ENERGY WEST
MINING COMPANY
A SUBSIDIARY OF PACIFICORP

C/015/0018
Received 1/13/15
Task ID #4782

Energy West Mining Company
P. O. Box 310
15 No Main Street
Huntington, Utah 84528

January 13, 2015

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

Subj: Deficiency Response to the Amendment to Transfer Cottonwood Creek Canyon Wells from the Deer Creek Mine Monitoring to the Trail Mountain Mine Water Monitoring Program, PacifiCorp, Deer Creek Mine C/015/0018, Trail Mountain Mine C/015/0009, Emery County, Utah, Task ID 4762.

PacifiCorp, by and through its wholly-owned subsidiary, Energy West Mining Company "Energy West" as mine operator, hereby submits a deficiency response to Task ID #4762 in which Energy West requests to transfer the six Cottonwood Creek Canyon wells from the Deer Creek Mine to the Trail Mountain Mine.

The original amendment was submitted on December 12, 2014. The following lists the Division's deficiency followed by the permittee's response.

Deficiency

General Contents

The application does meet the minimum Permit Application Format and Contents requirement of being clear and concise R645-301-121. Two edits are necessary for the Trail Mountain Water Monitoring Program table to clean it up and make it more easily understood. 1) The UPDES point for the Trail Mountain Mine Discharge should be UT-0023728-002 it is currently referenced as UT-0023728-001. 2) The (*) symbol next to "Level Only" in the REMARKS column for the six wells being added should be removed if they are not referencing a disclaimer or comment.

Response

1) The edits to the table have been made to more clearly and correctly identify the UPDES discharge points.

2) The permittee inadvertently left the comment to the (*) next to "Level Only" off the table. The comment is now shown at the bottom of the table.

Deficiency

Bonding and Insurance General

The application does not meet the minimum bonding requirements to File a Bond with a Determination of Bond Amount per the Division's rules R645-301-820 and R645-301-830. A reclamation bond needs to be posted for the five wells to cover the Permanent Casing and Sealing of Wells per R645-301-765.

Response

The permittee disagrees with the Division's determination for the posting of a reclamation bond to cover the wells developed 22 years ago in 1992. The wells were developed to monitor the potential effects of the mine on the groundwater regime near the Roans Canyon Fault. As required by the Coal Regulations on bonding requirements:

R645-301-820.110: The areas to be covered by the Performance Bond are:

R645-301-820.111: The bond or bonds will cover the entire permit area, or an identified increment of land within the permit area upon which the operator will initiate and conduct coal mining and reclamation operations during the initial term of the permit.

Well construction does not adhere to the definition "coal mining and reclamation operations." Part (a) of the definition in R645-100-200 points to specific activities; i.e. contour, strip, auger, montaintop removal, etc. The wells were not constructed utilizing any of these activities, nor were they developed within the

permit area boundary. Part (b) of the definition directs that the areas upon which the activities described under part (a) of the definition occur or where such activities disturb the natural surface of the land…

PacifiCorp maintains that the definitions of "coal mining and reclamation operations" do not apply in this case. The wells were developed outside the permit area boundary and approved by the BLM, USFS, DWRi, and DOGM prior to their construction. DOGM did not require a performance bond under the state permit at that time since they were developed under a federal coal exploration permit.

The federal coal exploration license (UTU-70069) was required for constructing the wells. These wells were constructed in 1992. As part of the federal coal exploration license, a performance bond for reclamation (UTB000009) was required and provided for by PacifiCorp. As this bond terminated, PacifiCorp provided replacement bonds for the sites (Travelers Casualty and Surety Company of America: Replacement Bond-103908973, effective 9/2002 for $36,000). This performance bond (Travelers Casualty and Surety Company of America: Replacement Bond-103908973, effective 9/2002 for $36,000) is still in effect.

Energy West resubmits the following information to amend the Deer Creek Mine MRP to *REMOVE* the above noted wells. Amendments to the Deer Creek MRP are as follows:

Volume 1:	Page 2-223 – Remove CCCW-1A, CCCW-1S, CCCW-2A, CCCW-3A, CCCW-3S U, and CCCW-3S L
Volume 1:	After page 2-225 - Remove CCCW-1A, CCCW-1S, CCCW-2A, CCCW-3A, CCCW-3S U, and CCCW-3S L from map HM-1A
Volume 9:	Appendix A-1 – Remove CCCW-1A, CCCW-1S, CCCW-2A, CCCW-3A, CCCW-3S U, and CCCW-3S L from Water Monitoring Program
Volume 9:	Maps Section – Remove CCCW-1A, CCCW-1S, CCCW-2A, CCCW-3A, CCCW-3S U, and CCCW-3S L from map HM-1A

ADDITIONS to the Trail Mountain Mine MRP include amending the hydrologic monitoring program table, with edits, (to include the CCCW wells) that outlines the hydrologic monitoring required for the Trail Mountain Mine, the monitoring location map, and adding the information detailing the 1992 hydrologic investigation of the Cottonwood Creek Canyon.

Amendments to the Trail Mountain Mine MRP are as follows:

Appendix Volume: Appendix 7-1 – Add monitoring wells CCCW-1A, CCCW-1S, CCCW-2A, CCCW-3A, CCCW-3S U, and CCCW-3S L to the water monitoring program table.

Appendix Volume: Appendix 7-1 – Add the location of monitoring wells CCCW-1A, CCCW-1S, CCCW-2A, CCCW-3A, CCCW-3S U, and CCCW-3S L to the Trail Mountain Water Monitoring Location Map.

Appendix Volume : Add Appendix 7-17, 1992 Hydrologic Investigation of the Cottonwood Creek Canyon

The required C1/C2 forms are also included with this submittal.

If you have any questions concerning this submittal, please contact Dennis Oakley at 435-687-4825.

Sincerely,

Kenneth S. Fleck

Kenneth Fleck
Geology and Environmental Affairs Manager

Cc: file

Encl Amendments to Deer Creek Mine Volume 1
Amendments to Deer Creek Mine Volume 9
Amendments to Trail Mountain Mine Appendix Volume
C1/C2 Forms

APPLICATION FOR COAL PERMIT PROCESSING

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

Permittee: PacifiCorp

Mine: Deer Creek Mine/Trail Mountain Mine **Permit Number:** C/015/0018, C/015/0009

Title: Amendment to Transfer Cottonwood Creek Canyon Wells from the Deer Creek Mine Monitoring to the Trail Mountain Mine Water Monitoring Program, PacifiCorp, Deer Creek Mine C/015/0018, Trail Mountain Mine C/015/0009, Emery County, Utah, Task ID 4762.

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

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

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

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

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

Kenneth Fleck — Kenneth S. Fleck — Manager of Environmental Affairs — JAN. 13, 2015
Print Name — Sign Name, Position, Date

Subscribed and sworn to before me this 13th day of January, 2015

Chris M Christensen
Notary Public

My commission Expires: April 24, 2015

Attest: State of Utah } ss:
County of Emery

NOTARY PUBLIC
CHRIS M CHRISTENSEN
607905
COMMISSION EXPIRES
APRIL 24, 2015
STATE OF UTAH

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining

Form DOGM- C1 (Revised March 12, 2002)

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

Permittee: PacifiCorp

Mine: Deer CreekMine/Trail Mountain Mine **Permit Number:** C/019/0018, C/015/0009

Title: Amendment to Transfer Cottonwood Creek Canyon Wells from the Deer Creek Mine Monitoring to the Trail Mountain Mine Water Monitoring Program, PacifiCorp, Deer Creek Mine C/015/0018, Trail Mountain Mine C/015/0009, Emery County, Utah, Task ID 4762.

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

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Deer Creek Mine MRP Volume 1, Amend page 2-223
☐ Add	☒ Replace	☐ Remove	Deer Creek Mine MRP Volume 1, Amend map HM-1A
☐ Add	☒ Replace	☐ Remove	Deer Creek Mine MRP Volume 9, Appendix A-1, Amend Hydrologic Monitoring Program, entire section.
☐ Add	☒ Replace	☐ Remove	Deer Creek Mine MRP Volume 9, Appendix A-1, Amend map HM-1A
☐ Add	☒ Replace	☐ Remove	Trail Mountain Mine MRP Appendix Volume, Appendix 7-1, Amend Water Monitoring Program Table
☐ Add	☒ Replace	☐ Remove	Trail Mountain Mine MRP Appendix Volume, Appendix 7-1, Amend Water Monitoring Location Map
☒ Add	☐ Replace	☐ Remove	Trail Mountain Mine MRP Appendix Volume, Add Appendix 7-17
☐ Add	☐ Replace	☐ Remove	
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	Received by Oil, Gas & Mining

Form DOGM - C2 (Revised March 12, 2002)

PacifiCorp

Energy West Mining Company

Deer Creek Mine MRP

Volume 1: Page 2-223

Remove CCCW-1A, CCCW-1S, CCCW-2A, CCCW-3A, CCCW-3S U, and CCCW-3S L from monitoring. Replace page

East Mountain Springs – Mill Fork Area (refer to Deer Creek Permit Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)

1) EM-216
2) MFR-30
3) JV-9
4) JV-34
5) RR-5
6) RR-15
7) RR-23A
8) MF-7
9) MF-10
10) MF-19B
11) MF-213
12) MF-219
13) SP1-26
14) SP1-29
15) MFR-10
16) UJV 101
17) UJV-206
18) UJV-213
19) EM Pond
20) Little Bear Spring
21) Grants Spring

Piezometric Data – Surface

Rilda Canyon

1) P1
2) P5
3) P6
4) P7
5) EM-47

Cottonwood Creek Canyon

1) EM-31
~~2) CCCW-1A~~
~~3) CCCW-1S~~
~~4) CCCW-2A~~
~~5) CCCW-3A~~
~~6) CCCW-3S U~~
~~7) CCCW-3S L~~

Piezometric Data – Underground

1) Refer to Annual Hydrologic Reports for Locations: Map HM-2

Waste Rock Wells

1) DCWR1

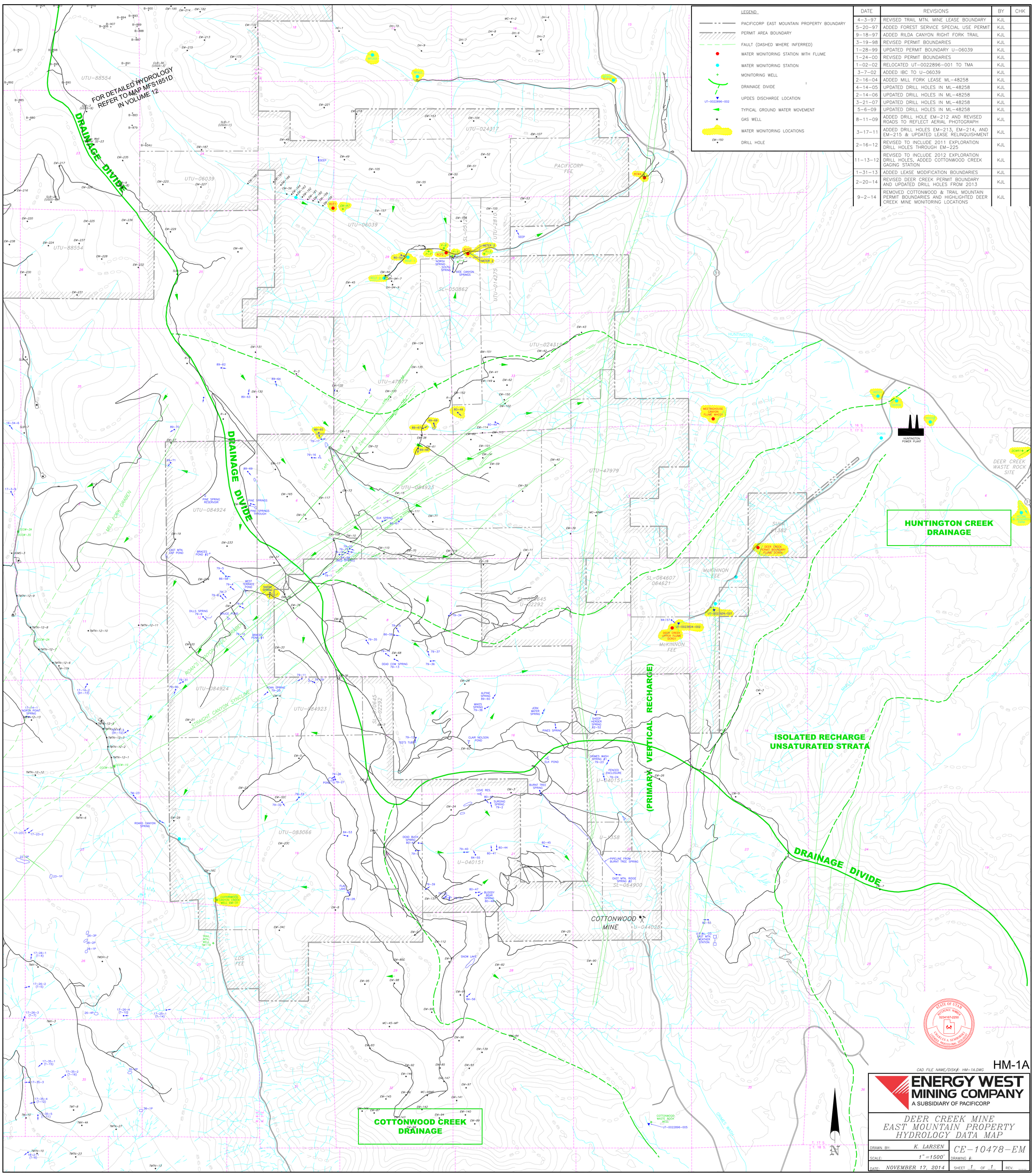
PacifiCorp

Energy West Mining Company

Deer Creek Mine MRP

Volume 1: Map HM-1A

Replace HM-1A



DATE	REVISIONS	BY	CHK
4-3-97	REVISED TRAIL MTN. MINE LEASE BOUNDARY	KJL	
5-20-97	ADDED FOREST SERVICE SPECIAL USE PERMIT	KJL	
9-18-97	ADDED RILDA CANYON RIGHT FORK TRAIL	KJL	
3-19-98	REVISED PERMIT BOUNDARIES	KJL	
1-28-99	UPDATED PERMIT BOUNDARY U-06039	KJL	
1-24-00	REVISED PERMIT BOUNDARIES	KJL	
1-02-02	RELOCATED UT-0022896-001 TO TMA	KJL	
3-7-02	ADDED IBC TO U-06039	KJL	
2-16-04	ADDED MILL FORK LEASE ML-48258	KJL	
4-14-05	UPDATED DRILL HOLES IN ML-48258	KJL	
2-14-06	UPDATED DRILL HOLES IN ML-48258	KJL	
3-21-07	UPDATED DRILL HOLES IN ML-48258	KJL	
5-6-09	UPDATED DRILL HOLES IN ML-48258	KJL	
8-11-09	ADDED DRILL HOLE EM-212 AND REVISED ROADS TO REFLECT AERIAL PHOTOGRAPH	KJL	
3-17-11	ADDED DRILL HOLES EM-213, EM-214, AND EM-215 & UPDATED LEASE RELINQUISHMENT	KJL	
2-16-12	REVISED TO INCLUDE 2011 EXPLORATION DRILL HOLES THROUGH EM-225	KJL	
11-13-12	REVISED TO INCLUDE 2012 EXPLORATION DRILL HOLES, ADDED COTTONWOOD CREEK GAGING STATION	KJL	
1-31-13	ADDED LEASE MODIFICATION BOUNDARIES	KJL	
2-20-14	REVISED DEER CREEK PERMIT BOUNDARY AND UPDATED DRILL HOLES FROM 2013	KJL	
9-2-14	REMOVED COTTONWOOD & TRAIL MOUNTAIN PERMIT BOUNDARIES AND HIGHLIGHTED DEER CREEK MINE MONITORING LOCATIONS	KJL	

STATE OF UTAH
REGISTERED
5234167-2250
CHARLES A. SHUMWAY
PROFESSIONAL ENGINEER

HM-1A

CAD FILE NAME/DISK#: HM-1A.DWG

ENERGY WEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

DEER CREEK MINE
EAST MOUNTAIN PROPERTY
HYDROLOGY DATA MAP

DRAWN BY:	K. LARSEN	CE-10478-EM	
SCALE:	1"=1500'	DRAWING #:	
DATE:	NOVEMBER 17, 2014	SHEET 1 OF 1	REV.

PacifiCorp

Energy West Mining Company

Deer Creek Mine MRP

Volume 9: Appendix A-1

Replace entire Water Monitoring Program, Deer Creek Mine, pages 1 - 14

PACIFICORP
ENERGY WEST
HYDROLOGIC MONITORING PROGRAM
DEER CREEK MINE

I. MONITORING LOCATIONS – DEER CREEK MINE

A. Surface Water Hydrology (for maps refer to Deer Creek and Wilberg/Cottonwood Mine: Volume 9 Map HM-1A, Deer Creek Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D Mill Fork Lease for East Mountain locations listed below

1. Cottonwood Creek Drainage System

a. ***Indian Creek*** (refer to Deer Creek Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)

(1) ICA - Indian Creek Above
(Approximately 2500 feet northwest of the Mill Fork permit boundary) 400 feet North, 2350 feet West of the Southwest corner of Section 3, Township 16 South, Range 6 East.

(2) ICF - Indian Creek Flume
(Approximately 2100 feet west of the Mill Fork permit boundary) 300 feet North, 3400 feet West of the Southwest corner of Section 10, Township 16 South, Range 6 East.

(3) ICD - Indian Creek Ditch
(Approximately 1600 feet west of the Mill Fork permit boundary, irrigation ditch for Upper Joes Valley) 240 feet North, 2850 feet West of the Southwest corner of Section 15, Township 16 South, Range 6 East.

(4) ICB - Indian Creek Below
(Approximately 3700 feet west of the Mill Fork permit boundary, junction of Indian Creek and FDR040) 70 feet North, 120 feet West of the Southwest corner of Section 16, Township 16 South, Range 6 East.

2. Huntington Creek Drainage System

a. ***Huntington Creek*** (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1A)

(1) HCC01 - Above Deer Creek Confluence:
1400 feet north, 2200 feet west of the southeast corner of Section 36, Township 16 South, Range 7 East.

(2) HCC02 - Below Deer Creek Confluence:
300 feet north, 300 feet west of the southwest corner of Section 31, Township 16 South, Range 8 East.

(3) HCC04 - @ Research Farm*
800 feet north, 200 feet east of the southwest corner of Section 5, Township 17 South, Range 8 East.
*Not listed on map due to scale.

b. ***Deer Creek*** (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1A)

(1) DCR01 - Above the mine:
(Approximately 600 feet upstream from the mine facility.) 200 feet North, 800 feet West of the Southeast corner of Section 10, Township 17 South, Range 7 East.

(2) DCR04 - Near C1/C2 Belt Intersection:
(Approximately 5,000 feet downstream from the mine facility.) 300 feet North, 2000 feet East of the Southeast corner of Section 2, Township 17 South, Range 7 East.

(3) DCR06 - @ Huntington Creek Confluence:
(Approximately 15,000 feet downstream from the facility) 1400 feet north, 1100 feet east of the southeast corner of Section 6, Township 16 South, Range 7 East.

c. ***Meetinghouse Canyon - South Fork*** (refer to Deer Creek, Wilberg/Cottonwood, Des-Bee-Dove Mine: Volume 9 Map HM-1)

(1) MHC01 - Meetinghouse Canyon South Fork (Approximately 200 feet upstream from the north and south convergence.) 800 feet North, 1500 feet East of the Southwest corner of Section 35, Township 16 South, Range 7 East.

d. ***Rilda Canyon*** (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1A)

(1) RCF-1 - Rilda Canyon - Right Fork: (Approximately 4000 feet upstream from the Right and Left fork convergence.) 400 feet South, 200 feet West of the Northeast corner of Section 30, Township 16 South, Range 7 East.

(2) RCLF1 - Rilda Canyon - Left Fork, below Rilda Canyon Portals: (Approximately 200 feet upstream from the Right and Left fork convergence.) 2400 feet North, 2100 feet West of the Southeast corner of Section 29, Township 16 South, Range 7 East.

(3) RCLF2 - Rilda Canyon - Left Fork, above Rilda Canyon Portals: (Approximately 1600 feet upstream from the Right and Left fork convergence.) 1600 feet North, 2300 feet West of the Southwest corner of Section 29, Township 16 South, Range 7 East.

(4) RCF2 - Rilda Canyon - Above NEWUSSD springs: 2500 feet South, 400 feet West of the Northeast corner of Section 29, Township 16 South, Range 7 East.

(5) RCF3 - Rilda Canyon - Below NEWUSSD springs: 2550 feet South, 1000 feet East of the Northeast corner of Section 28, Township 16 South, Range 7 East.

(6) RCW4 - Rilda Canyon: (Approximately 1000 feet upstream from the confluence with Huntington Creek.) 850 feet North, 1900 feet West of the Southeast corner of Section 26, Township 16 South, Range 7 East.

e. ***Mill Fork Canyon*** (refer to Deer Creek Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)

(1) MFA01 - Mill Fork Canyon - Above Old Mine: (Approximately 2000 feet above old mine portals @ end of USFS development road.) 100 feet North, 1500 feet West of the Southeast corner of Section 17, Township 16 South, Range 7 East.

(2) MFB02 - Mill Fork Canyon - Above Huntington Creek Confluence: (Approximately 200 feet above confluence with Huntington Creek @ culvert outfall.) 100 feet South, 1900 feet East of the Northwest corner of Section 22, Township 16 South, Range 7 East.

