

**MINING AND RECLAMATION PLAN  
SUFACO MINE  
AMENDMENT**

**OPERATED BY**



**CANYON FUEL COMPANY, LLC  
Sufco Mine**

**FINAL CLEAN COPY**

**South Fork Quitcupah 2R2S Block "A"**  
**JULY 2012**  
Revised January 2013



Canyon Fuel  
Company, LLC.  
Sufco Mine

A Subsidiary of Arch Western Bituminous Group, LLC.

Incoming  
C0410002  
# 4243  
OK

Ken May, General Manager  
597 South SR 24  
Salina, UT 84654  
(435) 286-4400 - Office  
(435) 286-4499- Fax

January 4, 2013

Permit Supervisor  
Utah Coal Regulatory Program  
Utah Division of Oil, Gas and Mining  
1594 West North Temple, Suite 1210  
P. O. Box 145801  
Salt Lake City, Utah 84114-5801

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DIV. OF OIL, GAS & MINING

Re: South Fork Quitcupah 2R2S Block "A" Amendment, 4<sup>th</sup> and Final Submittal, to the Canyon Fuel Company, LLC, Sufco Mine, Permit Number C/041/0002

Dear Permit Supervisor:

Please find enclosed with this letter the Sufco Mine permit revision to modify the current Sufco monitoring and mitigation plan for undermining the South Fork of Quitcupah 2R2S Block "A" portion of the stream channel. We have included Three copies of the modified text and plates in redline/strike through format along with completed C1 and C2 forms.

Two clean copies of the pages with modifications have also been included with this submittal for inclusion in the permit once the modification is approved.

This resubmittal has been revised to address the deficiencies itemized in the Division letter dated December 06, 2012 and received by Sufco on December 13, 2012.

The deficiencies and responses are:

1. **R645-301.731.224:** The downstream surface water monitoring point 006D should be added to Figure 7-9 in the MRP and included in the gain/loss surveys to be completed as part of the mitigation plan. (AAA)

**Response:**

Item #1 was addressed by adding monitoring point 006D to Figure 7-9, page 7-51K in the MRP and in the new Mining and Mitigation Plan for Undermining the South Fork Quitcupah 2R2S Block "A". A gain/loss survey that includes 006D has been added to the MRP as Appendix 3-14.

2. **R645-301.731.530:** Water Right 94-113 was found to be a small undeveloped seep. The PHC recommended a total of six springs be monitored along the reach of the South Fork of Quitcupah. The seep associated with Water Right No. 94-113, was not included in this group. The location of this seep is approximately 500 feet off the northwest edge of the 2R2S panel (refer to Plate 7-2Av6). Because this is a state appropriated water right and located within the angle of draw where subsidence cracks are possible, please include this seep in the water monitoring protocol. (AAA)

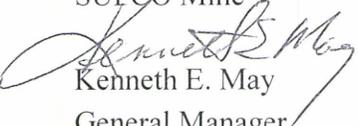
**Response:**

Item #2 was addressed by adding Water Right 94-113 to Table 7-2 Water Monitoring Program, Page 7-42A in the MRP and modifying Plate 7-3.

The Permittee was required to develop a data recovery plan and Memorandum of Agreement (MOA) in coordination with the Forest Service and the Utah State Historic Preservation Office (USHPO) for the 42SV3464 rock shelter site. A cultural resource investigation for the 42SV3464 rock shelter was requested and approved between the U.S. Forest Service, Utah State Historic Preservation Office (SHPO), EnviroWest, LLC and Canyon Fuel Company, LLC since the shelter appeared to have been disturbed. Testing of the rock shelter for significance was conducted by EnviroWest and Fishlake National Forest Archaeologist in the fall of 2012. A copy of the cultural resource investigation testing report and the Determination of Significance and Effect form are located in Appendix 4-2 in the Confidential folder of the M&RP. While the 42SV3464 rock shelter site was initially evaluated as being eligible for listing in the National Register of Historic Places, subsequent testing found it to be ineligible for listing due to disturbance and a data recovery plan and MOA are not required for mitigation of the site. Appendix 4-6 has been deleted from the amendment.

If you have any questions regarding the information contained in this letter or within the permit modification, please give Mike Davis a call at (435) 286-4421.

Sincerely,  
CANYON FUEL COMPANY, LLC  
SUECØ Mine

  
Kenneth E. May  
General Manager

Encl.

cc: DOGM Correspondence File

# APPLICATION FOR COAL PERMIT PROCESSING

Permit Change  New Permit  Renewal  Exploration  Bond Release  Transfer

**Permittee:** CANYON FUEL COMPANY, LLC

**Mine:** SUFCO MINE

**Permit Number:**

C/041/0002

**Title:** Final - South Fork Quitchupah 2R2S Block "A"

**Description,** Include reason for application and timing required to implement:

Modification of the Monitoring & Mitigation plan for the South Fork Quitchupah 2R2S Block "A" portion of the stream channel.

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

- Yes  No 1. Change in the size of the Permit Area? Acres: \_\_\_\_\_ Disturbed Area: \_\_\_\_\_  increase  decrease.
- Yes  No 2. Is the application submitted as a result of a Division Order? DO# \_\_\_\_\_
- Yes  No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
- Yes  No 4. Does the application include operations in hydrologic basins other than as currently approved?
- Yes  No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
- Yes  No 6. Does the application require or include public notice publication?
- Yes  No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
- Yes  No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
- Yes  No 9. Is the application submitted as a result of a Violation? NOV # \_\_\_\_\_
- Yes  No 10. Is the application submitted as a result of other laws or regulations or policies?

*Explain:* \_\_\_\_\_

- Yes  No 11. Does the application affect the surface landowner or change the post mining land use?
- Yes  No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
- Yes  No 13. Does the application require or include collection and reporting of any baseline information?
- Yes  No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
- Yes  No 15. Does the application require or include soil removal, storage or placement?
- Yes  No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
- Yes  No 17. Does the application require or include construction, modification, or removal of surface facilities?
- Yes  No 18. Does the application require or include water monitoring, sediment or drainage control measures?
- Yes  No 19. Does the application require or include certified designs, maps or calculation?
- Yes  No 20. Does the application require or include subsidence control or monitoring?
- Yes  No 21. Have reclamation costs for bonding been provided?
- Yes  No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
- Yes  No 23. Does the application affect permits issued by other agencies or permits issued to other entities?
- Yes  No 24. Does the application include confidential information and is it clearly marked and separated in the plan?

**Please attach three (3) review copies of the application. If the mine is on or adjacent to Forest Service land please submit four (4) copies, thank you.** (These numbers include a copy for the Price Field Office)

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

KENNETH E. MAY

GENERAL MANAGER

1/7/13 

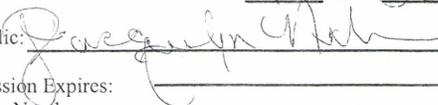
Print Name

Position

Date

Signature (Right-click above choose certify then have notary sign below)

Subscribed and sworn to before me this 7 day of January, 2013

Notary Public: , state of Utah.

My commission Expires: \_\_\_\_\_

Commission Number: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_

State: \_\_\_\_\_

Zip: \_\_\_\_\_

SS: \_\_\_\_\_



**JACQUELYN NEBEKER**

Notary Public  
State Of Utah

My Commission Expires 3/24/2015  
Commission# 606049

**For Office Use Only:**

Assigned Tracking  
Number:

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# APPLICATION FOR COAL PERMIT PROCESSING

## Detailed Schedule Of Changes to the Mining And Reclamation Plan

**Permittee:** CANYON FUEL COMPANY, LLC  
**Mine:** SUFCO MINE **Permit Number:** C/041/0002  
**Title:** Final - South Fork Quitcupah 2R2S Block "A"

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

### DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED

<input type="checkbox"/> Add	<input checked="" type="checkbox"/> Replace	<input type="checkbox"/> Remove	Pages 1-8 to 1-12 in Chapter 1, Volume 1 of MRP.
<input type="checkbox"/> Add	<input checked="" type="checkbox"/> Replace	<input type="checkbox"/> Remove	Pages 3-ii to 3-iv, 3-15 to 3-17, 3-22 to 3-36 in Chapter 3, Volume 1 of MRP.
<input type="checkbox"/> Add	<input checked="" type="checkbox"/> Replace	<input type="checkbox"/> Remove	Pages 4-12 to 4-12B in Chapter 4, Volume 1 of MRP.
<input type="checkbox"/> Add	<input checked="" type="checkbox"/> Replace	<input type="checkbox"/> Remove	Pages 5-39C to 5-39G in Chapter 5, Volume 1 of MRP.
<input type="checkbox"/> Add	<input checked="" type="checkbox"/> Replace	<input type="checkbox"/> Remove	Pages 7-iv, 7-vii, 7-41 to 7-43, 7-48, 7-51G to 7-51L in Chapter 7, Volume 2 of MRP.
<input checked="" type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	Add Lease relinquishment documents at the back of Appendix 1-2, Volume 4 of MRP.
<input checked="" type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	Add new 2R2S Block "A" Monitoring and Mitigation Plan in Appendix 3-14, Vol. 5 of MRP.
<input checked="" type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	Add new PHC in Appendix 7-26, Volume 8 of MRP.
<input type="checkbox"/> Add	<input checked="" type="checkbox"/> Replace	<input type="checkbox"/> Remove	Plates 5-6, 5-10A and 5-10C in Chapter 5, Volume 1 of MRP.
<input type="checkbox"/> Add	<input checked="" type="checkbox"/> Replace	<input type="checkbox"/> Remove	Plates 7-2A and 7-3 in Chapter 7, Volume 2 of MRP.
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<input type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	
<input type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	
<input type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	Sufco Mine Confidential MRP Binder
<input checked="" type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	2011 and 2012 Raptor Surveys at the back of Appendix 3-4 in the Confidential MRP Binder.
<input checked="" type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	Cultural Resource Studies at the back of Appendix 4-2 in the Confidential MRP Binder.
<input type="checkbox"/> Add	<input checked="" type="checkbox"/> Replace	<input type="checkbox"/> Remove	Plates 5-10AC and 5-10CC in Chapter 5, Confidential MRP Binder.
<input type="checkbox"/> Add	<input type="checkbox"/> Replace	<input type="checkbox"/> Remove	
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.

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CHAPTER 1  
GENERAL CONTENTS

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on the leased premises are presented in Appendix 1-2 Mining and Reclamation Plan for the SUFACO Mine. Appendix 1-2 is unmodified by this Notice of Change in Ownership and Control Information.

Federal Coal Lease SL-062583 grants the right to use lands for the construction and utilization of surface facilities necessary for underground coal mining.

The legal description of the SUFACO coal leases:

Federal Coal Lease U-28297 - (716.51 acres) - Approved January 1979  
Modified January 2012

T. 21 S., R. 5 E., SLM, Utah  
Sec. 32, lot 1, N1/2S1/2  
Sec. 33, NW1/4SW1/4  
T. 22 S., R. 5 E., SLM, Utah  
Sec. 5, W1/2W1/2;  
Sec. 7, S1/2NE1/4, E1/2SW1/4, W1/2SE1/4;  
Sec. 8, W1/2NW1/4.

Federal Coal Lease U-062453 - (480 acres) - Approved March 1962

T. 21 S., R. 5 E., SLM, Utah  
Sec. 28, SW1/4SW1/4  
Sec. 29, SE1/4SE1/4  
Sec. 32, N1/2  
Sec. 33, W1/2NW1/4

Federal Coal Lease U-0149084 - (240 acres) - Approved June 1966

T. 22 S., R. 4 E., SLM, Utah  
Sec. 12, NE1/4 and N1/2SE1/4

Federal Coal Lease SL-062583 - (3,079.83 acres) - Approved September 1941  
Modified January 1973  
Modified December 2009

T. 21 S., R. 4 E., SLM, Utah  
Sec. 36, S1/2  
T. 21 S., R. 5 E., SLM, Utah  
Sec. 31, all;  
T. 22 S., R. 4 E., SLM, Utah  
Sec. 1, lots 1 to 4 incl. S1/2N1/2, S1/2  
Sec. 2, SE1/4, S1/2SW1/4;  
Sec. 3, SE1/4SE1/4;  
Sec. 10, E1/2NE1/4, NE1/4SE1/4;  
Sec. 11, N1/2, N1/2S1/2;  
Sec. 12, NW1/4  
T. 22 S., R. 5 E., SLM, Utah

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Sec. 6, all;  
Sec. 7, N1/2NE1/4, E1/2NW1/4

Federal Coal Lease U-47080 - (1,953.73 acres) - Approved October 1981  
Modified December 2009

T. 21 S., R. 4 E., SLM, Utah  
Sec. 25, all;  
Sec. 35, E1/2, E1/2SW1/4;  
Sec. 36, N1/2.  
T. 21 S., R. 5 E., SLM, Utah  
Sec. 30, lots 2-4, W1/2SE1/4  
T. 22 S., R. 4 E., SLM, Utah  
Sec. 2, lots 1-4, S1/2NE1/4, S1/2NW1/4, N1/2SW1/4;  
Sec. 3, NE1/4SE1/4.

Federal Coal Lease U-63214 - (8,826.34 acres) - Approved July 1989  
Modified June 1999  
Modified December 2009  
Modified May 2011

Tract 1:

T. 21 S., R. 4 E., SLM, Utah  
Sec. 12, E1/2SE1/4  
Sec. 13, E1/2NE1/4, S1/2  
Sec. 14, E1/2SW1/4, SE1/4  
Sec. 23, E1/2, E1/2W1/2  
Sec. 24, all.  
T. 21 S., R. 5 E., SLM, Utah  
Sec. 15, W1/2  
Secs. 16-21, all;  
Sec. 22, W1/2  
Sec. 26, W1/2NW1/4SW1/4, SW1/4SW1/4  
Sec. 27, all;  
Sec. 28, N1/2, N1/2SW1/4, SE1/4SW1/4, SE1/4  
Sec. 29, E1/2NE1/4, NE1/4SE1/4  
Sec. 30, lot 1, N1/2NE1/4  
Sec. 33, NE1/4, E1/2NW1/4, NE1/4SW1/4, N1/2SE1/4  
Sec. 34, NW1/4NE1/4, NW1/4, NW1/4SW1/4.

Tract 2:

T. 21 S., R. 5 E., SLM, Utah  
Sec. 10, SE1/4NW1/4, E1/2SW1/4, E1/2E1/2SW1/4SW1/4,  
E1/2E1/2NW1/4SW1/4, E1/2E1/2SW1/4NW1/4.

Tract 3:

T. 21 S., R. 4 E., SLM, Utah  
Sec. 26, E1/2, E1/2SW1/4;  
Sec. 35, NW1/4, W1/2SW1/4.

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Federal Coal Lease UTU-76195 - (5,694.66 acres) - Approved October 1999  
Modified December 2006

- T. 21 S., R. 5 E., SLM
  - Sec. 2, lots 3,4, S1/2SW1/4, SW1/4SE1/4
  - Sec. 10, E1/2
  - Sec. 11, all
  - Sec. 12, S1/2SW1/4, NW1/4SW1/4
  - Sec. 13, NW1/4, S1/2
  - Sec. 14, all
  - Sec. 15, E1/2
  - Sec. 22, E1/2
  - Sec. 23-24, all
  - Sec. 25, N1/2, N1/2S1/2
  - Sec. 26, N1/2, NE1/4SW1/4, E1/2NW1/4SW1/4, SE1/4
- T. 21 S., R. 6 E., SLM
  - Sec. 19, lots 3-4, E1/2SW1/4
  - Sec. 30, lots 1-3, E1/2NW1/4, NE1/4SW1/4

State of Utah Coal Lease ML 49443-OBA - (2,134.19 acres) - Approved October 2004

- T. 21 S., R. 5 E., SLB&M
  - Sec. 4: Lots 1, 2, 3, 4, S1/2S1/2
  - Sec. 5: Lots 1, 2, 3, 4, S1/2S1/2
  - Sec. 7: Lots 2, 3, 4, S1/2NE1/4, SE1/4
  - Sec. 8: All
  - Sec. 9: All

Canyon Fuel Company, LLC acquired the right to entry on these properties in the merger described in Section 111 hereinabove.

In addition, the SUFCA Mine permit area includes certain fee lands owned by Canyon Fuel Company, LLC as follows:

- T. 21 S., R. 5 E., SLB&M, Utah
  - Sec. 29, SW1/4, NW1/4, W1/2NE1/4, W1/2SE1/4
  - Sec. 30, S1/2NE1/4, E1/2SE1/4
  - containing 640.00 acres
- T. 22 S., R. 4 E., SLB&M, Utah
  - Sec. 18, NW1/4NE1/4
  - containing 40 acres

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The name of the owner of these fee lands changed from Coastal States Energy Company to Canyon Fuel Company, LLC as a result of the merger transaction described in Section 111 hereinabove.

The SUFCA Mine also uses certain Forest Service lands in its operation for a spring collection system, pumphouse, water transmission line, sanitary discharge line, sanitary drainfield, access

road to the sediment pond, and 25 KV powerline. These USFS special use permit areas are shown on Plate 5-6 through portions of:

T. 22 S., R. 4 E., SLB&M, Utah  
Sec. 12, S1/2  
containing 15.32 acres

The name of the permittee changed from Southern Utah Fuel Company to Canyon Fuel Company, LLC pursuant to the merger described in Section 111 herein above.

The total lease area includes 20,991.07 acres of Federal coal leases, 2,134.19 acres of State of Utah coal leases, 640 acres of fee coal leases, the 40 acres waste rock disposal site and 15.32 acres under U.S. Forest Service special use permit for a total of 23,820.58 acres.

#### **115 Status of Unsuitability Claims**

To the best knowledge of Canyon Fuel Company, LLC, no portion of the area to be permitted is designated, or under study for being designated, unsuitable for mining.

Since the SUFCO Mine was in production before passage of the Surface Mining Control and Reclamation Act of 1977, the unsuitability criteria were not applied to the existing surface facilities.

Canyon Fuel Company, LLC does not propose to conduct coal mining or reclamation operations within 300 feet of any occupied dwelling. Coal mining and reclamation operations have been or will be conducted within 100 feet of a public road, see Section 5.2.1.1 for details. Forest Service approval to conduct coal mining and reclamation operations within 100 feet of the Link Canyon forest service road is located in Appendix 1-1 and the newspaper advertisement for public comment is located in Appendix 1-3.

#### **116 Permit Term**

The following information is presented to identify permit term requirements and stipulations. Canyon Fuel Company will be operating the SUFCO Mine with continuous miner and longwall

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mining methods. Although the Mining and Reclamation Permit Application covers the next five-year period of mining, information is presented below for the life of the mining operation.

- |    |                                    |  |
|----|------------------------------------|--|
| 1. | First coal produced                | 1941   |
| 2. | Termination of mining activity     | August, 2025                                 |
| 3. | Horizontal extent of mine workings | 23,820.58 acres<br>(Life of mine)            |
| 4. | Vertical extent of mine workings   | Surface to 2,000 feet deep<br>(Life of mine) |

The anticipated total acreage to be affected during the five years of operation by underground mining activities is 1,500 acres. The estimated number of total surface acres to be affected over the entire mining operation is 48.432 acres.

<u>PERMITTED DISTURBED AREA BOUNDARY</u>	<u>ACTUAL AREA CURRENTLY DISTURBED TO BE RECLAIMED</u>	<u>SITE DESCRIPTION</u>
30.210	17.405	Mine Site, East Spring Canyon
0.967	0.39	Spring Collection Field, Convulsion Canyon
0.220	0.075	Pump House, Convulsion Canyon
0.784	0.40	Leach Field, Convulsion Canyon
1.595	0.193	Water Tank, East Spring Canyon
0.286	0.017	3 East Portals
1.774	0.70	4 East Portals
0.302	0.017	South Portals
0.396	0.017	Quitcupah Portals
0.287	0.18	Link Canyon Substation No. 1
0.245	0.12	Link Canyon Substation No. 2
0.380	0.18	Link Canyon Portal
10.986	8.733	Waste Rock Disposal Site
0.000	0.00	North Water Mitigation Area
<u>0.000</u>	<u>0.00</u>	Quitcupah Fan and Shaft Site
48.432	28.427	Totals

The legal description of the SUFCO permit area:

Mine Site Facility, Water Tank, South Portals, Spring Collection Field, Pump House, Pipeline, Leachfield (Approximately 64.403 acres)

T. 22 S., R. 4 E., SLBM, Utah

Section 12: A Portion of the following:  
 E1/2NW1/4, SW1/4NW1/4NE1/4, S1/2

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CHAPTER 3

BIOLOGY

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Table 3-1

Federally Listed and Proposed Endangered Species in Utah  
Sevier and Emery Counties  
March 29, 2011

<u>Plants</u>		Status
Barneby Reed-Mustard	<u>Schoenocrambe barnebyi</u>	E
Heliotrope Milk-Vetch	<u>Astragalus montii</u>	T
Jones Cycladenia	<u>Cycladenis humilis var. jonesii</u>	T
Last Chance Townsendia	<u>Townsendia aprica</u>	T
San Rafael Cactus	<u>Pediocactus despainii</u>	E
Wright Fishhook Cactus	<u>Sclerocactus wrightiae</u>	E
Winkler Cactus	<u>Pediocactus winkleri</u>	T
 <u>Mammals</u>		
Black-Footed Ferret	<u>Mustela nigripes</u>	E-Extirpated
Utah Prairie Dog	<u>Cynomys parvidens</u>	T
Brown (Grizzly) Bear	<u>Ursus arctos</u>	T-Extirpated



**Snails**

**None listed in the Sevier and Emery Counties**

E - Endangered    T - Threatened    Extirpated - No longer occur in Utah    C - Candidate

For additional information contact: U. S. Fish and Wildlife Service, 2078 Administration Building,  
1745 West 1700 South, Salt Lake City, Utah 84204-5110  
Telephone: Commercial (801) 975-330

snails are present in the general area because of its isolated location and since the source of water only became available after the mine closed in the 1950's. Amphibians have not been reported in the area, possibly for the same reasons as those listed previously for the mollusks.

**East Fork Of Box Canyon.** Sufco intends to undermine portions of the East Fork of Box Canyon beginning in the Fall of 2003 through 2005 as they extract coal from the 3LPE and 4LPE longwall panels. Prior to the initiation of undermining and subsidence, a pre-subsidence qualitative evaluation of vegetation and channel conditions will be conducted in the East Fork of Box Canyon from the Joe's Mill Ponds downstream to a location above the west gate roads associated with the 3LPE panel. The survey will consist of video taping the condition of the stream channel paying particular note to surface flows and ground water discharge, vegetation types and conditions, animal species in the area including documenting the absence or presence of macroinvertebrates in the stream channel by filming the turning over of rocks or debris, general soil conditions, and the general geomorphology of the area. A qualified botanist will be used to identify and report in the video tape the major representative plant species along the stream channel. This will include riparian and spring locations found along the stream channel. Major hanging gardens will be identified and discussed. The general stream morphology will be discussed in the video including the width and depth of pools, height of natural drops, existing joints, cracks, and fractures, locations where flows naturally diminish or increase, etc.

A video tape will be made of the same portion of the East Fork at the same time of the year on the third year following undermining during September of 2008. A comparison will be made of the two tapes using the parameters described above and any changes due to mining activities will be noted. The tapes will be submitted to the Division as part of the Annual Report; the Fall 2003 video tape will be submitted with the 2003 Annual Report and the comparison tape will be submitted with the 2008 Annual Report.

Fourteen sites have been identified and established during the qualitative pre-subsidence survey for use in a quantitative evaluation of site-specific vegetative and hydrologic conditions (See Chapter 7 Section 7.3.1.2) The site locations have been mapped and identified in the field with

stakes and flagging. The sites include each of the springs found within the portion of the East Fork to be subsided and the Joe's Mill pond area.

A survey of the identified stream and spring monitoring sites will include a concentrated study of vegetative communities associated with the stream and spring sites. The vegetative survey of the East Fork will be conducted following the USFS and D.L. Rosgen stream channel survey protocol. The condition of the riparian vegetation flanking the channel at each of the sites will be described and the hillsides above the channels will also be monitored for changes in morphology. Maps of the surveyed areas will be prepared. The survey will be conducted before subsidence begins in the effected areas of Box Canyon Creek and will be repeated in 2004, 2005, 2006, and 2008.

The conditions of the vegetation at the spring sites will be monitored for the same parameters as the stream sites. The source and discharge area will be included in the survey. Photographs will be obtained at each of the monitoring stations of the vegetative communities along the stream channel, hillsides above the site, and at the spring locations. Permanent photo points will be established to allow for repeatability of photographing the vegetation.

Qualitative surveys of the vegetation at each monitoring station will be conducted twice per year, once at the beginning of the growing season and again at the end of the season, for the first three years as mining is commenced in the East Fork and then in the fifth year following undermining. The surveys will include observations of the conditions, types, notable changes, etc., of the vegetation in the Joe's Mill pond area vegetation and along stream banks and spring locations identified as monitoring sites.

Erosion of the hillsides will be monitored during the twice yearly qualitative vegetation survey using a numerical ranking system to identify the degree of erosion. The ranking system will be as follows:

4-Extreme erosion	deeply incised rills and gullies with unstable, actively slumping walls and loose material moving rapidly to the rill or gully floor, freshly exposed plant roots, no remaining topsoil, no vegetative litter, little to no vegetative cover.
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3-High erosion	incised rills and gullies slightly unstable slopes, only occasional slumps of the rill or gully wall, some plant roots exposed, little to no topsoil remaining, little to no vegetative litter, poor vegetative cover.
2-Moderate erosion	small rills, no gullies, moderately stable slopes, very little to no exposed roots, most of the topsoil remains, moderate vegetative cover.
1-Slight erosion	occasional small rills, no significant channeling in the soils, no exposed roots, topsoil remains, most vegetative litter in place, good vegetative cover.
0-No erosion	Appears relatively undisturbed, essentially no rills, vegetative litter in-place, healthy vegetative cover.

Photographic evidence of the state of erosion will be obtained each year at the East Fork monitoring sites for annual comparative and evaluation purposes. The climatic and overall vegetative conditions of the area will be noted. Particular attention will be paid to the effects of grazing on the vegetation and soils with respect to changes in the rank of erosion.

As part of the quantitative evaluation of the East Fork of Box Canyon, the locations of populations of the Link Canyon Columbine will be identified, mapped, and locations staked. The number of individuals in the populations will be counted or accurately estimated. All other populations of Threatened and Endangered and Sensitive Species found in the area of concern will be identified. The population location will be mapped, if appropriate, and the number of individuals will be recorded. The surveys of the TEC and Sensitive Species, if found, will be repeated in 2004, 2005, 2006, and 2008.

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A low level, colored infrared aerial survey will be conducted of the East Fork of Box Canyon in 2003 and in 2008. The survey will include the stream and spring monitoring points. The results of the survey will be reported to the Division in the mine's Annual Report in the year following the survey.

The vegetative, erosion, and colored infrared survey reports will be submitted to the Division as part of the annual report according to the schedule provided below. Two copies of the reports will be sent to the Division so that they may forward one copy to the Manti-LaSal National Forest.

1. 2003 Baseline Vegetation Report to be submitted with the mine's 2004 Annual Report. Also includes baseline colored infrared aerial photos and report of the monitored stream and spring areas within the east Fork of Box Canyon
2. Both 2004 Quantitative and Qualitative Vegetation Reports for the 1<sup>st</sup> year data collected following undermining will be submitted in the 2005 Annual Report.
3. 2005 Qualitative Vegetation Reports for the 2<sup>nd</sup> year following undermining will be submitted in the 2006 Annual Report. The Qualitative surveys only will be conducted.
4. 2006 Quantitative and Qualitative Vegetation Reports for the 3<sup>rd</sup> year following undermining will be submitted in the 2007 Annual Report.
5. 2008 Quantitative and Qualitative Vegetation Reports for the 5<sup>th</sup> year following undermining will be submitted in the 2009 Annual Report. Also includes the colored infrared aerial photos and report of the monitored stream and spring areas within the East Fork of Box Canyon.

If substantiated mining-induced changes occur in the vegetation within the affected areas of the East Fork of Box Canyon, a revegetation/enhancement mitigation plan will be created and submitted to the Division. The permittee understands that the mitigation plan will be approved only after the Division consults with the USFS on the proposed plan.

In addition to the East Fork of Box Canyon vegetative monitoring and mitigation plan, Sufco will implement a hydrologic monitoring plan as well as a stream channel subsidence crack mitigation plan. These plans are discussed in greater detail in Section 7.3.1.2 and Section 5.2.5.1 of this M&RP. Mitigation of cracks, if they occur, in the bottom of the stream channel requires the placement of bentonite grout to stop the diversion of surface flows. If mitigation is required during the critical elk and deer time periods of November 1<sup>st</sup> through April 1<sup>st</sup> and May 1<sup>st</sup> through July 1<sup>st</sup>,

or during the raptor nesting and rearing season of February 1<sup>st</sup> through August 31<sup>st</sup>, the Division will be contacted and the mitigation plans reviewed with the appropriate regulatory personnel. Mitigation work will be performed in such a manner as to minimize disturbance to wildlife.

A baseline macroinvertebrate survey was performed on the East Fork of the Box Canyon on October 20, 2003 by Dr. Dennis K. Shiozawa with assistance from Patrick Collins of Mt. Nebo Scientific. Ms. Katherine Foster of the Manti-LaSal National Forest was also present during the survey. Locations of the macroinvertebrate populations survey were determined based on the stream channel floor conditions, availability of water, and potential repeatability of the survey. Sites in the area of EFB-4 were not acceptable to Dr. Shiozawa since the channel floor was not stable and consisted of loose sand. The current environmental conditions, specifically the channel floor configuration, would likely be changing naturally over time and with every significant precipitation event. These naturally occurring changes would make repeating the survey in these types of locations very difficult at best. Additionally, the loose sands that formed the channel floor are abrasive and very detrimental to macroinvertebrate life. The movement of sand through the system as a result of a precipitation event could easily significantly diminish or destroy populations. Therefore, four locations were selected in the area of and upstream of site EFB-11. These locations appeared to have the most stable channel floor, bed rock, and repeatability of the survey at these locations would be possible.

The survey consisted of obtaining two sample sets from each site. The organisms captured at each site will be identified to the species level. The number of organisms per unit of measure were counted and recorded. Two copies of the results of this baseline survey will be submitted to the Division with the 2004 Annual Report. A second and third survey will be performed in 2004 and 2005 following undermining and two copies of the results will be submitted to the Division with the 2005 and 2006 Annual Reports.

A copy of the October 2003 "Monitoring and Mitigation Plan for Mining Under the East Fork of Box Canyon" prepared by the Division and reviewed and accepted by the Forest with some modifications has been included in Appendix 3-10. The preceding paragraphs have been prepared based on this

plan. Sufco will meet all of the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the East Fork of Box Canyon.

### **3.2.2.3 Fish and Wildlife Service Review**

If requested, the applicant authorizes the release of information pertaining to Section 3.2.2 and 3.3.3 to the U.S. Fish and Wildlife Service Regional and Field office for their review.

### **3.2.3 Maps and Aerial Photographs**

The lease area was mapped by use of a mosaic of aerial photographs and assured by ground inspection. Vegetation sampling locations/reference areas are shown on Plate 3-1.

#### **3.2.3.1 Location and Boundary of Proposed Reference Area**

The locations of the vegetative reference areas are found on Plate 3-1. Area 13 shown on Plate 3-1 is to be used as a mapping unit only and not a reference area or validation site. Site 12 will be used as the reference area for the minesite sedimentation pond area.

#### **3.2.3.2 Elevations and Locations of Monitoring Stations**

Raptor nest locations and elk and deer range are shown on Plate 3-2 and 3-3. The permit area contains no fish monitoring stations.

#### **3.2.3.3 Facilities for Protection and Enhancement**

Sections 3.3.3.3 and 3.5.8.5 contain additional discussion pertaining to protective measures taken by the applicant in behalf of wildlife.

Power lines within the SUFACO Mine permit area were modified during the summer of 1981 to comply with the guidelines of REA Bulletin 61-10, "Power Line Contacts by Eagles and Other Large Birds" (see Plate 5-5 for the power pole locations).

#### **3.2.3.4 Vegetation Type and Plant Communities**

Vegetative types and plant communities are outlined on Plate 3-1 of this application.

Table 3-2

Utah Wildlife Species of Special Interest  
Sevier and Emery Counties  
March 29, 2011

<u>Mammals</u>		<b>State Status</b>
Brown (Grizzly) Bear	<u>Ursus arctos</u> <sup>2,4</sup>	S-ESA
Gray Wolf	<u>Canis lupus</u> <sup>1</sup>	S-ESA
Black-footed Ferret	<u>Mustela nigripes</u> <sup>1,4</sup>	S-ESA
Utah Prairie Dog	<u>Cynomys parvidens</u> <sup>2</sup>	T
Fringed Myotis	<u>Myotis thysanodes</u>	SPC
Big Free-tailed Bat	<u>Nyctinomops macrotis</u>	SPC
Townsend's Big-eared Bat	<u>Plecotus townsendii</u>	SPC
Canada Lynx	Lynx canadensis <sup>2</sup>	S-ESA
Kit Fox	<u>Vulpes macrotis</u>	SPC
White-tailed Prairie-dog	<u>Cynomys leucurus</u>	SPC
Pygmy Rabbit	<u>Brachylagus idahoensis</u>	SPC

**Birds**

Southwestern Willow Flycatcher	<u>Empidonax traillii extimus</u> <sup>1</sup>	S-ESA
Bald Eagle	<u>Haliaeetus leucocephalus</u>	SPC
Ferruginous Hawk	<u>Buteo regalis</u>	SPC
Yellow-billed Cuckoo	<u>Coccyzus americanus occidentalis</u> <sup>3</sup>	S-ESA
Spotted (Mexican) Owl	<u>Strix occidentalis</u> <sup>2</sup>	S-ESA
Northern Goshawk	<u>Accipiter gentilis</u>	CS
Burrowing Owl	<u>Athene cunicularia</u>	SPC
Short-eared Owl	<u>Asio flammeus</u>	SPC
American White Pelican	<u>Pelecanus erythrorhynchos</u>	SPC
Three-toed Woodpecker	<u>Picoides tridactylus</u>	SPC
Greater Sage-Grouse	<u>Centrocercus urophasianus</u> <sup>3</sup>	S-ESA
Long-billed Curlew	<u>Numenius americanus</u>	SPC
Black Swift	<u>Cypseloides niger</u>	SPC
Lewis's Woodpecker	<u>Melanerpes lewis</u>	SPC

**Fish**

Bonytail	<u>Gila elegans</u> <sup>1</sup>	S-ESA
Humpback Chub	<u>Gila cypha</u> <sup>1</sup>	S-ESA
Razorback Sucker	<u>Xyrauchen texanus</u> <sup>1</sup>	S-ESA
Roundtail Chub	<u>Gila robusta</u>	CS
Flannelmouth Sucker	<u>Catostomus latipinnis</u>	CS
Bluehead Sucker	<u>Catostomus discobolus</u>	CS
Colorado River Cutthroat Trout	<u>Oncorhynchus clarki pleuriticus</u>	CS
Bonneville Cutthroat Trout	<u>Oncorhynchus clarki utah</u>	CS
Colorado Pikeminnow	<u>Ptychocheilus lucius</u> <sup>1</sup>	S-ESA
Southern Leatherside Chub	<u>Lepicomedea aliciae</u>	SPC

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**Reptiles and Amphibians**

Western (Boreal) Toad	<u>Bufo boreas</u> <sup>3</sup>	SPC
Cornsnake	<u>Elaphe guttata</u>	SPC
Great Plains Toad	<u>Bufo cognatus</u>	SPC

**MOLLUSK**

Carinate Glenwood Pyrg	<u>Pyrgulopsis inopinata</u>	SPC
Otter Creek Pyrg	<u>Pyrgulopsis fusca</u>	SPC
Smooth Glenwood Pyrg	<u>Pyrgulopsis chamberlini</u>	SPC

None of these species are located in the mine lease area.

<sup>1</sup>Species is federally listed as Endangered

<sup>2</sup>Species is federally listed as Threatened

<sup>3</sup>Species is federally listed as Candidate

<sup>4</sup>Species is federally listed as Extirpated

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Key to State Status Field

<u>Symbol</u>	<u>Definition</u>
S-ESA	Federally-listed or candidate species under the Endangered Species Act.
SPC	Wildlife species of concern.
CS	Species receiving special management under a Conservation Agreement in order to preclude the need for Federal listing.

