturbed acreage for the Dugout Mine as each site is constructed.

Additional correspondence pertaining to right-of-entry is located in Attachments 2-3, 4-2, 5-3, and 5-4.

Although notification of mining activities is required under R645.301.525.700, response when requested from landowner or others concerning right-of-entry is entirely at their discretion. The landowner agreement between the permittee and the Thayn Trust can be reviewed in Appendix 4-2 of the Methane Degassification Amendment.

115 Status of Unsuitability Claims

Refer to the same section of the approved M&RP.

116 Permit Term

Refer to the same section of the approved M&RP.

????The disturbed acreage for the AMV access road is approximately 14.25 acres including areas for topsoil storage and turnouts. STP-7 will add approximately 0.85 acres to the disturbed area.

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

The certificate of insurance(s) for each well will be obtained if required when the well is drilled. The

certificate of insurance(s) will be included in Appendix 1-2 of the approved M&RP and General Chapter 1.

118 Filing Fees

Refer to the same section of the approved M&RP.

120 PERMIT APPLICATION FORMAT AND CONTENTS

This amendment submittal will comply with R645-301-120.

130 REPORTING OF TECHNICAL DATA

All technical data submitted in the amendment will be accompanied by the name or organization responsible for the collection and analysis of data, dates of collection and descriptions of methodology used. Technical analyses will be planned by or under the direction of a qualified professional in the subject to be analyzed.

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.

TABLE 1-2
Disturbed Acres by Well Site

Well Site	Disturbed Acres
G-1	0.6
G-2	1.21
G-3	0.97
G-4	0.85
G-5	0.75
G-6	0.32
G-7	1.25
G-8	0.9
G-9	2.2
G-10	1.7
G-11	1.6
G-12	2
G-13	2.75
G-14	2
G-15	2.5
G-16	2
G-17	1.25
G-18	1.4
G-19	2.3
G-21	3
G-22 and Access Road	3.5
G-31	1.75

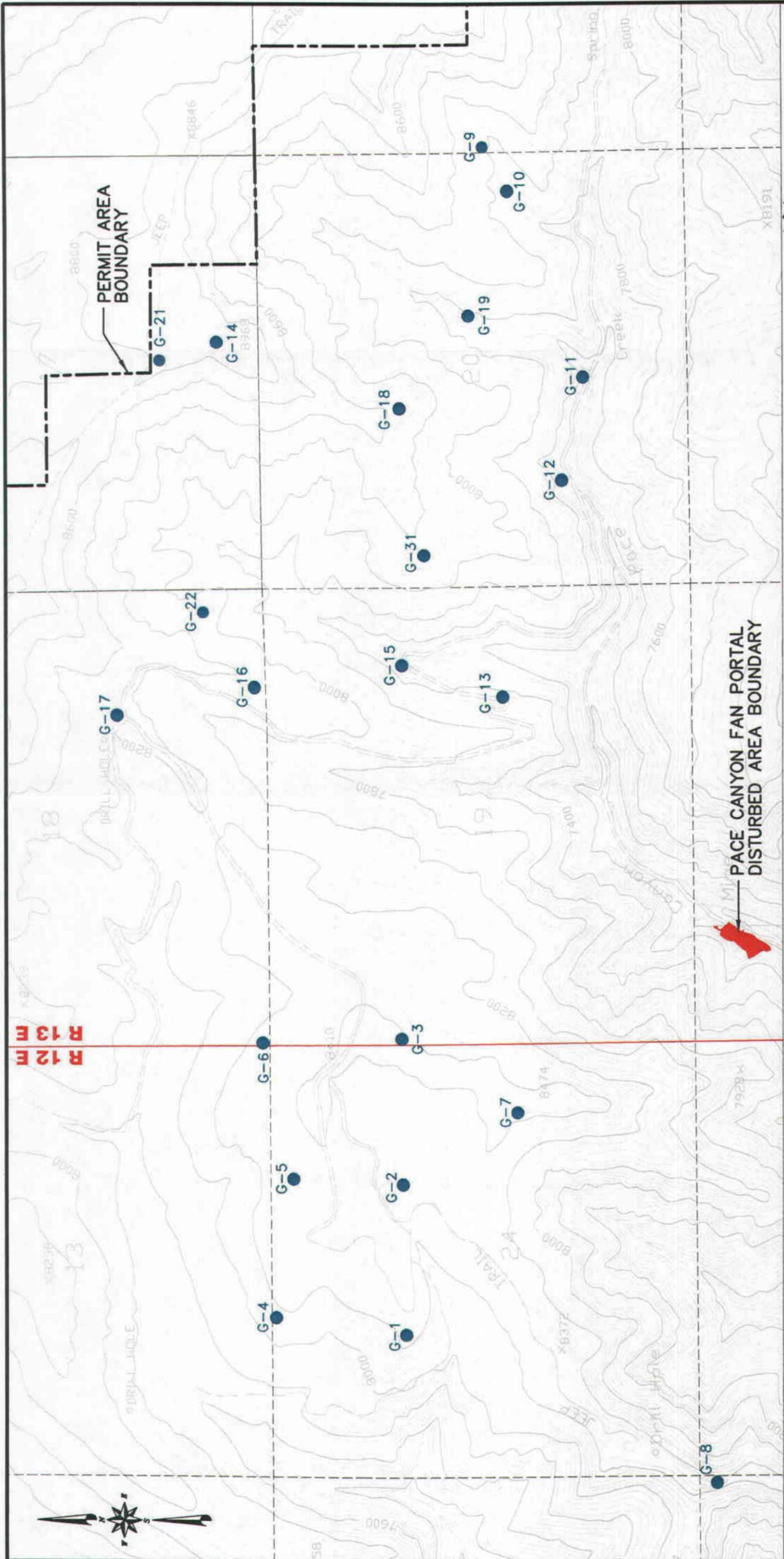


FIGURE 1-1. METHANE DEGAS BORE HOLE LOCATIONS



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210 INTRODUCTION

This chapter and associated attachments address the pertinent data required for the addition of the degassification well sites for the Dugout Canyon Mine. Only those sections of the Division regulations that apply to the well sites have been addressed. The remainder of the regulations have already been addressed in the existing M&RP. The M&RP and this document contain pertinent information relating to the identification, management, and reclamation activities associated with the soil resources.

220 ENVIRONMENTAL DESCRIPTION

The well sites range in elevation from approximately 7400 to 9000 feet. The well sites are located in the Pace Canyon area of the Book Cliffs. General vegetation includes sagebrush, serviceberry, aspen, Douglas-fir, and snowberry.

221 Prime Farmland Investigation

Due to limiting terrain, lack of water for irrigation and no evidence of past cultivation of the sites, it is concluded that no prime farmland exists within the area of the well site disturbance.

222 Soil Survey

222.100 Soils Map

The soils have been mapped as part of the Soil Survey of the Carbon Area, Utah by the Soil Conservation Service (1988), at an Order III intensity level.

A description of the soils is included in Appendix 2-2 of the approved M&RP and in Attachment 2-1, which includes a report by Dan Larsen, Soil Scientist, entitled "Soil Inventory and Assessment Six

Methane Degassification Borehole Sites". An additional report for well site G-6 was prepared in 2004 and is incorporated into Attachment 2-1. Soil information for Well G-7 is incorporated into Attachment 2-1. A photograph of the G-7 site is included in Attachment 3-1. Well site G-3 and the access road can be seen on the photograph.

The soils report prepared by Dan Larsen, Soil Scientist for wells G-8 thru G-13 is provided in Attachment 2-1. Wells are being permitted in groups: G-8 thru G-10, G-11 thru G-12 and G-13 thru G-17.

222.200 Soil Identification

<u>Well No.</u>	<u>Soil Map Unit</u>	<u>Soil Components</u>
G-1	62/88	Midfork-Comodore complex, Rabbitex-Datino Variant
G-2	7	Brycan, Beje-Trag complex, 3-30% slopes
G-3	7	Beje-Trag complex, 3-30% slopes
G-4	62/103	Midfork-Comodore complex, Senchert-Toze complex
G-5	103	Senchert-Croydon
G-6	62	Midfork-Comodore complex
G-7	7	Beje-Trag complex, 3-30% slopes
G-8	21	Croydon Loam, 8 to 30% slopes
G-9	97/62	Midfork-Comodore complex, Rottulee family-Trag complex
G-10	97	Rottulee family-Trag complex
G-11	11, 26	Cabba- family, 40 to 70 percent slopes, Doney family, 50 to 70 percent slopes
G-12	47, 88	Guben-Rock outcrop complex, Rabbitex family-Datino Variant complex

G-13	23	Curecanti family
G-14A	62	Midfork family - Comodore complex
G-15	115, 62	Trag stony loam, 30 to 60 percent slopes, Midfork family - Comodore complex
G-16	26	Doney family
G-17	103	Senchert-Toze family Complex
G-18	97	Rottulee family-Trag complex
G-19	62	Midfork family - Comodore complex
G-21	100	Senchert Series (Bachus Series)
G-22	97	Rottulee Series (Stubbs Series)
G-31	97	Rottulee family-Trag complex
Access Road	97	Rottulee family-Trag complex
	62	Midfork family - Comodore complex

222.300 Soil Description

Refer to Attachment 2-1 of the submittal for soil descriptions.

222.400 Soil Productivity

The depth of topsoil at each site was measured to determine the amount of growth medium available for reclamation. The following table lists each well site and the approximate amount of growth medium available.

TABLE 2-1
Topsoil Volumes*

Well No.	Cubic Yards of Material
G-1	415
G-2	3,104
G-3	1,182
G-4	1,100
G-5	1,909
G-6	792
G-7	1251
G-8	543
G-9	1,574
G-10	2,344
G-11	254
G-12	563
G-13	2,162
G-14	1,544
G-15	1,475
G-16	1,092
G-17	797
G-18	2,195
G-19	2,037
G-21	2,718
G-22 & Access Road	1,137
G-31	4,624
Access Road	9,167

* These total do not include soil salvaged from short roads accessing well sites which is bladed to the side of the road.

Figure 5-1 through Figure 5-25 show the layout and approximate size of well pads for G-1 thru G-6. Figures 5-27 thru 5-29 show the layout and size for well G-7. The figures for wells G-8 thru G-19, G-21 and G-22 (Including access road) are located in Attachment 5-1. Topsoil volume calculations can be found in Attachment 2-2.

Estimated topsoil salvage from the G-1 well site will average about 7". This site on a ridge top has previously been disturbed for exploration drilling. The site has pockets of fractured sandstone bedrock at the surface and stony subsoils, which are the limiting factors in the quantity of salvageable topsoil. The average topsoil depth at well site G-2 is 30". The average topsoil thickness for well site G-3 is 10". However, enough soil will be stripped to allow 12" of soil to be placed during reclamation. Thus some subsoils will be stripped with the topsoil to generate the required volume. The estimated topsoil salvage from well site G-4 area will be 28" except on the area of the exiting road(s). The average salvageable topsoil at well site G-5 is 22". Well site G-6 will be established on a pre-existing drill pad, with a portion of the new pad extending onto undisturbed area. Topsoil on the pre-existing drill pad ranges from 0 to 30 inches, on the north edge in from 20 to 28 inches and on the cut slope on the south edge from 6 to 30 inches. The slope will be restored to original contour with the application of topsoil, the entire site will receive at least 12 inches of topsoil. Twelve inches was used to calculate the volume of topsoil to be salvaged and to determine the size of the topsoil pile for drill site G-6. Degas well G-7 will be developed on a site with soils consistent with G-3. There is a pre-existing road to well G-3 that continues on to the G-7 proposed site. There are signs of previous vehicle disturbance at the site, however the majority of the site is undisturbed. Topsoil available for salvage has been estimated to be 10 to 12 inches. Available topsoil will be salvaged and if necessary some subsoils will be stripped with the topsoil to generate the required volume to place a minimum of 12 inches during site reclamation. Available topsoil at each site will be salvaged, stockpiled and redistributed.

Twelve inches of soil will be salvaged at well site s G-9. Well site G-9 has no topsoil over approximately half of the site, thus requiring the salvage of subsoil to generate the foot of soil proposed for reclamation. Suitable soil for salvage at site G-10 is approximately 15 inches with some areas having 24 inches of soil. Where available soil will be salvaged to a minimum of 15

inches and approximately 18 inches will be available to cover the G-10 disturbed area at the time of reclamation. G-8 was not constructed, however the available topsoil at site was estimated at about six inches.

The majority of the area at well site G-11 has been disturbed by road construction and the major part of the undisturbed portion has shallow eroded soils, except for a small area on the west side of the site. The shallow eroded soils are approximately 5 inches deep and the soils in the small area are between 10 and 16 inches deep. Approximately fifty percent of the G-12 well site is a road with no topsoil or vegetation. Between 12 and 30 inches of soil is suitable for salvage from the other fifty percent of the pad area for site G-12. Twelve inches will be returned to the reclamation slope at G-11 and between 12 and 15 inches at G-12. Large boulders are suspected to be present at the G-12 site.

At well site G-13, parent materials for soil formation are primarily colluvial deposits derived from sandstone and shale. The surface ranges from relatively smooth and non-stoney to very stoney. Suitable soil for salvage ranges from about 8 to 28 inches, limitation are due to high rock fragment content and low organic matter. Portions along the southeast edge are too stony for soil salvage. Well site G-14 (DUG205), is relatively uniform with soils of and similar to the Midfork family. Topsoil thickness range from 12 to 24 inches, with the typical depth being 15 to 18 inches. The G-14 well site has been disturbed by logging. Between 14 and 16 inches of topsoil will be placed at well sites G-13 and G-14 during reclamation.

The road to G-13 and G-14 are existing roads, however, the soil will be bladed to the side of the road at site G-14 and replaced during reclamation.

Well site G-15 is about 50 percent disturbed by a road, slope cut and fill. The undisturbed portion of the site is a slope with a southeast aspect (35 to 45 percent gradient). The topsoil on this slope is typically 13 to 20 inches thick, with a loam texture. Approximately 14 inches of topsoil will be replaced during reclamation.

Well site G-16 was previously the site of an exploration hole, having been disturbed and reclaimed. Approximately, 14 inches of soil will be salvaged as topsoil and replaced during reclamation. The topsoil on the access road will be bladed to one side of the road and replaced during reclamation.

At well site G-17 approximately one-third of the site is an existing road. Sufficient topsoil will be salvaged to replace 12 inches over the area of disturbance during reclamation.

The entire area of well site G-19 was previously disturbed by logging activities with two roads crossing through the area. During the soil survey it was determined that the topsoil was 8 inches in depth. Approximately 12 inches of topsoil and subsoil will be salvaged for replacement during reclamation. Although, two soil pits were samples only SP-2 is representative of the site. SP-1 is not within the G-19 site's disturbed area.

The report for sampling completed May 1 and 5, 2007 summarizes the methodology and results of the soil survey conducted by Clement Drilling & Geophysical, Inc. for the proposed access road and G-18 and G-31 wells (Attachment 2-1, May 22, 2007).

The proposed road (AMV) and drill pads for wells G-31 and G-18 were evaluated using the United States Department of Agriculture (USDA), Natural Resources Conservation Services (NRCS) WEB Soil Survey (WSS) utility. NRCS Order III descriptions for the soil series that occur in the study area are presented in Appendix A of the May 22, 2007 report located in Attachment 2-1.

Soil test pits were excavated at the two proposed well locations. The soil test pit at well G-31 was excavated by hand on May 1, 2007. The soil test pit for well G-18 was excavated by hand on May 5, 2007. Soil test pits were also excavated in areas representative of each of the three soil map units that occur in the vicinity of the proposed road and vent wells. The three test pits were excavated by hand on May 5, 2007. The coordinates of each test pit collected using a GPS receiver are presented in the test pit logs. The test pit logs are presented in Appendix B and photographs of the excavations in Appendix C. The soils observed in the test pits appear to

generally correlate to the NRCS Order III Map Units. Soil samples were collected from each test pit from each horizon, where possible, for laboratory analysis. The analyses will be incorporated into Attachment 2-1. Two additional soils samples were taken along the road corridor, these samples were labeled AMV SP-1 and AMV SP-2. These samples were dug by hand with a shovel and pick. The lab analysis of these samples is included in Attachment 2-1.

Per the review of aerial photography taken of the area in November 2006, there does not appear to be rock outcrops along the path of the AMV access road. When Mr. Clements walked the road area in conjunction with the soil survey, he identified no concerns with the soil map units designated on Plate 1 included in Attachment 2-1.

The soils report for G-21 and G-22 including the access was prepared by Ryan Sweetwood (Attachment 2-1). The soil text pits for well site G-22 and access road (SP10 thru SP13) provided two soil series, soil pits SP-11 and SP-12 closely matched the soil series designated in the NRCS, Web Soil Survey. SP-10 has a profiles not characteristic of Rottulee Series, the physical and chemical properties match more closely to the Stubbs Series.

223 Soil Characterization

The topsoil evaluation described in this chapter was performed by Daniel M. Larsen, Professional Soil Scientist and Dean Stacy, NRCS Range Management Specialist in accordance with the standards of the National Cooperative Soil Survey. The topsoil evaluation for Wells G-18, G-19, G-31 and the Access Road were performed by Craig Clement, P.G. and Dean Stacy, NRCS Management Specialist in accordance with the standards of the National Cooperative Soil Survey and using the USDA/NRCS WEB Soil Survey utility.

The topsoil evaluation for wells G-21, G-22 and access road was performed by Ryan Sweetwood, his resume is included in the report for the two wells in Attachment 2-1.

224 Substitute Topsoil

Dugout Canyon does not plan to use substitute topsoil as growth media except as described in Section 222.400.

230 OPERATION PLAN

231 General Requirements

231.100 Removing and Storing Topsoil Methods

The topsoil will be removed, stockpiled and protected with a berm and/or silt fence. A qualified person will be on site during soil salvage to monitor and supervise the operation for the purpose of maximizing salvage volumes. Prior to topsoil salvage shrubs/vegetation will be removed and placed/wind rowed along the inside perimeter of the disturbed area.

After the topsoil is removed, the mud pit will be excavated and the soils from the mud pit excavation will be stored immediately adjacent to the mud pit. Mud pit excavation of subsoil will be approximately 110 CY at each well site (G-2 thru G-6).

The subsoil excavation for the mud pits at G-7 thru G-19, G-21, G-22, and G-31 was approximately 430 CY. A portable container for drilling fluids will be used if necessary, should there not be sufficient subsoil depth to excavate a mud pit.

Topsoil beneath the topsoil stockpiles will not be removed. Ribbon or a marking fabric will be placed on top of the topsoil prior to placement of the topsoil from the well pad area.

The approximate volume of subsoil to be salvaged and used to create berms around the perimeter of the well site including the topsoil stockpile perimeter is: G-1 - 161 CY; G-2 - 254 CY, G-3 - 208 CY, G-4-165 CY, G-5 - 191 CY, G-6 - 156 CY, G-7 - 107 CY, G-8 - 143 CY, G-9 - 182 CY, G-10 - 137 CY, G-11 - 185 CY, G-12 - 260 CY, G-13 - 142 CY, G-14A - 123 CY, G-15 - 101 CY, G-16 -

98 CY, G-18 - 39 CY excludes topsoil pile, G-19 - 48 CY, G-21 - ??CY, G-22 - ??CY, G-22 Access Road - ??CY, G-31 - 62 CY excludes topsoil pile, Topsoil Stockpiles T-2 thru T10 - ~~309~~300 CY and Access Road - ~~265~~ 248 CY.

At the G-19 drill pad there is a variance between the disturbed area acreage and the acreage where topsoil will be salvaged. Portions of the site have no topsoil, due to previous disturbance by logging, these areas include roads, a gully and skid trails. In addition there is a perimeter buffer area that will not be disturbed and thus will not have topsoil removed from the area unless it becomes necessary due to unforeseen issues during construction, such as buried outcrops, large boulders, tree root systems, etc. An area within the northeastern portion of the disturbed area has two road forks extending from the end of the existing road, these two forks have no topsoil on them and the area between them will not be disturbed and therefore will not have topsoil salvaged. A sketch of these areas is located in Attachment 2-1.

There is a difference between the topsoil volumes totals and the estimated inches to be salvaged on pads G-18, G-31 and the AMV road. The topsoil volume totals assume that the entire disturbed area will be stripped of 12 inches of topsoil/growth medium. Any areas within the disturbed area boundary which can remain undisturbed will remain undisturbed. In addition, the soils to be salvaged are assumed to be the same depth as the test pit or 12 inches. The available soil for salvage is likely to vary throughout the areas to be salvaged. A commitment is made to salvage available topsoil or 12 inches of growth medium. Sketches of the well pads are included in Attachment 2-1.

231.200 Suitability of Topsoil Substitutes/Supplements

See Section 224.

231.300 Testing of Topsoil Handling and Reclamation Procedures Regarding Revegetation

Dugout will exercise care to guard against erosion during and after application of topsoil and will employ the necessary measures to ensure the stability on graded slopes. Erosion control measures will include silt fences, berms, seeding, straw bales, soil roughening, and mulching of the soils.

Topsoil will be redistributed and the original soil surface beneath the topsoil stockpile will be roughened as presented in Section 242.100 and seeded with the seed mix described in Chapter 3, Section 352.

Methods used to evaluate success of revegetation and stabilization are discussed in Chapter 3, Section 356.

231.400 Construction, Modification, Use, and Maintenance of Topsoil Storage Pile

Topsoil removed from the drill pad sites will be stockpiled on the site, except at well site G-14 where it will be stockpiled approximately 1/10 mile away. The estimated volumes of topsoil stockpile for each site are shown in Table 2-1. The stockpiles will be sized as shown in Table 2-2.

The slopes of the stockpile will be 1H:1V or approximately 45⁰ during the construction phase. Soils in these areas generally have an angle of repose greater than 50 degrees, making a stockpile with 1:1 slopes feasible. The steeper slope also help minimize the area to be disturbed. When space is available topsoil will be stockpiled with slopes of 2H:1V.

232 Topsoil and Subsoil Removal

232.100 Topsoil Removal and Segregation

All topsoil will be removed as a single layer with no segregation. Topsoil will be removed using a dozer and/or loader. Refer to Section 231.100 for additional details.

232.200 Poor Topsoil

No poor soils exist at the well sites see Attachment 2-1.

TABLE 2-2
Topsoil Stockpile Dimensions*

Well No.	Length (ft)	Width (ft)	Height (ft)
G-1	55	35	16
G-2	156	50	20
G-3	70	60	17
G-4	110	35	17
G-5	90	65	21
G-6	105	30	13
G-7	80	70	6 to12
G-8	168	60	6
G-9	160	90	30
G-10	170	80	65
G-11	40	50	12
G-12	60	80	18
G-13	120	100	17
G-14A	120	60	11

TABLE 2-2 (Continued)
Topsoil Stockpile Dimensions*

Well No.	Description	Length (ft)	Width (ft)	Height (ft)
G-15	Pad	90	90	19
G-16	Pad	100	80	12
G-17	Pad	85	55	10
G-18	T-10	118	80	20
G-19	Lower Road	235	8	5
	Pad	140	52	35
G-21	Pad Stored on G-14	110	60	24
G-22 and Access Road	Pad & road, Stored on G-16	85	65	25
G-31	T-8	85	67	7
	T-9	128	100	13
Access Road	T-2	40	90	8
	T-3	108	95	11
	T-4	12	45	5
	T-5	95	110	13
	T-6	95	138	14
	T-7	110	150	21

* These are approximate dimensions of the topsoil stockpile and construction dimensions may vary. The height represents the elevation difference between the lowest point and highest point of the topsoil stockpile. The topsoil thickness will vary with the slope of the native ground surface. When stored on steep slopes the topsoil thickness will be much less than the estimated height of the stockpile.

See Section 234.200 for detailed information on the topsoil stockpile(s).

232.300 Thin Topsoil

Not applicable see Attachment 2-1.

232.400 Minor Disturbances Not Requiring Topsoil Removal

Topsoil will not be removed along the fence line at the wells sites.

232.500 Subsoil Segregation

The B and C soil horizons will not be removed. Any small quantity of subsoil removed with the topsoil will not be segregated.

232.600 Timing

Topsoil removal will take place after all vegetation that could interfere with salvaging the topsoil has been grubbed.

232.700 Topsoil and Subsoil Removal Under Adverse Conditions

The topsoil will be removed first and stockpiled and the remaining soil horizons will be left in place, except where natural conditions render removal operations hazardous or detrimental to soils outside the disturbed area then topsoil will not be removed.

Conventional Machines - In locations 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 not be salvaged and stockpiled. Such conditions are not likely to occur in these areas.

Substitute Topsoil - Importing of substitute topsoil is not anticipated (Section 224).

233 Topsoil Substitutes and Supplements

233.100 Overburden Materials Supplementing and/or Replacing Topsoil

No overburden material will be used.

233.200 Suitability of Topsoil Substitutes and Supplements

No substitute topsoil is planned.

233.300 Physical and Chemical Analysis

See Section 243.

233.400 Testing of Substitute Topsoil

No substitute topsoil is planned.

234 Topsoil Storage

234.100 Topsoil Stockpiling

Topsoil will be stockpiled for later use in reclamation operations. The topsoil will be stored and treated as outlined in Section 234 of this amendment. Refer to Sections 231 through 234 of the M&RP for additional information pertaining to the topsoil at the Pace Canyon Fan site.

234.200 Topsoil Stockpile

Stable Stockpile Site - Stockpiled material will be placed on a stable site.

Protection from Contaminants and Compaction - To protect the topsoil from contaminants and unnecessary compaction that could interfere with vegetation, the stockpile will be isolated from the main surface area by a berm and/or silt fence. A sign designating "topsoil" will be installed on the stockpile.

The topsoil stockpile will be constructed in such a manner as to allow access for repair of the pile surfaces and diversion structures.

Wind and Water Erosion Protection - The topsoil stockpile will be protected from water erosion by berms, which trap sediment runoff from the stockpile. The berms have been designed to completely contain the 10-year 24-hour storm event (see Attachment 7-1). The stockpile will be surface pitted, gouged and/or roughened and revegetated using the grass seeds listed in Table 3-2 to prevent wind erosion.

Topsoil Redistribution - Stockpile soil will not be moved until redistribution during contemporaneous or final reclamation operations unless approved by the Division.

At well pad G-19 a portion of the salvaged topsoil will be stored on a fork of the existing road. There is no topsoil remaining on the road and the road will remain following reclamation of the G-19 pad site. Wide flagging will be used as a marker to identify the separate between the road surface and the stored topsoil. Landowner correspondence pertaining to topsoil storage on the existing road is contained in Attachment 2-3.

Cross-sections of topsoil piles T-2 thru T-10 are shown on Plate 2 and 3, in Attachment 5-4. As-built cross sections with horizontal and vertical scales equal with two perpendicular cross sections provided for each of the topsoil stockpiles will be submitted within 30 days following the completion of the construction of topsoil stockpiles T-2 thru T-10 (Attachment 5-4, Plate 3). The perpendicular cross sections will extend through the area where the stockpiles join the road, except T-8, T-9 and T-10 which do not join a road but are on degas well pads.

To minimize the disturbance for well pad G-21 the topsoil will be stored on the existing permitted pad for well G-14 which is approximately 500 feet east of the G-21 pad. The topsoil for the G-22 pad and access road will be stored on the existing G-16 drill pad. The topsoil piles for G-21 and G-22 will be separate from the existing piles for drill pads G-14 and G-16, and will have signs designating the drill pad number.

234.300 Topsoil Stockpile Relocation

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

240 RECLAMATION PLAN

As-built cross section where both horizontal and vertical scales are equal will be provided within 30 days of completion of the AMV road construction. The AMV as-built road cross sections are provided ~~would be drawn at stations are 0+15, 15+35, 33+81, 39+62, 45+49 and 51+07~~ on Plates 2 and 3 in Attachment 5-4. ~~the section of the road leading to G-31. On the section of the road leading to G-18 the proposed cross sections will be at station 0+44, 5+22, 10+05 and 12+40.~~ In addition, an as-built road profile will be provided within 30 days of completion of the AMV road construction.

241 General Information

Reclamation of the degassification sites (topsoil redistribution, amendments, and stabilization) is discussed in Sections 242, 243, and 244 respectively.

242 Soil Redistribution

242.100 Soil Redistribution Practices

The topsoil will be placed after recontouring of the site has occurred. Topsoil will be handled when they are loose or in a friable condition. The moisture content will be visually monitored and water will be added as needed to enhance the soil's condition for handling. The approximate amount of topsoil available for each site is shown in Table 2-1. The reclamation time line can be found on Figure 5-15 for sites G-2 and G-3 and on Figure 5-26 for sites G-4 thru G-19, G-21, G-22 (including access road) and G-31. Figure 5-26 has been revised to include the access road (AMV).

The topsoil will be distributed in two phases at well site G-2, the first phase will be the contemporaneous reclamation of a portion of the pad area used during well construction (see Figures 5-4, 5-8 and 5-12). During contemporaneous reclamation topsoil from the stockpile will be distributed in the depths shown in Table 2-3.

Final reclamation will occur at all well sites after venting of the methane gas is complete, venting equipment has been removed and the well has been plugged. Well plugging will be delayed at well sites G-2, G-5 and G-7, to allow additional time for venting of the gob behind the sealed panels and to provide surface access to the mine. The surface at well sites G-2 and G-5 will be reclaimed in 2007/2008, however the wells will not be plugged. The surface at well site G-7 will be reclaimed in 2008, but the wells will not be plugged. The topsoil stockpile storage area and access road (G-2 and G-5) will be reclaimed during this final phase. The access roads to G-3, G-4, G-6, G-7, G-8, G-9, G-10, G-11 and G-12 are pre-existing and will not be reclaimed.

The topsoil stockpile storage area and access road (G-2, G-5 and G-22) will be reclaimed following the plugging of the wells. The access roads to G-3, G-4, G-6, G-7, G-8, G-9, G-10, G-11, G-12, G-13, G-15, G-17, G-19 and G-21 are pre-existing and will not be reclaimed. The access road joining the pre-existing road to G-16 and the portion of the access road between the topsoil stockpile and the well site at G-14 will be pocked/gouged and seeded during final reclamation of the site.

The AMV access road will be reclaimed using the technology discussed in Section 240 of this amendment following the sealing and reclamation of well pads G-18 and G-31.

Refer to Section 341 for additional information.

Soil Thickness - The topsoil will be distributed during contemporaneous and final reclamation in the thickness shown in Table 2-3.

Compaction - Prior to the application of topsoil, compacted subsoils will be roughened or loosened for a depth of 18 to 24 inches. To prevent compaction of topsoil, soil moving equipment will refrain from unnecessary operation over spread topsoil. The topsoil will be in a loosened condition prior to seeding.

Following the drying of the mud pit materials, the dirt excavated to create the mud pit will be mixed with the drill cutting and returned to the pit to prevent a boundary of hard material from forming in the mud pit area that would hamper root penetration and then compacted to minimize settling.

Erosion - Care will be exercised to ensure the stability of topsoil on graded slopes to guard against erosion during and after topsoil application. Post reclamation (contemporaneous and final) erosion control measures will be surface roughing, mulching and seeding.

242.200 Regrading

The areas will be graded to their approximate original topographic configuration, except as approved by the Division.

242.300 Topsoil Redistribution on Impoundments and Roads

The mud pits will be dismantled and filled following completion of drilling. See Section 242.100, Compaction for additional information. Mud pits will be covered with the same amount of topsoil as the rest of the site. The roads existing prior to starting the drilling program will not be reclaimed. Access roads built to allow entrance to the drilling pads will be reclaimed and will receive topsoil in the same depth as their corresponding pad areas, unless specified otherwise .

243 Soil Nutrients and Amendments

The soils will be analyzed directly following salvage to determine if amendments are needed. Testing of the topsoil will be done according to Table 6 of the Division's Topsoil and Overburden Guidelines. The topsoil will be tested at a minimum for the following parameters: pH, electrical conductivity, total carbon, SAR, water holding capacity, plant available nitrogen, and phosphorus. Results of these analyses will be incorporated into Attachment 2-1 and 2-2.

244 Soil Stabilization

244.100 Protection and Stabilization of Surface Area

All reclaimed areas will be stabilized to control erosion by application of mulch, tackifier, and roughening of the surface. The areas will be graded to the approximately original topographic configuration. Seeding will be accomplished with the application of seeds and mulch with a long fiber tackifier or broadcast. Methods of protection and stabilization are further discussed in Chapter 3, Section 341.

244.200 Mulch Application

Mulch/tackifier will be applied to stabilize the soil on all areas that have been regraded and covered with growth media. For further discussion of revegetation practices to be utilized, see Chapter 3, Section 341.

244.300 Rills and Gullies

Postmining Land Use and Revegetation - Rills and gullies that are approximately nine (9) inches in depth and disrupt the postmining land use or reestablishment of vegetative cover will be regraded and seeded. In addition, the repair of rills and gullies will assist in the maintenance of water quality standards.

TABLE 2-3

Approximate Topsoil Distribution Thickness

Well Site No.	Topsoil Thickness (Inches)
G-1*	7
G-2	30
G-3	12
G-4	28
G-5	22
G-6	12
G-7	12
G-8*	12
G-9	12
G-10	18
G-11	12
G-12	15
G-13	14 - 16
G-14A	14 - 16
G-15	14
G-16	14
G-17	12
G-18	12
G-19	12
G-21	13 - 15
G-22, Access Road	10 - 13
G-31	15
AMV Access Road	12

* Wells G-1 and G-8 were never constructed.

250 PERFORMANCE STANDARDS

251 Topsoil, Subsoil, and Topsoil Supplements Management

All topsoil, subsoil, and topsoil supplements will be managed as outlined in Sections 230 and 240.

252 Stockpiled Topsoil and Subsoil

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

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~September 19, 2007~~

ATTACHMENT 2-1
SOIL INVENTORY AND ASSESSMENT

add to the back of existing information

Ryan Sweetwood
140E 600N #2
Provo, UT 84606
847-877-6925

January 24, 2008

Ms. Vicky Miller
Dugout Canyon Mine
PO Box 1029
Wellington, Utah 84542

Dear Ms. Miller,

This letter and report summarize the methodology and the results of the soil survey conducted in November 2007 at Dugout Mine. Thirteen (13) soil profiles within Dugout's permitted area were investigated.

NRCS Soil Data

All soil survey maps were created using the Natural Resources Conservation Services' (NRCS) Web Soil Survey (WSS) software. The survey maps represent the relative position of the soil pit and the soil series to which it is designated by the NRCS.

Site Reconnaissance

Each site was initially walked with Vicky Miller and potential location and number of soil pits was noted. Most soil pits were within a couple hundred feet of road access but for the most part had little to no recent human disturbances except for SP-6, which was logged.

Soil Test Pits

Soil pits SP1 through SP13 were excavated on November 13 and 14, 2007, and they are representative of the area of several potential well sites for the Dugout Mine: G-21, G-22, G-35, G-34, and G-33. Field observations included color using a Munsell color chart (10YR), structure, horizon depth, GPS coordinates, photographs, and an approximated map of vegetation and surface features for each site. Soil pits were excavated by hand until bedrock or until penetration became very difficult. All soil samples were collected in a plastic bag and shipped immediately for analysis. Appendix A contains the soil profile descriptions. Appendix B has photographs of each profile. Appendix C contains the maps generated by WSS and the soil series descriptions. Appendix D has the laboratory analyses. Appendix E has hand-drawn maps of surface features and vegetation for each site.

Soil profiles SP-1, SP-4, SP-11, and SP-12 closely match the soil series designated in the WSS. However, for reasons stated below, all other soil profiles more closely match competing soil series.

Soil profiles SP-1, SP-4, SP-11, and SP-12 closely match the soil series designated in the WSS. However, for reasons stated below, all other soil profiles more closely match competing soil series.

SP-2, SP-13 – They are shallow with an argillic horizon, which is not characteristic of Rottulee Series. Physical and chemical properties match the Beje Series. The Beje Series' description is provided in Appendix C.

SP-3 – This profile is shallow, has a high percentage of sand, and is slightly acidic, which are not characteristic of Senchert Series. This profile shares more properties with the Miracle Series. The Miracle Series has in similar depth to bedrock, an argillic horizon, and texture. The pH is slightly lower in the soil profile than the Miracle Series and the soil profile lacks a BA horizon. The Miracle Series' description is provided in Appendix C.

SP-5, SP-6, SP-7, SP-8 – These profiles shared the same properties and are found on the same north slope. They are black to dark brown, have no argillic horizons, and are slightly acidic, all of which are not characteristic of Senchert Series. None of the slightly acidic series in Carbon or Emery Counties fit these profiles. These profiles are unique. Bachus and Senchert Series are competing series for this region. They share some but not all properties of these profiles. The Bachus Series' description is provided in Appendix C.

SP-9 – This profile has an argillic horizon, is non-calcareous, and is neutral, which are not characteristic of Rottulee Series. This profile shares more properties with the Senchert Series. The Senchert Series has in similar depth to bedrock, argillic horizons, texture, and pH. The color in this soil profile is slightly darker than the Senchert Series. The Senchert Series' description is provided in Appendix C.

SP-10 – This profile has an argillic horizon, which is not characteristic of Rottulee Series. The colors of the B horizons contrast greatly between each other. The presence of many converging drainages and steep slopes suggest that there may have been periodic mass deposits from different sources of parent material. On either side of this site, soils appeared to pertain to Rottulee Series. Physical and chemical properties match more closely to the Stubbs Series. However, this profile lacks the AB horizon. The Stubbs Series' description is provided in Appendix C.

Please feel free to contact me with any questions or concerns. It was a pleasure to work with you.

Sincerely,



Ryan Sweetwood



Ryan Sweetwood

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847-877-6925

Email:
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Address: 210 Wymount Ter
Provo, UT 84604

Education

- BS Environmental Soil Science, Brigham Young University, 2006 – GPA 3.6
- MS Agronomy, Brigham Young University, December, 2007

Related Courses

- Hydrogeology
- Geology
- Environmental Soil Chemistry
- Hazardous Waste Management
- Environmental Case Studies
- Soil Taxonomy
- Soil Fertility
- Soil Microbiology
- Saline and Sodic Soils
- Statistics

Courses to be taken

- Geographic Infosystems (GIS)

Experience

Research Assistant

Brigham Young University, September 2004 to Present

- Supervised and trained 20+ students in soil laboratory analyses
- Collected 700+ soils from Mexico, Guatemala, and the US, analyzed 1,000+ soil samples, and compiled and wrote results for professors at several
- Trained on the ICP, Atomic Absorption, Elemental Analyzer, Mass spectrometer, Gas Chromatograph
- Initiated 2 long term research projects;
 - A study of denitrifiers in hypersaline environments from the sediments of the Great Salt Lake (future publications, date pending)
 - The soil resources of the ancient Maya city of Chunchucmil, Mexico (future publications, date pending)
- Presented research at 3 national conferences and 1 regional conference
- Served as a teacher's assistant for 2 classes
- Authored 2 grant proposals and co-authored 2 others (3 of 4 funded)
- Assisted Maya archaeologists and geomorphologists in studies in the Yucatan, Mexico

Market Research Intern

InstallShield/Macrovision Shamburg, IL, Nov-Dec 2003, June – September 2006

- Performed and analyzed market research for a computer software company

Landscape Intern

Valley Crest, Palentine, IL, Summer 2004

- Supervised work crews
- Operated heavy machinery
- Completed estimation costs for landscape maintenance

Area Director

Boy Scouts of America, Pearson, WI, Summer 1997-2001

- Instructed 1000+ youth in environmental science related subjects
- Organized numerous activities and environmental service projects
- Supervised 60+ staff members

Missionary for The Church of Jesus Christ of Latter-day Saints
Montreal, Quebec, Spanish Speaking, 2002-2003

Other Skills

- **Software-** SURFER, GPS, Word, Excel, PowerPoint

Awards Received

- Speaker at 2006 college convocation
- Dean's Award from Brigham Young University for humanitarian service, 2002
- Eagle, BSA, 1997
- Employee of the Year, Camp Ma-ka-ja-wan, 1999

LAB - Supr. as reference

Appendix A

Soil Profile Descriptions

Site G-21

SP4

Name	Ryan Sweetwood	Drainage	Well Drained								
Date	11/13/2007	Flooding	none								
Weather	cloudy, 60°F	Ponding	none								
Location	N 39.69086°, W 110.48454°	Depth to Water Table	Unknown								
Datum	NAD 83	Earth Cover	sagebrush w/some aspen and Douglas fir								
Slope Aspect	W	Parent Material	COL								
Slope Gradient	8%	Bedrock, Kind	SST, SIS, SHA								
Slope Complexity	complex	Bedrock, Fracture	-								
Slope Shape	LC linear, concave	Bedrock, Hardness	MO								
Hillslope Profile Position	SH, shoulder	Bedrock, Depth	38 cm								
Geomorphic Component	MT, mountain top	Erosion, Kind	G								
Microrelief	MH, microhigh	Erosion, Degree	2								
Drainage Pattern	Dendritic	Runoff Surface	M								
Diagnostic Horizons		Structure	very stony, 0.1 to 3%								
		Texture									
		Reaction (HCI)									
		% Rock Fragment Size & Size									
		% Roots, Size & Location									
A	SP	0 to 15	Gradual	Wavy	dark brown	3/3	I	1,ABK, M	NE	15%, GR to CB	10%, VF
B	SP	15 to 26	Gradual	Wavy	dark yellowish brown	4/4	I	1,ABK, M	VE	15%, GR to CB	15%, VF to M
Ck	SP	26 to 38	Gradual	Wavy	dark yellowish brown	4/6	nd	1,ABK, M	VE	40%, GR to CB	5%, VF to M

Site G-21 **SP-5**

Name	Ryan Sweetwood	Drainage	WD	Well Drained							
Date	11/13/2007	Flooding	none								
Weather	partly cloudy, 60°F	Ponding	none								
Location	N 39.69079°, W 110.48430°	Depth to Water Table	Unknown								
Datum	NAD 83	Earth Cover		aspen and Douglas fir w/ some juniper							
Slope Aspect	NWN	Parent Material	COL	colluvium							
Slope Gradient	2%	Bedrock, Kind	SST, SIS, SHA	Interbedded sandstone, siltstone and shale							
Slope Complexity	simple	Bedrock, Fracture	-								
Slope Shape	LL linear, linear	Bedrock, Hardness	MO								
Hillslope Profile Position	SH shoulder	Bedrock, Depth	~105 cm	estimated							
Geomorphic Component	MT mountain top	Erosion, Kind	S	sheet							
Microrelief	MH microhigh	Erosion, Degree	none	0%							
Drainage Pattern	Dendritic	Runoff	L	low							
Diagnostic Horizons		Surface Fragments	none								
		Color Moist	Dry								
		Texture									
		Structure									
		Reaction (HCI)									
		% Rock Fragments Size									
		% Roots, Size & Location									
O	SP	0	5	Abrupt	Wavy	black	2/1	0, MA	NE	0%	0%
A	SP	5	15	Clear	Wavy	black	2/2	2,ABK, CO	NE	0%	20%, VF to M
B1	SP	15	36	Gradual	Wavy	dark brown	4/4	2,ABK, M	NE	10%, GR	15%, M to VC
B2	SP	36	65+	Gradual	Wavy	dark brown	4/4	2,ABK, M	NE	15%, GR	5%, M to VC

*Became difficult to penetrate with shovel

Site G-22 road SP11

Name	Ryan Sweetwood	Drainage	WD	Well Drained								
Date	11/14/2007	Flooding	none									
Weather	60°F	Ponding	none									
Location	N 39.68993°, W 110.49628°	Depth to Water Table	Unknown	mountain mahogany w/ some Douglas fir and pine								
Datum	NAD 83	Earth Cover		pine								
Slope Aspect	E	Parent Material	COL	colluvium								
Slope Gradient	40%	Bedrock, Kind	SST, SIS, SHA	Interbedded sandstone, siltstone and shale								
Slope Complexity	complex	Bedrock, Fracture	-									
Slope Shape	LL linear, linear	Bedrock, Hardness	MO	moderate								
Hillslope Profile	BS backslope	Bedrock, Depth	41 cm									
Geomorphic Component	CT center third	Erosion, Kind	G	gully								
Microrelief	MH microhigh	Erosion, Degree	2	25 up to 75%								
Drainage Pattern	Dendritic	Runoff	H	high								
		Surface Fragments	3	extremely stony, 3 to <15%								
Diagnostic Horizons	Observation Method	Depth (cm)	Boundary	Color Moist	Dry	Structure	Reaction (HCI)	% Rock Fragments & Size	% Roots, Size & Location			
										From	To	Distinctness
A	SP	0	8	Gradual	Wavy	dark grayish brown	4/2	I	1,ABK, F	VE	10%, GR	10%, VF to F
B	SP	8	41	Gradual	Wavy	dark grayish brown	5/2	I	1,ABK, F	VE	15%, GR	10%, VF to M

Site G-22 road SP12

Name	Ryan Sweetwood	Drainage	WD	Well Drained							
Date	11/14/2007	Flooding	none								
Weather	60°F	Ponding	none								
Location	N 39.68910°, W 110.49728°	Depth to Water Table	Unknown								
Datum	NAD 83	Earth Cover		mountain mahogany and sagebrush w/ some juniper							
Slope Aspect	E	Parent Material	COL	colluvium							
Slope Gradient	15%	Bedrock, Kind	SST, SIS, SHA	Interbedded sandstone, siltstone and shale							
Slope Complexity	complex	Bedrock, Fracture	-								
Slope Shape	LC linear, concave	Bedrock, Hardness	MO	moderate							
Hillslope Profile Position	SH shoulder	Bedrock, Depth	~85 cm	estimated							
Geomorphic Component	MT mountain top	Erosion, Kind	G	gully							
Microrelief	ML microlow	Erosion, Degree	2	25 up to 75%							
Drainage Pattern	Dendritic	Runoff	M	medium							
		Surface Fragments	2	very stony, 0.1 to <3%							
Diagnostic Horizons		Color Moist	Dry								
		Texture									
		Structure									
		Reaction (HCI)									
		% Rock Fragments & Size									
		% Roots, Size & Location									
A	SP	0 13	Gradual	Wavy	very dark grayish brown	4/2	cl	1,ABK, M	ST	5%, GR	10%, VF to M
B1	SP	13 38	Gradual	Wavy	brown	6/3	sicl	2,ABK, VC	VE	0%	5%, VF to C
B2	SP	38 62+	Gradual	Wavy	brown	6/3	nd	2,ABK, VC	VE	0%	<5%, VF to M