(3) MFU03 - Mill Fork Canyon - Above Mill Fork Fault Crossing: (Approximately 700 feet upstream of projected Mill Fork Fault crossing) 1150 feet North, 1700 feet East of the Southwest corner of Section 17, Township 16 South, Range 7 East.

3. Reclamation Monitoring: Following final reclamation, backfilling and grading monitoring will be conducted at points immediately above and below the reclaimed site.

B. Groundwater Hydrology – Deer Creek Mine

1. East Mountain Springs (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 maps HM-4)

Sheba Springs 80-48
80-50
89-65
89-66
89-67
89-68
Rilda Canyon-(Meters 2&3) [1]

[1]-NEWUSSD controls Rilda Canyon meters. Monitoring will be conducted when meters are functioning.

2. East Mountain Springs - Mill Fork Area (refer to Deer Creek Permit Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)

EM-216	MFR-30
JV-9	RR-5
JV-34	RR-15
MF-7	RR-23A
MF-10	SP1-26
MF-19B	SP1-29
MF-213	UJV-101
MF-219	UJV-206
MFR-10	UJV-213
EMPOND	Grants Spring
Little Bear Spring	

3. Piezometric Data

a. Surface

(1) Rilda Canyon (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1a)

P1
P5
P6
P7
EM-47

(2) Cottonwood Canyon Creek

East Mountain (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1a)

EM-31
~~CCCW-1A~~
~~CCCW-1S~~
~~CCCW-2A~~
~~CCCW-3A~~
~~CCCW-3S U~~
~~CCCW-3S L~~

b. Underground: Deer Creek In-Mine

(1) (Refer to Annual Hydrologic Reports for Locations : Map HM-2)

5. Deer Creek In-Mine Water Locations

a. Refer to Annual Hydrologic Reports for Locations : Map HM-2

6. Waste Rock Wells (refer to Deer Creek Mine: Volume 10 Map CM-10778-WB)

a. DCWR1

C. UPDES Monitoring Locations – Deer Creek Mine

a. ***Deer Creek Mine***
UPDES UT0023604
001- Sediment Pond
002- Mine Discharge

II. MONITORING SCHEDULE – DEER CREEK MINE
(see enclosed monitoring schedules for operational, baseline, and reclamation monitoring)

A. Field Measurements

Field Measurements collected during quality sampling: Listed below are the sites which will be monitored by PacifiCorp - Energy West in accordance with the guidelines established by DOGM; i.e.

- Date and Time
- Flow
- pH
- Temperature
- Conductivity
- Dissolved oxygen (perennial streams only)

Surface Monitoring

Surface monitoring locations will be field monitored quarterly for all field parameters, except Indian Creek - monitoring to be conducted during base flow only.

1. Cottonwood Canyon Creek

a. Indian Creek

(1) ICA
(2) ICF
(3) ICD
(4) ICB

2. Huntington Canyon Drainage

a. Deer Creek

(1) DCR01
(2) DCR04
(3) DCR06

b. Huntington Creek

(1) HCC01
(2) HCC02
(3) HCC04

Flow in Huntington Creek is measured only at HCC01 by Utah Power, and will be reported in the Annual Hydrologic Report.

c. Meetinghouse Canyon - South Fork:

(1) MCH01

d. Rilda Canyon

(1) RCF1*
(2) RCLF 1
(3) RCLF 2
(4) RCF2
(5) RCF3
(6) RCW4

* Baseline flow will be measured adjacent to EM-163

e. Mill Fork Canyon

(1) MFA01
(2) MFB02
(3) MFU03

Groundwater Monitoring

1. East Mountain Springs (see monitoring location list I.B.1)

2. East Mountain Springs - Mill Fork Area (see monitoring location list I.B.3)

   East Mountain Springs will be field monitored during the months of July and October. Rilda Canyon Springs - (NEWUSSD: Meters 2 & 3; when functioning) will be field monitored monthly depending upon access.

3. In-Mine

   a. Deer Creek

   In-mine locations will be field monitored quarterly for all field parameters except pH, conductivity, and dissolved oxygen.

4. Piezometric Wells

   a. Surface

   Piezometric surface wells will be field monitored for level only on a monthly basis depending upon access.

   (1) Rilda Canyon (see Map HM-1 for locations)

   P1
   P5
   P6
   P7
   EM-47

   (2) Cottonwood Canyon Creek (see Map HM-1 for locations)

   EM-31
   ~~CCCW-1A~~
   ~~CCCW-1S~~
   ~~CCCW-2A~~
   ~~CCCW-3A~~
   ~~CCCW-3S U~~
   ~~CCCW-3S L~~

5. Waste Rock Wells

   a. Deer Creek

UPDES Monitoring

1. Deer Creek

UPDES sites 001 and 002 will be monitored as specified in the individual permit~~s~~.

Reclamation Monitoring

Surface Water Resources: (see enclosed summary of operational, baseline, and reclamation monitoring schedules)
Surface monitoring locations will be field monitored monthly for flow and all field parameters quarterly until bond release.

Ground Water Resources: (see enclosed summary of operational, baseline, and reclamation monitoring schedules)

Springs East Mountain Springs will be field monitored during the months of July and October.

Rilda Canyon Springs (NEWUSSD: Meters 2 & 3; when functioning) will be field monitored monthly for flow depending upon access. East Mountain Springs (including Rilda Springs) monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.

Wells: Piezometric surface wells (Rilda Canyon and Cottonwood Canyon): will be field monitored for level only on a monthly basis depending upon access. Piezometric surface well monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.

Waste Rock Well: will be field monitored for level only on a quarterly basis. Monitoring will be conducted until sealing during final reclamation.

UPDES: Sites will be monitored as specified in the individual permits

B. Quality Sampling (Laboratory Measurements)

1. Surface Water Hydrology: Water samples will be collected and analyzed quarterly (one sample at low flow and high flow) during the first or second week of the quarter, except for Indian Creek - quality samples will be collected during baseflow only. Parameters analyzed are those listed in the DOGM Guidelines for Surface Water Quality (see Table 1-Surface Water Quality Parameter List). Quarterly sampling was initiated during March 1988 and will continue throughout the year; i.e., June, September, and December. Baseline analysis was performed in 2011 and will be repeated every five years there-after.

a. Cottonwood Creek Drainage

(1) Indian Creek

(a) ICA
(b) ICD
(c) ICB

b. Huntington Creek Drainage

(1) Deer Creek

(a) DCR01
(b) DCR04
(c) DCR06

(2) Huntington Creek

(a) HCC01
(b) HCC02
(c) HCC04

(3) Meetinghouse Canyon - South Fork:

(a) MCH01

(5) Rilda Canyon

(a) RCF1
(b) RCF3
(c) RCW4

(6) Mill Fork Canyon

(a) MFA01
(b) MFB02
(c) MFU03

Reclamation Monitoring - Surface Water Hydrology: Water samples will be collected and analyzed quarterly (one sample at low flow and high flow) during the first or second week of the quarter. Parameters analyzed are those listed in the DOGM Guidelines for Surface Water Quality (see Table 1-Surface Water Quality Parameter List). Sampling will be conducted on a quarterly basis until bond release. Baseline analysis will be performed on the 5th and 9th years following reclamation. In no case will baseline sampling time frame exceed 5 years converting from operational to reclamation monitoring.

2. Groundwater Hydrology

a. East Mountain Springs: Water samples will be collected and analyzed during the months of July and October. Rilda Canyon Springs (NEWUSSD: Meters 2 & 3; when functioning) will be monitored for quarterly for quality. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).

b. In-Mine: Two water samples will be collected and analyzed per mine quarterly until mine is sealed or access is discontinued. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).

c. Wells: ~~Rilda and Cottonwood Canyon wells will be sampled quarterly. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).~~ No analysis required.

d. Waste Rock Wells: One water sample will be collected and analyzed per location quarterly. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).

Baseline analysis was performed in 2011 and will be repeated every five years thereafter.

Reclamation Monitoring - Groundwater Hydrology:

a. East Mountain Springs: Water samples will be collected and analyzed during the months of July and October. Rilda Canyon Springs (NEWUSSD: Meters 2 & 3; when functioning) will be monitored quarterly for quality. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List). East Mountain Springs (including Rilda Springs) monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.

b. In-Mine: Two water samples will be collected and analyzed per mine quarterly until the mine is sealed or the sites become inaccessible. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).

c. Wells: Rilda and Cottonwood Canyon wells will be sealed during final reclamation. Quarterly sampling will continue until sealing. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).

d. Waste Rock Wells: Waste rock wells will be sealed during final reclamation. One water sample will be collected and analyzed per location quarterly until well sealing. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).

e. Post Reclamation Monitoring: PacifiCorp commits to conduct annual surveys to identify new discharge locations within and below sealed portals. If discharge occurs, one water sample will be collected and analyzed per location quarterly. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List). Baseline analysis will be performed on the 5th and 9th year.

3. UPDES Monitoring Sites

a. Deer Creek Mine

UPDES sites will be monitored as specified in the individual permits.

III. ANNUAL REPORTS

All data collected regarding the hydrology of East Mountain will be summarized by the applicant in an annual Hydrologic Monitoring Report. Copies of the report will be submitted to the Utah State Division of Oil, Gas and Mining. In addition, any raw data collected will be submitted to the Utah State Division of Oil, Gas and Mining on a quarterly basis.

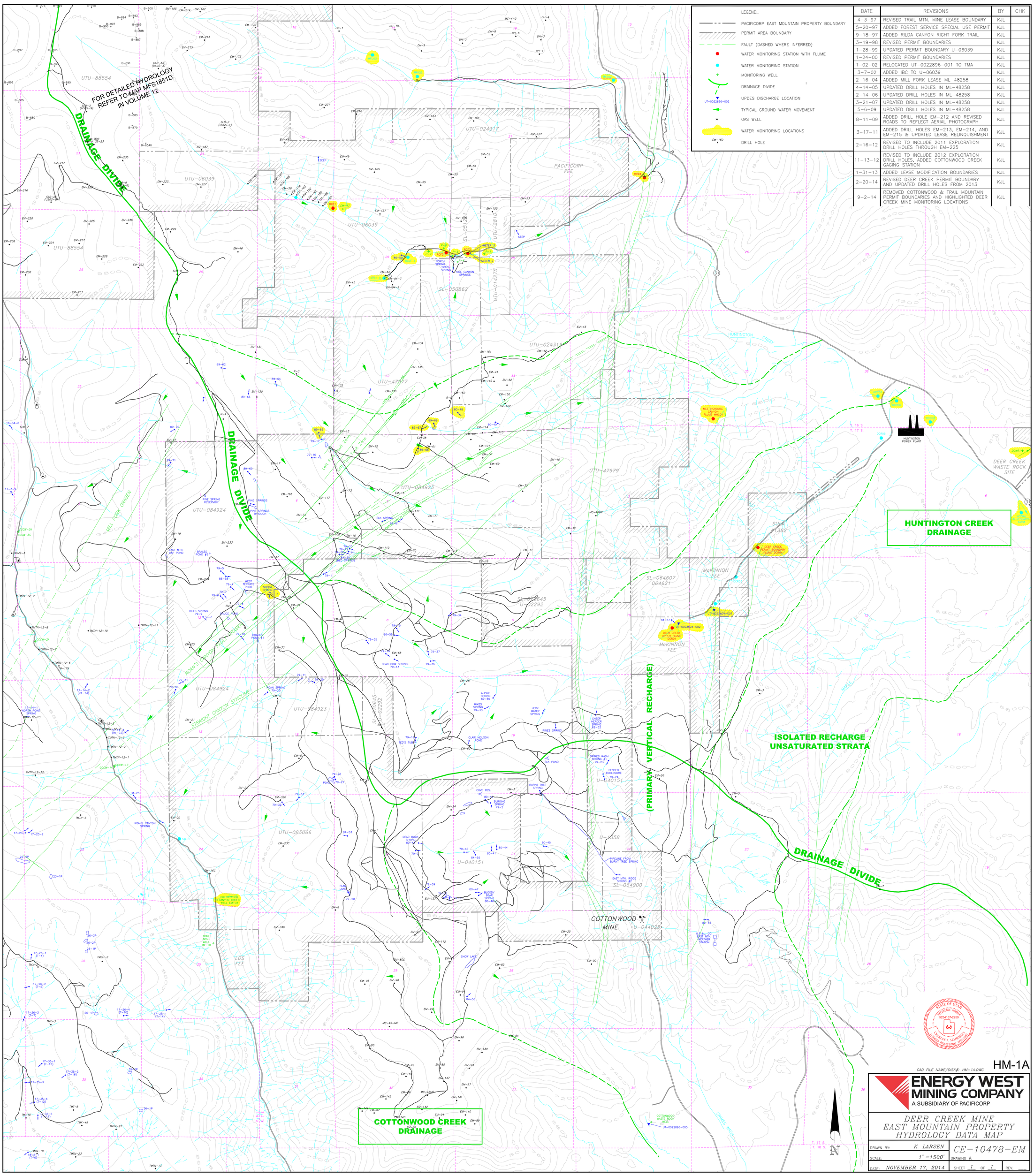
PacifiCorp

Energy West Mining Company

Deer Creek Mine MRP

Volume 9: Appendix A-1

Replace HM-1A



DATE	REVISIONS	BY	CHK
4-3-97	REVISED TRAIL MTN. MINE LEASE BOUNDARY	KJL	
5-20-97	ADDED FOREST SERVICE SPECIAL USE PERMIT	KJL	
9-18-97	ADDED RILDA CANYON RIGHT FORK TRAIL	KJL	
3-19-98	REVISED PERMIT BOUNDARIES	KJL	
1-28-99	UPDATED PERMIT BOUNDARY U-06039	KJL	
1-24-00	REVISED PERMIT BOUNDARIES	KJL	
1-02-02	RELOCATED UT-0022896-001 TO TMA	KJL	
3-7-02	ADDED IBC TO U-06039	KJL	
2-16-04	ADDED MILL FORK LEASE ML-48258	KJL	
4-14-05	UPDATED DRILL HOLES IN ML-48258	KJL	
2-14-06	UPDATED DRILL HOLES IN ML-48258	KJL	
3-21-07	UPDATED DRILL HOLES IN ML-48258	KJL	
5-6-09	UPDATED DRILL HOLES IN ML-48258	KJL	
8-11-09	ADDED DRILL HOLE EM-212 AND REVISED ROADS TO REFLECT AERIAL PHOTOGRAPH	KJL	
3-17-11	ADDED DRILL HOLES EM-213, EM-214, AND EM-215 & UPDATED LEASE RELINQUISHMENT	KJL	
2-16-12	REVISED TO INCLUDE 2011 EXPLORATION DRILL HOLES THROUGH EM-225	KJL	
11-13-12	REVISED TO INCLUDE 2012 EXPLORATION DRILL HOLES, ADDED COTTONWOOD CREEK GAGING STATION	KJL	
1-31-13	ADDED LEASE MODIFICATION BOUNDARIES	KJL	
2-20-14	REVISED DEER CREEK PERMIT BOUNDARY AND UPDATED DRILL HOLES FROM 2013	KJL	
9-2-14	REMOVED COTTONWOOD & TRAIL MOUNTAIN PERMIT BOUNDARIES AND HIGHLIGHTED DEER CREEK MINE MONITORING LOCATIONS	KJL	

STATE OF UTAH
REGISTERED
5234167-2250
CHARLES A. SHUMWAY
PROFESSIONAL ENGINEER

HM-1A

CAD FILE NAME/DISK#: HM-1A.DWG

ENERGY WEST MINING COMPANY
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DEER CREEK MINE
EAST MOUNTAIN PROPERTY
HYDROLOGY DATA MAP

DRAWN BY:	K. LARSEN	CE-10478-EM	
SCALE:	1"=1500'	DRAWING #:	
DATE:	NOVEMBER 17, 2014	SHEET 1 OF 1	REV.

PacifiCorp

Energy West Mining Company

Trail Mountain Mine MRP

Appendix Volume: Appendix 7-1

Replace Water Monitoring Program Table

TRAIL MOUNTAIN WATER MONITORING PROGRAM

STATION	LOCATION	TYPE	GEOLOGIC OCCURRENCE	FREQUENCY	STATUS	RESULTS TO:	REMARKS
SW-1	Cottonwood Cyn	Intermittent	Surface Stream	Monthly-Field	Operational	DOGM	Oil & Grease
	Above Mine	Stream	Crossing Blackhawk	Quarterly-Quality			Quarterly
			Formation				
SW-2	Cottonwood Cyn	Intermittent	Surface Stream	Monthly-Field	Operational	DOGM	Oil & Grease
	Below Mine	Stream	Crossing Starpoint/Mancos	Quarterly-Quality			Quarterly
			Formation				
SW-3	Cottonwood Cyn	Intermittent	Surface Stream	Monthly-Field	Operational	DOGM	Oil & Grease
	Below Mine	Stream	Crossing Mancos	Quarterly-Quality			Quarterly
			Formation				
T-10	Trail Mountain	Spring	Spring in North Horn	Quality July/Oct	Operational	DOGM	Inaccessible During Winter
	Section 26		Formation	Field July-Oct			
T-14	Trail Mountain	Spring	Spring in Upper	Quality July/Oct	Operational	DOGM	Inaccessible During Winter
	Section 25		Price River / Castlegate SS	Field July-Oct			
			Formation				
CCCW-1A	Cottonwood Creek Cyn. T.17S, R.6E, Sec. 14	Well	Alluvial Deposits	Monthly	Operational	DOGM	Level Only*
CCCW-1S	Cottonwood Creek Cyn. T.17S, R.6E, Sec. 14	Well	Starpoint Sandstone	Monthly	Operational	DOGM	Level Only*
CCCW-2A	Cottonwood Creek Cyn. T.17S, R.6E, Sec. 11	Well	Alluvial Deposits	Monthly	Operational	DOGM	Level Only*
CCCW-3A	Cottonwood Creek Cyn. T.17S, R.6E, Sec. 2	Well	Alluvial Deposits	Monthly	Operational	DOGM	Level Only*
CCCW-3S U	Cottonwood Creek Cyn. T.17S, R.6E, Sec. 2	Well	Blackhawk - Fluvial Sandstone	Monthly	Operational	DOGM	Level Only*
CCCW-3S L	Cottonwood Creek Cyn. T.17S, R.6E, Sec. 2	Well	Starpoint Sandstone	Monthly	Operational	DOGM	Level Only*
TM-1B	Mine Surface Near Bathhouse	Well	Starpoint Sandstone	Monthly	Operational	DOGM	Level Only
TM-3	Straight Canyon	Well	Starpoint Sandstone	Monthly	Operational	DOGM	Level Only
UT-0023728-001	Trail Mountain Sediment Pond	Point Discharge		Monthly	Operational	DOGM/DWQ	Oil and Grease if Visible
UT-0023728-002	Trail Mountain Mine Discharge	Point Discharge		Monthly	Operational	DOGM/DWQ	Oil and Grease if Visible

* refer to Appendix 7-17 for a full discussion the the Cottonwood Creek Canyon hydroloogy and the CCCW wells.