Utah Division of Wildlife Resources, 1596 West North Temple, Salt Lake City, Utah 84116-3195

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Table 3-3

USDA-FS Region 4 Sensitive Species  
Fishlake and Manti-LaSal  
July 27, 2011 update

<u>Plants</u>		<u>Status</u>
Link Trail Columbine	<u>Aquilegia flavescens var. rubicunda</u>	S
Cruetzfeldt-flower Cryptanth	<u>Cryptantha creutzfeldii</u>	S
Carrington Daisy	<u>Erigeron carringtoniae</u>	S
Canyon Sweetvetch	<u>Hedysarum occidentale var. canone</u>	S
Maguire Campion	<u>Silene petersonii</u>	S
Musinea Groundsel	<u>Senecio musinensis</u>	S
Arizona Willow	<u>Salix arizonica</u>	S
Wonderland Alice Flower	<u>Aliciella caespitosa</u>	S
Chatterley Onion	<u>Allium geyeri var. chatterleyi</u>	S
Sweet-flower Rock Jasmine	<u>Androsace chamaejasme ssp. Carinata</u>	S
Bicknell milkvetch	<u>Astragalus consobrinus</u>	S

Canyon Fuel Company, LLC  
SUFCO Mine

Mining and Reclamation Plan  
December 20, 1991 (R 07/12)

Isely's Milkvetch	<u>Astragalus iselyi</u>	S
Tushar Paintbrush	<u>Castilleja parvula var. parvula</u>	S
Pinnate Spring-parsley	<u>Cymopterus beckii</u>	S
Abajo Peak Draba	<u>Draba abajoensis</u>	S
Mt. Belknap Draba	<u>Draba ramulosa</u>	S
Creeping Draba	<u>Draba sobolifera</u>	S
Nevada Willowherb	<u>Epilobium nevadense</u>	S
Abajo Daisy	<u>Erigeron abajoensis</u>	S
Kachina Daisy	<u>Erigeron kachinensis</u>	S
Maquire Daisy	<u>Erigeron maguirei</u>	S
LaSal Daisy	<u>Erigeron mancus</u>	S
Elsinore Buckwheat	<u>Eriogonum batemanii var. ostlundii</u>	S
Canyonlands Lomatium	<u>Lomatium latilobum</u>	S
Fish Lake Naiad	<u>Najas caespitosa</u>	S
Beaver Mountain Groundsel	<u>Packera castoreus</u>	S
Little Penstemon	<u>Penstemon parvus</u>	S

Ward Beardtongue	<u>Penstemon wardii</u>	S
Bicknell Thelesperma	<u>Thelesperma subnudum var. alpinum</u>	S
Barneby Woody Aster	<u>Tonestus kingii var. barnebyana</u>	S
Sevier Townsendia	<u>Townsendia jonesii var. lutea</u>	S

**Mammals**

Townsend's Western Big-eared Bat	<u>Corynothinus townsendii townsendii</u>	S
Spotted Bat	<u>Euderma maculatum</u>	S
Bighorn Sheep	<u>Ovis canadensis</u>	S
Pygmy Rabbit	<u>Brachylagus idahoensis</u>	S

**Birds**

Northern Goshawk	<u>Accipiter gentilis</u>	S
Flammulated Owl	<u>Otus flammeolus</u>	S
Northern Three-toed Woodpecker	<u>Picoides tridactylus</u>	S
Bald Eagle	<u>Haliaeetus leucocephalus</u>	S
Greater Sage-grouse	<u>Centrocercus urophasianus</u>	S

Canyon Fuel Company, LLC  
SUFCO Mine

Mining and Reclamation Plan  
December 20, 1991 (R 07/12)

Peregrine Falcon	<u>Falco peregrinus anatum</u>	S
Yellow-billed Cuckoo	<u>Coccyzus americanus</u>	S

**Fish**

Colorado River Cutthroat Trout	<u>Oncorhynchus clarki pleuriticus</u>	S
Bonneville Cutthroat Trout	<u>Oncorhynchus clarki utah</u>	S
Southern Leatherside Chub	<u>Lepidomeda aliciae</u>	S

**Amphibians**

Spotted Frog	<u>Rana pretiosa</u>	S
Boreal Toad	<u>Bufo boreas</u>	S

S - Sensitive: Any species which, although still occurring in numbers adequate for survival, has been greatly depleted or occurring in limited areas and/or numbers due to a restricted or specialized habitat.

USDA-Manti-LaSal National Forest, 599 Price River Dr., Price , Utah 84501

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The Applicant agrees, however, to notify the regulatory authority and the Utah State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria.

### **West Coal Lease Modification Areas**

**Cultural and Historic Information.** Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2 in the Confidential folder of the M&RP. EarthTouch, Inc. conducted an intensive evaluation of the West Coal Lease Modification Areas.

The results of the cultural resource inventory for the project resulted in the identification of 15 cultural resource sites, which included three previously recorded sites (42SV1301, 42SV1386 and 42SV2688), and 12 new sites (42SV3207-3215 and 42SV3246-3248). Overall, the identified cultural resource sites consist of small- to moderate-sized lithic scatters and small rock shelters/overhangs, some with associated pictographs. Of the 15 sites identified within the West Coal Lease Modification Areas, six sites are recommended eligible for the National Register of Historic Places. These sites include 42SV3209, 42SV3211, 42SV3212, 42SV3213, 42SV3247 and 42SV3248 which consist of small rock shelters and rock shelters with pictographs. Site 42SV3209 will be the only site undermined under the present mine plan. This shelter is more of a terrace overhang that extends 6 meters long, with a 1.5 meter overhang or width.

### **South Fork of Quitchupah 2R2S Block "A" Area**

**Cultural and Historic Information.** Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2 in the Confidential folder of the M&RP. Canyon Environmental conducted an evaluation of the South Fork of Quitchupah in and adjacent to the 2R2S Block "A" panel Area.

The results of the cultural resource inventory for the project resulted in the identification of 4 cultural resource sites, which included one previously recorded site (42SV2690), and 3 new sites (42SV3462, 42SV3463 and 42S3464). Overall, the identified cultural resource sites consist of lithic

scatters and a small rock shelter/overhang. Of the 4 sites identified within the South Fork of Quitcupah Area, two sites are recommended eligible for the National Register of Historic Places. These sites include 42SV2690 which consists of a lithic scatter and 42SV3464 which consists of a lithic scatter associated with a small rock shelter. Both sites will be undermined under the present mine plan. This shelter is more of a terrace overhang that measures approximately 1.5 meters high and 4 meters wide at the opening and extends 1.5 meters beneath the rock to a tapered edge. The shelter shows signs of modern disturbance and it appears that some of the fill material has been disturbed by minor looting activities.

A cultural resource investigation plan for the 42SV3464 rock shelter was requested and approved between the U.S. Forest Service, Utah State Historic Preservation Office (SHPO), EnviroWest, LLC and Canyon Fuel Company, LLC since the shelter appeared to have been disturbed. Testing of the rock shelter for significance was conducted by EnviroWest and Fishlake National Forest Archaeologist in the fall of 2012. While the site was initially evaluated as being eligible for listing in the National Register of Historic Places, subsequent testing has found it to be ineligible for listing due to disturbance. A copy of the cultural resource investigation testing report and the Determination of Significance and Effect form are located in Appendix 4-2 in the Confidential folder of the M&RP.

No further testing of the 42SV2690 lithic scatter was required. In accordance with previous commitments the mine has made in previous sections of this M&RP, protection of eligible cultural resources will be in accordance with regulatory authority and Utah SHPO requirements. The Applicant will also instruct its employees that it is a violation of federal and state laws to collect individual artifacts or to otherwise disturb cultural resources.

The Applicant agrees to notify the regulatory authority and the Utah State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria.

#### 4.1.1.2 Previous Mining Activity

Portions of the mine plan area were mined prior to the filing of this permit application. SUFACO Mine began a small operation mining the Upper Hiawatha Coal seam in 1941. There was no previous mining activity prior to the 1941 SUFACO operation.

From 1941 through 1974, the coal was removed by conventional mining techniques. From 1974 through 1978, both conventional and continuous mining methods were used. From 1978 until October 1985, all mining used continuous mining methods. Since October 1985 both continuous mining and longwall mining methods have been used. The portion of the seam mined by conventional methods was only partially extracted leaving all pillars for support. The majority of the mining done has been full extraction. All longwall mining is full extraction.

The quantity of coal mined prior to this permit application was approximately 37,058,100 tons. The earlier workings are shown on Plate 5-1 as an integral part of the mining operation.

Use of the land preceding mining was primarily grazing. The area also supported limited timbering in the Ponderosa stands and hunting.

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stream channel or reduction in stream flows were noted as a result of undermining that portion of Burnout Canyon using the approved mining schedule.

A weekly report will be submitted via e-mail to the Division detailing the results of the inspections. The reports will include, but not necessarily be limited to: a map illustrating the current location of the longwall face; descriptions and dates of field activities; noted changes in stream and local geomorphology; location, width, frequency of cracks; and a description of repairs, if any, conducted. If the prescribed inspections cannot be conducted, the reason for the missed inspection and a record of the attempt to conduct the inspection will be submitted to the Division in the weekly report. The Division will be notified immediately after mining-induced cracks, if any, are found in the East Fork stream channel and the steps taken or planned to be taken as mitigation. Thereafter, the Division will be advised of continuing mitigation efforts, if needed, in the weekly report.

A copy of the October 2003 "Monitoring and Mitigation Plan for Mining Under the East Fork of Box Canyon" prepared by the Division and reviewed and accepted by the Forest with some modifications has been included in Appendix 3-10. The preceding paragraphs have been prepared based on this plan. Sufco will meet all of the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the East Fork of Box Canyon.

#### South Fork of Quitchupah 2R2S Block 'A' Subsidence Monitoring and Mitigation

Portions of the South Fork of Quitchupah will be undermined and subsided as longwall panel 2R2S is extracted. A monitoring and mitigation plan that is more intensive than the general Mining and Reclamation Plan area has been proposed for monitoring surface and ground water flows, subsidence cracks and repair of the cracks in the portions of the South Fork of Quitchupah channel to be undermined. The subsidence portion of the monitoring and mitigation plan is discussed in detail in the following text.

Prior to the initiation of undermining and subsidence, a pre-subsidence survey of the stream channel will be conducted in the portion of South Fork of Quitchupah that flows over the 2R2S panel and

associated gate roads. The survey will consist of a gain/loss survey of flow within the stream channel paying particular attention to surface flows and ground water discharge, soil conditions, and the general channel geomorphology of the area. A similar study was performed in the past but all stream measurements were not conducted on the same date. The second gain/loss survey will be completed on a single day at or near base flow conditions late in the summer or early fall of 2011. The mine will attempt, as part of this second survey, to occupy the same monitoring sites in the panel area as those chosen in the initial survey. The monitoring of surface and ground water flows are discussed in greater detail in Section 7.3.1.2.

The subsidence monitoring plan for the South Fork of Quitcupah will include frequent inspection of the stream channel during and after active subsidence. While mining is occurring under the stream channel, and within the 15-degree angle-of-draw above the active longwall face, that area of the channel will be inspected semi-weekly for subsidence cracks or other related features. As the longwall face advances and the 15-degree angle-of-draw area follows, the portions of the channel that now lie outside the 15-degree angle-of-draw will be monitored for subsidence features on a quarterly basis for two years following the cessation of subsidence related effects, if any, due to mining.

Mitigation of cracks that interrupt or divert flows from the stream channel will be sealed immediately with an appropriate impermeable grout or, in some cases, native materials. Sufco will attempt to seal cracks with the least intrusive methods (typically hand placement of grout or native materials) first. The sealing material may be placed by pouring it directly into the crack or, if cracks occur in an actively flowing portion of the stream, the stream may be temporarily diverted using native materials (or a designed flume if necessary to maintain the flow) until the crack is sealed. If cracks are present in channel walls defined by soil, the soil cracks will be hand filled using a native soil/bentonite mix. The sealing of the channel floor and walls will be accomplished with hand tools such as shovel, picks, trowels, etc.

As a backup plan, in the unlikely event that cracks too large to be sealed through the efforts of one or two persons in one day do occur and it appears there is a danger of water being diverted from the

channel for an extended period of time, the stream will be temporarily diverted using native materials and a pipe to carry the flow over the crack to maintain the channel flow. Arrangements will be made to get a contractor to the site as soon as possible to repair the crack after consultation with the Forest Service.

There may be sections of the stream channel that may require more intensive mitigation efforts to restore surface flows in the creek. These efforts could include the drilling of closely spaced shallow boreholes in and adjacent to the stream channel and the injection of an acceptable impermeable grout into the alluvium or bedrock. The work will be accomplished either using hand tools or low impact equipment to minimize surface disturbance. Existing roads and turnouts will be used as staging areas to locate larger equipment and supplies. Any hoses or lines will be transported from the staging areas to the nearby work sites either by hand, the use of pack animals, or by helicopter. This work will be done with a contractor selected after consultation with the Forest Service.

Additionally, it may be required to remove loose rock from the channel floor, either where the channel flows across thin-bedded bedrock or where large rock have fallen into the channel and is impeding flows. In the instance of the former, past experience has shown this can occur in the upper Blackhawk Formation and is easily repaired by removing enough of the broken channel surface to again expose the stream flow. In the instance of the later, removal of large rocks could be accomplished by drilling and then fracturing the rock into smaller fragments more easily moved to locations were they are not impeding flow. This work may be completed using available pneumatic or hydraulic tools that do not require road or pad building disturbances. In the unlikely event that large boulders do need to be moved, pumps and tanks necessary to complete the work will be located in pre-disturbed areas, such as roads or turnouts, and hoses will be walked into the work area.

A copy of the 2012 "Monitoring and Mitigation Plan for Undermining the South Fork of Quitcupah 2R2S Block "A" has been included in Appendix 3-14. The preceding paragraphs have been prepared based on this plan. Sufco will meet all of the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the South Fork of Quitcupah 2R2S Block "A".

Sufco will conduct longwall mining operations in such a manner as to minimize surface disturbance while mining within the 15-degree angle-of-draw area that includes the South Fork stream channel. This will be accomplished by advancing the longwall on a schedule where mining will not be suspended for a period to exceed 48 hours.

A bi-weekly (once every two weeks) report on the impacts to stream flow and required mitigation, if any, will be submitted via e-mail to the Division and the forest detailing the results of the inspections while mining is occurring under the stream channel. The reports will include, but not necessarily be limited to: a map illustrating the current location of the longwall face; descriptions and dates of field activities; noted changes in stream and local geomorphology; location, width, frequency of cracks; and a description of repairs, if any, conducted. If the prescribed inspections cannot be conducted, the reason for the missed inspection and a record of the attempt to conduct the inspection will be submitted to the Division and the forest in the report. The Division and the forest will be notified immediately after mining-induced cracks, if any, are found in the South Fork stream channel and the steps taken or planned to be taken as mitigation. Thereafter, the Division and the forest will be advised of continuing mitigation efforts, if needed, in the report.

Though not anticipated, short segments of Cowboy Creek could be subsided in the SITLA Muddy Tract. If this is anticipated to occur, Sufco, will submit a plan for mitigation to address, if it occurs, adverse impacts to Cowboy Creek. With the approval of the Division and concurrence of the Forest, Sufco will instigate a flow monitoring plan similar to the plan implemented prior to the undermining of the East Fork of Box Canyon. If mitigation of surface cracks are required, methods similar to those proposed and implemented in the East Fork of Box Canyon as described above could be used.

Mining within the area of the East Fork of the Box Canyon, South Fork of Quitcupah and within the area of Cowboy Canyon in the SITLA Muddy Tract will be conducted in accordance with State and Federal rules and regulations and the requirements and stipulations presented in the BLM's Conditions of Approval of the Resource Recovery and Protection Plan (July 31, 2003) located in Appendix 1-2. A survey of the water quality and quantity of surface and groundwater, including State

appropriated waters, within the SITLA Muddy Tract has been completed. The results of the area survey are included in the PHC for the SITLA Muddy Tract and included in Appendix 7-20. Ground and surface waters in the tract that have attached rights are listed in Appendix 7-1.

A discussion regarding the methods Sufco would employ to mitigate and replace an adversely affected State appropriated water supply is provided in Chapter 7, Section 7.3.1.8.

### 5.2.5.2 Subsidence Control

**Adopted Control Measures.** As indicated above, SUFACO Mine has adopted subsidence-control measures in areas where surface resources are to remain protected. These controls consist primarily of leaving support pillars in place in those areas designated on Plates 5-10A, 5-10B & 5-10C as not planned for subsidence. Based on experience and data collected from the lease area, the design of support pillars for those areas where subsidence is not planned has been based on the following equations:

$$SF = SD/OS \quad (5-1)$$

where SF = safety factor against pillar failure (fraction)

SD = support strength density (psi)  
=  $(Y_c)(1-ER)$

$Y_c$  = average compressive yield strength of the coal (psi)  
= 3090 psi for the Upper Hiawatha seam

ER = extraction ratio (fraction)  
=  $1-(A_p/A_t)$

$A_p$  = pillar area (ft<sup>2</sup>)

$A_t$  = area supported by pillar (ft<sup>2</sup>)

OS = overburden stress (psi)  
=  $(d)(D_o)/144$

d = overburden depth (ft)

$D_o$  = overburden density (lb/ft<sup>3</sup>)  
= 160 lb/ft<sup>3</sup> for the lease area

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**TABLE 7-2**  
**Water Monitoring Program**

<u>Monitoring Wells</u>	<u>Protocol</u>	<u>Comments</u>
US-80-2	A	Screened in Castlegate Sandstone
US-80-4	B	Screened in Castlegate Sandstone
89-20-2W	A	Screened in Castlegate Sandstone
US-79-13	B	Screened in Blackhawk Formation
US-81-3	A	Screened in Blackhawk Formation
US-81-4	A	Screened in Blackhawk Formation
01-8-1	A	Screened in Blackhawk Formation
 <u>Streams</u>		
SUFCO 006	C,2	Upper South Fork Quitchupah Creek
SUFCO 006A	F,1	Upper South Fork Quitchupah Creek
SUFCO 006B	F,1	Upper South Fork Quitchupah Creek
SUFCO 006C	F,1	Upper South Fork Quitchupah Creek
SUFCO 006D	F,1	Upper South Fork Quitchupah Creek
SUFCO 007	C,2	Upper North Fork Quitchupah Creek
SUFCO 041	C,2	Lower Quitchupah Creek
SUFCO 042	C,2	Lower North Fork Quitchupah Creek
SUFCO 046	C,2	Upper Quitchupah Creek
SUFCO 047A	C,2	Lower East Spring Canyon Creek
SUFCO 090	C,1	Upper Box Canyon Creek
Pines 106	C,2	Upper East Fork Box Canyon
Pines 302	C,1	Muddy Creek-Last Water Creek Confluence
Pines 403	C,2	Lower Box Canyon Creek
Pines 405	C,1	Muddy Creek - Box Creek Confluence
Pines 406b*	C,1	Lower Muddy Creek
Pines 407	C,1	Box Canyon Creek
Pines 408	C,1	East Fork Box Canyon Creek
USFS-109	C,1	Upper Main Fork of Box Canyon Creek
Link 001	C,2	Link Canyon Drainage
Link 002	C,2	Link Canyon Drainage
FP-1	G,6	East Fork of Main Fork of Box Canyon
FP-2	G,6	East Fork of East Fork of Box Canyon
M-STR4	C,1	Cowboy Creek

\*Monitoring point Pines 406 was moved downstream to the USGS monitoring point in 1999 and renumbered as Pines 406b. The point is located in the NW1/4NE1/4, Sec. 21, T21S. R6E.

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**TABLE 7-2 (Continued)**  
**Water Monitoring Program**

<u>Springs</u>	<u>Protocol</u>	<u>Comments</u>
SUFCO 001	D,3	Blackhawk Formation
SUFCO 047	D,4	Star Point Sandstone
SUFCO 057A	D,3	North Horn Formation
SUFCO 089	E,3	Castlegate Sandstone
GW-8	D,5	Price River Formation
GW-9	D,5	Price River Formation
GW-13	D,3	North Horn Formation
GW-20	D,5	Castlegate Sandstone
GW-21	D,3	Castlegate Sandstone
Pines 100	D,4	Castlegate Sandstone
Pines 105	D,3	Castlegate Sandstone
Pines 206	D,5	Blackhawk Formation
Pines 209	D,5	Blackhawk Formation
Pines 212	D,5	Blackhawk Formation
Pines 214	D,5	Blackhawk Formation
Pines 218	D,3	Castlegate Sandstone
Pines 303	D,3	Blackhawk Formation
Pines 310	D,7	Castlegate Sandstone
Pines 311	D,7	Castlegate Sandstone
Link Portal-West	D,4	Link Canyon Portal
Link Portal-East	D,4	Link Canyon Portal
M-SP01	D,3	Price River Formation
M-SP02	D,3	Price River Formation
M-SP08	D,3	North Horn Formation
M-SP18	D,3	Price River Formation
M-SP39	D,3	Price River Formation
M-SP53	D,3	North Horn Formation
Mud Spring	D,5	Price River Formation
Broad Hollow	D,5	Blackhawk Formation
006A Spring	H,3	Price River Formation
Roberts Spring	H,3	Price River Formation
RS-A	H,3	Price River Formation
RS-B	H,3	Price River Formation

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**TABLE 7-2 (Continued)**  
**Water Monitoring Program**

<u>Springs</u>	<u>Protocol</u>	<u>Comments</u>
Wedge Spring	H,3	Castlegate Sandstone
Amanda Spring	H,3	Castlegate Sandstone
94-113 Seep	H,3	Price River Formation

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**TABLE 7-3**

**Field and Laboratory Measurement Protocol**

Water level and flow measurements

- A Monitoring well: quarterly water level measurement
- B Monitoring well: annual water level measurement (3rd quarter)
- C Stream: quarterly discharge measurements
- D Spring: quarterly discharge measurements
- E Spring Pool: quarterly water level measurement
- F Stream: Bi-weekly measurements while mining is occurring under the stream in 2013, thereafter quarterly for two years.
- G Stream: identify perennial portion of stream on or near October 1 of each year.
- H Spring: Quarterly measurements while mining is occurring under the 2R2S panel stream in 2013, thereafter quarterly for two years.

Water quality

- 1 Stream: quarterly surface water quality field measurements
- 2 Stream: quarterly surface water quality operational laboratory measurements
- 3 Spring: quarterly groundwater quality field measurements
- 4 Spring: quarterly groundwater quality operational laboratory measurements
- 5 Spring: groundwater quality operational laboratory measurements quarterly for two (2) years, then reverting to quarterly water quality field measurements
- 6 Stream: flow measurements only, no water quality samples required.
- 7 Spring: initially ground water field measurements June 2006 through December 2006 as accessible then quarterly groundwater field measurements thereafter.

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essentially no tritium. Modern surface waters contain abundant tritium. They visited this site again in June 1996 and located several springs in the drainage several hundred feet above where samples are collected and classified the site as a spring-monitoring site. Nevertheless, Mayo now agrees with SUFCA that this site should be considered a surface water site for monitoring purposes because, at times, this drainage has flow which is contributed by snow melt, precipitation, or sediment pond discharge.

Monitoring sites are sampled three times per year. Surface water monitoring data are submitted to UDOGM by the end of the quarter following sampling. Monitoring data will be submitted to the Utah Coal Mining Water Quality Database by Electronic Data Input (EDI). UPDES reporting requirements will be met for the three UPDES discharge sites at the mine (see Appendix 7-7).

To better understand the effects that mining will have, if any, on the stream flows within Box Canyon, surface water monitoring sites Pines-407 and Pines-408 will be monitored for stream flows in gallons per minute once every week during the months of June, July, August, September, and October in 1999. Starting in the year 2000, sites 407 and 408 will be monitored once a month in July, August, September, and October for a five year period. If analysis of the data shows no significant changes during this time period, monitoring at these points will be eliminated from the water monitoring program on Table 7-2. Flow measurements at these two sites will be obtained on the same day. Also, the operator will endeavor to obtain the required samples at least five days after the last precipitation event in the drainage area.

To better understand the effects that mining will have, if any, on the stream flows within the South Fork of Quitcupah, surface water monitoring sites SUFCA 006A and SUFCA 006B will be monitored quarterly starting in 2010 for stream flows in gallons per minute and once every two weeks when accessible while mining is occurring within the 15 degree angle-of-draw of the stream channel. Two additional surface water monitoring sites will be monitored quarterly, SUFCA 006C starting in 2011 and SUFCA 006D starting in 2012. Once mining has been completed within the angle-of draw, the sites will be monitored on a quarterly basis for two years after mining has progressed past the 15 degree angle-of-draw. If analysis of the data shows no significant changes during this time period, monitoring at these points will be eliminated from the water monitoring program on Table 7-2. Flow measurements at these four sites will be obtained on the same day.

1. Determine if ground water discharge in the area of Pines 105 and Joes Mill Pond springs continue to discharge to the alluvium;
2. Monitor and evaluate the effects of mining on the surface and subsurface water in the Pines 310 and Pines 311 spring areas; and
3. Determine the potential for completing and operating ground water wells in the spring areas as part of the spring site mitigation activities.

The piezometers/wells completed as part of this project will be monitored on a bi-weekly basis through December 2006 or as accessible. Transducers with data loggers will be placed in several of the piezometers to record data on a more continuous basis. The monitoring frequency of the piezometers/wells after December 2006 will be dependant upon the results of the drilling investigation and the impacts to springs Pines 310, 311, 105, and the Joes Mill Pond of mining the 6LPE panel in the fall and winter of 2006.

A report detailing the results of the drilling and piezometer/ well installation and completion will be submitted to the Division by the end of October 2006. Water level data collected from the piezometers/wells will be reported to the Division electronically within two weeks at the end of each the month through December 2006. The Division will also be notified within three days via e-mail or telephone of significant changes to ground water elevations in Pines 310, 311, 105 spring areas as the 6LPE longwall panel is mined. A report compiling the water level data and interpretation of the data will be submitted to the Division by the end of January 2007.

Based on the findings of the investigation, Sufco will submit to the Division either additional plans (if water is not found in the Pines 105 and Joes Mill Pond area, additional bedrock drilling may be required to locate a suitable source of ground water) or a final plan for mitigation of the effected spring areas.

#### South Fork of Quitchupah 2R2S Block "A" Monitoring and Mitigation Plan

A monitoring and mitigation plan that is more intensive than the general Mining and Reclamation Plan area has been proposed for monitoring water flows, subsidence cracks, and repair of the cracks in the portions of the South Fork of Quitchupah channel to be undermined. This plan is outlined below.

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Prior to the initiation of undermining and subsidence, a pre-subsidence survey of the stream channel will be conducted in the portion of South Fork of Quitchupah that flows over the 2R2S Block "A" panel and associated gate roads. The survey will consist of a gain/loss survey of flow within the stream channel paying particular attention to surface flows and ground water discharge, soil conditions, and the general channel geomorphology. A similar study was performed in the past but all stream measurements were not conducted on the same date. The second gain/loss survey will be completed on a single day at or near base flow conditions late in the summer or early fall of 2011. The mine will attempt, as part of this second survey, to occupy the same monitoring sites in the panel area as those chosen in the initial survey.

Two weeks before and then once every two weeks after subsidence mining begins, the measuring locations occupied during the gain/loss survey will be reoccupied and flow measurements of the stream flow will be obtained. The approximate locations of these sites are illustrated on Figure 7-9. The once every other week flow measurements will be supplemented by visual observations of flow performed twice a week or once every three to four days. Flow/no flow conditions will be described on these days. If no flow or diminished flows are noted, the appropriate mine and Forest personnel will be contacted and the mitigation plan to restore flows will be implemented.

Semi-weekly flow observations and visual inspections will continue for at least 12 weeks, or as conditions allow, after the completion of mining under the stream channel. The bi-weekly (once every two weeks) stream flow monitoring will continue for at least four weeks, or as conditions and monitoring results indicate necessary, after the completion of subsidence mining under the stream channel. The monitoring plan will then change to quarterly flow and field parameter measurements for two years at four sites: one upstream of the panel, one within the panel, and two downstream of the panel. The location of these new temporary monitoring sites are listed in Table 7-2 and shown on Plate 7-3 and labeled as sites 006A, 006B, 006C and 006D. Additional flow monitoring may be needed to determine specific locations where flow is being lost, and treatments are needed.

The subsidence monitoring plan for the South Fork of Quitchupah will include frequent inspection of the stream channel during and after active subsidence. While mining is occurring under the stream channel, and within the 15-degree angle-of-draw above the active longwall face, that area of the channel will be inspected semi-weekly for subsidence cracks or other related features.

As the longwall face advances and the 15-degree angle-of-draw area follows, the portions of the channel that now lie outside the 15-degree angle-of-draw will be monitored for subsidence features on a quarterly basis for two years following the cessation of subsidence related effects, if any, due to mining.

Mitigation of cracks that interrupt or divert flows from the stream channel will be sealed immediately with an appropriate impermeable grout or, in some cases, native materials. Sufco will attempt to seal cracks with the least intrusive methods (typically hand placement of grout or native materials) first. The sealing material may be placed by pouring it directly into the crack or, if cracks occur in an actively flowing portion of the stream, the stream may be temporarily diverted using native materials (or a designed flume if necessary to maintain the flow) until the crack is sealed. If cracks are present in channel walls defined by soil, the soil cracks may be hand filled using a native soil/bentonite mix. The sealing of the channel floor and walls will be accomplished with hand tools such as shovel, picks, trowels, etc.

As a backup plan, in the unlikely event that cracks too large to be sealed through the efforts of one or two persons in one day do occur and it appears there is a danger of water being diverted from the channel for an extended period of time, the stream will be temporarily diverted using native materials and a pipe to carry the flow over the crack to maintain the channel flow. Arrangements will be made to get a contractor to the site as soon as possible to repair the crack after consultation with the Forest Service.

There may be sections of the stream channel that may require more intensive mitigation efforts to restore surface flows in the creek. These efforts could include the drilling of closely spaced shallow boreholes in and adjacent to the stream channel and the injection of an acceptable impermeable grout into the alluvium or bedrock. The work will be accomplished either using hand tools or low impact equipment to minimize surface disturbance. Existing roads and turnouts will be used as staging areas to locate larger equipment and supplies. Any hoses or lines will be transported from the staging areas to the nearby work sites either by hand, the use of pack animals, or by helicopter. This work will be done with a contractor selected after consultation with the Forest Service.

Additionally, it may be required to remove loose rock from the channel floor, either where the channel flows across thin-bedded bedrock or where large rock have fallen into the channel and

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is impeding flows. In the instance of the former, past experience has shown this can occur in the upper Blackhawk Formation and is easily repaired by removing enough of the broken channel surface to again expose the stream flow. In the instance of the later, removal of large rocks could be accomplished by drilling and then fracturing the rock into smaller fragments more easily moved to locations where they are not impeding flow. This work may be completed using available pneumatic or hydraulic tools that do not require road or pad building disturbances. In the unlikely event that large boulders do need to be moved, pumps and tanks necessary to complete the work will be located in pre-disturbed areas, such as roads or turnouts, and hoses will be walked into the work area.

Sufco will conduct longwall mining operations in such a manner as to minimize surface disturbance while mining within the 15-degree angle-of-draw area that includes the South Fork stream channel. This will be accomplished by advancing the longwall on a schedule where mining will not be suspended for a period to exceed 48 hours.

A copy of the 2012 "Monitoring and Mitigation Plan for Undermining the South Fork of Quitcupah 2R2S Block "A" has been included in Appendix 3-14. The preceding paragraphs have been prepared based on this plan. Sufco will meet all of the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the South Fork of Quitcupah 2R2S Block "A".

A bi-weekly (once every two weeks) report on the impacts to stream flow and required mitigation, if any, will be submitted via e-mail to the Division and the Forest detailing the results of the inspections while mining is occurring under the stream channel. The reports will include, but not necessarily be limited to: a map illustrating the current location of the longwall face; descriptions and dates of field activities; noted changes in stream and local geomorphology; location, width, frequency of cracks; and a description of repairs, if any, conducted. If the prescribed inspections cannot be conducted, the reason for the missed inspection and a record of the attempt to conduct the inspection will be submitted to Division and the Forest in the report. Division and the Forest will be notified immediately after mining-induced cracks, if any, are found in the South Fork stream channel and the steps taken or planned to be taken as mitigation. Thereafter, Division and the Forest will be advised of continuing mitigation efforts, if needed, in the report.

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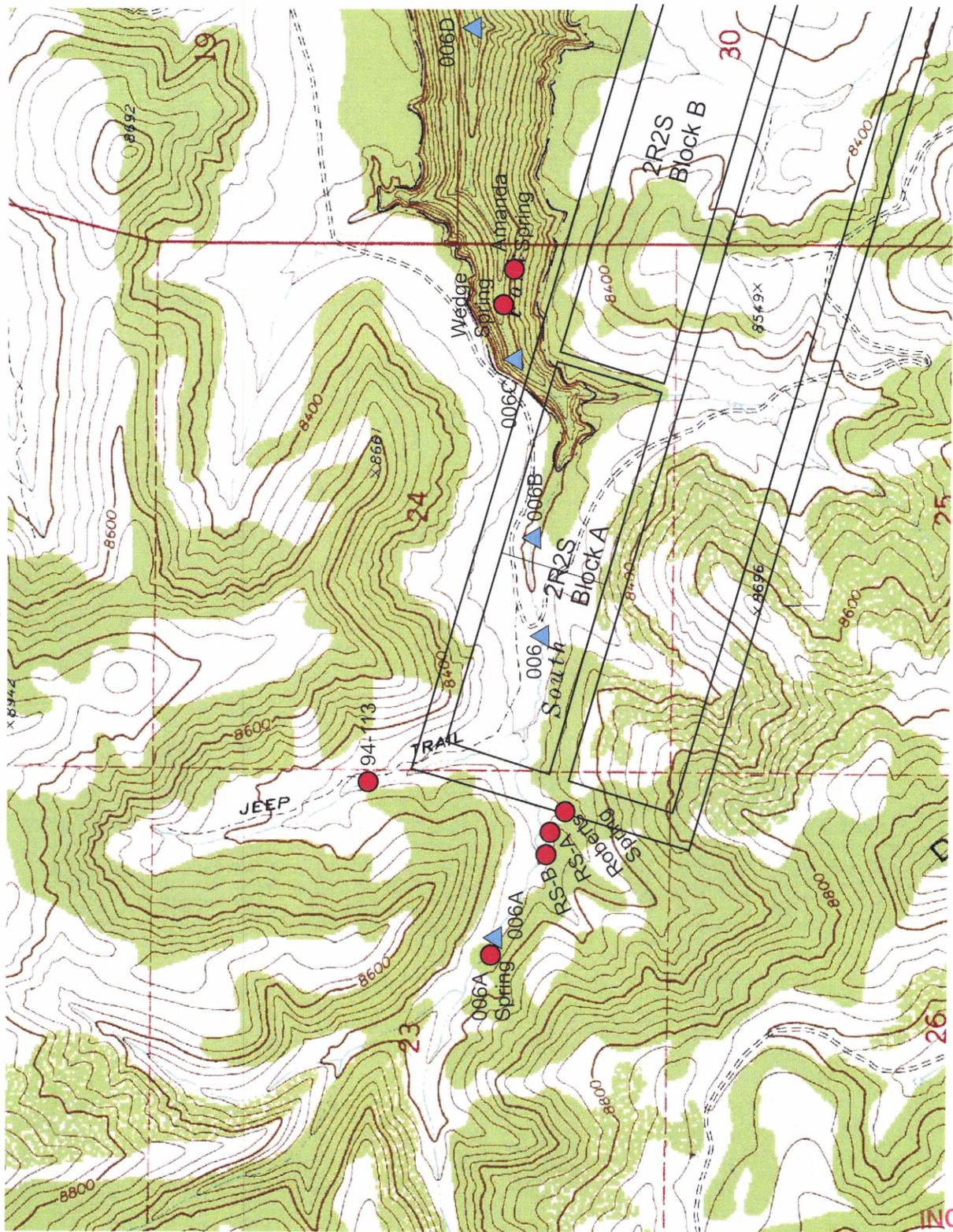


Figure 7-9 Monitoring stations in the South Fork of Quitcupah Creek area.

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Prior to implementation of any mining-induced subsidence mitigation efforts in the stream channel as described in Chapter 5, a Stream Alteration Permit will be obtained from the Utah Division of Water Rights. Sufco will have the alteration permit(s) prior to undermining the South Fork of Quitcupah stream channel since the mitigation efforts will occur as soon as possible after a need for mitigation is determined.