*Became difficult to penetrate with shovel

Site G-22 road SP13

Name	Ryan Sweetwood	Drainage	WD	Well Drained						
Date	11/14/2007	Flooding	none							
Weather	60°F	Ponding	none							
Location	N 39.68814°, W 110.49792°	Depth to Water Table	Unknown	sagebrush w/ some juniper, Douglas fir, and mountain mahogany						
Datum	NAD 83	Earth Cover	COL	colluvium						
Slope Aspect	SE	Parent Material	SST, SIS, SHA	Interbedded sandstone, siltstone and shale						
Slope Gradient	6%	Bedrock, Kind	-							
Slope Complexity	complex	Bedrock, Fracture	MO	moderate						
Slope Shape	VL convex, linear	Bedrock, Hardness	31 cm							
Hillslope Profile Position	SU summit	Bedrock, Depth	G	gully						
Geomorphic Component	MT mountain top	Erosion, Kind	3	75 up to 100%						
Microrelief	MIL microlow	Runoff	M	medium						
Drainage Pattern	Dendritic	Surface Fragments	3	extremely stony, 3 to <15%						
Diagnostic Horizons	Observation Method	Depth (cm)	Boundary	Color Moist	Texture	Structure	Reaction (HCI)	% Rock Fragment & Size	% Roots, Size & Location	
				From To	Distinc-ness	Topo-graphy	Dry			
A	SP	0 14	Gradual	Wavy	very dark grayish brown	I	0,SGR	VE	15%, GR	15%, VF to M
Bt	SP	14 31	Gradual	Wavy	very dark grayish brown	cl	1,ABK,F	VE	15%, GR	10%, VF to M

Appendix B

Photographs



SP-4 Site G-21



SP-4 Site G-21



SP-4 Site G-21

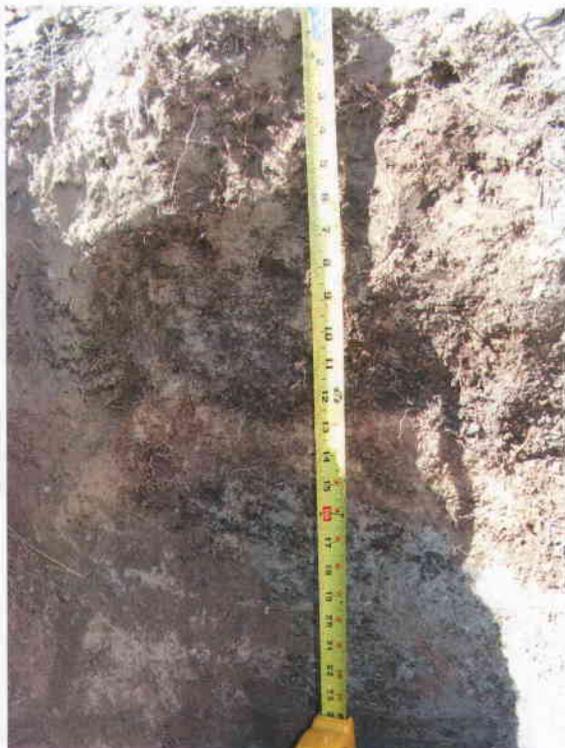


SP-5 Site G-21

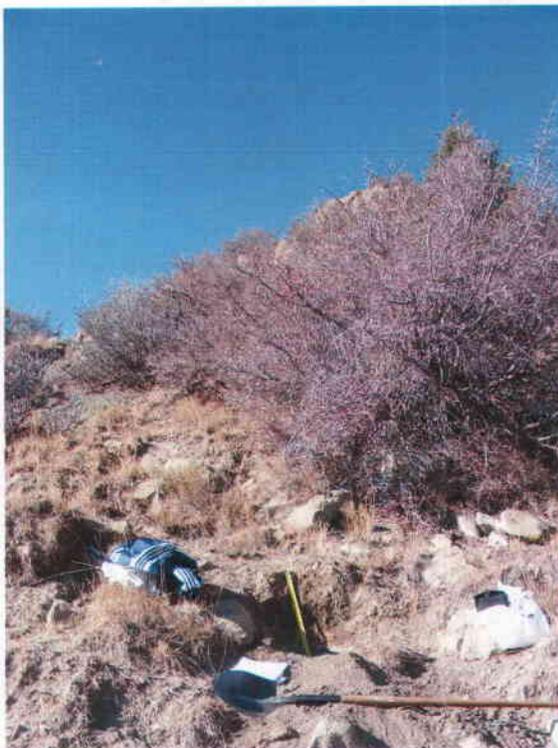


SP-5 Site G-21

SP-5 Site G-21



SP-10 Site G-22



SP-10 Site G-22



SP-11 Site G-22



SP-11 Site G-22



SP-12 Site G-22



SP-12 Site G-22



SP-13 Site G-22



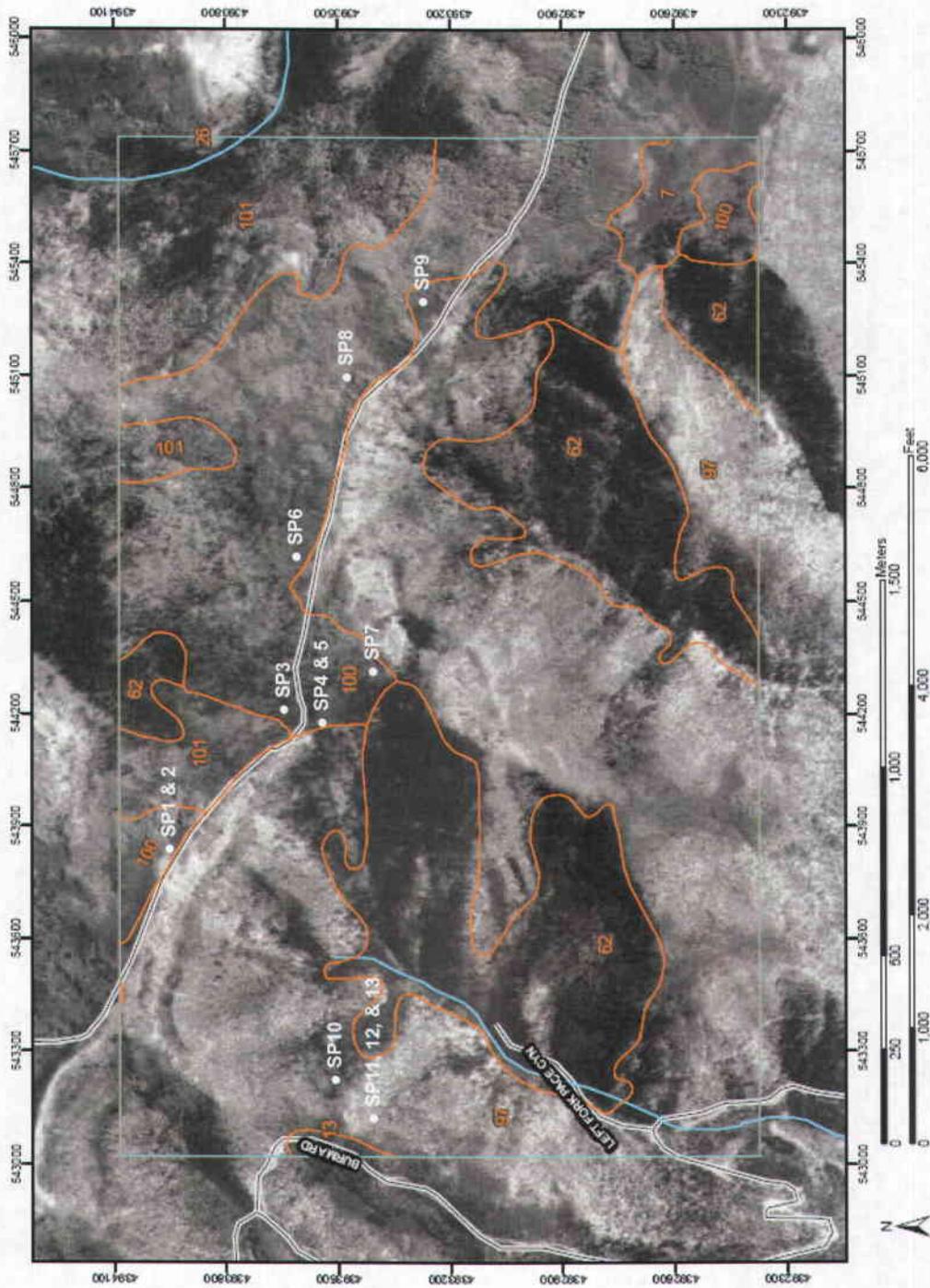
SP-13 Site G-22

B-4

Appendix C

NRCS Maps and Soil Series Description

Custom Soil Resource Report
Soil Map



Custom Soil Resource Report Legend

MAP LEGEND

- Area of Interest (AOI)
 - Area of Interest (AOI)
- Soils
 - Soil Map Units
- Special Point Features
 - Blowout
 - Borrow Pit
 - Clay Spot
 - Closed Depression
 - Gravel Pit
 - Gravelly Spot
 - Landfill
 - Lava Flow
 - Marsh
 - Mine or Quarry
 - Miscellaneous Water
 - Perennial Water
 - Rock Outcrop
 - Saline Spot
 - Sandy Spot
 - Severely Eroded Spot
 - Sinkhole
 - Slide or Slip
 - Sodic Spot
 - Spill Area
 - Stony Spot
- Special Line Features
 - Gully
 - Short Steep Slope
 - Other
- Political Features
 - Municipalities
 - Cities
 - Urban Areas
- Water Features
 - Oceans
 - Streams and Canals
- Transportation
 - Rails
 - Roads
 - Interstate Highways
 - US Routes
 - State Highways
 - Local Roads
 - Other Roads
- Very Stony Spot
- Wet Spot
- Other

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: **UTM Zone 12N**

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Carbon Area, Utah, Parts of Carbon and Emery Counties
 Survey Area Data: Version 3, Dec 14, 2006

Date(s) aerial images were photographed: 10/8/1998; 11/2/1998

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

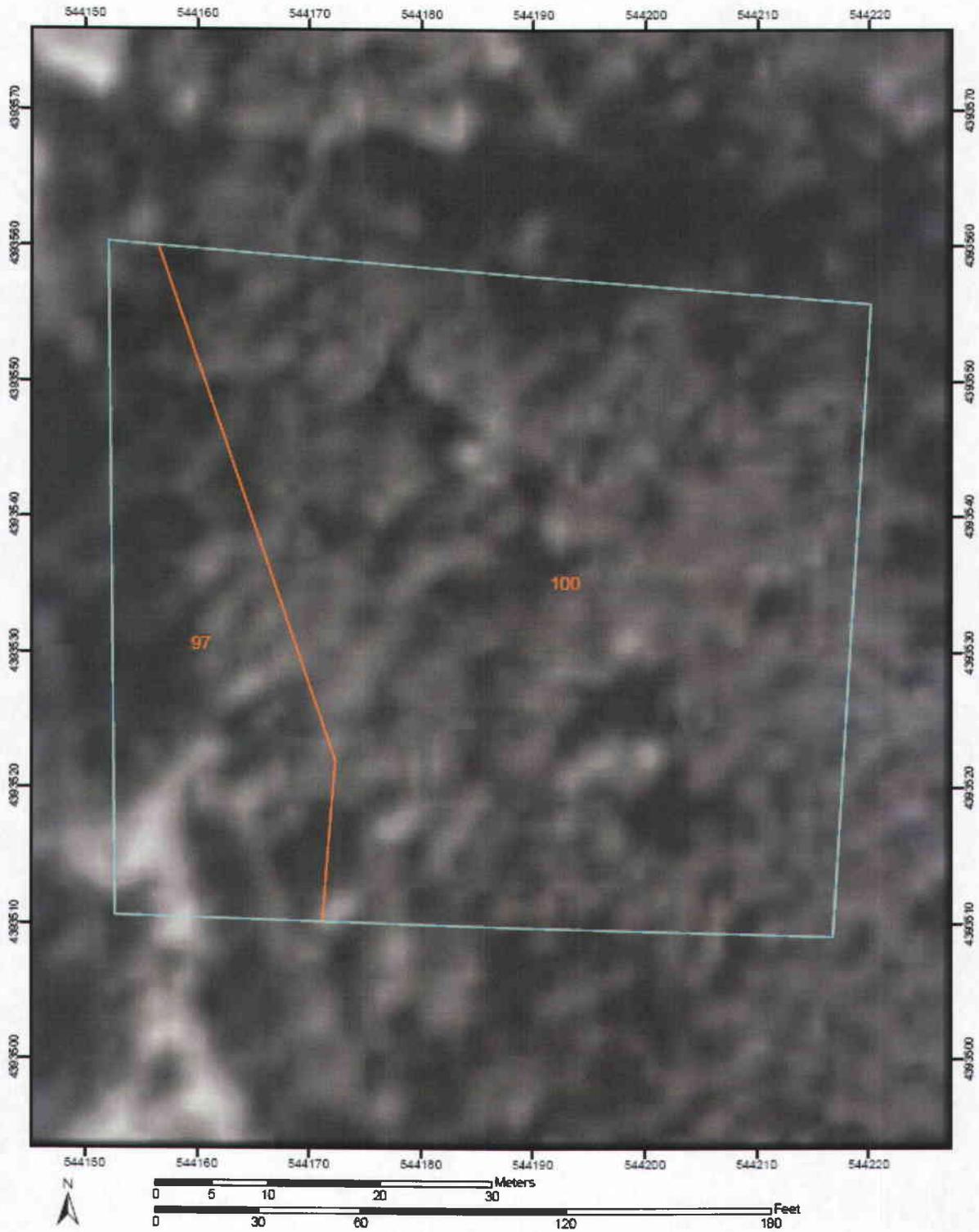
Custom Soil Resource Report

Map Unit Legend

Carbon Area, Utah, Parts of Carbon and Emery Counties (UT616)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
7	Beje-Trag complex	17.6	1.5%
13	Cabba family-Guben-Rock outcrop complex	3.4	0.3%
26	Doney family, 50 to 70 percent slopes	0.1	0.0%
62	Midfork family-Comodore complex	240.7	21.0%
97	Rottulee family-Trag complex	525.6	45.8%
100	Senchert loam, 3 to 15 percent slopes	235.7	20.5%
101	Senchert loam, 30 to 50 percent slopes	125.7	10.9%
Totals for Area of Interest (AOI)		1,148.8	100.0%

G-21

Custom Soil Resource Report Soil Map



Custom Soil Resource Report

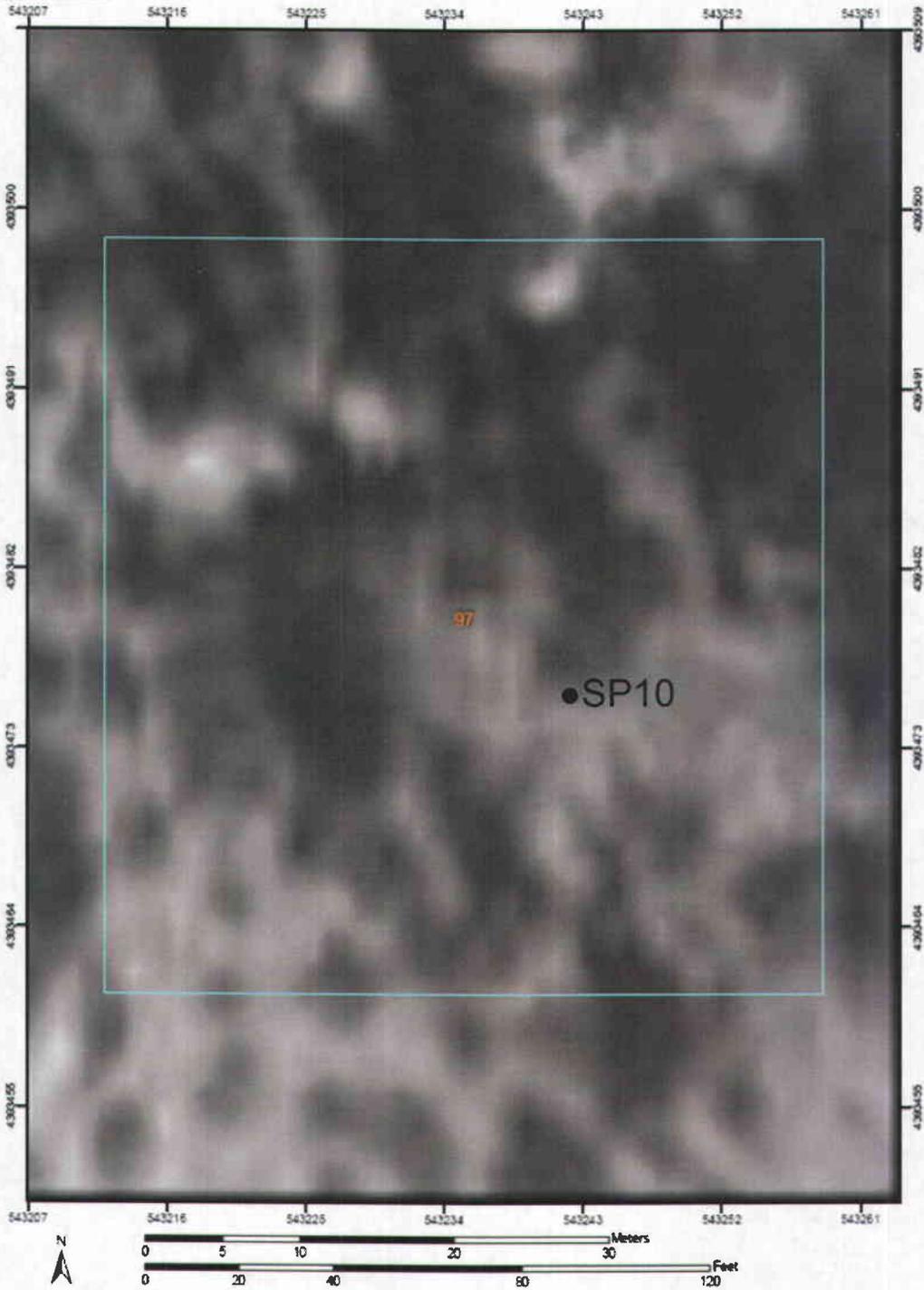
G - 21

Map Unit Legend

Carbon Area, Utah, Parts of Carbon and Emery Counties (UTS15)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
97	Rotulee family-Trag complex	0.2	21.5%
100	Senchert loam, 3 to 15 percent slopes	0.8	78.5%
Totals for Area of Interest (AOI)		1.1	100.0%

G-22

Custom Soil Resource Report
Soil Map



C-5

Custom Soil Resource Report

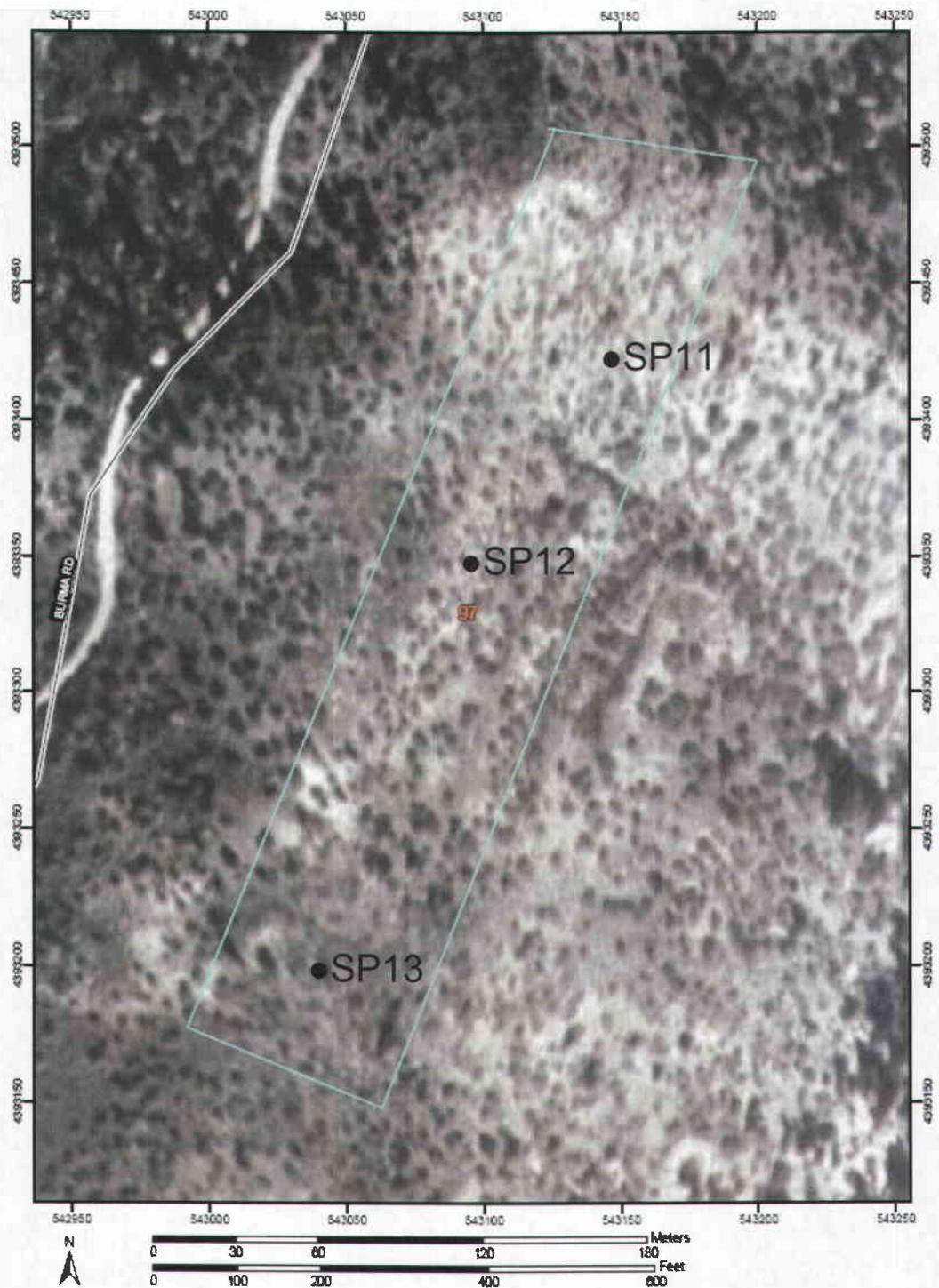
G-22

Map Unit Legend

Carbon Area, Utah, Parts of Carbon and Emery Counties (UT616)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
97	Rottulee family-Trag complex	0.6	100.0%
Totals for Area of Interest (AOI)		0.6	100.0%

G-22 Road

Custom Soil Resource Report Soil Map



Custom Soil Resource Report

G. 22 ROAD

Map Unit Legend

Legend for Map Unit Legend			
Map Unit	Description	Area (Acres)	Percent of AOI
97	Rottulee family-Trag complex	6.7	100.0%
Totals for Area of Interest (AOI)		6.7	100.0%

Established Series
REV: EJ/JMD/RLM
02/1999 G-21

SENCHERT SERIES¹

The Senchert series consists of moderately deep, well drained, moderately permeable soils that formed in alluvium and colluvium derived dominantly from sandstone and shale. These soils are on mountainsides, ridges and plateaus. Slopes range from 1 to 50 percent. Mean annual temperature is 37 degrees F. and average annual precipitation is 22 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive Pachic Argicryolls

0--3 inches to 0; somewhat decomposed leaves and twigs.

A--0 to 4 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; soft, very friable; few fine and very fine roots; neutral (pH 7.2); abrupt smooth boundary. (2 to 11 inches thick)

Bt1--4 to 9 inches; brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine medium and coarse roots; few very fine and fine pores; few thin clay films on faces of peds and in pores; neutral (pH 7.2); clear smooth boundary. (4 to 16 inches thick)

Bt2--9 to 16 inches; brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few very fine, fine and medium roots; few very fine and fine pores; common, moderately thick clay films on faces of peds and in pores; mildly alkaline (pH 7.6); clear smooth boundary. (0 to 16 inches thick)

Bt3--16 to 35 inches; brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine, fine and medium roots; few very fine and fine pores; few thin clay films on faces of peds and in pores; mildly alkaline (pH 7.6); abrupt smooth boundary. (0 to 19 inches thick)

R--35 inches; calcareous sandstone.

TYPE LOCATION: Carbon County, Utah, about 10 miles north and 2 miles west of East Carbon City; about 2,700 feet south and 1,000 feet east of the NW corner of sec. 4.,

T. 16 S., R. 16 E.

RANGE IN CHARACTERISTICS: The mollic epipedon and the solum are 16 to 35 inches thick. Depth to bedrock is 20 to 40 inches. Mean annual soil temperature ranges from 38 to 40 degrees F. The mean summer soil temperature is 44 to 47 degrees F.

The A horizon has value of 3 through 5 dry, 2 or 3 moist and chroma of 2 or 3. Clay content is 10 to 24 percent.

The Bt horizon has value of 4 or 5 dry and chroma of 2 or 3. Texture is loam or clay loam. Rock fragment content is 0 to 15 percent, which is mostly pebbles. Clay content is 18 to 35 percent. Reaction is neutral to mildly alkaline.

The C horizon where present is clay loam or silty clay.

COMPETING SERIES: These are Bachus, Benteen, Cambern, Clayburn, Decross, Demast, Dranyon, Echemoor, Gordo, Harmehl, Stubbs, Thulepah, and Winu series. Benteen soils have 20 to 40 percent limestone fragments in the lower profile. Cambern soils contain ash and tuff in the profile. Clayburn, Decross, Demast, Dranyon, Gordo, Thulepah soils lack bedrock within depths of 40 inches. Echemoor and Stubbs soils have paralithic contacts at depths of 20 to 40 inches. Harmehl and Winu soils have 15 to 35 percent rock fragments in the argillic horizon. Bachus soils are medium acid or slightly acid.

GEOGRAPHIC SETTING: Senchert soils are on mountainsides, ridges, plateaus and benches. Slopes are 1 to 50 percent. The soils formed in alluvium and colluvium from sandstone, shale, and siltstone. The elevation is 7,200 to 10,100 feet. The mean annual temperature is 36 to 38 degrees F. The average annual precipitation is 20 to 30 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are Beenon, Toze and Trag soils. Beenon and Trag soils are associated with Senchert at the lower elevation and have mean annual temperature of 38 to 42 degrees F. Beenon soils are shallow and Trag soils are deep. Troze soils lack argillic horizon and have calcic horizon.

DRAINAGE AND PERMEABILITY: Well drained; runoff is slow or medium; moderate permeability.

USE AND VEGETATION: Rangeland and wildlife habitat. Some areas have been used for woodland. Present vegetation is Douglas-fir, Englemann spruce, white fir, quaking aspen, mountain big sagebrush, snowberry, and Thurber fescue.

DISTRIBUTION AND EXTENT: The Senchert soils are moderately extensive. They are in the high mountain areas of Carbon County, Utah.

MLRA OFFICE RESPONSIBLE: Lakewood, Colorado

SERIES ESTABLISHED: Carbon County, Utah, 1982 The name of this series is coined.

REMARKS:

National Cooperative Soil Survey

¹<http://www2.ftw.nrcs.usda.gov/osd/dat/S/SENCHERT.html>

LOCATION BACHUS
Established Series
Rev. PSD/RJE/JAL
08/2002 G-21

WY

BACHUS SERIES¹

The Bachus series consists of moderately deep, well drained soils that formed in slope alluvium weathered from quartzitic sandstone. Bachus soils are on anticlines along mountain fronts and have slopes of 2 to 20 percent. The mean annual precipitation is about 20 inches, and the mean annual temperature is about 38 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive Pachic Argicryolls

TYPICAL PEDON: Bachus loam-grassland. (Colors are for dry soil unless otherwise stated.)

A1--0 to 13 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; strong fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; slightly acid (pH 6.4); clear smooth boundary. (3 to 18 inches thick)

A2--13 to 17 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure that parts to strong fine granular; hard, very friable, slightly sticky and slightly plastic; many fine roots; slightly acid (pH 6.2); gradual smooth boundary. (3 to 5 inches thick)

Bt1--17 to 26 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure that parts to moderate medium subangular blocky; very hard, very friable, moderately sticky and slightly plastic; common fine and medium roots; common faint clay films on faces of peds and in root channels and pores; moderately acid (pH 5.8); gradual smooth boundary. (3 to 10 inches thick)

Bt2--26 to 31 inches; brown (7.5YR 5/4) clay loam, brown (7.5YR 4/4) moist; moderate medium prismatic structure that parts to moderate medium subangular blocky; very hard, very friable, moderately sticky and slightly plastic; few medium roots; common faint clay films on faces of peds and in root channels and pores; 10 percent sandstone fragments; moderately acid (pH 5.7); gradual wavy boundary. (3 to 7 inches thick)

R--31 inches; hard, noncalcareous, quartzitic sandstone.

TYPE LOCATION: Johnson County, Wyoming; NE1/4, NE1/4 of Sec. 30, T. 45 N., R.

85 W. Tabletop Quad, 43 degrees 50 minutes 39 seconds north latitude and 107 degrees 6 minutes 35 seconds west longitude.

RANGE IN CHARACTERISTICS: The mollic epipedon is 16 to 30 inches thick. Depth to the lithic contact ranges from 20 to 40 inches. Organic carbon in the mollic epipedon ranges from 1 to 4 percent and decreases uniformly with depth. The soils are 60 to 90 percent base saturated. Rock fragments range from 0 to 15 percent in the particle size control section but range as high as 25 percent in Colorado. The mean annual soil temperature ranges from 39 to 47 degrees F., and the mean summer soil temperature from 50 to 58 degrees F.

The A horizon has hue of 2.5Y or 10YR, value of 3 through 5 dry, 2 or 3 moist, and chroma of 1 through 3. This horizon is neutral through moderately acid.

The Bt horizon has hue of 10YR through 5YR, value of 3 through 6 dry, 2 through 5 moist, and chroma of 1 through 4. It is loam or clay loam and has 18 to 35 percent clay, 25 to 50 percent silt, and 20 to 50 percent sand with less than 35 percent but more than 15 percent being fine sand or coarser. Oriented clay films occur in some parts of this horizon. This horizon is neutral through moderately acid. Some pedons may have thin C horizons above the bedrock.

COMPETING SERIES: These are the Bavdark, Benteen, Cambern, Clayburn, Croydon, Crystalbutte, Davtone Decross, Dehana, (T) Demast, Dranburn, Dranyon, Echemoor, Gordo, Hagenbarth, Millerlake, Pontuge, Senchert, Southmount(T), Squawval, Stubbs, Thulepah, Vadnais, and Winu series. Benteen, Senchert, and Squawval soils are neutral or slightly alkaline. Cambern soils formed in materials from ash and tuff and overlies tuff or ash. Bavdark, Clayburn, Croydon, Crystalbutte, Davtone, Decross, Dehana, Demast, Dranburn, Dranyon, Gordo, Hagenbarth, Millerlake, Pontuge, Southmount, and Thulepah soils lack bedrock at depths of less than 40 inches. Dranyon soils also have a solum 40 to 60 inches thick and have 15 to 35 percent rock fragments in the solum. Echemoor Squawval and Stubbs soils have a paralithic contact at depths of 20 to 40 inches. Vadnais soils formed in loess over basalt. Winu soils formed in residuum and colluvium derived from igneous rock and have summer soil temperature of 58 or 59 degrees F.

GEOGRAPHIC SETTING: Bachus soils are on anticlines along mountain fronts. Elevation is 6,800 to 9,000 feet. Slope is 2 to 25 percent. The soils formed in noncalcareous alluvium weathered from underlying quartzitic sandstone. The average annual precipitation is 15 to 25 inches. The mean annual temperature is about 33 to 44 degrees F., and the mean summer temperature is about 48 to 56 degrees F. The frost-free season is less than 90 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Decross and Sawcreek soils. Decross soils lack bedrock at depths of less than 40 inches and have continuous

horizons of carbonate accumulations. Sawcreek soils have mollic epipedons 7 to 15 inches thick and lack argillic horizons.

DRAINAGE AND PERMEABILITY: Well drained, medium runoff on lower slopes, rapid runoff on steeper slopes; moderate permeability.

USE AND VEGETATION: Used for range, recreation, and wildlife. Native vegetation is green needlegrass, Idaho fescue, and yarrow.

DISTRIBUTION AND EXTENT: Mountains of Wyoming. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bozeman, Montana

SERIES ESTABLISHED: Johnson County, Wyoming, South Part; 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon – 0 to 26 inches (A1,A2,Bt1)

Argillic horizon – 17 to 31 inches (Bt1,Bt2)

Lithic Contact – 31 inches ®

MLRR- E

SIR,s – WY0169, WY9714, WY9802

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¹<http://ortho.ftw.nrcs.usda.gov/osd/dat/B/BACHUS.html>

Established Series
Rev. JCM/CAM/JEB
02/1999 6-22

ROTTULEE SERIES¹

The soils of the Rottulee series are well-drained, moderately deep soils over shattered limestone. They are on shale and limestone bedrock uplands. The mean annual precipitation is about 18 inches and the mean annual air temperature is about 42 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Entic Haplustolls

TYPICAL PEDON: Rottulee silt loam, grassland. (Colors are for dry soil unless otherwise noted.)

A1--0 to 2 inches; dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3.2) when moist; weak, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots and tubular pores; moderately calcareous; clear, smooth boundary. (2 to 5 inches thick)

B1--2 to 6 inches; reddish-brown (5YR 5/3) silt loam, dark reddish brown (5YR 3/3) when moist; weak, medium, prismatic structure; slightly hard, very friable, slightly sticky and plastic; common very fine roots; common fine and very fine tubular pores; moderately calcareous; clear, wavy boundary. (2 to 6 inches thick)

B2--6 to 10 inches; light reddish-brown (5YR 6/3) heavy silt loam, reddish brown (5YR 4/4) when moist; moderate, medium, prismatic structure; hard, friable, sticky and plastic; common very fine roots; common fine and very fine tubular pores; moderately calcareous; clear, wavy boundary. (3 to 7 inches thick)

B3--10 to 15 inches; light reddish-brown (5YR 6/3) heavy silt loam, reddish brown (5YR 4/4) when moist; moderate, medium and fine, blocky structure; hard, friable, sticky and plastic; common very fine roots and tubular pores; strongly calcareous with a few threads of segregated lime; clear, wavy boundary. (4 to 8 inches thick)

Cca--15 to 22 inches; light reddish-brown (5YR 6/4) gravelly light clay loam, yellowish red (5YR 5/6) when moist; weak, fine, blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots and tubular pores; 20 percent (volume) shale fragments; strongly calcareous; common fine threads of segregated lime; gradual boundary.

R--22 inches, shattered limestone.

TYPE LOCATION: Big Horn County, Montana; 660 feet north and 220 feet east of the SW corner of sec. 18, T.8S., R.33E.

RANGE IN CHARACTERISTICS: The control section is silt loam, loam, light silty clay loam, or light clay loam with 20 to 34 percent clay and 15 to 25 percent fine or medium sand and with gravel-size shale fragments increasing to as much as 30 percent just above the bedrock. The soil is weakly to strongly calcareous with increasing quantity of lime with increased depth above the bedrock. The soil has hue of 7.5YR through 10R. Mean annual soil temperature ranges from 44 to 47 degrees F., and average summer soil temperature ranges from 59 to 65 degrees F.

The Cca horizon has few to common films and threads of lime or few masses of accumulated flour lime. It contains 8 to 15 percent (estimated) CaCO₃ equivalent.

COMPETING SERIES: These are the Amor, Bynum, Darret, Duffy, Max, Peritsa, Prospect, Quigley, Searing, Shambo and Twin Creek series. Amor and Peritsa soils have a paralithic contact at depths of 20 to 40 inches. Bynum soils have average summer soil temperature of 52 to 58 degrees F. and have hue of 10YR or 2.5Y. Darret soils have an argillic horizon. Duffy, Max, Prospect and Quigley soils have hue of 10YR through 5Y. Max, Prospect, Quigley, Shambo and Twin Creek soils lack bedrock within depth of 40 inches. Searing soils are noncalcareous to depths of 10 to 24 inches.

GEOGRAPHIC SETTING: Rottulee soils are on gently to strongly rolling red shale and limestone bedrock uplands at elevations of 4,500 to 5,500 feet. The climate is dry-subhumid with mean annual precipitation of 17 to 19 inches, 80 percent of which falls in April through October. The annual temperature ranges from 40 to 45 degrees F. and the mean summer temperature ranges from 55 to 65 degrees F. The frost-free season ranges from 90 to 110 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Abac soils and the competing Peritsa and Twin Creek soils. Abac soils have sandstone at depths shallower than 20 inches.

DRAINAGE AND PERMEABILITY: Well-drained; medium runoff; moderate permeability.

USE AND VEGETATION: Native range use. Native vegetation is phlox, green needlegrass, prairie junegrass, gayfeather, and bluebunch wheatgrass.

DISTRIBUTION AND EXTENT: South-central Montana. The Rottulee series is inextensive.

MLRA OFFICE RESPONSIBLE: Lakewood, Colorado

SERIES ESTABLISHED: Big Horn County (Big Horn Area), Montana, 1970.

REMARKS: The Rottulee soils were formerly classified as Chestnut soils.

OSD scanned by SSQA. Last revised by state on 8/74.

National Cooperative Soil Survey
U.S.A.

¹<http://www2.ftw.nrcs.usda.gov/osd/dat/R/ROTTULEE.html>

STUBBS SERIES¹

The Stubbs series consists of moderately deep, well drained soils that formed in material weathered in place from soft, calcareous shale interbedded with siltstone. Stubbs soils are on mountain sides and have slopes of 2 to 25 percent. The mean annual precipitation is about 20 inches, and the mean annual temperature is about 38 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive Pachic Argicryolls

TYPICAL PEDON: Stubbs loam-rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 6 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; strong fine granular structure; soft, very friable, moderately sticky and slightly plastic; neutral (pH 6.8); clear smooth boundary. (4 to 8 inches thick)

AB--6 to 16 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, moderately sticky and moderately plastic; neutral (pH 7.2); clear smooth boundary. (8 to 12 inches thick)

Bt1--16 to 20 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine prismatic structure parting to moderate fine subangular blocky; very hard, very friable, moderately sticky and moderately plastic; continuous faint clay films on faces of peds and in root channels; neutral (pH 7.2); gradual wavy boundary.

Bt2--20 to 30 inches; brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; moderate fine prismatic structure parting to moderate fine subangular blocky; very hard, very friable, moderately sticky and moderately plastic; continuous faint clay films on faces of peds and in root channels; slightly alkaline (pH 7.4); gradual wavy boundary. (Combined thickness of the Bt horizon is 8 to 24 inches)

Btk--30 to 34 inches; light yellowish brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/3) moist; weak medium subangular blocky structure; hard, very friable, moderately sticky and moderately plastic; common faint clay films on faces of peds and in root channels; strongly effervescent, lime in common soft masses; moderately alkaline (pH 8.4); gradual wavy boundary. (0 to 19 inches thick)

Cr--34 to 60 inches; weakly calcareous, soft shale and siltstone.

TYPE LOCATION: Johnson County, Wyoming; NW1/4, NW1/4, sec. 34, T. 45 N., R. 84 W.

RANGE IN CHARACTERISTICS: The mollic epipedon is 16 to 32 inches thick. Depth to calcareous material is 15 to 36 inches. The solum is 20 to 40 inches thick and usually rests on the paralithic contact. Some pedons have a thin C horizon. Depth to the paralithic contact is 20 to 40 inches. The mean annual soil temperature is 38 to 43 degrees F. Small, flat rock fragments range from 0 to 15 percent.

The A horizon has hue of 2.5Y or 10YR, value of 4 or 5 dry and 2 or 3 moist, and chroma of 1 or 2. It has granular or subangular blocky structure. This horizon is neutral or slightly alkaline.

The Bt horizon has hue of 2.5Y through 7.5YR, value of 5 or 6 dry and 3 or 4 moist, and chroma of 2 through 4. It is loam or clay loam which averages 28 to 35 percent clay. This horizon has prismatic or subangular blocky structure. It is neutral or slightly alkaline.

COMPETING SERIES: These are the Bachus, Bavdark, Benteen, Clayburn, Croydon, Crystalbutte, Davtone, Decross, Dehana, Demast, Dranburn, Dranyon, Dry Canyon, Echemoor, Hagenbarth, Millerlake, Pontuge, Senchert, Southmount, Squawval, Thulepah, Vadnais, and Winu series. Bavdark, Croydon, Crystalbutte, Decross, Dehana, Dranburn, Dry Canyon, Pontuge, Millerlake, Southmount, and Thulepah soils are more than 40 inches deep. Bachus, Benteen, Senchert, Winu, and Vadnais soils have a lithic contact at depths of less than 40 inches. Clayburn, Demast, Dranyon, and Hagenbarth soils are noncalcareous throughout. Davtone soils have hue of 5YR or 2.5YR in the Bt horizon. Squawval soils are not effervescent in any part and have paralithic materials consisting of weathered quartz monzonite in the lower part of the series control section.

GEOGRAPHIC SETTING: Stubbs soils are on mountain sides. Slopes are 2 to 25 percent. These soils formed in moderately fine textured sediments weathered residually from underlying calcareous, soft shale and siltstone. Elevation is 8,000 to 9,000 feet. The mean annual precipitation is about 18 to 24 inches, and the mean annual temperature is 35 to 41 degrees F. The frost-free season is less than 80 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Jenkinson and Turk soils. Jenkinson soils lack an epipedon and have very fine textured argillic horizons.

DRAINAGE AND PERMEABILITY: Well drained; medium runoff; moderate permeability.

USE AND VEGETATION: These soils are used for range, recreation, and wildlife

habitat. Native vegetation is big sagebrush, Idaho fescue, Columbia needlegrass, King fescue, silvery lupine, and thickspike wheatgrass.

DISTRIBUTION AND EXTENT: Big Horn Mountains of north-central Wyoming. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bozeman, Montana

SERIES ESTABLISHED: Johnson County (Southern Part Area), Wyoming; 1971.

National Cooperative Soil Survey
U.S.A.