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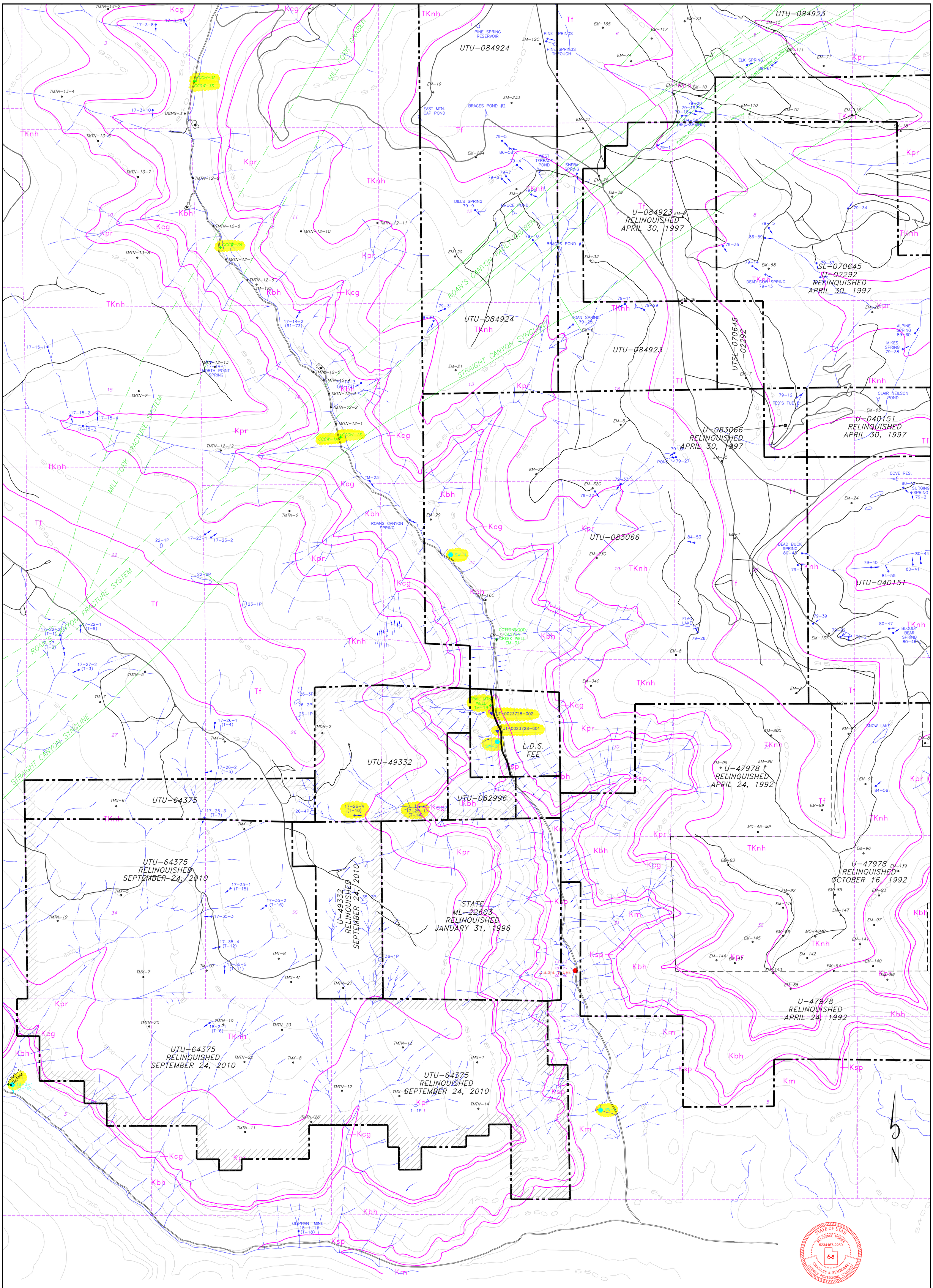
Trail Mountain Mine MRP

Appendix Volume: Appendix 7-1

Replace Trail Mountain Mine Water Monitoring Location Map



CAD FILE NAME/DISK#: SPRING MAP FROM HM-4

LEGEND

- TRAIL MOUNTAIN PERMIT BOUNDARY
- LEASE BOUNDARY
- FAULT (DASHED WHERE INFERRED)
- WATER MONITORING STATION WITH FLUME
- WATER MONITORING STATION
- UPDES DISCHARGE LOCATION (UT-0022896-004)
- GROUND WATER MONITORING LOCATIONS
- EM-73 DRILL HOLE
- LAKE
- TROUGH
- POND
- SPRING
- P-1 MONITORING WELL
- GAS WELL
- TKnh NORTH HORN FORMATION
- Tf FLAGSTAFF FORMATION
- Kpr PRICE RIVER FORMATION
- Km MANCOS SHALE
- Ksp STARPOINT SNADSTONE
- Kbh BLACKHAWK FORMATION
- Kcg CASTLEGATE SANDSTONE

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TRAIL MOUNTAIN MINE WATER MONITORING LOCATION MAP

DRAWN BY:	K. LARSEN	DRAWING #:	....
SCALE:	1" =1200'		
DATE:	NOVEMBER 17, 2014	SHEET 1 OF 1	REV. ___

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Trail Mountain Mine MRP

Appendix Volume: Appendix 7-17

Add Appendix 7-17, 1992 Hydrologic Investigation of the Cottonwood Creek Canyon

COTTONWOOD CANYON CREEK
1992 HYDROGEOLOGIC INVESTIGATION
REVISED IN 2000

The following document is a complete history of the Cottonwood Spring citizen complaint and resultant hydrogeologic study. The study confirmed that groundwater resources of Cottonwood Canyon area respond directly to precipitation and have not been influenced by mining in the Deer Creek Mine. PacifiCorp has gone to great lengths and expense to satisfy the concerns of the water users and regulatory agencies involved in Cottonwood Canyon.

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HISTORY OF CITIZEN COMPLAINT: COTTONWOOD SPRING

On July 31, 1991 a citizen complaint claiming that the mining in the Deer Creek Mine dried up a spring known as Cottonwood Spring (designated on map HM-1 and HM-12 as TM-23 [Section 14, Township 17 South, Range 6 East], Volume 9) was filed by Jim Peacock. According to Mr. Peacock, Cottonwood Spring produced approximately one to three cubic feet/second and was the main source of flow for Cottonwood Canyon Creek (conversation during an on site visit with Utah State Division of Water Rights, Cottonwood Irrigation Company, United States Forest Service, Utah State Division of Oil, Gas & Mining [DOGM], and PacifiCorp held on August 1, 1991). Mr. Peacock indicated that production from the spring had been decreasing over the past several years and that he was no longer able to irrigate approximately twenty-two acres located on the north side of Highway 31 at the junction of Cottonwood Canyon Creek and Straight Canyon. Discussions during the on site visit centered around: location and extent of mining in the Deer Creek Mine, mine water discharge trends, timing of the Roans Canyon fault crossing (3rd North), intersection of sympathetic faulting in 1st and 2nd Right off of 4th South, the drought which has had a major impact on the hydrologic resources of the area, and the hydrogeology of Cottonwood Spring.

COTTONWOOD SPRING

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As a result of the on site visit, DOGM reviewed the available historical data on the flow and quality of Cottonwood Spring (see Attachment 1). In addition to historical review, DOGM requested that PacifiCorp update the Probable Hydrologic Consequences (PHC) section of the Deer Creek Mine Permit Application Package (PAP). The Volume 9 - Hydrologic Section: PHC was updated and submitted on three separate occasions: December 19, 1991; March 23, 1992; and again on July 15, 1992. As part of the March 23, 1992 submittal PacifiCorp committed to drilling a series of wells and conducting a resistivity survey in Cottonwood Canyon Creek during the 1992 field season to determine the hydrologic significance of the alluvial deposits and their interrelationships with the surrounding strata. In addition to the work completed in 1992, PacifiCorp contracted Mayo & Associates during 1996 to complete a comprehensive hydrologic investigation of surface and groundwater systems in the East & Trail Mountain areas (refer to Mayo & Associates Study in Volume 9: Hydrologic Support Information). During the investigation, Mayo & Associates analyzed: 1) solute and isotopic compositions of surface waters and groundwaters, 2) surface water and groundwater discharge data, 3) piezometric data, and 4) geologic information.

This report will summarize the findings of PacifiCorp's and Mayo & Associates hydrogeologic investigation of Cottonwood Canyon Creek/Cottonwood Spring and will include a discussion on the following topics:

1 Introduction/General Description
- Cottonwood Canyon Drainage
- Cottonwood Spring
  - Relationship to the Deer Creek Mine
  - Water Rights Information

2. Spring and Seep Survey
- Cottonwood Spring (TM-23) Data
  - Historical Flow Data
  - United States Geological Survey Data
  - Mine Reclamation Plan Data Collection (Trail Mountain Mine)
  - Cottonwood Spring Source Development
  - Cottonwood Canyon Gain/Loss Surveys

3. Geology
   a. Stratigraphy
   b. Structure
   c. Geomorphology - Glaciation

4. Resistivity Survey Results
5. Drilling Results
6. Aquifer Test Results
7. Data from Mayo & Associates Study
8. DOGM Findings
9. Summary

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1. INTRODUCTION/GENERAL DESCRIPTION

Cottonwood Canyon Drainage

Cottonwood Canyon Creek is a major drainage system which borders the western limit of the East Mountain Federal Coal Leases (see HM-1, Volume 9 of the PAP). Based on data collected by PacifiCorp, Cottonwood Canyon Creek is an ephemeral stream from its headwaters to the northeast quarter of Section 24, Township 17 South, Range 6 East and intermittent from that point to its confluence with Cottonwood Creek at Straight Canyon. During periods of drought, flow in Cottonwood Canyon Creek is limited to flow emanating from the alluvial deposits at the intersection with Roans Canyon. From the intersection with Roans Canyon to Section 36 the stream loses water to the alluvial deposits. The drainage is dry from Section 36 to Section 6 except during spring runoff which normally occurs from late April through June or during precipitation events. Flow in the channel reemerges in Section 6 and continues to the confluence with Cottonwood Canyon at Straight Canyon.

The USGS installed a Parshall flume in Section 31, Township 17 South, Range 7 East and collected flow data daily from October 1977 through September 1979. PacifiCorp began collecting monthly flow information at the USGS flume in 1979. This information has been submitted in the Annual Hydrologic Reports and documents the trends indicated by the USGS. Distribution patterns of stream flow are characteristic of watersheds in the western highlands where the majority of the annual water yield occurs in the spring and early summer as a result of snowmelt runoff. Peak runoff, typically occurring in May/June, averages approximately four (4) cubic feet second (cfs), with base flows averaging less than one half (0.5) cfs (see Attachment 2 and the following figure).

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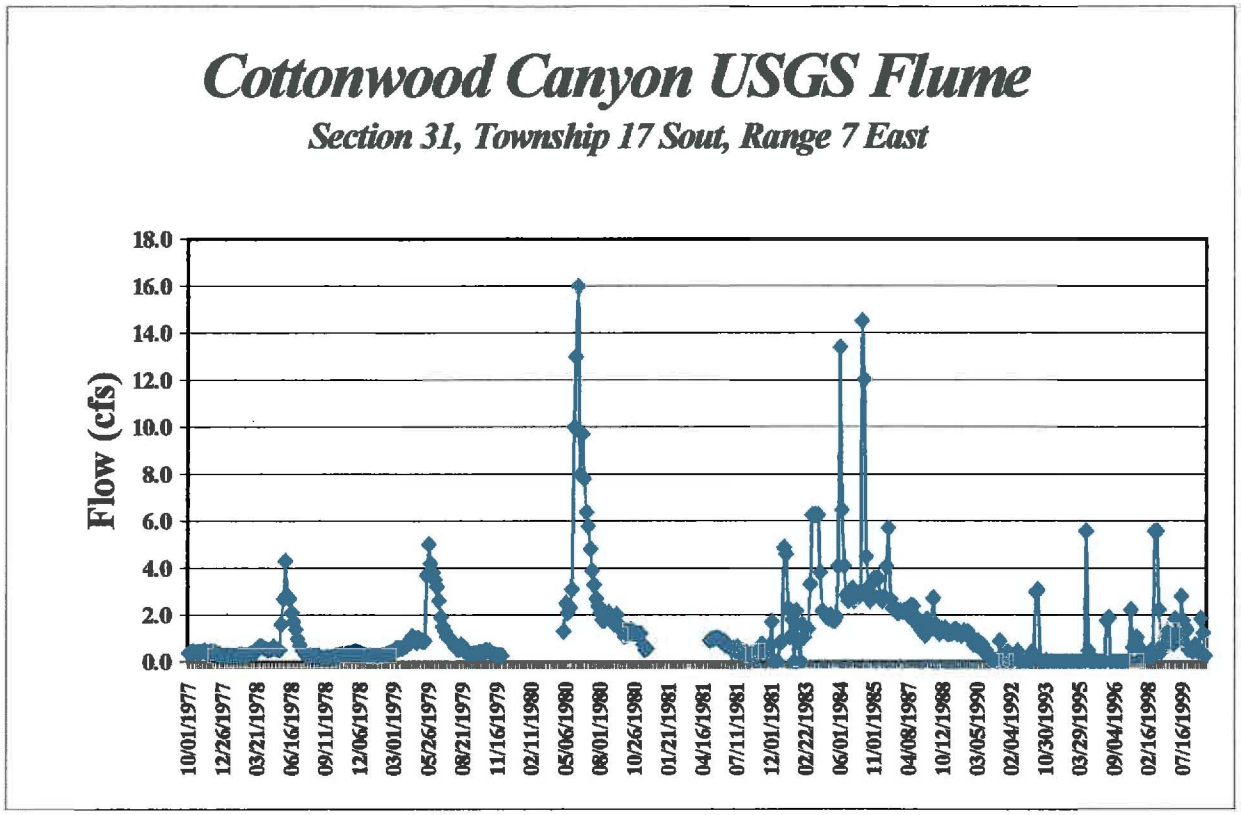

Cottonwood Spring

Cottonwood Spring is located in the southeast quarter of Section 14, Township 17 South, Range 6 East. A small access road leads from the main road (Forest Service Development Road 040) to the drainage bottom. Cottonwood Spring is situated on the east side of Cottonwood Canyon Creek approximately two (2) feet above the drainage bottom (site development and flow data will be discussed in the following section).

Relationship to the Deer Creek Mine:

Cottonwood Spring is located west of Federal Coal Lease U-083066 (limit of PacifiCorp's Federal Coal Leases). At the time the citizen compliant was filed (1991), the nearest mining was approximately two (2) miles to the east, as shown in the following figure:

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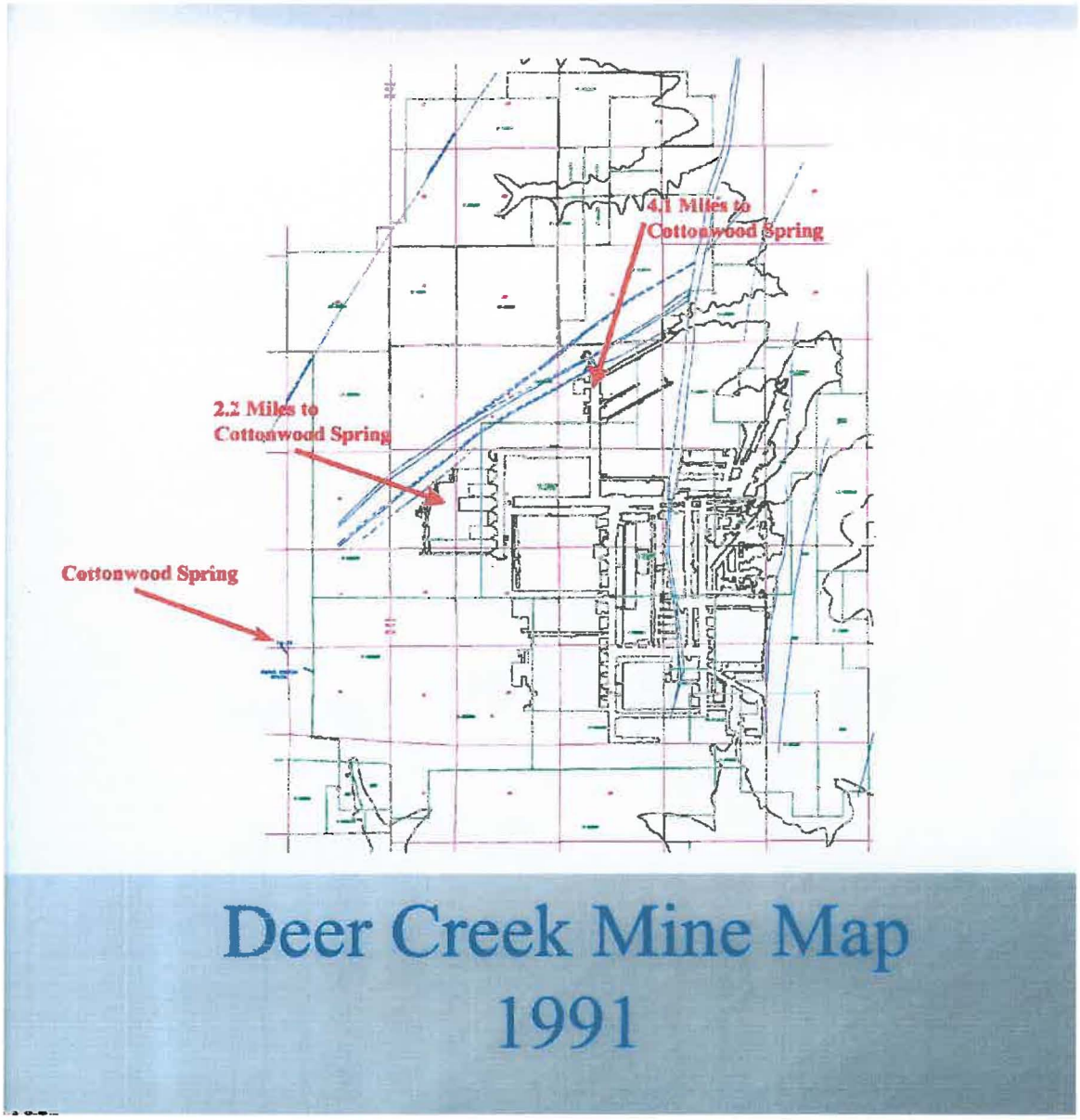

During the site visit on August 1, 1991, questions were raised concerning the proximity of mining in the Deer Creek Mine (in particular, the Roans Canyon Fault crossing and the area of current longwall mining – 4th South area). As shown on the figure, the Roans Canyon Fault crossing is approximately 4.1 miles east of Cottonwood Spring and 4th South area is approximately 2.2 miles east of Cottonwood Spring.

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Water Rights Information:

As documented during the site visit, the U.S. Forest Service held the water rights/point of diversion for Cottonwood Spring, Water Right # 93-701, quantity 0.0110 cfs. The following figure was reproduced from the Utah Division of Water Rights database:

UTAH DIVISION OF WATER RIGHTS
MAPLAT POINT OF DIVERSION LOCATION PROGRAM

MAP CHAR	WATER RIGHT	QUANTITY CFS	QUANTITY AND/OR	QUANTITY AC-FT	SOURCE DESCRIPTION or WELL INFO DIAMETER	DEPTH	YEAR LOG	POINT OF DIVERSION DESCRIPTION NORTH	EAST	CNR	SEC	TWN	RNG	B&M	UNPRR	APERR	PTEUR	SUGRU	PRTPD
0	93 701	.0110			.00 Cottonwood Spring													X	X X
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1875									
	USA Forest Service					324 25th Street				Ogden				UT 84401					
1	93 229	.0000			.00 Trail Canyon Creek													X	X X
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1875									
	USA Forest Service					324 25th Street				Ogden				UT 84401					

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2. SPRING AND SEEP SURVEY

PacifiCorp conducted a spring and seep survey during the summer of 1991 from north of the Trail Mountain Mine to north of Winks Canyon. This information, along with the East Mountain spring and seep surveys, was compiled to develop a comprehensive spring and seep map for the Cottonwood Canyon area (refer to HM-4). The spring surveys identified several sources along the down dip side of Cottonwood Canyon (East side). Two of the springs identified were included in the East Mountain Spring Monitoring Program in 1991 (springs 91-72 and 91-73). The contribution of groundwater from the upper portion of the Blackhawk Formation on the east side of Cottonwood Canyon was also documented in resistivity surveys (refer to Section 4: Resistivity Results). During the spring inventory, individual drainages were inspected and classified based on flow characteristics. Based on the field investigation conducted in the summer of 1991, all of the streams emanating from the Cottonwood Canyon Creek area would be classified as ephemeral except Cottonwood Canyon Creek, which would be classified as intermittent as discussed previously.

Cottonwood Spring (TM-23) Data:

Historical Flow Data:

The United States Geological Survey (USGS) collected quality and quantity data at the Cottonwood Spring site as part of comprehensive hydrologic study of the central Utah Coal Field from 1978 through 1982 (Open File Reports 81-539 and 84-067). Monitoring of Cottonwood Spring was included in the Trail Mountain MRP in 1986 following a spring and seep survey conducted by JBR in 1985. The following is a list of sources and the time frame in which data was collected:

USGS	1978 - 1982
JBR	1985 - Spring Survey
Trail Mountain Coal Co.	1986 - 1987
Mountain Coal Co.	1987 - 1992
Energy West Mining	1992 – Present

Flow prior to the drought in the mid to late 1980's averaged approximately 60 GPM. Post drought flows diminished rapidly (refer to the following hydrograph comparing Cottonwood Spring flow to the regional Palmer Drought Index).

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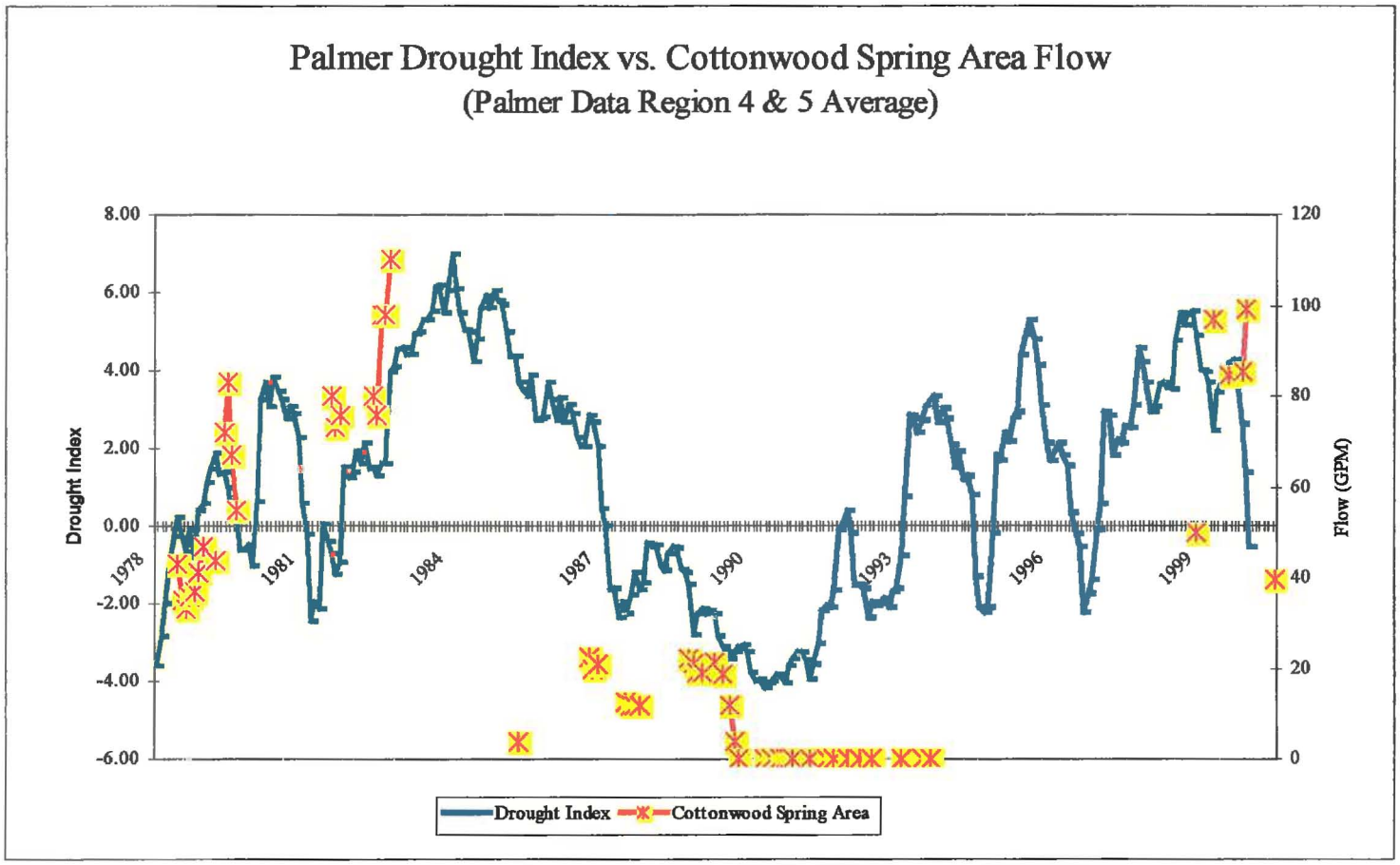

United States Geological Survey Flow Data:

As referenced above, the USGS conducted a comprehensive hydrologic investigation of the Central Utah Coal Field in the late 70's and early 80's. Cottonwood Canyon drainage system was included within study. Flow from Cottonwood Spring was reported in Open File Reports 81-539 and 84-067 ranging from 33 to 110 gallons per minute. Methods of data collection were not reported. During PacifiCorps investigation, concerns were expressed at several meetings with the regulatory agencies on the method of data collection (gain/loss vs. pipe measurement). Reviewing Open File Report 81-539, it is apparent that the method utilized to document flow from Cottonwood Spring was to conduct gain/loss measurements along Cottonwood Creek above and below the alluvial discharge area (method of measurement confirmed by Jim Kohler, BLM Geologist, personal conversation with USGS field assistant involved in the hydrologic investigation). The following figure includes pages reproduced from Open File Report 81-539, documenting spring flow and gain/loss measurements.