#### **7.3.1.3 Acid- and Toxic-Forming Materials**

Results of monitoring of mine discharge, surface, and groundwater, indicate that no impact to these waters from acid- and toxic-forming materials has been found in the permit and adjacent areas (Section 7.2.8.3). Parameters defining acid- and toxic-forming materials continue to be monitored as described in Volume 3 of this M&RP. In the event that acid- or toxic-forming materials are identified, they will be disposed of in the waste rock disposal area. The treatment of these materials will be handled as indicated in Volume 3 of this M&RP.

#### **7.3.1.4 Transfer of Wells**

Before final release of bond, exploration or monitoring wells will be sealed in a safe and environmentally sound manner in accordance with R645-301-631, R645-301-738, and R645-301-765. Ownership of wells will be transferred only with prior approval of the UDOGM. The conditions of such a transfer will comply with State and local laws. SUFCA will remain responsible for the management of the well until bond release in accordance with R645-301-529, R645-301-551, R645-301-631, R645-301-738, and R645-301-765.

#### **7.3.1.5 Discharges**

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**APPENDIX 1-2**

**Lease Documents**

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# United States Department of the Interior



## BUREAU OF LAND MANAGEMENT

Utah State Office  
P.O. Box 45155  
Salt Lake City, UT 84145-0155  
<http://www.blm.gov/ut/st/en.html>

IN REPLY REFER TO:  
3452  
UTU-28297  
SUFCO LMU  
(UT-923)

JAN 17 2012



CERTIFIED MAIL – 7011 1150 0000 6739 8566  
Return Receipt Requested

### DECISION

Canyon Fuel Company, LLC	:	Coal Lease
c/o Ark Land Company	:	UTU-28297
City Place One, Suite 300	:	
St. Louis, MO 63141	:	

### Coal Lease Partial Relinquishment Decision Amended

On December 15, 2011, a decision approving a partial relinquishment of the above noted federal coal lease was issued by this office.

A determination has been made that the legal description of the retained lands in the partial relinquishment decision were in error. The relinquished and retained lands are described as follows:

Coal lease UTU-28297:

#### Relinquished Lands

T. 21 S., R. 5 E., SLM, Utah  
Sec. 32, lots 2-4;  
Sec. 33, lot 1.

T. 22 S., R. 5 E., SLM, Utah  
Sec. 4, lot 4, SW $\frac{1}{4}$ NW $\frac{1}{4}$ , W $\frac{1}{2}$ SW $\frac{1}{4}$ ;  
Sec. 5, E $\frac{1}{2}$ W $\frac{1}{2}$ , E $\frac{1}{2}$ ;  
Sec. 7, E $\frac{1}{2}$ SE $\frac{1}{4}$ ;  
Sec. 8, S $\frac{1}{2}$ , NE $\frac{1}{4}$ , E $\frac{1}{2}$ NW $\frac{1}{4}$ ;  
Sec. 17, NE $\frac{1}{4}$ , N $\frac{1}{2}$ NW $\frac{1}{4}$ ;  
Sec. 18, NE $\frac{1}{4}$ , E $\frac{1}{2}$ NW $\frac{1}{4}$ .

Containing 1,915.47 acres

#### Retained Lands

T. 21 S., R. 5 E., SLM, Utah  
Sec. 32, lot 1, N $\frac{1}{2}$ S $\frac{1}{2}$ ;  
Sec. 33, NW $\frac{1}{4}$ SW $\frac{1}{4}$ .

T. 22 S., R. 5 E., SLM, Utah  
Sec. 5, W $\frac{1}{2}$ W $\frac{1}{2}$ ;  
Sec. 7, S $\frac{1}{2}$ NE $\frac{1}{4}$ , E $\frac{1}{2}$ SW $\frac{1}{4}$ , W $\frac{1}{2}$ SE $\frac{1}{4}$ ;  
Sec. 8, W $\frac{1}{2}$ NW $\frac{1}{4}$ .

Containing 716.51 acres\*

The acreages of the relinquished and retained lands remain the same.

Note\* that the remaining acreage in this lease may be changed at a later date due to an Amended Protraction Diagram No. 24, which was accepted effective May 19, 2000 and a still pending survey of sections 5, 7, and 8.

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When this lease was issued in January of 1979, the lands described in the lease were based on a skeleton survey as allowed in the regulations at 43 CFR 3471.1-2 (Portions of sections 5, 7, 8 and 18 have not been surveyed). Therefore, the calculated acreage remaining in this lease and the acreage of the relinquished lands are based on the skeleton survey and the plat acreage in existence at the time of issuance of the lease.

*Roger L Bankert*

Roger L Bankert  
Chief, Branch of Minerals

cc: Resource Development Coordinating Committee, ATTN: Mineral Leasing Taskforce,  
116 State Capital Building, Salt Lake City, Utah 84114  
Manti LaSal National Forest  
ONRR, ACM, Solid Minerals Staff, Attn: LeeAnn Martin, MS62300B, Box 25165, Denver, CO  
80225-0165  
Price Field Office (Attn: Steve Falk)  
Mr. John Baza, Director, UDOGM, Box 145801, Salt Lake City, Utah 84114-5801  
Christina Garcia, Forest Service, Southwest Region, Minerals and Geology, National Operations, 333  
Broadway, SE, Albuquerque, NM 87102

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BUREAU OF LAND MANAGEMENT  
Utah State Office  
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Salt Lake City, UT 84145-0155  
<http://www.blm.gov>

IN REPLY REFER TO:  
3452  
UTU-28297  
SUFCO LMU  
(UT-9223)

DEC 15 2011

Received

DEC 19 2011

Canyon Fuel Company  
SUFCO Mine

CERTIFIED MAIL – 7011 1150 0000 6739 5268  
Return Receipt Requested

### DECISION

Canyon Fuel Company, LLC	:	Coal Lease
c/o Ark Land Company	:	UTU-28297
City Place One, Suite 300	:	
St. Louis, MO 63141	:	
	:	

### Coal Lease Partial Relinquishment Accepted

On April 6, 2009, a partial relinquishment of the above noted federal coal lease was filed in this office by Canyon Fuel Company, LLC.

The partial relinquishment of this lease is approved as of the date of filing. The relinquished lands are subject to the continued obligation of the lessee to make payment of all accrued rentals and royalties and to complete the reclamation of the leased lands.

The relinquished and retained lands are described as follows:

Coal lease UTU-28297:

#### Relinquished Lands

T. 21 S., R. 5 E., SLM, Utah  
Sec. 32, lots 2-4;  
Sec. 33, lot 1.

T. 22 S., R. 5 E., SLM, Utah  
Sec. 4, lot 4, SW $\frac{1}{4}$ NW $\frac{1}{4}$ , W $\frac{1}{2}$ SW $\frac{1}{4}$ ;  
Sec. 5, E $\frac{1}{2}$ W $\frac{1}{2}$ , E $\frac{1}{2}$ ;  
Sec. 7, E $\frac{1}{2}$ SE $\frac{1}{4}$ ;  
Sec. 8, S $\frac{1}{2}$ , NE $\frac{1}{4}$ , E $\frac{1}{2}$ NW $\frac{1}{4}$ ;  
Sec. 17, NE $\frac{1}{4}$ , N $\frac{1}{2}$ NW $\frac{1}{4}$ ;  
Sec. 18, NE $\frac{1}{4}$ , E $\frac{1}{2}$ NW $\frac{1}{4}$ .

Containing 1,915.47 acres

#### Retained Lands

T. 21 S., R. 5 E., SLM, Utah  
Sec. 32, lot 1, N $\frac{1}{2}$ S $\frac{1}{2}$ ;  
Sec. 33, NW $\frac{1}{4}$ SW $\frac{1}{4}$ .

T. 22 S., R. 5 E., SLM, Utah  
Sec. 5, all;  
Sec. 7, S $\frac{1}{2}$ NE $\frac{1}{4}$ , S $\frac{1}{2}$ ;  
Sec. 8, N $\frac{1}{2}$ , SW $\frac{1}{4}$ .

Containing 716.51 acres\*

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Note\* that the remaining acreage in this lease may be changed at a later date due to an Amended Protraction Diagram No. 24 which was accepted effective May 19, 2000 and a still pending survey of sections 5, 7, and 8.

When this lease was issued in January of 1979, the lands described in the lease were based on a skeleton survey as allowed in the regulation in 43 CFR 3471.1-2 (Portions of sections 5, 7, 8 and 18 have not been surveyed). Therefore, the calculated acreage remaining in this lease and the acreage of the relinquished lands are based on the skeleton survey and the plat acreage in existence at the time of issuance of the lease.

The SUFCO Logical Mining Unit (LMU), UTU-73341, must be modified to exclude the relinquished acreage from the existing LMU (43 CFR 3487.1(h)). The modification of an LMU requires a case-by-case processing fee. The following actions will be addressed in this LMU modification:

LMU Action	Effective Date	LMU Acres Relinquished(-) or added(+)	LMU Reserves removed/mined(-) or added(+)(tons)	LMU Reserves remaining (tons)
Partial Relinquishment UTU-28297	4/6/2009	-1,957.47	-4,697,320	3,503,402
Remove Fee	11/2011	-640.00	-4,591,190	0
Partial Relinquishment UTU-63214	5/26/2011	-1869.12	0 (no mining in relinquished acres)	(total shown in lease modification line below)
Lease Modification SL-062583	12/1/2009	+880.00		(a) 24,908,306
Lease Modification UTU-47080	12/1/2009	+795.68		(a) 20,152,248
Lease Modification UTU-63214	12/1/2009	+640.00		(a) 88,234,391
Partial Relinquishment UTU-76195	12/20/2006	-1,477.00	0 (no mining in relinquished acres)	41,678,656

Note: (a) Total LMU Reserves remaining from new R2P2 which trued up the full lease including lease modification areas.

The BLM requests that Canyon Fuels submit a current LMU map so that any discrepancies between Canyon Fuels records and the BLM records can be resolved during this process.

A BLM cost estimate to process the LMU modification is enclosed pursuant to 43 CFR 3473.2(e). If you agree with the fee, please send a check for the estimated amount to the BLM. If you wish to provide comments on the estimated fee, you have 30 days to provide comments and the BLM will review your comments and make any adjustments as necessary. After the 30-day comment period is over, the BLM will mail you a final fee estimate accompanied with a bill. Payment is due within 30 days after receipt of the bill.

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The BLM will bill for the entire amount. If in processing the application we encounter higher costs than anticipated, we will provide a revised estimate but processing will not stop. If the final bill is less than estimated then the BLM will refund any unused funds.

This decision may be appealed to the Interior Board of Land Appeals, Office of the Secretary, in accordance with the regulations contained in 43 CFR, Part 4, and the enclosed Form 1842-1. If an appeal is taken, your notice of appeal must be filed in this office (at the above address) within 30 days after receipt of this decision. The appellant has the burden of showing that the decision appealed from is in error.

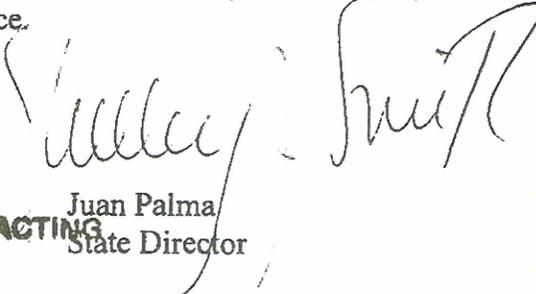
If you wish to file a petition (pursuant to regulation 43 CFR 4.21)(58 FR 4939, January 19, 1993)(request) for a stay (suspension) of the effectiveness of this decision during the time that your appeal is being reviewed by the Board, the petition for a stay must accompany your notice of appeal. A petition for a stay is required to show sufficient justification based on the standards listed below. If you request a stay, you have the burden of proof to demonstrate that a stay should be granted.

Standards for Obtaining a Stay

Except as otherwise provided by law or other pertinent regulation, a petition for a stay of a decision pending appeal shall show sufficient justification based on the following standards:

- (1) The relative harm to the parties if the stay is granted or denied,
- (2) The likelihood of the appellant's success on the merits,
- (3) The likelihood of immediate and irreparable harm if the stay is not granted, and
- (4) Whether the public interest favors granting the stay

Copies of the notice of appeal, petition for stay, and statement of reasons also must be submitted to each party named in this decision and to the Office of the Regional Solicitor, Intermountain Region, 125 South State Street, Suite 6201, Salt Lake City, Utah 84138, at the same time the original documents are filed in this office.

  
ACTING  
Juan Palma  
State Director

Enclosure  
Cost Recovery Worksheet

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cc:

Mr. Ken May, SUFCO Mine; Canyon Fuel Company, LLC, 397 South 800 West,  
Salina, UT 84654

Resource Development Coordinating Committee, ATTN: Mineral Leasing Taskforce,  
116 State Capital Building, Salt Lake City, Utah 84114

Manti LaSal National Forest

ONRR, ACM, Solid Minerals Staff, Attn: LeeAnn Martin, MS62300B, Box 25165,  
Denver, CO 80225-0165

Price Field Office (Attn: Steve Rigby)

Mr. John Baza, Director, UDOGM, Box 145801, Salt Lake City, Utah 84114-5801

Christina Garcia, Forest Service, Southwest Region, Minerals and Geology, National Operations,  
333 Broadway, SE, Albuquerque, NM 87102

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<http://www.blm.gov>

IN REPLY REFER TO:  
3452  
UTU-63214  
(UT-9223)

MAY 26 2011

CERTIFIED MAIL – Return Receipt Requested

Canyon Fuel Company, LLC  
c/o Ark Land Company  
City Place One, Suite 300  
St. Louis, MO 63141

DECISION

Coal Lease  
UTU-63214



Coal Lease Partial Relinquishment Accepted

On April 6, 2009, a partial relinquishment of the above noted federal coal lease was filed in the office by Canyon Fuel Company, LLC.

A determination has been made that the partial relinquishment of this lease may be accepted as of the date of filing. The relinquished lands are subject to the continued obligation of the lessee to make payment of all accrued rentals and royalties and to complete the reclamation of the leased lands.

The relinquished and retained lands are described as follows:

Coal lease UTU-63214:

Relinquished Lands

T. 21 S., R. 5 E., SLM, Utah  
Sec. 33, lots 2-4;  
Sec. 34, lots 1-4, NE $\frac{1}{4}$ NE $\frac{1}{4}$ , S $\frac{1}{2}$ NE $\frac{1}{4}$ , NE $\frac{1}{4}$ SW $\frac{1}{4}$ ,  
N $\frac{1}{2}$ SE $\frac{1}{4}$ ;  
Sec. 35, lots 1 and 2, W $\frac{1}{2}$ NW $\frac{1}{4}$ , N $\frac{1}{2}$ SW $\frac{1}{4}$ ;

T.22 S., R. 5 E., SLM, Utah  
Sec. 3, lots 1-4, S $\frac{1}{2}$ N $\frac{1}{2}$ , NE $\frac{1}{4}$ SW $\frac{1}{4}$ , S $\frac{1}{2}$ SW $\frac{1}{4}$ ,  
N $\frac{1}{2}$ SE $\frac{1}{4}$ , SW $\frac{1}{4}$ SE $\frac{1}{4}$ ;  
Sec. 4, lots 1 and 2, S $\frac{1}{2}$ NE $\frac{1}{4}$ , SE $\frac{1}{4}$ SE $\frac{1}{4}$ ;  
Sec. 9, NE $\frac{1}{4}$ NE $\frac{1}{4}$ ;  
Sec. 10, W $\frac{1}{2}$ NE $\frac{1}{4}$ , NW $\frac{1}{4}$ , N $\frac{1}{2}$ SW $\frac{1}{4}$ .

Containing 1869.12 acres

Retained Lands Tract 1:

T. 21 S., R. 4 E., SLM, Utah  
Sec. 12, E $\frac{1}{2}$ SE $\frac{1}{4}$ ;  
Sec. 13, E $\frac{1}{2}$ NE $\frac{1}{4}$ , S $\frac{1}{2}$ ;  
Sec. 14, E $\frac{1}{2}$ SW $\frac{1}{4}$ , SE $\frac{1}{4}$ ;  
Sec. 23, E $\frac{1}{2}$ , E $\frac{1}{2}$ W $\frac{1}{2}$ ;  
Sec. 24, all;

T. 21 S., R. 5 E., SLM  
Sec. 15, W $\frac{1}{2}$ ;  
Secs.16-21, all;  
Sec. 22, W $\frac{1}{2}$ ;  
Sec. 26, W $\frac{1}{2}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ , SW $\frac{1}{4}$ SW $\frac{1}{4}$ ;  
Sec. 27, all;  
Sec. 28, N $\frac{1}{2}$ , N $\frac{1}{2}$ SW $\frac{1}{4}$ , SE $\frac{1}{4}$ SW $\frac{1}{4}$ , SE $\frac{1}{4}$ ;  
Sec. 29, E $\frac{1}{2}$ NE $\frac{1}{4}$ , NE $\frac{1}{4}$ SE $\frac{1}{4}$ ;  
Sec. 30, lot 1, N $\frac{1}{2}$ NE $\frac{1}{4}$ ;  
Sec. 33, NE $\frac{1}{4}$ , E $\frac{1}{2}$ NW $\frac{1}{4}$ , NE $\frac{1}{4}$ SW $\frac{1}{4}$ , N $\frac{1}{2}$ SE $\frac{1}{4}$ ;  
Sec. 34, NW $\frac{1}{4}$ NE $\frac{1}{4}$ , NW $\frac{1}{4}$ , NW $\frac{1}{4}$ SW $\frac{1}{4}$ .

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Retained Lands Tract 2:

T. 21 S., R. 5 E., SLM, Utah  
Sec. 10, SE $\frac{1}{4}$ NW $\frac{1}{4}$ , E $\frac{1}{2}$ SW $\frac{1}{4}$ ;  
E $\frac{1}{2}$ E $\frac{1}{2}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ ,  
E $\frac{1}{2}$ E $\frac{1}{2}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ ,  
E $\frac{1}{2}$ E $\frac{1}{2}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ .

Retained Lands Tract 3:

T. 21 S., R. 4 E., SLM, Utah  
Sec. 26, E $\frac{1}{2}$ , E $\frac{1}{2}$ SW $\frac{1}{4}$ ;  
Sec. 35, NW $\frac{1}{4}$ , W $\frac{1}{2}$ SW $\frac{1}{4}$ .

Containing 8,826.34 acres

This decision may be appealed to the Interior Board of Land Appeals, Office of the Secretary, in accordance with the regulations contained in 43 CFR, Part 4, and the enclosed Form 1842-1. If an appeal is taken, your notice of appeal must be filed in this office (at the above address) within 30 days after receipt of this decision. The appellant has the burden of showing that the decision appealed from is in error.

If you wish to file a petition (pursuant to regulation 43 CFR 4.21)(58 FR 4939, January 19, 1993)(request) for a stay (suspension) of the effectiveness of this decision during the time that your appeal is being reviewed by the Board, the petition for a stay must accompany your notice of appeal. A petition for a stay is required to show sufficient justification based on the standards listed below. Copies of the notice of appeal and petition for a stay must also be submitted to each party named in this decision and to the Interior Board of Land Appeals and to the appropriate Office of the Solicitor (see 43 CFR 4.413) at the same time the original documents are filed in this office. If you request a stay, you have the burden of proof to demonstrate that a stay should be granted.

Standards for Obtaining a Stay

Except as otherwise provided by law or other pertinent regulation, a petition for a stay of a decision pending appeal shall show sufficient justification based on the following standards:

- (1) The relative harm to the parties if the stay is granted or denied,
- (2) The likelihood of the appellant's success on the merits,
- (3) The likelihood of immediate and irreparable harm if the stay is not granted, and



Juan Palma  
State Director

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cc: Resource Development Coordinating Committee, ATTN: Mineral Leasing Taskforce,  
116 State Capital Building, Salt Lake City, Utah 84114  
Manti LaSal National Forest  
ONRR, ACM, Solid Minerals Staff, Attn: LeeAnn Martin, MS62300B, Box 25165, Denver, CO  
80225-0165  
Price Field Office (Attn: Steve Falk)  
Mr. John Baza, Director, UDOGM, Box 145801, Salt Lake City, Utah 84114-5801  
Christina Garcia, Forest Service, Southwest Region, Minerals and Geology, National Operations, 333  
Broadway, SE, Albuquerque, NM 87102

APPENDIX 3-14

Monitoring and Mitigation Plan for Undermining  
the South Fork of Quitchupah 2R2S Block "A"

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## **Monitoring and Mitigation Plan for Undermining the South Fork of Quitchupah 2R2S Block "A"**

Implementation of the following mitigation plan will quickly identify surface disturbance or impacts from subsidence fractures intercepting spring and stream flows. Frequent monitoring will establish the degree of impacts to water resources, vegetation, wildlife and other uses.

The monitoring and mitigation plan adopted by the mine will provide sufficient data for all stakeholders associated with these resources and lands to make a determination of the degree of impacts. Information and data will be collected before the area is mined, throughout the mining period, and after mining is past. Monitoring and data collection will continue until the mine, Division and Forest agree that mining impacts, if any, have occurred, have been mitigated, and no further impacts are anticipated.

### **Hydrological and Subsidence Mitigation Plan for Undermining the South Fork of Quitchupah 2R2S Block "A"**

#### **Subsidence R645-301-525.454**

- Conduct pre- and post-mining surveys of the undermining the South Fork of Quitchupah 2R2S Block "A" stream channel over panel 2R2S. The mine will conduct a post-mining survey during 2015. This post-mining survey must apply the same procedures as the survey conducted in 2012.
  - o Conduct a stream channel profile survey from 006A above the 2R2S Panel to 006D located below the panel.
  - o Establish at least 4 stations to portray stream flow, vegetation, soils, etc. GPS coordinates shall be obtained for each site. Each site must be documented with fixed photo points that can be reproduced during subsequent monitoring intervals. Four sites include 006, 006A, 006B and 006C.
  - o Establish location of perennial flow, gaining/losing reaches of the stream channel from site 006A to 006D.
  - o Qualified botanist must participate in the survey of the channel.
    - Identify major representative plant species along the stream channel and riparian and spring areas.
  - o Survey and mention all animal species present:
    - Macroinvertebrate presence at monitoring stations along the stream channel and riparian and spring areas.
    - All other animal species along the stream channel and riparian and spring areas.
- Water monitoring shall be conducted prior to mining under the stream channel.

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- While mining under the channel, promptly identify subsidence-induced fractures, dewatering, diminution of water quality, and movement of the stream channel.

- Semi-weekly visual inspections for fractures, stream channel and flow observations while mining within the angle-of-draw of the stream channel. Monitor flow and channel bi-weekly while in the angle of draw. Continue monitoring quarterly for 2-year period after no subsidence, interception, diminution or diversions are identified. However, additional surface and/or groundwater samples will be collected for total iron if a visible iron precipitate is noted within the stream channel or originating from the springs and seep.

- Stockponds 94-115 and 94-116 will be monitored prior to mining and while mining within the angle-of-draw of the stream channel.

- Conduct uninterrupted longwall mining progression, except for normally scheduled maintenance, while under the 15-degree angle-of-draw of the stream channel.

- Provide a bi-weekly (once every two weeks) report to DOGM and the Fishlake National Forest via e-mail. Identify any changes in surface expression, dates, any fracturing of surface (location, width, spacing, etc.), any repairs, and location of longwall.

- If the applicant cannot gain access to the site, due to weather conditions, etc., attempts must be documented.

- Mitigate subsidence cracks and fractures identified within the stream channel wet bank. Access must be limited to methods that would not cause additional effects to the aquatic ecosystem.

- o Mitigation of cracks that interrupt or divert flows from the stream channel will be sealed immediately with an appropriate impermeable grout or, in some cases, native materials. Sufco will attempt to seal cracks with the least intrusive methods (typically hand placement of grout or native materials) first. The sealing material may be placed by pouring it directly into the crack or, if cracks occur in an actively flowing portion of the stream, the stream may be temporarily diverted using native materials (or a designed flume if necessary to maintain the flow) until the crack is sealed. If cracks are present in channel walls defined by soil, the soil cracks may be hand filled using a native soil/bentonite mix. The sealing of the channel floor and walls will be accomplished with hand tools such as shovel, picks, trowels, etc.

- o As a backup plan, in the unlikely event that cracks too large to be sealed through the efforts of one or two persons in one day do occur and it appears there is a danger of water being diverted from the channel for an extended period of time, the stream will be temporarily diverted using native materials and a pipe to carry the flow over the crack to maintain the channel flow. Arrangements will be made to get a contractor to the site as soon as possible to repair the crack after consultation with the Forest Service.

- o There may be sections of the stream channel that may require more intensive mitigation efforts to restore surface flows in the creek. These

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efforts could include the drilling of closely spaced shallow boreholes in and adjacent to the stream channel and the injection of an acceptable impermeable grout into the alluvium or bedrock. The work will be accomplished either using hand tools or low impact equipment to minimize surface disturbance. Existing roads and turnouts will be used as staging areas to locate larger equipment and supplies. Any hoses or lines will be transported from the staging areas to the nearby worksites either by hand, the use of pack animals, or by helicopter. This work will be done with a contractor selected after consultation with the Forest Service.

- The applicant will be required to abide by the mitigation outlined in the approved MRP.
- Comply with federal and State rules and regulations.
  - Refer to Conditions of Approval of the Resource Recovery and Protection Plan (R2P2), (June 8, 2011).
  - A stream alteration permit is required by Utah Division of Water Rights for any stream channel construction activities. The mine will obtain a stream alteration permit prior to construction activities within the stream channel.

**Water Rights Replacement of State Appropriated Water Supplies (R645-301-731.530)(MRP page 7-58A)**

- The mine will promptly provide alternate sources of water, replace or compensate any State appropriated water supply that is contaminated, diminished or interrupted by mining operations for:
  - Wildlife
  - Cattle
  - Drinking water
- Calculate the amount of diminished flows from monitoring data.

**Hydrologic and Subsidence Summary Report**

- The mine will submit a summary report to the Division documenting the pre- and post-mining conditions of springs and stream channels. The report will describe all activities and work conducted by the mine for site evaluation and mitigation. Further, the report will identify if impacts have occurred, and if mitigation activities have prevented material damage to resources. The report will be due 90 days after subsidence monitoring is complete for the 2R2S Block "A" panel section. The Division will provide a copy of the report to the Fishlake National Forest.

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## **Biology Monitoring Plan for Undermining the South Fork of Quitchupah 2R2S Block "A"**

The mine will follow the basics of the Division's Guidelines. A qualified botanist will survey the stream channel and associated spring areas starting from 006A above the 2R2S Panel to 006C located below the panel. A qualified biologist will survey the baseline populations of the macroinvertebrate within the portion of the stream channel to be subsided.

### **Stream channel and spring geomorphology and vegetation.**

The following information will be collected prior to mining:

- Stream channel geomorphology – at a minimum define:
  - Geologic/surface substrate of stream bottom.
  - Width of stream channel at water-monitoring locations.
- Spring and surrounding area geomorphology – at a minimum define:
  - Geologic/surface substrate of spring area where the water discharges.
  - Geologic/surface substrate of the spring *tributary* where water converges from the discharge site(s) and forms a *tributary* of the South Fork Quitchupah stream.
  - Width of the spring *tributary* at the location where the consultant surveys vegetation.
- Stream channel and spring vegetation communities – at a minimum:
  - Survey all stream and spring monitoring locations.
  - Define vegetation communities at all monitoring locations.
  - Inventory map of vegetation communities at all monitoring locations.
- Stream channel and spring area threatened, endangered, candidate, and sensitive species. Survey all TEC and Sensitive species. Provide population location and individual numbers for each population.
- Stream channel and spring area vegetation community condition – at a minimum:
  - Describe condition along steam bank. Concentrate observations at all monitoring locations.
  - Describe condition at all spring locations. Concentrate observations at all monitoring locations as well as discharge sites if different from monitoring locations.
  - Provide photographs of communities along stream channel, on hillsides flanking the steam channel, and at spring locations. Take photographs at established photo points.
  - Describe effects of erosion along stream channel, on hillsides flanking the steam channel, and at spring locations. Numerically rate erosion effects. For example, 1=extreme erosion, 2=high erosion, 3=moderate erosion, 4=slight erosion, 5=no erosion.
  - Repeat vegetation community condition observations two times a year (beginning and end of growing seasons) for the first two years and the fifth year following undermining. Refer to schedule below.

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- Provide two copies of the survey reports to DOGM. Include one copy in DOGM Annual Reports. The Division will provide the second copies to the Fishlake National Forest.
  - Baseline data prior to undermining: 2012 report in the 2013 Annual Report.
  - 1<sup>st</sup> year data following undermining: 2014 report in the 2015 Annual Report.
  - 2<sup>nd</sup> year data following undermining: 2015 report in the 2016 Annual Report.
  - 5<sup>th</sup> year data following undermining: 2018 report in the 2019 Annual Report.

**Stream channel macroinvertebrate:**

- Stream channel macroinvertebrate baseline survey and the fifth year following undermining. Refer to schedule below. The survey must include – at a minimum:
  - Three monitoring sites.
  - Organism species and number (#/m<sup>2</sup>).
  - Contractor must use an approved survey protocol.
- Provide two copies of the survey reports and maps to DOGM. Include one copy in the DOGM Annual Reports. The Division will provide the second copy to the Fishlake National Forest.
  - Baseline data prior to undermining: 2012 report in the 2013 Annual Report.
  - 5<sup>th</sup> year data following undermining: 2018 report in the 2019 Annual Report.

*The mine operator will implement, if necessary, a revegetation/mitigation plan as determined by DOGM in consultation with the USFS.*

**Cultural Resource Monitoring Plan for undermining the South Fork of Quitcupah 2R2S Block “A” panel (2012)**

Cultural and Historic information summary is located in M&RP, pages 4-12 to 4-12A. Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2 in the Confidential folder of the M&RP. No extraordinary monitoring, outside of that which is already required by the regulatory authorities and SHPO throughout the permit area, is required for the 2R2S Block "A" panel area.

The mine will provide two copies of an Executive Summary of monitoring results to the Division. One copy will be included in the mine’s Annual Report. The Division will provide the second copy to the Fishlake National Forest.

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**APPENDIX 7-26**

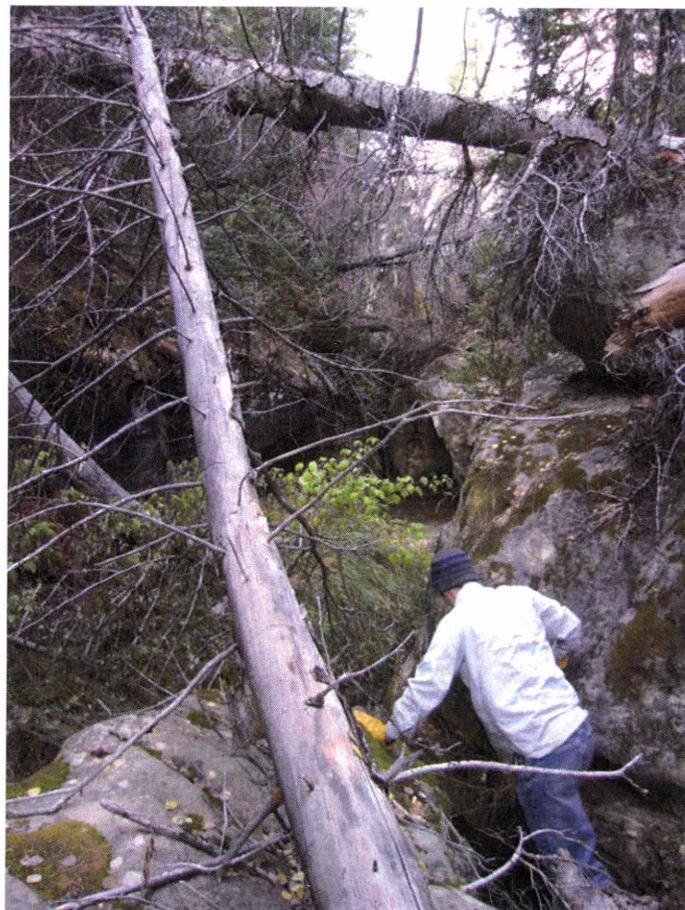
**Probable Hydrologic Consequences of Longwall Coal Mining of  
2R2S Block "A" at the Canyon Fuel Company, LLC Sufco Mine,  
Salina, Utah**

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**Probable Hydrologic  
Consequences of Longwall  
Coal Mining of 2R2S  
Block “A” at the Canyon  
Fuel Company, LLC  
Sufco Mine, Salina, Utah**

11 October 2012

Canyon Fuel Company, LLC  
Sufco Mine  
Salina, Utah



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**PETERSEN HYDROLOGIC, LLC**  
CONSULTANTS IN HYDROGEOLOGY

**Probable Hydrologic  
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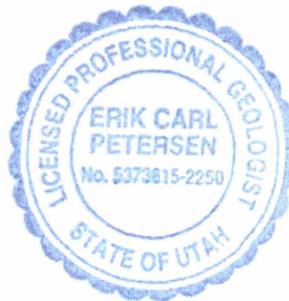
11 October 2012

Canyon Fuel Company, LLC  
Sufco Mine  
Salina, Utah

Prepared by:



Erik C. Petersen, P.G.  
Senior Hydrogeologist  
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**Probable Hydrologic Consequences of  
Longwall Coal Mining of 2R2S Block A  
At the Canyon Fuel Company, LLC  
Sufco Mine, Salina Utah**

**1.0 Introduction**

The Canyon Fuel Company, LLC Sufco Mine has been in operation since 1941. The mine is located in the southern Wasatch Plateau coal district approximately 17 miles east of Salina, Utah (Figure 1). Coal mining operations at the Sufco Mine are carried out using longwall mining techniques. Continuous mining techniques are primarily utilized to construct the development entries for the longwall panels.

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Development mining for the 2R2S longwall mining panel at the Sufco Mine is currently being completed (Figure 2). As initially proposed, the 2R2S longwall panel was laid out such that a block of coal situated beneath the South Fork of Quitcupah Creek was excluded from the mining plan (identified as *Block A* of the 2R2S longwall panel). The panel is

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located in Section 24, Township 21 South, Range 4 East on Federal lease UTU-63214. The Utah Division of Oil, Gas and Mining (Division) has previously approved the longwall mining at the 2R2S longwall panel with the exclusion of a stream buffer zone in the eastern half of Block A beneath the South Fork of Quitcupah Creek. (Based on the mining conditions at the site, it was determined that it would not be feasible to mine only the western half of Block A). After consultation with the U.S. Bureau of Land Management (BLM), it was proposed that the mining plan should be modified to include longwall mining of the entire 2R2S longwall panel, including all of Block A. The mining of the Block A panel was proposed to maximize the coal resource recovery (the Block A coal would likely never be recovered if not recovered with the 2R2S longwall panel) and to extend the life of the Sufco Mine. Approval was granted by the BLM to mine Block A of the 2R2S panel on 8 June 2011.

While the Probable Hydrologic Consequences of mining in the 2R2S panel (without the extraction of the eastern half of Block A) have previously been evaluated and approved by the Division as part of the approved Sufco Mine MRP, the probable hydrologic consequences relating specifically to the longwall mining of the 2R2S Block A panel beneath the South Fork of Quitcupah Creek have not been previously evaluated. The purpose of this investigation is to provide a determination of the probable hydrologic consequences (PHC) of mining Block A of the 2R2S panel at the Sufco Mine. The primary focus of this PHC determination is to evaluate the probable hydrologic consequences of the undermining and

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subsidence of the South Fork of Quitchupah Creek stream channel with Block A of the 2R2S longwall panel.

## 2.0 Methods of Investigation

- Discharge and water quality data have been collected during monitoring activities on the South Fork of Quitchupah Creek at monitoring site Sufco 006 since 1982. Most of the historic discharge measurements reported at Sufco 006 were performed using the permanently installed 12-inch Parshall flume at the site. During periods of low flow, discharge measurements at monitoring site 006 were sometimes performed using a 90-degree v-notch weir, a 3-inch Parshall flume, or using a calibrated container and stopwatch.

A series of stream gain/loss measurements were performed on the South Fork of Quitchupah Creek by Petersen Hydrologic, LLC from 2008 to 2012.

- On 16 October 2007, the South Fork of Quitchupah Creek in Section 24, T21S, R4E, which includes the steep, sheer-walled Castlegate Sandstone portion of the drainage, was surveyed by Petersen Hydrologic personnel. The surveyed area included the region extending from the upper rim of the Castlegate Sandstone escarpment, downward through the steep, narrow canyon area, and extending to the contact with the underlying Blackhawk Formation (Figure 3). During this site visit, discharge

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measurements on the creek were performed and the lower canyon area was surveyed for the presence of springs. Discharge measurements were performed using a calibrated container and stopwatch. The entire discharge in the creek was diverted through a length of pipe and directed into the calibrated container. Time-to-fill measurements were repeatedly performed at each monitoring site, and an average of all values was used to calculate the discharge rate. These measurements are considered to be accurate to within about 1 to 2 percent.