¹<http://www2.ftw.nrcs.usda.gov/osd/dat/S/STUBBS.html>

Appendix D

Laboratory Analyses

LabID	SampleID	Sampled	Begin Depth (cm)	End Depth (cm)	pH s.u.	Saturation %	Electrical Conductivity dS/m	Field Capacity %	Wilt Point %	Calcium meq/L	Magnesium meq/L
S0711436-001	SP-1 A	11/13/07	2	10	7.2	36.1	0.94	20	15	6.46	1.46
S0711436-002	SP-1 B1	11/13/07	10	33	7.4	40.6	0.53	18	14	3.72	1.05
S0711436-003	SP-1 B2	11/13/07	33	61	7.4	40.9	0.37	26	18	2.48	0.76
S0711436-004	SP-2 A	11/13/07	0	15	7.4	44.4	0.46	23	15	3.00	0.76
S0711436-005	SP-2 B	11/13/07	15	46	7.5	44.1	0.34	22	14	2.31	0.59
S0711436-006	SP-3 A	11/13/07	0	9	6.5	108	0.54	46	38	3.29	1.10
S0711436-007	SP-3 B	11/13/07	9	33	5.9	41.4	2.90	18	13	2.79	2.63
S0711436-008	SP-4 A	11/13/07	0	15	7.4	42.2	0.46	23	12	2.92	1.01
S0711436-009	SP-4 B	11/13/07	15	26	7.5	44.0	0.43	24	14	3.06	0.97
S0711436-010	SP-5 A	11/13/07	5	15	5.9	60.4	0.42	28	15	2.46	0.85
S0711436-011	SP-5 B1	11/13/07	15	36	5.5	37.0	0.19	19	10	1.15	0.28
S0711436-012	SP-6 A	11/13/07	5	38	5.8	52.5	0.31	28	15	2.15	0.50
S0711436-013	SP-6 B	11/13/07	38	69	6.3	38.5	0.20	25	10	1.10	0.38
S0711436-014	SP-7 A	11/14/07	3	15	6.4	61.8	0.15	26	18	0.78	0.38
S0711436-015	SP-7 B1	11/14/07	15	51	6.4	30.0	0.25	13	10	1.91	0.53
S0711436-016	SP-8 A	11/14/07	0	13	6.3	56.1	0.29	20	15	1.47	0.48
S0711436-017	SP-8 B1	11/14/07	13	45	6.5	31.8	0.14	11	10	0.87	0.28
S0711436-018	SP-9 A	11/14/07	3	18	6.8	68.2	0.43	29	24	2.63	0.69
S0711436-019	SP-9 B1	11/14/07	18	41	6.8	44.1	0.34	17	14	2.12	0.66
S0711436-020	SP-10 A	11/14/07	0	22	7.6	42.0	0.47	19	13	3.94	0.82
S0711436-021	SP-10 B1	11/14/07	22	33	7.6	44.0	0.44	18	16	3.35	0.76
S0711436-022	SP-10 B2	11/14/07	33	41	7.7	41.5	0.74	18	13	2.66	0.93
S0711436-023	SP-10 B3	11/14/07	41	67	7.8	37.6	0.33	18	13	2.50	0.60
S0711436-024	SP-11 A	11/14/07	0	8	8.0	51.3	0.54	19	14	4.10	1.64
S0711436-025	SP-11 B	11/14/07	8	41	7.8	38.2	0.52	18	12	3.35	1.29
S0711436-026	SP-12 A	11/14/07	0	13	7.5	60.5	0.54	28	23	4.37	0.77
S0711436-027	SP-12 B1	11/14/07	13	38	7.4	48.9	0.80	31	22	6.74	1.34
S0711436-028	SP-13 A	11/14/07	0	14	7.5	54.1	0.75	28	16	6.31	0.83
S0711436-029	SP-13 B	11/14/07	14	31	7.2	55.2	0.77	28	20	6.63	0.82

LabID	SampleID	Sampled	Sodium meq/L	Potassium meq/L	SAR	Sand %	Silt %	Clay %	Texture	Coarse Fragment %
S0711436-001	SP-1 A	11/13/07	0.41	1.07	0.20	43.0	39.0	18.0	Loam	6.26
S0711436-002	SP-1 B1	11/13/07	0.46	0.32	0.30	28.0	45.0	27.0	Clay Loam	0.64
S0711436-003	SP-1 B2	11/13/07	0.29	0.18	0.23	33.0	34.0	33.0	Clay Loam	0.14
S0711436-004	SP-2 A	11/13/07	0.47	0.12	0.34	46.0	22.0	32.0	Sandy Clay Loam	14.9
S0711436-005	SP-2 B	11/13/07	0.34	0.02	0.28	42.0	30.0	28.0	Clay Loam	9.52
S0711436-006	SP-3 A	11/13/07	0.24	0.74	0.16	61.0	30.0	9.0	Sandy Loam	19.8
S0711436-007	SP-3 B	11/13/07	20.9	0.33	12.7	53.0	29.0	18.0	Sandy Loam	6.48
S0711436-008	SP-4 A	11/13/07	0.55	0.44	0.39	50.0	30.0	20.0	Loam	7.34
S0711436-009	SP-4 B	11/13/07	0.22	0.08	0.15	42.0	39.0	19.0	Loam	11.4
S0711436-010	SP-5 A	11/13/07	0.39	0.46	0.30	52.0	34.0	14.0	Sandy Loam	3.64
S0711436-011	SP-5 B1	11/13/07	0.15	0.22	0.18	56.0	29.0	15.0	Sandy Loam	12.0
S0711436-012	SP-6 A	11/13/07	0.16	0.27	0.14	40.0	46.0	14.0	Loam	8.12
S0711436-013	SP-6 B	11/13/07	0.15	0.27	0.18	42.0	42.0	16.0	Loam	16.5
S0711436-014	SP-7 A	11/14/07	0.38	0.22	0.51	51.0	37.0	12.0	Loam	7.76
S0711436-015	SP-7 B1	11/14/07	0.22	0.13	0.20	59.0	31.0	10.0	Sandy Loam	9.46
S0711436-016	SP-8 A	11/14/07	0.24	0.34	0.24	69.0	22.0	9.0	Sandy Loam	1.59
S0711436-017	SP-8 B1	11/14/07	0.16	0.13	0.21	71.0	20.0	9.0	Sandy Loam	0.28
S0711436-018	SP-9 A	11/14/07	0.14	0.75	0.11	46.0	32.0	22.0	Loam	0.24
S0711436-019	SP-9 B1	11/14/07	0.14	0.49	0.12	40.0	33.0	27.0	Clay Loam	10.7
S0711436-020	SP-10 A	11/14/07	0.21	0.21	0.13	34.0	41.0	25.0	Loam	31.9
S0711436-021	SP-10 B1	11/14/07	0.19	0.05	0.13	8.0	54.0	38.0	Silty Clay Loam	55.3
S0711436-022	SP-10 B2	11/14/07	2.27	0.05	1.41					55.2
S0711436-023	SP-10 B3	11/14/07	0.26	0.03	0.21	29.0	39.0	32.0	Clay Loam	43.9
S0711436-024	SP-11 A	11/14/07	0.12	0.60	0.07	35.0	45.0	20.0	Loam	16.5
S0711436-025	SP-11 B	11/14/07	0.15	0.64	0.10	30.0	48.0	22.0	Loam	16.7
S0711436-026	SP-12 A	11/14/07	0.11	0.44	0.07	31.0	41.0	28.0	Clay Loam	28.7
S0711436-027	SP-12 B1	11/14/07	0.13	0.19	0.06	7.0	65.0	28.0	Silty Clay Loam	27.7
S0711436-028	SP-13 A	11/14/07	0.38	0.34	0.20	46.0	34.0	20.0	Loam	17.1
S0711436-029	SP-13 B	11/14/07	0.28	0.29	0.14	41.0	28.0	31.0	Clay Loam	1.51

LabID	SampleID	Sampled	TKN %	Nitrate ppm	Phosphorus ppm	Boron ppm	Selenium ppm	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t	Total Carbon %	TOC %
S0711436-001	SP-1 A	11/13/07	0.17	0.26	14.5	0.23	<0.02	0.03	0.97	104	103	2.6	1.4
S0711436-002	SP-1 B1	11/13/07	0.09	0.71	5.04	0.15	<0.02	0.01	0.41	154	154	2.3	0.5
S0711436-003	SP-1 B2	11/13/07	0.17	0.48	5.33	0.36	<0.02	0.02	0.63	18.5	17.9	1.3	1.1
S0711436-004	SP-2 A	11/13/07	0.12	<0.02	8.10	0.29	<0.02	0.01	0.45	14.0	13.6	1.1	0.9
S0711436-005	SP-2 B	11/13/07	0.06	<0.02	4.15	0.26	<0.02	<0.01	0	32.7	32.7	0.7	0.3
S0711436-006	SP-3 A	11/13/07	0.77	<0.02	55.0	0.96	<0.02	<0.01	0	6.66	6.66	5.0	5.0
S0711436-007	SP-3 B	11/13/07	0.08	0.10	12.9	0.28	<0.02	0.01	0.44	0.77	0.33	0.6	0.6
S0711436-008	SP-4 A	11/13/07	0.07	2.76	14.5	0.32	<0.02	<0.01	0	15.7	15.7	1.1	0.9
S0711436-009	SP-4 B	11/13/07	0.12	1.59	7.70	0.37	<0.02	<0.01	0	116	116	2.4	1.0
S0711436-010	SP-5 A	11/13/07	0.37	<0.02	57.8	0.64	<0.02	<0.01	0	5.68	5.68	2.8	2.7
S0711436-011	SP-5 B1	11/13/07	0.07	0.12	21.3	0.21	<0.02	<0.01	0	2.13	2.13	0.7	0.6
S0711436-012	SP-6 A	11/13/07	0.17	<0.02	51.6	0.27	<0.02	0.01	0.34	3.63	3.29	2.5	2.4
S0711436-013	SP-6 B	11/13/07	0.25	0.41	16.8	0.14	<0.02	<0.01	0	2.69	2.69	0.7	0.7
S0711436-014	SP-7 A	11/14/07	0.27	12.1	57.5	0.28	<0.02	0.03	1.08	6.60	5.52	4.0	3.9
S0711436-015	SP-7 B1	11/14/07	0.03	2.06	22.8	0.22	<0.02	<0.01	0	2.53	2.53	0.6	0.6
S0711436-016	SP-8 A	11/14/07	0.32	3.96	29.7	0.35	<0.02	0.02	0.72	3.68	2.95	3.7	3.6
S0711436-017	SP-8 B1	11/14/07	0.05	1.12	16.5	0.14	<0.02	<0.01	0	1.60	1.60	0.5	0.5
S0711436-018	SP-9 A	11/14/07	0.66	15.2	21.6	0.67	<0.02	0.03	0.96	7.23	6.27	4.0	3.9
S0711436-019	SP-9 B1	11/14/07	0.09	1.37	8.02	0.27	<0.02	<0.01	0	3.34	3.34	1.1	1.0
S0711436-020	SP-10 A	11/14/07	0.13	2.09	4.74	0.21	<0.02	<0.01	0	106	106	2.1	0.8
S0711436-021	SP-10 B1	11/14/07	0.08	<0.02	3.12	0.28	<0.02	<0.01	0	109	109	2.0	0.7
S0711436-022	SP-10 B2	11/14/07	0.07	0.06	3.65	0.26	<0.02	<0.01	0	310	310	2.9	<0.1
S0711436-023	SP-10 B3	11/14/07	0.06	<0.02	2.95	0.20	<0.02	0.02	0.71	185	184	0.8	<0.1
S0711436-024	SP-11 A	11/14/07	0.15	3.36	5.84	0.49	<0.02	0.01	0.39	141	140	2.9	1.2
S0711436-025	SP-11 B	11/14/07	0.10	4.37	6.26	0.39	<0.02	0.02	0.49	186	185	2.6	0.4
S0711436-026	SP-12 A	11/14/07	0.27	2.68	48.7	0.59	<0.02	0.02	0.54	58.3	57.8	4.0	3.3
S0711436-027	SP-12 B1	11/14/07	0.11	<0.02	8.40	0.40	<0.02	0.02	0.75	209	209	5.2	2.7
S0711436-028	SP-13 A	11/14/07	0.27	0.57	17.6	0.29	<0.02	<0.01	0	83.4	83.4	3.0	2.0
S0711436-029	SP-13 B	11/14/07	0.28	<0.02	14.7	0.34	<0.02	0.02	0.57	233	232	4.3	1.5

Appendix E

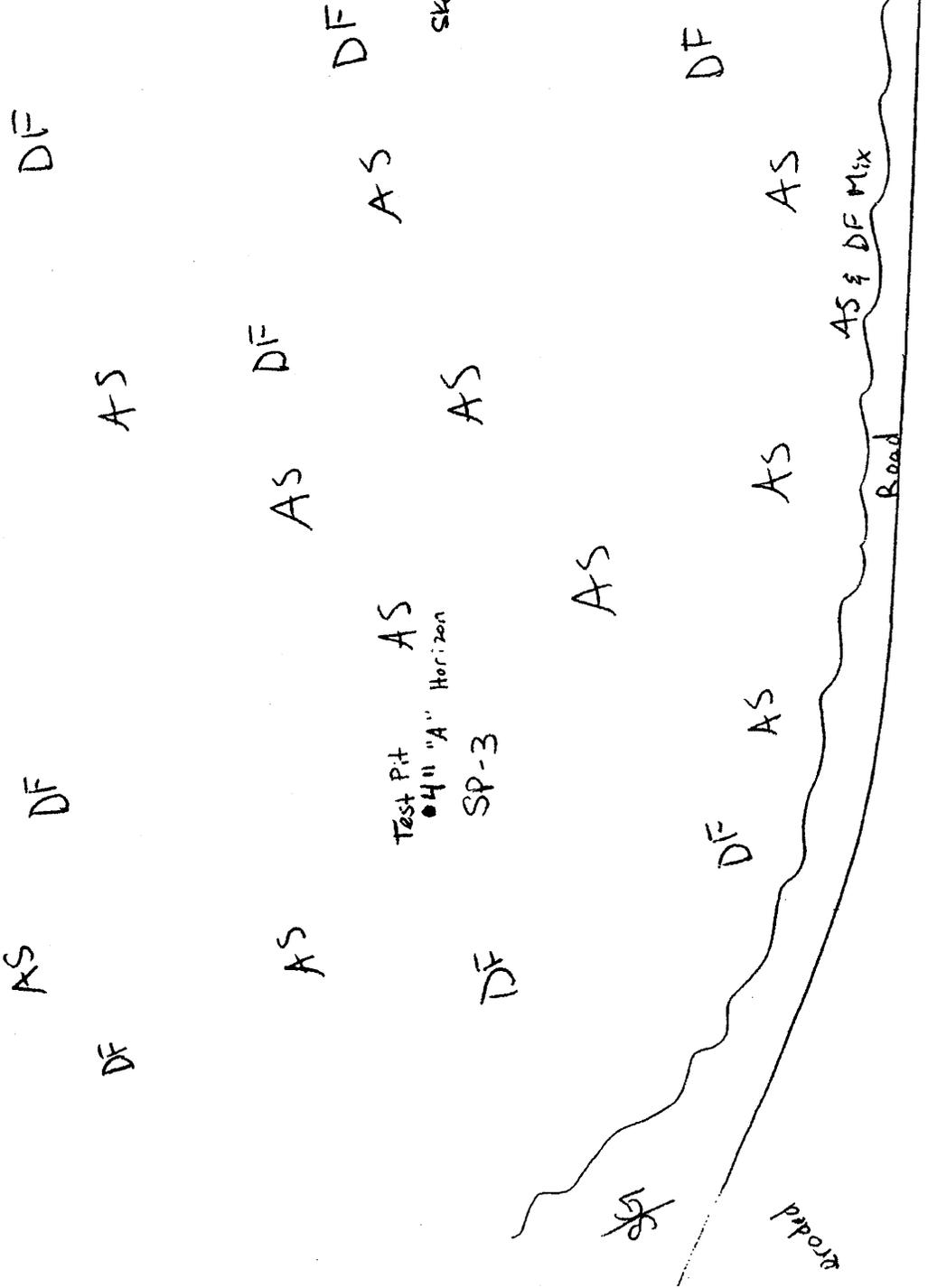
Hand-drawn Maps

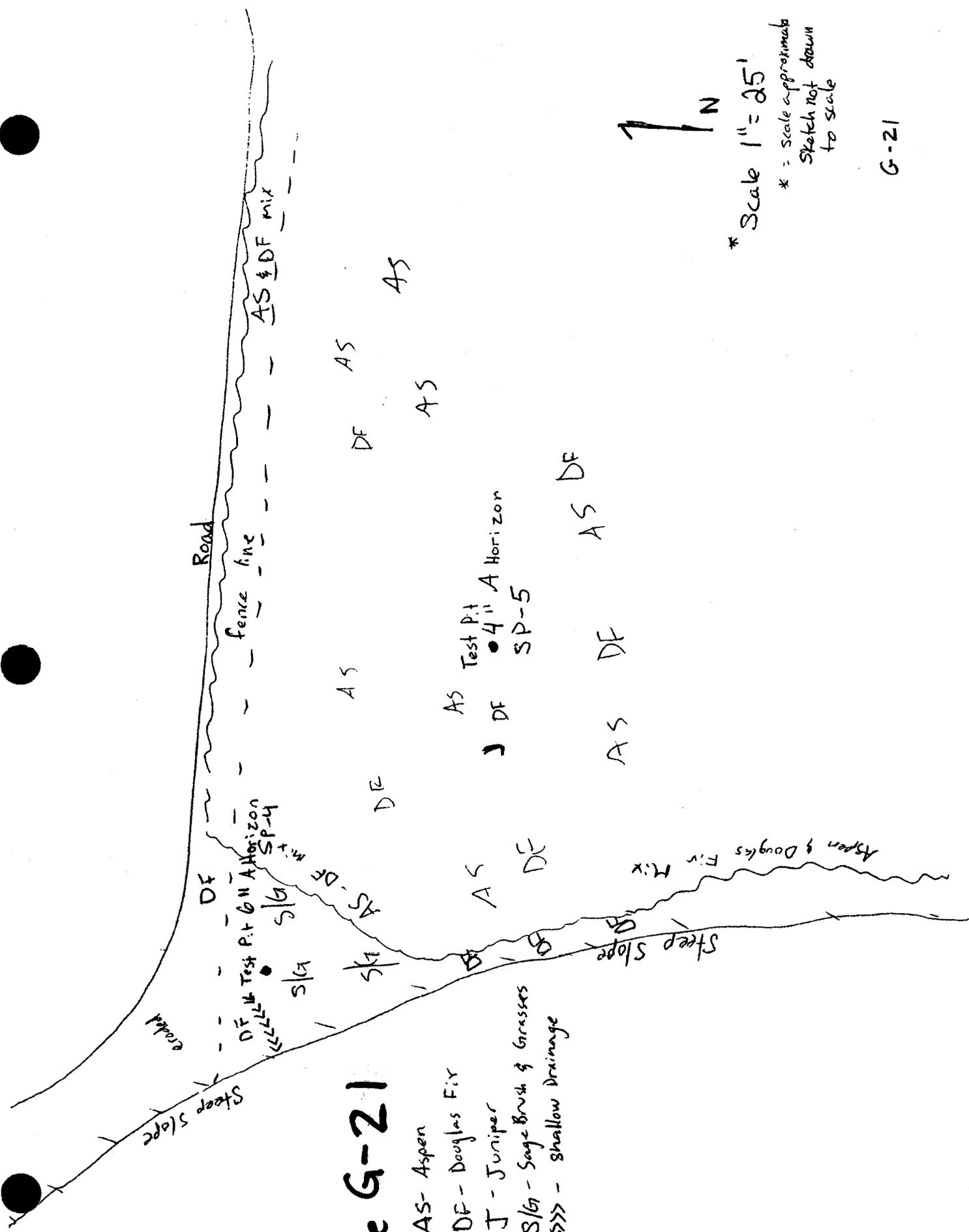
Site G-21

DF - Douglas Fir
 AS - Aspen
 S/G - Sage Brush & Grasses
 ● - Test Pit

Sketch not drawn to scale
 scale approximated

Scale 1" = 40'





Site G-21

- AS - Aspen
- DF - Douglas Fir
- J - Juniper
- S/G - Sagebrush & Grasses
- >>> - shallow drainage



* Scale 1" = 25'

* - Scale approximated
Sketch not drawn to scale

G-21

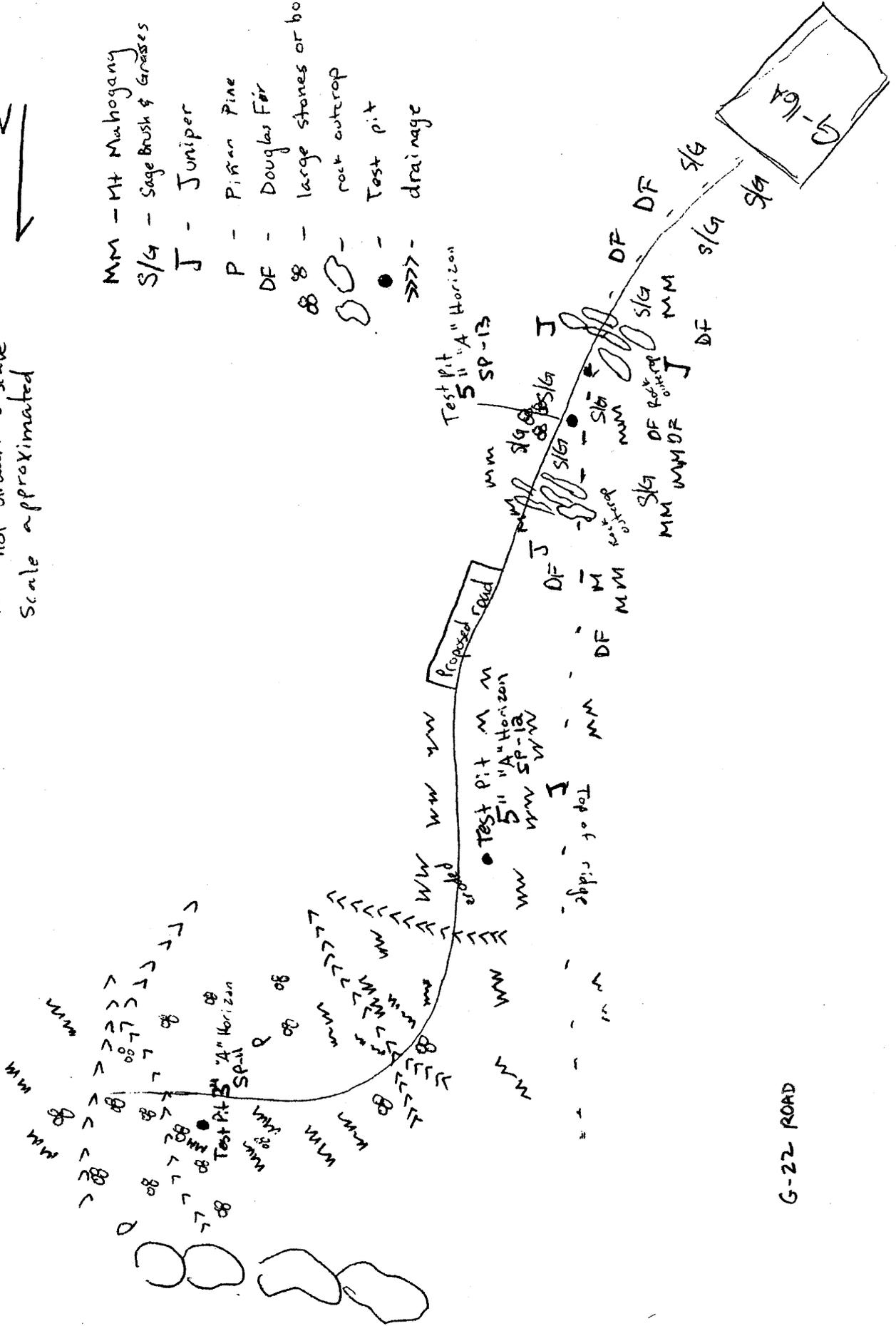
Site G-22 road

Scale 1" = 50'

Sketch not drawn to scale
Scale approximated



- MM - Mt Muhogany
- S/G - Sage Brush & Grasses
- J - Juniper
- P - Piñon Pine
- DF - Douglas Fir
- ⊗ - large stones or boulders
- ⊙ - rock outcrop
- - Test pit
- - drainage

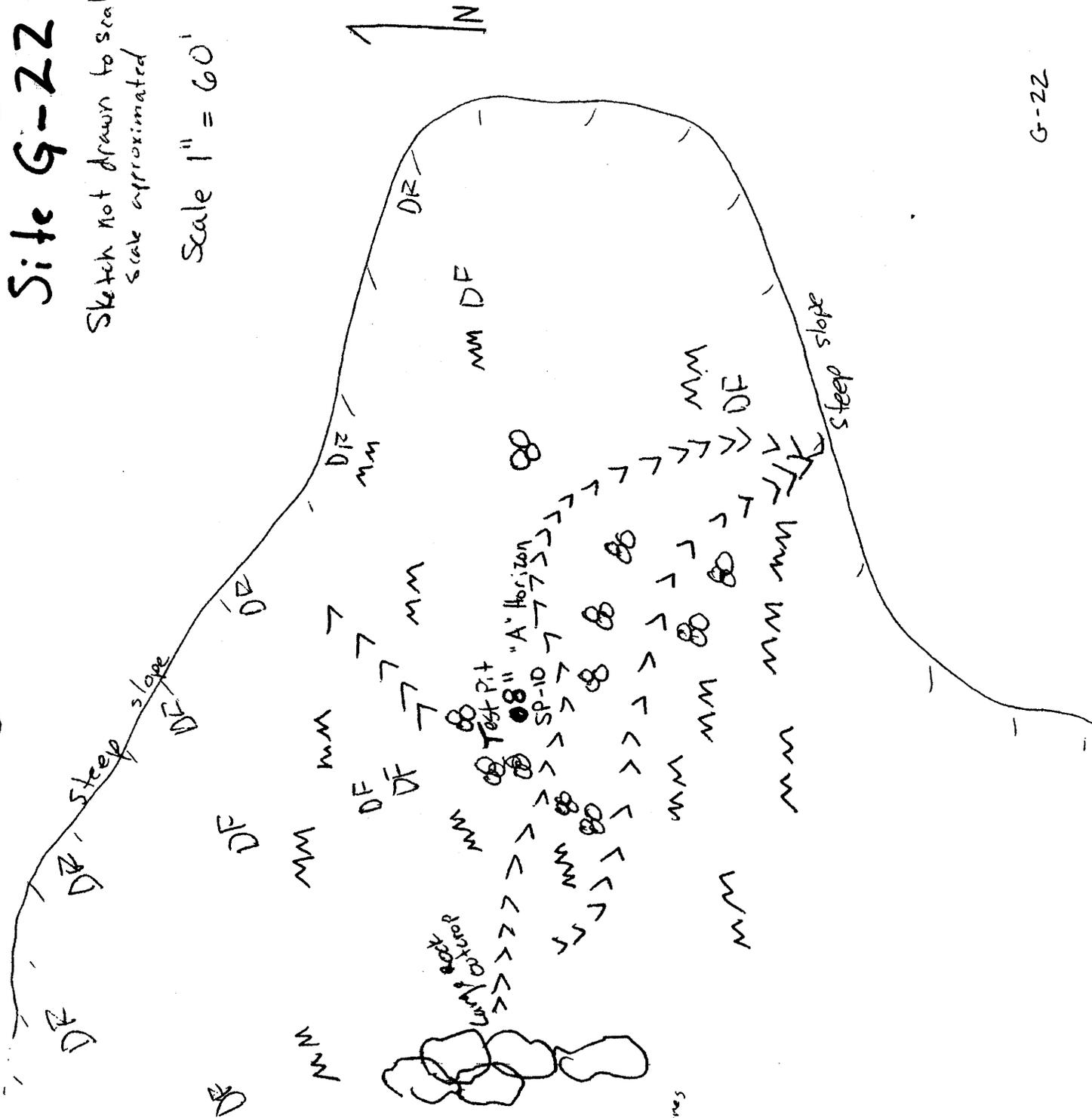


G-22 ROAD

Site G-22

Sketch not drawn to scale
Scale approximated

Scale 1" = 60'



- MM - Mt. Manzanary
- DF - Douglas Fir
- - Test Pit
- ⊗ - Boulders or large stones
- ⌞ - rock outcrop
- >>>> - drainage

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ATTACHMENT 2-2
TOPSOIL CALCULATIONS

add to the back of existing information

Pad G-21 Summary

Area within Disturbed Area Boundary (ac)	2.4
Disturbed Area Acreage (ac)	
Pad 21	1.6
Topsoil Excavation Volume Assuming 13 in. Salvage Depth (cyd)	2,718
Subsoil Volume for Berms (cyd)	198
Topsoil Stockpile Dimensions:	110'L X 60'W X 24'H

Topsoil Volume Calculation

Disturbed Area (ft ²)	Average Topsoil Depth (in)	Topsoil Volume (yd ³)
67,741	13	2,718

Notes

Average topsoil depth is taken from a site-specific soil survey of performed at the degas well pad.
 Topsoil Volume = Disturbed Area * Average Topsoil Depth

Topsoil Stockpile Capacity Calculation

Stockpile	Length (ft)	Width (ft)	Height (ft)	Volume (yd ³)
Pad on G-14	110	60	24	2,933

Notes

In order to minimize the disturbed area, topsoil will be stockpiled on previously permitted degas well pads, such as G-14.
 Volume calculated as 0.5*length of base * width * height of pile.
 Topsoil stockpile will be sloped at approximately 1.25H:1V

Excess Subsoil Volume Calculation

Area	AutoCAD Cut Volume (yd ³)	AutoCAD Fill Volume (yd ³)	Topsoil Volume (yd ³)	Percentage of Disturbed Area to be Cut	Total Subsoil Cut Volume (yd ³)	Total Subsoil Fill Volume (yd ³)	Total Berm Volume (yd ³)	Excess Cut (-) or Fill(+) (yd ³)
Pad on G-14	8,418	4,040	2,718	50%	7,059	5,399	198	1,462

Notes

AutoCAD cut and fill volumes do not consider topsoil.
 Topsoil volume taken from Topsoil Volume Calculation above.
 The percentage of disturbed area to be cut is the portion of the pad/road that will excavated below grade during construction.
 Total subsoil cut volume = AutoCAD cut volume - (percentage of disturbed area to be cut * total topsoil volume).
 Total subsoil fill volume = AutoCAD fill volume + (1-percentage of disturbed area to be cut) * total topsoil volume.
 Total berm volume includes the berm around the pad and the berm around the topsoil stockpile. The pad berm volume was assumed to be 2 feet tall with 1H:1V suide slopes, with a length of 995 feet. The topsoil stockpile berm volume calculation is tabulated on the attached Stockpile Runoff Containment Volume Calculations Table.
 Excess cut/fill indicates how much subsoil will have to be stockpiled (+ value) or imported (- value) to construct the pad. The net cut/fill = Total subsoil fill volume - Total subsoil cut volume - Total berm volume.

Pad G-22 Summary

Area within Disturbed Area Boundary (ac)	
Pad G-22	1.3
Access Road	2.2
Total	3.5
Disturbed Area Acreage (ac)	
Pad G-22	0.72
Access Road	0.85
Total	1.6
Topsoil Excavation Volume Assuming 10 in. Salvage Depth (cyd)	1,137
Subsoil Volume for Berms (cyd)	140
Topsoil Stockpile Dimensions:	
Stockpile Located on G-16 Pad	85'L X 65'W X 25'H

Topsoil Volume Calculation

Area	Disturbed Area (ft ²)	Average Topsoil Depth (in)	Topsoil Volume (yd ³)
Pad G-22	31,304	10	966
Access Road	36,849	10	1,137
TOTAL	68,153	10	2,103

Notes

Average topsoil depth is taken from a site-specific soil survey of performed at the degas well pad.

Topsoil Volume = Disturbed Area * Average Topsoil Depth

Topsoil Stockpile Capacity Calculation

Stockpile	Length (ft)	Width (ft)	Height (ft)	Volume (yd ³)
Pile on G-16	85	65	25	2,558

Notes

In order to minimize the disturbed area, topsoil will be stockpiled on previously permitted degas well pads, such as G-16.

Volume calculated as 0.5*length of base * width * height of pile.

Topsoil stockpile will be sloped at approximately 1.25H:1V

Excess Subsoil Volume Calculation

Area	AutoCAD Cut Volume (yd ³)	AutoCAD Fill Volume (yd ³)	Topsoil Volume (yd ³)	Percentage of Disturbed Area to be Cut	Total Subsoil Cut Volume (yd ³)	Total Subsoil Fill Volume (yd ³)	Total Berm Volume (yd ³)	Excess Cut (-) or Fill(+) (yd ³)
Pad G-22	1,429	2,161	966	22%	1,219	2,917	47	-1,746
Access Road	7,304	3	1,137	100%	6,167	3	46	6,118
TOTAL	8,733	2,164	2,103	NA	7,386	2,920	93	4,372

Notes

AutoCAD cut and fill volumes do not consider topsoil.

Topsoil volume taken from Topsoil Volume Calculation above.

The percentage of disturbed area to be cut is the portion of the pad/road that will excavated below grade during construction.

Total subsoil cut volume = AutoCAD cut volume - (percentage of disturbed area to be cut * total topsoil volume).

Total subsoil fill volume = AutoCAD fill volume + (1-percentage of disturbed area to be cut) * total topsoil volume.

Total topsoil stockpile berm volume (47 yd³) calculation tabulated on the attached Stockpile Runoff Containment Volume Calculations Table.

Total access road berm volume assumes a 1,233-foot long, 1-foot tall berm, with 1H:1V side slopes.

Excess cut/fill indicates how much subsoil will have to be stockpiled (+ value) or imported (- value) to construct the pad. The net cut/fill = Total subsoil fill volume - Total subsoil cut volume - Total berm volume.

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August 25, 2008 ~~September 20, 2007~~

CHAPTER 3
BIOLOGY

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310 INTRODUCTION

This chapter presents a description of the biological resources found on the Dugout Canyon degas well site areas and the AMV road.

311 Vegetative, Fish and Wildlife Resources

Vegetative, fish, and wildlife resource conditions in and adjacent to the proposed degassification wells are discussed in Section 320 of this submittal and the approved M&RP.

312 Potential Impacts to Vegetative, Fish, and Wildlife Resources

Potential impacts to vegetative, fish, and wildlife resources and the associated mitigation plan is 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 post mining land use is presented in Section 340.

320 ENVIRONMENTAL DESCRIPTION

321 Vegetation Information

This section and the approved M&RP contain the environmental descriptions of the vegetation for the permit and adjacent areas.

321.100 Plant Communities Within the Proposed Permit Area

During June 2003, the degassification well sites were surveyed by Patrick Collins, Mt. Nebo Scientific. The report and survey for the areas are included in Attachment 3-1. The site for G-6 was moved to a pre-disturbed exploration well pad, the plant communities described in Mr. Collins report reflect the undisturbed portions on the north and south edges of the well pad. Vegetation information for G-7 was obtained from a report prepared by the NRCS Range Management Specialist, Dean Stacy (refer to Attachment 2-1 and 3-1) and the Patrick Collins survey prepared for well site G-3. A photograph of the G-7 site is included in Attachment 3-1. Well site G-3 and the access road can be seen on the photograph.

A vegetation survey of well sites G-8 thru G-12 was completed in July 2005 by Patrick Collins, Mt. Nebo Scientific. These sites have all been pre-disturbed, with a road running through the center of G-8 and remnants of logging activity at both G-9 and G-10. Approximately fifty percent of the well pads at sites G-11 and G-12 are existing roads which have no topsoil or vegetation. The remaining area at site G-11 has been disturbed, except for a small portion on the west side of the site. Well site G-12 has evidence of disturbance above the road cut however both soil and vegetation are intact. The reports and surveys for the areas will be included in Attachment 3-1.

The vegetation survey of well sites G-13 thru G-17 were completed between July and September 2005. The reports and surveys for the areas are included in Attachment 3-1. At well site G-13, the surface ranges from relatively smooth and non-stoney to very stoney. Portions along the southeast edge are too stony for soil salvage. The G-14 well site has been disturbed by logging. The road to G-13 and G-14 are existing roads, however, the soil will be bladed to the side of the road at site G-14 and replaced during reclamation.

Well site G-15 is about 50 percent disturbed by a road, slope cut and fill. The undisturbed portion of the site is a slope with a southeast aspect (35 to 45 percent gradient). Well site G-16 was previously the site of an exploration hole, having been disturbed and reclaimed. The topsoil on

the access road to G-16 will be bladed to one side of the road and replaced during reclamation. At well site G-17 approximately one-third of the site is an existing road.

The entire area of well site G-19 was previously disturbed by logging activities with two roads crossing through the area. Well site G-18 appears to be undisturbed, while G-31 has evidence of disturbance by logging and evidence of use by cattle. The AMV access road to pad G-31 has been used by cattle and hunters to access the top of the ridge. The portion of the AMV road which accesses well site G-18 appears to be undisturbed.

Per an exception granted by the Division during a meeting on April 16, 2007, vegetation on the AMV is being compared to quantitative vegetative analysis information surveyed for degassification well pads. Qualitative data recorded on the access road is discussed in "Vegetation of the De-Gas Sites G-18, G-31 & Reference Area", located in Attachment 3-1. The reference area for the AMV road is the same area as G-16, G-17, G-18 and G-31. The path of the AMV road is a trail used by livestock, hunters, wildlife and a length was disturbed by logging activities, as well as the other activities.

The vegetation on the AMV is similar if not identical to the vegetation analysis presented for degas wells pads G-18, G-19 and G-31. Segment A (approximately 1100 feet) of the road parallels a drainage, the road is on the west side of the drainage and drill pad G-19 is on the east side of the same drainage. The vegetation on Segment A is similar to the vegetation surveyed on Degas pads G-18 and G-31. Segment B approximately 700 feet mimics the soil type and vegetation on the G-19 pad site. A second similarity to the G-19 pad is that Segment B of the road has also been disturbed by logging, containing slash piles and skid trails, this area has experienced natural recovery, except for the width of the trail. Segment C, includes the remainder of the road. Segment C mimics the vegetation on drill pads G-18 and G-31. Segments A and C have a trail running through them, the trail is approximately six feet wide and runs the entire length of the road, including running through Segment B. A drawing of the road, being included to show the segments described above, is provided in Attachment 3-1.

An area approximately 100 x 100 feet on drill pad G-18 was disturbed by logging activity and has experienced natural recovery.

Degas well site G-21 supports a conifer/aspen plant community, with the dominant overstory species being Douglas fir, understory woody species was represented by Wood's rose, snowberry and aspen. Proportions of lifeform composition of the understory was comprised of 72.94% woody species, 17.23 % forbs and 9.83% grasses.

Mountain brush/snowberry plant community is representative of well site G-22. Woody species, big sagebrush and snowberry dominated the site.

TABLE 3-1
Land Productivity

Well No.	Productivity (lbs.) Per Acre
G-1 (Previously Disturbed)	100
G-2	1,500*
G-3	1,500*
G-4 (Previously Disturbed)	150
G-5	1500*
G-6 (Majority Previously Disturbed)	300*
G-7	1200*
G-8 (Previously Disturbed)	1200
G-9 (Previously Disturbed)	1000*
G-10 (Previously Disturbed)	1000*
G-11 (Previously Disturbed)	1000*
G-12 (Previously Disturbed)	1000*

G-13	1000*
G-14 (Previously Disturbed)	1000*
G-15 (Previously Disturbed)	1000*
G-16 (Previously Disturbed)	1000*
G-17 (Previously Disturbed)	1000*
G-18	900 - 1200*
G-19 (Previously Disturbed)	500 - 800*
G-21	100*
G-22 and Access Road	1000*
G-31 (Previously Disturbed)	900 - 1200*
Access Road - AMV (Previously Disturbed)	900 - 1200*
Reference Areas	
Sagebrush/Snowberry/Grass (G-2, G-3, G-4, G-5, and G-7)	1500*
Aspen/Maple/Douglas Fir (G-1, G-6, and G-8)	300*
Mountain Brush/Conifer (G-9 thru G-11)	1200
Conifer/Mountain Brush/Pinyon Juniper (G-12, G-13 and G-15)	1100
Aspen/Conifer (G-14, G-19 and G-21)	300
Mountain Brush/Snowberry (G-16, G-17, G-18, G-22 and G-31, AMV Access Road)	1400

* Community composition is experiencing a declining trend, with decrease in herbaceous production, increase in shrub/tree production.

321.200 Land Productivity Prior to Mining

Productivity of the well site lands and the AMV road prior to mining are shown in Table 3-1. Refer to Appendix 3-1 for a copy of the NRCS letter pertaining to productivity.

322 Fish and Wildlife Information

Fish and wildlife information associated with the degas wells is provided in this chapter. A summary of the fish and wildlife resource information for the permit and adjacent areas is contained in Sections 322.100 through 322.200 of the approved M&RP.

322.100 Level of Detail

The scope and level of detail within the "Methane Degassification Amendment" are sufficient to design the protection and enhancement plan for wildlife and fish associated with the degas wells. Additional information pertaining to fish and wildlife in the permit area is located in the M&RP.

322.200 Site-Specific Resource Information

Raptors - An aerial raptor nest survey was done of the area by the Utah Division of Wildlife Resource (DWR, Chris Colt, Leroy Mead) and CFC personnel in May of 2003, refer to the Confidential Folder. Surveys were completed in May of 2004 and 2005, the information has been incorporated into the Confidential Folder.

No raptor nests were recorded during the survey (2003) in the area (portions of N1/2SE1/4NW1/4 and N1/2SW1/4NE1/4 of Section 24; a portions of N1/2SW1/4NW1/4 Section 19, Township 13 South, Range 13 East) of the degas wells. Refer to Figure 1-1 for mapped well locations.

During the 2004 raptor survey, there were no active or tended nests identified in the vicinity of the degas wells. During the 2005 raptor survey (May 12 & 20), there were no active or tended nests

identified in the vicinity of degas wells G-9 and G-10. Two golden eagles nests were observed in the cliffs adjacent to degas well G-8 (Nest 9, DWR 2005 Raptor Survey). A single young eagle was observed, but habitually vacates the nest within 45 days of birth. A raptor survey will be conducted of the well site areas, each year that the wells are in operation.

A raptor survey was performed by Division of Wildlife Resources personnel in May 2006, a copy of the written log is included with deficiencies for Task ID #2456 (located in the confidential folder). Nest 424 when inventoried during the 1998 annual raptor survey was determined to be an inactive raven nest and was not found or inventoried again until 2004 when it was listed as inactive. Nest 424 was not inventoried or found during the annual raptor surveys in 2005 and 2006 by the Division of Wildlife Resources.

During a ground-truthing by Leroy Mead of the Division of Wildlife Resources on July 11, 2006, the two well sites with potential habitat for NSO and northern goshawks were G-14 and G-17. A calling survey will be performed if drilling at either of these sites will begin prior to the end of the exclusionary period, described as July 15. *Although drill pad G-21 is adjacent to G-14 the well is being drilled post July 15th (end of exclusionary period).*

Well G-14 will be drilled in 2006 after July 15. Well G-17 is to be drilled in 2009, the date for drilling will be scheduled according to the availability of drilling companies and a calling survey if needed will be performed at that time. If a calling survey is performed, the results will be incorporated into the confidential folder.

A Northern Goshawk calling survey was performed in July of 2003 for four weeks in the area of well site G-17. According to the survey there was no response from a northern goshawk. A copy of this survey is located in the confidential binder.

On July 12, 2006, Nest 9 a golden eagle nest was inventoried on the ground by Leroy Mead, although there is evidence of disturbance associated with subsidence in the area, the nest was not disturbed. The 2006 raptor survey lists Nest 9 as being tended.

The G-19 well site was inventoried by Leroy Mead in November 2006 and on June 11, 2007, no wildlife concerns were noted. The area was part of the annual raptor survey, no nest are located in the area.

Well sites G-18, G-31 and the AMV access road were inventoried by Leroy Mead on June 11, 2007, no wildlife concerns were noted. Cattle were observed along the road and on the G-31 well pad site. The area was part of the annual raptor survey, no nests are located in the area.

A raptor survey was done by the Division of Wildlife Resources in May 2008, an inactive (since 2004) redtail hawk and two inactive (since 2004) raven nests are located near the area proposed for construction of degas pads for wells G-21 and G-22.

Bats - No known open mine shafts, caves, adits or other man made structures that might provide habitats for bats are known to exist in the degas project area.

During June of 2005 a bat survey was performed by JBR Environmental Consultants, Inc, on Pace Creek. Site/stop #6 was in the W1/2SE1/4 of Section 20, Appendix 3-3 of M&RP, Confidential Folder, Figure 1, this stop was the closest to the proposed AMV road and drill pads G-18 and G-19. In the summary of the report it states "the nearly constant bat activity at the Stop #7 pond suggests that this water feature is an important resource for bats in terms of both water and feeding." The Stop #7 pond is approximately one mile east of Site/stop #6, drill sites G-18, G-19 and the AMV road and will not be disturbed in association with these mining activities. The same pond is approximately 1.5 miles from drill pad G-31 and the portion of the AMV road which connects the G-31 and G-18 pads. According to the JBR consultants the pond surveyed at Site/stop #7 which is at a minimum one mile east of the road and drill sites is likely one of the water source used by the bats in the area.

According to the 2005 survey only the Fringed Myotis is listed as a bat species of concern when compared with the Utah Sensitive Species list dated October 17, 2006. "Concerning the fringed myotis, of the 3,246 recordings, 10 were identified as showing nearly conclusive patterns to that known for the species. The 10 good recordings occurred over 3 consecutive nights at Station 7,

located at the east edge of the Inventory Area. It is unknown if the species actually utilizes the Inventory Area for roosting or if it just visits the pond for foraging (JBR, 2005).”

On the nights of May 21 and 22, 2007 JBR Environmental Consultants, Inc conducted bat surveys along the northern cliffs of Pace Creek Canyon. The inventory area of the survey included portions of Sections 16, 17, 18, 19, 20 and 21 T13SR13E. Pads G-19, G-21 and G-22 were within the area inventoried. During the two night of recording bat calls, no bat call files were produced (Attachment 3-2).

Mexican Spotted Owl - In the Summer of 2003, a calling point survey was conducted in the degas well area by EIS Environmental and Engineering Consulting. The survey report concluded that “within the project area, a thorough search did not reveal the presence of any Mexican spotted owls”. The report is included in Attachment 3-2. A second survey was completed in May of 2004, the information is incorporated into Appendix 3-3 of the M&RP.

Threatened and Endangered Plant and Wildlife Species - There are no known federally or state listed threatened and endangered plant and wildlife species within the sites planned for degassification wells or for the AMV road.

Bureau of Land Management Environmental Assessment No. UT-070-2001-83 and UT-070-2004-49 contain determination in accordance with the United States Fish and Wildlife Service’s protocols, for sites G-11, G-15, G-16 and G-17. The sites were inventoried for the presence of threatened, endangered, and sensitive faunal, and floral species in June of 2001, April, May and June of 2004, no species were found. In the assessment the sites were being used for exploration holes and were referenced by a different number which is in parenthesis following the degas well number G-11 (DT-2), G-15(DUG0204), G-16 (E) and G-17 (DUG0304).

Mt. Nebo Scientific, Inc. conducted a survey of Pad G-18, G-19, G-21, G-22, G-31 and the AMV access road no rare, endemic, threatened or endangered or otherwise sensitive species were found in the study area (Attachment 3-1).

There are no known groundwater or surface water flows to the Colorado or Green Rivers with potential for impact by the drilling of the degas wells. Potential adverse effects to the four Colorado River endangered fish species (refer to table below) would not be likely since there is no direct route to the Colorado River or Green River from the proposed well locations. Per the Windy Gap Process (referenced by personal communication Jerriann Ernstsens, 8/19/03) consumption estimates for the degas wells: evaporation from ventilation - zero, drill holes will not intersect the coal seam being mined, therefore no access to mine ventilation until after area is sealed; coal preparation - zero, no coal preparation at degas sites (see Sections 522 and 523); sediment pond evaporation - zero, no sediment pond at degas sites (see Section 732.200); subsidence effects on springs - zero, no anticipated subsidence at degas sites (see Section 525); alluvial aquifer abstractions into mines - zero, no alluvial aquifer abstractions associated with degas drill holes (see Sections 513.500 and 600); postmining inflow to workings - zero, no workings for postmining inflow associated with degas wells (see Sections 513.500 and 600); coal moisture loss - zero, no coal therefore no moisture loss (see Sections 522 and 523); direct diversion - zero, no direct diversions associated with degas wells (see Sections 522 and 523). Water **purchased** for drilling is estimated at 420,000 gallons per hole. Mitigation will not be required since the estimated loss for the construction and reclamation of the degas holes is zero acre feet per year.

Windy Gap Process as it Applies to Existing Coal Mines in the Upper Colorado River Basin

Per meetings with Division of Water Quality personnel during application for a UPDES permit in 2004, "there is no data supporting the premise that surface waters associated with the area of the mine operations reached the Price River or Colorado River prior to or since mining disturbance".

Refer to the Dugout Canyon Mine M&RP for the most recent calculations associated with the "Windy Gap Process".

Mining Consumption:

~~Culinary Water is purchased from PRWID and hauled by D & D Trucking to the Mine.~~

~~Estimated Purchased Gallons/yr: 2,522,160~~

Ventilation Consumption/Evaporation:

~~87,108 gallons/day~~

~~$87,108 \times 0.5 = 43,554$ gallons/day (average)~~

~~$43,554 \times 365 = 15,897,210$ gallons/yr~~

Coal Producing Consumption/Coal Moisture Loss:

~~Water added to coal produced — 3.97% inherent moisture — source Dugout Geologist~~
~~6.38% run-of-mine moisture — year to date average~~
~~2.41% moisture added to coal by cutting operation~~

~~Projected Tonnage 2005 — 4,525,093 tons~~
~~Projected Tonnage 6 year average — 4,894,100 tons~~
~~Tons water/yr — 117,977~~
~~Pounds water/yr — 235,954,986~~
~~Gallons water/yr — 28,258,082~~

~~Sediment Pond Evaporation:~~

~~Mine Site Pond — 0.107 acres (surface area)~~
~~18.1 in/yr (high estimate based on HCI Technical Memo, August 22, 2002)~~
~~0.16 ac/ft~~
~~7030 gallons/yr~~

~~Refuse Pile Pond — 0.41 acres (surface area)~~
~~9 in/yr~~
~~0.31 ac/ft~~
~~5612 gallons/yr (high estimate)~~

~~Spring and Seeps Effects From Subsidence — Not Applicable~~

~~Alluvial Aquifer Abstractions into Mines — Not Applicable~~

~~Alluvial Well Pumpage — Not Applicable~~

~~Deep Aquifer Pumpage — Not Applicable~~

~~Postmining Inflow to Workings — Not Applicable~~

~~Direct Diversions: — Not Applicable~~

~~Dust Suppression — 1,000 gallons per truck load, 3 load per day, for 335 days = 1,005,000 gallons plus 1,000 per truck load, 1 load per day, for 193 days = 193,000. Total: 1,198,000 gallons per year.~~

~~Mine Discharge: 6 Month Average 420,537gpd = 155,260,050 gal/yr~~

~~Calculation estimates for water use in 2005 were necessary since we are using 2005 purchases and usage and the year is 2 months short.~~

**Utah's Federally (US F&WS) Listed
Carbon County, Utah - County of Occurrence
08/27/07**

<u>Common Name</u>	<u>Scientific Name</u>	<u>Status</u>	<u>Habitat Present*</u>
Plants Species			
Uinta Basin Hookless Cactus	Sclerocactus glaucus T		No habitat available

Fish Species

Humpback Chub	<i>Gila cypha</i>	E	No habitat available
Bonytail	<i>Gila elegans</i>	E	No habitat available
Colorado Pikeminnow	<i>Ptychocheilus lucius</i>	E	No habitat available
Razorback Sucker	<i>Xyrauchen texanus</i>	E	No habitat available

Birds

Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	C	No habitat available
Mexican Spotted Owl	<i>Strix occidentalis lucida</i>	T	Habitat possible in general area

Mammals

Black-footed Ferret	<i>Mustela nigripes</i>	E/EXP	No habitat available
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* Habitat availability in Carbon County/Dugout Mine/Degas Well Sites and AMV road.