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Cottonwood Canyon Spring

U.S.G.S. Report 81-539

Table 9.--Field determinations of discharge, specific conductance, pH, water temperature, and alkalinity at selected springs--Continued

LOCATION	GEOLOGIC UNIT	DATE OF SAMPLE	ALTITUDE	DISCHARGE (GAL/MIN)	SPECIFIC CONDUCTANCE (µMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	ALK-LINITY FIELD (MG/L) AS CACO3
(D-16- 7)32DCC-S2	125NMNR	79-08-21	7740.00	2.3	450	--	8.0	--
	125NMNR	79-09-19	7740.00	1.4	510	--	8.0	--
35ABC-S1	111ALVH	78-10-13	6820.00	27	--	--	--	--
	111ALVH	78-11-06	6820.00	20	--	--	--	--
	111ALVH	78-12-11	6820.00	23	--	--	--	--
	111ALVH	79-05-11	6820.00	26	--	--	--	--
	111ALVH	79-06-28	6820.00	30	960	8.1	10.5	--
	111ALVH	79-07-20	6820.00	21	800	7.2	10.5	--
	111ALVH	79-08-07	6820.00	21	760	7.3	11.0	--
	111ALVH	79-08-22	6820.00	25	1080	--	10.0	--
	111ALVH	79-08-31	6820.00	26	--	--	--	--
	111ALVH	79-09-17	6820.00	40	1000	--	9.5	--
	111ALVH	79-10-16	6820.00	22	600	--	11.0	--
(D-16- 6)16CAD-S1	120NMNR	79-08-09	5200.00	1.8	400	7.3	6.5	210
21CDC-S1	211SRPH	79-08-09	7320.00	3.6	2630	7.4	11.5	425
28ABD-S1	200PMCS	79-08-09	6960.00	1.0	2710	7.2	21.0	--
(D-17- 6) 1BAA-S1	124PLGF	78-07-27	10280.00	5.5	400	--	6.0	--
	124PLGF	78-10-14	10280.00	.3	485	--	7.0	--
	124PLGF	79-06-15	10280.00	49	480	--	3.0	--
	124PLGF	79-07-17	10280.00	6.3	--	--	6.0	--
	124PLGF	79-08-21	10280.00	2.1	390	--	6.5	--
	124PLGF	79-09-19	10280.00	.1	430	--	7.0	--
3BAD-S1	211PGRV	79-06-25	8960.00	.7	550	7.2	7.5	320
3BAD-S2	211PGRV	79-07-25	8960.00	.4	550	7.6	7.5	320
3ABC-S1	211CSL6	79-07-04	8940.00	7.1	550	7.6	7.5	300
3ABD-S1	211CSL6	79-07-04	8940.00	24	550	7.5	7.5	300
	211CSL6	79-09-20	8940.00	19	560	--	8.0	--
3BAB-S1	125NRPP	79-07-20	9040.00	.1	490	7.4	7.2	250
3BAD-S1	211PGRV	79-07-25	9460.00	1.0	450	7.6	6.4	265
3CBC-S1	211CSL6	79-07-04	8930.00	13	550	7.4	7.2	300
12ABC-S1	125NRNR	79-08-08	9460.00	6.2	480	7.5	5.6	285
12DAA-S1	125NRNR	79-08-08	9400.00	3.8	450	7.4	6.2	295
14BCD-S1	125NRNR	79-06-27	9080.00	.6	620	8.0	22.5	295
21BCD-S1	125NRNR	79-07-24	9320.00	.40	590	7.6	6.2	320
23AAA-S1	211BCKX	78-06-28	7766.80	43	--	--	--	--
	211BCKX	78-06-28	7766.80	41	--	--	--	--
	211BCKX	78-07-19	7766.80	39	--	--	--	--
	211BCKX	78-07-27	7766.80	38	--	--	--	--
	211BCKX	78-07-28	7766.80	33	--	--	--	--
	211BCKX	78-08-09	7766.80	36	--	--	--	--
	211BCKX	78-08-06	7766.80	37	--	--	--	--
	211BCKX	78-10-09	7766.80	39	590	--	8.5	--
	211BCKX	78-10-13	7766.80	41	--	--	--	--
	211BCKX	78-10-30	7766.80	42	590	--	7.5	--
	211BCKX	79-06-05	7766.80	44	--	--	8.0	--
	211BCKX	79-05-31	7766.80	72	650	--	8.0	--
	211BCKX	79-06-13	7766.80	63	630	7.0	8.0	--
	211BCKX	79-07-05	7766.80	67	610	--	8.0	--
	211BCKX	79-07-19	7766.80	64	600	--	8.0	--
	211BCKX	79-08-22	7766.80	58	--	--	--	--

73

Cottonwood Spring Flow
8-28-79 55 GPM

Table 5.--Streamflow measurements made during 1977-79 in the upper drainages of Huntington and Cottonwood Creeks--Continued

HUNTINGTON CREEK DRAINAGE--Continued

Stream	Site no. (pl. 1)	Date	Discharge (ft^3/s)	Stream	Site no. (pl. 1)	Date	Discharge (ft^3/s)
Deer Creek	85	8-28-79	0.07	Huntington Creek	88 (gaging station 09318000)	8-30-79	88
Do.	86	8-28-79	.13				
Do.	87	8-14-79	1.9				
				Fish Creek	89	8-10-79	.18
				Do.	90	8-14-79	2.6

COTTONWOOD CREEK DRAINAGE

Stream	Site no. (pl. 1)	Date	Discharge (ft^3/s)	Stream	Site no. (pl. 1)	Date	Discharge (ft^3/s)
Marinus Canyon	91	8-13-79	.11	Cottonwood Creek	100	8- 1-79	1.2
		8-30-79	.02			9- 6-79	.34
Winks Canyon	92	8-13-79	.09			8-13-79	2.8
						8-28-79	.46
Mill Canyon	93	8-13-79	.62	Flume Canyon	101	8- 1-79	3.4
		8-30-79	.01			8-13-79	.73
						8-28-79	.04
Dairy Canyon	94	8-13-79	.48				
		8-30-79	.02	Cottonwood Creek	102	4-27-78	.43
						8- 1-78	4.7
Westinghouse Canyon	96	8-13-79	.03			9- 6-78	.34
		8-30-79	.01			8-28-78	.80
				Do.	104 (gaging station 09324000)	9- 6-78	.35
Unnamed tributary to Cottonwood Creek	98	8-13-79	.03			8-13-79	3.3
						8-28-79	.81
Trail Canyon	97	8-13-79	.08				
		8-30-79	.01				
				Do.	105	8-28-79	.58
Cottonwood Creek	98	9- 6-79	Dry				
		8-13-79	2.0	Grimes Wash	106	8-28-79	.02
		8-28-79	.07				
				Do.	107	8-28-79	.03
Do.	99	9- 6-79	.08				
		8-28-79	.19				

*Accuracy of low measurements may be affected by ice formations.

Site 98 Above Cottonwood Spring
Site 99 Below Cottonwood Spring

Cottonwood Spring Flow
8-28-79 55 GPM

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Mine Reclamation Plan Data Collection (Trail Mountain Mine):

Data collected by Trail Mountain Mine during 1985-1992 revealed that flow from Cottonwood Spring varied from 0 to approximately 22 gpm (pipe flow collected)

JBR		1985 - Spring Survey
Trail Mountain Coal Co.	1986 - 1987	
Mountain Coal Co.	1987 - 1992	

Date	Flow (gpm)	Comments
10/28/85	4.0	
9/30/86	22.5	
10/20/86	20.0	
11/11/86	20.8	
6/30/87	12.6	
7/15/87	12.0	
8/31/87	12.0	
9/25/87	12.0	
6/30/88	0.0	
9/20/88	22.0	
10/31/88	21.0	
11/29/88	19.0	
12/7/88	19.2	
3/13/89	21.5	
5/25/89	18.5	
7/19/89	12.0	Pipe all but dry, approx. 12 seeping up at base of channel
8/25/89	4.0	Pipe not flowing, measured at base of channel
9/17/89	0.0	
1989-92	0.0	

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During meetings with the regulatory agencies, questions were raised concerning the supposed coincidence of the timing of the Roans Canyon fault crossing and the reduction in flow of Cottonwood Spring (refer to Attachment 5 for Cottonwood Spring field data sheets). The extensive hydrogeologic data and Cottonwood Spring flow data collected by the previous operator reveals that Cottonwood Spring reduced to zero flow one year prior to the rock slope development. Another interesting factor is, as the flow from the decreased, the source of Cottonwood Spring moved to the base of the channel.

Cottonwood Spring Source Development

Site development during the initial review (1991) included a three (3) inch section of PVC pipe with a small board supporting the discharge (see adjoining photo). As documented earlier, USGS utilized gain/loss measurements to collect groundwater production data from the Cottonwood Spring area. Measurements collected as part of the hydrologic monitoring programs of the previous coal companies, were discharge rates from the PVC pipe, except when the flow diminished in July of 1989 and discharge from the base of the channel was included. Based on review of the data, it is unclear when the PVC pipe was installed.

As part of the Cottonwood Spring investigation, PacifiCorp excavated the site (only hand shovel required) to verify the development construction. A three (3) inch PVC pipe, approximately three [3] feet in length, was simply inserted into coarse gravel lens with soil compacted around the pipe (see adjoining photo). The gravel lens is approximately two (2) feet thick and is heavily oxidized indicating near surface influence.

Alluvial/glaciated deposits of Cottonwood Canyon consist of stratified layers ranging from silt to coarse gravels (refer to the Geomorphology Section for a complete discussion on Cottonwood Canyon). Stratification was documented in the development of the Cottonwood Canyon monitoring wells and can be seen in the eroded bank deposits near Cottonwood Spring (see adjoining photo). The very fine sediments (very low transitivity) effectively impedes vertical groundwater migration.

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Cottonwood Canyon Gain/Loss Surveys

Energy West Mining Company initiated gain/loss surveys in 1998 of Cottonwood Canyon to verify/compare:

- Surface/groundwater relationships
- Hydrologic trends of the Cottonwood Canyon monitoring wells
- Cottonwood Spring discharge rates
- Compare recent data Cottonwood Spring flow data to USGS study

Gain/loss surveys included measurements collected along the Cottonwood drainage from Mill Canyon in Section 2, Township 17 South, Range 6 East to below Roans Canyon in Section 24, Township 17 South, Range 6 East (refer to Attachment 4). The survey included measurements of each of the contributing sub-drainages and Spring 91-72. Depending upon flow, quantity data was collected at each site utilizing either the bucket/stop watch method or by temporarily installing a 90° v-notch weir.

Energy West closely monitors the groundwater levels in a series of monitoring wells in Cottonwood Canyon as well as climatic trends of central Utah (refer to Drilling Results Section for more detail). As climatic trends returned to normal patterns, (refer to Palmer Drought Index figure presented earlier), the alluvial system of Cottonwood Canyon started to recharge. This is evident by the upward trends in the alluvial monitoring wells (refer to Drilling Results Section, Drill Site #1). As the trend line of the water elevation of well CCCW-1A equaled the elevation of the Cottonwood Spring area, discharge from the alluvial deposits was re-established. From the data collected over a two year period (1998 – 2000), discharge from Cottonwood Spring area ranged from approximately 40 to 99 GPM (refer to Attachment 4 for Gain/Loss data).

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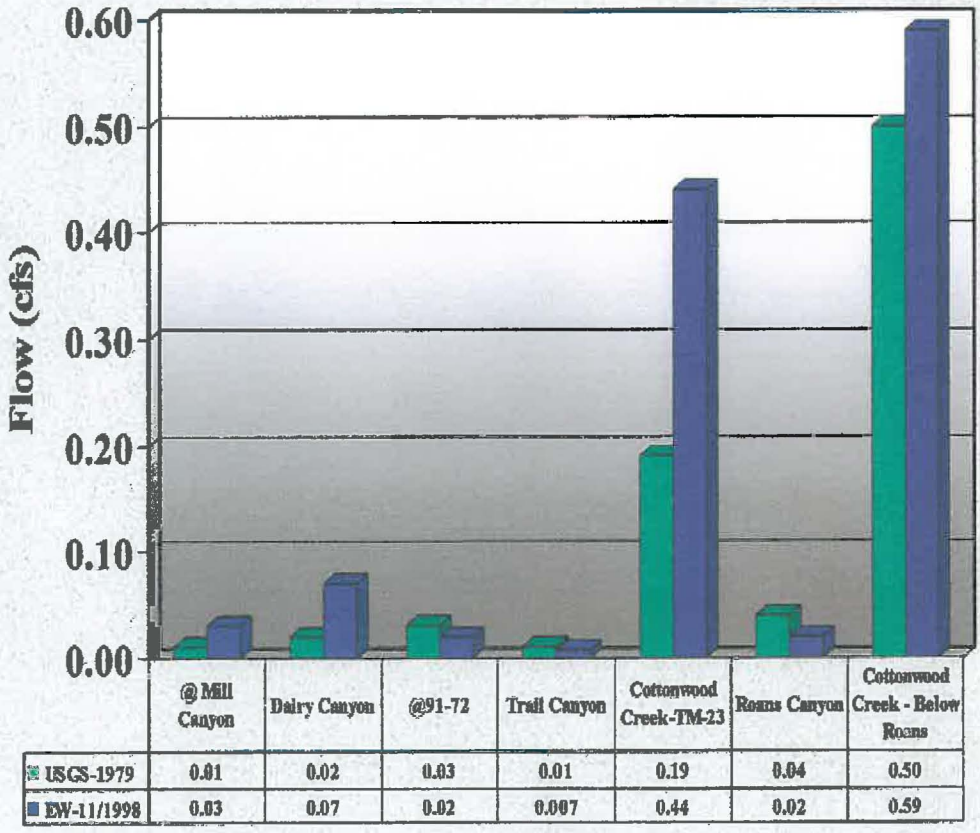
The following figure illustrates the data collected by Energy West in November 1998 compared directly to the data collected by the USGS in 1979.

Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West November 1998



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-11/1998	0.03	0.07	0.02	0.007	0.44	0.02	0.59

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 57.8 GPM/0.13 CFS

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3. GEOLOGY

a. STRATIGRAPHY

The rock formations exposed in the Cottonwood Canyon Creek area range from Upper Cretaceous to Tertiary in age (refer to HM-12). The formations, in ascending order:

Masuk Shale:

Age: Cretaceous EST. Thickness: +1000'

Uppermost member of the Mancos Shale; consists of light- to medium-gray marine mudstones; weathers readily, forming slopes which are often covered with debris. This formation interfingers with the Starpoint Sandstone. Exposure is limited to the area south of the Trail Mountain Mine.

Star Point Sandstone:

Age: Cretaceous EST. Thickness: 400'

Consists of three distinct sandstone tongues separated by Masuk Shale. The lower and upper members are cliff forming, massive, gray, fine to medium grained sandstone units.

Blackhawk Formation:

Age: Cretaceous EST. Thickness: 750'

Consists of alternating mudstones, siltstones, sandstones, and coal. Although coal is generally found throughout the formation, the only minable seam exposed in Cottonwood Canyon Creek is the Hiawatha Seam located directly above the Starpoint Sandstone. Outcrops of the Blackhawk Formation occur throughout the length of Cottonwood Canyon Creek from the Trail Mountain Mine to Flat Canyon.

Castlegate Sandstone:

Age: Cretaceous EST. Thickness: 250'

Forms an escarpment which surrounds Cottonwood Canyon Creek. Consists of coarse-grained, light gray, fluvial sandstones; pebble conglomerates; and zones of mudstone.

Price River Formation:

Age: Cretaceous EST. Thickness: 350'

Consists mainly of fine-medium grained sandstones with subordinate amounts of mudstone and conglomerates. Forms slopes and ledges above the Castlegate Sandstone.

North Horn Formation:

Age: Cretaceous/Tertiary EST. Thickness: 850'

Mudstones dominate the rock types present and vary in color from gray, red, yellow, green to red. Localized, lenticular sandstone channels are present throughout the formation.

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Flagstaff Limestone:

Age: Tertiary/Paleocene EST. Thickness: 100'

The Flagstaff Limestone is a light gray to tan fossiliferous lacustrine limestone. The Flagstaff forms the "Cap, " or mesa – like table top to North Horn, Trail, and East Mountains.

Alluvial Deposits:

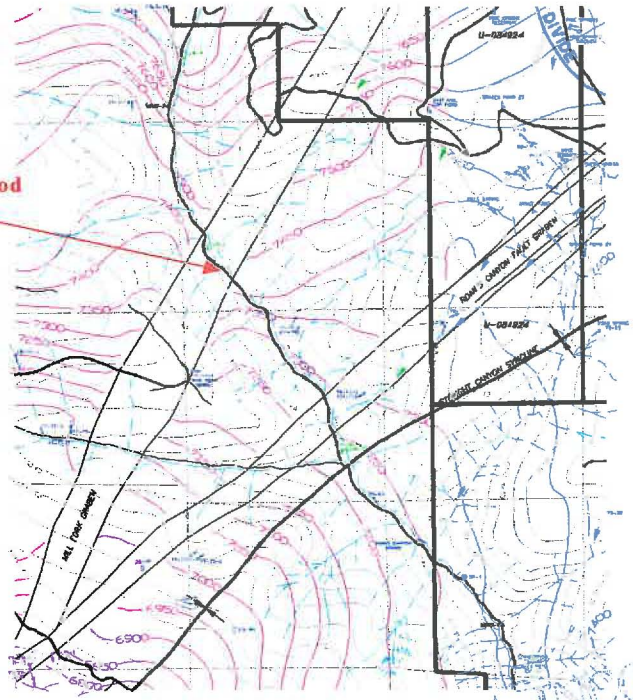
Age: Pleistocene EST. Thickness: Variable

Consists of sandstone boulders, sand, silt, and clay. Glacial deposits and lateral/terminal moraines occur above the intersection of Roans Canyon. Below, the canyon is characterized by non-glaciated valley fill deposits.

b. STRUCTURE

Two main structural features occur within the Cottonwood Canyon Creek area, the Straight Canyon Syncline and northeast-southwest trending fault-fracture systems. The Straight Canyon Syncline is a north-northeast trending syncline (refer to the Geologic Section of the PAP). In the area south of the syncline the strata dips gently in a northwest direction toward the syncline at approximately one to three degrees. Northwest of the syncline axis the strata dip to the southwest at approximately three to five degrees.