- On 4 September 2009, a stream survey of the South Fork of Quitcupah Creek was performed by Petersen Hydrologic personnel from near its headwater area along the base of the White Mountain cliffs to the contact with the upper rim of the Castlegate Sandstone escarpment. Six discharge measurements were performed over this approximately 3 mile reach of the stream (Figure 4). These discharge measurements were performed using a Marsh-McBirney Model 2000 electromagnetic type current velocity meter with wading rod. Measurements performed using this technique are typically considered to be accurate to within about 5 to 10 percent.
- On 12 October 2009, a series of high-accuracy discharge measurements were performed in Sections 23 and 24, T21S, R4E near proposed coal mining areas under baseflow conditions (Figure 5). These measurements were performed by Petersen Hydrologic personnel using a 90-degree v-notch weir. Stream locations where near-ideal measuring conditions were present were selected for monitoring. The

measurements reported for this investigation are believed to be accurate to within about 1 to 2 percent.

- On 17 June 2011, 21 September 2011, 12 October 2011, and on 1 June 2012, discharge measurements were performed on each occasion at three locations on the South Fork of Quitchupah Creek (Figure 6). These included site Sufco 006A, which is an established baseline monitoring site upstream of the 2R2S longwall panel area, site Sufco 006B, which is an established baseline monitoring site within Block A near the geologic contact between the Price River Formation and the underlying Castlegate Sandstone, and site Sufco 006C, which is located within the sheer-walled, deeply incised portion of the canyon downstream of the 2R2S panel area (which is situated near the contact between the Castlegate Sandstone and the underlying Blackhawk Formation). These stream gain/loss measurement activities were performed during high-flow and low-flow conditions, and during a period of drought (2012) and a period of extreme wetness (2011).
- The topography of the stream channel of the South Fork of Quitchupah Creek in Section 24, T21S, R4E, was surveyed by Sufco Mine personnel. The stream channel topographic profile was plotted electronically using AutoCAD software.
- A sediment permeability study was performed on the near-surface sediments adjacent to the stream channel along the South Fork of Quitchupah Creek by Jones and

DeMille Engineering, Inc. of Richfield, Utah during November 2010. Field-saturated hydraulic conductivity measurements were performed using a single ring infiltrometer. Additionally, sediment samples were collected for laboratory analysis of Atterberg Limits (liquid limit LL and plasticity index PI) and the classifications of the soils.

- The Sufco Mine workings in the 2R2S and adjacent areas were visited during late 2011 and early 2012. During these visits, samples for solute and isotopic analysis were collected. Tritium analyses were performed by the University of Miami Tritium Laboratory of Miami, Florida.

### 3.0 Climate

Climatic conditions in the Utah Region 4 area have varied substantially during the period of baseline monitoring in the South Fork area. This is illustrated in a plot of the Palmer Hydrologic Drought Index (PHDI) for Utah Region 4 (Figure 7). The PHDI is a monthly value generated by the National Climatic Data Center using a variety of hydrologic parameters that indicates the severity of wet and dry spells. The PHDI is calculated from several hydrologic parameters including precipitation, temperature, evapotranspiration, soil water recharge, soil water loss, and runoff. Consequently, it is a useful tool for evaluating the relationship between climate and groundwater and surface water discharge data. It is apparent in Figure 7 that beginning in the early 1980s the region began a transition from a period of drought to a period of extreme wetness that peaked during 1983 and 1984.

Subsequent to this period of extreme wetness, the region began an essentially continuous period of drying, peaking with a period of extreme drought in 1990. This period of drought persisted through 1992, when the region transitioned to a period characterized by alternating wet and dry spells that persisted through the end of 1996. Beginning in early 1997, the region transitioned into a three-year period of moderate to extreme wetness. Beginning in 2000, the region transitioned into a period of dryness that persisted approximately 4 years, followed by a brief period of extreme wetness that peaked during the spring of 2005. During 2006 the region transitioned into a period characterized primarily by mild to moderate drought that persisted until early 2010. Beginning in early 2010 the region began a transition to a period of severe to extreme wetness that peaked in mid-2011. Starting in mid-2011, the region began a rapid transition towards dryer climatic conditions. As of September of 2012 the region was experiencing drought conditions.

#### 4.0 Geology

Four Cretaceous- to Tertiary-age bedrock formations crop out in the South Fork of Quitchupah Creek area (Figure 2). These include, in descending order, the North Horn Formation, Price River Formation, Castlegate Sandstone, and the Blackhawk Formation. These geologic formations are shown on a geologic map in Figure 2. Each of these formations, and their water bearing and transmitting potential, is described briefly below.

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***North Horn Formation***

The North Horn Formation consists of variegated (mainly shades of red) shales with minor sandstone, conglomerate, and freshwater limestone (Doelling, 1972). It is estimated to be about 1,490 feet thick in the study area, although no drilling in the area has penetrated both the upper and lower contacts of the formation. The lower contact of the formation is transitional with the underlying Price River Formation. The formation is vulnerable to mass movement, slope failures, and landslides (USFS, 2005). The North Horn Formation is present at the surface in the higher elevation regions surrounding the 2R2S panel area (Figure 2).

Because of the pervasiveness of low-permeability shale horizons in the North Horn Formation, vertical migration of groundwater through the formation is limited. Consequently, groundwater flow in the North Horn Formation occurs primarily through fractured or shallow weathered zones, or locally through sandstone paleochannels. For these reasons, groundwater recharge through the North Horn Formation to the underlying Price River Formation is likely not appreciable.

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***Price River Formation***

The Price River Formation forms low-lying hills on the plateau in the South Fork area (Figure 2). The Price River Formation is present at the land surface over most of the 2R2S

longwall panel. The formation is reported to be approximately 550 feet thick in the Sufco permit area. The Price River Formation consists of gray to white gritty sandstone interbedded with shale and conglomerate deposited in a fluvial environment. The Price River Formation typically forms ledges and slopes due to the interbedding of resistant sandstones with less resistant shales and claystones.

While individual fluvial sandstones in the Price River Formation are capable of transmitting water, water is typically not transmitted over great vertical or horizontal distances in the formation. This is because of the lenticular geometry of the sandstone units and the interbedded low-permeability shales and claystone layers present in the formation. The springs which discharge from the Price River Formation in the study area appear to discharge from fractured bedrock units where these units intersect the land surface and are underlain by low-permeability strata within the formation. Because of the presence of interbedded low-permeability strata within the formation, the flow of groundwater within the Price River Formation likely occurs primarily as lateral flow within individual fractured sandstone members. Vertical migration of groundwater within the formation is likely minimal. The presence of the Price River Formation over most of the study area greatly limits the potential for groundwater recharge to underlying strata.

Soils and near-surface unconsolidated sediments derived largely from the Price River Formation in the 2R2S panel area consist largely of clays that are of very low permeability (Appendix C).

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*Castlegate Sandstone*

The Castlegate Sandstone is a cliff-forming unit that comprises the rim rocks of the deeply incised South Fork of Quitchupah Creek canyon. The Castlegate Sandstone is disconformably overlain by the Price River Formation. The Castlegate Sandstone, which is about 200 feet thick in the study and adjacent area, is predominately massively-bedded, coarse-grained sandstone with some interbeds of shale, siltstone, and conglomerate. Pervasive silica and carbonate cement makes the formation well indurated and brittle. The Castlegate Sandstone was formed in a braided fluvial depositional system.

Although some of the sandstone rocks in the Castlegate are sufficiently permeable to transmit appreciable groundwater, groundwater flow through the pore spaces in the formation is limited. This is due primarily to the presence of mudstone drapes and bounding layers that are interbedded with the sandstone units in the formation. Near-vertical jointing in the Castlegate Sandstone is pervasive and readily observable where the formation is exposed in the steep-walled lower portions of the South Fork. In the greater Sufco Mine area, it has been observed that groundwater flow occurs locally along bedding plains where permeable strata are underlain by the thin clay or shale perching layers that exist locally in the formation. The direction of bedding plain groundwater flow in the area is controlled by the local dip of the stratigraphic bedding horizons (which is generally toward the north-

northwest). Because of the discontinuous nature of the shale layers, and the fact that permeable sandstone strata are not continuous over significant distances, long, regional-type flow systems generally do not develop in the Castlegate Sandstone. Rather, Castlegate Sandstone groundwater systems, where they exist, are typically local in nature with small to moderate quantities of groundwater discharged.

Where the Price River Formation, which generally does not support vertical migration of fluids, is present above the Castlegate Sandstone, the potential for recharge to the Castlegate Sandstone is minimal. Consequently, recharge to the Castlegate Sandstone commonly occurs where the formation is directly exposed at the surface, or where it is covered only by a thin covering of sandy sediments. The Castlegate Sandstone is underlain by the Blackhawk Formation, which acts as a basal confining layer, preventing appreciable vertical migration of groundwater from the unit into deeper strata.

***Blackhawk Formation***

The Blackhawk Formation in the study area consists predominantly of lenticular, discontinuous beds of sandstone, siltstone, mudstone, shale, and coal. The coal to be mined in the 2R2S panel is present in the Upper Hiawatha Coal seam in the lower portion of the Blackhawk Formation. The Upper Hiawatha Coal seam is underlain in the region by a sequence of shaley lagoonal deposits, ranging in thickness from 2 to 29 feet, which include the Lower Hiawatha Coal Seam (Mayo and Associates, 1997). In the study area, the upper 500 feet of the formation generally has massive, fine- to medium-grained, cliff-forming

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sandstone units (Thiros and Cordy, 1991). The number and thicknesses of sandstone units decreases toward the base of the unit. The lower 300 feet of the formation contains thinly-bedded sandstone and shale. The thickness of the Blackhawk Formation in the study and adjacent area is about 800 feet.

Because of the presence of interbedded low-permeability units in the Blackhawk Formation and the vertical and lateral discontinuity of sandstone horizons, the potential for vertical and horizontal movement of groundwater is limited. For this reason, groundwater flow in the formation occurs primarily through sandstone paleochannels, or occasionally through faults and fractures, while migration of groundwater across geologic formations (either vertically or horizontally) is limited. The direction of groundwater flow within permeable sandstone channels is largely constrained by the geometry of the sinuous channel structures and also by the structural dip of the strata. Because of the lenticular nature of the permeable strata in the Blackhawk Formation (both at a micro and macro scale), and due to the fact that individual sandstone channels often interpenetrate and are truncated, regional type groundwater flow regimes typically do not form within the Blackhawk Formation in the Sufco Mine area.

The Blackhawk Formation is known to contain swelling clays that tend to naturally heal mining-induced fractures in the formation. Well drilling reports and laboratory analysis of samples indicate that the claystone layers in the Blackhawk Formation contain swelling clays which plastically deform when fractured (Mayo and Associates, 1997). Chempet Research

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Corporation (1989) found that Blackhawk Formation claystone layers contain up to 58% montmorillonite.

***Structure***

Major faulting has not been identified in the 2R2S panel area. However, small displacement faults (apparent vertical displacement of about three feet or less) and some of greater displacement have been encountered in various locations within the SUFCO mine. These faults most commonly strike approximately N10° to 15°W and are inclined nearly vertical. Joints are both parallel and normal to the fault trend. Both minor faults and joints may exist in the South Fork area. Joints in the Castlegate Sandstone are common. The surface traces of these joints are up to approximately 1,000 feet in length and are spaced about 16 to 33 feet apart. The primary fracture orientation in the Sufco Mine area is approximately N 26° W, with a secondary set of fractures oriented about N 65° E also being measured (Thiros and Cordy, 1991).

Rock units in the study area strike roughly 40°E and dip 1 to 2° (about 250 feet per mile) to the northwest. Local dips of the coal seam may range up to 10 degrees in areas where underlying paleochannels caused significant differential compaction.

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## 5.0 Presentation of Data

The location of the 2R2S Block A and adjacent mine workings are shown on a geologic map on Figure 2. Baseline monitoring site details for springs and streams are provided in Table 1. Locations of spring and stream monitoring stations are shown on Figure 6. The geologic formations present in the South Fork of Quitchupah Creek stream channel substrate are shown on Figure 8. The discharge data collected at the South Fork of Quitchupah Creek during the Petersen Hydrologic 2009-2012 field investigations are presented in Table 2. Historic discharge and water quality data collected at the South Fork of Quitchupah Creek from 1982-2012 are presented in Table 3. Discharge and water quality data from springs, seeps and additional monitoring sites on the South Fork are also shown on Table 3. The results of tritium analyses from groundwater samples from the underground Sufco Mine workings in the vicinity of the 2R2S panel are presented in Table 4. The results of the Jones and DeMille soil permeability investigation are presented in the Appendix .

A discharge hydrograph for the South Fork of Quitchupah Creek as monitored at the Sufco 006 monitoring station for the period 1982-2012 is presented together with a plot of the Palmer Hydrologic Drought Index (PHDI) in Figure 7. The PHDI is a numerical value generated monthly by the National Climatic Data Center (NCDC) that indicates the severity of wet and dry spells (NCDC, 2010). Monitoring site locations for the October 2007, September 2009, and October 2009 field investigations are shown on Figures 3, 4, and 5, respectively. The results of the gain/loss measurements performed on the South Fork of Quitchupah Creek during 2011 and 2012 are plotted in Figures 9, 10, 11, 12, and 12a.

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Discharge hydrographs for 006A spring and for Roberts Spring are presented in Figures 13 and 14. A map showing the geologic formations present in the South Fork of Quitchupah Creek stream substrate is presented in Figure 8. A plot of TDS concentrations versus discharge rates in the South Fork of Quitchupah Creek is presented in Figure 15. A plot of the longitudinal topographic profile of the South Fork of Quitchupah Creek stream channel in Section 24, T21S, R4E is provided in Plate 1. Stream gradients in any selected reaches of the stream may be calculated using the information provided in Plate 1.

### **6.0 Groundwater and Surface Water Systems**

The South Fork of Quitchupah Creek is a mountain stream that drains portions of the Canyon Fuel Company, LLC Sufco Mine permit area. Monitoring of discharge rates and water quality in the stream has been routinely performed since the early 1980s as part of Sufco Mine's quarterly water monitoring program. During 2007 - 2012, supplemental monitoring activities were performed in selected reaches of the South Fork of Quitchupah Creek. Additionally, the topography of the South Fork stream channel was surveyed during 2010 and a stream channel profile was created.

Historically, discharge measured in the South Fork of Quitchupah Creek has ranged from no flow during low-flow conditions during a period of drought in 2001 to 1,116 gpm during the high-flow period of an extreme wet spell in 2011. Flows of about 1 gpm or less have been measured in the creek (at Sufco 006) on seven occasions during six different years,

demonstrating a lack of a substantial drought-resistant component of baseflow discharge in the drainage.

It should be noted that a crude, undeveloped surface diversion on the South Fork of Quitchupah Creek that diverts surface water to the Skumpah drainage is present in the south-central portion of Section 15, T21S, R4E (Figure 4). Historical information on the magnitude of water diverted from the South Fork to Skumpah Creek at this location is not available. When the drainage was surveyed on 4 September 2009, a flow of 29 gpm was being diverted, which represents approximately 13% of the total flow (relative to the 215 gpm measured upstream at SFQ-5). Additionally, a United States Forest Service diversion for stock watering use is present at monitoring site SFQ-5 (Figure 4).

Discharge measured at Sufco 006 is a function of seasonal and climatic variability. Yearly discharge peaks are readily apparent in the discharge hydrograph for the South Fork (Figure 16). The yearly discharge peaks typically occur during the second quarter monitoring event (usually in May or June) in response to the annual snowmelt event. The minimum flow monitored during a year typically occurs during the 4<sup>th</sup> quarter monitoring event (usually in October or November) as seasonal water is gradually drained over the summer and fall months.

The peak and baseflow discharge rates in the South Fork increased markedly in response to significantly wet periods that occurred in the early 1980s, the late 1990s, and the mid-2000s

(Figure 16). Peak and baseflow discharge rates were low in the creek during the early 1990s and early 2000s in response to regional drought conditions that prevailed during these times (Figure 16).

It is apparent from the results of the September 2009 monitoring activities that discharge in the South Fork of Quitchupah Creek was at a maximum in the upland areas within the North Horn Formation (Monitoring sites SFQ-4 and SFQ-5). Lower discharge rates were observed in the lower reaches of the South Fork where the stream flows over the Price River Formation. These losses are most likely attributable to exchange of groundwater between the stream and the permeable alluvial sediments underlying portions of the stream channel and to losses of surface water to evapotranspiration during the warm early-September day on which the monitoring was performed.

A series of high-accuracy discharge measurements were performed on 12 October 2009 in the South Fork of Quitchupah Creek in areas proposed for mining (Sections 23 and 24, T21S, R4E; Figure 5). The monitoring occurred in portions of the stream underlain by the Price River Formation (from its upper portion downstream to the contact with the underlying Castlegate Sandstone). It is apparent from the discharge data in Table 2 that gains in stream flow do not occur in this portion of the South Fork of Quitchupah Creek. Rather it is apparent from the October 2009 data and from subsequent monitoring at stations 006A and 006B that discharge rates in the creek typically decline marginally over this reach (Tables 2 and 3). During the high-flow period in June 2010, the discharge decreased from 500 gpm at

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Sufco 006A to 433 gpm at Sufco 006B, which represents a decrease of about 13%. During the low-flow period in October 2009, this discharge decreased from 75 gpm at Sufco 006A to 65 gpm at Sufco 006B, which represents a decrease of about 13% between these two monitoring stations. This information suggests that there is no measurable groundwater baseflow contribution to discharge in the South Fork over this reach of the stream in the Price River Formation. The observed modest declines in discharge over this reach are likely attributable to interactions with the adjacent stream alluvium and to losses to evapotranspiration. Consumption of stream water by numerous cattle present in the area at the time of the monitoring may possibly also have marginally diminished the flow in the stream.

Mayo et al. (2003) presented a conceptual model of groundwater flow that describes active and inactive flow regimes in stratified mountainous terrains. This model was developed based on an analysis of solute, isotopic, and hydrographic data from a large number of springs and in-mine sampling locations in the Wasatch Plateau and Book Cliffs coal fields of Utah as well as western Colorado. The model is based on an analysis of interactions between surface waters and shallow and deep groundwater systems.

As defined by Mayo et al. (2003) active-zone groundwater flowpaths are continuous, responsive to annual recharge and climatic variability, and have groundwater ages that become progressively older from recharge to discharge areas. Springs discharging from active-zone groundwater systems contain appreciable  $^3\text{H}$  (tritium) and anthropogenic  $^{14}\text{C}$ .

Inactive-zone groundwater systems have extremely limited or no communication with annual recharge and have groundwater mean residence times that do not progressively increase along the flow path. Groundwaters in the inactive-zone may be partitioned, occur as discrete bodies, and may occur in hydraulically isolated regions that do not have hydraulic communication with each other. Inactive-zone groundwaters typically have no  $^3\text{H}$  and have mean residence times (groundwater “ages”) of 500 to 20,000 years. Inactive-zone groundwater systems commonly occur where the depth of cover is less than about 250 to 500 feet and extend into cliff-faces for a distance of about 500 to 1,000 feet. Under deeper cover and further from cliff faces, inactive-zone groundwater systems are commonly present. Inactive-zone groundwater systems are commonly encountered in Utah underground coal mine environments (away from cliff faces and under considerable bedrock overburden thicknesses).

Two spring areas have been identified in the South Fork canyon between Sufco 006A and Sufco 006C. These include 006A spring, which discharges at less than 0.5 gpm from the Price River Formation west of the 2R2S panel area, and the Roberts Spring complex, which consists of Roberts Spring (which discharges at less than 0.5 gpm from the Price River Formation just west of the 2R2S panel area) and springs RS-A and RS-B, which seep at low rates just east of Roberts Spring. Discharge hydrographs for these springs are presented in Figures 13 and 14. It is noteworthy that no appreciable springs were identified in the Price River Formation adjacent to the stream between monitoring points Sufco 006A and Sufco

006B (Figure 6). An area of minor bank seepage was also observed east of Roberts Spring adjacent to the South Fork stream channel.

It is apparent in Figures 13 and 14 that these Price River Formation springs respond to climatic variability, suggesting that these springs are associated with active-zone groundwater systems. Responses to seasonal variability during the period of baseline monitoring at these springs are not readily apparent.

No springs were observed in the Castlegate Sandstone or upper Blackhawk Formation in the 2R2S Block A panel area. However, two springs that discharge from near the base of the Castlegate Sandstone were identified in the region north of the 2R2S Block B longwall panel (Figure 6). These two springs (The Wedge Spring and Amanda Spring) discharge from the steep canyon wall in areas that are several hundred feet down-dip (northwest) of the existing, previously permitted 2R2S Block B panel. Subsidence fracturing of the Castlegate Sandstone bedrock strata at the discharge locations for these springs is not anticipated. The Price River Formation is present in the adjacent upland plateau areas within the 2R2S Block B panel up-gradient of these springs.

When the South Fork of Quitcupah Creek in Section 24, T21S, R4E, which includes the steep, sheer-walled Castlegate Sandstone portion of the drainage, was surveyed in October 2007, only minimal surface-water flows were present (the monitoring occurred during a period of regional drought). The discharge was measured in three locations in the canyon.

These include a measurement at the upper rim of the Castlegate Sandstone escarpment (8.11 gpm), a measurement in the middle section of the Castlegate Sandstone (5.90 gpm), and a measurement near the base of the Castlegate Sandstone at the Blackhawk Formation contact (6.10 gpm). It is apparent from these data that the stream did not gain any appreciable water as it flowed over the Castlegate Sandstone. Rather, the discharge rate measured near the base of the formation was about 2 gpm less than that measured at the top of the formation. The observed minor decrease in flow in the South Fork in this reach is most likely attributable to evapotranspiration loss and/or infiltration of minor amounts of water into the Castlegate Sandstone bedrock or alluvial deposits.

During the October 2007 visit, no springs in the Castlegate Sandstone or upper Blackhawk Formation were identified in that section of the canyon (between 006 and 006C within the 2R2S Block A panel area). Some zones of moderately increased soil moisture with increased vegetation were observed on north-facing slopes within the steep-walled portion of the canyon. However, no water was observed at these locations, nor were there any obvious indications of water recently being present at these locations.

Surface waters in the South Fork of Quitcupah Creek as monitored at Sufco 006 are generally of the no-dominant cation – bicarbonate geochemical type. Sodium, Calcium, and Magnesium are all present in appreciable quantities. TDS concentrations average approximately 435 mg/L and have historically ranged from a low of 269 mg/L during June of 1988 to a high of 850 mg/L during August 1984. The variability in the TDS concentrations

of surface waters in the South Fork is likely attributable to 1) diluting affects of seasonal low-TDS snowmelt waters, and 2) the dissolution of soluble minerals commonly known to occur in the Price River Formation (Petersen Hydrologic, 2010).

The TDS concentrations of South Fork stream waters are plotted against stream discharge rates in Figure 15. It is apparent from Figure 15 that the highest TDS values occur during periods of low flow. The lower- and middle-range TDS values do not appear to correlate with stream discharge rates. It is likely that the highest observed TDS values may be attributable to a low water/rock ratio (which maximizes the effects of mineral dissolution), or perhaps to the effects of evapoconcentration during low-flow periods.

It is apparent in the water quality data for monitoring sites Sufco 006A and Sufco 006B (Table 3) that the specific conductance of the water consistently increases moderately between the upstream (006A) and downstream (006B) monitoring sites. This observed increase in specific conductance is consistent with the dissolution of soluble minerals in the Price River Formation in the stream bed over this distance. It should also be noted that the area between Sufco 006A and Sufco 006B is used frequently by livestock. The livestock activity in and near the creek could potentially result in some degradation of water quality over this reach. Little change in water quality was observed between monitoring sites 006B and 006C (See Table 3). Similarly, when the new 006D monitoring station on the South Fork of Quitcupah Creek was monitored during September 2012, it was found that the

quality of the surface water monitored at 006D was also very similar to that at up-gradient monitoring stations 006B and 006C.

A gain/loss investigation of the South Fork of Quitchupah Creek was performed on 1 June 2012. At the time of this survey, discharge in the South Fork was essentially absent. The absence of flow was likely attributable to the combination of the effects of the prevailing drought conditions, and also to likely diversions of water at up-gradient locations. Because of the lack of water in the stream channel at that time, observations of areas potentially contributing baseflow to the stream channel could readily be observed. It was noted during that survey that a meager discharge of less than 1 gpm was present at monitoring site 006A. Discharges of less than 1 gpm were intermittently present in the reach between 006A and 006B (which was considered likely to represent the re-emergence of water originating at upstream locations as alluvial seepage into the creek where it was forced to the surface as a result of the alluvial geometry). No discharge was present in the stream in the reach between monitoring sites 006B and 006C. This observation is significant, because it indicates that there are apparently no appreciable sources of groundwater-derived baseflow to the stream in the 2R2S panel area (between monitoring sites Sufco 006A and Sufco 006C).

The surveyed profile of the stream channel of the South Fork of Quitchupah Creek underlying and adjacent to the 2R2S longwall mining area is shown in Plate 1. The profile extends from near the upper (western) margin of the longwall panel downstream to a location beyond where the stream channel crosses the northern edge of the projected longwall panel

area (Plate 1). The overall channel gradient over the area surveyed (from location A to A') is approximately 0.058 (5.8%), with a change of approximately 230 feet of elevation over about 3,980 linear feet of stream channel. Stream gradients in the western portion of the surveyed profile, where the stream channel is developed on the Price River Formation or associated alluvial sediments, range from about 0.020 to 0.030, generally steepening to the east. Stream gradients in the eastern portion of the surveyed profile are generally steeper but less uniform due to the presence of ledges and cliffs of the resistant Castlegate Sandstone in the stream substrate. Channel gradients in the eastern portion vary from near vertical in the cliff and ledge areas, to about 0.066 in the easternmost portion of the surveyed profile.

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## 7.0 Determination of Probable Hydrologic Consequences

As part of the previous permitting actions, the Probable Hydrologic Consequences of coal mining in the South Fork of Quitchupah Creek area have been analyzed and reviewed by the Division. The following section presents the specific determination of Probable Hydrologic Consequences of Coal Mining associated with the undermining of the South Fork of Quitchupah Creek with the 2R2S panel at the Sufco Mine.

### *728.100 Quality and quantity of surface water and groundwater under seasonal flow conditions*

Information on the quantity and quality of surface-water and groundwater under seasonal flow conditions in the 2R2S Block A and surrounding areas is presented in Table 3.

Additional information on groundwater and surface-water quality and quantity in and around the 2R2S Block A area has been submitted electronically to the Utah Division of Oil, Gas and Mining through the on-line coal water quality database, which is freely accessible and located at: <http://ogm.utah.gov/coal/edi/wqdb.htm>.

Stiff diagrams depicting the solute chemical composition of groundwaters and surface waters in the 2R2S panel area are shown on Figure 6. Stiff diagrams are a useful analytical tool that allows the graphical representation of groundwater and surface-water solute compositions.

The shape of the Stiff diagram is a reflection of the geochemical type of the water, while the size of the diagram is related to the total dissolved solids concentration of the water.

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Groundwaters and surface waters in the South Fork of Quitchupah Creek drainage commonly acquire their solute compositions through a series of well-documented chemical reactions.

These are briefly summarized below.

Carbon dioxide gas is produced naturally in the soil at concentrations greatly exceeding atmospheric concentrations by root-zone respiration and also by the decay of organic matter.

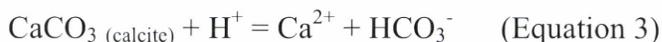
Recharge water (rain and snow melt), upon entering the soil mantle, reacts with  $\text{CO}_2$  to produce carbonic acid according to:



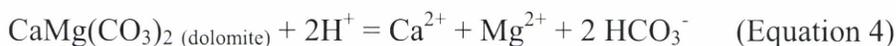
The produced carbonic acid subsequently dissociates into hydrogen ions (acid) and bicarbonate according to:



The  $\text{H}^+$  produced from Equation 2 reacts with carbonate minerals pervasive in the rocks of the Wasatch Plateau coal field yielding calcium and magnesium ions and additional bicarbonate ions to the water according to:



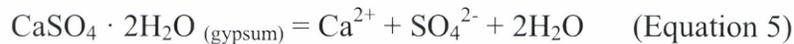
and



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Because of the limited solubility of calcite and dolomite in the absence of an additional source of CO<sub>2</sub>, waters acquiring their solute compositions through the geochemical evolutionary pathway described in Equations 1 through 4 typically have relatively low TDS concentrations.

Groundwaters from formations containing soluble evaporite minerals often acquire a different solute geochemical type and dissolved solids concentrations appreciably greater than that typically resulting from geochemical evolutionary pathway as described by equations 1-4 above. Surface waters flowing over sediments containing soluble evaporite minerals may also acquire elevated TDS concentrations and changed solute geochemical type. The geochemical reactions often responsible for these changes in chemical composition include:



Waters rich in Ca<sup>2+</sup> resulting from the dissolution of gypsum (Equation 5) may undergo ion exchange on clay minerals resulting in an increase in Na<sup>+</sup> concentrations at the expense of exchanged Ca<sup>2+</sup> ions according to:



Ion exchange may also occur on zeolite minerals such as the sodium zeolite analcime according to:

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Stiff diagrams graphically depicting the solute chemical compositions of groundwaters and surface-waters in the South Fork of Quitcupah Creek (2R2S panel area) are presented in Figure 6.

The chemical compositions of groundwater discharging from springs and surface waters in streams in and around the 2R2S Block A area are presented in Table 3. Discharge hydrographs for springs are presented in Figures 13 and 14. A discharge hydrograph for the South Fork of Quitcupah Creek as monitored at site Sufco 006 is presented in Figure 16.

Springs identified in the 2R2S panel area discharge from the Price River Formation and Castlegate Sandstone (Table 1). The chemical compositions of these springs are depicted graphically as Stiff diagrams in Figure 6. The TDS concentrations of the Price River springs range from 658 to 974 mg/L (Table 3), which is typical for springs discharging from the Price River Formation in the Sufco Mine area. The groundwaters are variable in chemical type. The dominant anion for each of the three springs is bicarbonate, with appreciable sulfate also being present. The dominant cation for each of the three springs is sodium, with lesser amounts of calcium and magnesium also being present (See Table 3 and Figure 6).

The pH levels for the spring groundwaters are all near-neutral to moderately alkaline, ranging from 7.17 to 7.83. The discharge rates from these springs are modest. The historical discharge rates measured at these springs have not exceeded 0.44 gpm.

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As indicated above, two springs discharge from the Castlegate Sandstone in areas several hundred feet down-gradient of the previously permitted 2R2S Panel B area (Figure 6). Laboratory measurements of TDS for these springs range from 342 to 428 mg/L. Measured pH values range from 7.20 to 7.50. Discharge rates measured at these springs range from about 0.3 to 4.6 gpm.

The chemical composition of surface waters flowing in the South Fork of Quitcupah Creek have exhibited considerable variability over the period of monitoring, with TDS concentrations ranging from 269 to 850 mg/L. As shown on Figure 15, although a strong correlation is not present, the greatest TDS concentrations are often associated with periods of low flow, while the lower TDS concentrations are often associated with periods of moderate or high flow. The solute compositions of surface waters during baseflow conditions (October 2011) in the South Fork of Quitcupah Creek are depicted graphically as Stiff diagrams in Figure 6. It is evident in Figure 6 and Table 3 that the South Fork waters are of the calcium-magnesium bicarbonate chemical type. Sulfate concentrations are also appreciable in these surface waters.

Discharge of groundwater from the Blackhawk Formation to springs has not been observed in the 2R2S panel area. However, inactive-zone groundwater from the Blackhawk Formation is routinely encountered in the underground Sufco Mine workings. Historically, discharge from the Blackhawk Formation within the Sufco Mine underground workings does not show seasonal variability in discharge rate. Rather, discharge from Blackhawk

Formation sandstone paleochannels in the mine workings is typically short-lived, with discharge rates declining rapidly after first being encountered (Personal communication, Mark Bunnell, 2011). In some areas of the mine, more sustained groundwater discharges have occurred. This is consistent with the inactive-zone origins of the ancient water in the Blackhawk Formation and demonstrates the hydraulic isolation of these waters from shallow, seasonal recharge sources. A further characterization of groundwater quantity and quality in the Blackhawk Formation within the Sufco Mine is presented by Mayo and Associates (1997, 1999).

It is noteworthy that the TDS concentrations of the three sampled in-mine groundwaters (which average about 360 mg/L) are much lower than the average TDS concentrations of springs in the Price River Formation (averaging about 658 mg/L). This strongly suggests that the groundwaters encountered in the underground mine workings in the 2R2S panel area are *not* recharged via downward migration of groundwater through the Price River Formation (as there is no plausible geochemical evolutionary pathway that would reduce the TDS of the groundwater were it to migrate downward through the Price River Formation toward the Blackhawk Formation).

#### ***728.200 Baseline hydrologic information***

Spring and seep inventories have been conducted previously in the South Fork area in conjunction with the previous permitting actions at the Sufco Mine. As part of this investigation, supplemental monitoring of springs, seeps and streams has been performed by

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Petersen Hydrologic, LLC. In conjunction with the baseline monitoring activities, groundwater and surface-water discharge rates and field water- quality parameters, including water temperature, pH, specific conductivity, and dissolved oxygen were measured. Additional monitoring of springs, streams, and wells was performed previously by the United States Geologic Survey (Thiros and Cordy, 1991) as part of a hydrologic reconnaissance of the Quitchupah and Pines areas. The results of the baseline monitoring activities at the 2R2S panel area are presented in Table 3. Additional baseline hydrologic data for the South Fork area have been submitted electronically to the Division of Oil, Gas and Mining Coal Water Quality Database, which are available on line at: <http://ogm.utah.gov/coal/edi/wqdb.htm>.

*728.310 Whether adverse impacts may occur to the hydrologic balance*

The hydrologic balance is the sum of the flow interactions between surface waters and groundwaters and between various groundwater flow systems. This section describes the potential for adverse impacts to the hydrologic balance as a result of coal mining activities beneath the South Fork of Quitchupah Creek in the 2R2S panel area.

For reasons described in previous sections of this report (Mayo and others, 2003; Mayo and Associates, 1997), the potential for the establishment of hydrodynamic communication between the shallow, active-zone groundwater systems that support spring and seep discharges in the 2R2S panel area and the deep, inactive-zone groundwater systems that will likely be encountered in the underground mine workings of the Sufco Mine is considered remote. Accordingly, while the deep inactive-zone groundwaters held primarily in sandstone

paleochannels immediately overlying the mined coal seam will be dewatered through mining activities, it is considered highly unlikely that surface waters or shallow groundwaters could migrate from the near surface into the underlying mine workings where the depth of cover exceeds several hundred feet (which includes all proposed mining areas in the 2R2S panel).

Active-zone groundwater systems in near-surface sediments and strata in the Price River and North Horn Formations, where overburden thicknesses are greater than about 600 feet should not be impacted by mining operations. This conclusion is based on the following lines of evidence:

- 1) The Price River and North Horn Formations are known to contain abundant and relatively thick shale and claystone layers. These low-permeability layers inhibit the vertical migration of groundwater into deeper strata. Additionally, the Mesa Verde Group shales and claystones in the region are known to contain hydrophyllic clays which are of low permeability and swell when wetted to effectively seal subsidence cracking.
- 2) In order to estimate the height overlying mining areas to which subsidence-induced fracturing may extend, and to project minimum overburden thickness required to protect hydrologic resources, the Society for Mining, Metallurgy, and Exploration (SME, 2011) has developed empirical relationships between the thickness of the extracted coal seam and the upward fracture propagation distances (see Chapter 10.6, "Mine Subsidence"). Utilizing these relationships, the Mining Engineers Handbook recommends that a minimum

vertical distance between the mine and an overlying water body with the potential for causing catastrophic damage should be a minimum of 60 times the coal mining height. The same minimum vertical separation distance is recommended for protection of aquifers overlying total extraction mining areas. Using this relationship, and estimating a mining height of 10 feet, it would be recommended that an overburden thickness of 600 feet be present to protect critical water bodies and aquifers overlying areas of total extraction mining.