E = A taxon that is listed by the U.S. Fish and Wildlife Service as “endangered” with the possibility of worldwide extinction.

E/EXP = E Experimental - An endangered taxon that is considered by the U.S. Fish and Wildlife Service to be experimental and non-essential in its designated use areas in Utah.

T = A taxon that is listed by the U.S. Fish and Wildlife Service as “threatened” with becoming endangered.

C = A taxon for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threats to justify it being a “candidate” for listing as and endangered or threatened.

Source: Utah Division of Wildlife Resources - created 8/27/2007(Attachment 3-2)

Refer to Attachment 3-2 for a listing of Federal and State Listed, Threatened, Endangered and Candidate Species and Sensitive Species.

322.300 Fish and Wildlife Service Review

If requested, Dugout Canyon 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. On the 25th of May 2005, Leroy Mead of the DWR toured degas well sites G-8, G-9, G-10, G-11 thru G-14. During the tour no wildlife concerns were noted.

The G-18, G-19 and G-31 well sites, as well as, the AMV access road was inventoried by Leroy Mead on June 11, 2007 and no concerns were noted.

323 Maps and Aerial Photographs

Location of the well sites can be seen in Figure 1-1 of this submittal. The AMV road is shown on Plate1 , in Attachment 5-4.

323.100 Location and Boundary of Proposed Reference Area

Reference areas for the degassification wells were established during the vegetative study conducted in the Summer of 2003. Well sites G-2, G-3, G-4, G-5, and G-7 will be compared to the Sagebrush/Snowberry/Grass reference area and G-1, G-6, and G-8 to the Aspen/Maple/Douglas Fir reference area. Mountain Brush and Conifer is the reference area for well sites G-9 thru G-11. The reference area for Degas Well G-12 , G-13 and G-15 is Conifer, Mountain Brush and Pinyon Juniper. The reference area for Degas Well G-14, G-19 and G-21 is Aspen/Conifer, the reference area for G-16 thru G-18, G-22, G-31 and the AMV access road is Mountain Brush/Snowberry. Refer to Attachment 3-1 and Figure 3-1 for the location of the reference areas associated specifically with the degas wells. Reference areas are also shown on Plate 3-1 and 3-1E in the M&RP.

323.200 Elevation and Locations of Monitoring Stations

Refer to Section 323.200 of the approved M&RP.

323.300 Facilities for Protection and Enhancement

Section 333.300 and 358.500 of the approved M&RP contain additional discussion pertaining to protective measures to be taken by Dugout Canyon on behalf of wildlife.

323.400 Vegetation Type and Plant Communities

Vegetative types and plant communities are outlined in the vegetative report in Attachment 3-1. Figure 3-2 and the vegetation drawing in Attachment 3-1 (Vegetation, Sections 19 and 20, Township 13 S R13 E) give details of the vegetation types located adjacent to the well sites and the AMV road.

330 OPERATION PLAN

331 Measures Taken to Disturb the Smallest Particle Area

The well sites will be sized to disturb the smallest acreage possible and still meet the requirements for the drilling equipment. The AMV road will be constructed disturbing the small area possible. The drainage control required will be built to satisfy the environmental requirements.

332 Description of Anticipated Impacts of Subsidence

Refer to Section 525.

333 Plan to Minimize Disturbances and Adverse Impacts

General control and mitigation measures addressing potential related biological impacts will include the following:

- Minimizing the total area of disturbance,
- Design, construction, and operation of the well sites and AMV road to minimize impacts
- Establishment of stream buffer zones
- Control of surface discharges
- Exclusion of wildlife from potentially hazardous areas, and

- Reclamation of disturbed areas when they are no longer needed.

All water associated with the drilling of these wells will be appropriated and hauled and/or pumped to the sites by a licensed contractor. Since the drilling of degas wells does not involve the mining of coal, the USWFS consumption requirements for underground operations do not apply (i.e., evaporation from ventilation, coal preparation, sediment pond evaporation, subsidence of springs, alluvial aquifer abstractions into the mine, postmining inflow to workings, coal moisture loss, direct diversions).

As inventoried by the Division of Wildlife Resources in 2003, 2004, 2005, 2006, 2007 and 2008, Nest 424 was determined to be a raven's nest, which was either inactive, not inventoried or found. Wells G-13, G-14 were drilled post July 15th. Wells G-18, G-19, G-21, G-22 and G-31 will be drilled post September 1st.

333.100 Minimize Disturbance to Endangered or Threatened Species

Dugout Canyon will apply all methods necessary to minimize disturbances or any adverse effects to threatened or endangered species. See Section 322.200.

333.200 Species and Habitats

All species and habitats within the permit area will be protected to the best of Dugout Canyon's ability.

333.300 Protective Measures

Refer to Section 333.300 of the approved M&RP.

AMV Road - Protection of Upper Channel

Probable Hydrologic Consequences within the area associated with the road is discussed in Section 728.300 and Attachment 7-1, buffer zone designation is discussed in Section 731.600, road drainage is further discussed in Sections 732.400 and 742.400.

Silt fencing will be used at the down hill toe of the slope of the road fill during road construction and reclamation to capture loose soils and rocks. A diagram of the AMV road is provided in Attachment 7-1, during the operation phase the road will have a ditch, berm and culverts with rip rapped outlets to collect and treat road runoff. Outslopes and ditches associated with the road will be seeded during operations to encourage the establishment of vegetation and for erosion control.

A spring designated at SC-96 on Plate 7-1 (M&RP) was not flowing during the months of permitting preparations for the AMV road. Employees of Dugout Canyon Mine were traversing the area in May thru August, during that time no flow from the spring was observed.

340 RECLAMATION PLAN

341 Revegetation

Revegetation of the sites will occur in two phases at drill site G-2. The first phase is to redistribute topsoil and seed the well area not needed for access and operation of the gas exhaust blower. The second phase will consist of plugging the well and distributing the remaining topsoil and seeding on the remaining pad area. Complete final reclamation at well sites G-2, G-5 and G-7 will be delayed, refer to Section 242.100 for additional detail and Attachment 5-2. Sites G-3, G-4, G-6, G-8 (never constructed), G-9, G-10, G-11 thru G-19, G-21, G-22 and G-31 will be reclaimed in one phase. A separate reclamation schedule has been proposed for the AMV road, it will be needed to access the degas wells during and following reclamation (Figure 5-26).

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, and productive range. 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.

The well sites will be fenced to discourage wildlife and livestock from grazing the reclaimed areas until bond release.

341.100 Schedule and Timetable

The reclamation timetable is shown in Figures 5-15 (G-2) and 5-26 (G-3 thru G-19, G-21, G-22, G-31 and AMV access road) of this submittal and the reclamation monitoring schedule is found in Chapter 3, Table 3-3 of the approved M&RP.

341.200 Descriptions

Species and Amounts of Seed - The well sites and AMV road will be planted with the seed mix listed on Table 3-2. The seed mix will be used in both contemporaneous and final reclamation phases. The seed will be incorporated with a small amount of wood fiber mulch and applied by hydroseeding equipment or broadcast. Refer to Section 234.200 for topsoil stockpile seeding description.

Methods Used for Planting and Seeding - The degassification sites will be graded to final contour, then ripped to relieve compaction. The depth of ripping will be from 18 to 24 inches. Following ripping, topsoil will be applied to the ripped surface and left in a gouged and roughened state.

Mulching Techniques - Wood fiber mulch will be applied on top of the seed with hydroseeding equipment at the rate of 2,000 pounds per acre and anchored with a tackifier in amounts specified by the manufacturer.

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.

341.300 Greenhouse Studies, Field Trials or Other Equivalent Studies

Refer to the Section 341.300 of the approved M&RP.

342 Fish and Wildlife

342.100 Enhancement Measures

Post bond release enhancement measure will include the establishment of vegetation for wildlife food, cover, and the break up of large blocks of monoculture to diversify habitat. The current blocks of monoculture include large area of sagebrush and mixed brush. According to Dean Stacy, Range Management Specialist, USDA-NRCS "past management practices have allowed the shrub (mainly mountain sage brush) to surpass the 25-35%, while the herbaceous production has declined". By planting reclamation seed mixes with grasses and forbs the planted areas will breakup the monocultures and provide a future seed source.

In consultation with UDWR (Tony Wright, July 6, 2004) and UDOGM (Jerriann Ernstsens, July 6, 2004) a mitigation project was designated for the Northern Saw Whet Owl to compensate for drilling during the exclusionary period. The project will be completed prior to October 1, 2004. The project will include the construction and installation of 6 to 10 nest boxes on property owned by Canyon Fuel Company, LLC. Because of the UDWR knowledge and experience their personnel will choose the location and install the boxes. Information (goals, procedures, agencies, dates, box locations - township, range, section) concerning the owl mitigation project will be included in the annual report for 2004.

342.200 Plants Used for Wildlife Habitat

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

Cover - Cover will be comparable to the cover on the associated reference area.

342.300 Cropland

Cropland is not a postmining land use.

342.400 Residential, Public Service, and Industrial Land Use

No residential, industrial or public service use is planned.

350 PERFORMANCE STANDARDS

351 General Requirements

Dugout Canyon 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 preformed contemporaneously. Contemporaneous reclamation will be performed at the well sites following construction of the wells. Refer to Section 341 for additional details.

353 Revegetation: General Requirements

A vegetative cover will be established on all reclaimed areas to allow for the designated postmining land use of grazing. Refer to Section 411 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 vegetation mixture will be comprised of species indigenous to the area and capable of achieving the postmining land use. Diversity of species should allow utilization of plants by wildlife and domestic livestock. The recommended seed mix is comprised of native species.

Extent of Cover - The vegetative cover will be at least equal in extent to the cover at the designated reference areas.

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

353.200 Reestablished Plant Species

Compatible - The reestablished plant species have been selected to insure their compatibility with the approved postmining use.

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 mix purchased to revegetate the degassification well sites and AMV road will contain no poisonous or noxious plant (see Section 234.200). No species will be introduced in the area without being approved by the Division.

353.300 Vegetative Exception

Dugout Canyon does not require vegetative exception at this time.

353.400 Cropland

The permit area contains no land designated as cropland.

354 Revegetative: Timing

Dugout Canyon will follow the recommended guidelines for revegetation and planting during the first normal period for favorable planting conditions after replacement of the topsoil. In Utah the planting period is usually Fall due to the precipitation events.

355 Revegetation: Mulching and Other Soil Stabilizing Practices

Mulch and/or other soil stabilizing practices (roughing, etc.) will be used on all areas that have been regraded and covered by topsoil (Section 341.200). Dugout Canyon Mine will exercise care to guard against erosion during and after application of topsoil.

Table 3-2
Reclamation Seed Mix

<u>SPECIES</u>	<u># pls/acre</u>	<u># pls/sq. ft.**</u>
Grasses, Forbs, and Shrubs		

Kentucky Bluegrass (1,390,000 seeds/lb)*	0.5	16
Mountain Brome (64,000 seeds/lb)*	2.0	3
Sandberg Bluegrass (1,100,000 seeds/lb)*	1.0	25
Bluebunch Wheatgrass (126,000 seeds/lb)*	4.0	12
Bottlebrush Squirreltail (192,000 seeds/lb)*	1.0	4
Rocky Mountain Penstemon (478,000 seeds/lb)*	1.0	11
Mountain Lupine (12,000 seeds/lb)*	3.0	1
Mtn. Snowberry (54,000 seeds/lb)*	4.0	5
Wyoming Big Sage (2,500,000 seeds/lb)*	<u>0.5</u>	<u>29</u>
TOTAL	17	106

* Native Plants

** Rounded nearest whole seed

Grass seed quantities will be doubled if the area is broadcast seeded.

356 Revegetation: Standards for Success

356.100 Success of Revegetation

The success of revegetation will be judged on the effectiveness of the vegetation for postmining land use, the extent of cover on each degassification well site and the AMV road compared to their respective reference areas.

Sampling Techniques - Dugout Canyon will comply with the standards for success, statistically valid sampling techniques for measuring success, and the approved methods outline in the Division's "Vegetation Information Guidelines, Appendix A" for 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). The Jaccard's Community Coefficient will be used to calculate acceptable plant similarity and diversity.

Standards for Success - The standards for success will include criteria representative of undisturbed lands in the area of the degas wells as means to evaluate ground cover, production and stocking of the reclaimed site.

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 and Pasture Land - The ground cover and production of living plants on the revegetated area will be at least equal to the reference area.

Cropland - There is no area designated as cropland within the degassification well sites or the area of the AMV road.

Fish and Wildlife Habitat - The postmining land use for the degas well sites and AMV road will be grazing, except on pre-existing roads or trails. Pre-existing roads will be returned to their approximate original contour and compacted.

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

Previously Disturbed Areas - Site G-1 (never constructed), G-4, G-6, G-7, G-8 (never constructed), G-9, G-10, G-11, G-12, G-14, G-15, G-16, G-17, G-19, G-31 and AMV access road have been previously disturbed. The AMV access road was previously used for logging, as a trail for hunting and for cattle to access the site of degas well G-31, the road from G-31 to G-18 has not been disturbed. Sites G-2, G-3, G-5, G-13, G-18, G-21 and G-22 (including access road) have not

been previously disturbed. Standards of success for all sites will be applied in accordance with the postmining land use of grazing as described in this section.

356.300 Siltation Structures

Siltation structures will be maintained until the disturbed areas have been stabilized and revegetated. For additional details on siltation structures, see Sections 542 and 763 of this amendment.

356.400 Removal of Siltation Structures

The land on which siltation structures are located will be revegetated in accordance with the reclamation plan discussed in Section 353 and 357. Refer to Section 763 for addition information pertaining to the removal of siltation structures.

357 Revegetation: Extended Responsibility Period

Dugout Canyon 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.

357.100 Extended Period Begins

The period of extended responsibility will begin after disturbed areas have been reseeded.

357.200 Vegetation Parameters

Vegetation parameters will equal or exceed the approved success standard during the last 2 years of the responsibility period. The success standards are outline in Section 356 of this application.

357.300 Husbandry Practices

The use of husbandry practices are not being requested by Dugout Canyon for the degas well sites and the AMV road.

358 Protection of Fish, Wildlife, and Related Environmental Values

Dugout Canyon will minimize disturbances and adverse impacts on wildlife and their related environments as outline in Section 333 of the approved M&RP and Sections 333 and 342 of this submittal. See Chapter 7, Section 731.100 of the approved M&RP for methods to protect water sources in the area.

358.100 Existence of Endangered or Threatened Species

The well sites and the AMV road will not be constructed or operated where they might jeopardize the existence of any endangered or threatened species. Refer to Section 322.200 and Attachments 3-1, 3-2 and 3-3 for additional information pertaining to threatened, endangered, and sensitive species.

State or federally listed endangered or threatened species will be reported to the Division upon its discovery.

358.200 Bald and Golden Eagles

Dugout Canyon understands that there is no permission implied by these regulations for taking of bald or golden eagles, their nests, or eggs. If found, nests will be reported to the Division.

358.300 Taking of Endangered or Threatened Species

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

358.400 Replacement of Wetland or Riparian Vegetation

The sites contain no wetland or riparian vegetation, unless specifically noted in the vegetation survey. The disturbed area of the AMV road, outlined on Plate 1 (Attachment 5-4) contains no wetland or riparian vegetation.

358.500 Manmade Wildlife Protection Measure

Electric Power Lines - No utilities will exist at the well sites or on the AMV road.

Potential Barriers - No potential barriers will exist at any of the well sites or on the AMV road, except for the perimeter fence at the well sites. No ponds exist at the well sites or on the AMV road. Refer to Sections 231.100 and 242 for information pertaining to the mud pit.

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~September 20, 2007~~

**ATTACHMENT 3-1
VEGETATION INVENTORY
NRCS LETTER**

add to the back of existing information

**VEGETATION OF
DE-GAS DRILL SITES:
G-21, G-22
&
REFERENCE AREAS**

**FOR THE
DUGOUT CANYON MINE**



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July 2008



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INTRODUCTION

History of Vegetation Sampling in the Area

Canyon Fuel Company has been constructing borehole drill sites as part of a de-gasification process that facilitates coal mining operations for safety considerations at the Dugout Canyon Mine on the Book Cliffs Plateau in eastern Utah. Permitting of the “de-gas” drill sites has been done in consecutive order on a site-by-site basis and has been driven by their location and role in the mine plan. Earlier reports have been submitted beforehand to address the plant communities to be impacted by previously constructed drill sites. The first of these reports was called *Vegetation of the Dugout Canyon Mine De-gas Borehole Sites* (July 2003). This report quantitatively described the vegetation proposed for disturbance and reference areas chosen to represent future revegetation success standards on the following drill sites: G-1, G-2, G-3, G-4, G-5, G-6. A study was later conducted for the next drill sites to be constructed. The final report for these sites was called *Vegetation of the De-gas Borehole Sites: G-8, G-9, G-10 & Reference Areas* (August 2005). The next report in the sequence provided vegetation data for sites G-11, G-12, and the reference areas associated with them [the final report was titled *Vegetation of the De-gas Borehole Sites: G-11, G-12 & Reference Areas* (November 2005)]. The next document of the sequence quantified and described boreholes sites G-13, G-14, G-15, G-16, G-17 and the reference areas chosen for future revegetation success standards. The last document reported results from sampling De-gas Site G-19.

This document contains quantitative information for De-gas Drill Sites G-21 and G-22. Existing reference areas previously chosen, sampled, and compared to other drill sites have also been used to represent revegetation success standards for G-21 and G-22 in this report.

Drill Pad Construction

In order to develop the drill pads, a small amount of land has been proposed to be disturbed at each de-gas site location. Most of the proposed drill pads have been approximately 200 ft. x 300 ft in size. The plant communities proposed for disturbance at each of these sites have been described and sampled with the results provided in this report. A sensitive plant species survey was also conducted at the sites.

Like the earlier developed de-gas borehole sites, attempts have been made to minimize disturbance to the native plant communities by planning proposed construction of the new sites in areas where previous disturbance had already been caused by logging, road construction or other activities.

Revegetation Success Standards

As mentioned, reference areas were chosen to represent future standards for final revegetation success. The reference areas were chosen with respect to their similarities in geology, soils, slopes, aspects and plant community composition to the areas that are proposed for disturbance.

In those cases where the proposed new disturbances existed in areas that were previously disturbed by other activities, *attempts were made to choose the reference areas to represent the native plant communities that were present at the site prior to these perturbations.* Therefore, undisturbed plant communities have been chosen as the reference areas for de-gas drill pads – even though the current condition of the proposed pad may be much less than pristine.

As mentioned above, vegetation sampling has been conducted on proposed de-gas sites for the past few years. Consequently, many of the plant communities that were sampled previously on the earlier drill sites are the same, or very similar to, those that have been proposed for new drilling activities. Because the earlier drill sites have reference areas associated with them that will be used for final revegetation success standards, and because these reference areas were very similar plant communities of the currently proposed drill pads, data from the same reference areas have been used for comparisons herein. Accordingly, some of the existing reference areas will also be used for revegetation standards for the new drill sites at the time of final reclamation.

METHODS

Methodologies used for this study were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGGM). Quantitative and qualitative data were recorded within the plant communities proposed for disturbance at sites G-21 and G-22 on June 25, 2008. The reference area for these sites were sampled in the growing season of 2005.

Proposed drill sites were surveyed, mapped and staked in the field by Canyon Fuel prior to the vegetation sampling. The reference areas chosen were approximately one acre in size and were marked in the field using a GPS instrument. The coordinates for the proposed de-gas drill pads and reference areas are provided below.

**GPS COORDINATES FOR
DUGOUT CANYON MINE
DE-GAS BOREHOLE SITES:
G-21, G-22 & REFERENCE AREAS**

Waypoint Name	Zone	Easting	Northing	Notes
DUGG0821	12	0544249	4393340	De-gas Drill Site G-21
DUGG0822	12	0543352	4393187	De-gas Drill Site G-22
DUG14R	12	0544338	4393299	Aspen/Douglas Fir Reference Area for G-21 (also G-14 & G-19).
DUG16R	12	0542993	4392921	Mtn. Brush/Sagebrush Reference Area for G-22 (also G-16 & G-17).

Sampling Design and Transect/Quadrat Placement

Transect lines for vegetation sampling were placed randomly within the boundaries of the proposed disturbed and reference areas. The sample boundaries included 100 ft outside the proposed drill site. The transect placement technique was employed with the goal to adequately sample a representative subset of the entire site. Once the transects were established, quadrat locations for sampling were chosen using random numbers from the transect lines with the objective to record data without preconceived bias.

Cover and 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 notes such as: slope, exposure, grazing use, disturbance and/or other appropriate notes. Plant nomenclature follows "A Utah Flora" (Welsh et al., 2003).

Woody Species Density

Density of woody plant species for the proposed disturbed and reference areas were estimated using the point-quarter 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 results of the calculations.

Sample Size & Adequacy

Sampling adequacy for cover and density was attempted by using the formula given below.

$$n_{MIN} = \frac{t^2 s^2}{(dx)^2}$$

where,

n_{MIN} = 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 sample adequacy with 80% confidence within a 10% deviation from the true mean. In areas where sample viability was unnaturally high (e.g. previous disturbance sites), these parameters sometimes prove to be too stringent.

Statistical Analyses

Student’s t-tests were employed to compare the total living cover and total woody species density of each proposed disturbed de-gas site with its reference area.

Photographs

Color photographs of the sample areas were taken at the time of sampling and have been submitted with this report.

Threatened & Endangered Plant Species

Prior to recording quantitative data on the plant communities, a sensitive plant species survey

was conducted. To initiate the study, appropriate agencies had been consulted (e.g. *Utah Natural Heritage Program*) and other sources were reviewed (sensitive species files at *Mt. Nebo Scientific, Inc.*) for potential plant species that are known to be rare, endemic, threatened, endangered or otherwise sensitive in the study area.

Raw Data

The raw data for cover have been summarized on a spreadsheet and were included in the Appendix of this report.

RESULTS

De-gas Site G-21

De-gas Site G-21 that has been proposed for disturbance by drilling activities supports a conifer/aspen plant community. Quantitative sampling in the proposed disturbed community indicated the dominant overstory species was Douglas Fir (*Pseudotsuga menziesii*) by quite a wide margin (Table 1). The dominant understory woody species were snowberry (*Symphoricarpos oreophilus*), Douglas fir and aspen (*Populus tremuloides*). The most common understory forb was (*Osmorhiza depauperata*) and the only grass present in the sample quadrats was junegrass (*Koeleria nitida*).

Overstory cover dominated the total living cover and was estimated at 62.25%, whereas understory cover was only 17.95% (Table 2-A). Proportions of lifeform composition of the understory cover was comprised of 72.94% woody species, 17.23% forbs and 9.83% grasses (Table 2-B)

The total woody species density consisted of 2,917 plants per acre (Table 3). The dominant woody species for this parameter were snowberry, aspen, Douglas fir and Wood's rose (*Rosa woodsii*).

Aspen/Douglas Fir Reference Area

The reference area chosen to represent future standards for revegetation success for De-gas Site G-21 (and earlier de-gas sites G-14 and G19) was an aspen/conifer plant community. Although there may have been some previous logging in this area when some of the conifers were harvested, the site represents an appropriate area to be used for future revegetation success parameters. As a possible result of early logging in the area, aspen trees in the overstory were slightly more common by cover and frequency than Douglas Fir trees (Table 4). Common understory species in this reference area were snowberry, Douglas fir, muttongrass (*Poa fendleriana*), and heartleaf arnica (*Arnica cordifolia*).

Overstory was greater than the understory cover of the area comprising 50.50% and 27.25%, respectively (Table 5-A). Total combined living cover was estimated at 77.75%. Lifeform

composition results for the understory cover consisted of 48.64% woody species, 28.66% forbs, and 22.71% grasses (Table 5-B). The total woody species density for this reference area was 2,176 individuals per acre and was dominated by aspen, snowberry, and Douglas fir (Table 6).

De-gas Site G-22

Like so many of the proposed drill sites, this area was within an ecotone, or an area where the plant communities were transitional between two or more other communities. Although this de-gas pad and its access road primarily supported a sagebrush and mountain brush ecotone, scattered pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) trees, as well as Douglas fir and white fir (*Abies concolor*) trees, were also scattered throughout the area (see Photographs).

Random quadrats were placed for the entire length of the access road as well as the proposed drill pad. Because the communities were similar, the data were “lumped” for the summary tables. Differentiation can be made between the access road and drill pad by examining the raw data included in the APPENDIX of this report.

Shown on Table 7 are all the plant species, along with their cover and frequency values, present in the sample quadrats of the area. The most common species were sagebrush (*Artemisia tridentata*) and Salina wildrye (*Elymus salinus*) and northern sweetvetch (*Hedysarum boreale*).

Total living cover of the area was estimated at 49.33%, of which consisted of 45.33% understory and 4.00% overstory (Table 8-A). Lifeform composition of the understory cover consisted of 41.97% trees and shrubs, 31.45% grasses and 9.57% forbs (Table 9-B).

Woody species density was estimated at 4,256 individuals per acre and was dominated by a wide margin by sagebrush, but followed by alder-leaf mountain-mahogany (*Cercocarpus montanus*), serviceberry (*Amelanchier utahensis*) and snowberry (Table 9).

Mountain Brush/Sagebrush Reference Area

The reference area chosen for future revegetation success standards for De-gas Site G-22 (as well as G-16 and G-17 in previous reports) was located in a mountain brush/snowberry plant community. The most common species in this reference area were big sagebrush, Watson's penstemon (*Penstemon watsonii*), snowberry and serviceberry (Table 10).

The total living combined cover here was 64.50%; 57.00% was from understory and 7.50% from overstory (Table 11-A). Woody species dominated the composition at 54.44%, followed by forbs at 28.08% and grasses at 17.49% (Table 11-B). The woody species density was estimated at 5,137 plants per acres and was dominated by big sagebrush and snowberry (Table 12).

Threatened & Endangered Plant Species Survey

State databases revealed only one potential sensitive species to be located in the vicinity of the proposed disturbed borehole sites. This plant was canyon vetch (*Hedysarum occidentale* var. *canone*). Each proposed disturbed area was surveyed in the field for canyon vetch (or any other unusual or sensitive plants). This survey was done prior to recording the quantitative data used to describe the major plant community of the study area. In addition, more searching for sensitive species was done during quantitative sampling of the areas. No rare, endemic, threatened or endangered or otherwise sensitive species were found in the study areas.

Table 1. Dugout Mine: Proposed Disturbed De-gas Site G-21. Total Cover, Standard Deviation and Frequency by Species (2008).

	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
<i>Abies concolor</i>	5.50	16.58	10.00
<i>Populus tremuloides</i>	17.50	20.46	45.00
<i>Pseudotsuga menziesii</i>	39.25	31.40	70.00
UNDERSTORY			
TREES & SHRUBS			
<i>Abies concolor</i>	0.65	2.24	10.00
<i>Mahonia repens</i>	1.75	4.75	20.00
<i>Populus tremuloides</i>	2.00	4.30	20.00
<i>Pseudotsuga menziesii</i>	3.75	6.37	40.00
<i>Rosa woodsii</i>	0.65	1.59	15.00
<i>Symphoricarpos oreophilus</i>	4.95	7.46	55.00
FORBS			
<i>Lupinus argenteus</i>	0.25	1.09	5.00
<i>Osmorhiza obtusa</i>	2.35	3.79	40.00
<i>Taraxacum officinale</i>	0.25	1.09	5.00
GRASSES			
<i>Koeleria nitida</i>	1.35	2.15	30.00

Table 2. Dugout Mine: De-gas Site G-21. Total Cover, Standard Deviation and Sample Size (2008).

	Mean Percent	Standard Deviation	Sample Size
A. TOTAL COVER			
Overstory (O)	62.25	16.47	20
Understory (U)	17.95	9.02	20
Litter	69.55	18.25	20
Bareground	11.05	17.22	20
Rock	1.45	1.12	20
O + U	80.20	16.71	20
B. % COMPOSITION			
Trees & Shrubs	72.94	30.79	20
Forbs	17.23	26.02	20
Grasses	9.83	16.74	20

Table 3. Dugout Mine: De-gas Site G-21. Woody Species Densities (2008).

Species	Individuals Per Acre
<i>Abies concolor</i>	36.46
<i>Populus tremuloides</i>	948.02
<i>Pseudotsuga menziesii</i>	437.55
<i>Pachistima myrsinites</i>	36.46
<i>Rosa woodsii</i>	255.24
<i>Symphoricarpos oreophilus</i>	1203.26
TOTAL	2916.99

Table 4. Dugout Mine: Aspen/Douglas Fir Reference Area for De-gas Site G-21 (also for G-14 & G-19). Total Cover, Standard Deviation and Frequency by Species (2005).

	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
<i>Abies concolor</i>	1.75	7.63	5.00
<i>Populus tremuloides</i>	25.75	20.93	65.00
<i>Pseudotsuga menziesii</i>	23.00	27.95	45.00
UNDERSTORY			
TREES & SHRUBS			
<i>Abies concolor</i>	0.50	2.18	5.00
<i>Mahonia repens</i>	0.75	1.79	15.00
<i>Populus tremuloides</i>	1.25	2.17	25.00
<i>Pseudotsuga menziesii</i>	4.25	11.21	20.00
<i>Rosa woodsii</i>	0.50	2.18	5.00
<i>Symphoricarpos oreophilus</i>	6.05	6.65	70.00
FORBS			
<i>Achillea millefolium</i>	1.40	2.03	35.00
<i>Aquilegia caerulea</i>	0.25	1.09	5.00
<i>Arnica cordifolia</i>	3.10	11.96	15.00
<i>Delphinium nelsonii</i>	0.25	1.09	5.00
<i>Epilobium sp.</i>	0.65	1.59	15.00
<i>Lupinus argenteus</i>	0.50	1.50	10.00
<i>Osmorhiza depauperata</i>	2.10	2.79	45.00
GRASSES			
<i>Poa fendleriana</i>	5.70	5.68	70.00

Table 5. Dugout Mine: Aspen/Douglas Fir Reference Area De-gas Site G-21 (also for G-14 & G-19). Total Cover, Standard Deviation and Sample Size (2005).

	Mean Percent	Standard Deviation	Sample Size
A. TOTAL COVER			
Overstory (O)	50.50	13.68	20
Understory (U)	27.25	13.83	20
Litter	65.05	12.89	20
Bareground	6.65	3.31	20
Rock	1.05	0.22	20
O + U	77.75	16.84	20
B. % COMPOSITION			
Trees & Shrubs	48.64	35.66	20
Forbs	28.66	28.56	20
Grasses	22.71	24.47	20

Table 6. Dugout Mine: Aspen/Douglas Fir Reference Area for De-gas Site G-21 (also for G-14 & G-19). Woody Species Densities (2005).

Species	Individuals Per Acre
<i>Abies concolor</i>	27.19
<i>Populus tremuloides</i>	870.16
<i>Pseudotsuga menziesii</i>	516.66
<i>Rosa woodsii</i>	108.77
<i>Symphoricarpos oreophilus</i>	652.62
TOTAL	2175.70

Table 7. Dugout Mine: Proposed Disturbed De-gas Site G-22 and the Access Road. Total Cover, Standard Deviation and Frequency by Species (2008).

	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
<i>Amelanchier utahensis</i>	4.00	8.60	20.00
UNDERSTORY			
TREES & SHRUBS			
<i>Amelanchier utahensis</i>	2.00	5.26	16.67
<i>Artemisia tridentata</i>	14.17	15.82	66.67
<i>Ceanothus martinii</i>	0.33	1.80	3.33
<i>Cercocarpus montanus</i>	2.17	7.71	10.00
<i>Gutierrezia sarothrae</i>	0.50	2.69	3.33
<i>Mahonia repens</i>	0.33	1.80	3.33
<i>Symphoricarpos oreophilus</i>	1.17	2.79	16.67
FORBS			
<i>Agoseris glauca</i>	0.50	1.98	6.67
<i>Castilleja rhexifolia</i>	0.67	2.81	6.67
<i>Castilleja flava</i>	0.33	1.80	3.33
<i>Cymopterus longipes</i>	0.33	1.80	3.33
<i>Erigeron engelmannii</i>	0.67	1.70	13.33
<i>Eriogonum ovalifolium</i>	1.33	4.46	10.00
<i>Hedysarum boreale</i>	3.17	5.55	30.00
<i>Linum lewisii</i>	0.17	0.90	3.33
<i>Penstemon watsonii</i>	2.50	5.88	20.00
<i>Petroradia pumila</i>	1.33	2.87	20.00
<i>Tragopogon dubius</i>	0.17	0.90	3.33
GRASSES			
<i>Elymus salinus</i>	9.33	9.81	63.33
<i>Elymus spicatus</i>	2.67	6.42	16.67
<i>Poa pratensis</i>	1.00	3.74	6.67
<i>Stipa hymenoides</i>	0.50	2.69	3.33

Table 8. Dugout Mine: De-gas Site G-22 and the Access Road. Total Cover, Standard Deviation and Sample Size (2008).

	Mean Percent	Standard Deviation	Sample Size
A. TOTAL COVER			
Overstory (O)	4.00	8.60	20
Understory (U)	45.33	12.24	20
Litter	7.17	3.34	20
Bareground	33.00	15.14	20
Rock	14.50	10.19	20
O + U	49.33	12.16	20
B. % COMPOSITION			
Trees & Shrubs	41.96	28.13	20
Forbs	9.57	16.03	20
Grasses	31.45	23.21	20

Table 9. Dugout Mine: De-gas Site G-22 and the Access Road. Woody species densities (2008).

Species	Individuals Per Acre
<i>Amelanchier utahensis</i>	390.10
<i>Artemisia tridentata</i>	2659.74
<i>Ceanothus martinii</i>	106.39
<i>Cercocarpus montanus</i>	567.41
<i>Chrysothamnus viscidiflorus</i>	106.39
<i>Gutierrezia sarothrae</i>	106.39
<i>Pseudotsuga menziesii</i>	35.46
<i>Symphoricarpos oreophilus</i>	283.71
TOTAL	4255.59

Table 10. Dugout Mine: Mtn. Brush/Sagebrush Reference Area for De-gas Site G-22 (also for G-16 & G-17). Total Cover, Standard Deviation and Sample Size (2005).

	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
<i>Amelanchier utahensis</i>	6.75	12.58	25.00
<i>Juniperus scopulorum</i>	0.75	3.27	5.00
UNDERSTORY			
TREES & SHRUBS			
<i>Amelanchier utahensis</i>	7.00	16.16	35.00
<i>Artemisia tridentata</i>	15.25	14.79	75.00
<i>Juniperus scopulorum</i>	0.25	1.09	5.00
<i>Symphoricarpos oreophilus</i>	10.50	15.96	50.00
FORBS			
<i>Astragalus sp.</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	4.05	4.60	55.00
<i>Penstemon watsonii</i>	10.70	7.89	80.00
GRASSES			
<i>Elymus salinus</i>	0.25	1.09	5.00
<i>Elymus spicatus</i>	2.00	3.67	25.00
<i>Elymus trachycaulus</i>	2.00	3.67	25.00
<i>Poa pratensis</i>	2.25	5.36	20.00
<i>Poa secunda</i>	2.50	6.22	20.00

Table 11. Dugout Mine: Mtn. Brush/Sagebrush Reference Area for De-gas Site G-22 (also for G-16 & G-17). Total cover, standard deviation and sample size (2005).

	Mean Percent	Standard Deviation	Sample Size
A. TOTAL COVER			
Overstory (U)	7.50	12.60	20
Understory (O)	57.00	12.08	20
Litter	18.60	7.52	20
Bareground	15.65	13.13	20
Rock	8.75	9.59	20
O + U	64.50	19.49	20
B. % COMPOSITION			
Trees & Shrubs	54.44	26.60	20
Forbs	28.08	17.03	20
Grasses	17.49	14.43	20

Table 12. Dugout Mine: Mtn. Brush/Sagebrush Reference Area for De-gas Site G-22 (also for G-16 & G-17). Woody Species Densities (2005).

Species	Individuals Per Acre
<i>Amelanchier utahensis</i>	834.68
<i>Artemisia tridentata</i>	2375.64
<i>Juniperus scopulorum</i>	64.21
<i>Symphoricarpos oreophilus</i>	1861.99
TOTAL	5136.52

DISCUSSION & CONCLUSIONS

The vegetation data of proposed disturbed de-gas drill pads and, when relevant, the access roads to them were compared statistically to the reference areas chosen to represent future revegetation success standards. When the total living cover of De-gas Site G-21 was compared to the

Aspen/Douglas Fir

Reference Area, the

differences were not

statistically

significant (Figure

1). Moreover, when

the total woody

species density of

these two areas

were compared, the

difference between

them was also non-

significant (Figure

2).

FIGURE 1. A statistical comparison (Student's t-tests) of the total living cover between the proposed disturbed de-gas sites and their reference areas.

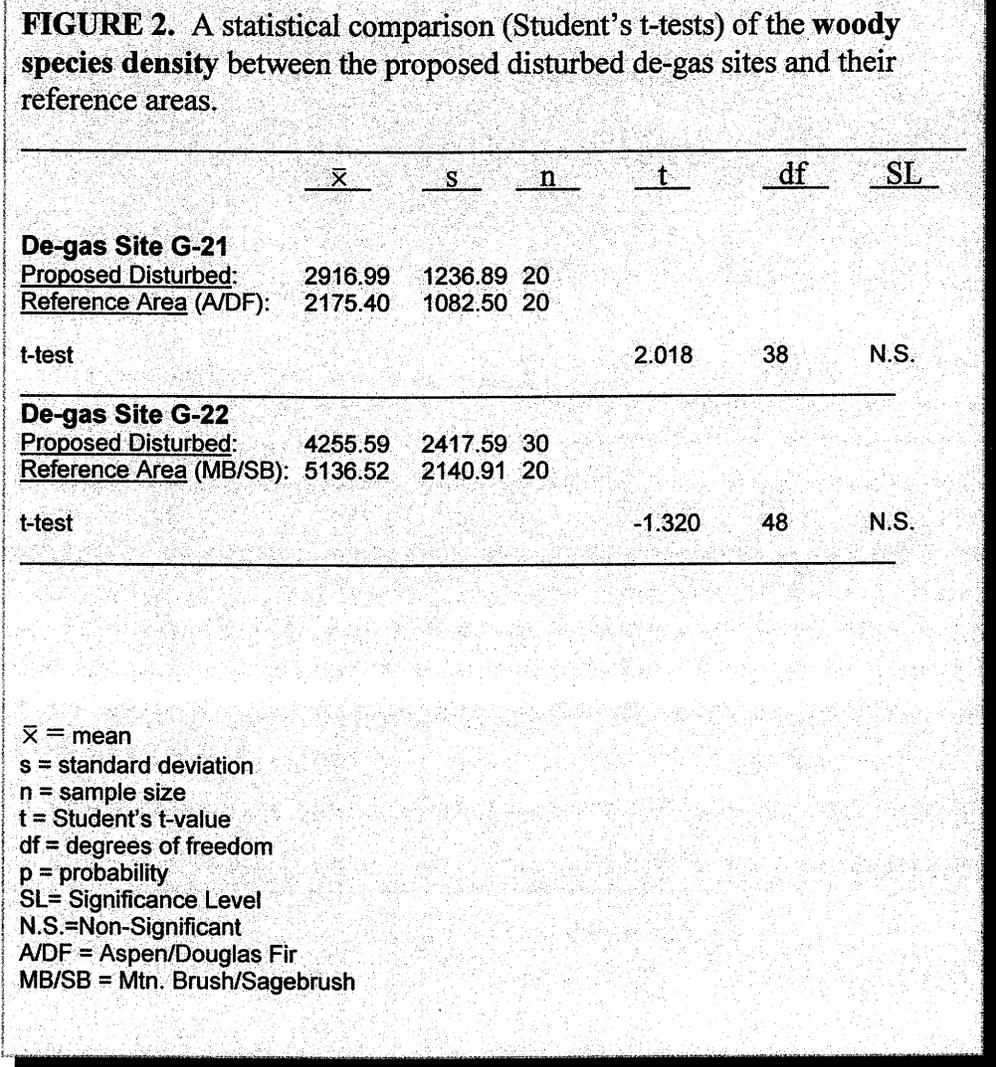
	\bar{x}	s	n	t	df	SL
De-gas Site G-21						
Proposed Disturbed	80.20	16.71	20			
Reference Area (ADF)	77.75	16.84	20			
t-test				0.462	38	N.S.
De-gas Site G-22						
Proposed Disturbed	49.33	12.16	30			
Reference Area (MB/SB)	64.50	19.49	20			
t-test				-3.374	48	p < 0.01

\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. = Not Significant
ADF = Aspen/Douglas Fir

Next, when the total living cover of De-gas Site G-22 (and access road) was compared to the

previously-established Mountain Brush/Sagebrush Reference Area, the reference area cover was greater (Figure 1). However, there was no significant difference when woody species densities were compared (Figure 2).

Dominant species present in the proposed disturbed and reference areas were similar (see Table 7 and Table 10). Interestingly, there were more forb species present in the sample quadrats in the proposed



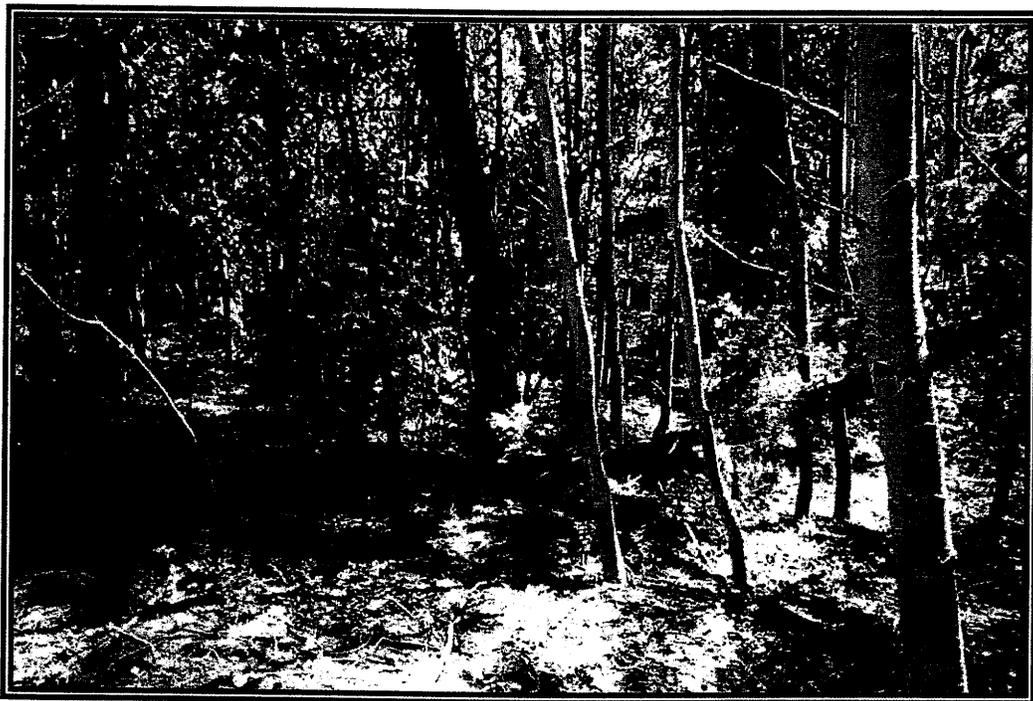
disturbed area (compare Table 7 with Table 10), yet forbs comprised more of the species composition in the reference area (compare Table 8-B with Table 11-B).

Although quite similar, De-gas Site G-22 and the Mountain Brush/Sagebrush Reference Area did not match exactly. Even though this reference area may represent appropriate standards for revegetation success here, the following considerations could be entertained. As mentioned, the total living cover of the reference area was greater statistically when compared to the proposed drill pad. Consequently, there are options that could be considered at the time of final reclamation. For example, DOGM could consider the option that the final total living cover of the reclaimed drill pad would be considered adequate once it reached 77 percent of the total living cover of the reference area (its proportion at this time). Another option would be that a new reference area could be chosen to represent final revegetation standards prior to final reclamation. Finally, the operator could commit to the present values, although more stringent for living cover in the Mountain Brush/Sagebrush Reference Area, for revegetation success standard at this site.

**COLOR PHOTOGRAPHS
OF THE
SAMPLE AREAS**



De-gas Drill Site G-21



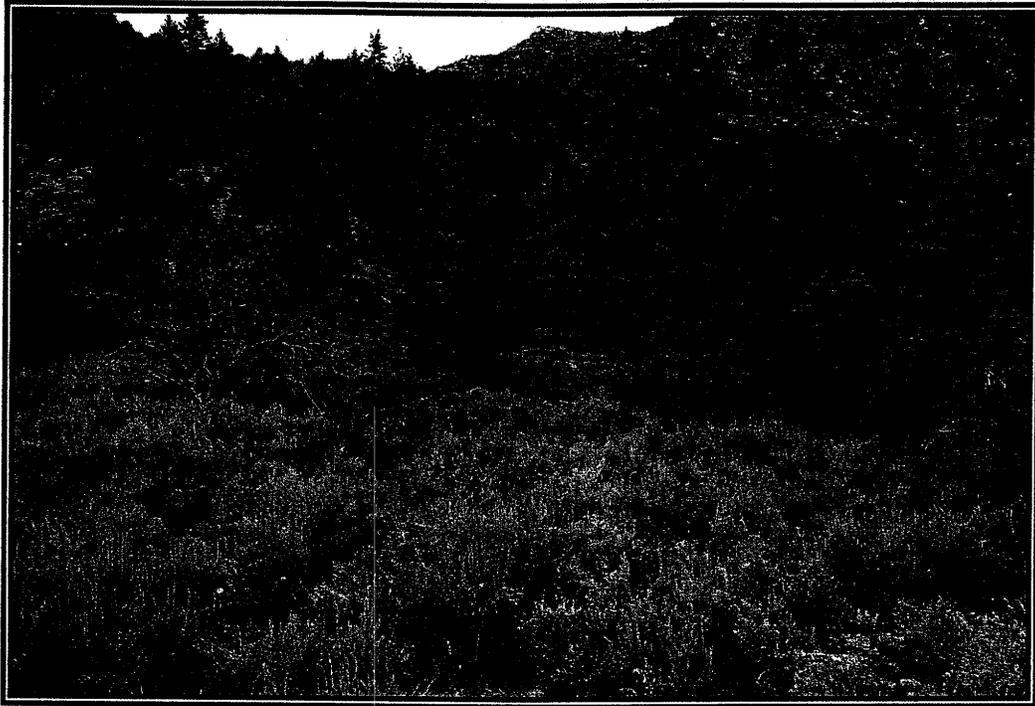
Aspen/Fir Reference Area



Access to Site G-22 (1 of 2)



Access to Site G-22 (2 of 2)



De-gas Drill Site G-22



Mtn. Brush/Sagebrush Reference Area

APPENDIX

(Raw Data)

CANYON FUEL
 Dugout Mine
 DE-GAS SITE: G-21

Douglas Fir/Aspen

Exposure: SE

Slope: 2 deg.