Cottonwood Canyon Geology Map



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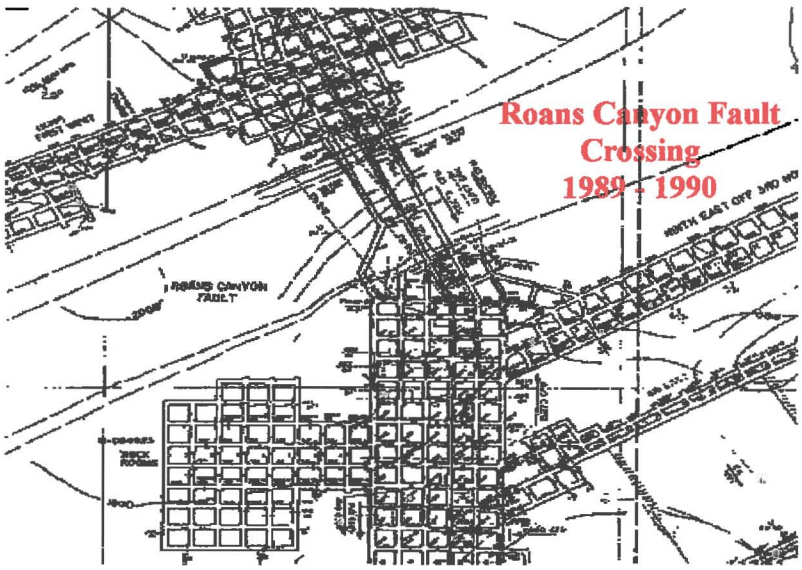
The second structural feature consists of northeast-southwest trending fault systems known as the Roans Canyon and Mill Fork Canyon grabens. The Roans Canyon graben bisects the northern reserves of the East Mountain Federal Coal Leases and occurs parallel to the axis of the Straight Canyon Syncline (see HM-1 and HM-12, Volume 9 of the PAP). The system contained up to six normal faults with displacements ranging from a few feet to over 150 feet in the 3rd North fault crossing (see the following figure).

DEER CREEK MINE
3rd NORTH ROANS CANYON FAULT CROSSING



PacifiCorp has conducted extensive studies to document the hydrologic significance of the graben structure (see Volume 9, R645-301-711, A. Existing Groundwater Resources: Structural Hydrologic Features). Based on research conducted by PacifiCorp, faulting along the Roans Canyon system occurred during two phases. During the first (east-west compression phase), strike slip movement occurred prior to the deposition of the Flagstaff Limestone; during the second (east-west tension phase), normal faulting occurred along a strike slip faulting plane, resulting in the formation of a graben structure. Displacement along the Roans Canyon Fault system increases to the north until it is terminated by the Pleasant Valley Fault system. In the area of Cottonwood Canyon Creek the Roans Canyon Fault system consists of two or more fractures with little or no displacement (see Cottonwood Geology Map on previous page).

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During the resistivity study a second linear feature, which could possibly be a southern extension of the Mill Fork Canyon fault system, was detected on transect line CCCR-5 (refer to Cottonwood Canyon Resistivity Study - Volume 9 Hydrologic Support Information). The southernmost fault of the Mill Fork Canyon Graben was intersected in Arco's Beaver Creek #4 Mine in Mill Fork Canyon and has a displacement of about twenty (20) feet down on the northwest side. Where the fault crosses the northern end of East Mountain, the fault has a displacement of about thirty (30) feet down on the northwest side (see HM-7 in Volume 9 of the PAP).

c. Geomorphology: Glaciation

Cottonwood Canyon is a major drainage system where evidence of glaciation exists. Since mountain glaciers are surrounded by areas of exposed rock that are constantly subject to erosion, they collect a great deal of rock waste that is carried by the ice toward the terminus of the glacier. This debris, referred to as a moraine, is supplied by the mechanically weathered material which falls from the walls of the valley and by rock abraded from the bed and is classified with reference to its position as ground, lateral, or terminal moraine deposits. All material deposited beneath the advancing ice, together with that deposited from the base as an irregular sheet during melting, constitutes the ground moraine. At the terminus of the glacier, where the amount of ice waste due to melting equals the advance due to glacial movement, debris is dropped as a terminal moraine. The debris that accumulates on the borders of a valley glacier forms the lateral moraines of the moving ice-stream. When the glacier melts, the lateral moraines are left as ridges, or terrace-like structures, bordering the steep-sided mountain valleys[1].

From the headwaters to Section 24, Township 17 South, Range 6 East the canyon is characterized by U-shaped valleys with associated lateral and terminal moraine deposits, (topographic landscape modification in Cottonwood Canyon due to Pleistocene glaciation has been documented by the Utah Geological and Mineral Survey [U.G.M.S.], Bulletin No. 112, page 7).

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[1] Emmons, W.H.; Thiel, G.A.; Stauffer, C.R.; Allison, I.S., 1955, Geology: Principles and Process, pp. 241-244

Utah Geological and Mineral Survey [U.G.M.S.], Bulletin No. 112, page 7

Limestone, dense, light gray, thin-bedded, fossiliferous 25.2
Covered slope 79.4

Total Flagstaff Limestone 104.6

North Horn Formation

The stratigraphic relationships of the units just described are shown diagrammatically in figure 6. For stratigraphic work relating to coal, the two key horizons in the field are the top of the Star Point and the top of the Castlegate.

Quaternary Deposits

Unconsolidated Quaternary deposits consist of alluvium (stream channel and valley fill deposits), regolith, glacial drift, moraines (figure 7), and colluvium (including talus) on slopes and at the base of slopes and cliffs. These deposits consist of mixed proportions of clay, silt, sand, and gravel with boulders.

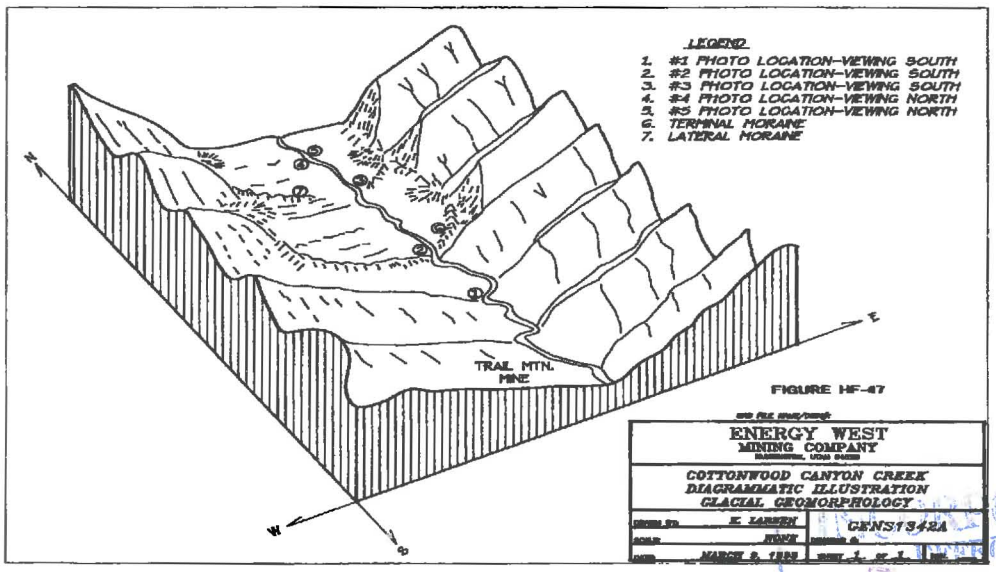
Some examples of alluvial thicknesses are: (1) drill hole 3 in Cottonwood Canyon, 120 feet; (2) drill hole 4 in Cottonwood Canyon, 60 feet; (3) drill hole 5

Structure

Tectonically, the Wasatch Plateau is in a transition zone between the relatively stable Colorado Plateau on the east side and the relatively complex and unstable Basin and Range province on the west side. On the west side the strata of the plateau dip into a

Figure 7. A view to the north of upper Cottonwood Canyon. The topography has been modified by Pleistocene glaciation.

Lateral moraine deposits most commonly occur at intersections with side canyons. Terminal moraine deposits occur at the northwest corner of Section 24, and from this point to near the confluence with Straight Canyon the canyon can be characterized as a V-shaped valley with little evidence of glaciation. A series of photos and diagrammatic illustrations of Cottonwood Canyon Creek depict the mountain glacial features discussed above (see Volume 9, photo section and Figure HF-47).



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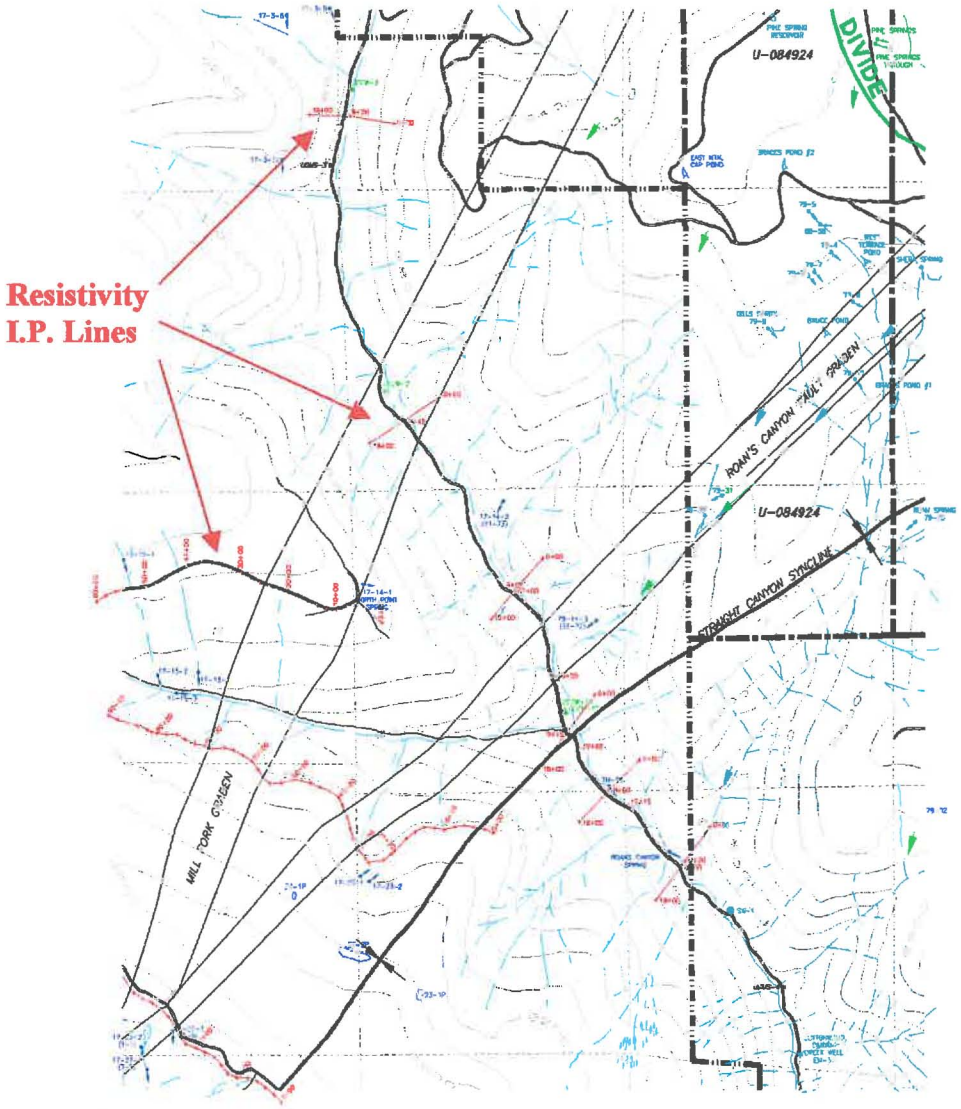
Cottonwood Canyon Glacial Geomorphology

4. RESISTIVITY RESULTS

PacifiCorp/Energy West Mining Company contracted Geowestern to conduct a Resistivity-Induced Polarization (I.P.) Survey in Cottonwood Canyon Creek in the summer 1992.

Location of Resistivity Surveys



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The intent of the survey was to identify fractures/faults and estimate the depth and the extent of alluvium in Cottonwood Canyon Creek by contrasting areas of Resistivity and I.P. response (see Volume 9, Hydrologic Support Information - Results of a Resistivity-Induced Polarization

Survey, Rilda and Cottonwood Canyons: East Mountain Property). Profiling in Cottonwood Canyon Creek included six lines perpendicular to the canyon generally extending to outcrops of the Blackhawk Formation and one parallel to the canyon bottom. Based upon the results of the resistivity and induced polarization surveys it is apparent that the depth of the alluvium is relatively consistent throughout the length of the canyon surveyed but the lateral extent of the deposits increases from north to south to a point just north of CCCR-2 (refer to HM-7). The pseudosections indicate that the fractures/faults cutting the lower end of the Cottonwood Canyon impound water in the alluvium approximately 300-500 feet up-canyon from the fracture/fault. The pseudosections also indicate that the level of groundwater increases in the area of Cottonwood Spring due to the change in the volume of the alluvium caused by change in geomorphology (glaciated-nonglaciated). It is also apparent that the lithologic contrast/fracture displaying high resistivity values on the east side of Cottonwood Canyon may be contributing water to the alluvial area. The resistivity high on the east side of Cottonwood Canyon is due to a series of small seeps and springs in the Blackhawk Formation forming on the down dip portion of the Straight Canyon Syncline (examples of springs: 91-72, 91-73 and minor seeps between Cottonwood Canyon Spring and Roans Canyon Spring).

Cottonwood Spring, located at station #880 (elevation 7749) on Line CCCR-2, is fed by flow from the water coursing downstream through the alluvium with additional flow contributed from the lithologic contrast/fracture on the east side of Cottonwood Canyon. Discharge rates from the spring area would reflect the level of groundwater within the alluvial deposits and the recharge both to the alluvial deposits and the strata above the Blackhawk Formation on the south side of Cottonwood Canyon.

Maximum alluvial depths (depth to bedrock estimates) within the survey area appear to range from 40 to 70 feet. These estimates are dependent upon the configuration of the survey spacing, lithologic contrast and the presence of groundwater. As discussed in the resistivity results (see Volume 9, Hydrologic Support Information - Results of Resistivity-Induced Polarization Survey, Rilda and Cottonwood Canyon Creek: East Mountain Property) electrode separation for profiling in Cottonwood Canyon Creek consisted of four 20-foot spacings with a horizontal setup interval of 20 feet. Although this provides a very dense data pattern, the maximum depth of penetration is roughly seventy to eighty percent of the maximum spacing, or approximately 50 to 60 feet. Generally, 50 to 60 feet of penetration was adequate for determining the depth to bedrock contrast, but in areas where the presence of groundwater or lithologic contrast existed with the alluvium (resistivity highs) and coincided with the maximum depth of penetration, the depth to bedrock was biased toward those factors. As the drilling of the alluvial wells indicated (discussed in detail in the following section), the depth to groundwater/saturated alluvium or lithologic contrast within the alluvium was fairly consistent with the pseudosections conducted perpendicular to the line of well locations. The depth estimates on the road profile CCCR-7 do not reflect maximum alluvial thickness since the cross profiles indicate maximum depths further eastward in the center of the drainage.

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5. DRILLING RESULTS

To delineate any potential impact to the first aquifer-saturated zone below the lowest mineable seam (Starpoint Sandstone-Spring Canyon Member), PacifiCorp proposed to drill a series of wells in Cottonwood Canyon downgradient of the existing and proposed mine development (see map in Appendix F, Volume 9 of the PAP). The proposed locations were originally submitted to DOGM on March 23, 1992. An on site location review was held with the Forest Service and DOGM on June 4, 1992 to finalize the site locations. It was agreed that a total of three sites would be completed, one south and two north of the Roans Canyon fault system. At each of the three proposed sites (one alternate site was chosen should difficulties arise during the permitting process or site access) two single completion wells were installed, one in the colluvial/alluvial deposits and one in the first saturated zone (Star Point Sandstone - Spring Canyon Member). Holes completed in the colluvial/alluvial deposits will be utilized to compare the well hydrographs to those of Cottonwood Canyon Creek and the Spring Canyon Member. The locations were selected for the following reasons:

a. Location of the drill sites was based on the regional dip of the top of the Spring Canyon Member of the Starpoint Sandstone Formation and positioned downgradient of the projected mine workings of the Deer Creek Mine.

b. Site selection was also based on the confinements of drilling in Cottonwood Canyon as well as to minimize environmental impacts. The sites did not require extensive site preparation (crossing the stream was not necessary) and were positioned at least 500 feet from existing natural gas wells.

c. The sites are as close to the western limit of East Mountain Federal Coal leases and will allow year-round access. Positioning the holes in the canyon also minimized the depth necessary to intersect the Starpoint Sandstone.

d. To document changes in hydrologic and climatic characteristics encountered in previous drilling programs (U.G.M.S. Drill Hole 3, Bulletin 112).

Drilling of the wells was initiated on November 17, 1992 and was completed on January 19, 1993. Six (6) wells were drilled, and five (5) were completed for hydrologic monitoring. Data regarding coal thickness is confidential and is being withheld from this submittal. The following table lists the hole identification, location, depth drilled, screened zone, and initial water level (review Annual Hydrologic Reports for monitoring information).

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1992 COTTONWOOD CANYON DRILL HOLE DATA					
HOLE ID	LOCATION SEC/TOWN/RANGE	DEPTH DRILLED	SCREEN ZONE	WATER LEVEL	WELL ELEVATION
CCCW-1A	14/17S/6E	136'	Alluvium	112.2'	7843.2
CCCW-1S	14/17S/6E	720'	Star Point Sandstone	189.0'	7844.5
CCCW-2A	11/17S/6E	136'	Alluvium	30.8'	8133.9
CCCW-2S	11/17S/6E	760'	Star Point Sandstone	*	N/A
CCCW-3A	2/17S/6E	110'	Alluvium	56.0'	8369.7
CCCW-3S	2/17S/6E	740'	Blackhawk Star Point Sandstone	77.7' 597.6'	8367.6

* Casing imploded, permanently sealed

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Drill Site #1

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Hole CCCW-1A

Drilling Procedure and Well Design

Well CCCW-1A was drilled utilizing a standard rotary type drill rig and standard drilling procedures (air mist and soap). A twelve-inch (12") diameter hole was drilled to a depth of twenty (20) feet where eighteen (18) feet of 9-5/8" steel surface casing was set and grouted. The remainder of the hole was drilled to a diameter of 8-5/8" to a total depth of one hundred thirty-six (136) feet. Bedrock was encountered at a depth of one hundred twenty (120) feet (review lithologic log in Volume 9 - Hydrologic Support Information: East Mountain Drill Holes). A review of the resistivity data (transect line CCCR-3)

indicates a resistivity high along the estimated bedrock boundary. During drilling, damp alluvium was encountered at a depth of forty (40) feet. Upon completion the static level was measured on January 14, 1993 at 112.2 feet, or an elevation of 7731.0 feet (review Well Completion Information in Volume 9 - Hydrologic Support Information). This elevation approximately equals the elevation where the groundwater reemerges from the alluvium at Roans Spring (see map HM-1, Volume 9 of the PAP).

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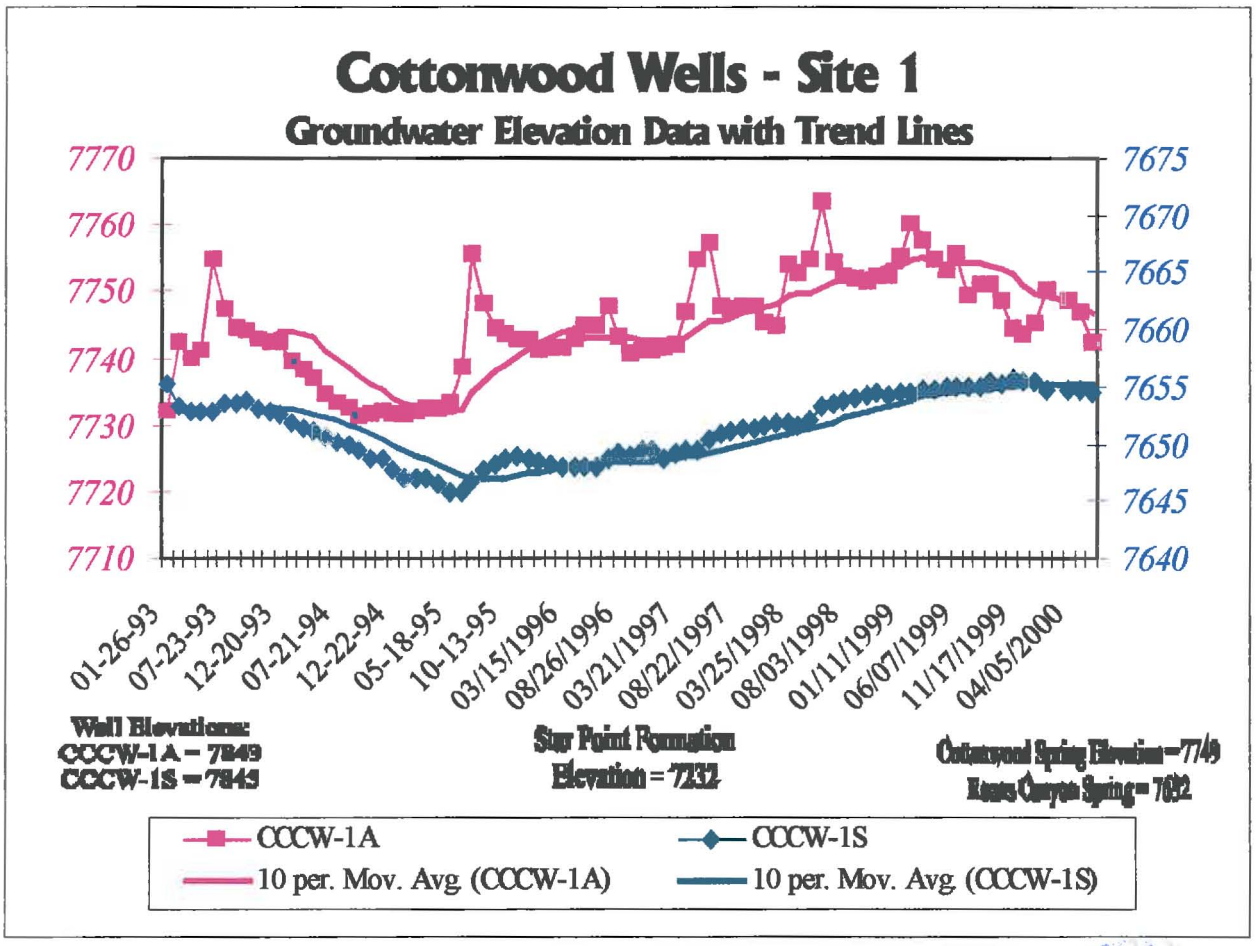
Hole CCCW-1S

Drilling Procedure and Well Design

Well CCCW-1S was drilled utilizing a standard rotary type drill rig and standard drilling procedures (air mist and soap). A twelve-inch (12") diameter hole was drilled to a depth of one hundred sixty (160) feet where one hundred forty (140) feet of 9-5/8" steel surface casing was set and grouted to isolate the alluvial deposits from the lower stratigraphic units. The remainder of the hole was drilled to a diameter of 8-5/8" to a total depth of seven hundred twenty (720) feet. The first measurable groundwater inflow occurred at approximately five hundred eighty (580) feet, which is twenty-three (23) feet above the Hiawatha Seam. Groundwater inflow increased with depth, especially in the upper fractured portion of the Starpoint Sandstone (see lithologic log in Volume 9 Hydrologic Support Information: East Mountain Drill Holes). The strata above the fluvial sandstone which occurs from 569.5 feet through 590.5 feet formed an effective barrier to vertical migration of groundwater. Well completion included setting screen in the upper Starpoint member and isolating the upper member of the Starpoint from the Blackhawk Formation (see well development data in Volume 9 - Hydrologic Support information: Well Completion Section). Upon completion the static water level was measured on January 15, 1993 at one hundred eighty-nine (189) feet, or an elevation of 7655.5 feet. The static pressure above the Hiawatha is equivalent to 179 psi. In reviewing the resistivity results (lines CCCR-3 and CCCR-7) and lineament projections from aerial photos, drill hole CCCW-1S was slightly north of the southernmost fault extension of the Roans Canyon fault system. Estimated static pressure of 179 psi above the Hiawatha Seam is comparable to the data collected in previous investigations of the Roans Canyon fault system. Pressures recorded in the Deer Creek Mine 3rd North fault investigation projects [Blind Canyon Seam, stratigraphy located approximately eighty (80) feet above the Hiawatha seam] ranged from 110 to 90 psi or 145 to 125 ft, respectively, based on the elevation of the Hiawatha Seam. It is apparent from reviewing the drilling and well completion data that the groundwater inflow intercepted in CCCW-1S was fracture controlled and is not hydrologically connected to the upper Blackhawk Formation or the alluvial deposits.