- 3) While surface cracking in these formations, which typically extend less than about 50 feet below the land surface (SME, 2011), can occur as a result of subsidence, the presence of uncompromised shale or claystone layers beneath the subsidence cracked zone prevents further downward migration of groundwater into deeper formations. Additionally, unconsolidated soils and weathered shales and clays are known to be present in North Horn- and Price River-derived sediments regionally. In areas where these formations are present near the surface and where tension cracking may occur, the tension cracks would likely remain open for only short periods of time. This is because the weathered or unconsolidated clayey or shaley sediments derived from these formations are typically plastic in nature and of low-permeability (See Appendix). These materials, through infilling or in-place swelling, tend to rapidly heal all but the largest tension cracks, minimizing impacts to local groundwater flow regimes. That this is the case is supported by decades of

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previous experience in the Wasatch Plateau and Book Cliffs coal districts of Utah, where many springs discharging from these formations have been undermined without perceptible or quantifiable impacts occurring to groundwater and surface-water quality or quantity.

It should be noted that, while the downward migration of shallow groundwater into deeper geologic formations is unlikely to occur, the potential exists for the moving of groundwater discharge locations at the surface. Occasionally, where near-surface tension cracking is extensive, spring discharge locations may be moved to locations topographically lower than the original spring discharge location. For example, if a low-permeability perching layer upon which groundwater was flowing toward a spring were to be compromised as a result of extensive tension cracking, the discharge previously flowing to the spring could be rerouted through the fractured perching layer downward until a lower, uncompromised perching layer was present. Under this scenario, the post-mining discharge location for the spring would likely occur where the lower perching layer first intersected the ground surface in a down-dip location.

Mine workings in the 2R2S panel will likely intercept primarily ancient, perched groundwater systems in sandstone channels in the mine roof. Samples of groundwaters intercepted in the 2R2S panel and other nearby development entries were collected in the underground Sufco Mine workings. Tritium analysis was performed on these samples. The lack of tritium in these groundwaters (See Table 4) indicates that the groundwaters have been

isolated from the land surface or shallow recharge sources for at least the past 50 years. Mining operations will dewater the ancient, perched groundwater systems. However, because these systems are not in good hydraulic communication with the ground surface or shallow overlying active-zone groundwater systems, dewatering of the deep, perched systems will likely have no impact on overlying groundwater or surface water regimes.

As discussed previously, inactive-zone groundwater systems in the Blackhawk Formation occur in isolated partitions that are not in good hydraulic communication with the land surface or shallow, overlying active-zone groundwater systems that support springs and seeps. Therefore, it is likely that groundwater that will be intercepted in the Blackhawk Formation in the 2R2S panel area will be groundwater being removed from storage. Because inactive-zone groundwater systems are not in hydraulic communication with the land surface or shallow, active-zone groundwater systems, groundwater being removed from the Blackhawk Formation is likely not being replenished by recharge from adjacent or overlying groundwater systems or from infiltration of surface waters at any appreciable rate.

At any underground longwall coal mine, interruption and deformation of strata above longwall-mined areas has the potential to alter pre-mining groundwater flow conditions. The potential for this impact to occur in the 2R2S panel area is considered minimal. Rock mechanics equations have been developed that predict the height to which bedrock fracturing will likely extend above areas subsided by coal mines. In western coal mines, it is estimated that subsidence fractures commonly propagate upward approximately 30 times the height of

the extracted coal (Kadnuck, 1994). Other researchers have estimated the maximum height of upward propagation of fracturing at 60 times the height of the extracted coal (SME, 2011). Assuming a mining thickness of 10 feet, it would be anticipated that fracturing would extend upward for a distance of approximately 300 to 600 feet. Above this height, rock strata tend to flex rather than fracture, and no appreciable increase in vertical hydraulic conductivity is anticipated. Differential ground subsidence can also result in the formation of tension cracks at the land surface, particularly above abutments, longwall panel ends, and longwall gate roads. Previous experience at the Sufco Mine and information provided by SME (2011) indicates that these fractures commonly extend less than about 50 feet below the land surface. Thus, in the 2R2S panel area, a sequence of several hundred feet of unfractured rocks will likely exist between the bottom of the shallow tension cracks near the surface and the top of the fractured zone above longwall mined regions. This sequence of low-permeability rock prevents the downward migration of active-zone groundwaters into the deeper subsurface. The presence of hydrophyllic clays in the fine-grained rocks of the Sufco Mine area effectively seal fractures that may form in the subsurface, preventing appreciable downward migration of groundwater.

It is apparent in the information presented above that there is no quantifiable baseflow contribution to the surface-water system in the South Fork of Quitcupah Creek from the Price River Formation and Castlegate Sandstone in proposed mining areas (below monitoring point 006A). Accordingly, the South Fork of Quitcupah Creek in these areas appears to act essentially as a conveyance ditch for surface waters in this area. The surface waters that are

conveyed through this area originate considerable distances up-stream of proposed mining areas. Accordingly, the potential for mining-related losses of stream water in these portions of the South Fork would likely be limited to stream losses associated with capture of surface flows through open subsidence fractures. While it is possible that such losses could occur, such losses could likely be mitigated by physically repairing the stream channel in fractured zones. This condition would be most likely to occur in stream reaches where the stream substrate consists of exposed bedrock without appreciable alluvial cover. In areas where considerable thickness of unconsolidated sediments/alluvium is present beneath the stream channel (particularly the clayey alluvium associated with the Price River and North Horn Formations; See Appendix), tension cracks that do form will likely heal themselves naturally as the unconsolidated alluvial sediments settle and infill any cracks that may form subsequent to subsidence.

It should be emphasized that the hydrologic conditions present in the proposed mining areas in the South Fork of Quitcupah Creek area are fundamentally different than those encountered in portions of the recently mined Pines area. The surface waters in the North Water Canyon area, for example, are largely sourced from discharge from Castlegate Sandstone bedrock groundwater systems located within subsided areas. In contrast, only minimal groundwater discharge has been observed in the proposed mining areas at the 2R2S panel. Rather, under pre-mining conditions, the stream generally loses small amounts of surface water over the reach between Sufco 006A and Sufco 006B and is generally unchanged in the reach between 006B and 006C. Accordingly, it is my professional opinion

that the mitigation of potential subsidence-related losses of surface water in this portion of the creek would likely be practically accomplishable and essentially equivalent to a ditch maintenance operation.

Where undermining of the South Fork of Quitchupah Creek within the steep-walled canyon area surrounded by the Castlegate Sandstone escarpment occurs, there is the potential for accumulation of rock fall material onto the canyon bottom. If subsidence fractures that divert surface waters from the creek were to occur in areas subsequently covered by rock fall material, it would likely be necessary to remove this material to allow access to the original channel surface to effect channel repairs (in the event that natural healing of the subsidence fractures did not occur within a reasonable period of time).

In summary, based on the characterization of groundwater and surface-water systems presented above, and on the proposed mining plan, no significant impacts to the overall hydrologic balance are anticipated as a result of mining in the 2R2S panel.

***728.320 Whether acid-forming or toxic-forming materials are present that could result in the contamination of surface water or groundwater supplies***

In the general sense, acid- and toxic-forming materials in soil and rock disturbed by coal mining have the potential to impact groundwater and surface water quality. Mine discharge water from the Sufco Mine is routinely monitored for indicators of increased acidity (iron and pH) and toxic materials. Although the concentrations of iron in mine discharge water are

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occasionally elevated relative to springs in the region, mine discharge waters rarely exceed permitted discharge limits.

No new topsoil or waste rock piles are planned as a consequence of mining in the 2R2S panel area and no impact from acid- or toxic-forming materials is anticipated.

With the exception of modest quantities of pyrite or similar sulfide minerals, no significant quantities of any acid- or toxic-forming materials are believed to be present in the 2R2S panel area. Iron pyrite or other sulfide minerals are commonly present in western coal mines. The oxidation of pyrite, which occurs when the mineral is exposed to water and oxygen, releases  $H^+$  ions (acid) into the mine water. The acid produced from pyrite oxidation temporarily lowers the pH of the water. However, the acid produced from pyrite oxidation is rapidly consumed by reactions with the carbonate minerals which are pervasive in the rocks associated with the coal fields of the Wasatch Plateau. Thus, acid mine discharge in mine discharge water does not occur. The iron released into the water from pyrite oxidation is readily precipitated as iron-hydroxide when it contacts oxygenated water.

It is anticipated that the mineralogical characteristics of the rocks and coals of the 2R2S panel will be generally similar to other mining areas at the Sufco Mine. Thus, the potential for acid-forming or toxic-forming materials to result in contamination of surface-water or groundwater supplies is believed to be similar to those encountered in other portions of the Sufco Mine.

*728.331 What impact the proposed coal mining and reclamation operation will have on sediment yield from the disturbed areas*

The sediment load of streams can potentially be affected as a result of erosion and sediment transport from disturbed areas. Canyon Fuel Company has implemented a rigorous and effective sediment control program that is designed to minimize the sediment yield from disturbed areas. This includes the use of sediment control fences, re-vegetation of previously disturbed areas, and the diversion of surface waters around disturbed areas. Runoff from disturbed areas is collected near source areas and diverted into sediment control ponds for retention and settlement of suspended solids before being discharged to natural drainages.

The 2R2S panel is accessed through the existing Sufco Mine portals where effective sediment control structures are currently in place. No new surface disturbances are proposed for the mining of this panel. The sediment control plan is described in Chapter 7, Sections 7.2.8 and 7.3.2 of the Sufco Mine MRP. Details for the East Spring Canyon Surface Facilities are shown on Plate 5-2A. The East Spring Canyon Drainage Detail map is included in the MRP as Plate 7-6. No surface facilities or disturbances within the 2R2S panel are proposed. Consequently, there is minimal potential for additional impacts resulting from coal mining activities in disturbed areas associated with mining of the 2R2S panel.

*728.332 What impact the proposed coal mining and reclamation operation will have on acidity, total suspended and dissolved solids and other important water quality parameters of local impact*

Impacts to the water quality of active-zone groundwater systems that support springs and seeps in the 2R2S panel area are not anticipated. The potential for appreciable increases in sediment yield as a result of mining in the 2R2S panel area (that could result in elevated suspended solids concentrations) is minimal. It should be noted that where differential subsidence of the land surface occurs (typically along longwall panel margins), there is the potential for localized changes in stream gradients. In areas where the stream gradient may be decreased, localized ponding in the stream could occur. In areas where differential subsidence could cause the stream gradient to be increased, increased stream velocities and associated erosion potential could occur locally. However, these occurrences would likely be short-lived, as the stream tends to return to equilibrium with its channel by infilling of ponded areas with available sediment and down-cutting of areas of steepened stream gradient. Additionally, because of the steepness of the stream channel gradient in most areas (relative to the magnitude of the anticipated ground subsidence) the lengths of potential ponded areas in the stream would likely be modest.

Thus, detrimental impacts to important water quality parameters such as acidity, total suspended solids, and total dissolved solids in the South Fork of Quitcupah Creek or in springs in the 2R2S panel area are generally considered unlikely.

It should be noted that in the event that subsidence fracturing of bedrock horizons beneath a stream or near the discharge location of a spring occurs, there is a potential of a modest, temporary increase in TDS concentration. This increase could result if the bedrock horizons fractured contained pyrite or other sulfide minerals. When subsidence-fractured rock surfaces expose pyrite to an aqueous, oxygen-rich environment, sulfide mineral oxidation may occur. Under such circumstances some solutes, primarily sulfate, bicarbonate, calcium, and magnesium can increase. Such reactions typically do not occur in deep groundwater systems because of the lack of available oxygen in these systems. Because the pyrite is consumed by the oxidation reaction, the reaction ceases when all the freshly exposed pyrite is oxidized.

Fuels, greases, and oils are stored and used in the Sufco Mine permit area. There is the potential for spillage of these substances during equipment maintenance and operations, during filling of storage tanks and vehicle tanks, and from leakage from potentially leaking storage tanks.

The Sufco Mine has previously implemented a rigorous spill prevention plan that is designed to minimize the potential for spillage of these substances and to ensure that any potential spills that may occur are promptly cleaned-up. This plan will continue to be followed during mining in the 2R2S panel. Because the 2R2S panel will be accessed from the permitted existing surface facilities area (including equipment maintenance and fueling areas and

chemical storage areas), there should be no additional potential for spillage as a result of mining of the 2R2S panel.

The discharge of Sufco Mine water to surface water drainages will have an impact on the water quality of receiving waters. The nature and magnitude of this impact is related to the relative quality of the receiving water and the mine discharge water. If the mine discharge water is of poorer quality than the receiving water, then the quality of the receiving water will be degraded proportionally. If the mine discharge water is of better quality than the receiving water, the quality of the receiving water will be improved. Historically, the discharge water from the Sufco Mine has generally been of relatively good quality and has usually met the beneficial use standards of the receiving water (UDOGM, 2012).

Based on the fact that the geologic conditions at the 2R2S panel are generally similar to those in the adjacent existing Sufco Mine permit area, it is anticipated that the character of groundwater inflows in terms of both quality and quantity will likely be similar to those that have historically occurred in the existing Sufco Mine. Consequently, no impacts to important water quality parameters above those that may occur at the existing Sufco Mine area are anticipated as a result of mining in the 2R2S panel. The discharge of Sufco Mine water is regulated under a UPDES permit issued from the Utah Division of Water Quality.

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*728.333 What impact the proposed coal mining and reclamation operation will have on flooding or streamflow alteration*

There are no known geologic features in the 2R2S panel area that are substantively different than those that have been encountered elsewhere in the Sufco Mine (Personal communication, Mark Bunnell, 2012). Mining practices to be utilized in mining the 2R2S panel area will also be similar to those currently implemented at the Sufco Mine.

Accordingly, it is anticipated that discharge rates from the Sufco Mine during mining in the 2R2S panel will likely be of similar magnitude to those that are currently occurring. Thus, no significant increase to the flooding or streamflow alteration potential of Sufco Mine discharge water to Quitcupah Creek is anticipated above that currently occurring as a result of mining of the 2R2S panel.

*728.334 What impact the proposed coal mining and reclamation operation will have on groundwater and surface-water availability*

It has been demonstrated that the active-zone groundwater systems that support springs and seeps in the 2R2S panel area are isolated from the inactive-zone groundwater systems that will be encountered during mining in the 2R2S panel. As discussed previously, the potential for impacts to springs and seeps in the overlying Price River and North Horn Formations is considered minimal. Therefore, the availability of these groundwaters and surface waters will likely not be impacted.

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It should be noted here that impacts to the two Castlegate Sandstone springs (The Wedge Spring and Amanda Spring) located adjacent to the 2R2S panel area resulting from the undermining of the South Fork of Quitchupah Creek with the 2R2S Block A panel are not anticipated. Although considered unlikely, in the event that the Castlegate Sandstone bedrock near the spring discharge locations were to be compromised as a result of subsidence fracturing near the spring discharge locations, the potential for diminution of groundwater discharge rates from these springs would be considered low. This is because 1) the strata near the base of the Castlegate Sandstone from which the springs discharge are underlain by abundant low-permeability shaley bedrock strata of the Blackhawk Formation which would inhibit the downward migration of groundwater to deeper horizons or into the mine workings, and 2) the steep topography of the hillside from which the two springs discharge would minimize the horizontal displacement of previously existing spring locations if they were to be altered by subsidence fracturing (i.e., if the spring locations were to move, they would likely not move large distances and the groundwater would “daylight” at locations near the previously existing spring locations).

Current mining operations have made available several hundreds of gallons per minute of mine discharge water that has previously been unavailable for use. It is anticipated that as mining progresses in the 2R2S panel, additional groundwater inflows into the mine workings will occur and discharge of groundwater to the Quitchupah Creek surface-water drainage will likely continue. It should be noted that the discharge of mine water at current discharge rates would likely not be sustained over a long period of time. Historically, discharge rates from

individual inactive-zone mine inflows usually decline over time. This is because the inactive-zone groundwater is being removed from storage and is not being actively recharged. Rather, the rate of discharge from the mine is best correlated with the rate at which the mine workings are advanced into new mining areas, and not to the total cumulative footprint of the mine workings (Mayo and Associates, 1997). It should not be assumed that the groundwater discharging from the mine will be a long-term source of water.

*728.350 Whether the underground coal mining and reclamation activities may result in contamination, diminution or interruption of State-appropriated water*

The active-zone groundwater systems that support springs and seeps in the 2R2S panel area are isolated from the inactive-zone groundwater systems that will likely be encountered during mining activities. Accordingly, the potential for contamination, diminution, or interruption of groundwater systems resulting from draining of active-zone groundwaters into deep horizons (or the mine workings) is considered remote. Inactive-zone groundwater systems that will likely be encountered during mining in the 2R2S panel include primarily perched systems associated with sandstone channels in the Blackhawk Formation. While deep, inactive-zone Blackhawk Formation groundwater systems will be intercepted and dewatered during mining activities, in the pre-mining condition, there are no known uses or State appropriations of these waters.

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## 8.0 Recommended Monitoring Plan

The recommended monitoring plan for groundwaters and surface waters near the 2R2S panel area is presented below. The purposes of the recommended groundwater and surface-water monitoring plan are to 1) document the effects of seasonal and climatic variability on groundwater and surface-water resources, 2) collect data to document that the shallow, active-zone groundwater systems in the 2R2S panel area operate independently of the deep, inactive-zone groundwater systems encountered in the Sufco Mine, 3) to provide verification that mining-related impacts to groundwater and surface-water systems do not occur and 4) to determine the magnitude and character of any potential impacts to water quantity or water quality if such were to occur. The recommended monitoring plan is summarized below.

### *Springs*

We recommend the monitoring of six springs in the vicinity of the 2R2S panel area. These include 006A Spring, Roberts Spring, RS-A, RS-B, The Wedge Spring, and Amanda Spring. These springs discharge from the Price River Formation and Castlegate Sandstone (See Figure 6 for monitoring station locations). Impacts to water quantity and water quality resulting from the undermining of the 2R2S longwall panel are not anticipated. To verify this conclusion, we recommend that each of these four springs be monitored quarterly for discharge rate and field water quality parameters while the mining in the 2R2S longwall panel is occurring under the springs and for a period of two years after mining in the area is complete.

*Streams*

We recommend the monitoring of stream monitoring stations Sufco 006, Sufco 006A, Sufco 006B, Sufco 006C, and Sufco 006D (See Figure 6 for monitoring site locations) in conjunction with the undermining of the 2R2S longwall panel. We recommend that sites Sufco 006A, Sufco 006B, and Sufco 006C be monitored bi-weekly for discharge rate and for field water quality parameters while mining in the 2R2S longwall panel is occurring under the stream and thereafter quarterly for a period of two years. We recommend the quarterly monitoring of site Sufco 006D for discharge rate and field water quality parameters while mining in the 2R2S panel is occurring under the stream and thereafter for a period of two years. Quarterly monitoring at site Sufco 006 for discharge rate and field and laboratory water quality measurements is already included in Sufco Mine's monitoring plan.

**Use of the Groundwater and Surface-Water Monitoring Plans**

The purposes of Sufco's groundwater and surface-water monitoring plans are to provide verification that mining-related impacts to groundwater and surface-water systems do not occur, and to determine the magnitude and character of potential impacts if they do occur. Comparisons between monitoring data (for the parameter of interest or concern) collected during baseline, pre-mining conditions should be made with monitoring data (for the same parameter or interest of concern) collected during the operational and/or reclamation phase of mining to determine impacts. When changes to monitored parameters subsequent to mining in an area are observed in the monitoring data, an analysis of all relevant data should be

performed to determine the cause(s) of the change in the hydrologic condition. In utilizing the monitoring data to detect or quantify potential mining-related impacts, it is necessary to evaluate all factors relevant to the prevailing hydrologic conditions together with the monitoring data. This is because other factors, which are not related to the mining activity, may cause changes in the prevailing hydrologic conditions. In particular, climatic variability (which may result in increased or decreased groundwater and surface-water flow rates, changes in water levels in wells, and changes in water quality) should be carefully evaluated together with the monitoring data. Other factors that may influence coal mine hydrology include grazing practices, land use, and range condition. A convenient and useful means of evaluating regional climatic data is through the use of the Palmer Hydrologic Drought Index, which is a monthly value that indicates the severity of wet and dry spells that is generated by the National Climatic Data Center and available on-line at <http://www1.ncdc.noaa.gov/pub/data/cirs/drd964x.phdi.txt>.

The use of Stiff (1951) diagrams is a useful technique that is frequently used to analyze and compare groundwater and surface-water quality characteristics from various sources.

Information required to create Stiff diagrams is available from the Division of Oil, Gas and Mining Coal Water Quality Database, which is freely accessible at:

<http://ogm.utah.gov/coal/edi/wqdb.htm>. Additional information on coal mining hydrology and potential mining-related impacts, which can be used to assist in the evaluation of monitoring data and potential mining-related impacts, is provided on the Utah Division of Oil, Gas and Mining web page at <http://ogm.utah.gov/coal/water/default.htm>.

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## 9.0 References Cited

- Bunnell, Mark, 2012, personal communication, Sufco Mine.
- Canyon Fuel Company, 1998, Mining and Reclamation Plan (MRP) for the SUFCO Mine.
- Division of Oil, Gas and Mining, 2012, On-line hydrology database,  
<http://ogm.utah.gov/coal/edi/wqdb.htm>.
- Marley, W.E. and others, 1979, Coal accumulation in Upper Cretaceous Marginal Deltaic Environments of the Blackhawk formation and Star Point Sandstone, Emery, Utah, Utah Geol. V. 6, No. 2.
- Mayo, A.L., Morris, T.H., Peltier, S., Petersen, E.C., Payne, K., Holman, L.S., Tingey, D., Fogel, T., Black, B.J., Gibbs, T.D., 2003, Active and inactive groundwater flow systems: Evidence from a stratified, mountainous terrain, GSA Bulletin v. 115; no. 12; p. 1456-1472.
- Mayo and Associates, 1999, Investigation of Surface-Water and Groundwater Systems in the Pines Tract Area, Sevier County, Utah: Probable Hydrologic Consequences of Coal Mining in the Pines Tract and Recommendations for Surface Water and Groundwater Monitoring Investigation of surface and groundwater systems in the vicinity of the Pines Tract.
- Mayo and Associates, 1997, Investigation of surface and groundwater systems in the vicinity of the SUFCO Mine, Sevier County, Utah: Probable hydrologic consequences of coal mining at the SUFCO Mine and recommendations for surface and groundwater monitoring. Unpublished consulting report prepared for Southern Utah Fuel Company, 7 January 1997.
- National Climatic Data Center, 2012, On-line climatic data,  
<http://www.ncdc.noaa.gov/oa/climate/onlineprod/drought/xmrg3.html>
- Petersen Hydrologic, LLC, 2010, Investigation of Groundwater and Surface-Water Systems in the West Lease Modification Area; Probable Hydrologic Consequences of Coal Mining And Recommendations for Groundwater and Surface-Water Monitoring, unpublished consulting report for Canyon Fuel Company, LLC.
- SME Mining Engineering Handbook, 2011, Edited by Peter Darling, Published by Society for Mining, Metallurgy, and Exploration, Inc

Stiff, A.H., Jr., 1951, The interpretation of chemical water analyses by means of patterns: Journal of Petroleum Techniques, Technical Note 84, p. 15-17.

Thiros, S.A., and Cordy, G.E., 1991, Hydrology and potential effects of mining in the Quithupah and Pines coal-lease tracts, Central Utah. USGS Water-Resources Investigations Report 90-4084.

US Forest Service, 2005, Groundwater and surface water Technical Report for NEPA analysis at the Muddy Tract, prepared in conjunction with Cirrus Ecological Solutions, LC.

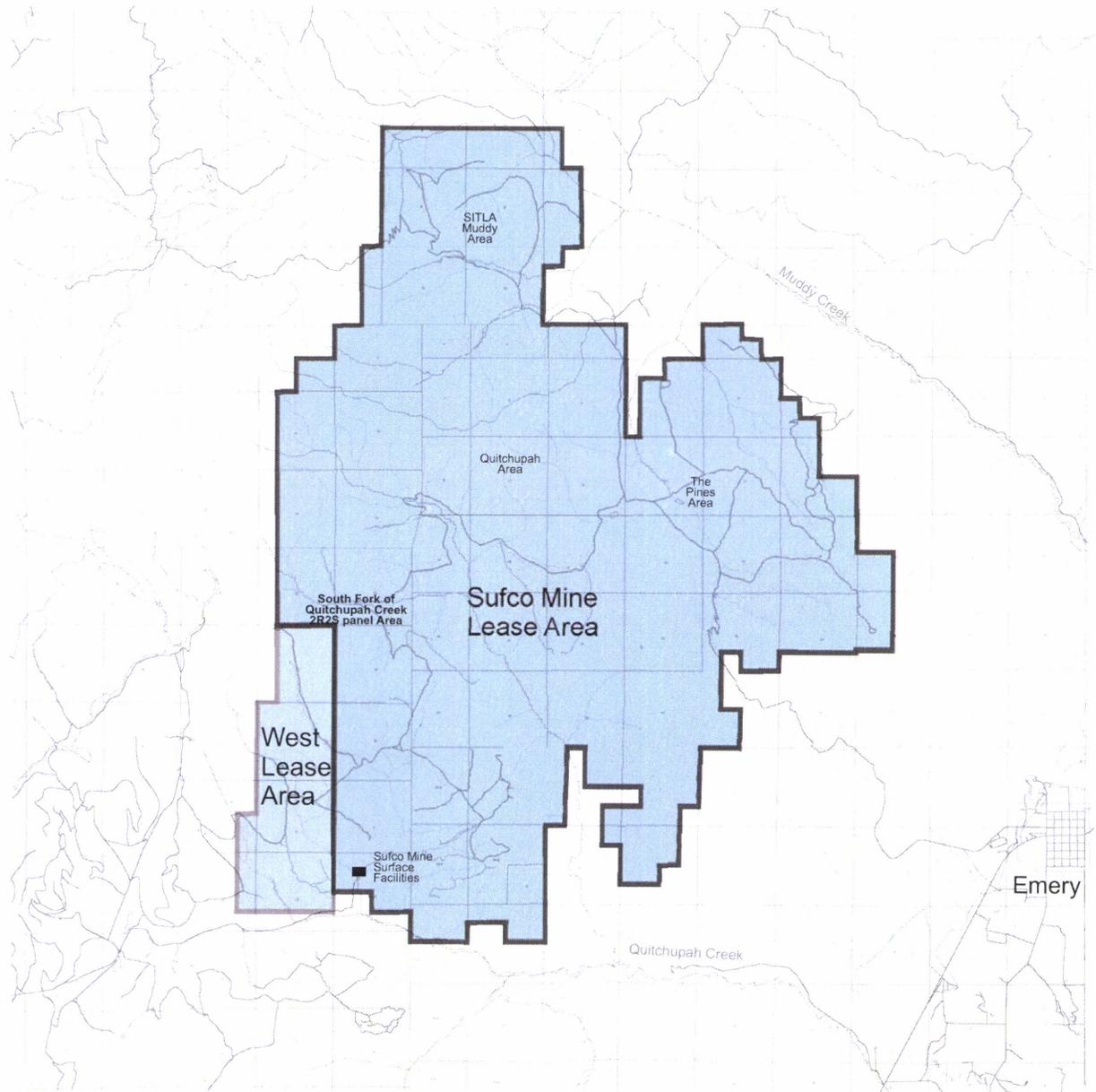
US Forest Service, 2005, Technical Report of environmental consequences of coal mining in the Muddy Tract, Manti-La Sal National Forest.

US Forest Service, 1999, Pines Tract Project, Final Environmental Impact Statement and Record of Decision, Region Four, Manti-La Sal National Forest, Emery and Sevier Counties, Utah.

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Figure 1 Location of Sulco Mine and 2R2S panel areas.

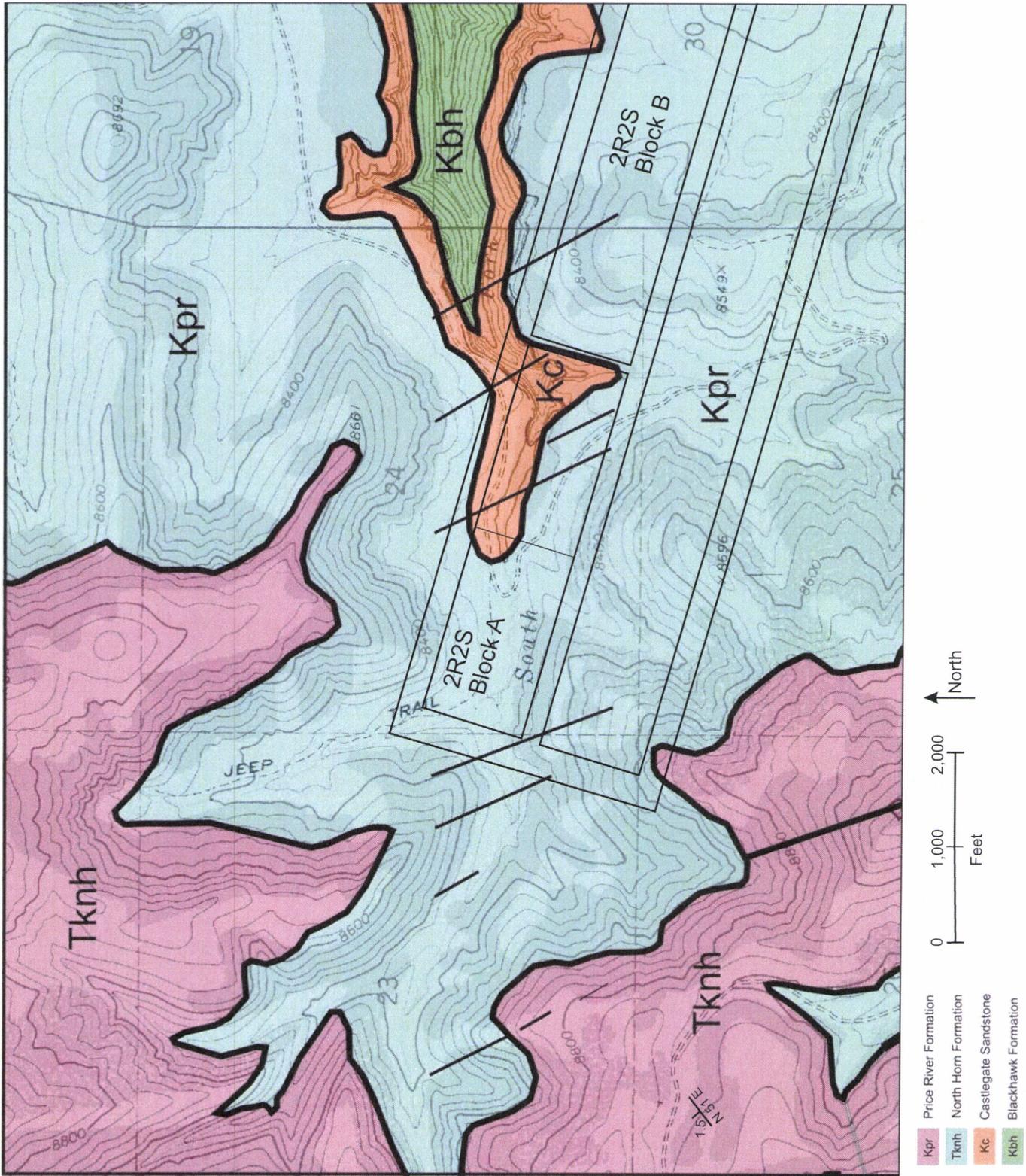
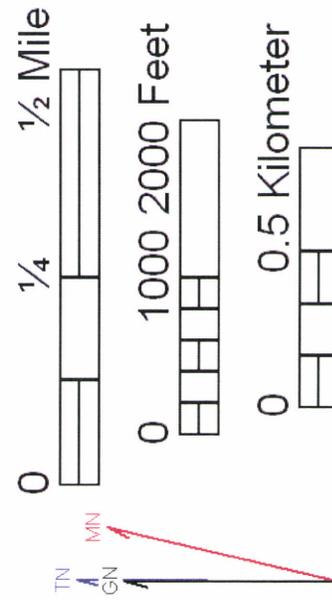
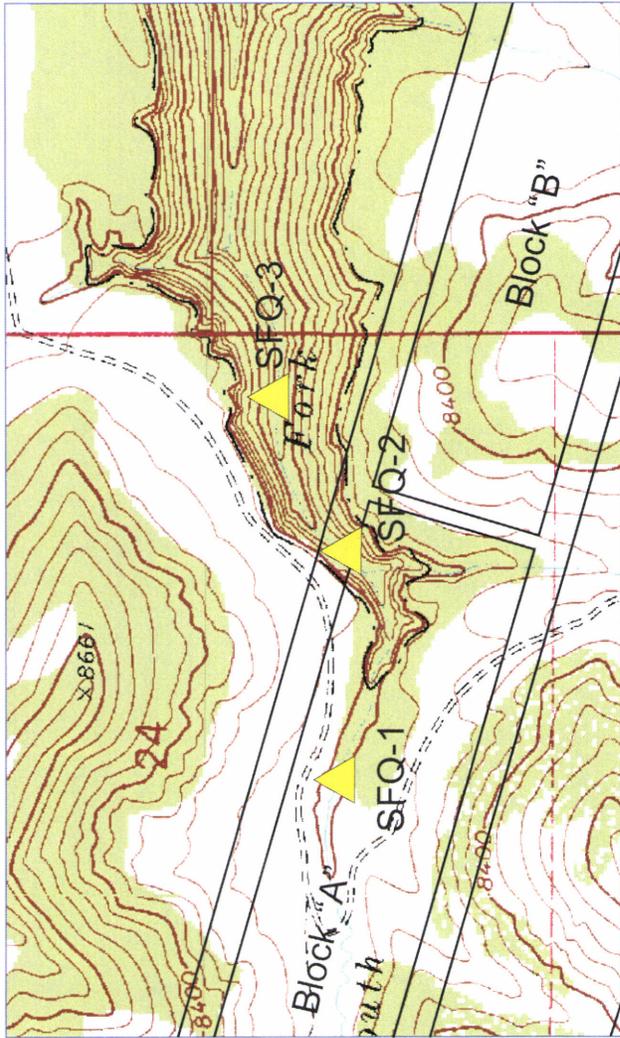


Figure 2 Geologic map of the 2R2S panel area.

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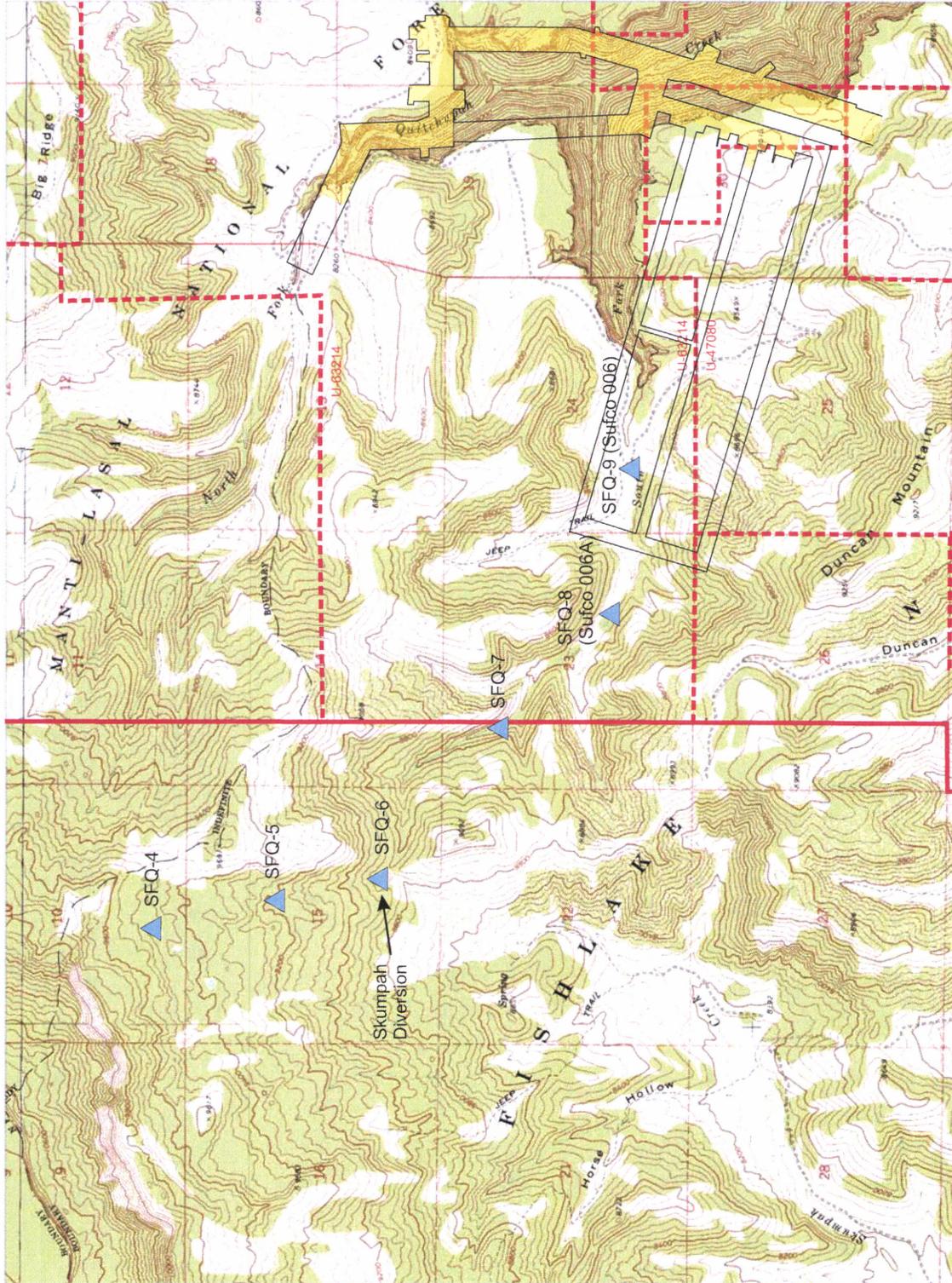
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Figure 3 Discharge monitoring locations for the 16 October 2007 survey.