Sample Date: June 25 2008

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
OVERSTORY							
<i>Abies concolor</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Populus tremuloides</i>	35.00	25.00	50.00	35.00	0.00	0.00	0.00
<i>Pseudotsuga menziesii</i>	30.00	45.00	0.00	0.00	50.00	80.00	75.00
UNDERSTORY							
TREES & SHRUBS							
<i>Abies concolor</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Mahonia repens</i>	0.00	0.00	0.00	0.00	0.00	0.00	10.00
<i>Populus tremuloides</i>	0.00	0.00	0.00	10.00	0.00	0.00	0.00
<i>Pseudotsuga menziesii</i>	5.00	0.00	0.00	0.00	5.00	0.00	2.00
<i>Rosa woodsii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Symphoricarpos oreophilus</i>	5.00	5.00	5.00	30.00	20.00	0.00	0.00
FORBS							
<i>Lupinus argenteus</i>	0.00	0.00	0.00	0.00	5.00	0.00	0.00
<i>Osmorhiza obtusa</i>	5.00	0.00	2.00	0.00	0.00	5.00	8.00
<i>Taraxacum officinale</i>	0.00	0.00	0.00	0.00	0.00	5.00	0.00
GRASSES							
<i>Koeleria nitida</i>	5.00	5.00	0.00	0.00	0.00	5.00	0.00
COVER							
Overstory	65.00	70.00	50.00	35.00	50.00	80.00	75.00
Understory	20.00	10.00	7.00	40.00	30.00	15.00	20.00
Litter	70.00	3.00	90.00	50.00	63.00	80.00	70.00
Bareground	4.00	85.00	2.00	9.00	5.00	4.00	9.00
Rock	6.00	2.00	1.00	1.00	2.00	1.00	1.00
% COMPOSITION							
Shrubs	50.00	50.00	71.43	100.00	83.33	0.00	60.00
Forbs	25.00	0.00	28.57	0.00	16.67	66.67	40.00
Grasses	25.00	50.00	0.00	0.00	0.00	33.33	0.00
Overstory + Understory	85.00	80.00	57.00	75.00	80.00	95.00	95.00

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	0.00	0.00	50.00	60.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	35.00	0.00	0.00	40.00	0.00	0.00	0.00	60.00
90.00	95.00	35.00	0.00	0.00	40.00	50.00	75.00	50.00	0.00
0.00	0.00	0.00	10.00	3.00	0.00	0.00	0.00	0.00	0.00
0.00	3.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	20.00
15.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00
0.00	5.00	0.00	0.00	0.00	10.00	15.00	0.00	25.00	0.00
5.00	0.00	0.00	0.00	5.00	0.00	3.00	0.00	0.00	0.00
0.00	0.00	7.00	5.00	5.00	10.00	2.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
90.00	95.00	70.00	50.00	60.00	80.00	50.00	75.00	50.00	60.00
20.00	10.00	7.00	20.00	15.00	35.00	20.00	5.00	25.00	20.00
75.00	80.00	90.00	75.00	75.00	55.00	70.00	85.00	65.00	65.00
4.00	9.00	2.00	4.00	9.00	9.00	9.00	8.00	9.00	14.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	1.00
100.00	80.00	100.00	75.00	100.00	85.71	100.00	100.00	100.00	100.00
0.00	20.00	0.00	0.00	0.00	14.29	0.00	0.00	0.00	0.00
0.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00
110.00	105.00	77.00	70.00	75.00	115.00	70.00	80.00	75.00	80.00

CANYON FUEL
 Dugout Mine
 DE-GAS SITE: G-21

Exposure: SE
 Slope: 2 deg.
 Sample Date: June 25 2008

18.00	19.00	20.00	Mean	SDev	Freq Cnts	Freq	
							OVERSTORY
0.00	0.00	0.00	5.50	16.58	2.00	10.00	<i>Abies concolor</i>
0.00	40.00	30.00	17.50	20.46	9.00	45.00	<i>Populus tremuloides</i>
40.00	0.00	30.00	39.25	31.40	14.00	70.00	<i>Pseudotsuga menziesii</i>
							UNDERSTORY
							TREES & SHRUBS
0.00	0.00	0.00	0.65	2.24	2.00	10.00	<i>Abies concolor</i>
0.00	0.00	0.00	1.75	4.75	4.00	20.00	<i>Mahonia repens</i>
0.00	5.00	0.00	2.00	4.30	4.00	20.00	<i>Populus tremuloides</i>
8.00	0.00	0.00	3.75	6.37	8.00	40.00	<i>Pseudotsuga menziesii</i>
0.00	0.00	0.00	0.65	1.59	3.00	15.00	<i>Rosa woodsii</i>
0.00	0.00	0.00	4.95	7.46	11.00	55.00	<i>Symphoricarpos oreophilus</i>
							FORBS
0.00	0.00	0.00	0.25	1.09	1.00	5.00	<i>Lupinus argenteus</i>
5.00	0.00	15.00	2.35	3.79	8.00	40.00	<i>Osmorhiza obtusa</i>
0.00	0.00	0.00	0.25	1.09	1.00	5.00	<i>Taraxacum officinale</i>
							GRASSES
2.00	5.00	0.00	1.35	2.15	6.00	30.00	<i>Koeleria nitida</i>
							COVER
40.00	40.00	60.00	62.25	16.47			Overstory
15.00	10.00	15.00	17.95	9.02			Understory
75.00	80.00	75.00	69.55	18.25			Litter
8.00	9.00	9.00	11.05	17.22			Bareground
2.00	1.00	1.00	1.45	1.12			Rock
							% COMPOSITION
53.33	50.00	0.00	72.94	30.79			Shrubs
33.33	0.00	100.00	17.23	26.02			Forbs
13.33	50.00	0.00	9.83	16.74			Grasses
55.00	50.00	75.00	80.20	16.71			Overstory + Understory

CANYON FUELS
 Dugout Mine
 Ref. Area G-14, G-19, G21
 Aspen/Doug Fir

Slope: 6 deg
 Exposure: NW

Sample Date: 5-9 July 2005

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
OVERSTORY							
<i>Abies concolor</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Populus tremuloides</i>	45.00	20.00	45.00	0.00	40.00	50.00	0.00
<i>Pseudotsuga menziesii</i>	0.00	0.00	0.00	50.00	20.00	0.00	60.00
UNDERSTORY							
SHRUBS							
<i>Abies concolor</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Mahonia repens</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Populus tremuloides</i>	5.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pseudotsuga menziesii</i>	0.00	0.00	0.00	0.00	0.00	0.00	40.00
<i>Rosa woodsii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Symphoricarpos oreophilus</i>	5.00	0.00	5.00	2.00	0.00	15.00	0.00
FORBS							
<i>Achillea millefolium</i>	0.00	2.00	5.00	0.00	3.00	0.00	0.00
<i>Aquilegia caerulea</i>	5.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Arnica cordifolia</i>	0.00	55.00	0.00	0.00	0.00	0.00	0.00
<i>Delphinium nelsonii</i>	0.00	0.00	0.00	5.00	0.00	0.00	0.00
<i>Epilobium sp.</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lupinus argenteus</i>	0.00	0.00	0.00	0.00	0.00	5.00	0.00
<i>Osmorhiza depauperata</i>	5.00	3.00	5.00	1.00	3.00	0.00	0.00
GRASSES							
<i>Poa fendleriana</i>	0.00	5.00	10.00	2.00	4.00	5.00	0.00
COVER							
Overstory	45.00	20.00	45.00	50.00	60.00	50.00	60.00
Understory	20.00	65.00	25.00	10.00	10.00	25.00	40.00
Litter	75.00	33.00	70.00	85.00	80.00	65.00	55.00
Bareground	4.00	1.00	4.00	4.00	9.00	9.00	4.00
Rock	1.00	1.00	1.00	1.00	1.00	1.00	1.00
% COMPOSITION							
Shrubs	50.00	0.00	20.00	20.00	0.00	60.00	100.00
Forbs	50.00	92.31	40.00	60.00	60.00	20.00	0.00
Grasses	0.00	7.69	40.00	20.00	40.00	20.00	0.00
Overstory + Understory	65.00	85.00	70.00	60.00	70.00	75.00	100.00

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25.00	35.00	0.00	25.00	0.00	35.00	0.00	35.00	0.00	0.00
0.00	0.00	70.00	25.00	50.00	0.00	55.00	0.00	75.00	55.00
0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	5.00	0.00	5.00	0.00	5.00
5.00	0.00	5.00	0.00	0.00	0.00	5.00	5.00	0.00	0.00
5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	35.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	5.00	17.00	5.00	0.00	5.00	5.00	15.00	5.00
0.00	0.00	0.00	0.00	5.00	5.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	2.00	5.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	5.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00
0.00	10.00	0.00	0.00	0.00	5.00	5.00	5.00	0.00	0.00
0.00	15.00	0.00	18.00	15.00	0.00	5.00	5.00	0.00	5.00
25.00	70.00	70.00	50.00	50.00	35.00	55.00	35.00	75.00	55.00
15.00	40.00	15.00	35.00	30.00	25.00	25.00	25.00	15.00	50.00
75.00	58.00	75.00	55.00	60.00	65.00	70.00	65.00	80.00	40.00
9.00	1.00	9.00	9.00	8.00	9.00	4.00	9.00	4.00	9.00
1.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00
100.00	25.00	100.00	48.57	16.67	20.00	40.00	60.00	100.00	90.00
0.00	37.50	0.00	0.00	33.33	80.00	40.00	20.00	0.00	0.00
0.00	37.50	0.00	51.43	50.00	0.00	20.00	20.00	0.00	10.00
40.00	110.00	85.00	85.00	80.00	60.00	80.00	60.00	90.00	105.00

CANYON FUELS
 Dugout Mine
 Ref. Area G-14, G-19, G21
 Aspen/Doug Fir
 Slope: 6 deg
 Exposure: NW
 Sample Date: 5-9 July 2005

18.00	19.00	20.00	Mean	SDev	Freq	
<hr/>						OVERSTORY
0.00	0.00	0.00	1.75	7.63	5.00	<i>Abies concolor</i>
55.00	50.00	55.00	25.75	20.93	65.00	<i>Populus tremuloides</i>
0.00	0.00	0.00	23.00	27.95	45.00	<i>Pseudotsuga menziesii</i>
<hr/>						UNDERSTORY
<hr/>						SHRUBS
0.00	0.00	0.00	0.50	2.18	5.00	<i>Abies concolor</i>
0.00	0.00	0.00	0.75	1.79	15.00	<i>Mahonia repens</i>
0.00	0.00	0.00	1.25	2.17	25.00	<i>Populus tremuloides</i>
0.00	0.00	0.00	4.25	11.21	20.00	<i>Pseudotsuga menziesii</i>
0.00	0.00	10.00	0.50	2.18	5.00	<i>Rosa woodsii</i>
0.00	7.00	25.00	6.05	6.65	70.00	<i>Symphoricarpos oreophilus</i>
<hr/>						FORBS
0.00	3.00	0.00	1.40	2.03	35.00	<i>Achillea millefolium</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Aquilegia caerulea</i>
0.00	0.00	0.00	3.10	11.96	15.00	<i>Arnica cordifolia</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Delphinium nelsonii</i>
0.00	5.00	0.00	0.65	1.59	15.00	<i>Epilobium sp.</i>
0.00	0.00	0.00	0.50	1.50	10.00	<i>Lupinus argenteus</i>
0.00	0.00	0.00	2.10	2.79	45.00	<i>Osmorhiza depauperata</i>
<hr/>						GRASSES
15.00	5.00	5.00	5.70	5.68	70.00	<i>Poa fendleriana</i>
<hr/>						COVER
55.00	50.00	55.00	50.50	13.68		Overstory
15.00	20.00	40.00	27.25	13.83		Understory
75.00	65.00	55.00	65.05	12.89		Litter
9.00	14.00	4.00	6.65	3.31		Bareground
1.00	1.00	1.00	1.05	0.22		Rock
<hr/>						% COMPOSITION
0.00	35.00	87.50	48.64	35.66		Shrubs
0.00	40.00	0.00	28.66	28.56		Forbs
100.00	25.00	12.50	22.71	24.47		Grasses
<hr/>						
70.00	70.00	95.00	77.75	16.84		Overstory + Understory
<hr/>						

CANYON FUEL
 Dugout Mine
 DE-GAS SITE: G-22

Sagebrush/Mtn. Brush
 Access & Pad

1 thru 15 = Access Road

Exposure: Variable
 Slope: Variable

Sample Date: June 25 2008

1.00 2.00 3.00 4.00 5.00 6.00 7.00

OVERSTORY

Amelanchier utahensis 0.00 0.00 0.00 10.00 0.00 15.00 0.00

UNDERSTORY

TREES & SHRUBS

Amelanchier utahensis 0.00 0.00 0.00 25.00 0.00 0.00 0.00
Artemisia tridentata 30.00 40.00 0.00 15.00 0.00 25.00 5.00
Ceanothus martinii 0.00 0.00 0.00 0.00 0.00 10.00 0.00
Cercocarpus montanus 0.00 0.00 0.00 0.00 0.00 0.00 0.00
Gutierrezia sarothrae 0.00 0.00 0.00 0.00 0.00 0.00 0.00
Mahonia repens 0.00 10.00 0.00 0.00 0.00 0.00 0.00
Symphoricarpos oreophilus 5.00 0.00 10.00 0.00 0.00 5.00 0.00

FORBS

Agoseris glauca 0.00 0.00 0.00 0.00 0.00 0.00 0.00
Castilleja rhexifolia? 0.00 0.00 0.00 0.00 15.00 5.00 0.00
Castilleja flava 0.00 0.00 0.00 10.00 0.00 0.00 0.00
Cymopterus longipes 0.00 0.00 0.00 0.00 0.00 0.00 0.00
Erigeron engelmannii 5.00 5.00 0.00 0.00 5.00 0.00 0.00
Eriogonum ovalifolium 0.00 0.00 5.00 0.00 0.00 0.00 0.00
Hedysarum boreale 0.00 0.00 5.00 0.00 0.00 5.00 0.00
Linum lewisii 0.00 0.00 0.00 0.00 5.00 0.00 0.00
Penstemon watsonii 0.00 0.00 0.00 0.00 0.00 5.00 5.00
Petradoria pumila 0.00 0.00 0.00 0.00 5.00 0.00 0.00
Tragopogon dubius 0.00 0.00 0.00 0.00 0.00 0.00 0.00

GRASSES

Elymus salinus 10.00 0.00 30.00 0.00 5.00 0.00 0.00
Elymus spicatus 0.00 0.00 0.00 0.00 0.00 0.00 25.00
Poa pratensis 0.00 0.00 0.00 0.00 0.00 0.00 0.00
Stipa hymenoides 0.00 0.00 0.00 0.00 15.00 0.00 0.00

COVER

Overstory 0.00 0.00 0.00 10.00 0.00 15.00 0.00
 Understory 50.00 55.00 50.00 50.00 50.00 55.00 35.00
 Litter 15.00 5.00 5.00 10.00 5.00 10.00 5.00
 Bareground 25.00 15.00 15.00 20.00 15.00 20.00 30.00
 Rock 10.00 25.00 30.00 20.00 30.00 15.00 30.00

% COMPOSITION

Shrubs 70.00 90.91 20.00 80.00 0.00 72.73 14.29
 Forbs 10.00 9.09 10.00 20.00 40.00 9.09 0.00
 Grasses 20.00 0.00 60.00 0.00 40.00 0.00 71.43

Overstory + Understory 50.00 55.00 50.00 60.00 50.00 70.00 35.00

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	30.00	0.00
0.00	0.00	0.00	10.00	0.00	10.00	10.00	0.00	5.00	0.00
10.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	40.00	15.00	0.00	0.00	0.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	15.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00
0.00	5.00	5.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	15.00	15.00	0.00	10.00	10.00	0.00	30.00	0.00	10.00
10.00	0.00	15.00	20.00	0.00	0.00	10.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	30.00	0.00
50.00	65.00	45.00	40.00	50.00	35.00	20.00	50.00	30.00	50.00
10.00	5.00	15.00	5.00	5.00	5.00	5.00	5.00	10.00	10.00
30.00	25.00	15.00	30.00	20.00	40.00	70.00	35.00	55.00	30.00
10.00	5.00	25.00	25.00	25.00	20.00	5.00	10.00	5.00	10.00
40.00	46.15	0.00	25.00	80.00	71.43	50.00	30.00	16.67	80.00
20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.00	23.08	66.67	50.00	20.00	28.57	50.00	60.00	0.00	20.00
50.00	65.00	45.00	40.00	50.00	35.00	45.00	50.00	60.00	50.00

16 thru 30 = Pad

18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00
0.00	0.00	0.00	0.00	15.00	25.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55.00	35.00	40.00	5.00	40.00	10.00	20.00	5.00	10.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	15.00
0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	15.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00
0.00	10.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
10.00	10.00	10.00	0.00	0.00	0.00	25.00	10.00	25.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	15.00	15.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	15.00	25.00	0.00	0.00	0.00	0.00
65.00	65.00	65.00	30.00	55.00	30.00	60.00	35.00	35.00	30.00
5.00	10.00	5.00	15.00	5.00	5.00	10.00	5.00	5.00	5.00
25.00	15.00	25.00	50.00	35.00	25.00	25.00	55.00	55.00	60.00
5.00	10.00	5.00	5.00	5.00	40.00	5.00	5.00	5.00	5.00
84.62	53.85	61.54	16.67	72.73	50.00	33.33	14.29	28.57	16.67
0.00	0.00	0.00	33.33	0.00	0.00	0.00	57.14	0.00	50.00
15.38	15.38	15.38	50.00	27.27	0.00	41.67	28.57	71.43	16.67
65.00	65.00	65.00	30.00	70.00	55.00	60.00	35.00	35.00	30.00

CANYON FUEL
Dugout Mine
DE-GAS SITE: G-22

Access & Pad

Exposure: Variable

Slope: Variable

Sample Date: June 25 2008

28.00	29.00	30.00	Mean	SDev	Freq Cnts	Freq	
OVERSTORY							
0.00	0.00	0.00	4.00	8.60	6.00	20.00	<i>Amelanchier utahensis</i>
UNDERSTORY							
TREES & SHRUBS							
0.00	0.00	0.00	2.00	5.26	5.00	16.67	<i>Amelanchier utahensis</i>
10.00	0.00	5.00	14.17	15.82	20.00	66.67	<i>Artemisia tridentata</i>
0.00	0.00	0.00	0.33	1.80	1.00	3.33	<i>Ceanothus martinii</i>
0.00	0.00	0.00	2.17	7.71	3.00	10.00	<i>Cercocarpus montanus</i>
0.00	0.00	0.00	0.50	2.69	1.00	3.33	<i>Gutierrezia sarothrae</i>
0.00	0.00	0.00	0.33	1.80	1.00	3.33	<i>Mahonia repens</i>
0.00	0.00	0.00	1.17	2.79	5.00	16.67	<i>Symphoricarpos oreophilus</i>
FORBS							
0.00	10.00	0.00	0.50	1.98	2.00	6.67	<i>Agoseris glauca</i>
0.00	0.00	0.00	0.67	2.81	2.00	6.67	<i>Castilleja rhexifolia?</i>
0.00	0.00	0.00	0.33	1.80	1.00	3.33	<i>Castilleja flava</i>
0.00	0.00	0.00	0.33	1.80	1.00	3.33	<i>Cymopterus longipes</i>
0.00	0.00	0.00	0.67	1.70	4.00	13.33	<i>Erigeron engelmannii</i>
0.00	0.00	0.00	1.33	4.46	3.00	10.00	<i>Eriogonum ovalifolium</i>
0.00	20.00	15.00	3.17	5.55	9.00	30.00	<i>Hedysarum boreale</i>
0.00	0.00	0.00	0.17	0.90	1.00	3.33	<i>Linum lewisii</i>
0.00	0.00	0.00	2.50	5.88	6.00	20.00	<i>Penstemon watsonii</i>
0.00	0.00	0.00	1.33	2.87	6.00	20.00	<i>Petradoria pumila</i>
0.00	0.00	0.00	0.17	0.90	1.00	3.33	<i>Tragopogon dubius</i>
GRASSES							
30.00	5.00	15.00	9.33	9.81	19.00	63.33	<i>Elymus salinus</i>
0.00	0.00	0.00	2.67	6.42	5.00	16.67	<i>Elymus spicatus</i>
0.00	0.00	0.00	1.00	3.74	2.00	6.67	<i>Poa pratensis</i>
0.00	0.00	0.00	0.50	2.69	1.00	3.33	<i>Stipa hymenoides</i>
COVER							
0.00	0.00	0.00	4.00	8.60			Overstory
40.00	35.00	35.00	45.33	12.24			Understory
5.00	5.00	5.00	7.17	3.34			Litter
45.00	50.00	35.00	33.00	15.14			Bareground
10.00	10.00	25.00	14.50	10.19			Rock
% COMPOSITION							
25.00	0.00	14.29	41.96	28.13			Shrubs
0.00	28.57	0.00	9.57	16.03			Forbs
75.00	14.29	42.86	31.45	23.21			Grasses
40.00	35.00	35.00	49.33	12.16			Overstory + Understory

CANYON FUEL
 Dugout Mine
 AMUT/SYOR/ARTR
 Ref. Area G-16, G-17, G-22

Slope: W

Exposure: 10 deg

Sample Date: 13-14 Sept 2005

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
OVERSTORY							
<i>Amelanchier utahensis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Juniperus scopulorum</i>	0.00	0.00	0.00	15.00	0.00	0.00	0.00
UNDERSTORY							
SHRUBS							
<i>Amelanchier utahensis</i>	0.00	0.00	0.00	0.00	0.00	15.00	0.00
<i>Artemisia tridentata</i>	10.00	10.00	20.00	0.00	15.00	5.00	20.00
<i>Juniperus scopulorum</i>	0.00	0.00	0.00	5.00	0.00	0.00	0.00
<i>Symphoricarpos oreophilus</i>	0.00	15.00	5.00	5.00	0.00	20.00	0.00
FORBS							
<i>Astragalus sp.</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lupinus argenteus</i>	10.00	10.00	0.00	10.00	5.00	1.00	15.00
<i>Penstemon watsonii</i>	25.00	0.00	20.00	0.00	10.00	19.00	5.00
GRASSES							
<i>Elymus salinus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Elymus spicatus</i>	10.00	5.00	10.00	0.00	0.00	0.00	0.00
<i>Elymus trachycaulus</i>	0.00	0.00	0.00	0.00	0.00	0.00	10.00
<i>Poa pratensis</i>	0.00	0.00	0.00	20.00	15.00	5.00	0.00
<i>Poa secunda</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COVER							
Overstory	0.00	0.00	0.00	15.00	0.00	0.00	0.00
Understory	55.00	40.00	55.00	40.00	45.00	65.00	50.00
Litter	25.00	8.00	15.00	40.00	10.00	15.00	20.00
Bareground	10.00	45.00	25.00	5.00	30.00	15.00	15.00
Rock	10.00	7.00	5.00	15.00	15.00	5.00	15.00
% COMPOSITION							
Shrubs	18.18	62.50	45.45	25.00	33.33	61.54	40.00
Forbs	63.64	25.00	36.36	25.00	33.33	30.77	40.00
Grasses	18.18	12.50	18.18	50.00	33.33	7.69	20.00
Overstory + Understory	55.00	40.00	55.00	55.00	45.00	65.00	50.00

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	0.00	0.00	25.00	0.00	35.00	0.00	40.00	0.00	20.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	70.00	5.00	30.00	5.00	10.00	0.00	0.00
50.00	35.00	45.00	0.00	35.00	0.00	10.00	10.00	20.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	5.00	35.00	15.00	45.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	5.00	0.00	0.00	5.00	0.00	5.00	0.00	0.00	10.00
15.00	15.00	15.00	5.00	15.00	0.00	5.00	0.00	25.00	10.00
5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	10.00	10.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00
0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	25.00
0.00	0.00	0.00	25.00	0.00	35.00	0.00	40.00	0.00	20.00
70.00	70.00	70.00	75.00	70.00	65.00	50.00	65.00	60.00	45.00
15.00	15.00	25.00	20.00	25.00	19.00	20.00	30.00	20.00	15.00
10.00	10.00	4.00	4.00	4.00	15.00	15.00	1.00	15.00	35.00
5.00	5.00	1.00	1.00	1.00	1.00	15.00	4.00	5.00	5.00
71.43	50.00	64.29	93.33	64.29	100.00	60.00	100.00	33.33	0.00
21.43	28.57	21.43	6.67	28.57	0.00	20.00	0.00	41.67	44.44
7.14	21.43	14.29	0.00	7.14	0.00	20.00	0.00	25.00	55.56
70.00	70.00	70.00	100.00	70.00	100.00	50.00	105.00	60.00	65.00

CANYON FUELS
 Dugout Mine
 AMUT/SYOR/ARTR
 Ref. Area G-16, G-17, G-22
 Slope: W
 Exposure: 10 deg
 Sample Date: 13-14 Sept 2005

18.00	19.00	20.00	Mean	SDev	Freq	
<hr/>						OVERSTORY
15.00	0.00	0.00	6.75	12.58	25.00	<i>Amelanchier utahensis</i>
0.00	0.00	0.00	0.75	3.27	5.00	<i>Juniperus scopulorum</i>
<hr/>						UNDERSTORY
<hr/>						SHRUBS
0.00	0.00	5.00	7.00	16.16	35.00	<i>Amelanchier utahensis</i>
0.00	10.00	10.00	15.25	14.79	75.00	<i>Artemisia tridentata</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Juniperus scopulorum</i>
55.00	0.00	10.00	10.50	15.96	50.00	<i>Symphoricarpos oreophilus</i>
<hr/>						FORBS
0.00	5.00	0.00	0.25	1.09	5.00	<i>Astragalus sp.</i>
0.00	5.00	0.00	4.05	4.60	55.00	<i>Lupinus argenteus</i>
5.00	15.00	10.00	10.70	7.89	80.00	<i>Penstemon watsonii</i>
<hr/>						GRASSES
0.00	0.00	0.00	0.25	1.09	5.00	<i>Elymus salinus</i>
10.00	0.00	0.00	2.00	3.67	25.00	<i>Elymus spicatus</i>
0.00	0.00	0.00	2.00	3.67	25.00	<i>Elymus trachycaulus</i>
0.00	0.00	0.00	2.25	5.36	20.00	<i>Poa pratensis</i>
0.00	5.00	5.00	2.50	6.22	20.00	<i>Poa secunda</i>
<hr/>						COVER
15.00	0.00	0.00	7.50	12.60		Overstory
70.00	40.00	40.00	57.00	12.08		Understory
15.00	10.00	10.00	18.60	7.52		Litter
5.00	45.00	5.00	15.65	13.13		Bareground
10.00	5.00	45.00	8.75	9.59		Rock
<hr/>						% COMPOSITION
78.57	25.00	62.50	54.44	26.60		Shrubs
7.14	62.50	25.00	28.08	17.03		Forbs
14.29	12.50	12.50	17.49	14.43		Grasses
<hr/>						Overstory + Understory
85.00	40.00	40.00	64.50	19.49		

United States Department of Agriculture



Natural Resources Conservation Service
540 West Price River Drive
Field Office
Price, UT 84501
(435) 637-0041
FAX (435) 637-3146

June 16, 2008

Ms Vicky Miller
Canyon Fuel Company, LLC
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

Re: Vegetation Production of Proposed Degas Wells G-21, G-25, G-28, G-29, G-26, G-30,
DUG-01 and DUG-04.

Dear Ms Miller,

Following the review of the photos you provided, as well as experience with recent climatic conditions, I have made the following determinations for vegetative production and overall health and trend of the sites. The three ecotypes that will be described in relation to these proposed well sites are *shrub/grass and aspen and Pinyon/Juniper*. It is noted that some of the sites have previously been disturbed with differing levels of success in the reestablishment of the Potential Natural Community (PNC).

Well location G-21 lies within an area that has the Ecological Site Description (ESD) classified as *High Mountain Loam (Aspen)*. The site has the characteristics as a "Climax Forest" due to the lack of natural disturbances. The site characteristics include very tall aspen with small crowns in the high overstory. The site also displays the characteristics of coniferous trees beginning to invade the site (also a sign of the lack of natural disturbance). Due to the density of the trees and abundant overstory much of the herbaceous understory is absent because of lack of ability to compete with the trees. At the time of our visit I would estimate that there was far less than 100 pounds acre⁻¹. Based off of the potential of the site given the rest of the growing season I would estimate that it will produce approximately 100 pounds acre⁻¹ of herbaceous vegetation.

Well location G-25, G-28, G-29 and G-30 lie within an area with the ESD classified as *Mountain Shallow Loam (Mountain Big Sagebrush)*. G-25 lies adjacent to the current road system and appeared to have been slightly disturbed from livestock. It appeared that a portion of the proposed site has been used for many years as an area the livestock producers places his salt blocks. Sites like this eventually show signs of this from the heavy hoof action of the livestock. Although the area was only about 25% of the proposed location site I believe the production estimates would otherwise be higher. G-28 also has some previous disturbance on the proposed location as the road dissects it running north to south. Although the rest of the sites looked fairly

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well I did notice that the sagebrush and juniper components of the system were getting pretty high. Like the aspen site this is a sign of the lack of a natural disturbance and thus the slow decline in your herbaceous component. G-29 is the only one of the three that did not appear to have any previous disturbance but also showed the signs of the lack of a natural disturbance. G-30 located on a very old well location but has been left undisturbed for long enough that it come back very well to the natural plant community. Based on my observations from our visit, I would estimate this site would produce approximately 1,500 pounds acre⁻¹ for G-25, G-28 and G-30. For G-29 I would estimate produce approximately 1,800 pounds acre⁻¹.

Both DUG-01 and DUG-04 are located on sites that have been severely disturbed and have not recovered. I would estimate that the sites would produce less than 100 pounds acre⁻¹.

Please feel free to contact me if you have any further questions or concerns.

Sincerely,



M. DEAN STACY
Range Management Specialist
USDA-NRCS, Price AO

cc: Barry Hamilton, ASTC-FO, Price AO
Wayne Greenhalgh, District Conservationist, Price FO
File

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~August 28, 2007~~

CHAPTER 4
LAND USE AND AIR QUALITY

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Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~August 28, 2007~~

LIST OF ATTACHMENTS

Attachment 4-1 Information Moved to Confidential Folder in 2005
Attachment 4-2 Surface Land Owner Agreement

410 LAND USE

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.

411.100 Premining Land Use

The area is utilized for the landowners private use, including hunting and as open range for livestock and wildlife.

411.110 Land Use Map and Narrative

Refer to the same section of the approved M&RP.

411.120 Land Capability

The major plant communities at the well sites are identified in Section 321. No cultivated lands lie within the well boundaries, due to the limiting terrain and lack of water for irrigation. Refer to Section 321.200, Table 3-1 of this submittal for forage production per acre for each well site.

The well site areas are located on the flatter mesa tops and rolling terrain. This type of terrain receives heavier pressure because of more available forage and easier movement by livestock.

411.130 Land Use Description

The wells are located on land administered by Milton & Ardith Thayn Trust and zoned by Carbon County for mining and grazing (MG-1).

No industrial or municipal facilities are located on or immediately adjacent to the well sites.

411.140 Cultural and Historic Resources Information

Cultural and Historic Resource Maps - Archaeological surveys were conducted in 2003 of the well sites G-1 through G-6. Nothing was found that required future investigation. There are no cemeteries, public parks, or units of the National System of Trails or the Wild and Scenic Rivers System located within the well site boundaries. The reports can be found in Attachment 4-1 of this submittal, Appendix 4-1 and 4-3 of the M&RP and in the Confidential Folder. Well site G-7 and G-8 were inventoried by AERC in 1980 (see below), a letter from John Senulis of Senco-Phenix to SHPO has been written requesting proof of clearance for the G-7 and G-8 sites. A copy of the Senco-Phenix letter is included in the confidential folder.

Previous research in 1980 by "AERC surveyed several sample blocks in Sections 13 and 24, T13S, R12E and Sections 18, 19 and 30 T13S, R13E. They also surveyed the access road into the Snow Mine site. One archeological site (42CB292) was located. The site was described as "Coal mine located in Pace Canyon consists of one known mine portal which has been closed. Site of historic Snow Mine in Pace Canyon which was active in 1906 but had its primary production period from 1932-1940." The site was relatively pristine at the time and still contained a standing coal loadout and foundation with depth potential. Avoidance was recommended pending further historic research. As noted the site has since been extensively modified" (Attachment 4-1, Senco-Phenix, June 24, 2003, SPUT-455, page 2).

Access to the degas holes will not impact or disturb what remains of the archeological site (42CB292). The road in the bottom of Pace Canyon passes the archeological site, but the closed

portal is not visible from the road, therefore there is nothing to draw attention to the site. The loadout referenced in the survey no longer exist at the site.

During June 2005 a Class III intensive walkover survey was performed of the access roads and degas well sites G-9 thru G-13 and site DUG0105/DUG0205 (G-14) by Senco-Phenix. The well sites are being permitted in groups. Wells G-8 thru G-10 are the group currently being presented for consideration for approval. In the canyon where degas well sites G-9 and G-10 are located near site 42CB2435. The major portion of the site has been removed and there is little potential for further information. The site is not considered eligible for the NRHP. Reference the Confidential Binder for further information pertaining to the aforementioned survey. Per the survey "No other cultural resources were located and the potential for undetected remains is remote. A finding of no effect is appropriate and archeological clearance without stipulations is recommended" by Senco-Phenix to SHPO for the G-8 thru G-14 degas well sites. Site 42CB1595 was recommended for archeological clearance without stipulations by Senco-Phenix to SHPO and was not recommended as eligible for the NRHP.

The sites of G-11 and G-16 were previously used for coal exploration holes. No "areas of critical environmental concern" or "native american religious concerns" were identified for either site in the archeological inventory of the area conducted by Senco-Phenix Archeological Consulting Services in June 20, 2001 (SPUT-387, Confidential Binder) and no cultural or historical properties were listed by NRHP. Site G-11 was labeled as "DT-2" and site G-16 was labeled as "E" in SPUT-387.

Sites G-15 (DUG0204), G-17 (DUG0304) were previously used for coal exploration holes. An archeological inventory of the area was conducted by Senco-Phenix Archeological Consulting Services in 2001 (SPUT-387, Confidential Binder) and no historical or cultural resources were identified for listing by NRHP/SHPO per the BLM EA UT-070-2004-49, provided for incorporation into Attachment 3-3. Site G-15 was labeled as "DUG0204" and site G-17 was labeled as "DUG0304" in the Environmental Assessment prepared by the BLM for the drilling of these exploration holes. The areas for the exploration holes were presumably cleared by the BLM prior to the drilling of the exploration holes.

In SPUT-387 the drill pad areas are not labeled with a number but are designated as being inventoried by a blue outline on the drawing provided in the sput. A IMACS site form was prepared and submitted to SHPO for a site at well pad G-17 (42CB1596), this site was "Determined NR ineligible and non-significant for National Register Status.

A drawing has been prepared by archeological consultants "Senco-Phenix" designating areas including roads surveyed for archeological and cultural resources. The drawing entitled "Previous Archeological Surveys, July 2006" is included in the confidential binder. The road used for access to all degas drill sites have been surveyed.

SPUT-553 prepared by Senco-Phenix contains an intensive survey on 14 acres. Part of this survey was an access road connect the existing road to well pad G-19 and a trail to G-31 and on to well pad G-18. "A finding of no effect is appropriate and archeological clearance without stipulations is recommended" for the area associated with the sites listed above.

The G-31 well pad was surveyed in 2001 by Senco-Phenix (SPUT-387). In the report, the site is referenced as DT-3 and was inventoried as a location for a potential exploration well. A copy of SPUT-387 is on file at the Division and was submitted to SHPO in association with the Pace Canyon Fan Portal amendment. In the report it states that, "a finding of no effect is appropriate and archeological clearance without stipulations is recommended" for this site.

SPUT-555 also includes a survey of a proposed well site G-21 and the existing road from G-14 to G-22. Cultural resources (42CB2621) were located during this survey, but are not related to the AMV access road, well site G-21, G-22, G-31 or G-18. The information for this site was provided to the Division on June 14, 2007 under separate cover for submittal to SHPO.

A cultural resource survey and inventory of G-22 was performed in June 2008. Two fragments (under 1/2 inch) of broken glass were located but were likely displaced from their original location. No other cultural resources were located and a finding of no effect is appropriate and archeological clearance without stipulation is recommended by the consulting archeologists.

SPUT-542 is an intensive cultural resource survey covering three drill holes and a staging area. The site for Degas well G-19 (G-190) is part of this survey. The refer to the drawing within the survey and Figure 1-1 of this amendment for verification of the surveyed location. "No cultural resources were located and the potential for undetected remains is remote. A finding of no effect is appropriate and archeological clearance without stipulations is recommended."

Dugout Canyon agrees to notify the Division and State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of operations. Dugout Canyon 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. Dugout Canyon will also instruct its employees that it is a violation of federal and state law to collect individual artifacts or to otherwise disturb cultural resources.

411.200 Previous Mining Activity

Dugout Canyon has no knowledge of previous removal of coal or other minerals in the well site areas.

412 Reclamation Plan

412.100 Postming Land-Use Plan

All uses of the land prior to the wells construction/operation and the capacity of the land to support prior alternate uses will remain available throughout the life of the sites.

Dugout Canyon intends the postmining land use to be livestock and wildlife grazing and other uses as dictated by the land owner (hunting, roads, corrals, stock ponds, etc.). Final reclamation activities will be completed in a manner to provide the lands able to parallel the premining land use.

412.200 Land Owner or Surface Manager Comments

Milton & Ardith Thayn Trust is the landowner. Canyon Fuel Company, LLC has a surface land owner agreement with the Thayne Trust for the drilling of degassification holes (Attachment 4-2). Prior to drilling the landowner will be contacted and the requirements related to drilling as outlined in the surface land owner agreement will be met. A copy of the letter will be included in Attachment 4-2.

413 Performance Standards

413.100 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 uses (see Chapters 2, 3, 5, and 7).

413.200 Determining Premining Uses of Land

Refer to Section 411.100.

413.300 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

421 Air Quality Standards

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

422 Compliance Efforts

See Fugitive Dust Control Plan, Section 424.

423 Monitoring Program

Refer to the same section in the approved M&RP.

424 Fugitive Dust Control Plan

Operational areas that are used by mobile equipment will be water sprayed to control fugitive dust. The application of water will be of sufficient frequency and quantity to maintain the surface material in a damp/moist condition unless it is below freezing.

425 Additional Division Requirements

Refer to the same section of the approved M&RP.

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~September 18, 2007~~

CHAPTER 5
ENGINEERING

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510 INTRODUCTION

This chapter provides a discussion of general engineering aspects, an operation plan, a reclamation plan, design criteria, and performance standards related to the degassification well sites. The activities associated with the construction and reclamation of the well sites have been or will be designed, located, constructed, maintained, and reclaimed in accordance with the operation and reclamation plans.

511 General Requirements

The permit application includes descriptions of construction, maintenance, and reclamation operations of the proposed well sites with maps and plans. Potential environmental impact 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 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

Cross sections for the degassification well pads are shown on Figures 5-2, 5-6, 5-10, 5-18, 5-21, 5-24 and typical road cross sections are shown on Figures 5-13 and 5-14. Cross sections for the degassification well pads G-8, G-9, G-10, G-11 thru G-19, G-21, G-22, and G-31 are shown on figures located in Attachment 5-1.

512.200 Plans and Engineering Designs

Excess Spoil - No excess spoil will be generated from the well sites.

Durable Rock Fills - No durable rock fills will exist at the well sites.

Coal Mine Waste - No coal mine waste will exist at the well sites.

Impoundments - Refer to Section 733.200 of this submittal.

Primary Roads - Short sections of road are required to access well sites G-2, G-5, G-16 and G-22. These access roads are classified as primary roads. Well sites G-1 and G-8 (not drilled), G-3 thru G-15, G-19 and G-21 are on existing roads, no primary access roads will be constructed. Refer to Section 527.200 for additional information.

Variance from Approximate Original Contour - No variance from approximate original contour is required for the well sites.

513 Compliance with MSHA Regulations and MSHA Approval

513.100 Coal Processing Waste Dams and Embankments

No coal processing waste dams and embankments will exist at the well sites.

513.200 Impoundments and Sedimentation Ponds

Refer to Section 733.200 of this submittal.

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

No underground waste, coal processing waste, and excess spoil will exist at the well sites.

513.400 Refuse Piles

No refuse piles will exist at the well sites.

513.500 Underground Openings to the Surface

The well will be equipped with a valve that will be closed and locked when not in use. A typical well head is shown in Figure 5-16.

513.600 Discharge to Underground Mine

No discharge to the underground mine will occur at the well sites.

513.700 Surface Coal Mining and Reclamation Activities

No surface coal mining, or reclamation activities associated with surface coal mining will occur at the well sites.

513.800 Coal Mine Waste Fire

No coal waste will be developed, therefore, no coal waste fires will occur at the well sites.

514 Inspection

514.100 Excess Spoil

No excess spoil will be stored at the well sites.

514.200 Refuse Piles

No refuse piles will exist at the well sites.

514.300 Impoundments

Refer to Section 733.200 of this submittal.

515 Reporting and Emergency Procedures

515.100 Slides

Refer to Section 515.100 in the approved M&RP.

515.200 Impoundments Hazards

No impoundments will exist at the well sites.

515.300 Temporary Cessation of Operations

If temporary cessation of the mining operations does occur, the wells will remain open. Once liberation of the methane gas is completed, the wells will be sealed as discussed in Section 542.700 of this submittal.

520 OPERATION PLAN

521 General

See Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 (G-8 thru G-19, G-21, G-22, and G-31) for the contour map showing pre-disturbance and drilling phase contours. These figures also show the disturbed area boundary and the new access road contours. Figures 5-3, 5-7, 5-11, 5-19, 5-22, 5-25, 5-29 and Attachment 5-1 (G-8 thru G-19, G-21, G-22, and G-31) show the layout of the well sites during the drilling phase. Figures 5-4, 5-8, 5-12 show the layout of the well sites during the operational phase and the area to be reclaimed at the completion of drilling. Cross sections for each site can be found on Figures 5-2, 5-6, 5-10, 5-18, 5-21, 5-24, 5-28 and Attachment 5-1 (G-8 thru G-19, G-21, G-22, and G-31). Attachment 5-1 contains figures showing the road to be constructed to access drill pad G-22, they are on the same figures as the G-22 drill pad.

521.100 Cross Sections and Maps

Existing Surface and Subsurface Facilities Features - No buildings are located on or within 1,000 feet of any of the well sites.

Landowner, Right-of-Entry, and Public Interest - The land which the wells will be drilled on is owned by the Milton and Ardith Thayn Trust. Canyon Fuels, LLC has reached an agreement with the Thayn trustees to allow access for the construction and drilling of the wells (see Attachment 4-2).

Mining Sequence and Planned Subsidence - Refer to Section 525. Mining sequence maps showing the location of drilled degas wells are submitted to the BLM and UDOGM as part of their annual reports. A drawing representing the drill holes previously permitted for drilling and those currently proposed for drilling in 2007 are shown on a drawing included in Attachment 5-4. The drawing shows the pad locations not the location where the drill hole will be completed. Drill holes from the G-9 pad were or are being drilled to release gas from the Gil-5 and Gil-6 panels. Drill holes from the G-10, G-11, G-12, and G-13 pads were drilled to release gas from the Gil-5 panel. Drill holes from the G-15, G-18, G-19, and G-31 pads will be drilled to release gas from the Gil-6 panel.

Drill holes from the G-21, G-22 pads will be drilled to release gas from the Gil-8 panel.

Land Surface Configuration - Surface contours of undisturbed well sites are included in Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 (G-8 thru G-19, G-21, G-22, and G-31).

Surface Facilities - No permanent surface facilities will exist at the well sites.

521.200 Signs and Markers

Mine and Permit Identification Signs - A mine and permit identification sign will be displayed at each well site. 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 release of all bonds for the well site areas. The sign will contain the following information:

- Mine name,
- Company name,
- Company address and telephone number
- MSHA identification number, and
- Permanent program permit identification number

Perimeter Markers - The perimeter of all areas affected will be clearly marked before beginning mining activities. The 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 all bonds for the permit area.

Buffer Zone Markers - Stream buffer zone markers will not be required at the G-2 thru G-10, G-13, G-14, G-16, G-17, G-21 and G-22 well sites. Stream buffer zone markers will be placed at G-11, G-12, G-15, G-19 and on the AMV road where required by regulation.

Topsoil Markers - Markers will be placed on all topsoil 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 topsoil is redistributed on the well sites.

Construction Markers - Not applicable.

Hazard Signs - Signs will be placed at the degas wells with open degas holes, declaring danger, no smoking, etc.

522 Coal Recovery

No coal recovery will be performed at the well sites. The operator has been contacted by the BLM, in reference to changes in Operator's R2P2 associated with Federal Regulation 43 CFR Chapter 11, Subpart 3484. Degas wells G-11, G-12, G-18, G-19, G-21, G-22, and G-31 are on the SITLA lease and not on a federal lease, therefore changes in the R2P2 are not required.

523 Mining Methods

No mining will be performed at the well sites.

524 Blasting and Explosives

No explosives are to be used at the well sites.

525 Subsidence

No subsidence will occur at the well sites, as a result of drilling and development of the degassification well sites. Subsidence could occur at the well site because of underground mining see Section 525 of the approved M&RP.

526 Mine Facilities

526.100 Mine Structures and Facilities

No buildings exist or are proposed at the well sites; therefore, no existing building will be used in connection with or to facilitate this proposed coal mining and reclamation plan.