To document the hydrologic characteristics of the alluvium and the Starpoint Sandstone, PacifiCorp has collected water level information on a monthly basis since the completion of the wells. The following illustration represents data collected from 1993 to 2000.

It is evident from the trendlines that water elevation in the alluvial system varies as function of precipitation, whereas yearly responses to precipitation in the Starpoint Sandstone are less apparent.



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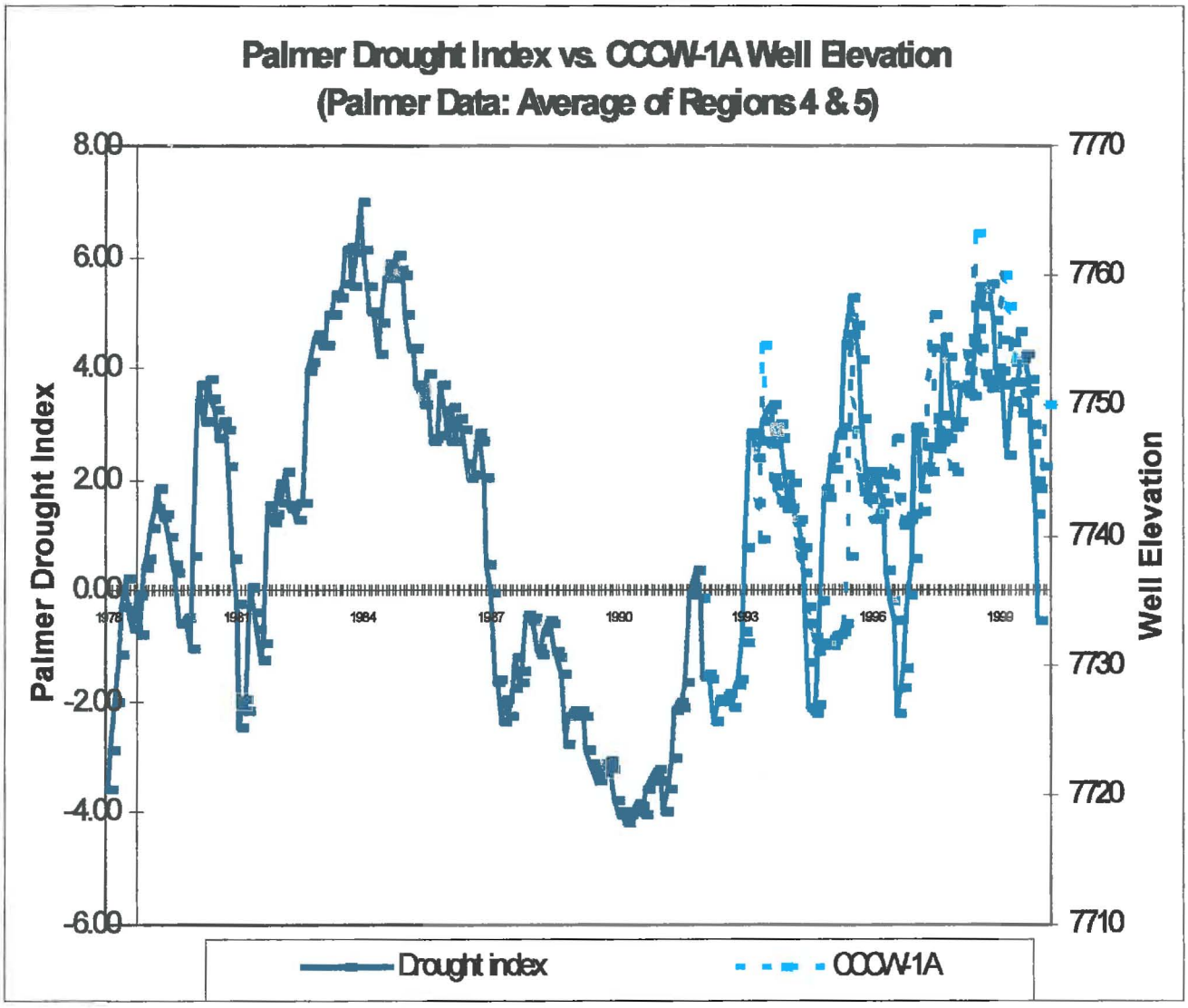
To further emphasize the correlation between the climatic and alluvial groundwater trends, the following figure compares the Palmer Drought Index to the groundwater elevations from well CCCW-1A. Well CCW-1A is located approximately 1000 feet north (up canyon) of Cottonwood Spring. The response to climatic conditions in well CCCW-1A is rapid.



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Drill Site #2

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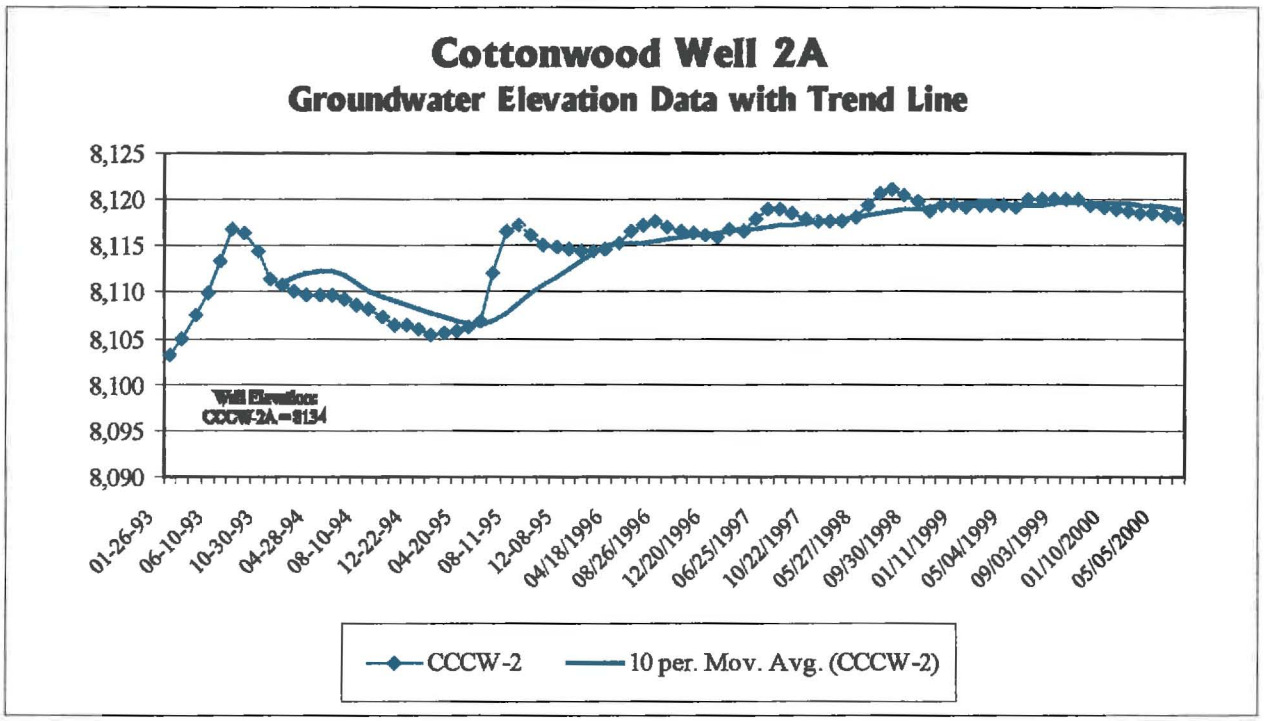
Hole CCCW-2A

Drilling Procedure and Well Design

Drill site #2 was moved from the proposed site to the alternate site due to the small size of the proposed site and poor weather. Well CCCW-2A was drilled utilizing a standard rotary type drill rig and standard drilling procedures (drilling mud was utilized to stabilize the hole). A twelve-inch (12") diameter hole was drilled to a depth of twenty (20) feet where eighteen (18) feet of 9-5/8" steel surface casing was set and grouted. The remainder of the hole was drilled to diameter of 8-5/8" to a total depth of one hundred thirty-six (136) feet. Bedrock was encountered at a depth of one hundred ten (110) feet (review lithologic log in Volume 9 - Hydrologic Support Information: East Mountain Drill Holes). A review of the resistivity data (Volume 9 - Hydrologic Support

Information: Cottonwood Canyon Creek Resistivity-I.P., transect line CCCR-5) indicates a buried gas line caused the depth to bedrock estimates to be less accurate than transects without cultural effects. During drilling saturated alluvium was encountered at a depth of forty-five (45) feet. Upon completion the static level was measured on January 26, 1993 at 30.76 feet, or an elevation of 8103.1 feet (review Well Completion Information in Volume 9 - Hydrologic Support Information).



Water elevations in CCCW-2A vary with precipitation trends similar to CCCW-1A. It is also apparent from the trendline that alluvial system is recharging in response to precipitation.

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Hole CCCW-2S

Drilling Procedure and Well Design

Well CCCW-2S was drilled utilizing a standard rotary type drill rig and standard drilling procedures. Drilling mud was utilized to stabilize the alluvial deposits prior to setting the surface casing. Air mist/soap was used to drill the remaining portion of the hole. A twelve-inch (12") diameter hole was drilled to a depth of one hundred ninety (190) feet, where one hundred eighty-eight (188) feet of 9-5/8" steel surface casing was set and grouted to isolate the alluvial deposits from the lower stratigraphic units. The remainder of the hole was drilled to diameter of 8-5/8" to a total depth of seven hundred sixty (760) feet. The first measurable groundwater inflow (<5 GPM) occurred at approximately seven hundred thirty (730) feet, which is sixty-four (64) feet below the Hiawatha Seam. Groundwater inflow remained less than 5 (<5) GPM throughout the remaining portion of the upper member of the Starpoint Sandstone (see lithologic log in Volume 9 Hydrologic Support Information: East Mountain Drill Holes). Well completion included setting screen in the upper Starpoint member and isolating the upper member of the Starpoint from the Blackhawk Formation (see well development data in Volume 9 - Hydrologic Support Information: Well Completion Section). During the grouting process the PVC casing imploded and the hole was permanently sealed. The weight of the cement grout exceeded the compressive strength for 4-inch schedule forty (40) PVC pipe. Grouting procedure for the remaining Starpoint Sandstone holes was altered to prevent the casing from collapsing. A review of drilling data reveals groundwater inflow was the result of formation production intercepted in the Starpoint Sandstone below the Hiawatha Seam and was limited to less than five (<5) GPM. Based on these observations, the lower Blackhawk/Starpoint aquifer is not hydrologically connected the upper Blackhawk Formation or the alluvial deposits.

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Drill Site #3

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Hole CCCW-3A

Drilling Procedure and Well Design

Well CCCW-3A was drilled utilizing a standard rotary type drill rig and standard drilling procedures (drilling mud was utilized to stabilize the hole). A twelve inch (12") diameter hole was drilled to a depth of twenty (20) feet where eighteen (18) feet of 9-5/8" steel surface casing was set and grouted. The remainder of the hole was drilled to diameter of 8-5/8" to a total depth of one hundred ten (110) feet. Bedrock was encountered at a depth of ninety-six (96) feet (review lithologic log in Volume 9 - Hydrologic Support Information: East Mountain Drill Holes). In reviewing the resistivity data (Volume 9 - Hydrologic Support Information: Cottonwood Canyon Creek Resistivity-I.P., transect line CCCR-6) which was conducted perpendicular to the hole location, the depth to bedrock was estimated at forty-five (45) feet. Discussions with Geowestern indicated that a layer of sandstone boulders would simulate bedrock in the resistivity data. During drilling, saturated alluvium was encountered at a depth of forty-five (45) feet. Upon completion the static level was measured on December 4, 1992 at 56.0 feet, or an elevation of 8313.7 feet (review Well Completion Information in Volume 9 - Hydrologic Support Information).

Hole CCCW-3S

Drilling Procedure and Well Design Well CCCW-3S was drilled utilizing a standard rotary type drill rig and standard drilling procedures. Drilling mud was utilized to stabilize the alluvial deposits prior to setting the surface casing. Air mist/soap was used to drill the remaining portion of the hole. A twelve inch (12") diameter hole was drilled to a depth of one hundred forty-five (145) feet where one hundred forty-two (142) feet of 9-5/8" steel surface casing was set and grouted to isolate the alluvial deposits from the lower stratigraphic units. The remainder of the hole was drilled to 8-5/8" to a depth of one hundred sixty eight (168) feet and then down-sized to 6-1/8" to a total depth of seven hundred forty (740) feet. The first measurable groundwater inflow (≈ 55 GPM) occurred at approximately one hundred forty-six (146) feet from fractured/oxidized sandstone. The Utah Geological Mineral Survey drill hole UGMS-3 (drilled in 1975), located within approximately five hundred (500) feet of CCCW-3S, had artesian flow of one hundred fifty (150) GPM from the same stratigraphic unit (refer to the following page for a copy of page 36 of UGMS Bulletin 112, artesian flow encountered at a of depth 129).

Groundwater production from the fractured fluvial sandstone remained relatively constant at fifty to sixty five (≈ 55-65) GPM during drilling of the lower stratigraphic units (see lithologic log in Volume 9 Hydrologic Support Information: East Mountain Drill Holes). Well completion was altered to include a dual completion: lower section - set screen in the upper Starpoint member and isolating the upper member of the Starpoint from the Blackhawk Formation; upper section - set screen in the fluvial sandstone to document seasonal variations in the upper portion of the Blackhawk Formation (see well development data in Volume 9 - Hydrologic Support information: Well Completion Section). Upon completion the static level was measured on January 26, 1993 at 77.6 feet, or an elevation of 8290.0 feet, for the upper section and 597.6 feet, or an elevation of 7777.0 feet, for the lower section (review Well Completion Information in Volume 9 - Hydrologic Support Information).

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PROJECT Wasatch Plateau Drilling SHEET 2 OF 9

SITE Dairy Canyon D.H. 3

ELEVATION	DEPTH	LOG	DESCRIPTION
			72 Sandstone boulder, gray, fine-grained
8270	80		82 Alluvium; silt, sand and gravel; water entering hole
8260	90		
8250	100		
8240	110		
8230	120		120 Shale, gray, fissile
8220	130		129 Sandstone, tan, fine-grained, water-saturated; artesian flow of 150 gallon/minute
8210	140		143 Shale, gray, fissile
			145 Coal
			146 Shale, gray, fissile
8200	150		

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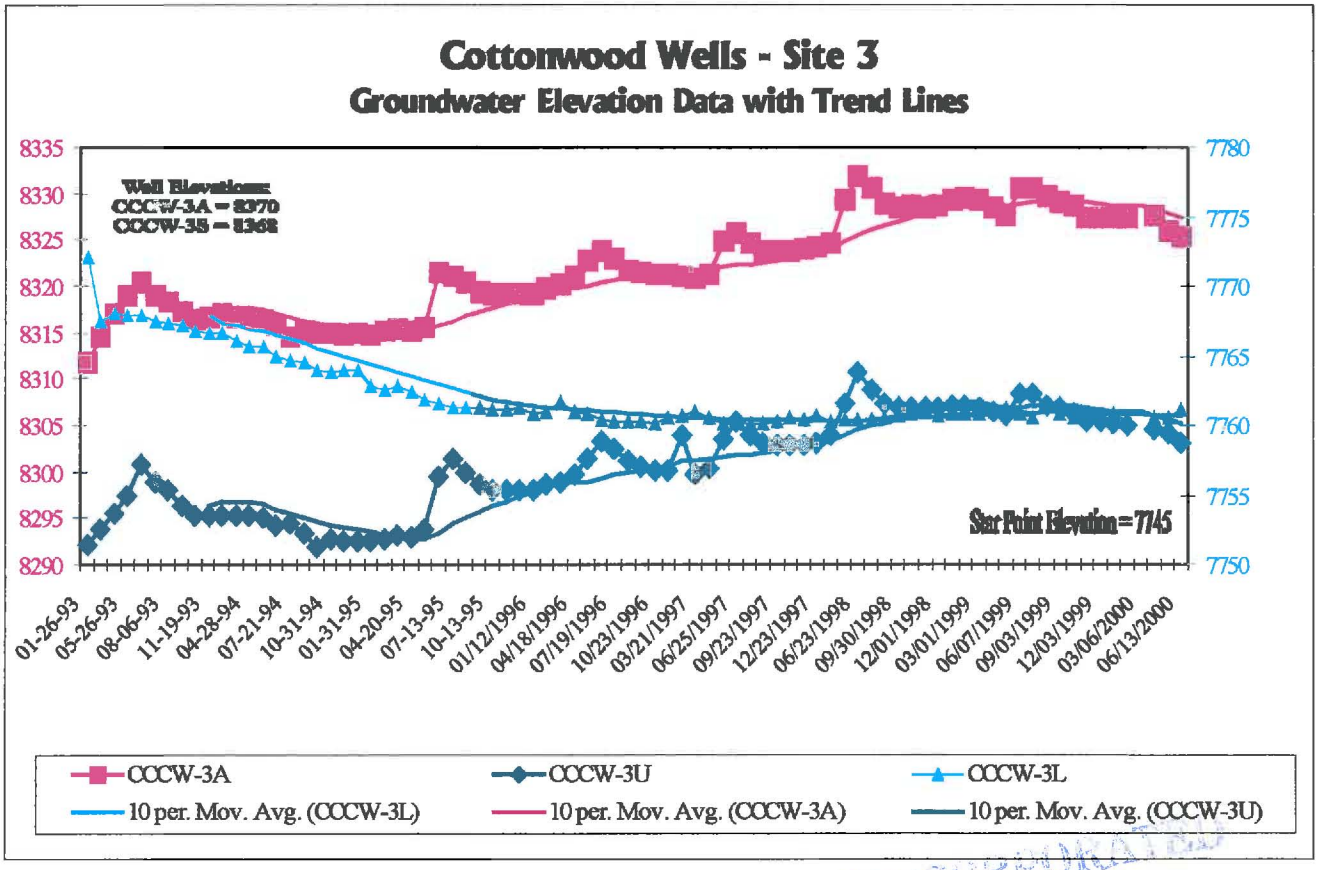
Site CCCW-3S was chosen for a variety of reasons including: 1) the ability to monitor seasonal variations in the stratigraphic units north of the Roans Canyon fault/fracture system; 2) the site is positioned downgradient of any projected mine workings; 3) site access limited impact to the surrounding area; 4) site CCCW-3S is located over two miles and up stratigraphic dip from the existing Deer Creek Mine workings; and 5) close proximity to UGMS-3 (previous hydrologic data collected during drilling of UGMS-3 could be compared to the results of CCCW-3S to document climatic patterns in groundwater production). At the same stratigraphic unit (fluvial sandstone), groundwater production from UGMS-3 was artesian flow measured at one hundred fifty (150) GPM and CCCW-3S was measured 77.6 feet below the ground surface. This would indicate a minimum reduction of head of approximately thirty four (34) psi or 77.6 feet. From reviewing the drilling, well completion data and well monitoring data (refer to well hydrograph on the following page) it is apparent that the lower Blackhawk/Starpoint aquifer is not hydrologically connected to the upper Blackhawk Formation. Water level in well CCCW-3A was measured during drilling of the upper Blackhawk Formation and the lower Blackhawk/Starpoint Sandstone. The static level remained relatively constant, indicating the alluvial deposits are not hydrologically connected to the lower stratigraphic units.