111° 28' 38.082" W  
39° 0' 2.987" N

111° 23' 3.558" W  
39° 0' 4.222" N



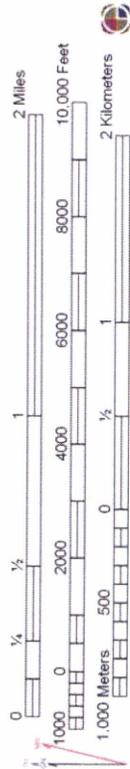
38° 56' 47.207" N  
111° 28' 36.769" W

38° 56' 48.440" N  
111° 23' 2.500" W

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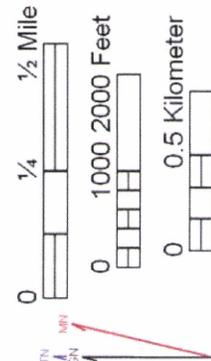
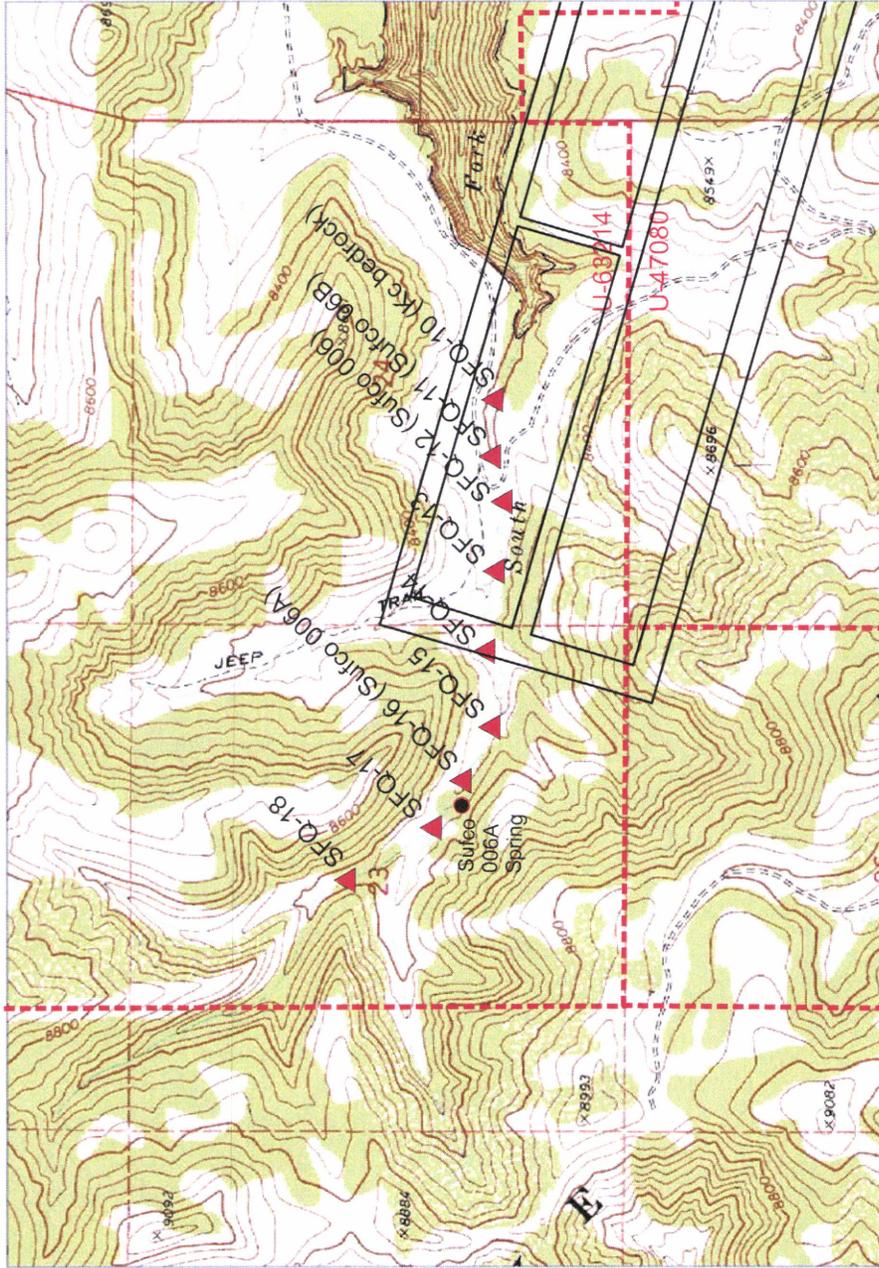


1927 North American Datum: UTM grid zone 12  
Generated by BigTopo7 ([www.bigtopo.com](http://www.bigtopo.com))  
Map compiled from USGS Quads: Helirotrope Mountain;  
UT Accord Lakes; UT



BigTopo Map

Figure 4 Discharge monitoring locations for the 4 September 2009 survey.



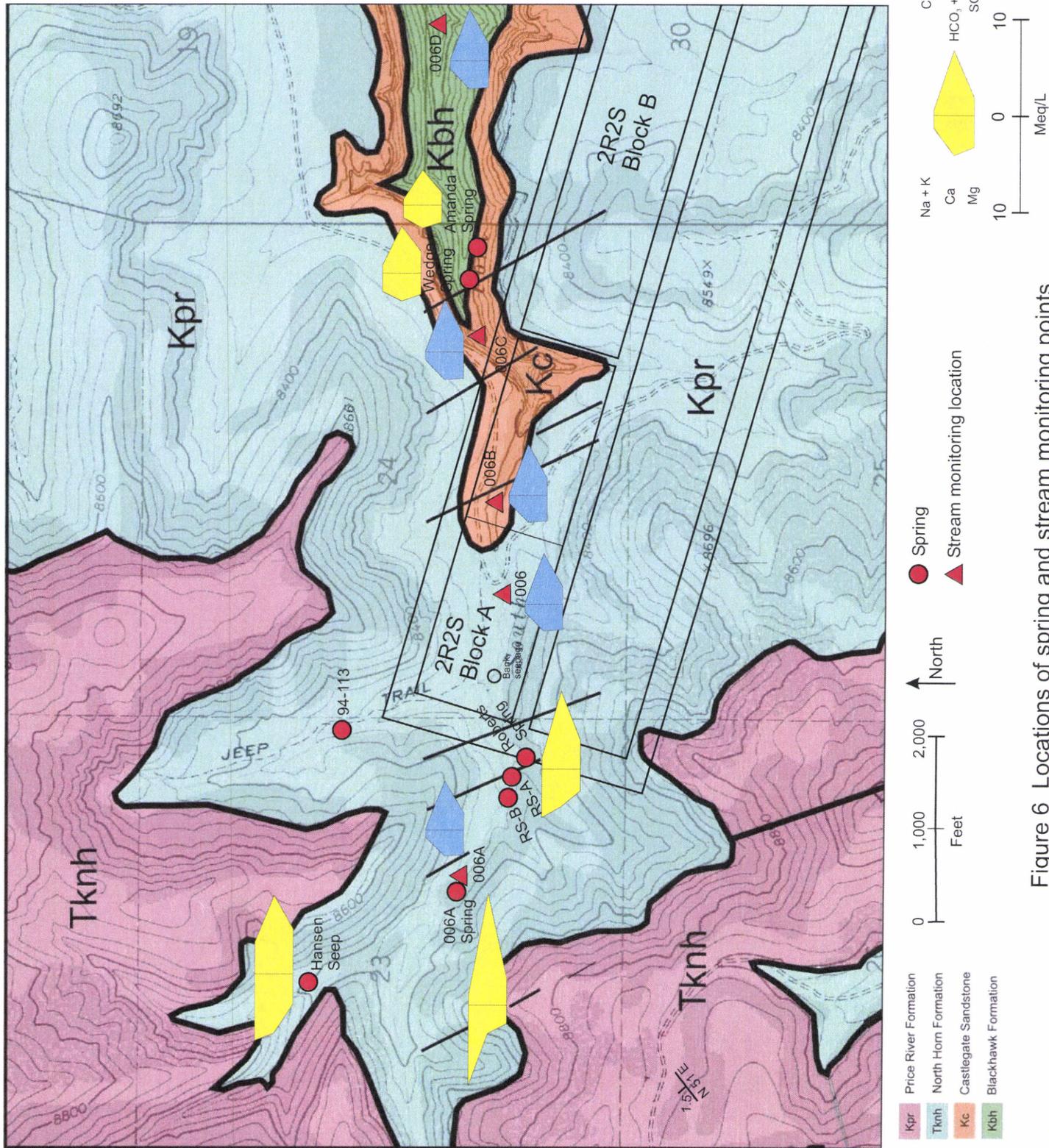
UTM Grid and 2010 Magnetic North  
 Declination at Center of Sheet  
 GN to TN 0.266° (5 mils)  
 TN to MN 12.963° (230 mils)

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Figure 5 Discharge monitoring locations for 12 October 2009 survey.

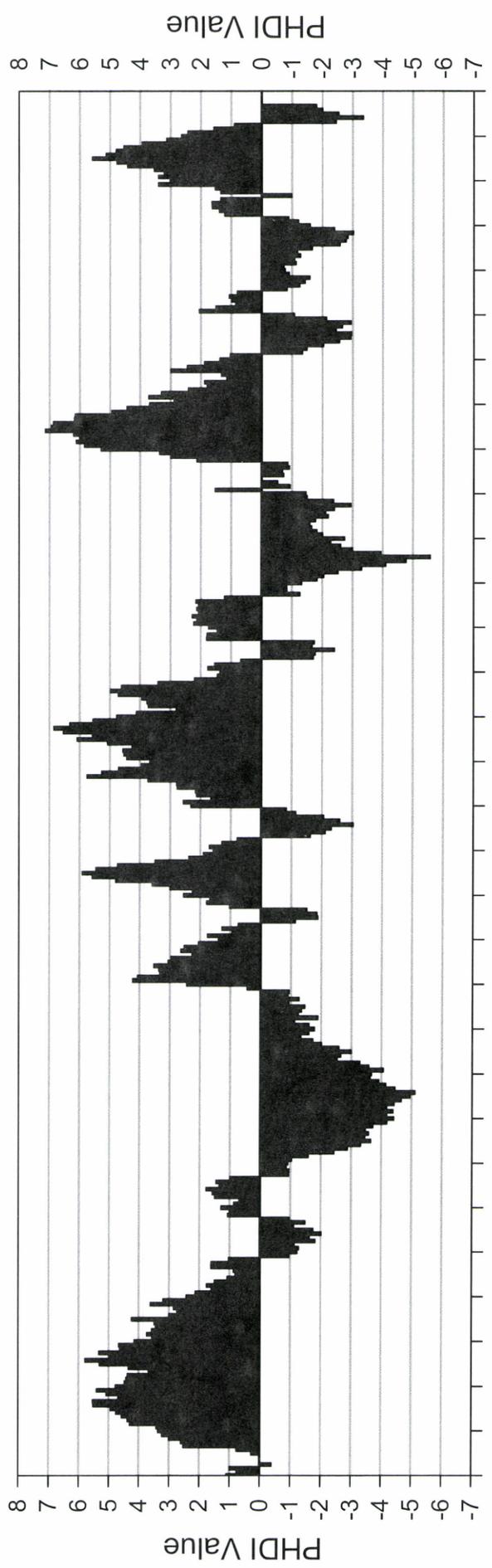


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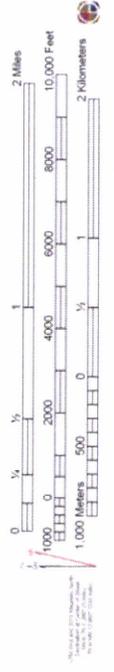
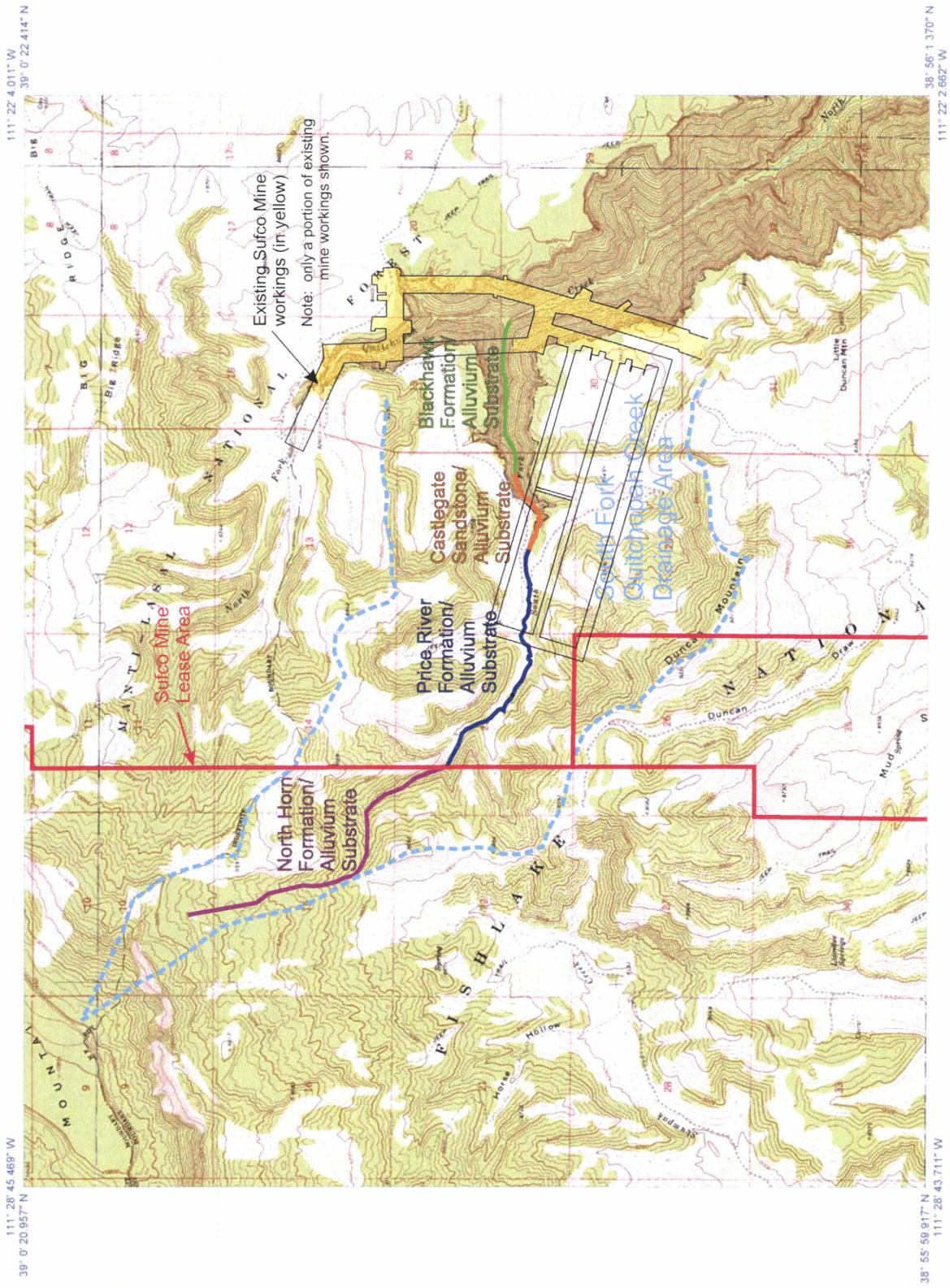
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Figure 6 Locations of spring and stream monitoring points with Stiff diagrams.



- 1 to -2 Mild Drought
- 2 to -3 Moderate Drought
- 3 to -4 Severe Drought
- 4 to -5 Extreme Drought
- 1 to 2 Mild Wet Spell
- 2 to 3 Moderate Wet Spell
- 3 to 4 Severe Wet Spell
- 4 to 5 Extreme Wet Spell

Figure 7 Plot of Palmer Hydrologic Drought Index for Utah Region 4.

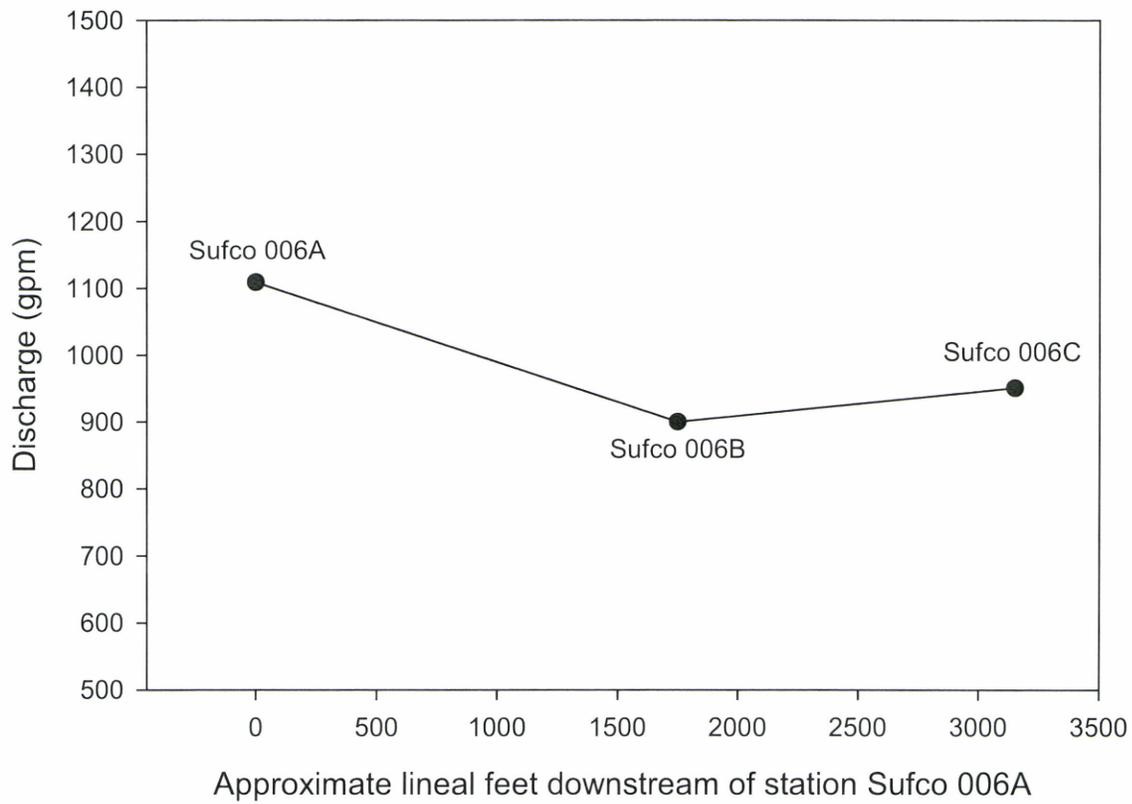


- North Horn Formation/Alluvium Substrate
- Price River Formation/Alluvium Substrate
- Castlegate Sandstone/Alluvium Substrate
- Blackhawk Formation/Alluvium Substrate

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Figure 8 Geologic formation present in stream substrate.

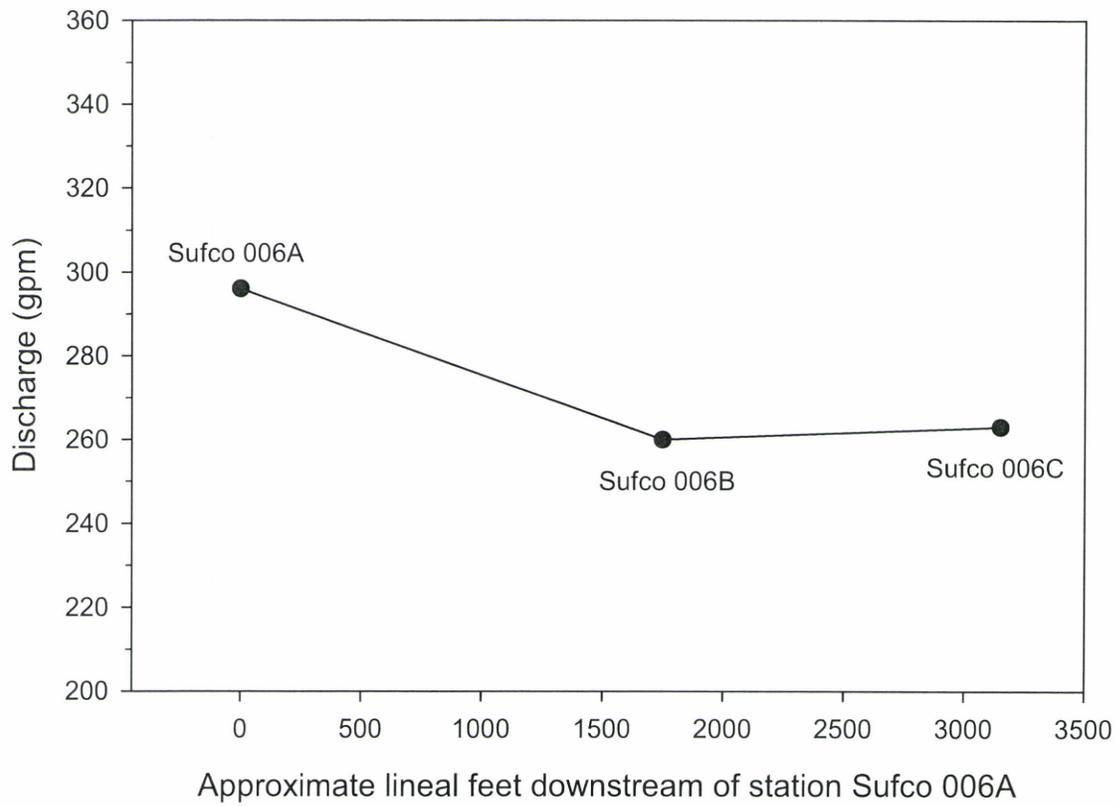
17 June 2011  
Stream Survey



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Figure 9 17 June 2011 stream survey.

21 September 2011  
Stream Survey



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Figure 10 21 September 2011 stream survey.

12 October 2011  
Stream Survey

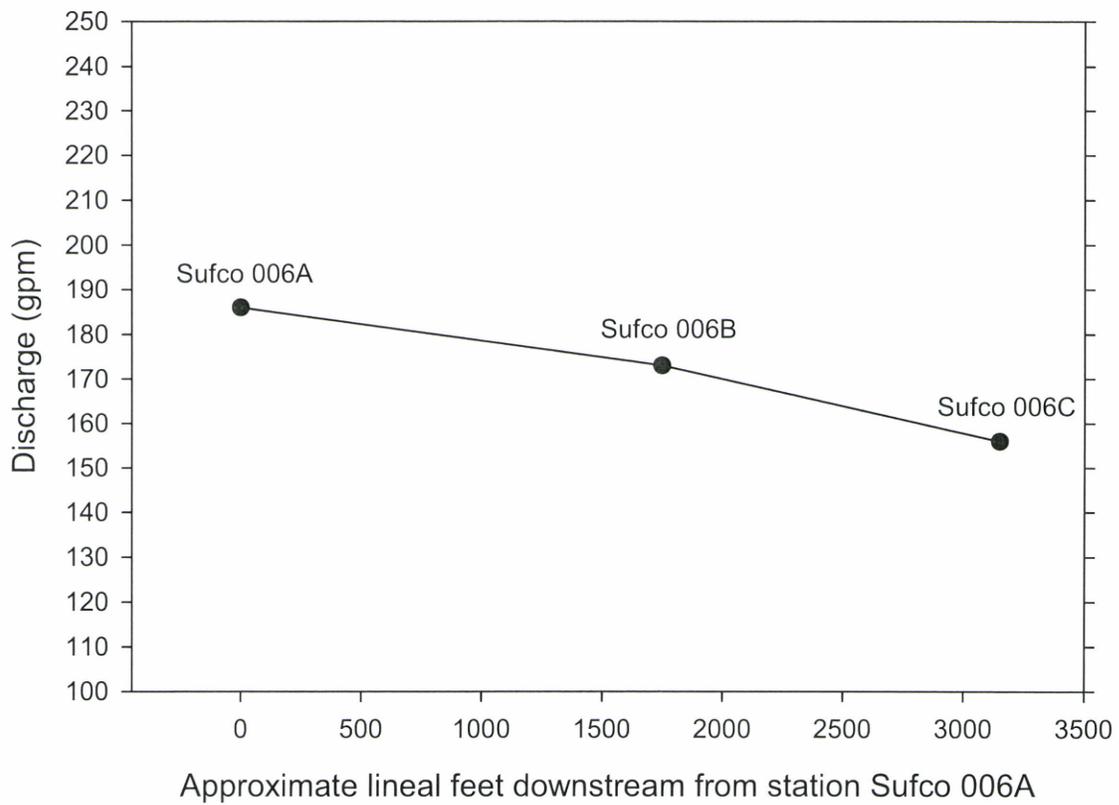


Figure 11 12 October 2011 stream survey.

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1 June 2012  
Stream Survey

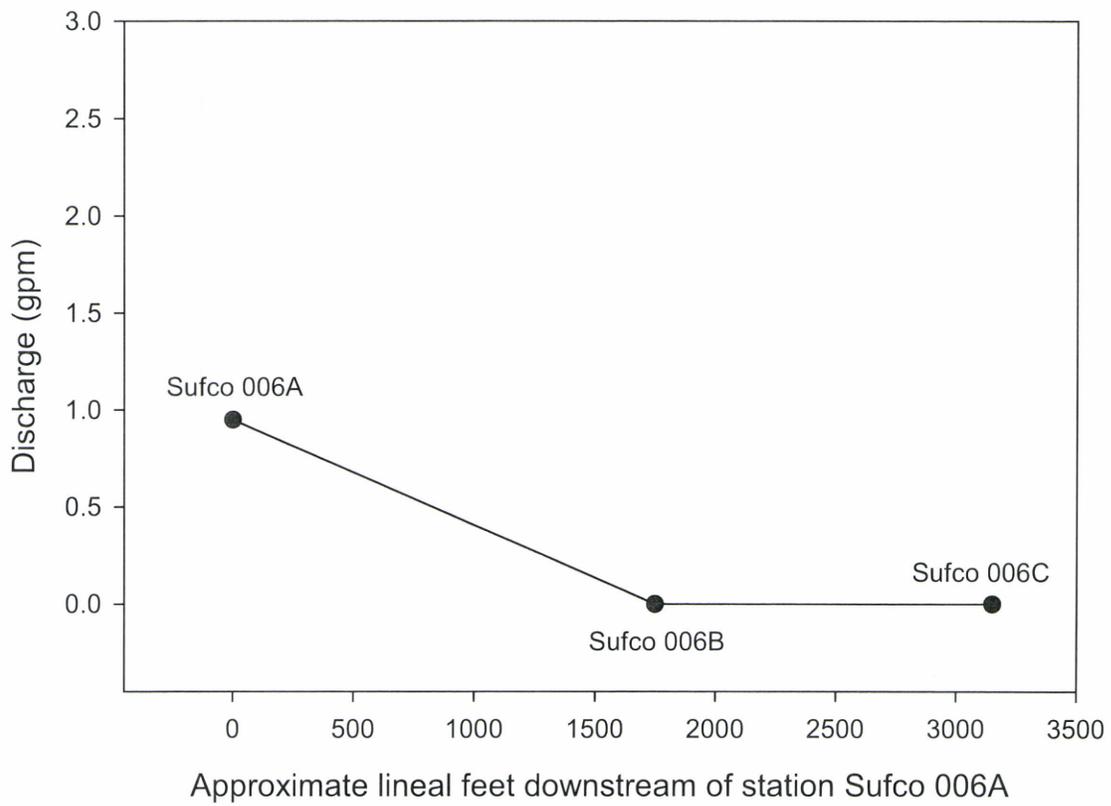


Figure 12 1 June 2012 stream survey.

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12 September 2012  
Stream Survey

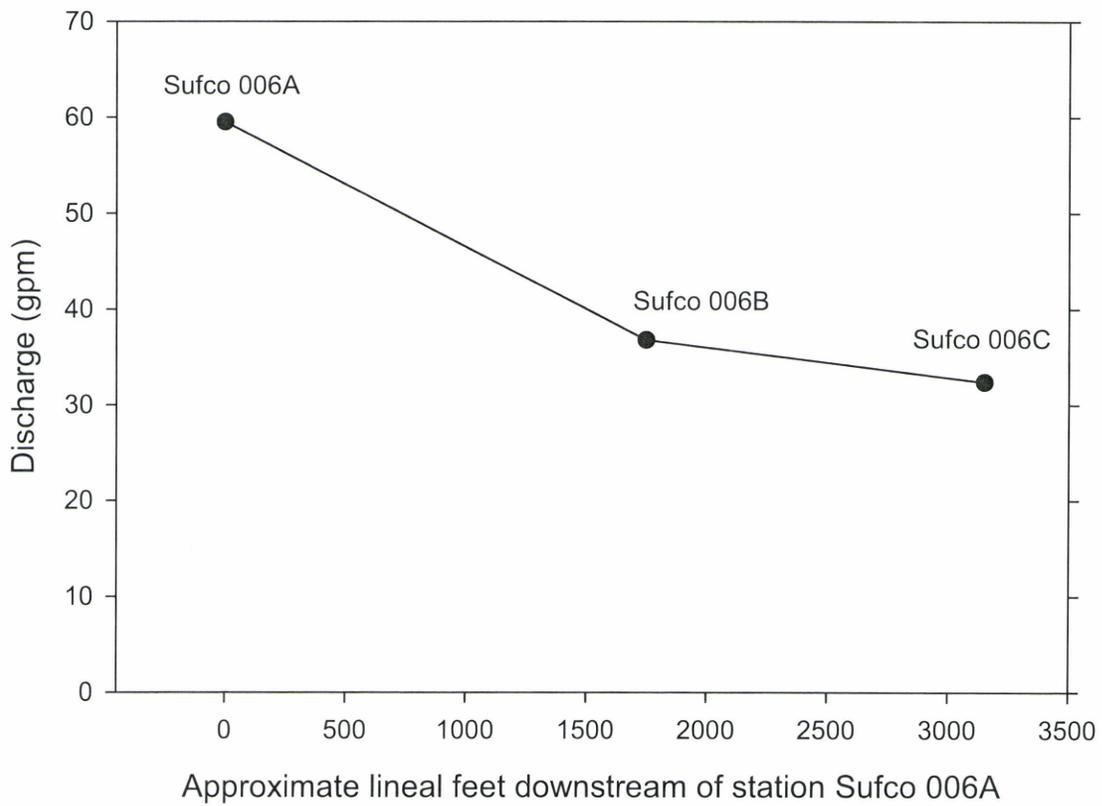


Figure 12a 12 September 2012 stream survey.

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### 006A Spring

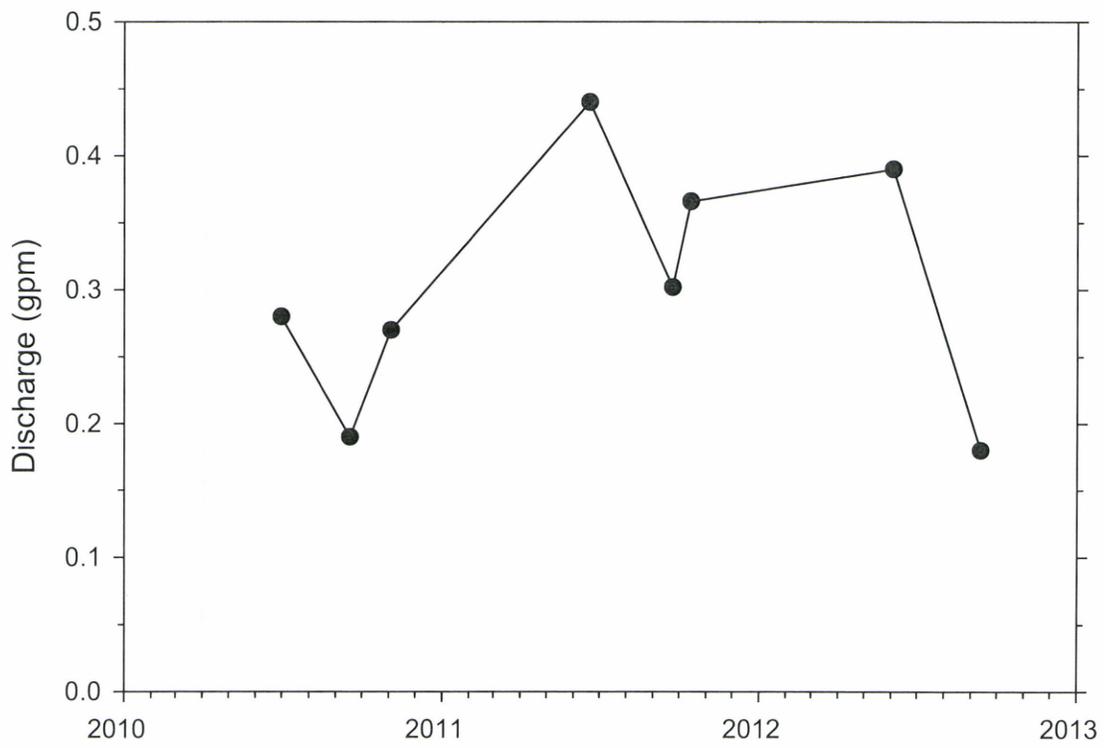


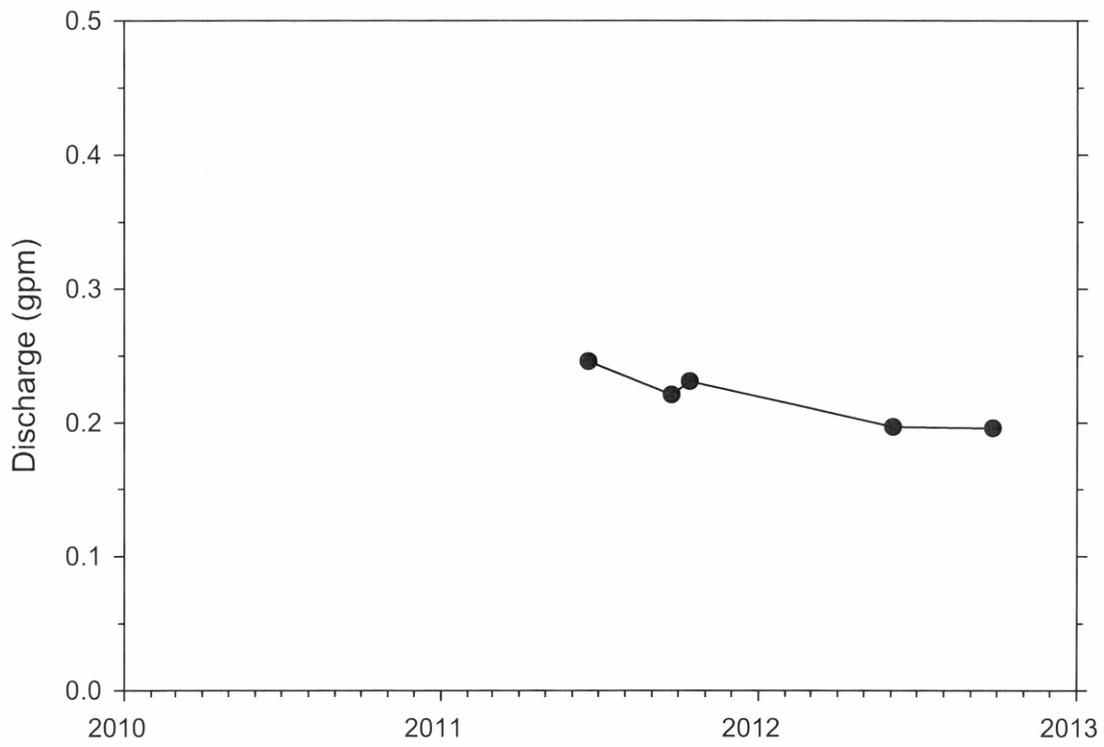
Figure 13 Discharge hydrograph for 006A spring.