526.200 Utility Installation and Support Facilities

No utilities are to be installed at the well sites. A portable methane exhaust unit will be temporarily installed to draw methane to the surface from the mined panel. The exhaust blower will be started by using propane from portable tanks. Once started and running, the unit will be powered by burning the extracted methane gas. The level of extracted methane required to operate the exhaust blower is greater than 30%. Excess methane will be vented to the atmosphere. The blower is approximately 12-feet long by 6-feet wide and about 10-feet tall. It is not known how long the degassification of the longwall panel will take.

527 Transportation Facilities

527.100 Road Classification

Well sites will be developed near existing private roads as shown on Figures 1-1, 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 (G-8 thru G-17 and G-19). The new short segments of access roads will be classified as primary roads and will be maintained by the permittee (see Figure 5-14). The AMV access road will be classified as an ancillary road per a discussion with Wayne Western during a meeting at the UDOGM offices on April 16, 2007. The road is improving a trail used for hunting, cattle and for logging. There are small slash piles along segments of the trail.

527.200 Description of Transportation Facilities

The well sites were chosen close to existing roads in the area to limit surface disturbance. The existing roads were constructed and are maintained by the land owner. The existing roads are approximately 20 feet wide and are shown on Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 (G-8 thru G-17, G-19, and G-21). See Figure 5-13 for a typical cross section of the existing roads.

The access road to the G-16 well site follows an existing road which has been reclaimed. The incised road is approximately 500 feet long, 15 to 20 feet wide and will be constructed on compacted subsoil. Topsoil will be stripped from the road alignment and either wind rowed adjacent to the road or stored with the topsoil stripped from the pad area. The access road will have a maximum grade of 10% and an average grade of 5%. The road will be constructed as shown on Figure 5-14 in the approved methane degassification amendment. As needed, water bars will be used to direct flow off the road and either silt fences or strawbales will be used to treat runoff. Refer to Chapter 5, Attachment 5-1 for drawings of well site. The access road to G-16 is also discussed in Chapter 7, Section 732.400.

The AMV access road will be classified as an ancillary road per a discussion with Wayne Western during a meeting at the UDOGM offices on April 16, 2007. The road is improving a trail used for hunting, cattle and for logging. A drawing showing the alignment of the road can be found in Attachment 5-4, as Plate 1. The drawing outlines the disturbed area and shows the road center line, culvert locations, turnouts and topsoil stockpile locations. Topsoil will be removed from the road and stockpiled along the road as shown on Plate 1. The cut and fill volumes for the road have been determined to be close, making it unlikely that subsoil will need to be stored. However, should it be necessary to store subsoil a pile will be created on one of the proposed turnouts. The subsoil pile will be bermed, pocked, gouged and seeded. The topsoil piles will be treated as described in Chapters 2 and 3 of the Methane Degassification Amendment.

A typical road cross section is found in Attachment 5-4 as Figure 1. The road will be at a minimum 12 feet wide, with two additional feet of the road width being added as a berm and two feet being used as a ditch, making the road approximately 16 feet wide. Additional descriptive information for the road is located in Attachment 5-4, including cross-sections of the road on Plates 2 and 3 within the attachment.

The steepness of access road cut slopes will depend on the stability of the exposed subsurface material. Cuts into competent material such as bedrock will be sloped at angles of approximately 0.5H:1V (63.4 degrees). Cut into unconsolidated material such as soils will be sloped at angles of approximately 1H:1V (45 degrees). The steepness of these slopes is justified by the presence of several near-vertical bedrock outcrops and naturally steep (approximately 1H:1V) colluvial slopes along road cuts in the vicinity of the proposed access road. Furthermore, the nearby cut slopes along access roads have maintained such slopes for several years. Cut slopes will be maintained along the length of the proposed access road. Area determined to be unstable will be regraded to a stable configuration.

When necessary during the normal use of the AMV road, it will be graded, berms will be repaired, culverts inlets/outlets and ditches will be cleaned. The materials excavated during road maintenance will be stockpiled to be used for either repair or during reclamation. The AMV road

is not likely to be used during winter due to the access from below the road being impassable, therefore snow removal and storage has not been discussed. Damage to the AMV access road will be repaired as soon as practical following a catastrophic event. The Division will be notified of a catastrophic event involving the failure of the AMV road and/or drill pads.

On the AMV road silt fences will be placed in the ditch upstream of the approach to the culverts to treat road runoff during construction. Silt fences will be placed at the toe of fill slopes during construction to reduce the amount of loose soil material and sediment laden runoff from entering the drainage. Outslopes and ditches associated with the road will be seeded during operations to encourage the establishment of vegetation and erosion control.

The access road to drill pad G-22 is approximately 0.21 miles long, constructed along the contour of the hillside. The road will begin at the edge of permitted drill pad G-16 and proceed west to drill pad G-22.

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

No disposal of coal, excess spoil, and coal mine waste will occur at the well sites.

529 Management of Mine Openings

The perimeter of the sites, including the topsoil stockpiles will be fenced with gates on the access roads. The well casing will have a valve that is closed and locked. The valve will also prevent access by animals or other material. Mine openings will be monitored in accordance with Federal and State Regulations.

During the life of the methane wells, the sites will be inspected as needed by mine personnel to verify the continued operation of the pumping equipment and general site conditions. Motorized vehicles to access the methane wells may include trucks, four-wheelers, a snow cat, snowmobiles and etc.

530 OPERATIONAL DESIGN CRITERIA AND PLANS

531 General

This section contains the general plans for the construction of sediment controls and general construction and maintenance of the well sites.

The decision to construct each well will be based on the amount of methane encountered during mining. If small amounts of methane are encountered and the mine's ventilation system can dilute the methane, no well will be drilled. The proposed well site locations are shown on Figure 1-1.

The topography above the Dugout Canyon Mine severely limits the selection of methane drainage drill sites (degas wells). Various other factors also affect the drill site locations. These include proximity to the mining area, existing access verses new access, site slope, meeting reclamation success standards, etc. Sites with exiting access are given preference over sites without, where possible sites are located along existing roads and at other pre-disturbed areas. In addition, drill methods are often modified (using directional drilling methods vs. conventional vertical drilling methods) to allow drilling along existing access and to reduce environmental impacts. Directional drilling methods allow the surface site to be located as described yet allow the bottom of the hole to be completed in the required mining area.

532 Sediment Control

Sediment control measures for the well sites are described in Sections 732 and 742 of this submittal. Runoff control structures at the well sites have been designed to convey runoff in a non-erosive manner. Sediment yields in the well permit area are minimized by:

- Disturbing the smallest practicable area during the construction of the well site and
- Contemporaneously reclaiming areas suitable for such reclamation.

The runoff control measures for the AMV access road are discussed in Attachment 5-4 , Attachment 7-1, Sections 732.400 and 742.

533 Impoundments

No impoundments will exist at the well sites or on the AMV road.

534 Roads

Refer to Section 527 and 532 of this submittal.

535 Spoil

No spoil will be generated at the well sites.

536 Coal Mine Waste

No coal mine waste will be stored at the well sites.

537 Regraded Slopes

537.100 Division Approval

No mining or reclamation activities will be conducted in the permit area that requires approval of the Division for alternative specifications or for steep cut slopes.

537.200 Regrading of Settled and Revegetated Fills

Upon completion of the well site, the areas not required for the exhaust blower will be regraded to approximate original contour. Because of the nature of the well site, settling is not anticipated. However, if settlement does occur, these areas will be regraded.

540 RECLAMATION PLAN

541 General

541.100 Commitment

Upon the permanent cessation of methane venting, Dugout Canyon Mine will seal the wells and permanently reclaim all affected areas in accordance with the R645 regulations and this reclamation plan.

541.200 Surface Coal Mining and Reclamation Activities

Not applicable.

541.300 Underground Coal Mining and Reclamation Activities

Upon completion of the methane venting activities the wells will be reclaimed.

541.400 Environmental Protection Performance Standards

The plan presented 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

A timetable for the completion of each major step in the reclamation plan is presented in Figure 5-15 (G-2 and G-5) and 5-26 (G-3, G-4, G-6 thru G-19, G-21, G-22, G-22 Access Road, G-31 and the AMV access road). Per Task ID #2408, "the Division requires notification and a reasonably specific time to initiate the reclamation activities associated with degassification well sites." In addition to the two figures referenced above, information pertaining to reclamation timing for methane degas wells is provided in Attachment 5-2 of this amendment.

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

Following completion of the venting activities, the well site will be prepared for contouring and soil distribution. Details regarding topsoil placement and revegetation are provided in Section 242 and Section 353, respectively.

Sedimentation Pond Removal and Interim Sediment Control - See Section 542.500 of this submittal.

542.300 Final Surface Configuration Maps and Cross Sections

The sites will be regraded to the approximate original contour, the contours representing the pre-disturbance topography also represent the reclamation topography. Refer to Figures 5-2, 5-6, 5-10, 5-18, 5-21, 5-24, 5-28 and Attachment 5-1 (G-8 thru G-19, G-21, G-22, and G-31) to see cross sections representing the final surface configuration. Refer to Attachment 5-4, Plates 1 thru 3 for the surface configuration of the road and cross sections showing pre-mining, operational and post-mining contours. ~~Selected as-built cross sections are shown on Plate 4, Attachment 5-4.~~

542.400 Removal of Temporary Structures

The well sites will not have surface structures.

542.500 Removal of Sedimentation Pond

No sediment pond will be constructed at the well sites.

542.600 Roads

The roads which existed prior to the drilling program will be retained after reclamation. The access roads established during the drilling program will be reclaimed after methane extraction has been completed. See Section 242 for additional detail concerning the reclamation plan.

The road to well site G-16 is pre-existing however it has been reclaimed, the road to access well sites G-13, G-14, G-15, G-17, G-19 and G-21 are existing roads. Subsoil being cut in order to construction the pad for well G-15 will be placed on the existing road, causing it to be elevated. Refer to Section 527.200 and Attachment 5-4 for a description of the AMV access road.

Once the degassification is completed at wells G-18 and G-31 the AMV road will be reclaimed. To begin, the segment of the road will be reclaimed which joins pad G-18 to G-31, then reclamation of the road will continue on downhill until the road rejoins the existing road connecting the Pace Canyon road and degas pad G-19. The area of the road will be returned to approximate original contour, pocked and gouged and seeded (Section 350).

Once the degassification is completed at well G-22 and the pad has been reclaimed the access road will be reclaimed. To begin, the segment of the road nearest the pad will be reclaimed, then reclamation of the road will continue on towards the G-16 well pad until completed. The area of the road to drill pad G-22 will be returned to approximate original contour, pocked and gouged and seeded (Section 350).

542.700 Final Abandonment of Mine Openings and Disposal Areas

Degas drill holes G-9 thru G-19, G-21, G-22, and G-31 will be sealed in accordance with Federal Regulations 43 CFR Ch. 11, Subpart 3484, (3) per a decision by the BLM and UDOGM.

The casings on degas well sites G-2 thru G-7 will be plugged at the bottom to hold concrete. A lean concrete mixture will be poured into the casing until the concrete is within five (5) feet of the surface. At that time the casing will be cut off at ground level and the rest of the casing will be filled with lean concrete. The concrete will be allowed to harden before final reclamation is completed.

A copy of 43 CFR Ch. 11, Subpart 3484, (3) and a discussion of how methane is removed from mines is contained in Attachment 5-2.

542.800 Estimated Cost of Reclamation

Refer to the Appendix 5-6 of the existing M&RP. It is anticipated that the cost of reclamation of the well sites and AMV road are adequately covered by the Dugout Canyon Reclamation Bond, refer to Chapter 8 for additional detail.

550 RECLAMATION DESIGN CRITERIA AND PLANS

551 Casing and Sealing of Underground Openings

Permanent sealing is described in Section 542.700.

552 Permanent Features

552.100 Small Depressions

No permanent small depressions will be created as part of the well site or AMV road construction and reclamation.

552.200 Permanent Impoundments

See Section 515.200 of this submittal.

553 Backfilling and Grading

553.100 Disturbed Area Backfilling and Grading

Approximate Original Contour - The well sites and AMV road will be returned to their approximate original contour after reclamation is completed.

Erosion and Water Pollution - Sediment controls will consist of gouging the surface to create depressions and mounds which store and impede the movement of water. As vegetation becomes established on the reclaimed surface, erosion potential will be further minimized.

Post-Mining Land Use - The disturbed area will be reclaimed in a manner that supports the approved post-mining land use. Refer to Sections 411 and 412 for additional detail.

553.200 Spoil and Waste

Spoil - No spoil will be generated within the well sites.

Coal Processing Waste - No coal processing waste will be generated within the well sites.

553.250 Refuse Piles

No refuse piles will exist at the well sites.

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

No coal seams will be left exposed at the well sites. All wells will be sealed according to Federal and State regulations.

553.400 Cut and Fill Terraces

No cut and fill terraces will be constructed at the well sites or on AMV road.

553.500 Highwall From Previously Mined Areas

No highwalls exist or will be built at the well sites or on AMV road.

553.600 Previously Mined Area

No previously mined areas exist at the well sites or on AMV road.

553.700 Backfilling and Grading - Thin Overburden

No surface mining and reclamation activities involving thin overburden will occur at the well sites or on AMV road.

553.800 Backfilling and Grading - Thick Overburden

No surface mining and reclamation activities involving thick overburden will occur at the well sites or on AMV road.

553.900 Regrading of Settled and Revegetated Rills

If settlement or rills occur at the well sites or on AMV road, they will be regraded and revegetated. Refer to Section 244.300.

560 PERFORMANCE STANDARDS

Dugout Canyon Mine well sites will be conducted in accordance with the approved permit and the requirements of R645-301-510 through R645-301-553.

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~September 18, 2007~~

ATTACHMENT 5-1

Degas Wells G-8 thru G-19, G-21, G-22 (including access road) and G-31

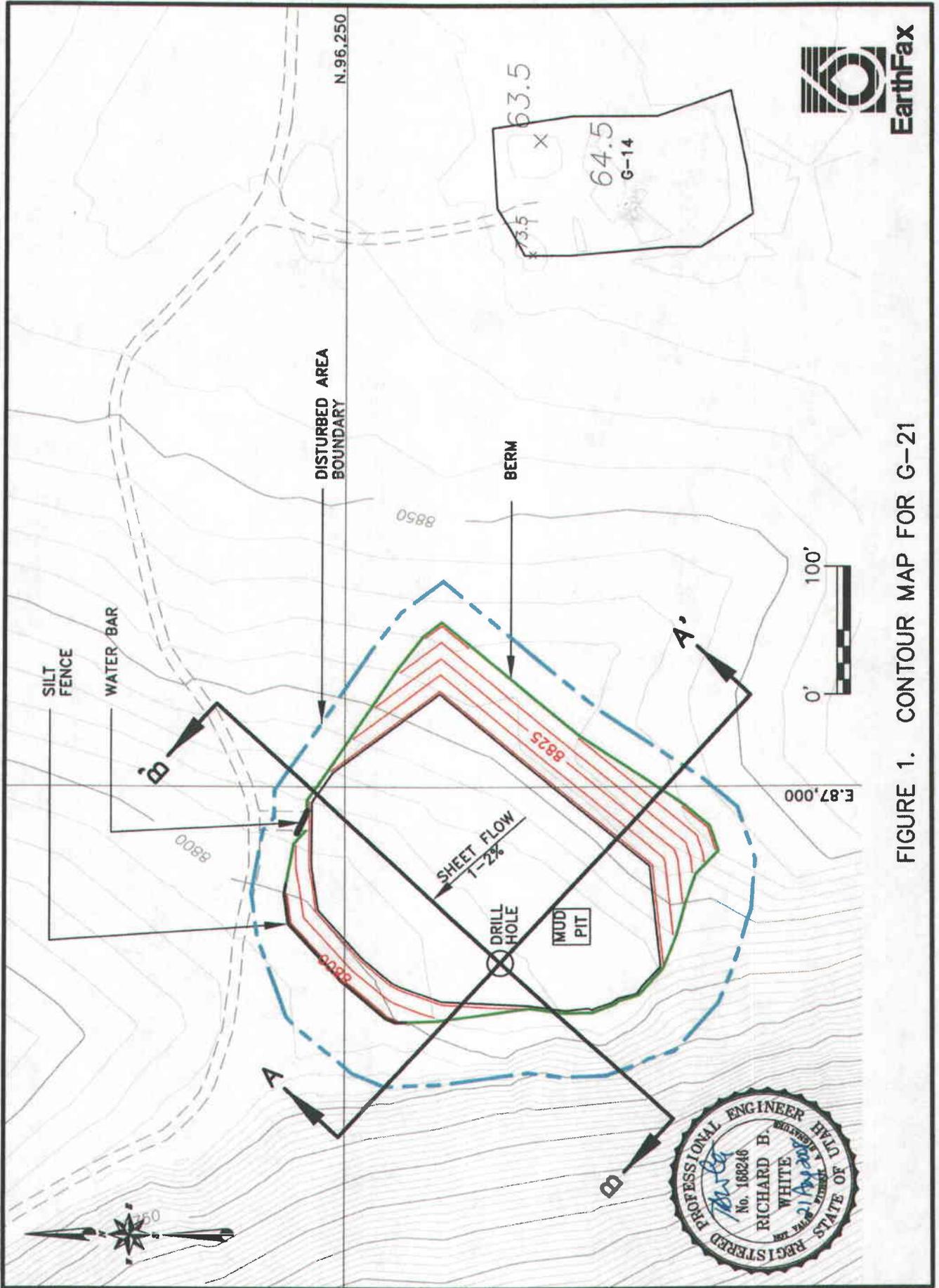


FIGURE 1. CONTOUR MAP FOR G-21

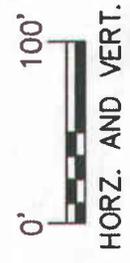
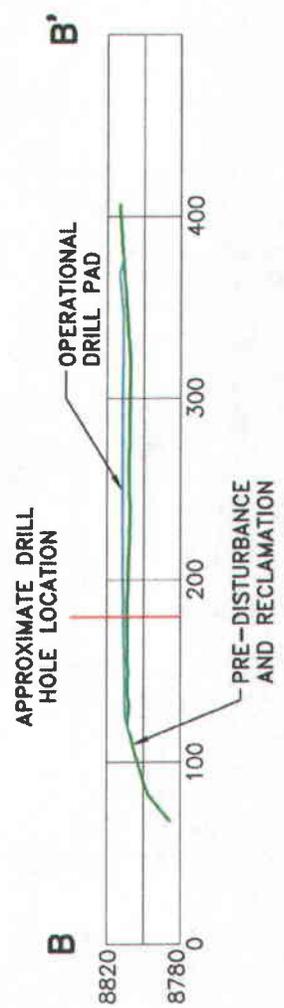
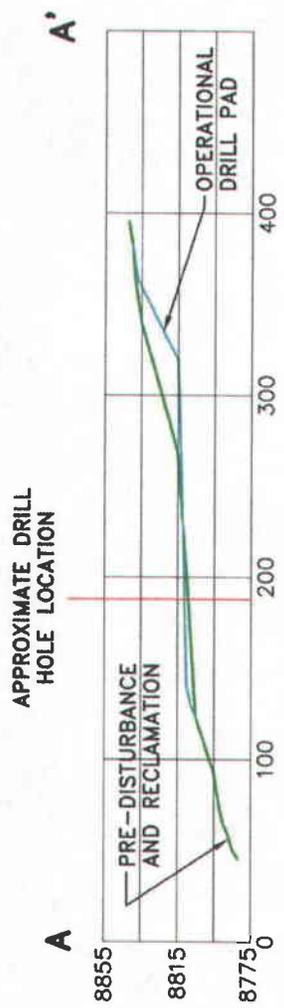


FIGURE 2. TYPICAL CROSS-SECTIONS FOR G-21

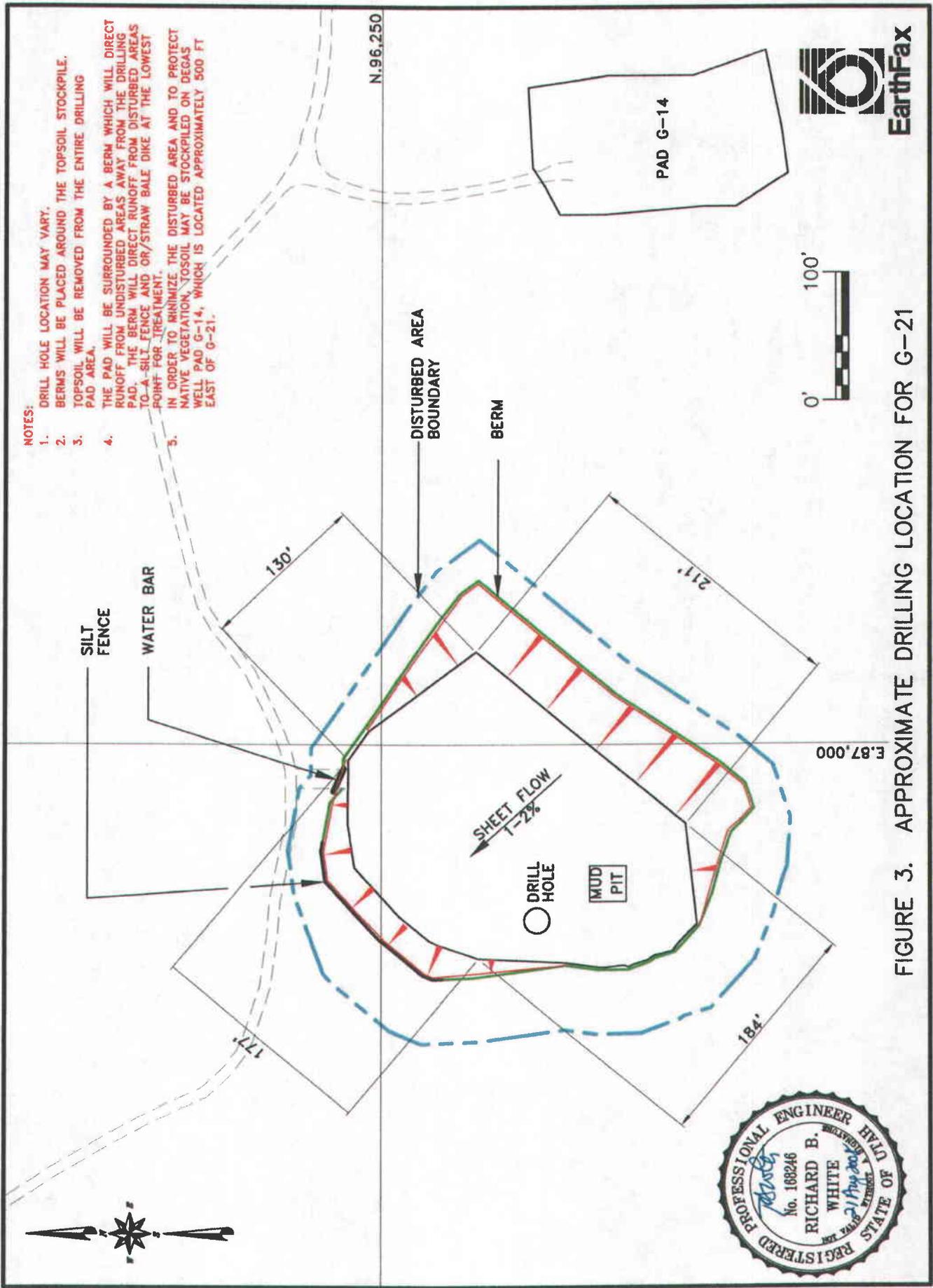


FIGURE 3. APPROXIMATE DRILLING LOCATION FOR G-21

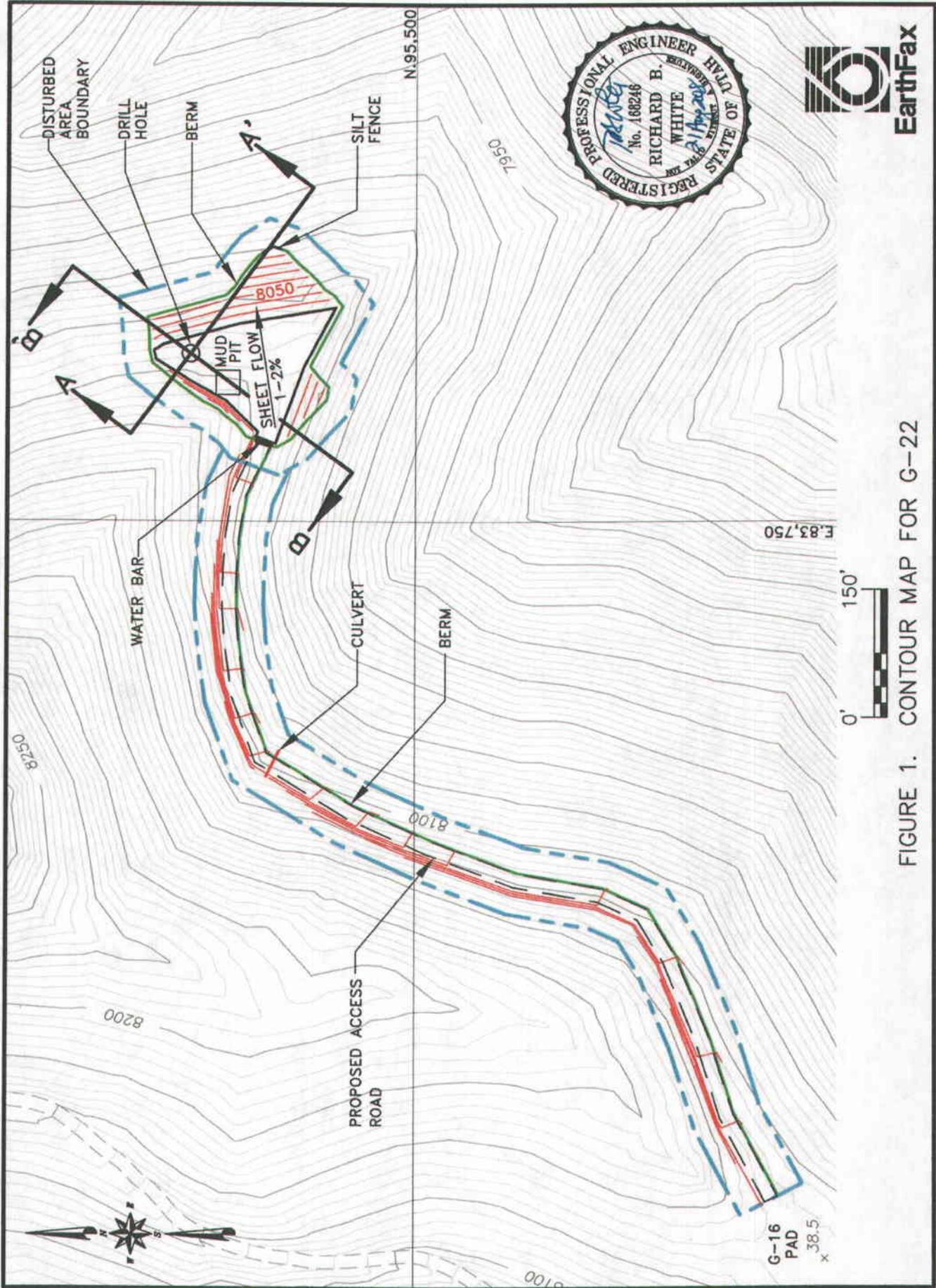


FIGURE 1. CONTOUR MAP FOR G-22



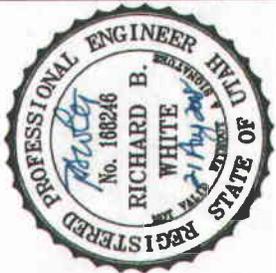
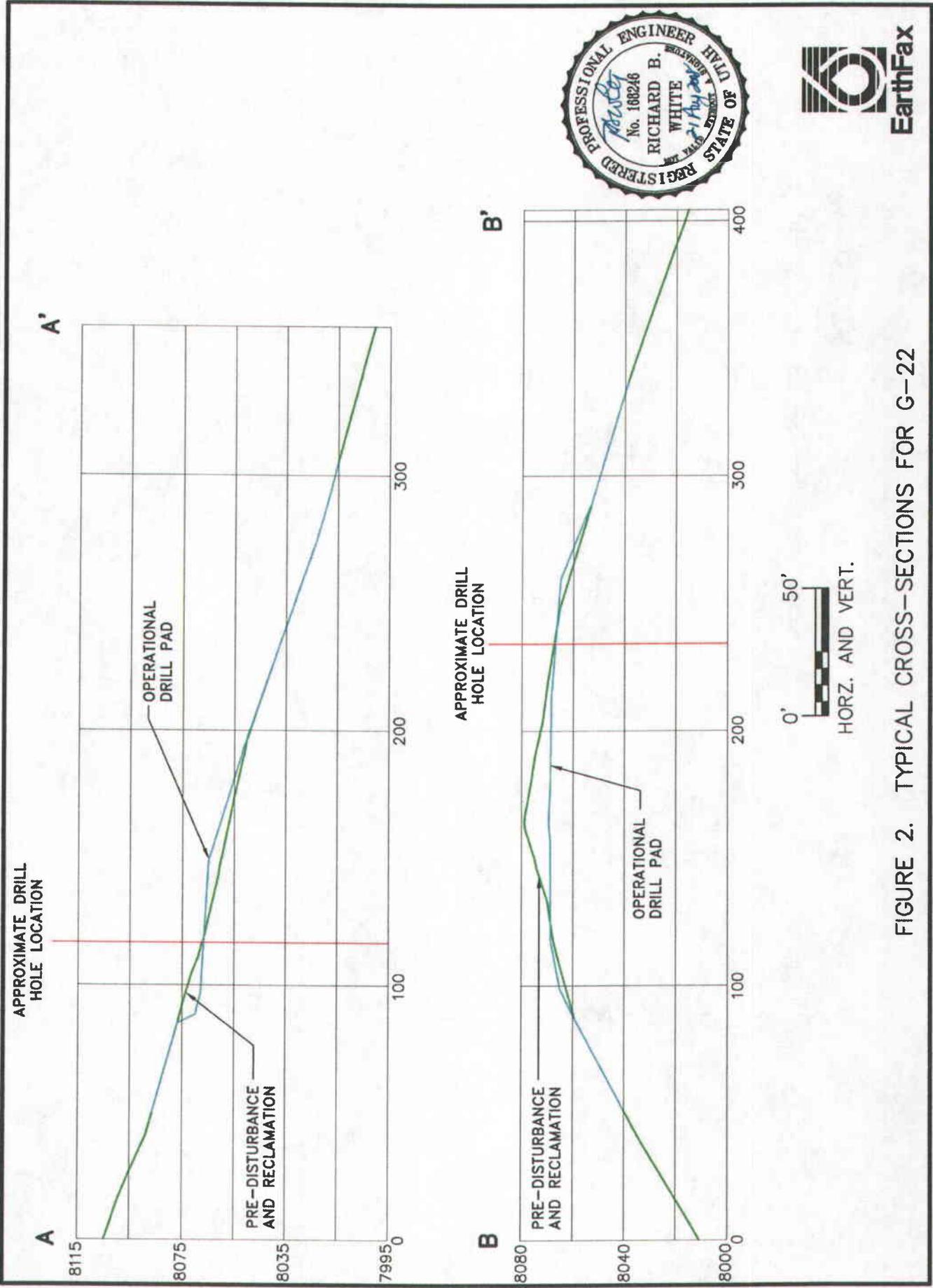


FIGURE 2. TYPICAL CROSS-SECTIONS FOR G-22

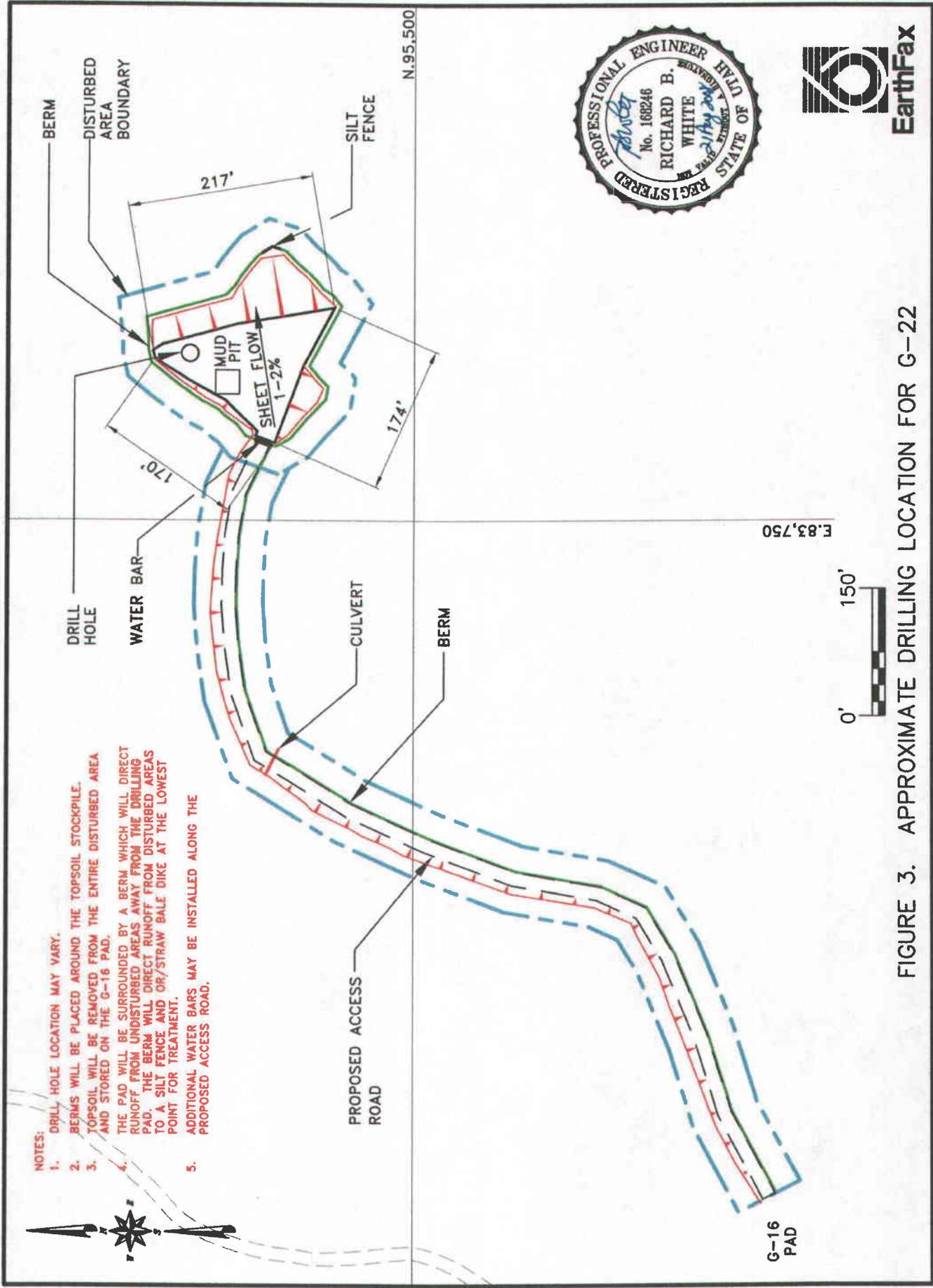


FIGURE 3. APPROXIMATE DRILLING LOCATION FOR G-22

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~September 18, 2007~~

CHAPTER 7
HYDROLOGY

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LIST OF ATTACHMENTS

Attachment 7-1 Hydrology Calculations

710 INTRODUCTION

711 General Requirements

This chapter presents a description of the following:

- 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

All maps, plans, and cross sections presented in this chapter have been certified by a qualified, registered professional engineer.

713 Inspection

Inspections are not required since no permanent impoundments will exist at the well sites.

720 ENVIRONMENTAL DESCRIPTION

721 General Requirements

The application will include a description of the existing premining hydrologic resources with the proposed permit and adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operations.

722 Cross Sections and Maps

722.100 Location and Extent of Subsurface Water

Figure 7-1 in the approved M&RP shows a generalized hydrostratigraphic cross section of the permit and adjacent areas including the well sites. Section 724.100 of the approved M&RP provides baseline groundwater conditions.

722.200 Location of Surface Water Bodies

Plate 7-2 in the approved M&RP shows the locations of surface-water bodies and existing or pending water rights. Section 724.200 of the approved M&RP provides baseline surface water conditions.

722.300 Locations of Monitoring Stations

Plate 7-1 in the approved M&RP shows the location of surface water and groundwater monitoring stations.

722.400 Locations and Depth of Water Wells

Refer to Section 722.400 and Plate 7-1 of the approved M&RP for information pertaining to the groundwater monitoring wells. Refer to Appendix 7-9 of approved M&RP for details pertaining to the Gilson well.

722.500 Surface Topography

Surface topography features at the well sites and adjacent areas are shown on Figures 1-1, 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and in Attachment 5-1 for Degas Wells G-8 thru G-19, G-21, G-22, and G-31. Refer to Plate 1-4 in the M&RP for well locations.

The surface topography for the AMV access road is shown on Plate 1 included in Attachment 5-4.

723 Sampling and Analysis

Refer to Section 723 of the approved M&RP.

724 Baseline Information

Refer to Section 724 of the approved M&RP.

724.100 Groundwater Information

Refer to Section 724.100 of the approved M&RP.

724.200 Surface Water Information

Refer to Section 724.200 of the approved M&RP.

724.300 Geologic Information

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

724.400 Climatological Information

Climatological data are summarized in Appendix 4-1 behind the Air Quality Permit of the approved M&RP and RA Attachment 7-5 of the Refuse Pile Amendment.

724.500 Supplemental Information

Refer to Section 724.500 of the approved M&RP.

724.600 Survey of Renewable Resource Lands

Refer to Section 724.600 of the approved M&RP.

724.700 Alluvial Valley Floor Requirements

Information regarding the presence or absence of alluvial valley floors in the well sites and adjacent areas is presented in Chapter 9 of this submittal and the approved M&RP.

725 Baseline Cumulative Impact Area Information

The CHIA currently in place for the Dugout Canyon Mine covers the well sites. The hydrologic and geologic information required for the Division to develop a Cumulative Hydrologic Impact Assessment (CHIA) is presented in the approved M&RP.

726 Modeling

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

727 Alternative Water Source Information

Not applicable.

728 Probable Hydrologic Consequences

This section addresses the probable hydrologic consequences of construction and reclamation operations at the well sites. Mitigation measures are discussed generally in this section and in detail in Section 730 of the approved M&RP.

728.100 Potential Impacts of Surface and Groundwater

Potential impacts of the well sites in this area on the quality and quantity of surface and groundwater flow may include contamination from materials associated with the drilling of the wells. Once installed, the wells are designed as an ambient vent of methane gas, having no affect on the surface or groundwater. The potential impact is addressed in Section 728.300 of this submittal and the approved M&RP.

728.200 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of the approved M&RP. Baseline hydrologic information is presented in Section 724.100 and 724.200 of the approved M&RP.

728.300 PHC Determination

Potential Impacts to the Hydrologic Balance - Potential impacts of the Dugout Canyon Mine on the hydrologic balance of the well sites and adjacent areas are addressed in the subsections of this submittal and the approved M&RP. The PHC prepared by Mayo and Associates for the Dugout Canyon Mine is located in Appendix 7-3, Section 3 , of the approved M&RP. Refer to Chapter 3,

Section 322.200 for information addressing water usage for degas well drilling, as well as mining. Little to no impacts to the Hydrologic Balance are anticipated since 1) the potential impacts are limited to the drilling and construction of the wells; 2) BTCA techniques for sediment control are implemented for the surface disturbance of the well pad; 3) hydrogeologic information from in-mine observations, Degas wells G-1 through G-9, and PHC information included in the approved M&RP support that minimal groundwater is encountered in the geologic formations being drilled; and 4) any water encountered during drilling and construction of the well will need to be sealed for the well to function as an ambient vent of methane gas.

Acid and Toxic Forming Materials - No acid or toxic forming materials have been identified in the soils or strata of the Dugout Canyon Mine (Chapter 6, Section 623 of this submittal). Additional information is located in Appendix 6-2 of the approved M&RP.

Groundwater - When encountered during drilling groundwater aquifers will be sealed using drilling mud. At completion, the casing will be grouted and cement placed inside the well casing during reclamation. .

Once drilling is completed, the casing is grouted in the well hole, sealing aquifers to prevent groundwater migration, including groundwater migrating down the outside of the casing into the mine. Should water inflow greater than 15 gallon per minute be encountered during the drilling of the degas wells the depth and volume will be recorded and included in Attachment 7-1. No measurable inflows of water have been encountered during the drilling of degas wells G-1 thru G-9. **Water was encountered while drilling degas wells G-18A and G-31A, but the inflows were not measureable.**

The development and construction of degas wells does not have the potential to decrease creek flow or spring discharges, the wells are not designed to capture water, dewater aquifers or cause subsidence. Methane gas, not liquid (water) is pumped from the wells following construction.

Surface Water - Degas wells are not used to access water to be discharged to the surface. As mentioned above, no measureable water has been encountered during the drilling, construction and operation of degas wells G-1 thru G-9. Also, the well cannot function as a degas well if significant water is encountered, and will need to be abandoned.

Potential Hydrocarbon Contamination - Hydrocarbon products will not be stored at the well sites, however fuels, greases, and other oils may leak from equipment during drilling operations. Absorbent materials will be used for the collection of leaked fuels, greases, and other oils. The saturated absorbent materials will be disposed of at an appropriate landfill facility.

G-18, G-31 and AMV Access Road

728.300 The PHC Determination:

728.310 - The construction and operation of the G-18, G-31 well pads and associated access road is not anticipated to cause adverse impacts to the hydrologic balance. Several springs are located in the drainage in which the road begins. One small seep, SC-96, has been recorded a short distance down hill of a portion of the road near the center of Section 20, T13S R13E. However, this seep has not been observed flowing the past several year, which could be due to the dry climatic conditions the area has experienced. It should be understood that SC-96 is not a seep monitored on a quarter basis. It is unlikely the construction and operation of the road will impact the aquifer that has discharged at the seep since road construction will not require significant excavation or over the aquifer outcrop. Sediment control structures will be used to reduce the amount of suspended material that will leave that portion of the disturbed area of the road during runoff events that is directed to the small drainage where the seep is located. The remaining seeps and springs are located upstream of the road and near the canyon head. These groundwater discharge locations should not be impacted by road construction and operation since the aquifers feeding these discharges will either not be encountered during construction or minimal disturbance at the outcrops of the up-dip end of the aquifer will occur.

Sediment control structures will be used to reduce the likelihood of erosion and increased sediment loads greater than background to the ephemeral and intermittent drainage areas. Sediment controls have been designed to adequately address treatment of runoff from the steep hillsides and grades associated with the access road. The locations, designs, and descriptions of the sediment control structures to be implemented during road and pad construction, operation, and reclamation are contained in Attachments 5-4 and 7-1.

Examples of construction and operational sediment and erosion control on the road include building appropriately sized water bars or the canting of the road surface toward the uphill side of the road to divert runoff into the roadside ditch. When necessary the water bar outlets will be rip rapped with native rock. Native rock will be collected during the construction of the road to be used as rip rap. Culverts will be located at appropriate sites (Attachment 5-4, Plate 1) to direct flow from the ditch to drainages that would normally contain the area runoff. Where required appropriately sized rip-rap will be placed at the outlet of the culverts used to divert water into the existing ephemeral drainages.

According to calculations, culvert inlet velocities should be less than 5 fps, therefore no inlet protection is required. Silt fences will also be placed on the upstream end of the approach to the culverts to treat road runoff during construction. Silt fences will be placed at the toe of fill slopes during construction to reduce the amount of loose soil material and sediment laden runoff from entering the drainage. Outslopes and ditches associated with the road will be seeded during operations to encourage the establishment of vegetation and erosion control.

Erosion, runoff and sediment control at pads G-18 and G-31 during construction, operation, and reclamation may include, but not necessarily be limited to, construction of berms around the disturbed areas and the use of silt fence to treat runoff.

Reclamation of the road and well pads is described in Sections 340 and 760. As part of the reclamation activities the reclaimed and resoiled surfaces will be deep gouged to reduce the length of surface flow paths and trap runoff. The reclamation plan described in these sections have been

designed to minimize erosion and runoff by encouraging timely revegetation of the disturbed areas. Where necessary, silt fencing will be used during reclamation activities to contain loose soils and reduce sediment laden runoff.

728.320 - Soil samples have been obtained from selected sites in the road and pad areas. Results of the soil analyses indicate the samples did not contain acid-forming or toxic-forming materials. Thus, the soils moved or exposed as a result of the construction of the road and pad will not result in the contamination of the surface or ground-water supplies. Refer to Section 231 and Attachment 2-1.

728.330 - The sediment control structures to be constructed as part of the access road and G-18 and G -31 well pads project should minimize the sediment yield from disturbed areas during runoff events. As described in Section 527 and above in Section 728.310, silt fencing will be used at the downhill toe of the slope of the road fill during road construction to capture loose soils and rock. This will prevent loose material from entering the channels.

As described in the preceding sections, acid forming materials will not be exposed or created as part of the construction, operation, or reclamation of the road and pad areas. Total suspended solids will be controlled through the use of sediment control structures. Dissolved solids within the runoff from the disturbed areas is not likely to noticeably increase above background levels since the disturbance is generally occurring within weathered soils and bedrock surfaces. Much of the soluble material will have naturally leached from the shallow soils prior to the proposed disturbance. The soil samples obtained and analyzed are located in Attachment 2-1 and referenced in Section 728.320 above do not contain significant volumes of highly soluble minerals. Therefore, it is unlikely exposing these soils to increased moisture will result in increased total dissolved solids in the surface water relative to known background levels. No significant volumes of highly soluble materials are proposed to be imported as part of the construction, operation, and reclamation of the road and pad.

No impoundments or restriction of stream flows are anticipated as part of the road and pad project, making it unlikely that unnatural flooding will occur as a result of this project. No additional or new perennial or intermittent stream channel alterations are anticipated as part of this project. Culverts are to be placed in ephemeral channels at road crossings. The culverts are adequately sized such that flooding due to the placement of the culverts should not occur. Only minimal alteration to the ephemeral channels will occur during the placement of the culverts.

No groundwater is anticipated to be encountered during construction of the road or pads, therefore no change in groundwater availability is anticipated. Minimal amounts of surface water will be used for dust suppression during construction and operation of the road and pads.

728.340 - The sediment controls installed during construction, operation, and reclamation of the road and pad will not proximately result in contamination, diminution or interruption of an underground or surface source of water within the proposed permit or adjacent areas which is used for domestic, agricultural, industrial or other legitimate purpose.