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AQUIFER TEST RESULTS

PacifiCorp completed a "slug test" at each well to determine aquifer characteristics of the isolated zone (refer to the following table and Volume 9 - Hydrologic Support Information: East/Trail Mountain Aquifer Test Results for complete test results).

WELL No.	Aquifer Type	PERMEABILITY (ft/min)	TRANSMISSIVITY (ft^2/min)
CCCW-1A	Unconfined	5.814E-5	NA
CCCW-2A	Unconfined	9.387E-5	NA
CCCW-3A	Unconfined	7.64E-5	NA
CCCW-1S	Confined	5.23E-3	0.5032
CCCW-3 U	Confined	1.37E-3	2.462E-2
CCCW-3S L	Confined	2.97E-5	2.453E-3

7. DATA FROM MAYO & ASSOICATES

In 1996, as a part of comprehensive review of the surface and groundwater systems of East and Trail mountains, Mayo & Associates collected stable and unstable isotopic data from the alluvial groundwater system in Cottonwood Canyon at Roans Spring, water from the Star Point Sandstone formation isolated in well CCCW-1S, and in-mine groundwater sources. The ^{14}C and ^{3}H compositions of the spring and well water (see the following table) indicate that it is of modern origin and is not related to the deep groundwater systems encountered within the mines. The interception of groundwaters within the mine workings, therefore, does not adversely impact groundwater flow rates in the alluvial springs in Cottonwood Canyon (refer to the following table and Volume 9 – Hydrologic Support Information: Mayo & Associates Study for complete study results).

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Cottonwood Canyon Isotopic Data

Sample Location	Sample Date	^{14}C (pmc)	^{3}H (TU)	Mean Residence Time (Years)
Roans Canyon Spring	4/2/96	73.24	11.2	Modern
91-72	12/14/96	75.47	14.9	Modern
91-73	12/15/96	79.49	2.63	Modern
MW Seals Cottonwood Mine	2/26/97	21.99	1.34	8,000
3rd South Seals Deer Creek Mine	2/26/97	14.4	0.88	12,000
CCCW-1S	12/9/96	46.17	1.10	1,000 Mixed

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8. DOGM FINDINGS

The Division of Oil, Gas and Mining's initial findings dated September 11, 1991, indicated that with existing information it was possible to show that the Deer Creek Mine had intercepted significant groundwater quantities which may have caused the decreased flow at the spring (see Attachment 1). In addition, the Division produced a chronology of events related to Cottonwood Spring and the Roans Canyon Graben crossing (internal memo dated October 16, 1998). The Division listed several areas of concern which are discussed and refuted below.

Cottonwood Canyon Wells

"The ground water conditions reported from the Cottonwood Creek wells do not support the company's theory that the spring was alluvial water…."

As shown earlier, ground water elevations in the Cottonwood Canyon Creek alluvial system vary as a function of precipitation and wells which isolate the Star Point Sandstone trend independently from precipitation (CCCW-1S is less apparent due to well completion). As the graphs illustrate, (review Drilling Results – Drill Site No. 1, Groundwater Elevation Data with Trend Lines and Palmer Drought Index vs. CCCW-1A Well Elevation), central Utah experienced dramatic shift climate patterns from extremely above normal precipitation from 1982 through 1986 to a extreme drought from late 1986 through 1993. As the climatic patterns returned to a normal pattern in 1993, groundwater in the alluvial system began to recharge. Recharge to the alluvial system peaked in early 1999 and began a downward trend. PacifiCorp stated in the MRP and meetings concerning Cottonwood Spring, as the alluvial system recharged, flow from the Cottonwood Spring area would re-develop. Based on the groundwater trends in well CCCW-1A, PacifiCorp initiated gain/loss surveys of Cottonwood Canyon in 1998 to confirm experienced in the monitoring wells and to document areas of groundwater discharge. Gain/loss surveys were conducted throughout reach of Cottonwood Canyon from Mill Canyon in Section 2, Township 17 South, Range 6 East to below Roans Canyon in Section 24, Township 17 South, Range 6 East. Station selection was based upon areas of detected change and to duplicate previous research (USGS). As discussed earlier, data collected compared directly to the climatic trends and to the data collected by the USGS (refer to Attachment 5 for Gain/Loss Survey Data). Over a two year period (1998-2000), flow from the Cottonwood Spring area ranged from approximately 100 gpm to 40 gpm.

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Cottonwood Canyon Wells: Groundwater Flow

The Division staff calculated the amount of water flowing through the alluvium based upon slug test results conducted on the alluvial wells. Based on the assumptions used, the Division surmised the alluvial system was incapable of producing the volume of water historical recorded from the spring site. In reviewing the lithologic logs of the completed alluvial monitoring holes, site visits with the Division staff and numerous

meetings, the alluvial deposits of Cottonwood Canyon were shown to consist of stratified layers of very fine silt to large boulders. The following photo illustrates the stratified deposits of Cottonwood Canyon (photo of eroded banks near Cottonwood Spring).

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During development of the alluvial monitoring wells, several zones of "flowing sediments" were encountered. Well screen and sand were selected to protect of the integrity of the well and individual sediment sequences were not isolated. Overall, the hydrologic test results represent the entire sequence and not individual sediment horizons. The alluvial wells were installed to monitor changes in the groundwater elevations, not for the purpose of hydrologic testing.

In alluvial systems like Cottonwood Canyon, horizontal component of flow is a key factor in movement of groundwater and dictates areas of surface flow. As the gain/loss surveys conducted by PacifiCorp revealed, surface flow of Cottonwood Canyon includes several areas of groundwater recharge and discharge. One area of groundwater discharge is the Cottonwood Spring area. As previously discussed, PacifiCorp excavated the site (only hand shovel required) to verify the development construction. A three (3) inch PVC pipe, approximately three [3] feet in length, was simply inserted into coarse gravel lens with soil compacted around the pipe (see adjoining photo). The gravel lens is approximately two (2) feet thick and is heavily oxidized indicating near surface influence. As discussed with the Division and regulatory staffs, the area of recharge of Cottonwood Spring exists up-canyon and the discharge area is a function of change in topography from glacial to non-glacial terrain.

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Timing of Mining

The Division staff documented the apparent timing of interception of groundwater in the Deer Creek Mine and the reduced flows of Cottonwood Spring. Two areas were discussed, 1) installation of test wells to analyze the hydrologic characteristics of the Roans Canyon Graben, and 2) interception of groundwater in the 4th South longwall panel area.

As documented in MRP, PacifiCorp initiated two separate hydrologic testing programs to quantify hydrologic aspects of the Roans Canyon Graben as preparation for crossint the fault zone to access additional reserves north of the fault. The first program was conducted in 1985 and the second in 1988. Drill holes completed in 1985 were small diameter (AW; <2"), and were shut in after completing each hole (five holes were completed in 1985). A constant rate drawdown test was conducted utilizing drill hole #4 at a rate of 35 gpm for 1700 minutes. After the test was completed, all wells were shut in and capped. Prior to the 1988 test, the 1985 drill holes were inspected for possible inclusion in the 1988 program. All of the holes completed in 1985 were squeezed shut or plugged, and were not included in the 1988 project.

A total of five holes were completed in 1988. After the completion of each test well, a short duration discharge test were conducted (normally <30 minutes) to evaluate the well completion techniques. As documented in the Hydro-Search Report, the original design used on wells TW-6 and TW-7 was abandoned because the casing (1 1/4") excessively restricted ground water discharge and the casing material (PVC) collapsed due to high lithostatic pressures (open hole flow from the completed well TW-7 was <45 gpm). After completion of the five holes (TW-6 through TW-10), aquifer zones were allowed to stabilize from Sept. 2-10, 1988. A drawdown test was initialized on Sept. 10, 1988 using TW-10 with a constant flow rate set at 76 gpm for a duration of 10,000 minutes.

The purpose of the 1988 program was two-fold: 1) to evaluate and confirm the 1985 Hydrologic Test results, and 2) to analyze de-watering scenarios (slope construction with and without de-watering and grouting). Based upon the 1988 test results, Hydro-Search recommended de-watering the fault zones prior to slope development and grouting to control local ground water inflow after slope construction. Test wells completed in 1988 were analyzed for de-watering potential, and the same conditions which rendered the 1985 wells unusable (flow constrictions due to casing failures) also hampered the 1988 wells. Only test well TW-10 functioned as originally designed and has been monitored since December 1988 (see attached graph). Flow from well TW-10 dissipated rapidly from ≈40 gpm to <5 gpm. Due to the ineffectiveness of the de-watering wells, PacifiCorp initiated a grouting program <u>during</u> slope development to minimize ground water inflow. Grout holes were drilled around the circumference of the tunnels prior to the fault zones to develop a grout "curtain". As a result, long term ground water inflow from the Roans Canyon Fault crossing tunnels has been less than originally projected and averages <30 gpm.

The second point of mine timing the Division listed was the interception of large quantities of groundwater in the Deer Creek Mine (interception of the Roans Canyon fault, in the 4th South longwall panel area). As the following figure illustrates, a sympathetic fault of the Roans Canyon Graben was intercepted in 1st and 2nd Right in early 1990. As documented earlier, flow from Cottonwood Spring dissipated (recorded flow 0.0 June 1988) <u>prior</u> to the interception of groundwater from the sympathetic fault.

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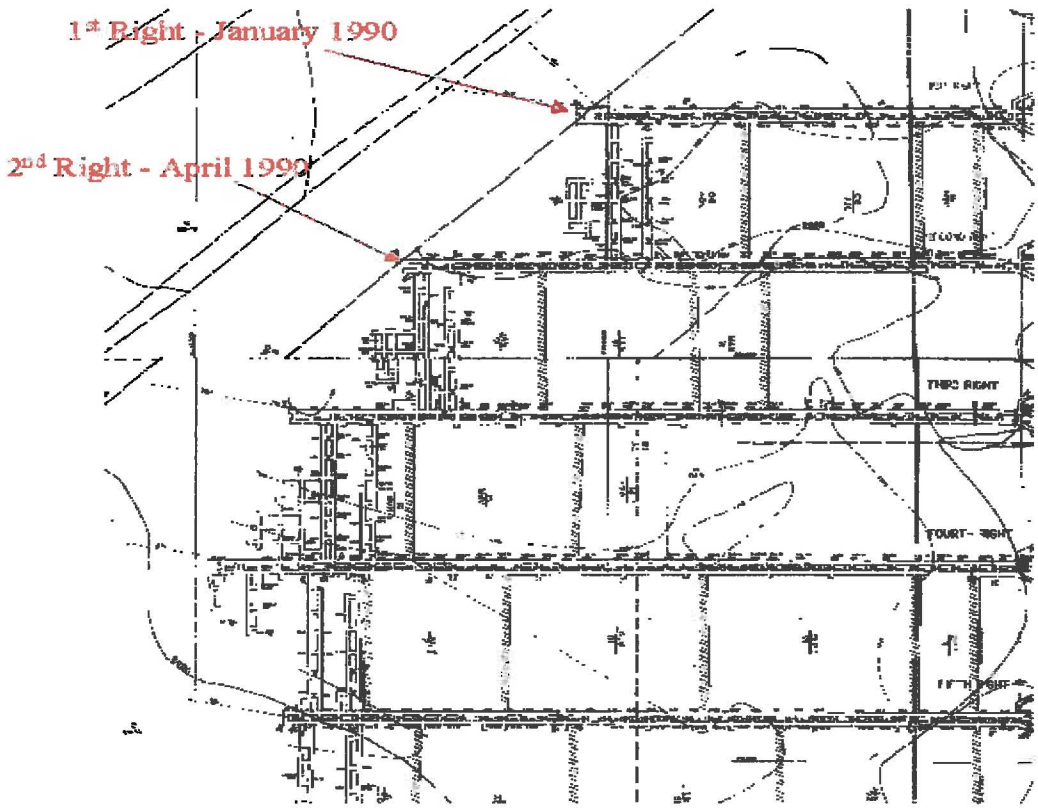
Deer Creek Mine
4th South Area
Intercepted Roans Canyon Fault



During meetings with the regulatory agencies, PacifiCorp presented data and maps to demonstrate that the upper Blackhawk strata in Cottonwood Canyon were unsaturated between the alluvial deposits and the coal seam interval. Map HM-12 was developed and included in Volume 9 to show the hydrogeology of the Cottonwood Canyon and includes cross sections through East and Trail mountain. In addition to the work completed by PacifiCorp, Mayo & Associates was hired to develop a comprehensive hydrogeologic model of East Mountain and Trail Mountain. As the study documented, intercepted groundwater in PacifiCorp's East & Trail mountain properties is <u>not</u> hydraulically connected to surface water resources (refer to Hydrologic Support Information).

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Stiff Diagrams

The Division's September 11, 1991 investigation of Cottonwood Spring concluded, "Stiff diagrams reflected very consistent quality, with little seasonal fluctuation, indicating that the source was from groundwater and not alluvial water". As document in the Volume 9 and in numerous meetings, water quantity from near surface alluvial systems can vary rapidly from season to season but quality will remain fairly constant. PacifiCorp, in corporation with North Emery Water Users Association, has conducted several studies of a similar alluvial system located in Rilda Canyon. Alluvial discharge in Rilda Canyon can vary from 80 to 300 gpm during the runoff season and the quality will remain constant.

Oxidation at 2000' depth

As the Division's October 16, 1998 report states "that surface water was reaching the mine 2000 feet below the ground surface, since large areas were oxidized at the mine level along the Roans Canyon Fault crossing". The report went on to utilize the observed Roans Canyon test wells elevations in direct comparison to the elevation of Cottonwood Spring. The Division ignored information reported in Volume 9 and the hydrologic investigation Roans Canyon fault crossing concerning horizontal gradient, location of the crossing and hydrogeologic information of the Roans Canyon intercept in the 4th South area of the Deer Creek Mine.

- As reported in the Roans Canyon hydrologic investigation, the horizontal gradient shown in the test wells was dipping steeply dipping from west to east towards Meetinghouse Canyon, away from the direction of Cottonwood Spring.
- The Roans Canyon fault crossing at 3rd North is located in close proximity (less than one mile) to the right fork of Meetinghouse Canyon and isotopic data indicates that the source of water is of modern age (refer to Volume 9 – Hydrologic Support Information: Mayo & Associates report).
- The 4th South Roans Canyon fault intercept (located approximately two [2] miles west of the 3rd North fault crossing) was <u>not</u> oxidized, and isotopic data indicates the water intercepted was "old water", in excess of ten thousand (10,000) years old and therefore not hydraulically connected to the surface systems.

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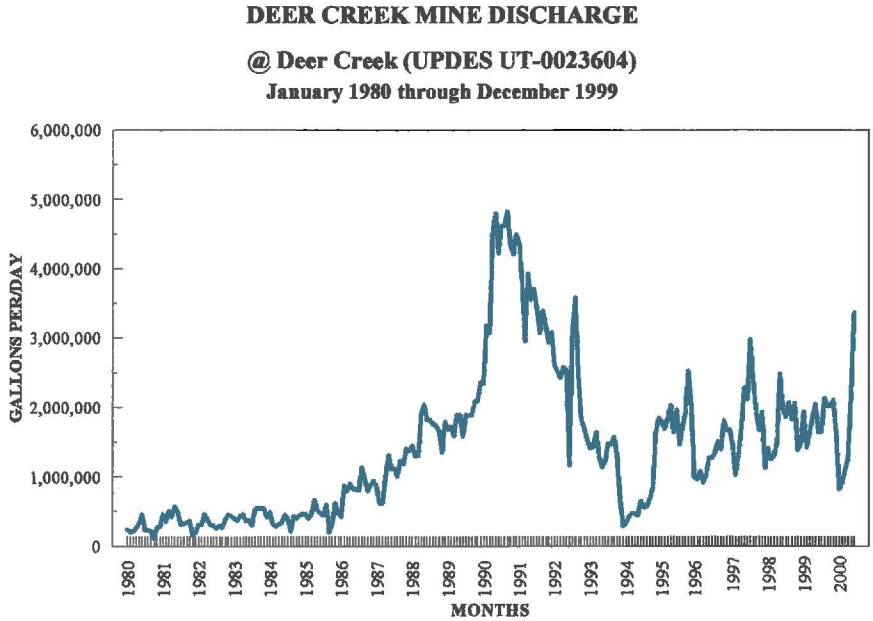
Mine Discharge Graphs

The Division's report describes historical water production and incorrectly accounts for changes in the hydrograph. As stated in the report, "water production began increasing in 1985 when the mine workings were approaching the graben and exploratory drilling commenced. Major increases in mine water discharge in 1988 was probably due to drilling into the graben for testing and dewatering purposes. The graben crossing was constructed in 1989 and additional inflows fromthe graben dewatering…".



- As PacifiCorp has stated, hydrologic testing in 1985 was conducted on a limited scale with very little water production and all test wells were sealed after the hydrologic drawdown test was complete.
- The major source of groundwater interception from 1986 through 1990 was related to mining in the trough of the Straight Canyon Syncline in areas dominated by water saturated fluvial sandstone channel deposits (refer to HM-2, 3rd and 4th South area).
- Hydrologic investigation of the Roans Canyon conducted in 1988 included drilling a series of wells to identify hydrologic characteristics of the graben area. A total of five (5) wells were completed across the graben area. After each well was completed, flow was eliminated and pressure gauges were installed to monitor well recovery. At the completion exploration phase, a drawdown test was conducted on one (1) well, while pressure was monitored on the remaining wells. After the hydrologic test, all wells were sealed. Initial plans for the test wells included de-watering in advance of slope construction to minimize hydraulic pressures. As a result of well construction techniques and geologic conditions encountered during development, the wells never functioned as intended. As pointed out in Volume 9, PacifiCorp instituted a pressure grout system in advance of slope construction to minimize groundwater inflow and to stabilize ground conditions. As tours of the 3rd North crossing with the government agencies have shown, the grout curtain effectively isolated the rock slopes and minimized hydrologic impacts.

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Cottonwood Creek Flows

During the Division's October 1998 evaluation, review of Cottonwood Canyon Creek flow data was limited to the time period from 1984 through 1991 (data supplied by PacifiCorp). With this limited review, the Division stated that the base flow was generally over 1 CFS. PacifiCorp updated the Cottonwood Canyon hydrograph and supplied this information to the Division during July 1998 on-site review, which clearly shows that the base of Cottonwood Canyon Creek averages less than one half (<0.5) CFS (included previously in this appendix, Introduction /General Section). In addition, as the normal precipitation patterns returned, the Cottonwood Creek hydrograph exhibits flow characteristics similar to historical data.

Conclusion of Department of Oil, Gas & Mining Cottonwood Spring Study

On October 27, 1998 the Division sent a letter to the Bureau of Land Management and the United States Forest Service that stated, "The Division has made an extensive review of this issue (Cottonwood Spring) and has made findings to conclude the complaint. By this letter and enclosed memos, the Division also concludes the issue of Cottonwood Spring. To date, no definitive connection between Cottonwood Spring has been cited or proven in relation to mining at the Deer Creek Mine. Hopefully, this documentation from our division will provide the needed paperwork for the US Forest Service and the Bureau of Land Management to move forward with the lease relinquishment for this area."

After the Division's findings were sent to subsuface and surface regulatory agencies, the USFS (surface owner) sent a response letter dated May 5, 1999. The letter indicated to reslove the Cottonwood Spring issue, the USFS would accept three (3) listed alternatives: 1) for PacifiCorp to conduct gain/loss surveys for a two year period to confirm hydrologic trends, 2) for PacifiCorp to restore perennial flow of like quantity and quality at or above Cottonwood Spring, or 3) for PacifiCorp to finance manipulation of existing watershed to increase water yield. PacifiCorp did not receive an official notification from the USFS or the Division concerning these alternatives listed above. Findings listed in the USFS letter dated May 5, 1999 consist of the same inconsistencies which were discussed above.

To help resolve and bring closure to the Cottonwood Spring issue, for the last two years PacifiCorp has voluntarily conducted periodic gain/loss surveys of Cottonwood Canyon area. As detailed earlier, (refer to Cottonwood Canyon gain/loss Surveys), gain/loss surveys included measurements collected along the Cottonwood drainage from Mill Canyon in Section 2, Township 17 South, Range 6 East to below Roans Canyon in Section 24, Township 17 South, Range 6 East (refer to Attachment 4). These surveys included measurements of each of the contributing sub-drainages and Spring 91-72. Depending upon flow, quantity data was collected at each site utilizing either the bucket/stop watch method or by temporarily installing a 90° v-notch weir.

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displacements ranging from a few feet to over 150 feet. PacifiCorp has conducted extensive studies to document the hydrologic significance of the graben structure. (See Volume 9, R645-301-711, A. Existing Groundwater Resources: Structural Hydrologic Features). Based on research conducted by PacifiCorp, faulting along the Roans Canyon system occurred during two phases -- during the first (east-west compression phase) strike slip movement occurred prior to the deposition of the Flagstaff Limestone; during the second (east-west tension phase) normal faulting occurred along strike slip faulting plane resulting in the formation of a graben structure. Displacement along the Roans Canyon Fault system increases to the north until it is terminated by the Pleasant Valley Fault system. In the area of Cottonwood Canyon Creek, the Roans Canyon Fault system consists of two or more fractures with little or no displacement.