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### Roberts Spring



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Figure 14 Discharge hydrograph for Roberts Spring.

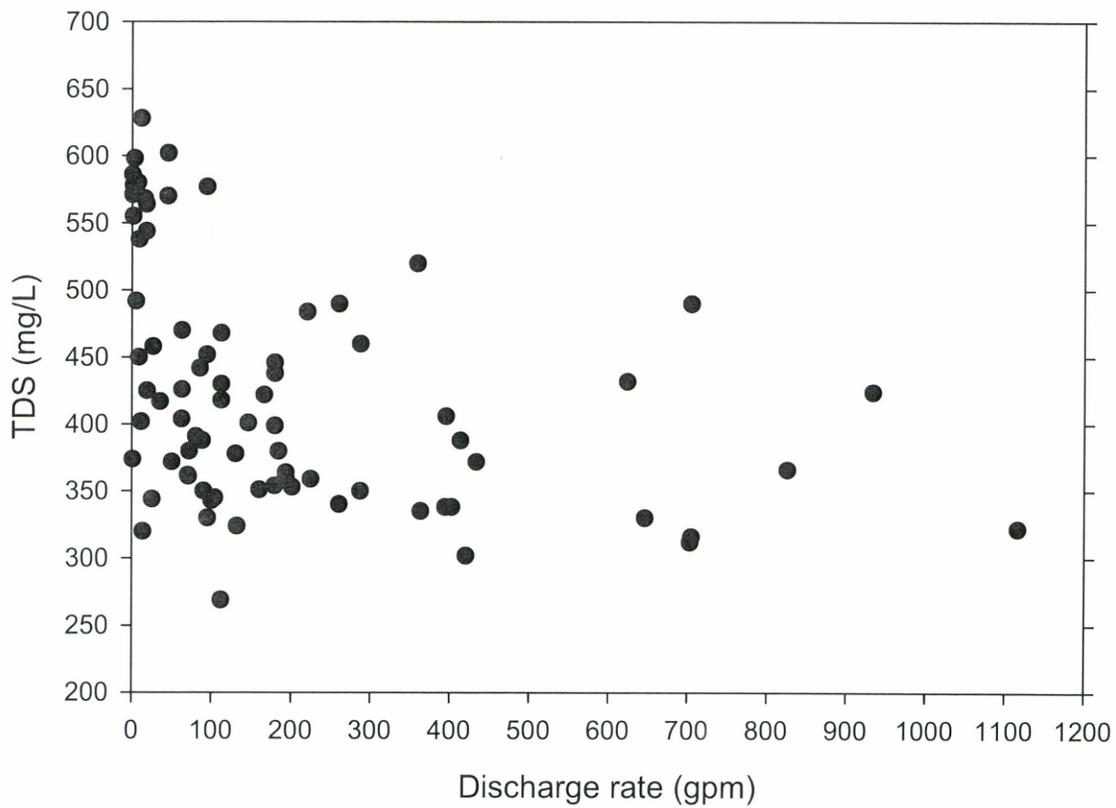


Figure 15 Total dissolved solids concentrations of South Fork Quitchupah Creek water versus stream discharge rate.

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# South Fork Quitchupah Creek (Sufco 006)

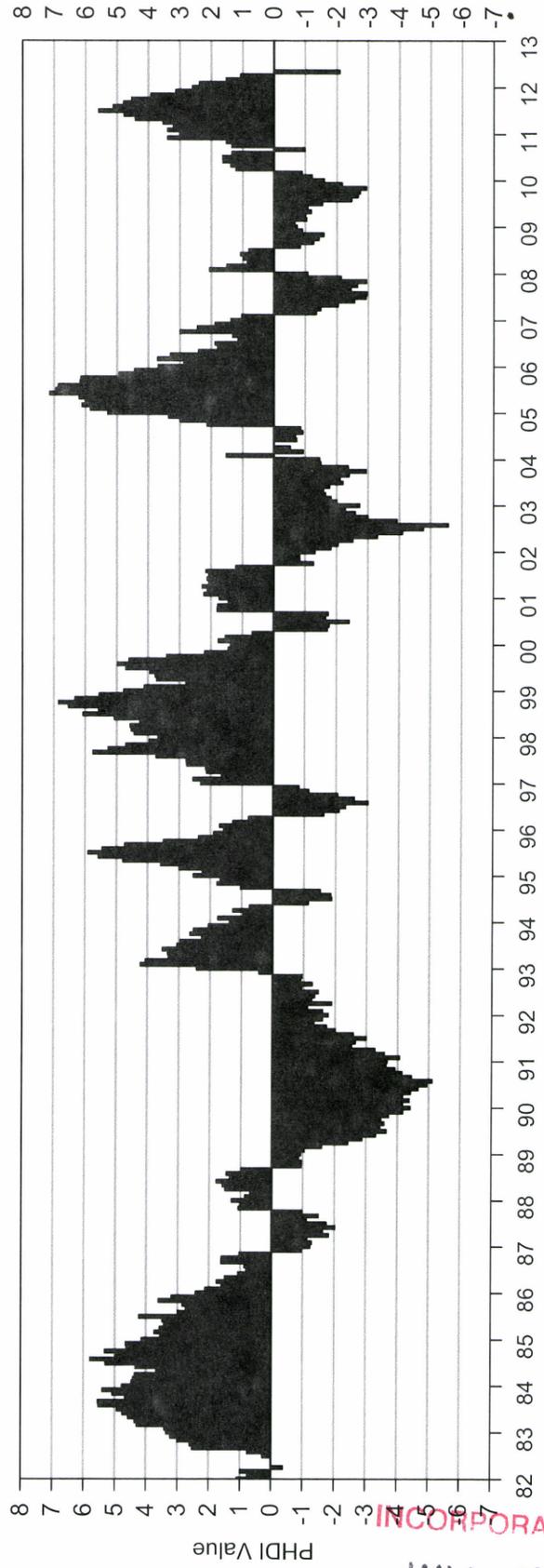
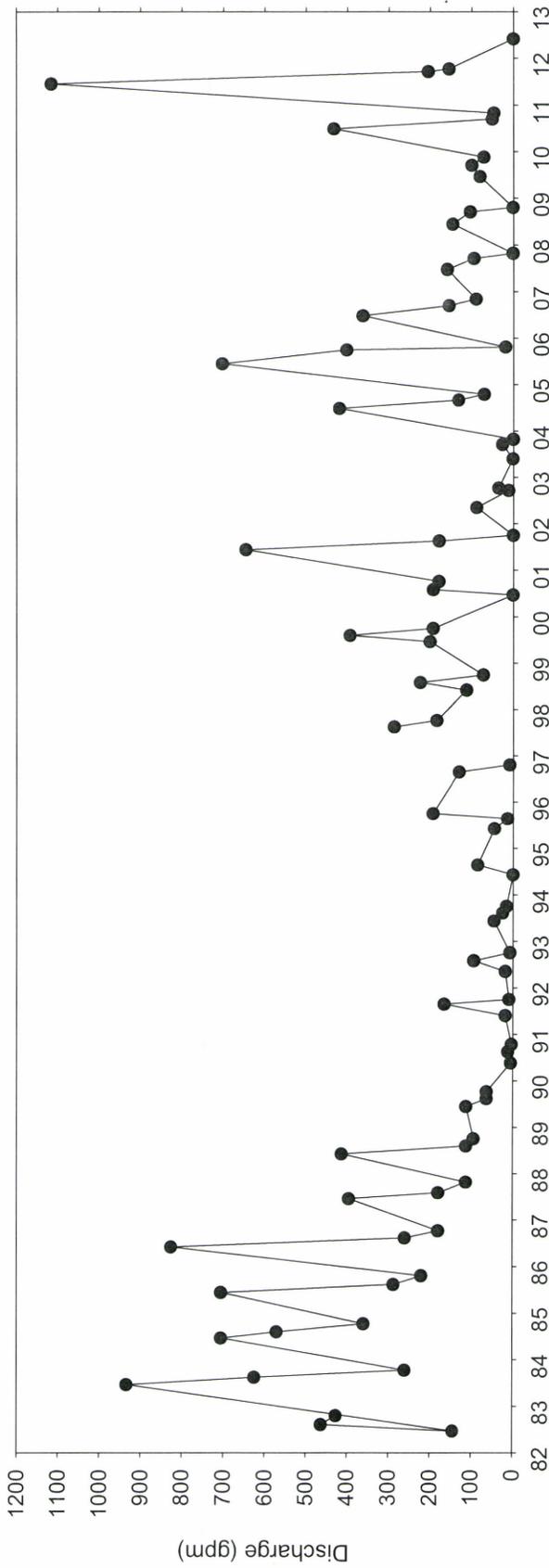


Figure 16 Discharge hydrograph for the South Fork of Quitchupah Creek (Sufco 006) together with plot of Palmer Hydrologic Drought Index (1982-2012).

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Table 1 Baseline monitoring locations for groundwater and surface-water.

Site ID	Location	Location UTM, NAD 27	Geology	Use
<b>Springs</b>				
Sufco 006A Spring	South Fork Quitchupah Creek drainage	462827	Price River Formation	Wildlife/stockwatering
Roberts Spring	South Fork Quitchupah Creek drainage	463270	Price River Formation	Wildlife/stock watering
RS-A	South Fork Quitchupah Creek drainage	463193	Price River Formation	Wildlife/stock watering
RS-B	South Fork Quitchupah Creek drainage	463123	Price River Formation	Wildlife/stock watering
Hansen Seep	South Fork Quitchupah Creek drainage	462514	Price River Formation	Wildlife
94-113	South Fork Quitchupah Creek drainage	463350	Price River Formation	None apparent/wildlife
Wedge Spring	South Fork Quitchupah Creek drainage	464817	Castlegate Sandstone	None apparent/wildlife
Amanda Spring	South Fork Quitchupah Creek drainage	464918	Castlegate Sandstone	None apparent/wildlife
<b>Streams</b>				
Sufco 006	South Fork Quitchupah Creek	463784	Price River Formation	Wildlife/stockwatering
Sufco 006A	South Fork Quitchupah Creek	462900	Price River Formation	Wildlife/stockwatering
Sufco 006B	South Fork Quitchupah Creek	463932	Price River/Castlegate contact area	Wildlife/stockwatering
Sufco 006C	South Fork Quitchupah Creek	464673	Castlegate Sandstone (lower)	Wildlife/stockwatering

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**Table 2 Discharge measurements from the South Fork of Quitchupah Creek, 2007-2012.**

Site ID	Location	Date	Location UTM, NAD 27	Discharge (gpm)	Measurement type*
SFQ-1	Top of Castlegate Sandstone	16-Oct-07	464146 4312827	8.11	1
SFQ-2	Middle of Castlegate Sandstone	16-Oct-07	464578 4312818	5.90	1
SFQ-3	Near Castlegate Sandstone/Blackhawk Contact	16-Oct-07	464941 4312950	6.10	1
SFQ-4	Upper South Fork site	4-Sep-09	460899 4315842	127	2
SFQ-5	USFS Cattle Diversion	4-Sep-09	461073 4315053	215	2
SFQ-6	Flow to Skumpah Diversion	4-Sep-09	461230 4314420	29	2
SFQ-7	Lower South Fork Site	4-Sep-09	462180 4313626	149	2
SFQ-8	Sufco 006A Monitoring Site	4-Sep-09	462900 4312941	166	2
SFQ-9	Sufco 006 Monitoring Site	4-Sep-09	463784 4312810	121	4
SFQ-10	At Castlegate Sandstone contact	12-Oct-09	464116 4312849	66.5	3
SFQ-11	Sufco 006B Monitoring Site	12-Oct-09	463932 4312856	65.2	3
SFQ-12	Sufco 006 Monitoring Site	12-Oct-09	463784 4312810	69.2	3
SFQ-13	Middle Site	12-Oct-09	463575 4312844	69.2	3
SFQ-14	Lower Meadow Area	12-Oct-09	463310 4312861	69.2	3
SFQ-15	Top of Meadow Area	12-Oct-09	463079 4312857	72.0	3
SFQ-16	Sufco 006A Monitoring Site	12-Oct-09	462900 4312941	74.8	3
SFQ-17	Forks Area	12-Oct-09	462769 4313040	72.0	3
SFQ-18	Upper Site	12-Oct-09	462598 4313306	76.3	3
006A	Monitoring site Sufco 006A	17-Jun-11	462900 4312941	1109	2
006B	Monitoring site Sufco 006B	17-Jun-11	463932 4312856	900	2
006C	Monitoring site Sufco 006C	17-Jun-11	464673 4319209	951	2
006A	Monitoring site Sufco 006A	21-Sep-11	462900 4312941	296	2
006B	Monitoring site Sufco 006B	21-Sep-11	463932 4312856	260	2
006C	Monitoring site Sufco 006C	21-Sep-11	464673 4319209	263	2
006A	Monitoring site Sufco 006A	12-Oct-11	462900 4312941	186	2
006B	Monitoring site Sufco 006B	12-Oct-11	463932 4312856	173	2
006C	Monitoring site Sufco 006C	12-Oct-11	464673 4319209	156	2
006A	Monitoring site Sufco 006A	1-Jun-12	462900 4312941	0.95	1
006B	Monitoring site Sufco 006B	1-Jun-12	463932 4312856	0	---
006C	Monitoring site Sufco 006C	1-Jun-12	464673 4319209	0	---
006A	Monitoring site Sufco 006A	12-Sep-12	462900 4312941	59.5	1
006B	Monitoring site Sufco 006B	12-Sep-12	463932 4312856	36.8	1
006C	Monitoring site Sufco 006C	12-Sep-12	464673 4319209	32.4	1
006D	Monitoring site Sufco 006D	12-Sep-12	464673 4312909	50.5	1

\*Measurement Types:

- 1: calibrated container and stopwatch
- 2: Marsh-McBirney electromagnetic current velocity meter and wading rod
- 3: 90-degree v-notch weir
- 4: 12-inch Parshall flume

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Table 3 Discharge and water quality data for South Fork Quitcupah Creek area.

Site	Date	Flow gpm	Water T °C	Cond µS/cm	pH	TDS mg/L	Ca <sup>2+</sup> mg/L	Mg <sup>2+</sup> mg/L	Na <sup>+</sup> mg/L	K <sup>+</sup> mg/L	HCO <sub>3</sub> <sup>-</sup> mg/L	CO <sub>3</sub> <sup>2-</sup> mg/L	SO <sub>4</sub> <sup>2-</sup> mg/L	Cl <sup>-</sup> mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L	
<b>Creeks</b>																			
Sufco 006 (South Fork Quitcupah Creek)	20-Oct-1982	426.4	1	545	8.6										3.00	0.08			0.055
Sufco 006 (South Fork Quitcupah Creek)	12-Aug-1982	462.3	12	510	8.3										2.76	0.075			0.02
Sufco 006 (South Fork Quitcupah Creek)	22-Jun-1982	143.6	12.5	423	7.7										2.88	0.01			0.005
Sufco 006 (South Fork Quitcupah Creek)	21-Jun-1983	934	16	710	8	424	60	35.52	59		400	0	74	36	0.81	0.03	0.065		0.042
Sufco 006 (South Fork Quitcupah Creek)	16-Aug-1983	624	17	680	7.6	432	56	33.6	52.5		371	0	62	4	5.4	0.09	0.045		0.015
Sufco 006 (South Fork Quitcupah Creek)	12-Oct-1983	260	10	750	7.8	490	68	37.92	55	3.5	390	0	87	34	0.25	0.04	0.08		0.07
Sufco 006 (South Fork Quitcupah Creek)	21-Jun-1984	705	11	760	7.7	490	91.6	18.72	66	3.6	416	0	66	36.4	0.07	0.01	0.04		0.03
Sufco 006 (South Fork Quitcupah Creek)	9-Aug-1984	570	18	1,300	7.8	850	64	108	47.8		384	0	405	29.4	1.3	0.07	0.09		0.07
Sufco 006 (South Fork Quitcupah Creek)	11-Oct-1984	359	6	680	8.1	520	64	55.5	60.3		390	0	95	34	0.06	0.23	0.09		0.07
Sufco 006 (South Fork Quitcupah Creek)	13-Jun-1985	705	14	490	8	316	58.8	23.8	40	3.8	256	0	75	14.2	24.6	0.03	0.73		0.01
Sufco 006 (South Fork Quitcupah Creek)	14-Aug-1985	287	13	708	8.4	460	60	32.2	80	3.5	349	0	85	28	0.06	0.01	0.03		0.02
Sufco 006 (South Fork Quitcupah Creek)	22-Oct-1985	220	1	719	8.2	484	77.6	36.5	49.8		329	0	87	24.5	0.56	0.01	0.09		0.05
Sufco 006 (South Fork Quitcupah Creek)	3-Jun-1986	826	16	635	8.35	366	50.4	33.1	38.03		279	0	95	20.3	0.62	0.01	0.07		0.02
Sufco 006 (South Fork Quitcupah Creek)	13-Aug-1986	260	17	622	8.4	340	54.4	34.6	39.82		276	14.4	69	17.2	0.57	0.01	0.05		0.01
Sufco 006 (South Fork Quitcupah Creek)	9-Oct-1986	180	6	742	8.2	446	64.8	33.6	55.2		256	0	80	3.9	1.01	0.02	0.11		0.06
Sufco 006 (South Fork Quitcupah Creek)	18-Jun-1987	395	10	666	8	406	84	18.7	34.72		315	0	77	15	0.26	0.01	0.07		0.05
Sufco 006 (South Fork Quitcupah Creek)	5-Aug-1987	180	18	717	8.2	438	54.8	31.29	34.12		301	0	75	13.7	0.2	0.01	0.08		0.05
Sufco 006 (South Fork Quitcupah Creek)	28-Oct-1987	112	5	635	8.2	418	62.63	33.53	43.53		348	0	80	17.4	0.64	0.01	0.11		0.09
Sufco 006 (South Fork Quitcupah Creek)	7-Jun-1988	413	16	715	7.9	388	114.4	0.1	29.69		316	0	73	11.3	0.3	0.03	0.09		0.05
Sufco 006 (South Fork Quitcupah Creek)	9-Aug-1988	112	17.5	659	8.25	430	115.2	2.88	32.59		301	0	83	32.5	0.68	0.03	0.09		0.03
Sufco 006 (South Fork Quitcupah Creek)	5-Oct-1988	94	15.5	782	7.1	577	156	8.4	38.81		381	0	174	15	0.75	0.03	0.15		0.08
Sufco 006 (South Fork Quitcupah Creek)	14-Jun-1989	112	15.5	798	7.3	468	65.48	32.61	40.05		344	0	18	2.9	0.86	0.2	0.17		0.14
Sufco 006 (South Fork Quitcupah Creek)	15-Aug-1989	63	19.5	759	7.1	470	63.57	27.35	43.68		328	0	84	13.8	1.29	0.03	0.08		0.01
Sufco 006 (South Fork Quitcupah Creek)	9-Oct-1989	63	14	857	7.9	426	63.88	33.32	44.46		374	0	87	2.9	0.67	0.03	0.13		0.08
Sufco 006 (South Fork Quitcupah Creek)	23-May-1990	5	17.4	814	7.6	492	69.76	38.54	66.47		407	0	98	34	0.24	0.03	0.01		0.01
Sufco 006 (South Fork Quitcupah Creek)	20-Aug-1990	12	17.3	973	8.4	628	75.96	43.98	57.21		392	0	102	23.3	0.03	0.03	0.02		0.04
Sufco 006 (South Fork Quitcupah Creek)	15-Oct-1990	3	12.1	964	7.8	598	42.4	23.72	43.46		468	0	93.5	24.8	0.27	0.03	0.06		0.04
Sufco 006 (South Fork Quitcupah Creek)	29-May-1991	18	21.3	912	8.01	564	50.43	43.29	73.15		382	0	115	32.5	0.211	0.505	0.09		0.03
Sufco 006 (South Fork Quitcupah Creek)	27-Aug-1991	166	14.8	434	8.07	422	67.56	33.31	34.62		285	0	100	8.3	0.48	0.05	0.05		0.04
Sufco 006 (South Fork Quitcupah Creek)	3-Oct-1991	9	15.2	893	7.8	538	41.08	44.75	66.96		431	0	100	37	0.06	0	0.03		0.03
Sufco 006 (South Fork Quitcupah Creek)	12-May-1992	18	15.5	686	8.1	544	63.03	48.09	64.77	2.97	399	0	93	26	1.33	0	0.09		0
Sufco 006 (South Fork Quitcupah Creek)	4-Aug-1992	94	17.9	735	7.84	452	52.1	30.1	36.6		262	0	100	11.3	1	0.13	0.04		0.01
Sufco 006 (South Fork Quitcupah Creek)	6-Oct-1992	7	10.7	1,042	8.08	580	80.4	47.4	68.7		358	0	126	35.2	0.08	0.05	0.02		0.02
Sufco 006 (South Fork Quitcupah Creek)	9-Jun-1993	45	18.4	1,032	8.22	602	71.8	41.8	88.2		468	0	101	33.1	0	0	0.05		0.029
Sufco 006 (South Fork Quitcupah Creek)	11-Aug-1993	25	19.7	641	8.36	344	62.3	36.7	24.7		247	6.9	78.9	6.88	0	0	0.023		0.02
Sufco 006 (South Fork Quitcupah Creek)	4-Oct-1993	16	15.4	943	7.95	568	67.4	45	66.7		372	0	112	21.3	0.018	0	0.018		0
Sufco 006 (South Fork Quitcupah Creek)	8-Jun-1994	0	20.8	865	8.44	586	46.7	34.7	71.5		380	0	114	35	0.285	0.03	0.019		0
Sufco 006 (South Fork Quitcupah Creek)	23-Aug-1994	85	20.2	775	8.18	442	77	40	48		278	0	93	13	1.54	0.02	0.06		0.03
Sufco 006 (South Fork Quitcupah Creek)	6-Jun-1995	45	16.1	977	8.07	570	73	35	78	4	420	0	95	33	0.3	0	0		0
Sufco 006 (South Fork Quitcupah Creek)	24-Aug-1995	13	16	578	8.46	320	56	32	18		235	20	73	6	0.3	0	0		0
Sufco 006 (South Fork Quitcupah Creek)	3-Oct-1995	193	12.5	636	8.2	360	57	33	19	1	275	0	66	7	0.2	0	0		0
Sufco 006 (South Fork Quitcupah Creek)	27-Aug-1996	130	15.9	635	8.35	378					317	23	72	8	0.1	<.1	<.1		<.1
Sufco 006 (South Fork Quitcupah Creek)	22-Oct-1996	9	1.02	398	8.28	450					440	<5	81	14	0.3	<.1	<.1		<.1
Sufco 006 (South Fork Quitcupah Creek)	2-Jun-1997		21.53	805	8.3	460					469	<5	86	19	0.9	<.1	<.1		<.1

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Site	Date	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca <sup>2+</sup> mg/L	Mg <sup>2+</sup> mg/L	Na <sup>+</sup> mg/L	K <sup>+</sup> mg/L	HCO <sub>3</sub> <sup>-</sup> mg/L	CO <sub>3</sub> <sup>2-</sup> mg/L	SO <sub>4</sub> <sup>2-</sup> mg/L	Cl <sup>-</sup> mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 006 (South Fork Quitcupah Creek)	18-Aug-1997	287	18.9	574	8.44	350					251	<5	77	5	0.8	<.1	<.1	31
Sufco 006 (South Fork Quitcupah Creek)	8-Oct-1997	184	5.5	629	8.35	380					287	<5	92	9	0.6	<.1	<.1	32
Sufco 006 (South Fork Quitcupah Creek)	4-Jun-1998	112	13.1	901	8.42	269	66	40	72	2	456	<5	95	32	1.1	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	3-Aug-1998	224	22.75	577	8.08	359	55	31	17	2	135	72	70	5	1.4	<.01	<.01	
Sufco 006 (South Fork Quitcupah Creek)	1-Oct-1998	72	11.54	626	8.33	380	54	34	23	2	292	<5	70	9	0.5	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	21-Jun-1999	201	17.3	625	8.19	353	55	33	17	1	290	5	73	5	1.5	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	9-Aug-1999	394	22.04	592	8.3	338	50	31	17	1	273	6	70	5	4.1	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	4-Oct-1999	193	12.11	647	8.3	364	54	32	21	1	275	9	88	6	0.6	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	21-Jun-2000	0.8	15.32	627	8.13	374	53	32	18	1	258	9	94	5	3.7	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	2-Aug-2000	193	21.3	600	8.39	364	51	32	16	2	263	<5	89	4	2.9	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	5-Oct-2000	180	9	747	8.12	399	59	35	34	2	323	<5	90	13	0.5	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	11-Jun-2001	646	17.5	592	8.34	330	53	30	13	<1	237	8	96	3	1.2	<.1	<.1	
Sufco 006 (South Fork Quitcupah Creek)	20-Aug-2001	179	16.3	512	8.76	354	49	31	15	1	232	9	84	3.3	1.5	<.1	<.05	
Sufco 006 (South Fork Quitcupah Creek)	2-Oct-2001	0																
Sufco 006 (South Fork Quitcupah Creek)	8-May-2002	88	10.4	621	8.28	388	63	35	29	2	291	8	107	7	1.9	<.1	<.05	
Sufco 006 (South Fork Quitcupah Creek)	20-Sep-2002	12	16.8	721	8.47	402	63	33	37	3	301	7	107	11	2	<.1	<.05	
Sufco 006 (South Fork Quitcupah Creek)	8-Oct-2002	35	10.8	738	8.2	417	64	35	32	2	297	8	114	10	0.5	<.1	<.05	
Sufco 006 (South Fork Quitcupah Creek)	29-May-2003	0.91	20.9	962	8.42	571	66.1	43.2	80.1	3.77	371	<5	152	34	1.16	0.006	0.013	
Sufco 006 (South Fork Quitcupah Creek)	19-Sep-2003	26	13.5	631	8.53	458	63.4	35.5	28.9	2.25	285	10	108	9	0.447	0.009	0.005	
Sufco 006 (South Fork Quitcupah Creek)	30-Oct-2003	0.13	8.8	1,228	8.58	828	94.7	56.4	110	6.47	549	<5	203	45	0.162	0.008	0.021	
Sufco 006 (South Fork Quitcupah Creek)	26-Jun-2004	420	13	493	8.77	302	50.9	30.4	10.9	1.01	184	16	95	3	1.9	<.03	0.006	
Sufco 006 (South Fork Quitcupah Creek)	1-Sep-2004	132	16.9	529	8.72	324	54	31.7	12.8	1.59	173	21	93	4	0.05	<.03	0.005	
Sufco 006 (South Fork Quitcupah Creek)	15-Oct-2004	70	9.6	593	8.47	362	56.5	31.5	20.2	1.79	218	<5	109	5	0.37	<.03	0.003	
Sufco 006 (South Fork Quitcupah Creek)	13-Jun-2005	703	15.5	523	8.37	312	63	34.8	15.4	2.17	282	<5	82	4	7.64	<.03	<.002	
Sufco 006 (South Fork Quitcupah Creek)	30-Sep-2005	402	12.1	542	8.57	338	52.2	32.6	14.5	1.35	215	16	98	3	0.77	<.03	0.007	
Sufco 006 (South Fork Quitcupah Creek)	24-Oct-2005	19	8.5	719	8.53	425	63.5	34	36.9	1.58	314	<5	93	13	<.05	<.03	0.006	
Sufco 006 (South Fork Quitcupah Creek)	26-Jun-2006	363	16.8	522	8.54	335	56.1	32.7	12.4	1.05	245	<5	77	4	2.93	<.03	<.002	
Sufco 006 (South Fork Quitcupah Creek)	13-Sep-2006	155	14.6	536	8.45	320	52.79	31.18	16.58	1.48	225	10	87	5	1.66	<.03	0.003	
Sufco 006 (South Fork Quitcupah Creek)	4-Nov-2006	90	3.9	591	8.48	350	59.61	34.32	28.01	1.2	281	<5	91	9	0.91	<.03	0.007	
Sufco 006 (South Fork Quitcupah Creek)	25-Jun-2007	160	17.6	543	8.62	351	55.1	33.8	14.3	0.93	244	<5	88	4	3.71	<.03	<.002	
Sufco 006 (South Fork Quitcupah Creek)	19-Sep-2007	95	12.3	515	8.89	330	50.2	33.7	17.1	1.72	128	79	95	4	0.19	<.03	0.003	
Sufco 006 (South Fork Quitcupah Creek)	29-Oct-2007	1	6.1	920	8.72	555	72.06	41.5	65.89	2.5	389	<5	122	25	0.23	<.03	0.007	
Sufco 006 (South Fork Quitcupah Creek)	12-Jun-2008	146	14.9	649	8.65	401	62.72	34.03	26.37	1.38	282	15	90	8	0.95	<.03	0.004	
Sufco 006 (South Fork Quitcupah Creek)	15-Sep-2008	104	11.9	518	8.63	345	56.09	33.36	14.57	1.36	224	<5	92	3	0.2	<.03	0.002	
Sufco 006 (South Fork Quitcupah Creek)	21-Oct-2008	1	7.2	882	8.44	578	81.24	45.53	76.47	3.87	412	<5	134	26	0.1	<.03	0.007	
Sufco 006 (South Fork Quitcupah Creek)	19-Jun-2009	80	16.5	617	8.46	391	65.11	35.56	25.93	1.64	273	27	95	7	2.33	<.03	0.007	
Sufco 006 (South Fork Quitcupah Creek)	17-Sep-2009	100	14.1	531	8.61	343	54.06	32.98	14.37	1.62	212	30	92	3	1.4	0.03	0.007	
Sufco 006 (South Fork Quitcupah Creek)	19-Nov-2009	71	0.3	612	8.39	361	56.79	34.34	21.27	1.83	256	<5	102	5	0.8	<.03	0.004	
Sufco 006 (South Fork Quitcupah Creek)	28-Jun-2010	433	18.8	576	8.43	372	57.6	32.99	14.8	4.21	250	<5	97	3	1.84	<.03	0.004	<0.002
Sufco 006 (South Fork Quitcupah Creek)	15-Sep-2010	50	11.2	532	8.42	372	55.4	31.5	20.4	2.2	297	12	98	4	1.26	0.03	0.034	<0.005
Sufco 006 (South Fork Quitcupah Creek)	1-Nov-2010	62	3.2	585	8.21	404	60.4	32.8	22.2	1.6	261	2	102	5	1.41	0.02	0.048	0.006
Sufco 006 (South Fork Quitcupah Creek)	17-Jun-2011	1116	9.5	525	8.74	322	55.4	29.6	14.2	1.1	275	4	69	4	1.3	<0.02	0.057	<0.005
Sufco 006 (South Fork Quitcupah Creek)	21-Sep-2011	205	11.6	533	8.62	336	53.4	31.3	14.5	1.4	295	7	86	4	1.1	<0.02	0.037	<0.005
Sufco 006 (South Fork Quitcupah Creek)	12-Oct-2011	155	6.4	578	8.62	366	55.7	32.2	17.2	1.5	317	3	88	4	0.59	<0.02	0.024	<0.005
Sufco 006 (South Fork Quitcupah Creek)	1-Jun-2012	0.21	17.5	968	8.43	596	64.3	43.1	84.1	3.9	433	<1	135	27	0.24	<0.02	0.010	<0.005
Sufco 006 (South Fork Quitcupah Creek)	12-Sep-2012	45.3	11.1	557	8.65	338	55.2	34.9	24.4	2.0	246	4	105	5	0.10	<0.02	0.009	<0.005

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Site	Date	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca <sup>2+</sup> mg/L	Mg <sup>2+</sup> mg/L	Na <sup>+</sup> mg/L	K <sup>+</sup> mg/L	HCO <sub>3</sub> <sup>-</sup> mg/L	CO <sub>3</sub> <sup>2-</sup> mg/L	SO <sub>4</sub> <sup>2-</sup> mg/L	Cl <sup>-</sup> mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 006A	28-Jun-2010	500	16.8	538	8.51	360	56.93	32.42	12.89	1.54	224	13	95	2	1.27	<0.03	0.072	<0.002
Sufco 006A	15-Sep-2010	51	11.7	529	8.44	366	48.3	29	16.1	2.6	296	7	99	4	0.58	0.02	0.023	0.008
Sufco 006A	1-Nov-2010	82	3.4	560	8.22	362	53.5	29.8	17.8	1.3	251	2	101	4	0.72	0.02	0.039	0.013
Sufco 006A	17-Jun-2011	1109	9.5	512	8.77	312	56.1	30.1	13.2	1.0	267	4	68	4	0.58	<0.02	0.035	<0.005
Sufco 006A	21-Sep-2011	296	11.7	524	8.68	348	47.5	28.8	12.0	1.1	293	8	86	3	0.78	<0.02	0.031	<0.005
Sufco 006A	12-Oct-2011	186	7.9	558	8.60	342	54.0	31.6	15.3	1.3	307	2	86	4	0.32	<0.02	0.019	<0.005
Sufco 006A	1-Jun-2012	0.95	14.3	1,182	8.50	776	64.7	37.0	151	2.5	506	4	183	47	0.74	<0.02	0.016	0.006
Sufco 006A	12-Sep-2012	59.5	11.8	547	8.56	356	45.2	28.8	18.9	1.4	243	4	103	4	0.13	<0.02	0.014	<0.005
Sufco 006B	19-Oct-2009	65																
Sufco 006B	28-Jun-2010	433	18.5	553	8.45	375	58.18	33.19	14.68	1.8	234	<5	96	3	2.21	<0.03	0.117	<0.002
Sufco 006B	15-Sep-2010	39	11.1	537	8.47	376	49.7	28.3	17.8	1.7	296	12	99	4	1.09	0.02	0.027	<0.005
Sufco 006B	1-Nov-2010	73	3.0	585	8.17	396	56.9	30.8	21.8	1.6	261	3	101	5	1.17	0.02	0.038	0.006
Sufco 006B	17-Jun-2011	900	9.8	519	8.74	328	55.1	29.5	14.4	1.1	277	4	69	4	1.64	<0.02	0.059	<0.005
Sufco 006B	21-Sep-2011	260	11.5	537	8.64	356	50.3	29.6	13.2	1.1	302	8	87	3	1.2	<0.02	0.038	<0.005
Sufco 006B	12-Oct-2011	173	6.3	583	8.61	370	55.1	32.1	16.8	1.5	319	3	87	4	0.63	<0.02	0.023	<0.005
Sufco 006B	1-Jun-2012	0																
Sufco 006B	12-Sep-2012	36.8	11.5	555	8.66	390	52.5	31.3	20.9	1.9	247	4	104	5	0.36	<0.02	0.013	<0.005
Sufco 006C	17-Jun-2011	951	10.9	511	8.84	300	54.1	28.4	13.9	1.1	272	5	68	4	2.43	0.06	0.195	0.008
Sufco 006C	21-Sep-2011	263	7.9	533	8.71	350	50.9	30.0	13.2	1.2	306	5	86	3	1.47	<0.02	0.042	<0.005
Sufco 006C	12-Oct-2011	156	3.8	583	8.86	384	58.4	33.6	17.5	1.5	319	5	87	4	0.53	<0.02	0.015	<0.005
Sufco 006C	1-Jun-2012	0																
Sufco 006C	12-Sep-2012	32.4	11.4	548	8.58	364	48.9	30.2	20.5	2.0	254	5	102	5	0.83	<0.02	0.025	<0.005
Sufco 006D	12-Sep-2012	50.5	10.9	582	8.67	366	49.8	30.0	24.4	1.9	262	5	105	8	0.083	<0.02	0.024	<0.005
<b>Springs</b>																		
Sufco 006A Spring	28-Jun-2010	0.28	5.3	1,302	7.39													
Sufco 006A Spring	15-Sep-2010	0.19	6.5	1,255	7.29													
Sufco 006A Spring	1-Nov-2010	0.27	5.6	1,227	7.17	832	63.2	24.8	205	3.4	605	<1	151	37	0.59	<0.02	0.012	<0.005
Sufco 006A Spring	17-Jun-2011	0.44	4.5	1,261	7.66	796	59.3	23.4	206	3.3	644	<1	150	38	0.14	<0.02	<0.005	<0.005
Sufco 006A Spring	21-Sep-2011	0.30	6.5	1,277	7.47	816	59.6	23.3	190	3.4	713	<1	135	36	0.09	<0.02	<0.005	<0.005
Sufco 006A Spring	12-Oct-2011	0.37	6.1	1,298	7.68													
Sufco 006A Spring	1-Jun-2012	0.39	4.4	1,263	7.36	800	62.1	24.8	207	3.4	629	<1	137	37	0.29	<0.02	<0.005	<0.005
Sufco 006A Spring	12-Sep-2012	0.18	7.1	1,216	7.56	772	42.8	21.4	204	3.3	640	<1	130	34	0.4	<0.02	0.005	<0.005
Roberts Spring	17-Jun-2011	0.246	4.2	1,023	7.54													
Roberts Spring	21-Sep-2011	0.221	6.7	1,126	7.46													
Roberts Spring	12-Oct-2011	0.231	6.5	1,130	7.54													
Roberts Spring	1-Jun-2012	0.197	4.7	1,125	7.60	658	78.4	27.7	113	3.5	496	<1	145	41	0.47	<0.02	0.011	<0.005
Roberts Spring	26-Sep-2012	0.196	7.2	1,104	7.44													
RS-A	1-Jun-2012	0.077	7.5	1,145	7.81													
RS-A	23-Sep-2012	<0.25	7.2	1,098	7.84													
RS-B	1-Jun-2012	<0.05	8.8	1,139	7.83													
RS-B	23-Sep-2012	<0.05	8.6	1,076	7.74													