728.350 - Five ephemeral drainages will be diverted by culverts placed at various locations along the length of the AMV access road. Because of the installation of the sediment controls and since no ground water and only surface water as described previously will be diverted as a result of this project, the road and pad construction will result in imperceptible contamination, diminution or interruption of State-appropriated water in existence within the proposed permit or adjacent areas at the time the application is submitted.

G-22 Access Road

728.300 The PHC Determination:

The construction and operation of the G-22 well pad and associated access road is not anticipated to cause adverse impacts to the hydrologic balance. Sediment control structures will be used to reduce the amount of suspended material that will leave that portion of the disturbed

area of the road during runoff events. There are no known springs in the path of the road or in the immediate area of the road and drill pad.

Sediment controls have been designed to adequately address treatment of runoff from the steep hillsides and grades associated with the access road. The locations, designs, and descriptions of the sediment control structures to be implemented during road and pad construction, operation, and reclamation are contained in Attachments 5-4 and 7-1.

Examples of construction and operational sediment and erosion control on the road include building appropriately sized water bars or the canting of the road surface toward the uphill side of the road to divert runoff into the roadside ditch. When necessary the water bar outlets will be rip rapped with native rock. Native rock will be collected during the construction of the road to be used as rip rap. Culverts will be located at appropriate sites (Figure 1, Contour Map for G-22, Attachment 5-1) to direct flow from the ditch to drainages that would normally contain the area runoff. Where required appropriately sized rip-rap will be placed at the outlet of the culverts used to divert water into the existing ephemeral drainages.

According to calculations, culvert inlet velocities should be less than 5 fps, therefore no inlet protection is required. Silt fences will be placed at the toe of fill slopes during construction to reduce the amount of loose soil material and sediment laden runoff from entering the drainage. Outslopes and ditches associated with the road will be seeded during operations to encourage the establishment of vegetation and erosion control.

Erosion, runoff and sediment control during construction, operation, and reclamation may include, but not necessarily be limited to, construction of berms around the disturbed areas and the use of silt fence to treat runoff.

Reclamation of the road and well pads is described in Sections 340 and 760. As part of the reclamation activities the reclaimed and resoiled surfaces will be deep gouged to reduce the length of surface flow paths and trap runoff. The reclamation plan described in these sections have been

designed to minimize erosion and runoff by encouraging timely revegetation of the disturbed areas. Where necessary, silt fencing will be used during reclamation activities to contain loose soils and reduce sediment laden runoff.

Soil samples have been obtained from selected sites in the road and pad areas. Results of the soil analyses indicate the samples did not contain acid-forming or toxic-forming materials. Thus, the soils moved or exposed as a result of the construction of the road and pad will not result in the contamination of the surface or ground-water supplies. Refer to Section 231 and Attachment 2-1.

As described in the preceding sections, acid forming materials will not be exposed or created as part of the construction, operation, or reclamation of the road and pad areas. Total suspended solids will be controlled through the use of sediment control structures. Dissolved solids within the runoff from the disturbed areas is not likely to noticeably increase above background levels since the disturbance is generally occurring within weathered soils and bedrock surfaces. It is unlikely exposing these soils to increased moisture will result in increased total dissolved solids in the surface water relative to known background levels. No significant volumes of highly soluble materials are proposed to be imported as part of the construction, operation, and reclamation of the road and pad.

No additional or new perennial or intermittent stream channel alterations are anticipated as part of this project. Culverts are to be placed in ephemeral channels at road crossings. The culverts are adequately sized such that flooding due to the placement of the culverts should not occur. Only minimal alteration to the ephemeral channels will occur during the placement of the culverts.

No groundwater is anticipated to be encountered during construction of the road or pads, therefore no change in groundwater availability is anticipated. Minimal amounts of surface water will be used for dust suppression during construction and operation of the road and pads.

729 Cumulative Hydrologic Impact Assessment (CHIA)

The Cumulative Hydrologic Impact Assessment currently in place for the Dugout Canyon Mine includes the well sites and adjacent areas.

730 OPERATION PLAN

731 General Requirements

731.100 Hydrologic - Balance Protection

Groundwater Protection - The effect on groundwater at the well sites is expected to be minimal. Groundwater encountered during drilling will be sealed off, refer to Section 728.300.

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 prevent water pollution.

During initial drilling, the sites will be graded to ensure that storm runoff will flow towards the berms surrounding the drilling pad area. The berms will direct the runoff to the lowest point(s) within the pad area where a silt fence and/or straw bale dike(s) will treat the runoff (see Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1). The berm placed at the top of the drilling pad cut slopes will divert runoff around the drilling pad. Thus reducing the runoff affected by the drilling pad.

The pad will be re-graded to cause the storm runoff to sheet flow towards a silt fence and/or straw bale dike. A berm will be placed at the top of the fill slope to direct any runoff from the operational pad to the silt fence and/or straw bale dike(see Figures 5-4, 5-8, 5-12, 5-19, 5-22, 5-25, 5-29 and Attachment 5-1). The silt fences and/or straw bale dikes will be periodically inspected, and accumulated sediment will be removed as needed to maintain functionality. The sediment from the silt fence and/or straw bale dikes will be piled on the pad and will be used for fill during final reclamation of the well site. During the drilling phase a berm and silt fence will be installed at the toe of the fill slope as shown on Figures 5-1, 5-5, 5-9, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1 to treat any runoff from the drilling pad.

731.200 Water Monitoring

No water monitoring will be conducted at the degas well sites. Refer to approved M&RP for a description of water monitoring.

731.300 Acid or Toxic Forming Materials

No acid or toxic forming materials are anticipated at the well sites (see Section 728.300).

731.400 Transfer of Wells

Refer to Section 731.400 of the approved M&RP.

731.500 Discharge

No discharges to underground workings.

731.600 Stream Buffer Zones

Stream Channel Diversions - No stream channel diversions are planned at the well sites, unless specified in the runoff controls specific to each well site. Streams in five ephemeral drainages will be diverted with the installation of culverts at various locations along the AMV road.

Buffer Zone Designation - When drilling sites are adjacent to a perennial or an intermittent stream, a stream buffer zone will be established. Well sites G-11, G-12, G-15 and G-19 require buffer zone designation. Refer to Chapter 5, Attachment 5-1 for drawings of well sites G-8 through G-17, G-19, G-21, G-22, and G-31. A buffer zone designation will be required on approximately the first 1100 feet of the AMV road, signs will be placed along the road at intervals so that the previous sign is visible at the location of the current sign.

731.700 Cross Section and Maps

Not applicable.

731.800 Water Rights and Replacement

Refer to Sections 728.300 and 731.800 of the approved M&RP.

732 Sediment Control Measures

The sediment control measures within the well sites have been designed to prevent additional contributions of sediment to stream flow or to runoff outside the well sites. In addition, the well sites have been designed to minimize erosion to the extent possible.

The structures to be used for runoff control at the well sites are berms, silt fences and/or straw bale dikes.

732.100 Siltation Structures

Berms, silt fences and straw bales dikes will be used to treat runoff.

732.200 Sedimentation Pond

The drilling sites will not have sedimentation ponds.

732.300 Diversions

Refer to Section 731.100 of this submittal.

732.400 Road Drainage

No diversion ditches will be constructed along the primary roads leading to the well sites. See Figures 5-13 and 5-14 for typical road cross sections. Where needed roads accessing the drill sites will have a water bar constructed at the base of the road to divert water off the road prior to the runoff reaching the drilling pad.

The incised road to well site G-16 will be constructed as shown on Figure 5-14 in the approved permit, water bars will be used to direct flow off the road and either silt fences or strawbales will be used to treat runoff. Refer to Chapter 5, Attachment 5-1 for drawings of well site G-16 showing the location of a single water bar, additional water bar(s) will be constructed as required to direct water from the road. Refer to Section 527.200 for road construction information.

Subsoil being cut in order to construction the pad for well G-15 will be placed on the existing road, causing it to be elevated, no new access road will be constructed to well site G-15.

The AMV access road will be classified as an ancillary road per a discussion with Wayne Western during a meeting at the UDOGM offices on April 16, 2007. The road is improving a trail used for hunting, cattle and for logging. Drawings showing the alignment and cross-sections of the road can be found in Attachment 5-4, as Plate 1 thru 3. A typical road cross section is found in Attachment

5-4 as Figure 1. The drawing outlines the disturbed area and shows the road center line, water bars, culverts, turnouts and topsoil stockpile locations.

The steepness of access road cut slopes will depend on the stability of the exposed subsurface material. Cuts into competent material such as bedrock will be sloped at angles of approximately 0.5H:1V (63.4 degrees). Cut into unconsolidated material such as soils will be sloped at angles of approximately 1H:1V (45 degrees). The steepness of these slopes is justified by the presence of several near-vertical bedrock outcrops and naturally steep (approximately 1H:1V) colluvial slopes in the vicinity of the proposed access road.

733 Impoundments

733.100 General Plans

Not applicable.

733.200 Permanent and Temporary Impoundments

No permanent impoundments will exist at the well sites.

734 Discharge Structures

A berm will surround the entire drill pad at each well site during the drilling phase (excepted as noted). The berm will divert undisturbed runoff around the drilling pad and direct runoff from the pad to a silt fence/straw bale dike at the lowest point within the well pad disturbed area. A silt fence and/or straw bale dike will be the discharge structure for each of the well sites during the operational phase.

735 Disposal of Excess Spoil

There will be no excess spoil generated at the well sites.

736 Coal Mine Waste

There will be no coal mine waste generated or stored at the well sites.

737 Non-Coal Mine Waste

There will be no non-coal mine waste disposed at the well sites.

738 Temporary Casing and Sealing of Wells

Refer to Section 542.700 of this submittal.

740 DESIGN CRITERIA AND PLANS

741 General Requirements

This submittal includes general well site plans that incorporate design criteria for the control of drainage.

742 Sediment Control Measures

742.100 General Requirements

Design - Sediment control measures have been formulated to prevent additional contributions of sediment to stream flow or to runoff outside the well site area; and minimize erosion to the extent possible.

Measures and Methods - Sediment control methods will include silt fences, berms, and straw bales to reduce runoff and trap sediment.

742.200 Siltation Structures

General Requirements - Additional contributions of suspended solids and sediment or runoff outside the well site area, including access roads will be prevented to the extent possible using silt fences, berms, and straw bale dikes. Construction activities will not occur during major precipitation events. As required, siltation structures will be installed prior to beginning site construction.

Design - All hydrology calculations were made using the 10-year, 24-hour precipitation event. Hydrology calculations are in Attachment 7-1. Locations of the berms and silt fences are shown on Figures 5-1, 5-4, 5-5, 5-8, 5-9, 5-12, 5-17, 5-20, 5-23, 5-27 and Attachment 5-1.

742.300 Diversions

No diversion ditches will be constructed as part of the drilling or operational phases, with the exception of the AMV road.

742.400 Road Drainage

Refer to Section 732.400 of this submittal. The road design for G-16 is shown on drawings located in Chapter 5, Attachment 5-1 and Figure 5-16. The road design for the AMV access road is shown in Attachment 5-4.

743 Impoundments

No impoundments will exist at the well sites.

744 Discharge Structures

No discharge structures have been planned or designed.

745 Disposal of Excess Spoil

There will be no excess spoil generated at the well sites.

746 Coal Mine Waste

746.100 General Requirements

There will be no coal mine waste used at the well sites.

746.200 Refuse Piles

There will be no refuse piles at the well sites.

746.300 Impounding Structures

Refer to Section 733.200 of this submittal.

746.400 Return of Coal Processing Waste to Abandoned Underground Workings

No coal processing waste will be generated at the well sites.

747 Disposal of Non-Coal Mine Waste

All non-coal mine waste will be disposed of at an approved landfill.

748 Casing and Sealing Wells

Refer to Section 542.700 of this submittal.

750 PERFORMANCE STANDARDS

751 Water Quality Standards and Effluent Limitations

Water encountered during drilling and runoff water will be treated using silt fence and/or straw bale dikes prior to leaving the site. Should it become necessary the water encountered during drilling will be pumped into a tank and hauled from the site for disposal at a licensed facility.

752 Sediment Control Measures

All sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Section 732, 742, and 760 of this submittal.

752.100 Siltation Structures and Diversions

Siltation structures will be located, maintained, constructed and reclaimed according to plans and designs presented in Section 732, 742, and 763 of the submittal.

752.200 Road Drainage

Refer to Section 732.400 of this submittal.

753 Impoundments and Discharge Structures

Refer to Section 733.200 of this submittal.

754 Disposal of Excess Spoil, Coal Mine Waste and Non-Coal Mine Waste

There will be no excess spoil or coal mine waste generated at the well sites. Refer to Section 747 of this submittal regarding non-coal waste disposal.

755 Casing and Sealing

Refer to Section 542.700 of this submittal.

760 RECLAMATION

761 General Requirements

A detailed reclamation plan for the well sites is presented in Section 540. No structures will exist at the well sites.

762 Roads

Refer to Section 542.600.

762.100 Restoring the Natural Drainage Patterns

The natural drainage patterns will be restored after degassification is completed.

762.200 Reshaping Cut and Fill Slopes

Cut and fill slopes will be reshaped at the well sites.

763 Siltation Structures

763.100 Maintenance of Siltation Structures

All siltation structures will be maintained until removed in accordance with the approved reclamation plan.

763.200 Removal of Siltation Structures

When a siltation structure is removed, the land on which the siltation structure was located will be regraded and revegetated in accordance with the reclamation plan presented in Section 540.

764 Structure Removal

A timetable for the reclamation of the sites is presented in Figures 5-15 (G-2 and G-5) and 5-26 (G-3, G-4, G-6 thru G-19, G-21, G-22, G-22 access road, G-31 and AMV access road).

765 Permanent Casing and Sealing of Wells

Refer to Section 542.700 of this submittal.

Canyon Fuel Company, LLC
Dugout Canyon Mine

Methane Degassification Amendment
August 25, 2008 ~~September 18, 2007~~

**ATTACHMENT 7-1
HYDROLOGY CALCULATIONS**

add to the back of existing information

HYDROLOGY CALCULATIONS
FOR
DEGAS WELL G-21



Pad G-21 Summary

Area within Disturbed Area Boundary (ac)	2.4
Disturbed Area Acreage (ac)	
Pad 21	1.6
Topsoil Excavation Volume Assuming 13 in. Salvage Depth (cyd)	2,718
Subsoil Volume for Berms (cyd)	198
Topsoil Stockpile Dimensions:	110'L X 60'W X 24'H

Topsoil Volume Calculation

Disturbed Area (ft ²)	Average Topsoil Depth (in)	Topsoil Volume (yd ³)
67,741	13	2,718

Notes

Average topsoil depth is taken from a site-specific soil survey of performed at the degas well pad.
 Topsoil Volume = Disturbed Area * Average Topsoil Depth

Topsoil Stockpile Capacity Calculation

Stockpile	Length (ft)	Width (ft)	Height (ft)	Volume (yd ³)
Pad on G-14	110	60	24	2,933

Notes

In order to minimize the disturbed area, topsoil will be stockpiled on previously permitted degas well pads, such as G-14.
 Volume calculated as 0.5*length of base * width * height of pile.
 Topsoil stockpile will be sloped at approximately 1.25H:1V

Excess Subsoil Volume Calculation

Area	AutoCAD Cut Volume (yd ³)	AutoCAD Fill Volume (yd ³)	Topsoil Volume (yd ³)	Percentage of Disturbed Area to be Cut	Total Subsoil Cut Volume (yd ³)	Total Subsoil Fill Volume (yd ³)	Total Berm Volume (yd ³)	Excess Cut (-) or Fill(+) (yd ³)
Pad on G-14	8,418	4,040	2,718	50%	7,059	5,399	198	1,462

Notes

AutoCAD cut and fill volumes do not consider topsoil.
 Topsoil volume taken from Topsoil Volume Calculation above.
 The percentage of disturbed area to be cut is the portion of the pad/road that will excavated below grade during construction.
 Total subsoil cut volume = AutoCAD cut volume - (percentage of disturbed area to be cut * total topsoil volume).
 Total subsoil fill volume = AutoCAD fill volume + (1-percentage of disturbed area to be cut) * total topsoil volume.
 Total berm volume includes the berm around the pad and the berm around the topsoil stockpile. The pad berm volume was assumed to be 2 feet tall with 1H:1V suide slopes, with a length of 995 feet. The topsoil stockpile berm volume calculation is tabulated on the attached Stockpile Runoff Containment Volume Calculations Table.
 Excess cut/fill indicates how much subsoil will have to be stockpiled (+ value) or imported (- value) to construct the pad. The net cut/fill = Total subsoil fill volume - Total subsoil cut volume - Total berm volume.

Stockpile Runoff Volume Calculations

Stockpile	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. - P (in)	Curve Number (CN)	Potential Max. Retention - S (in.)	Runoff - Q (in)	Runoff Volume - V (ft ³)
Pad on G-14	6,600	0.15	2.05	87	1.49	0.94	520

Notes

Calculations have been performed for the 10-year, 24-hour design storm event.

Topsoil is derived from the Senchert Loam and Bachus Soils, as described in a site-specific soil survey performed at the pad. Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

Precipitation for 10-year, 24-hour event taken from National Weather Service web site (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/ut_pfds.html)

$CN = 87$, based on Table 9.1, NEH s4 ch9. Use Hydrologic Soil Group C, as given for the both the Senchert Loam and for Bachus Soils in the published NRCS Surveys. Assume road, dirt surface (non-vegetated, conservative case).

$$S = (1000/CN) - 10$$

$$L = [(1^{0.8} (S+1)^{0.7}) / (1900Y^{0.5})]$$

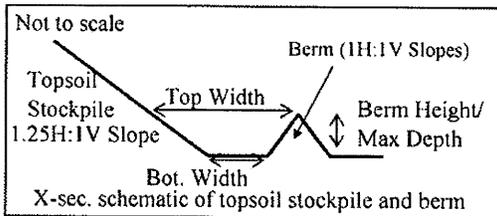
$$T_c = 1.67L$$

$$Q = (P - 0.2*S)^2 / (P + 0.8*S)$$

$$V = \text{Area} * Q$$

Stockpile Runoff Containment Volume Calculations

Stockpile	Bottom Width (ft)	Top Width (ft)	Max Depth (ft)	Impounding Length of Berm (ft)	Total Length of Berm (ft)	Fill Req'd for Berm (yd ³)	Contnmt Vol. (ft ³)	Contain Vol > Runoff Vol ?
Pad on G-14	1	5.5	2	300	340	50	1,950	Yes



Notes

The bottom width is the distance between the toe of the topsoil stockpile and the base of the berm. (see schematic)

The top width is the horizontal distance between the crest of the berm and the topsoil stockpile. (see schematic)

The max depth is the height of the berm.

The Impounding Length of the berm accounts for the slope of the ground, and is the portion of the berm that will impound

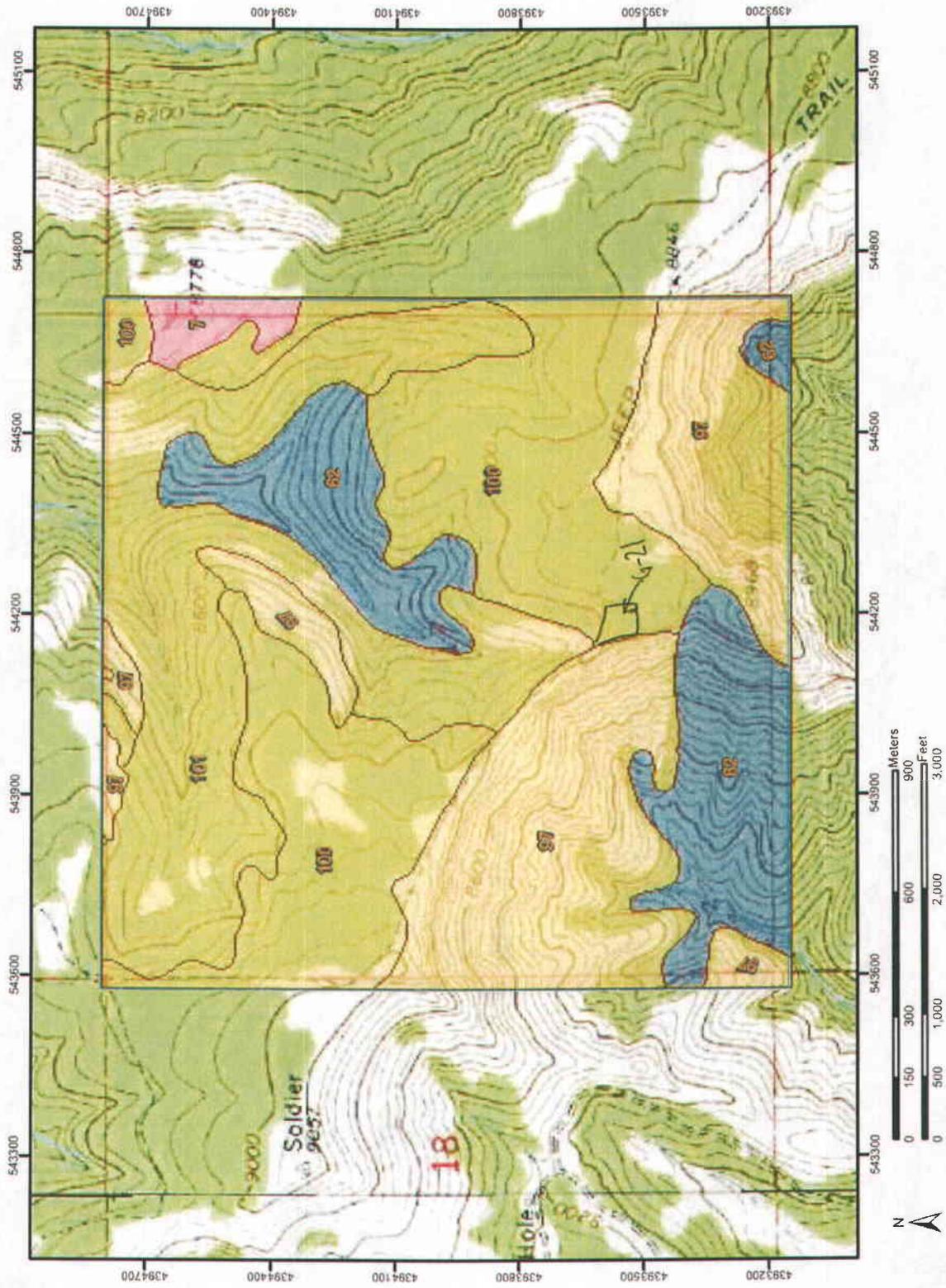
The Total Length of Berm is its entire length around the topsoil stockpile.

The Fill Required for Berm is the volume of subsoil required to construct each berm, and is based on the length, height, and width of each berm. Berms shall be constructed with 1H:1V slopes.

The Containment Volume = Length * Cross sectional area of the space between the topsoil stockpile and the inby side of the berm.

BACKGROUND INFORMATION

Hydrologic Soil Group—Carbon Area, Utah, Parts of Carbon and Emery Counties



MAP LEGEND

- Area of Interest (AOI)
 - Area of Interest (AOI)
- Soils
 - Soil Map Units
- Soil Ratings
 - A
 - A/D
 - B
 - B/D
 - C
 - C/D
 - D
- Not rated or not available
- Political Features
 - Municipalities
- Cities
- Urban Areas
- Water Features
 - Oceans
 - Streams and Canals

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: UTM Zone 12N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Carbon Area, Utah, Parts of Carbon and Emery Counties
Survey Area Data: Version 4, Jul 2, 2008

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Carbon Area, Utah, Parts of Carbon and Emery Counties				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
7	Beje-Trag complex	D	10.4	1.5%
62	Midfork family- Comodore complex	B	113.5	16.4%
97	Rottulee family-Trag complex	C	193.6	28.0%
100	Senchert loam, 3 to 15 percent slopes	C	204.9	29.7%
101	Senchert loam, 30 to 50 percent slopes	C	168.4	24.4%
Totals for Area of Interest (AOI)			690.8	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower



POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14



Utah 39.68175 N 110.48129 W 7946 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G M Bonnin, D Martin, B I in, T Parzybok, M Yekta, and D Riley
NOAA National Weather Service, Silver Spring, Maryland, 2006

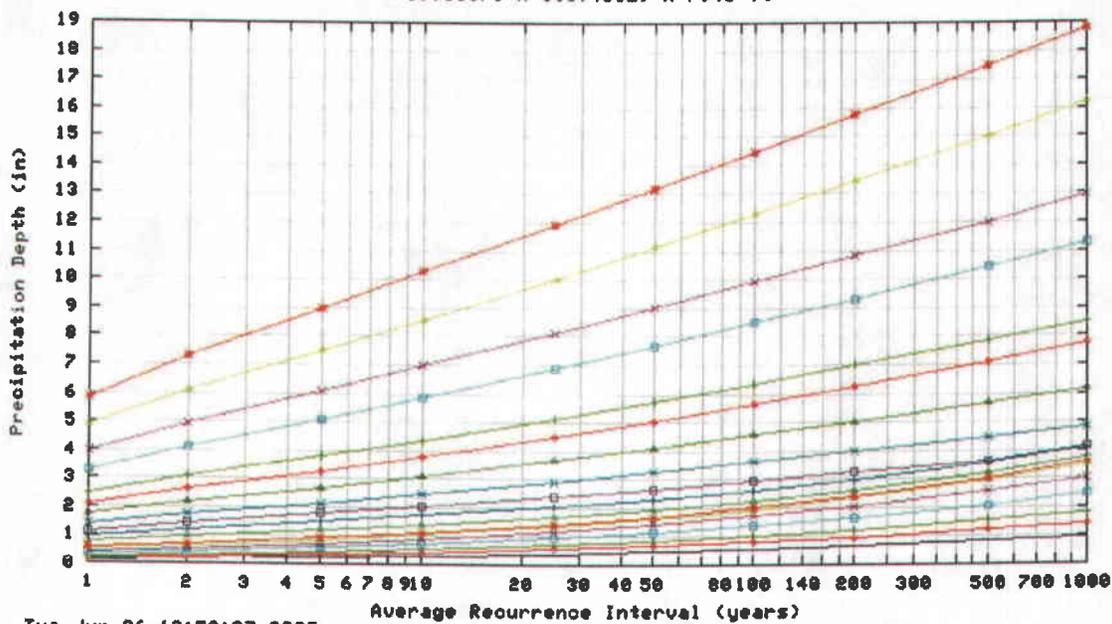
Extracted Tue Jun 26 2007

Precipitation Frequency Estimates (inches)																		
ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.14	0.20	0.25	0.34	0.42	0.52	0.59	0.77	0.99	1.18	1.40	1.74	2.12	2.44	3.26	3.97	4.88	5.83
2	0.17	0.26	0.33	0.44	0.55	0.65	0.74	0.96	1.23	1.46	1.74	2.16	2.65	3.06	4.08	4.95	6.10	7.31
5	0.24	0.36	0.45	0.60	0.74	0.86	0.95	1.19	1.50	1.78	2.13	2.67	3.29	3.78	5.05	6.09	7.50	9.00
10	0.29	0.45	0.55	0.74	0.92	1.06	1.15	1.38	1.73	2.05	2.46	3.08	3.80	4.36	5.82	6.98	8.59	10.29
25	0.38	0.58	0.72	0.97	1.20	1.36	1.45	1.67	2.05	2.40	2.89	3.65	4.52	5.14	6.86	8.15	10.04	11.96
50	0.46	0.70	0.86	1.16	1.44	1.64	1.72	1.92	2.32	2.68	3.24	4.09	5.08	5.74	7.66	9.04	11.15	13.22
100	0.55	0.83	1.03	1.39	1.72	1.96	2.04	2.22	2.60	2.96	3.60	4.55	5.67	6.36	8.48	9.94	12.29	14.50
200	0.65	0.99	1.23	1.66	2.05	2.33	2.41	2.57	2.94	3.25	3.96	5.03	6.28	7.00	9.31	10.84	13.44	15.78
500	0.82	1.24	1.54	2.08	2.57	2.93	3.03	3.18	3.53	3.64	4.45	5.67	7.11	7.86	10.44	12.03	14.99	17.48
1000	0.97	1.47	1.83	2.46	3.04	3.49	3.59	3.74	4.09	4.13	4.84	6.17	7.77	8.53	11.30	12.94	16.22	18.80

[Text version of table](#)

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

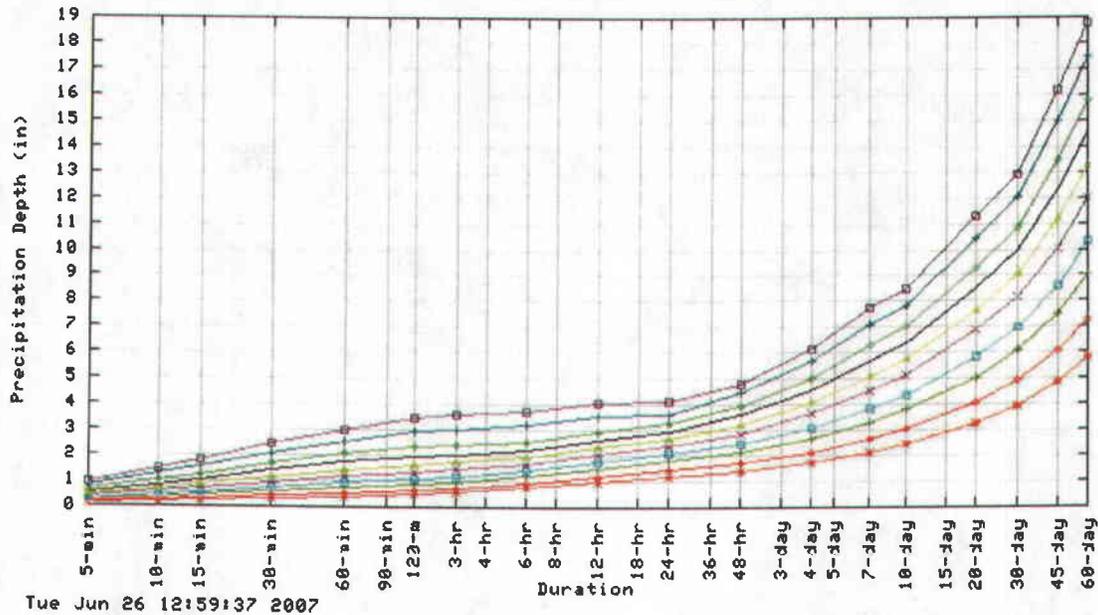
Partial duration based Point Precipitation Frequency Estimates Version: 4
 39.68175 N 110.48129 W 7946 ft



Tue Jun 26 12:59:37 2007

Duration			
5-min	120-min	48-hr	30-day
10-min	3-hr	4-day	45-day
15-min	6-hr	7-day	60-day
30-min	12-hr	10-day	
60-min	24-hr	20-day	

Partial duration based Point Precipitation Frequency Estimates Version: 4
39.68175 N 110.48129 W 7946 ft



Confidence Limits -

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.16	0.24	0.30	0.41	0.51	0.60	0.69	0.88	1.11	1.31	1.56	1.94	2.41	2.74	3.65	4.43	5.44	6.49
2	0.21	0.32	0.39	0.53	0.65	0.76	0.86	1.09	1.38	1.63	1.94	2.42	3.01	3.42	4.56	5.54	6.80	8.12
5	0.28	0.43	0.53	0.72	0.89	1.01	1.11	1.35	1.68	2.00	2.38	2.98	3.73	4.24	5.66	6.80	8.37	10.00
10	0.35	0.53	0.66	0.89	1.10	1.24	1.33	1.58	1.94	2.29	2.74	3.44	4.33	4.89	6.53	7.79	9.60	11.44
25	0.46	0.69	0.86	1.16	1.43	1.60	1.69	1.91	2.32	2.69	3.23	4.08	5.15	5.76	7.70	9.12	11.24	13.33
50	0.55	0.83	1.04	1.40	1.73	1.93	2.01	2.21	2.63	3.00	3.62	4.58	5.80	6.45	8.61	10.14	12.51	14.77
100	0.66	1.00	1.24	1.67	2.07	2.33	2.40	2.58	2.97	3.33	4.03	5.11	6.50	7.17	9.55	11.18	13.80	16.25
200	0.79	1.20	1.49	2.01	2.49	2.79	2.87	3.01	3.38	3.66	4.45	5.65	7.22	7.91	10.53	12.23	15.15	17.77
500	1.01	1.54	1.90	2.56	3.17	3.59	3.67	3.79	4.13	4.17	5.04	6.42	8.24	8.93	11.88	13.66	17.01	19.80
1000	1.22	1.85	2.30	3.09	3.83	4.35	4.43	4.52	4.85	4.90	5.51	7.04	9.06	9.75	12.94	14.77	18.49	21.43

* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than
 ** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
 Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

*** Lower bound of the 90% confidence interval**

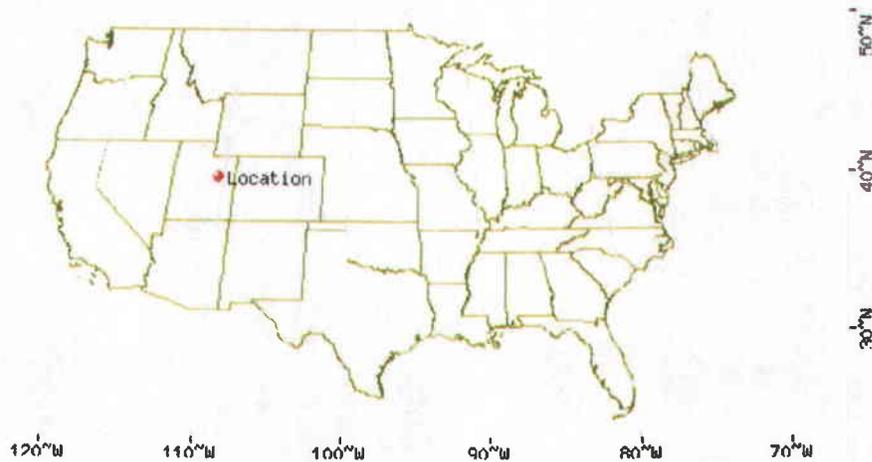
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.12	0.18	0.22	0.29	0.36	0.45	0.52	0.69	0.90	1.07	1.26	1.56	1.89	2.19	2.94	3.59	4.41	5.28
2	0.15	0.23	0.28	0.38	0.47	0.57	0.65	0.85	1.11	1.32	1.57	1.95	2.36	2.75	3.68	4.48	5.51	6.61
5	0.20	0.31	0.38	0.52	0.64	0.75	0.84	1.05	1.34	1.61	1.92	2.39	2.92	3.38	4.53	5.49	6.75	8.10
10	0.25	0.38	0.47	0.63	0.79	0.90	1.00	1.22	1.54	1.84	2.20	2.75	3.37	3.88	5.22	6.26	7.69	9.22
25	0.32	0.48	0.59	0.80	0.99	1.14	1.24	1.45	1.81	2.15	2.58	3.23	3.97	4.55	6.10	7.27	8.94	10.66
50	0.37	0.56	0.70	0.94	1.17	1.34	1.44	1.65	2.02	2.39	2.86	3.60	4.43	5.05	6.76	8.02	9.86	11.71
100	0.43	0.66	0.82	1.10	1.36	1.56	1.67	1.88	2.23	2.62	3.15	3.97	4.90	5.55	7.41	8.75	10.78	12.73
200	0.50	0.76	0.94	1.27	1.57	1.81	1.93	2.13	2.48	2.85	3.44	4.34	5.36	6.06	8.07	9.47	11.69	13.73
500	0.60	0.91	1.13	1.52	1.88	2.17	2.32	2.56	2.93	3.15	3.81	4.82	5.99	6.71	8.90	10.36	12.86	15.01
1000	0.68	1.04	1.29	1.73	2.15	2.48	2.65	2.94	3.34	3.38	4.10	5.18	6.46	7.19	9.53	11.03	13.76	15.97

* The lower bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are less than
 ** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval

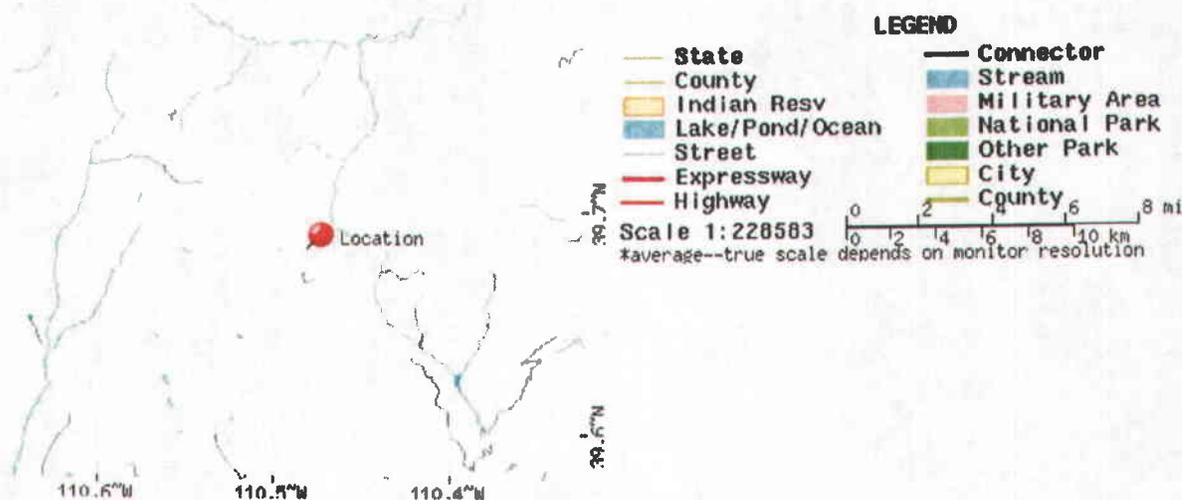
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero

Maps -



These maps were produced using a direct map request from the
 U.S. Census Bureau Mapping and Cartographic Resources
 Tiger Map Server

Please read disclaimer for more information.



Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; USGS Aerial Photograph may also be available from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to our documentation.

Using the National Climatic Data Center's (NCDC) station search engine, locate other climate stations within:

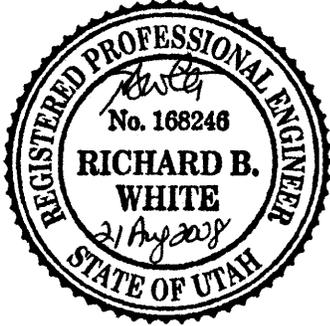
...OR... of this location (39.68175/-110.48129). Digital ASCII data can be obtained directly from NCDC.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOWpack TELEmetry) stations by visiting the Western Regional Climate Center's state-specific SNOTEL station maps.

Hydrometeorological Design Studies Center
 DOC/NOAA/National Weather Service
 1325 East-West Highway
 Silver Spring, MD 20910
 (301) 713-1669
 Questions? HDSC.Questions@noaa.gov

Disclaimer

HYDROLOGY CALCULATIONS
FOR
DEGAS WELL G-22



Pad G-22 Summary

Area within Disturbed Area Boundary (ac)	
Pad G-22	1.3
Access Road	2.2
Total	3.5
Disturbed Area Acreage (ac)	
Pad G-22	0.72
Access Road	0.85
Total	1.6
Topsoil Excavation Volume Assuming 10 in. Salvage Depth (cyd)	1,137
Subsoil Volume for Berms (cyd)	140
Topsoil Stockpile Dimensions:	
Stockpile Located on G-16 Pad	85'L X 65'W X 25'H

Topsoil Volume Calculation

Area	Disturbed Area (ft ²)	Average Topsoil Depth (in)	Topsoil Volume (yd ³)
Pad G-22	31,304	10	966
Access Road	36,849	10	1,137
TOTAL	68,153	10	2,103

Notes

Average topsoil depth is taken from a site-specific soil survey of performed at the degas well pad.
 Topsoil Volume = Disturbed Area * Average Topsoil Depth

Topsoil Stockpile Capacity Calculation

Stockpile	Length (ft)	Width (ft)	Height (ft)	Volume (yd ³)
Pile on G-16	85	65	25	2,558

Notes

In order to minimize the disturbed area, topsoil will be stockpiled on previously permitted degas well pads, such as G-16.
 Volume calculated as 0.5*length of base * width * height of pile.
 Topsoil stockpile will be sloped at approximately 1.25H:1V

Excess Subsoil Volume Calculation

Area	AutoCAD Cut Volume (yd ³)	AutoCAD Fill Volume (yd ³)	Topsoil Volume (yd ³)	Percentage of Disturbed Area to be Cut	Total Subsoil Cut Volume (yd ³)	Total Subsoil Fill Volume (yd ³)	Total Berm Volume (yd ³)	Excess Cut (-) or Fill(+) (yd ³)
Pad G-22	1,429	2,161	966	22%	1,219	2,917	47	-1,746
Access Road	7,304	3	1,137	100%	6,167	3	46	6,118
TOTAL	8,733	2,164	2,103	NA	7,386	2,920	93	4,372

Notes

AutoCAD cut and fill volumes do not consider topsoil.
 Topsoil volume taken from Topsoil Volume Calculation above.
 The percentage of disturbed area to be cut is the portion of the pad/road that will excavated below grade during construction.
 Total subsoil cut volume = AutoCAD cut volume - (percentage of disturbed area to be cut * total topsoil volume).
 Total subsoil fill volume = AutoCAD fill volume + (1-percentage of disturbed area to be cut) * total topsoil volume.
 Total topsoil stockpile berm volume (47 yd³) calculation tabulated on the attached Stockpile Runoff Containment Volume Calculations Table.
 Total access road berm volume assumes a 1,233-foot long, 1-foot tall berm, with 1H:1V side slopes.
 Excess cut/fill indicates how much subsoil will have to be stockpiled (+ value) or imported (- value) to construct the pad. The net cut/fill = Total subsoil fill volume - Total subsoil cut volume - Total berm volume.

Stockpile Runoff Volume Calculations

Stockpile	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. - P (in)	Curve Number (CN)	Potential Max. Retention - S (in.)	Runoff - Q (in)	Runoff Volume - V (ft ³)
Pile on G-16	5,525	0.13	2.05	88	1.36	1.01	463

Notes

Calculations have been performed for the 10-year, 24-hour design storm event.

Topsoil is derived from the Rotulee-Trag family complex and Beje Soils, as described in a site-specific soil survey performed at the pad.

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

Precipitation for 10-year, 24-hour event taken from National Weather Service web site (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/ut_pfds.html)

CN = 88, based on Table 9.1, NEH s4 ch9. Use the average value for the Rotulee-Trag family (87), which is classified as Hydrologic Soil Group C, and Beje Soils (89), which is classified as Hydrologic Soil Group D. Assume road, dirt surface (non-vegetated, conservative case).

$$S = (1000/CN) - 10$$

$$L = [(1^{0.8} (S+1)^{0.7}) / (1900Y^{0.5})]$$

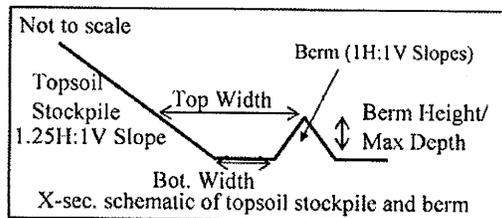
$$T_c = 1.67L$$

$$Q = (P - 0.2*S)^2 / (P + 0.8*S)$$

$$V = \text{Area} * Q$$

Stockpile Runoff Containment Volume Calculations

Stockpile	Bottom Width (ft)	Top Width (ft)	Max Depth (ft)	Impounding Length of Berm (ft)	Total Length of Berm (ft)	Fill Req'd for Berm (yd ³)	Cntnmt Vol. (ft ³)	Contain Vol > Runoff Vol ?
Pile on G-16	1	5.5	2	180	320	47	1,170	Yes



Notes

The bottom width is the distance between the toe of the topsoil stockpile and the base of the berm. (see schematic)

The top width is the horizontal distance between the crest of the berm and the topsoil stockpile. (see schematic)

The max depth is the height of the berm.

The Impounding Length of the berm accounts for the slope of the ground, and is the portion of the berm that will impound

The Total Length of Berm is its entire length around the topsoil stockpile.

The Fill Required for Berm is the volume of subsoil required to construct each berm, and is based on the length, height, and width of each berm. Berms shall be constructed with 1H:1V slopes.

The Containment Volume = Length * Cross sectional area of the space between the topsoil stockpile and the inby side of the berm.

Access Road Hydrology Calculations

	Upper Watershed	Lower Watershed
Road Ditch Specifications		
Side Slopes	1H:1V	1H:1V
Bottom width (ft)	0	0
Min. Depth (ft)	0.67	0.67
Road Ditch Hydrology - Design Event		
Peak Stage (ft)	0.44	0.36
Peak Flow (cfs)	0.42	0.35
Peak Flow Velocity (fps)	2.18	2.64
Culvert/Water Bar Specifications		
Structure	Culvert	Water Bar
Material	CSP/HDPE	Compacted earth
Min. Diameter (in)/Dimensions	20	See Notes
Slope (ft/ft)	0.075 - 0.10	0.05 - 0.10
Culvert/Water Bar Hydrology - Design Event		
Peak Stage (ft)	0.35	0.09
Peak Flow (cfs)	1.96	0.35
Peak Flow Velocity (fps)	5.92	2.60
Culvert/Water Bar Outlet Specifications		
Min. D ₅₀ of Outlet Armor (in)	12	None Required
Min. Length of Outlet Armor (ft)	7	NA
Culvert/Water Bar Outlet Hydrology - Design Event		
Steady State Peak Flow Velocity (fps)	6.34	4.72

Notes

Hydrology calculations for road ditches and water bars are based on the 10-year, 6-hour design precipitation event. Calculations for the culvert discharge to an ephemeral stream channel are based on the 10-year, 24-hour design precipitation event. Modeling was performed with HydroCAD 8.00 and Flowmaster software (see attached output sheets)

Refer to Figure 1 for locations of watersheds. NRCS soils units with their corresponding Hydrologic Soil Groups are shown on the attached NRCS Web Soil Survey Maps.

Flow velocities less than 5 fps were considered to be nonerosive, and thus ditches and outlet structures with such velocities do not require rip rap protection.

Where modeled flow velocities exceed 5 fps, rip rap has been specified based on its potential to reduce flow velocities and resist erosion. The flow velocity reduction caused by rip rap was modeled with Flowmaster using a relationship between Manning's Roughness (n), channel slope, and the D₅₀ of the rip rap Abt et. Al (1987). This relationship is expressed as $n = 0.0456(D_{50} \times S)^{0.159}$, where D₅₀ is the median rip rap diameter in inches and S is the channel slope. The stability of the rip rap against the modeled flow velocities was verified according to recommendations in FHWA HEC No. 11, Figure 2 (1978). Since the culvert outlet would discharge to an ephemeral stream channel, it is assumed that this channel is sufficiently self-armored to handle the peak design culvert discharge velocity. As a conservative measure, rip rap has been specified near the culvert outlet. No rip rap would be required at the water bar outlet since flow velocity is already less than 5 fps.