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Site	Date	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca <sup>2+</sup> mg/L	Mg <sup>2+</sup> mg/L	Na <sup>+</sup> mg/L	K <sup>+</sup> mg/L	HCO <sub>3</sub> <sup>-</sup> mg/L	CO <sub>3</sub> <sup>2-</sup> mg/L	SO <sub>4</sub> <sup>2-</sup> mg/L	Cl <sup>-</sup> mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L	
94-113	23-Apr-2012	0.1 (est)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
94-113	1-Jun-2012	0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Hansen Seep	23-Apr-2012	0.356	11.3	1,489	7.63	974	124	38.4	158	3.3	501	<1	228	118	1.06	0.48	0.277	0.279	
Hansen Seep	12-Sep-2012	0.108	13.7	1,370	7.79	948	117	38.2	163	2.9	505	<1	225	116	0.27	<0.02	0.19	<0.005	
The Wedge Spring	28-Aug-2012	4.62	6.2	701	7.20	428	56.2	25.6	42.1	2.3	285	2	105	29	0.1	<0.02	0.005	<0.005	
The Wedge Spring	12-Sep-2012	4.45	6.4	707	7.59	428	56.2	25.6	42.1	2.3	285	2	105	29	0.1	<0.02	0.005	<0.005	
Amanda Spring	12-Sep-2012	0.295	7.2	532	7.55	342	47.1	20.4	32.2	2.2	230	<1	67	22	0.07	<0.02	0.005	<0.005	
<b>In-Mine groundwaters</b>																			
2S Bleeder	16-Dec-2011	5 est.	13.7	536	7.66	308	61.1	27.6	19.6	1.9	276	<1	49	14	0.42	<0.02			
2R2S	16-Dec-2011	50 est.	12.6	570	7.75	304	65.3	27.9	10.0	1.9	258	<1	57	12	0.14	<0.02			
1R2L E1XC45 Fault	23-Feb-2012	500 est.	12.8	688	7.54	466	74.1	28.4	19.9	1.8	320	<1	101	15	0.63	<0.02	0.017	0.014	

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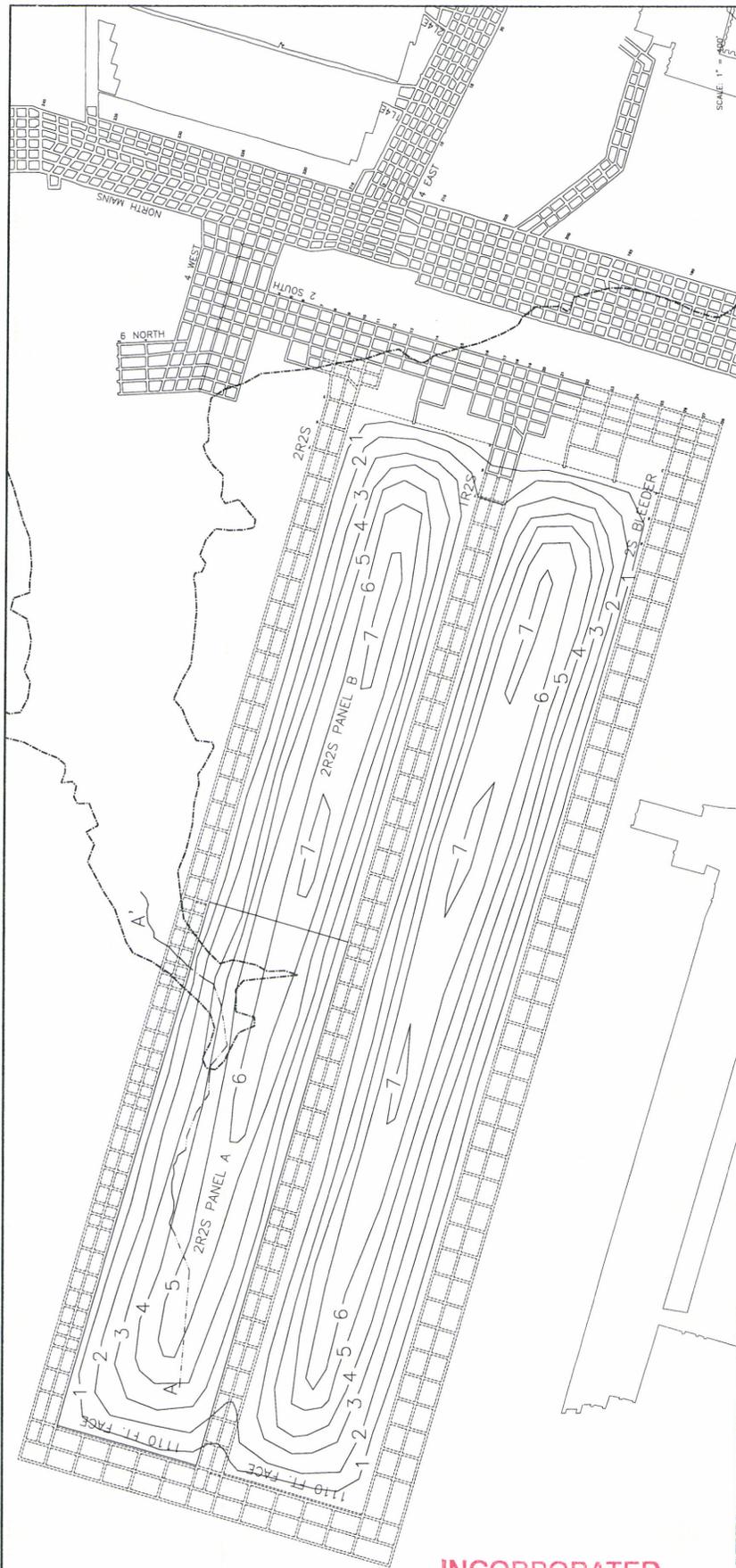
Table 4 Tritium contents of Sufco Mine groundwaters near the South Fork of Quitichupah Creek.

Site	Date	Tritium ( <sup>3</sup> H) TU	eTU
2 Right 2 South (fracture)	16-Dec-11	-0.01	0.09
2 South Bleeder 16	16-Dec-11	0.09	0.09
1RT 2STH E1XC45 Fault	23-Feb-12	0.00	0.09

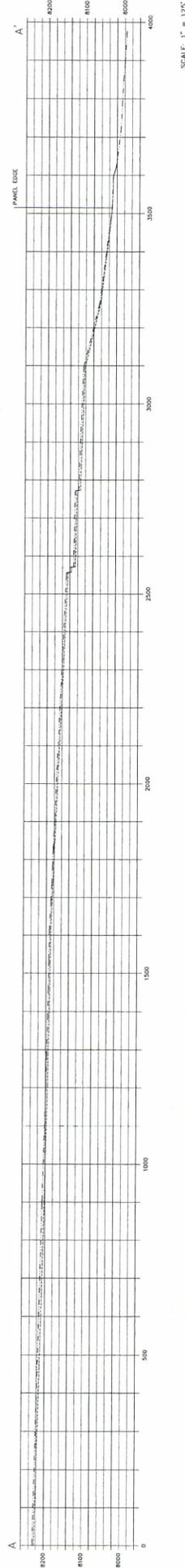
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- LEGEND**
- CONCEPTUAL SUBSIDENCE CONTOUR
  - EXISTING STREAM CHANNEL
  - CONCEPTUAL SUBSIDED STREAM CHANNEL

REVISIONS		REMARKS
NO.	DATE	REC'D BY (ING. BY)

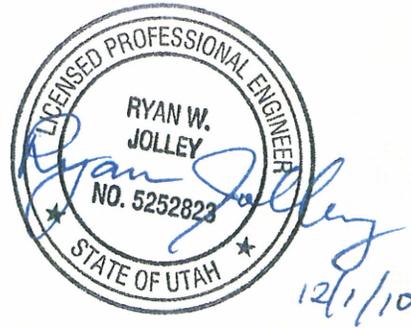
**California First Company, LLC**  
**SIFFCO Mine**  
 597 South St., W. Aurora, CT 04454  
 (435) 286-4458 Fax

**2 SOUTH LONGWALL DISTRICT**  
**CHANNEL PROFILE/CONCEPTUAL SUBSIDENCE**

SCALE	DATE	DRAWN BY	CHECKED BY	PROJECT NO.
1" = 125'	07/21/09	JAM	JAM	5
H:\SPRINGFIELD\2 South\Channel\subP19a.dwg				

December 1, 2010

Canyon Fuel Company, LLC  
 SUFCO Mine  
 597 South SR24  
 Salina, UT 84654



Attn: Leland Roberts

Subject: Permeability Summary for South Fork Quitcupah Creek near Duncan Mtn.

Hydraulic conductivity, also called permeability, is a measure of continuous voids. It is not enough for a soil to have large voids. The voids must also be connected for water to flow through them. A permeable material permits a significant flow of water.

Sands and gravels are pervious while clays are considered relatively impervious.

Table 1: Typical Hydraulic Conductivities

Soil	Coefficient of Permeability, K, cm/sec	Degree of Permeability
Gravel	$> 10^{-1}$	Very High
Sandy Gravel, Clean Sand, Fine Sand	$10^{-1} > k > 10^{-3}$	High to Medium
Sand, Dirty Sand, Silty Sand	$10^{-3} > k > 10^{-5}$	Low
Silt, silty clay	$10^{-5} > k > 10^{-7}$	Very Low
Clay	$> 10^{-7}$	Virtually Impermeable

Knowing the coefficient of permeability of a soil can assist in determining how much water will flow through a layer of that soil. Darcy's Law, which describes the flow of a fluid through porous medium, enables this calculation.

$$Q = KiA$$

Where:

Q = flow rate

K = hydraulic conductivity

i = hydraulic gradient where  $i = dh/dL$  for vertical flow

dh = depth from the water surface elevation to the base of the soil layer in question

dL = thickness of the soil layer

A = surface area of the soil layer

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MATERIALS TESTING

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1535 South 100 West Richfield, Utah 84701 435.896.8266 435.896.8268 fax

1675 South Highway 10 Price, Utah 84501 435.637.8266 435.637.8268 fax

www.jonesanddemille.com

Example: A stream flowing 6 inches deep is 1-foot wide and ½ mile long. The amount of water seeping through a 2-foot thick stream bed that has a hydraulic conductivity of  $2.5 \times 10^{-7}$  cm/s is determined by:

$$Q = \left(2.5 \times 10^{-7} \frac{cm}{s}\right) \left(\frac{2 \text{ ft} + 6 \text{ inches}}{2 \text{ ft}}\right) (1 \text{ foot} \times 0.50 \text{ miles})$$

$$Q = 2.71 \times 10^{-5} \text{ ft}^3 \text{ per second (cfs)}$$

If the thickness of the stream bed were increased to 10 feet, then  $2.27 \times 10^{-5}$  cfs would seep through the layer. The amount of water flowing through a layer of material depends more on hydraulic conductivity and water depth than it does the thickness of the layer.

At the request of Canyon Fuel Company's Sufco Mine, Jones and DeMille Engineering, Inc. performed 4 separate hydraulic conductivity tests along a section of the South Fork of Quitchupah Creek. These tests were completed using a single ring infiltrometer. The single ring infiltrometer test gives the results for a soil's field-saturated hydraulic conductivity. The results of these tests are presented in Table 2. Samples taken at each of the sites were tested to determine the Atterberg Limits (liquid limit LL, and plasticity index PI) and the classifications of the soils. The results of each of the tests are also included in Table 2.

Table 2: Measured Hydraulic Conductivity

Site	Field-Saturated Hydraulic Conductivity (cm/s)	USCS Classification	Atterberg Limits (LL/PI)
Site 1	$2.45 \times 10^{-7}$	CL	31/11
Site 2	$1.40 \times 10^{-7}$	CL	35/15
Site 3	$2.27 \times 10^{-7}$	CL	31/10
Site 4	$2.36 \times 10^{-7}$	CH	57/31

The soil in each of these locations was found to be nearly impermeable with hydraulic conductivities representative of clay soils. The thickness of the soil layer in each location was found to be in excess of 2 feet thick and estimated to be at least several feet thick. The very low hydraulic conductivity rates in conjunction with the shallow stream depth indicate that there is very minimal seepage from the creek into subsurface layers below the tested sites.

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# FIELD PERMEABILITY TEST

JONES & DEMILLE ENGINEERING  
 1535 SOUTH 100 WEST  
 Richfield, Utah 84701  
 435-896-8266 Fax 435-896-0282

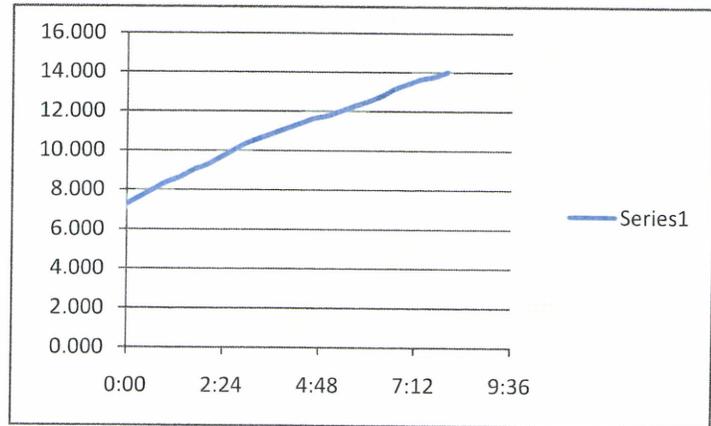
Project Name Sufco Mine Permeability Tests Date November 1, 2010  
 Project Number 1008-167 Test Number 1  
 Test Location South Fork Quitchumpah, Creek 1 is furthest east, 4 is furthest west.  
 Test Notes 1:30 pm to 3:30 pm, temp 56 degrees F

### TEST DATA

	inches	cm
Depth to Wet Front, L	0.375	0.9525
Radius of Measuring Tube, Rt	0.13	0.3302
Radius of Permeameter Ring, Rr	5.06	12.8524
Height of Water, Ht	72	182.88

### TIMED WATER DROP READINGS

min:sec	inches	min:sec	inches
0:00	7.250	4:20	11.375
0:20	7.625	4:40	11.625
0:40	8.000	5:00	11.75
1:00	8.375	5:20	12
1:20	8.625	5:40	12.25
1:40	9.000	6:00	12.5
2:00	9.250	6:20	12.75
2:20	9.625	6:40	13.125
2:40	10.000	7:00	13.375
3:00	10.375	7:20	13.625
3:20	10.625	7:40	13.75
3:40	10.875	8:00	14
4:00	11.125		

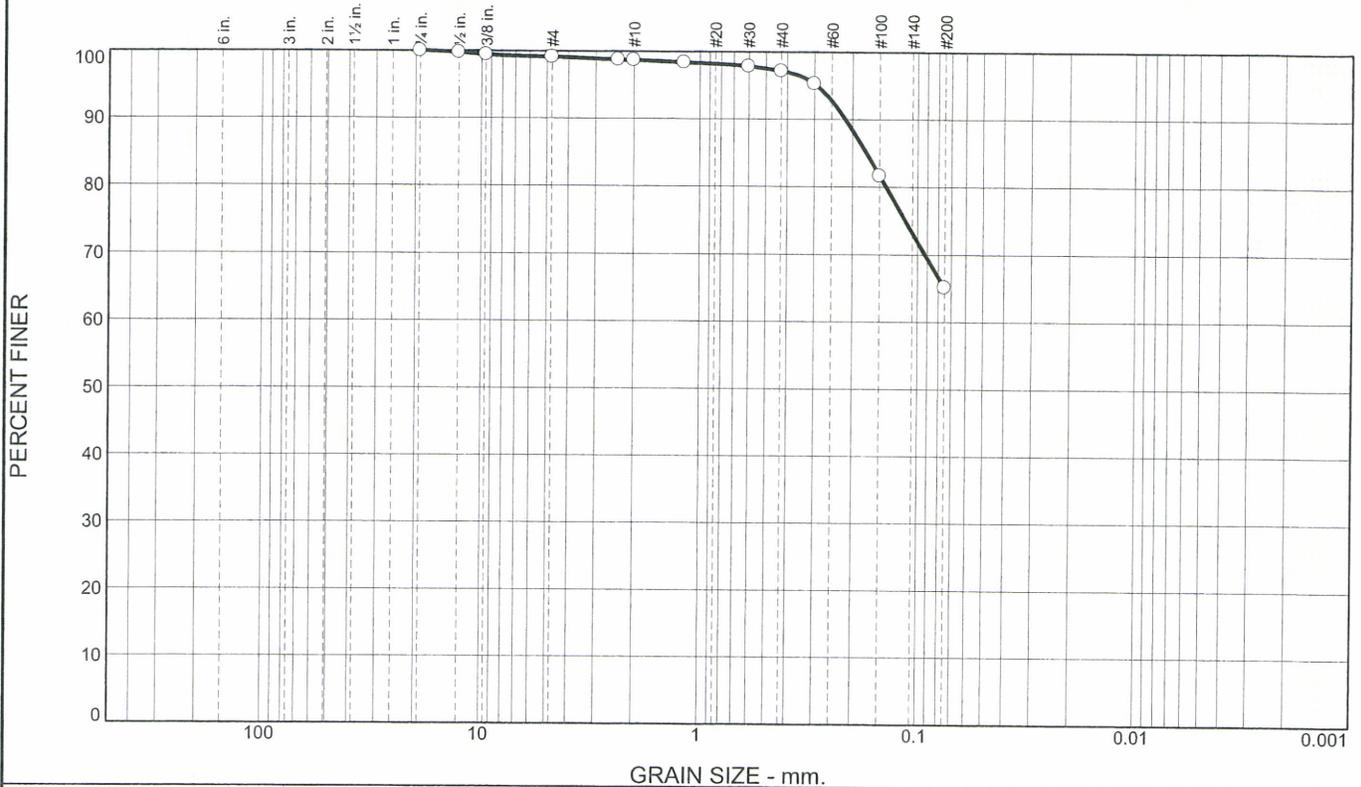


### RESULTS

	in/min	cm/sec
Change in Head/Time, dH/dT	0.84	0.035719
Ks	NA	2.45E-07

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# Particle Size Distribution Report





# FIELD PERMEABILITY TEST

JONES & DEMILLE ENGINEERING  
 1535 SOUTH 100 WEST  
 Richfield, Utah 84701  
 435-896-8266 Fax 435-896-0282

Date November 1, 2010

Project Name Sufco Mine Permeability Tests  
 Project Number 1008-167 Test Number 2  
 Test Location South Fork Quitchumpah, Creek 1 is furthest east, 4 is furthest west.  
 Test Notes 1:30 pm to 3:30 pm, temp 56 degrees F

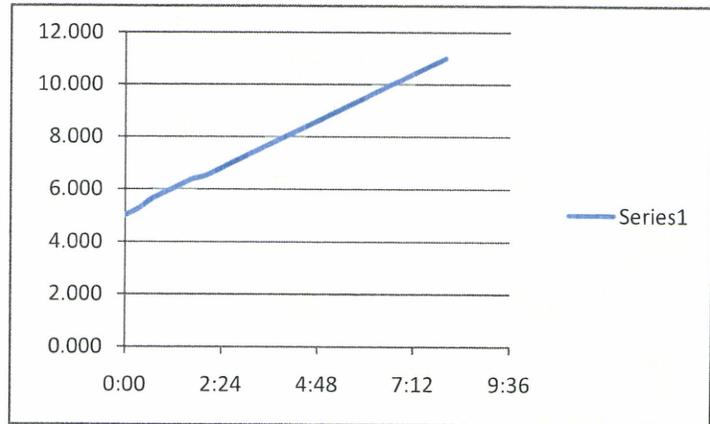
### TEST DATA

inches      cm

Depth to Wet Front, L	0.25	0.635
Radius of Measuring Tube, Rt	0.13	0.3302
Radius of Permeameter Ring, Rr	5.06	12.8524
Height of Water, Ht	74.5	189.23

### TIMED WATER DROP READINGS

min:sec	inches	min:sec	inches
0:00	5.000	4:20	8.25
0:20	5.250	4:40	8.5
0:40	5.625	5:00	8.75
1:00	5.875	5:20	9
1:20	6.125	5:40	9.25
1:40	6.375	6:00	9.5
2:00	6.500	6:20	9.75
2:20	6.750	6:40	10
2:40	7.000	7:00	10.25
3:00	7.250	7:20	10.5
3:20	7.500	7:40	10.75
3:40	7.750	8:00	11
4:00	8.000		



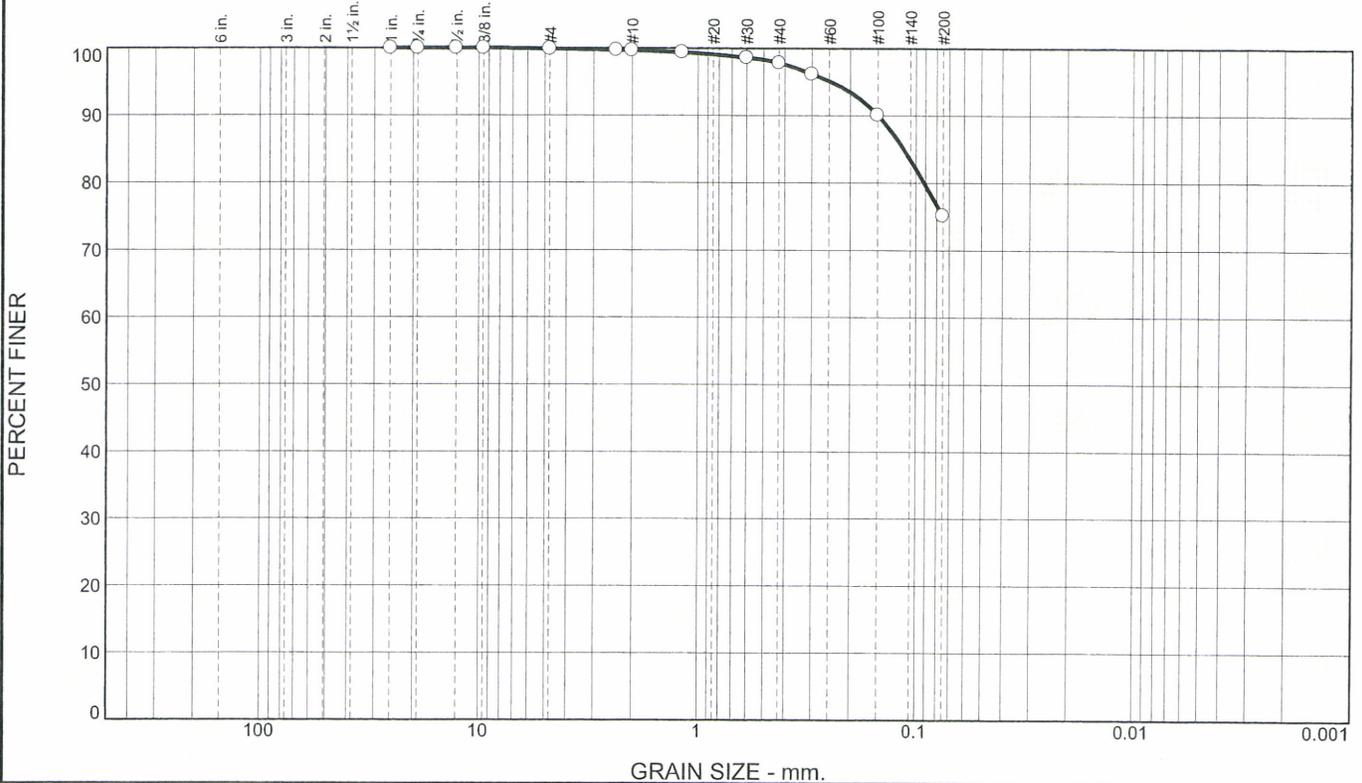
### RESULTS

in/min      cm/sec

Change in Head/Time, dH/dT	0.75	0.03175
Ks	NA	1.4E-07

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# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.2	1.9	22.7	75.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.9		
#8	99.7		
#10	99.7		
#16	99.4		
#30	98.6		
#40	97.8		
#50	96.1		
#100	90.1		
#200	75.1		

**Material Description**

Native Clays and top soil lean clay with sand

PL= 20	<b>Atterberg Limits</b>	LL= 35	PI= 15
D <sub>90</sub> = 0.1491	<b>Coefficients</b>	D <sub>85</sub> = 0.1139	D <sub>60</sub> =
D <sub>50</sub> =		D <sub>30</sub> =	D <sub>15</sub> =
D <sub>10</sub> =		C <sub>u</sub> =	C <sub>c</sub> =

USCS= CL      **Classification**      AASHTO= A-6(10)

**Remarks**

F.M.=0.16

\* (no specification provided)

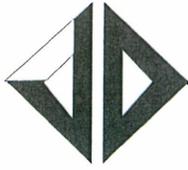
Location: Native Clay Sample #2  
 Sample Number: S-1108b

Date: 11/12/10

<b>JONES &amp; DEMILLE ENGINEERING INC. Richfield, Utah</b>	Client: Sufco mine Project: Sufco mine Project No: 1008-167	<div style="color: red; font-weight: bold; font-size: 1.2em;">INCORPORATED</div> <div style="font-size: 1.5em; font-weight: bold;">JAN 16 2013</div> <div style="color: red; font-weight: bold; font-size: 1.2em;">Div. of Oil, Gas &amp; Mining</div>
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Tested By: Steve and Kent

Checked By: Steve R Gossard



# FIELD PERMEABILITY TEST

JONES & DEMILLE ENGINEERING  
 1535 SOUTH 100 WEST  
 Richfield, Utah 84701  
 435-896-8266 Fax 435-896-0282

Date November 2, 2010

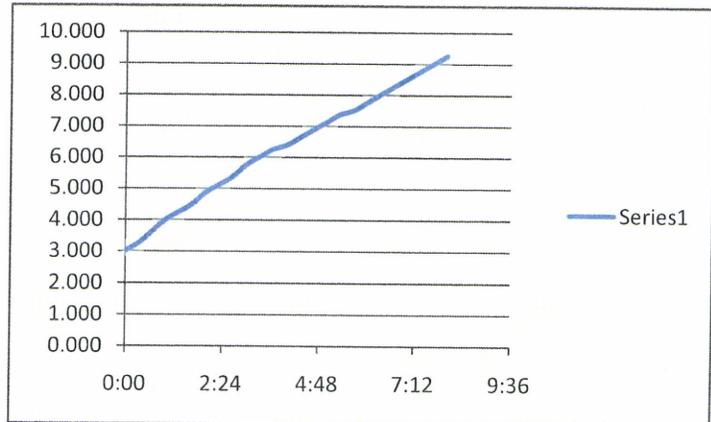
Project Name Sufco Mine Permeability Tests  
 Project Number 1008-167 Test Number 3  
 Test Location South Fork Quitchumpah, Creek 1 is furthest east, 4 is furthest west.  
 Test Notes 2:15 pm to 6:15 pm, temp 53 degrees F

## TEST DATA

	inches	cm
Depth to Wet Front, L	0.375	0.9525
Radius of Measuring Tube, Rt	0.13	0.3302
Radius of Permeameter Ring, Rr	5.06	12.8524
Height of Water, Ht	72	182.88

## TIMED WATER DROP READINGS

min:sec	inches	min:sec	inches
0:00	3.000	4:20	6.625
0:20	3.250	4:40	6.875
0:40	3.625	5:00	7.125
1:00	4.000	5:20	7.375
1:20	4.250	5:40	7.5
1:40	4.500	6:00	7.75
2:00	4.875	6:20	8
2:20	5.125	6:40	8.25
2:40	5.375	7:00	8.5
3:00	5.750	7:20	8.75
3:20	6.000	7:40	9
3:40	6.250	8:00	9.25
4:00	6.375		



## RESULTS

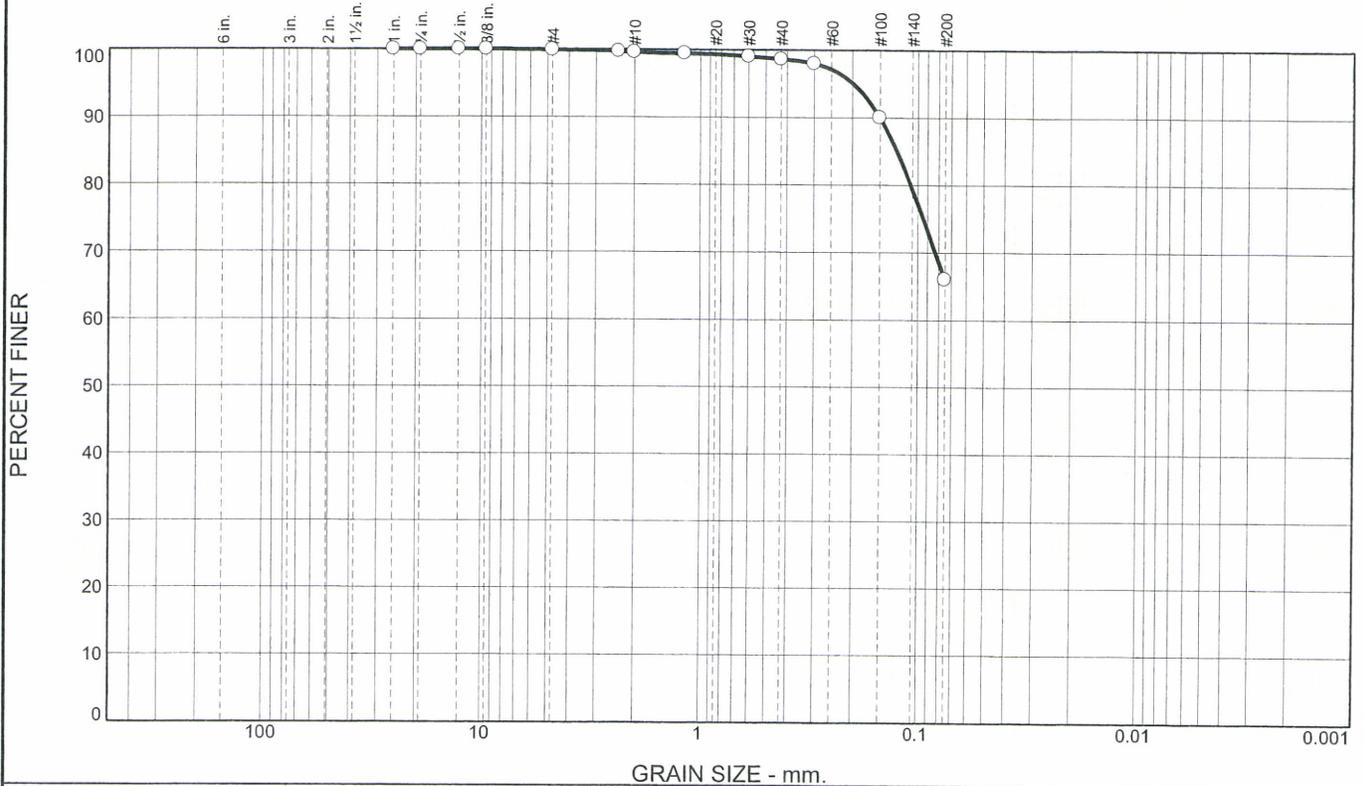
	in/min	cm/sec
Change in Head/Time, dH/dT	0.78	0.033073
Ks	NA	2.27E-07

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# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.3	1.0	32.6	66.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.9		
#8	99.7		
#10	99.6		
#16	99.4		
#30	99.0		
#40	98.6		
#50	98.0		
#100	90.0		
#200	66.0		

**Material Description**

Native Clays and top soil: sandy lean clay

PL= 21	<b>Atterberg Limits</b>	LL= 31	PI= 10
D <sub>90</sub> = 0.1499	<b>Coefficients</b>	D <sub>85</sub> = 0.1251	D <sub>60</sub> =
D <sub>50</sub> =	D <sub>30</sub> =	D <sub>15</sub> =	
D <sub>10</sub> =	C <sub>u</sub> =	C <sub>c</sub> =	

USCS= CL      **Classification**      AASHTO= A-4(5)

**Remarks**

F.M.=0.14

\* (no specification provided)

Location: Naive Clay Sample #3  
 Sample Number: S-1108c

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Date: 11/12/10

**JONES & DEMILLE  
 ENGINEERING INC.  
 Richfield, Utah**

Client: Sufco mine  
 Project: Sufco mine

JAN 16 2013

Project No: 1008-167

Div. of Oil, Gas & Mining

Figure

Tested By: Steve G

Checked By: Steve R Gossard



# FIELD PERMEABILITY TEST

JONES & DEMILLE ENGINEERING  
 1535 SOUTH 100 WEST  
 Richfield, Utah 84701  
 435-896-8266 Fax 435-896-0282

Date November 2, 2010

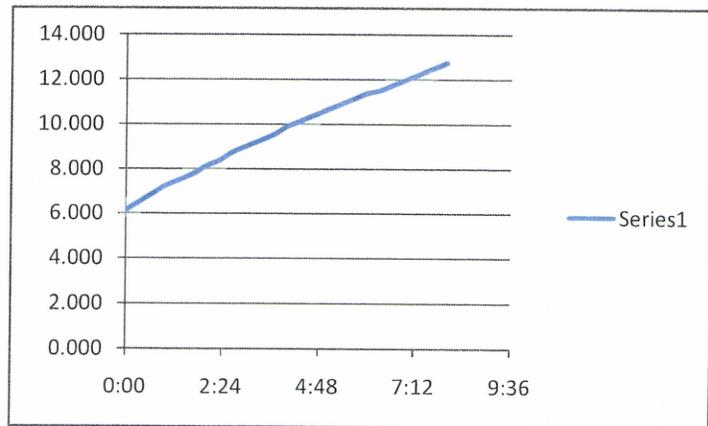
Project Name Sufco Mine Permeability Tests  
 Project Number 1008-167 Test Number 4  
 Test Location South Fork Quitchumpah, Creek 1 is furthest east, 4 is furthest west.  
 Test Notes 2:00 pm to 6:00 pm, temp 53 degrees F

### TEST DATA

	inches	cm
Depth to Wet Front, L	0.375	0.9525
Radius of Measuring Tube, Rt	0.13	0.3302
Radius of Permeameter Ring, Rr	5.06	12.8524
Height of Water, Ht	73.25	186.055

### TIMED WATER DROP READINGS

min:sec	inches	min:sec	inches
0:00	6.125	4:20	10.125
0:20	6.500	4:40	10.375
0:40	6.875	5:00	10.625
1:00	7.250	5:20	10.875
1:20	7.500	5:40	11.125
1:40	7.750	6:00	11.375
2:00	8.125	6:20	11.5
2:20	8.375	6:40	11.75
2:40	8.750	7:00	12
3:00	9.000	7:20	12.25
3:20	9.250	7:40	12.5
3:40	9.500	8:00	12.75
4:00	9.875		



### RESULTS

	in/min	cm/sec
Change in Head/Time, dH/dT	0.83	0.035057
Ks	NA	2.36E-07

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