Water bars should have side slopes of approximately 3H:1V and 6H:1V, 1 foot of flat bottom, and must be sloped at 5-10%.

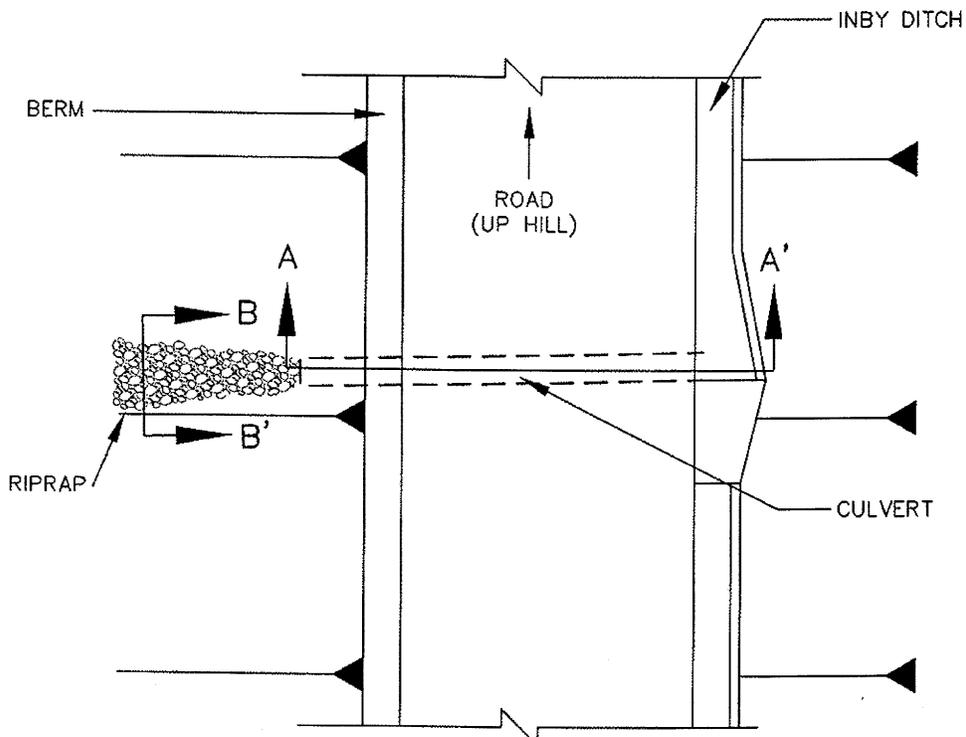
Although only one water bar is specified along the access road (at the entrance to pad G-22), additional water bars may be installed.

Culvert inlet stage was determined to be negligible using using FHWA HEC No. 5 Chart 5 (USDOT, 1977) (attached)

Lengths of culvert and water bar outlet protection were determined from recommendations in FHWA HEC No. 14, Table 10.1.

Refer to Figure 2 for a typical drawing of road culverts and outlet protection.

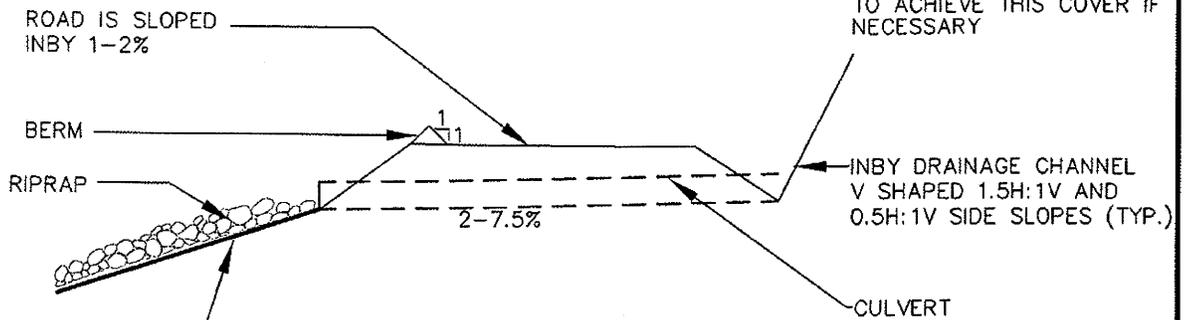
CALCULATIONS



PLAN

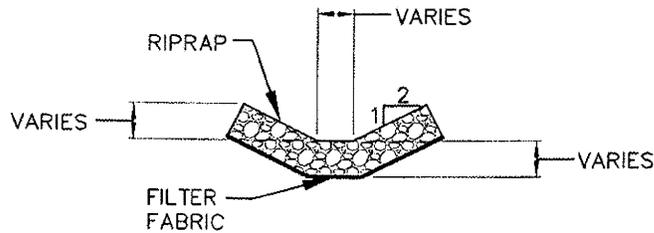
NOT TO SCALE

CULVERT MUST HAVE 1 FT. MIN. COVER. CHANNEL MAY BE WIDENED AND DEEPENED TO ACHIEVE THIS COVER IF NECESSARY



SECTION A-A'

NOT TO SCALE



SECTION B-B'

NOT TO SCALE

FIGURE 2. ROAD RUNOFF CULVERT PLAN



Culvert Outlet Rip Rap Calculation (D50 = 12") Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Culvert Outlet Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.061
Slope	0.500000 ft/ft
Left Side Slope	2.00 H:V
Right Side Slope	2.00 H:V
Bottom Width	0.00 ft
Discharge	2.20 cfs

$n = 0.0456 (D_{50} \times S)^{0.153}$
 $D_{50} = 12''$
 $S = 0.5 \text{ ft/ft}$

Results	
Depth	0.44 ft
Flow Area	0.4 ft ²
Wetted Perimeter	1.95 ft
Top Width	1.74 ft
Critical Depth	0.60 ft
Critical Slope	0.094197 ft/ft
Velocity	5.79 ft/s
Velocity Head	0.52 ft
Specific Energy	0.96 ft
Froude Number	2.19
Flow Type	Supercritical

*> 5 fps, but since culvert discharges to an ephemeral stream channel with $D_{50} > \approx 6''$, this is acceptable.
 (see FHWA Hec No. 11 Fig 2 graph)*

Reference: Use of Riprap for Bank Protection
 Hydraulic Engineering Circular No. 11
 U.S. DOT Federal Highway Admin 1978

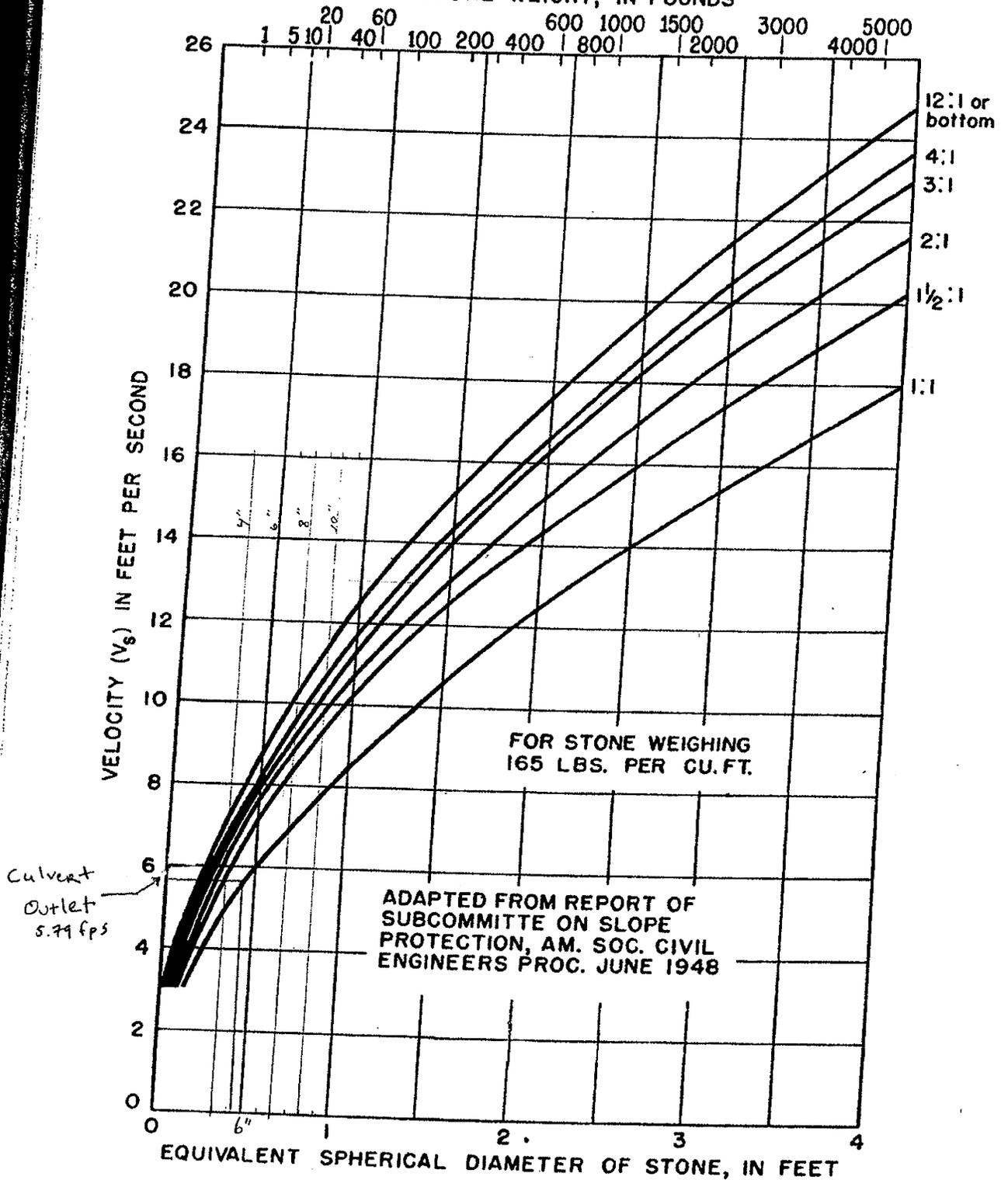
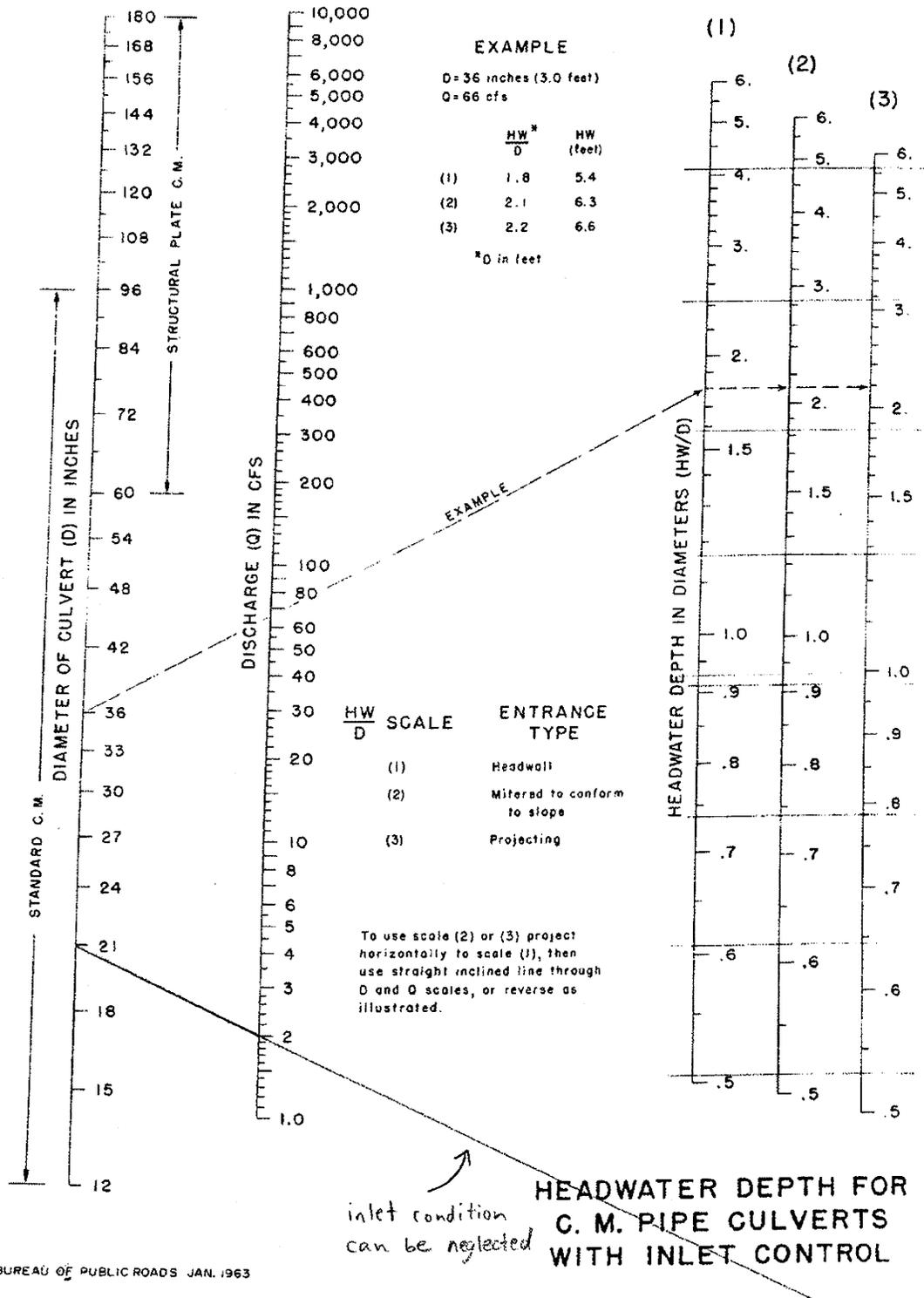


FIG. 2 - SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

CHART 5



Water Bar Outlet Protection Calculation (No Protection) Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Water Bar Outlet Ditch
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

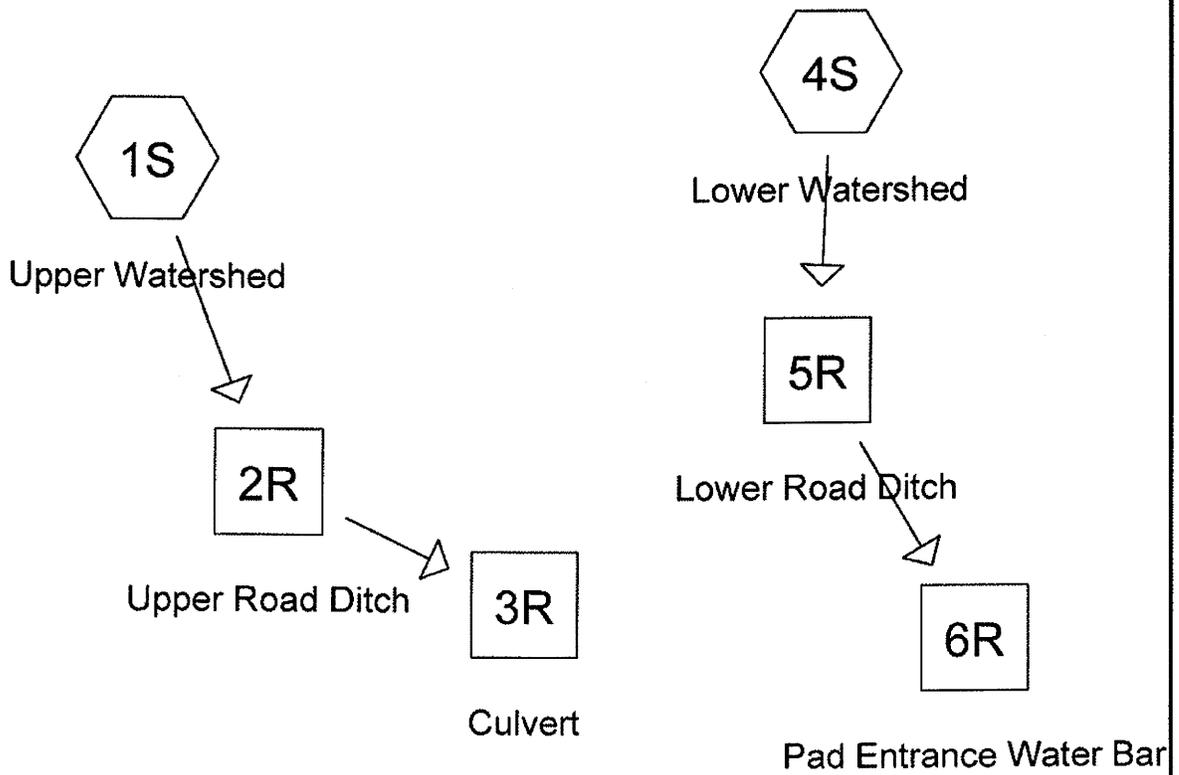
Input Data	
Mannings Coefficient	0.035
Slope	0.560000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	1.00 ft
Discharge	0.35 cfs

$n = 0.035 \rightarrow$ Rough Earth

Results	
Depth	0.07 ft
Flow Area	0.1 ft ²
Wetted Perimeter	1.29 ft
Top Width	1.26 ft
Critical Depth	0.14 ft
Critical Slope	0.038716 ft/ft
Velocity	4.72 ft/s
Velocity Head	0.35 ft
Specific Energy	0.41 ft
Froude Number	3.44
Flow Type	Supercritical

$v < 5.0$ fps, nonerosive

10 year, 6 hour precip event



Drainage Diagram for G22 Road 10-6
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G22 Road 10-6

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.216	74	(1S,4S)
6.216		TOTAL AREA

G22 Road 10-6

Type II 24-hr 6.00 hrs Rainfall=1.38"

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Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points

Runoff by SCS TR-20 method, UH=SCS

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Upper Watershed Runoff Area=173,593 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=845' Slope=0.4809 '/' Tc=4.8 min CN=74 Runoff=0.75 cfs 0.036 af

Subcatchment 4S: Lower Watershed Runoff Area=97,193 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=742' Slope=0.5443 '/' Tc=4.1 min CN=74 Runoff=0.47 cfs 0.020 af

Reach 2R: Upper Road Ditch Avg. Depth=0.44' Max Vel=2.18 fps Inflow=0.75 cfs 0.036 af
n=0.040 L=845.0' S=0.0414 '/' Capacity=1.30 cfs Outflow=0.42 cfs 0.036 af

Reach 3R: Culvert Avg. Depth=0.17' Max Vel=3.74 fps Inflow=0.42 cfs 0.036 af
D=20.0" n=0.025 L=40.0' S=0.0800 '/' Capacity=20.46 cfs Outflow=0.42 cfs 0.036 af

Reach 5R: Lower Road Ditch Avg. Depth=0.36' Max Vel=2.64 fps Inflow=0.47 cfs 0.020 af
n=0.040 L=383.0' S=0.0783 '/' Capacity=1.79 cfs Outflow=0.35 cfs 0.020 af

Reach 6R: Pad Entrance Water Bar Avg. Depth=0.09' Max Vel=2.60 fps Inflow=0.35 cfs 0.020 af
n=0.022 L=20.0' S=0.0500 '/' Capacity=54.87 cfs Outflow=0.35 cfs 0.020 af

Total Runoff Area = 6.216 ac Runoff Volume = 0.057 af Average Runoff Depth = 0.11"
100.00% Pervious = 6.216 ac 0.00% Impervious = 0.000 ac

G22 Road 10-6

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Type II 24-hr 6.00 hrs Rainfall=1.38"

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Summary for Subcatchment 1S: Upper Watershed

Runoff = 0.75 cfs @ 3.06 hrs, Volume= 0.036 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
* 173,593	(74)	Rotulee-Trag Complex, Hyd Soil Group C
173,593		Pervious Area

Mountain Brush Mixture, Poor COND
IN TABLE 7-15, UDOT MANUAL OF INSTRUCTION.

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	845	0.4809	2.94		Lag/CN Method, Contour Length= 3,339' Interval= 25'

Summary for Subcatchment 4S: Lower Watershed

Runoff = 0.47 cfs @ 3.04 hrs, Volume= 0.020 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Type II 24-hr 6.00 hrs Rainfall=1.38"

Area (sf)	CN	Description
* 97,193	(74)	same soils / vegetation as upper watershed
97,193		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	742	0.5443	3.05		Lag/CN Method, Contour Length= 2,116' Interval= 25'

Summary for Reach 2R: Upper Road Ditch

Inflow Area = 3.985 ac, 0.00% Impervious, Inflow Depth = 0.11"

Inflow = 0.75 cfs @ 3.06 hrs, Volume= 0.036 af

Outflow = 0.42 cfs @ 3.26 hrs, Volume= 0.036 af, Atten= 44%, Lag= 12.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Max. Velocity= 2.18 fps, Min. Travel Time= 6.5 min

Avg. Velocity= 0.98 fps, Avg. Travel Time= 14.4 min

Peak Storage= 163 cf @ 3.15 hrs, Average Depth at Peak Storage= 0.44'

Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.30 cfs

0.00' x 0.67' deep channel, n= 0.040 Earth, cobble bottom, clean sides

Side Slope Z-value= 1.0 ' Top Width= 1.34'

Length= 845.0' Slope= 0.0414 ' /'

Inlet Invert= 8,140.00', Outlet Invert= 8,105.00'

G22 Road 10-6

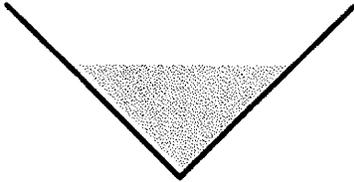
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Type II 24-hr 6.00 hrs Rainfall=1.38"

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Summary for Reach 3R: Culvert

→ Note: this is the 10-year, 6-hour condition. The design event for the culvert is the 10yr, 24 hr event. See attached sheets for the 10-24 event

[52] Hint: Inlet/Outlet conditions not evaluated

[61] Hint: Exceeded Reach 2R outlet invert by 0.17' @ 3.26 hrs

Inflow Area = 3.985 ac, 0.00% Impervious, Inflow Depth = 0.11"
Inflow = 0.42 cfs @ 3.26 hrs, Volume= 0.036 af
Outflow = 0.42 cfs @ 3.27 hrs, Volume= 0.036 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Max. Velocity= 3.74 fps, Min. Travel Time= 0.2 min

Avg. Velocity = 1.91 fps, Avg. Travel Time= 0.3 min

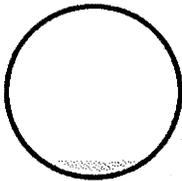
Peak Storage= 4 cf @ 3.26 hrs, Average Depth at Peak Storage= 0.17'

Bank-Full Depth= 1.67', Capacity at Bank-Full= 20.46 cfs

20.0" Diameter Pipe, n= 0.025 Corrugated metal

Length= 40.0' Slope= 0.0800 '/'

Inlet Invert= 8,105.00', Outlet Invert= 8,101.80'



Summary for Reach 5R: Lower Road Ditch

Inflow Area = 2.231 ac, 0.00% Impervious, Inflow Depth = 0.11"
Inflow = 0.47 cfs @ 3.04 hrs, Volume= 0.020 af
Outflow = 0.35 cfs @ 3.12 hrs, Volume= 0.020 af, Atten= 26%, Lag= 4.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Max. Velocity= 2.64 fps, Min. Travel Time= 2.4 min

Avg. Velocity = 1.44 fps, Avg. Travel Time= 4.4 min

Peak Storage= 50 cf @ 3.08 hrs, Average Depth at Peak Storage= 0.36'

Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.79 cfs

0.00' x 0.67' deep channel, n= 0.040 Earth, cobble bottom, clean sides

Side Slope Z-value= 1.0 '/' Top Width= 1.34'

Length= 383.0' Slope= 0.0783 '/'

Inlet Invert= 8,105.00', Outlet Invert= 8,075.00'

G22 Road 10-6

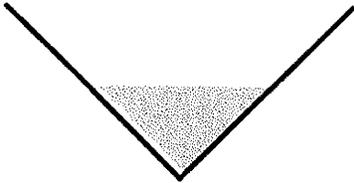
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Type II 24-hr 6.00 hrs Rainfall=1.38"

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Page 6



Summary for Reach 6R: Pad Entrance Water Bar

[61] Hint: Exceeded Reach 5R outlet invert by 0.09' @ 3.12 hrs

Inflow Area = 2.231 ac, 0.00% Impervious, Inflow Depth = 0.11"
Inflow = 0.35 cfs @ 3.12 hrs, Volume= 0.020 af
Outflow = 0.35 cfs @ 3.13 hrs, Volume= 0.020 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.60 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 0.2 min

Peak Storage= 3 cf @ 3.12 hrs, Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 54.87 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.0500 '/'
Inlet Invert= 8,075.00', Outlet Invert= 8,074.00'



G22 Road 10-24

Prepared by {enter your company name here}
HydroCAD® 8.50 s/n 003900 © 2007 HydroCAD Software Solutions LLC

Type II 24-hr Rainfall=2.05"
Printed 8/7/2008

Summary for Reach 3R: Culvert

[52] Hint: Inlet/Outlet conditions not evaluated

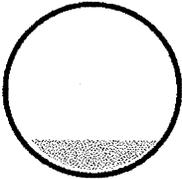
[61] Hint: Exceeded Reach 2R outlet invert by 0.35' @ 12.10 hrs

Inflow Area = 3.985 ac, 0.00% Impervious, Inflow Depth = 0.37"
Inflow = 1.97 cfs @ 12.09 hrs, Volume= 0.124 af
Outflow = 1.97 cfs @ 12.09 hrs, Volume= 0.124 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Max. Velocity= 5.93 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.13 fps, Avg. Travel Time= 0.3 min

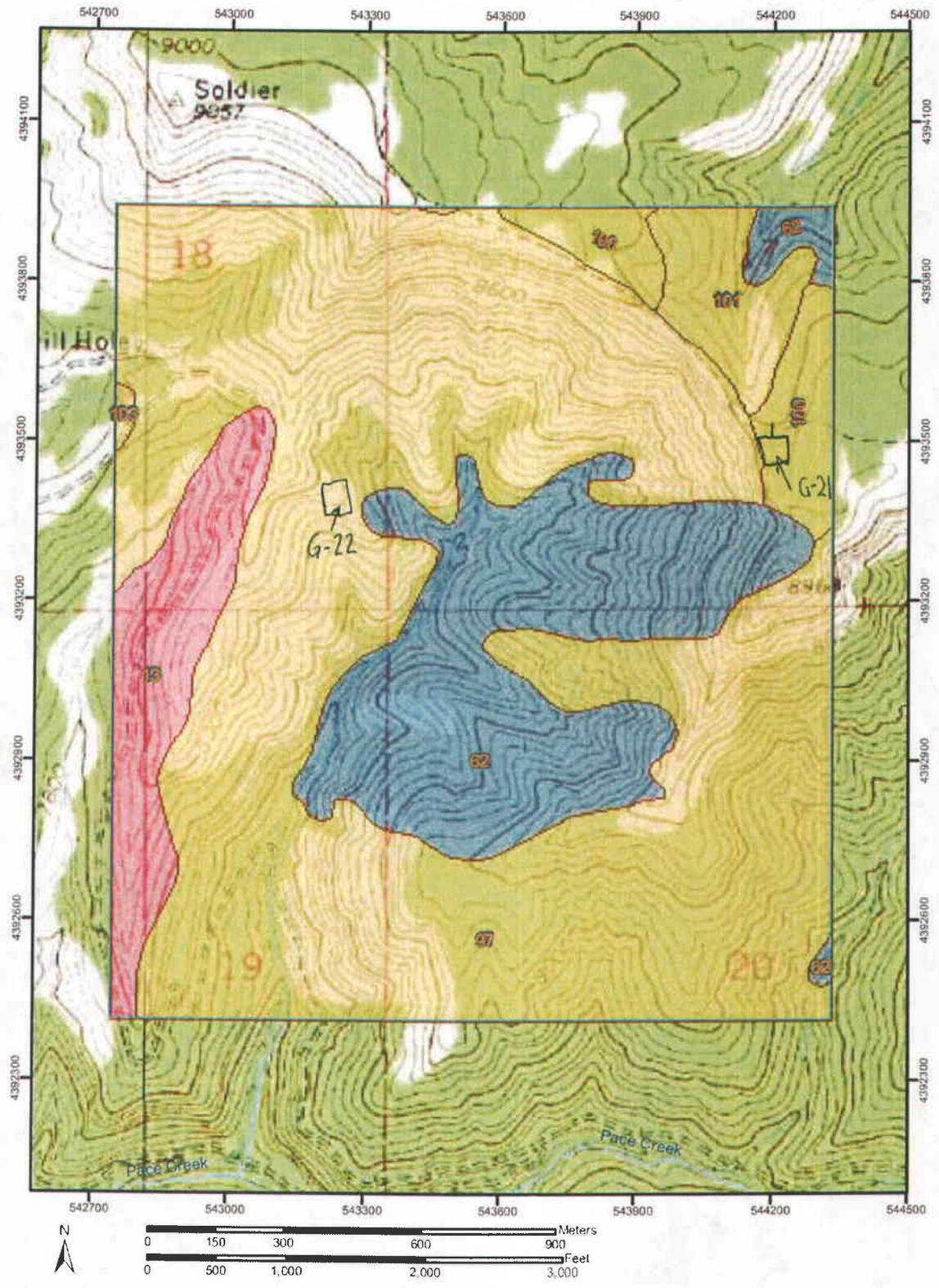
Peak Storage= 13 cf @ 12.09 hrs, Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.67', Capacity at Bank-Full= 20.46 cfs

20.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 40.0' Slope= 0.0800 '/
Inlet Invert= 8,105.00', Outlet Invert= 8,101.80'



*10 year - 24 hour event
2.05" precip*

Hydrologic Soil Group—Carbon Area, Utah, Parts of Carbon and Emery Counties



Natural Resources Conservation Service

Web Soil Survey 2.0
National Cooperative Soil Survey

MAP LEGEND

- Area of Interest (AOI)
 - Area of Interest (AOI)
- Soils
 - Soil Map Units
 - Soil Ratings
 - A
 - A/D
 - B
 - B/D
 - C
 - C/D
 - D
 - Not rated or not available
- Political Features
 - Municipalities
 - Cities
 - Urban Areas
- Water Features
 - Oceans
 - Streams and Canals

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: UTM Zone 12N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Carbon Area, Utah, Parts of Carbon and Emery Counties
 Survey Area Data: Version 4, Jul 2, 2008

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Carbon Area, Utah, Parts of Carbon and Emery Counties				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
13	Cabba family-Guben-Rock outcrop complex	D	48.3	6.8%
62	Midfork family-Comodore complex	B	139.5	19.5%
97	Rottulee family-Trag complex	C	473.8	66.3%
100	Senchert loam, 3 to 15 percent slopes	C	28.4	4.0%
101	Senchert loam, 30 to 50 percent slopes	C	23.5	3.3%
103	Senchert-Toze family complex	C	1.3	0.2%
Totals for Area of Interest (AOI)			714.7	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower



POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14



Utah 39.68175 N 110.48129 W 7946 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Tue Jun 26 2007

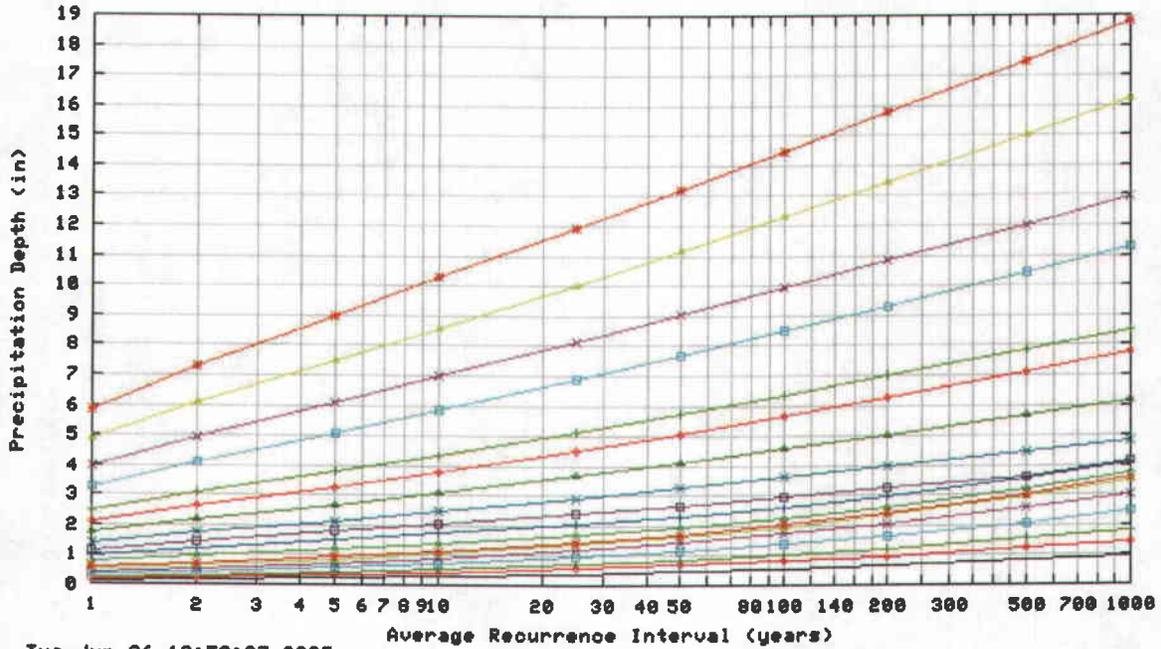
Confidence Limits
Seasonality
Location Maps
Other Info.
GIS data
Maps
Help
D

Precipitation Frequency Estimates (inches)																		
ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.14	0.20	0.25	0.34	0.42	0.52	0.59	0.77	0.99	1.18	1.40	1.74	2.12	2.44	3.26	3.97	4.88	5.83
2	0.17	0.26	0.33	0.44	0.55	0.65	0.74	0.96	1.23	1.46	1.74	2.16	2.65	3.06	4.08	4.95	6.10	7.31
5	0.24	0.36	0.45	0.60	0.74	0.86	0.95	1.19	1.50	1.78	2.13	2.67	3.29	3.78	5.05	6.09	7.50	9.00
10	0.29	0.45	0.55	0.74	0.92	1.06	1.15	1.38	1.73	2.05	2.46	3.08	3.80	4.36	5.82	6.98	8.59	10.29
25	0.38	0.58	0.72	0.97	1.20	1.36	1.45	1.67	2.05	2.40	2.89	3.65	4.52	5.14	6.86	8.15	10.04	11.96
50	0.46	0.70	0.86	1.16	1.44	1.64	1.72	1.92	2.32	2.68	3.24	4.09	5.08	5.74	7.66	9.04	11.15	13.22
100	0.55	0.83	1.03	1.39	1.72	1.96	2.04	2.22	2.60	2.96	3.60	4.55	5.67	6.36	8.48	9.94	12.29	14.50
200	0.65	0.99	1.23	1.66	2.05	2.33	2.41	2.57	2.94	3.25	3.96	5.03	6.28	7.00	9.31	10.84	13.44	15.78
500	0.82	1.24	1.54	2.08	2.57	2.93	3.03	3.18	3.53	3.64	4.45	5.67	7.11	7.86	10.44	12.03	14.99	17.48
1000	0.97	1.47	1.83	2.46	3.04	3.49	3.59	3.74	4.09	4.13	4.84	6.17	7.77	8.53	11.30	12.94	16.22	18.80

[Text version of table](#)

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval. Please refer to the [documentation](#) for more information. NOTE: Formatting forces estimates near zero to appear as zero.

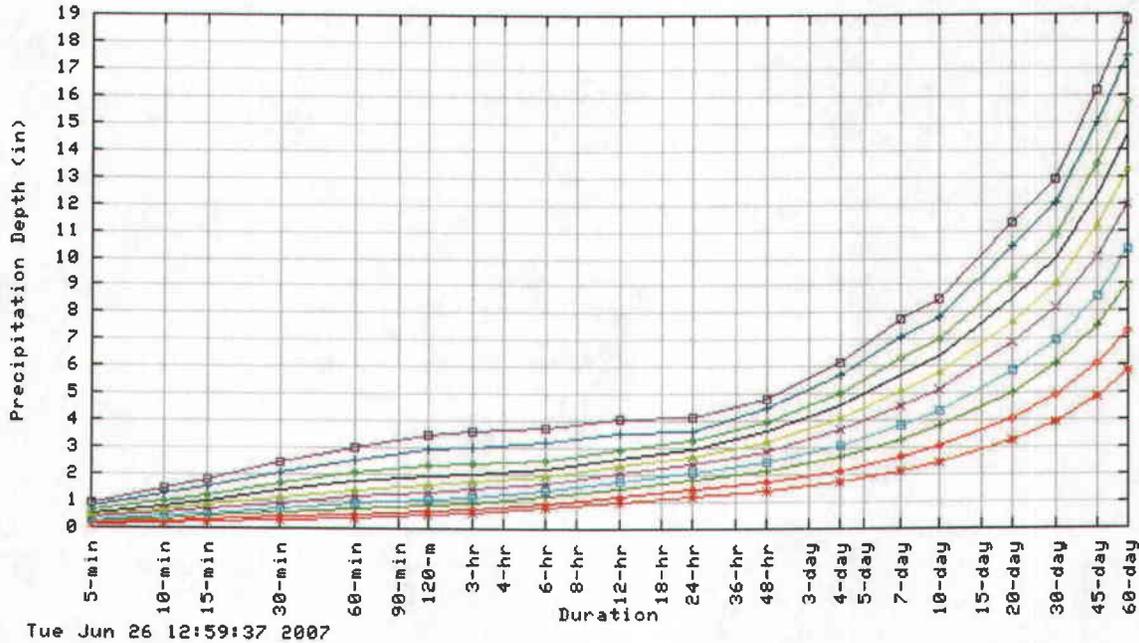
Partial duration based Point Precipitation Frequency Estimates Version: 4
 39.68175 N 110.48129 W 7946 ft



Tue Jun 26 12:59:37 2007

Duration			
5-min	120-min	48-hr	30-day
10-min	3-hr	4-day	45-day
15-min	6-hr	7-day	60-day
30-min	12-hr	10-day	
60-min	24-hr	20-day	

Partial duration based Point Precipitation Frequency Estimates Version: 4
39.68175 N 110.48129 W 7946 ft



Confidence Limits -

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.16	0.24	0.30	0.41	0.51	0.60	0.69	0.88	1.11	1.31	1.56	1.94	2.41	2.74	3.65	4.43	5.44	6.49
2	0.21	0.32	0.39	0.53	0.65	0.76	0.86	1.09	1.38	1.63	1.94	2.42	3.01	3.42	4.56	5.54	6.80	8.12
5	0.28	0.43	0.53	0.72	0.89	1.01	1.11	1.35	1.68	2.00	2.38	2.98	3.73	4.24	5.66	6.80	8.37	10.00
10	0.35	0.53	0.66	0.89	1.10	1.24	1.33	1.58	1.94	2.29	2.74	3.44	4.33	4.89	6.53	7.79	9.60	11.44
25	0.46	0.69	0.86	1.16	1.43	1.60	1.69	1.91	2.32	2.69	3.23	4.08	5.15	5.76	7.70	9.12	11.24	13.33
50	0.55	0.83	1.04	1.40	1.73	1.93	2.01	2.21	2.63	3.00	3.62	4.58	5.80	6.45	8.61	10.14	12.51	14.77
100	0.66	1.00	1.24	1.67	2.07	2.33	2.40	2.58	2.97	3.33	4.03	5.11	6.50	7.17	9.55	11.18	13.80	16.25
200	0.79	1.20	1.49	2.01	2.49	2.79	2.87	3.01	3.38	3.66	4.45	5.65	7.22	7.91	10.53	12.23	15.15	17.77
500	1.01	1.54	1.90	2.56	3.17	3.59	3.67	3.79	4.13	4.17	5.04	6.42	8.24	8.93	11.88	13.66	17.01	19.80
1000	1.22	1.85	2.30	3.09	3.83	4.35	4.43	4.52	4.85	4.90	5.51	7.04	9.06	9.75	12.94	14.77	18.49	21.43

* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than
 ** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
 Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

*** Lower bound of the 90% confidence interval**

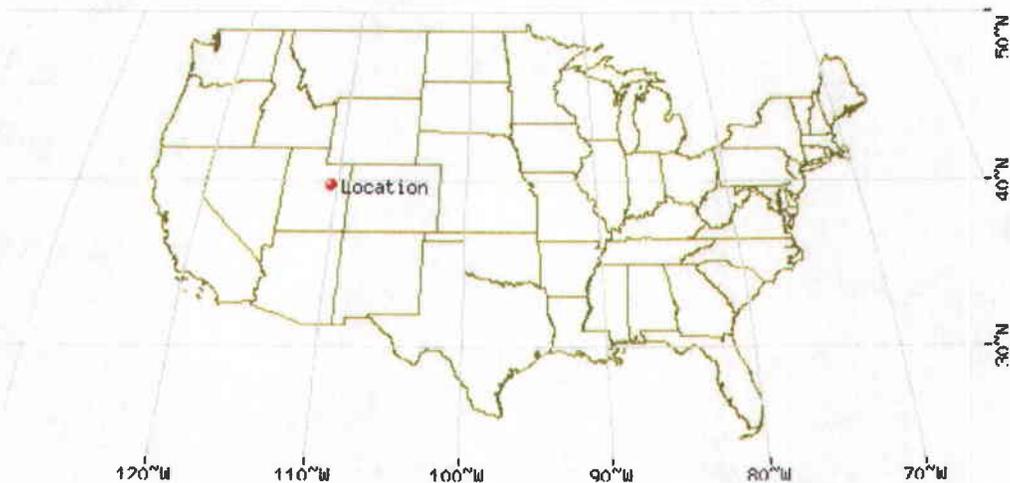
Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.12	0.18	0.22	0.29	0.36	0.45	0.52	0.69	0.90	1.07	1.26	1.56	1.89	2.19	2.94	3.59	4.41	5.28
2	0.15	0.23	0.28	0.38	0.47	0.57	0.65	0.85	1.11	1.32	1.57	1.95	2.36	2.75	3.68	4.48	5.51	6.61
5	0.20	0.31	0.38	0.52	0.64	0.75	0.84	1.05	1.34	1.61	1.92	2.39	2.92	3.38	4.53	5.49	6.75	8.10
10	0.25	0.38	0.47	0.63	0.79	0.90	1.00	1.22	1.54	1.84	2.20	2.75	3.37	3.88	5.22	6.26	7.69	9.22
25	0.32	0.48	0.59	0.80	0.99	1.14	1.24	1.45	1.81	2.15	2.58	3.23	3.97	4.55	6.10	7.27	8.94	10.66
50	0.37	0.56	0.70	0.94	1.17	1.34	1.44	1.65	2.02	2.39	2.86	3.60	4.43	5.05	6.76	8.02	9.86	11.71
100	0.43	0.66	0.82	1.10	1.36	1.56	1.67	1.88	2.23	2.62	3.15	3.97	4.90	5.55	7.41	8.75	10.78	12.73
200	0.50	0.76	0.94	1.27	1.57	1.81	1.93	2.13	2.48	2.85	3.44	4.34	5.36	6.06	8.07	9.47	11.69	13.73
500	0.60	0.91	1.13	1.52	1.88	2.17	2.32	2.56	2.93	3.15	3.81	4.82	5.99	6.71	8.90	10.36	12.86	15.01
1000	0.68	1.04	1.29	1.73	2.15	2.48	2.65	2.94	3.34	3.38	4.10	5.18	6.46	7.19	9.53	11.03	13.76	15.97

* The lower bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are less than

** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval

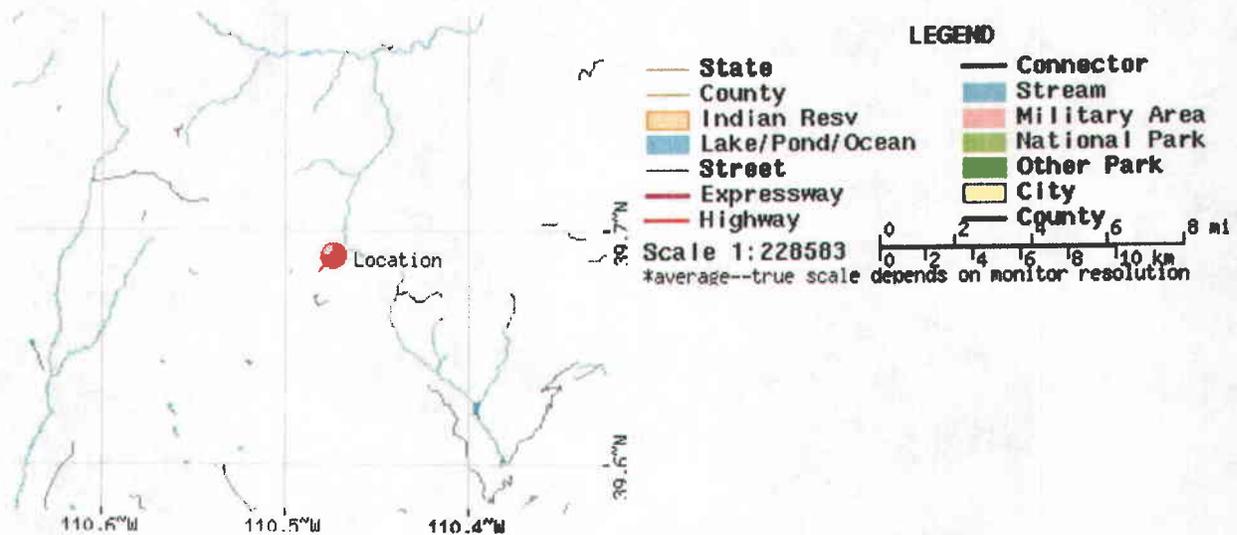
Please refer to the [documentation](#) for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Maps -



These maps were produced using a direct map request from the U.S. Census Bureau Mapping and Cartographic Resources Tiger Map Server.

Please read disclaimer for more information.



Other Maps/Photographs -

View [USGS digital orthophoto quadrangle \(DOQ\)](#) covering this location from TerraServer; [USGS Aerial Photograph](#) may also be available

from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the [USGS](#) for more information.

Watershed/Stream Flow Information -

Find the [Watershed](#) for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to our documentation.

Using the [National Climatic Data Center's \(NCDC\)](#) station search engine, locate other climate stations within:

...OR... of this location (39.68175/-110.48129). Digital ASCII data can be obtained directly from [NCDC](#).

Find [Natural Resources Conservation Service \(NRCS\)](#) SNOTEL (SNOWpack TELEmetry) stations by visiting the [Western Regional Climate Center's state-specific SNOTEL station maps](#).

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