During the resistivity study a second linear feature, which could possibly be a southern extension of the Mill Fork Canyon fault system, was detected on transect line CCCR-5. The southernmost fault of the Mill Fork Canyon Graben was intersected in Arco's Beaver Creek #4 Mine in Mill Fork Canyon and has a displacement of about twenty (20) feet down on the northwest side. Where the fault crosses the northern end of East Mountain, the fault has a displacement of about thirty (30) feet down on the northwest side.

* Cottonwood Canyon Creek is a major drainage system where evidence of glaciation exists. From the headwaters to Section 24, Township 17 South, Range 6 East the canyon is characterized by U-shaped valleys with associated lateral and terminal moraine deposits. Lateral moraine deposits most commonly occur at the intersection with side canyons. Terminal moraine deposits occur at the northwest corner of Section 24, and from this point to near the confluence with Straight Canyon the canyon can be characterized as a V-shaped valley with little evidence of glaciation.

* Based upon the results of the resistivity and induced polarization study it is apparent that the depth of the alluvium is relatively consistent throughout the length of the canyon surveyed, but the lateral extent of the deposits increases from north to south to a point just north of CCCR-2. The pseudosections indicate that the fractures/faults cutting the lower end of the Cottonwood Canyon impound water in the alluvium approximately 300-500 feet up-canyon from the fracture/fault. The pseudosections also indicate that the level of groundwater increases in the area of Cottonwood Spring due to the change in the volume of the alluvium caused by change in geomorphology (glaciated-nonglaciated). It is also apparent that the lithologic contrast/fracture displaying high resistivity values on the east side of Cottonwood Canyon may be contributing water to the alluvial area.

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Cottonwood Spring, located at Station # 880 on Line CCCR-2, is probably fed by flow from the water coursing through the alluvium with additional flow contributed from the lithologic contrast/fracture on the east side of Cottonwood Canyon. Discharge rates from the spring area would reflect the level of groundwater within the alluvial deposits and the recharge both to the alluvial deposits and the strata above the Blackhawk Formation on the south side of Cottonwood Canyon. Maximum alluvial depths within the survey area appear to range from 40 to 70 feet. General resistivity highs within the alluvium indicate an abundance of fresh water. The depth estimates on the road profile CCCR-7 do not reflect maximum alluvial thickness since the cross profiles indicate maximum depths further eastward in the center of the drainage.

* To delineate any potential impact to the first aquifer-saturated zone below the lowest minable seam (Starpoint Sandstone-Spring Canyon Member) PacifiCorp developed a series of wells downgradient of the existing and proposed mine development. The proposed locations were originally submitted to DOGM on March 23, 1992. An on site location review was held with the Forest Service and DOGM on June 4, 1992 to finalize the site locations. It was agreed that a total of three sites would be completed, one south and two north of the Roans Canyon fault system. Drilling of the wells was initiated on November 17, 1992 and was completed on January 19, 1993. Six (6) wells were drilled, and five (5) were completed for hydrologic monitoring. At each of the three sites two single completion wells were installed (except for CCCW-2), one in the colluvial/alluvial deposits and one in the first saturated zone below the lowest minable seam (Spring Canyon Member of the Star Point Sandstone). An additional well was developed in the Blackhawk Formation at site CCCW-3.

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It is apparent from the drilling results that groundwater production greater than five (>5) GPM was fracture controlled and inflow from non-fractured strata was less than five (<5) GPM. Based on the drilling and well completion data the lower Blackhawk/Upper Starpoint is not hydrologically connected to the upper Blackhawk Formation or the alluvial deposits, even in the area of the Roans Canyon Fault trace. In reviewing the data from drill site CCCW-3S, the effects of the drought in the upper Blackhawk Formation are evident. At the same stratigraphic unit, fluvial sandstone, groundwater production from UGMS-3 was artesian flow measured at one hundred fifty (150) GPM, and CCCW-3S was measured 77.6 feet below the ground surface. This would indicate a minimum reduction of head of approximately thirty-four (34) psi or 77.6

feet. At well CCCW-1A the static level was measured on January 14, 1993 at 112.2 feet, or an elevation of 7731.0 feet. This elevation approximately equals the elevation where the groundwater reemerges from the alluvium at Roans Spring.

Monitoring of the wells completed has shown that water elevations in the Cottonwood Canyon Creek alluvial system vary as a function of precipitation and wells which isolate the Star Point Sandstone trend independently from precipitation (CCCW-1S is less apparent due to well completion). As the graphs illustrate, (review Drilling Results – Drill Site No. 1, Groundwater Elevation Data with Trend Lines and Palmer Drought Index vs. CCCW-1A Well Elevation), central Utah experienced dramatic shift climate patterns from extremely above normal precipitation from 1982 through 1986 to an extreme drought from late 1986 through 1993. As the climatic patterns returned to a normal pattern in 1993, groundwater in the alluvial system began to recharge. Recharge to the alluvial system peaked in early 1999 and began a downward trend. PacifiCorp stated in the MRP and meetings concerning Cottonwood Spring, as the alluvial system recharged, flow from the Cottonwood Spring area would re-develop. Based on the groundwater trends in well CCCW-1A, PacifiCorp initiated gain/loss surveys of Cottonwood Canyon in 1998 to confirm experienced in the monitoring wells and to document areas of groundwater discharge. Gain/loss surveys were conducted throughout reach of Cottonwood Canyon from Mill Canyon in Section 2, Township 17 South, Range 6 East to below Roans Canyon in Section 24, Township 17 South, Range 6 East. Station selection was based upon areas of detected change and to duplicate previous research (USGS). As discussed earlier, data collected compared directly to the climatic trends and to the data collected by the USGS (refer to Attachment 5 for Gain/Loss Survey Data). Over a two year period (1998-2000), flow the Cottonwood Spring area ranged from approximately 100 gpm to 40 gpm. The discharge data collected by PacifiCorp from 1998-2000 from the Cottonwood Spring area compared directly to the data collected by the USGS during the late 70's and early 80's.

- Data from a study conducted by Mayo & Associates indicate that water from the alluvial system in Cottonwood Canyon is of modern age and is not related to the deep groundwater systems encountered in the mine.

- On October 27, 1998 the Division concluded the issue of Cottonwood Spring. As stated in the letter, "no definitive connection between Cottonwood Spring has been cited or proven in relation to mining at the Deer Creek Mine".

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VOLUME 9
HYDROLOGIC SECTION

Appendix C

Cottonwood Canyon Creek Hydrogeologic Investigation

Attachment 1
DOGM Correspondence

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Norman H. Bangerter
Governor
Dee C. Hansen
Executive Director
:e R. Nielson, Ph.D.
Division Director

State of Utah

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING

355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203
801-538-5340

September 11, 1991

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OOP

TO: Pamela Grubaugh-Littig, Permit Supervisor

FROM: Ken Wyatt, Tom Munson, Reclamation Hydrologists

RE: Cottonwood Spring Citizen's Complaint, Deer Creek Mine, Pacificorp Electric Operations, ACT/015/018, Folder # 2 and Citizen's Complaint File, Emery County, Utah

SYNOPSIS

On August 1, 1991, the Division received a letter from Mr. Jim Peacock stating that a spring located in Cottonwood Creek had ceased flowing over the last several years. He had heard about the increased flows from the Deer Creek Mine and requested the Division to investigate whether these increased flows from the mine had any relation to this spring. Mr. Peacock has water rights along Cottonwood Creek.

In response to the citizen complaint from Jim Peacock received by the Division on August 1, 1991, a meeting was held on August 20, in the Cottonwood Creek area. The following persons were in attendance.

NAME	AGENCY/AFFILIATION	ADDRESS, PHONE #
Eugene Johansen	Cottonwood Creek Consolidated Irrigation Co.	Castledale
Jay Humphrey	Emery Water Conservancy District	Castledale
Rodger Fry	Pacificorp	SLC, 220-4610
Chuck Semborski	Pacificorp	Huntington, 653-2312
Carly Burton	Pacificorp	SLC, 220-2174
Val Payne	Pacificorp	Huntington, 653-2312
Denise Dragoo	Attorney for Pacificorp	215 S. State, Suite 1200 SLC, 84111; 531-8900
Ken Wyatt	Utah Div. Oil, Gas & Mining	SLC, 538-5266
Tom Munson	Utah Div. Oil, Gas & Mining	SLC, 538-5288
Bill Warmack	Utah Div. Water Rights	Price, 637-1303
Jim Peacock	Ranch Owner	150 E 7060 S, Midvale, 84047; 255-2221
Paul Peacock	Ranch Operator	Orangeville

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ANALYSIS

The meeting commenced at 11:00 a.m. at the junction of Straight Canyons and Cottonwood Canyons. Mr Jim Peacock began by describing his properties in the area, the history of these properties and the agricultural practices used on this land. The land being affected by the loss of this spring water is located in Section 7 and 8 of T18S R7E. (See attachment 1)

The tour then went up Cottonwood Canyon to the point of diversion from Cottonwood Creek. At this time approximately .23 CFS flow was observed entering this canal. (Approx. .25 feet in a 6" flume)

Following this observation, we visited the site of the spring. No water was observed in the creek channel or from the spring discharge pipe. The spring previously surfaced from the Northeast hillside slightly above creek level. Discussions were held concerning the flow of this spring. Eugene Johansen indicated that this spring has been diminishing for 8 - 10 years. U.S. Geological Survey records from 1977 - 1982 indicated that the spring flowed between 40 and 110 GPM continuously from the Blackhawk Formation. Cottonwood Creek between Mountain Coal Mine to the Spring was wet with very limited surface water.

The tour then proceeded to the culvert outlet at Mountain Coal Mine where it was observed that the majority of Cottonwood Creek flow was from the mine water discharge pipe below the sediment pond. The stream flow as measured at the USGS monitoring station was .32 CFS (.19 feet through a 12"flume).

Examination of map No.3 (partial copy as attachment 2) included in the Deer Creek Mine UPDES Permit Application shows that the area of major water production within the mine is located just south of the Roans Canyon Fault. The spring is located just south of the Roans Canyon Fault on the down-dipped side of the canyon near the axis of the Straight Canyon Syncline. The mine water discharge at the Deer Creek Mine averaged 6.75 CFS from December 1990, to July 1991.

Using water chemistry data from the Trail Mountain Mine 1986 water monitoring program, Stiff diagrams were generated for this spring and Cottonwood Creek. Pacificorp FAXed the Division data for two springs adjacent to the one in question that they monitored this year. Additionally, I plotted Stiff diagrams for some of the Deer Creek mine inflows and the adjacent springs in Cottonwood Creek. The Stiff diagrams are attached.

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The Stiff diagrams did show that the spring water quality was very consistent throughout 1986. The diagrams can be superimposed over the others and they show very little difference. This indicates that the source of the water is groundwater from a formation and probably not from the alluvial stream channel. If it were the stream channel one would expect the diagrams to change over the year from periods of peak flow to base flow in late summer and fall.

After reviewing stiff diagrams, the mine permit application, flow records, and the geologic information presented in the PAP, it is possible that the Deer Creek Mine has intercepted significant groundwater quantities which may have caused the decreased flow at the spring. The last six years have been drought years which presents the possibility that the loss of this spring may have been drought related.

Other theories are that the spring flow originates from stream water present in the alluvial material in the canyon floor and that this water is surfacing at the spring site since the canyon narrows considerably in this area. Based on the conditions present there is insufficient evidence to indicate that the mine has intercepted the entire flow of this spring. More research would be required to collect additional information.

RECOMMENDATION

The Division requested that Pacificorp revise their Probable Hydrologic Consequences (PHC) after the large amount of water was intercepted. This revised document was received on May 1, 1991 and is currently being reviewed. Information in the revised PHC may help answer some of these questions. Sufficient information is not available at this time to confirm or negate the impacts of the Deer Creek Mine on this spring and others. These questions will be addressed in the revised PHC review.

KW/jbe
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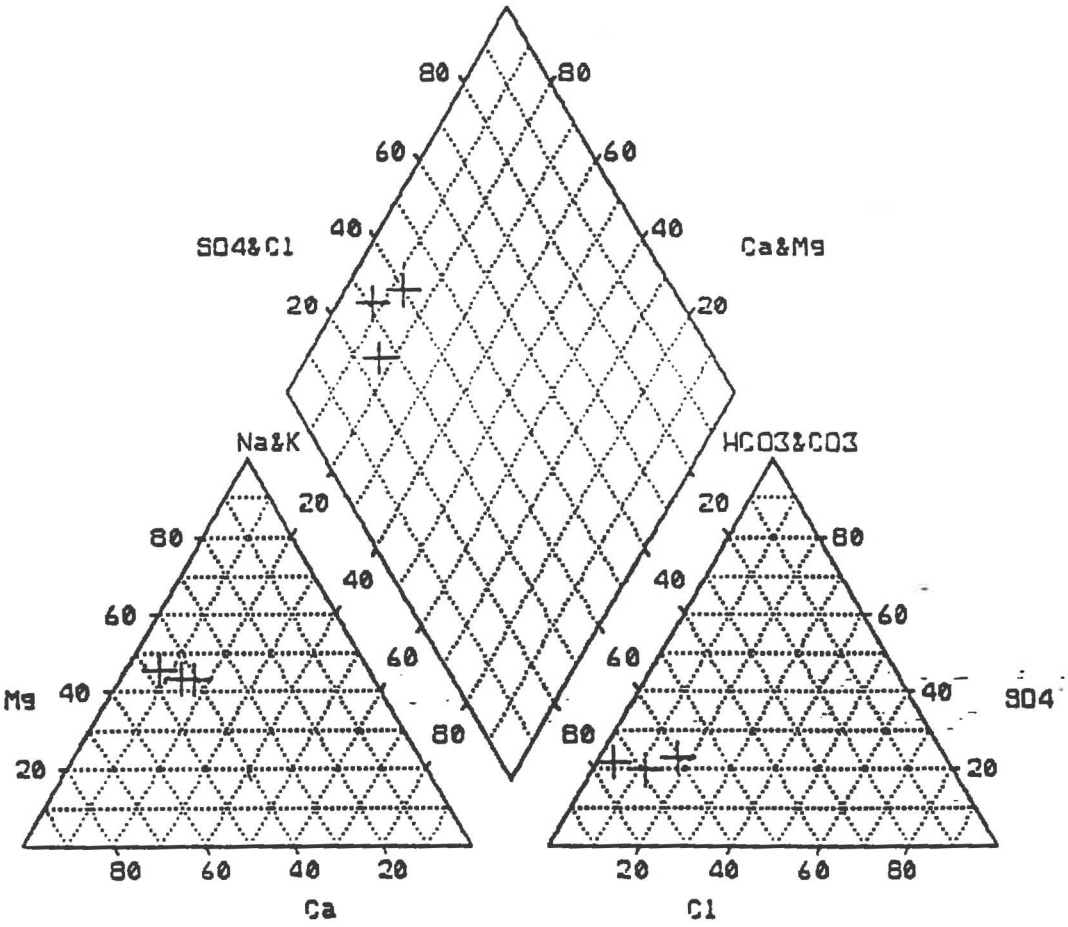
HC - GRAM

HydroChemical Graphic Representation Analysis Methods

Version: HC-GRAM 1.42

23-Sep-1991 11:33:45.72

Project: Cottonwood Canyons Springs



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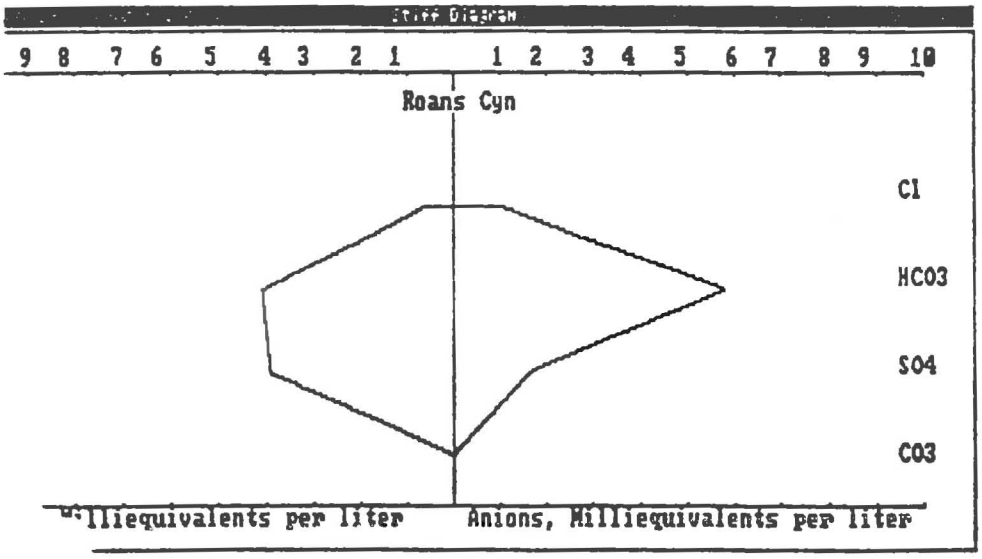
ep-1991 11:27:24.70

Chemical Constituents in ppm

ample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
	5-22-91	81.90	47.90	14.22	1.79	355.00	0.00	80.00	35.00	0.00	0.00	0.00	0.00

Chemical Constituents in Equivalents per Million

ample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
s Cyn	5-22-91	4.09	3.94	0.62	0.05	5.82	0.00	1.67	0.99	0.00	0.00	0.00	0.00



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Report: Cottonwood Canyon Springs

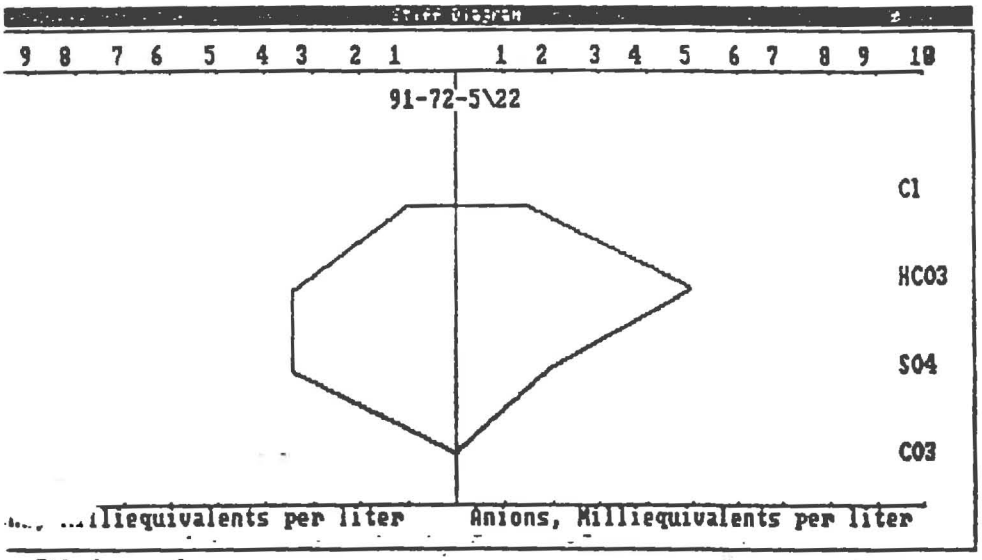
ep-1991 11:27:50.02

Chemical Constituents in ppm

	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
2	5-22-91	67.90	41.40	22.20	2.40	303.00	0.00	90.00	50.00	0.00	0.00	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
2-5\22	5-22-91	3.39	3.41	0.97	0.06	4.97	0.00	1.87	1.41	0.00	0.00	0.00	0.00



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Report: Cottonwood Canyon Springs

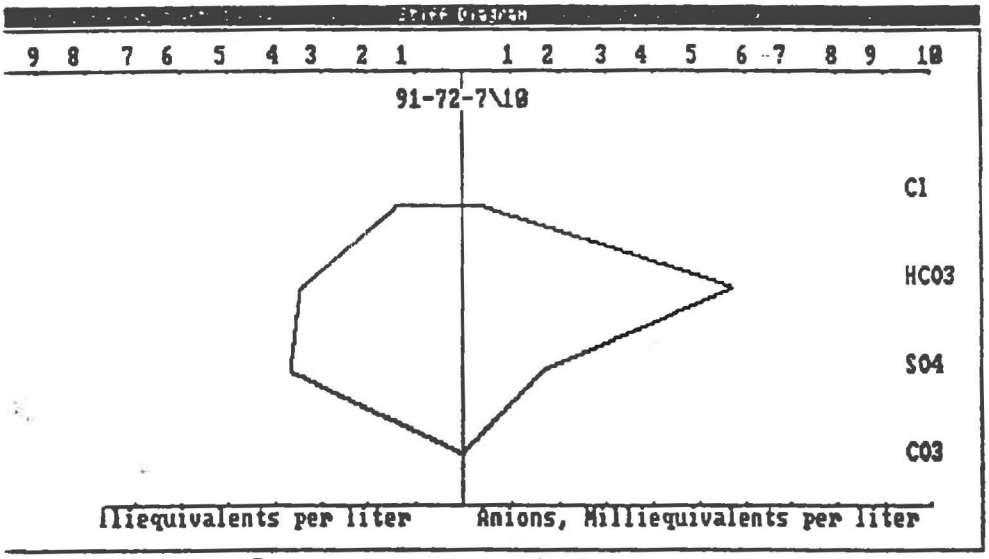
Sep-1991 11:28:15.29

Chemical Constituents in ppm

ple	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
[illegible]	7-10-91	69.10	44.60	31.40	0.66	351.00	0.00	80.00	10.00	0.00	0.00	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
2-7\10	7-10-91	3.45	3.67	1.37	0.02	5.75	0.00	1.67	0.28	0.00	0.00	0.00	0.00



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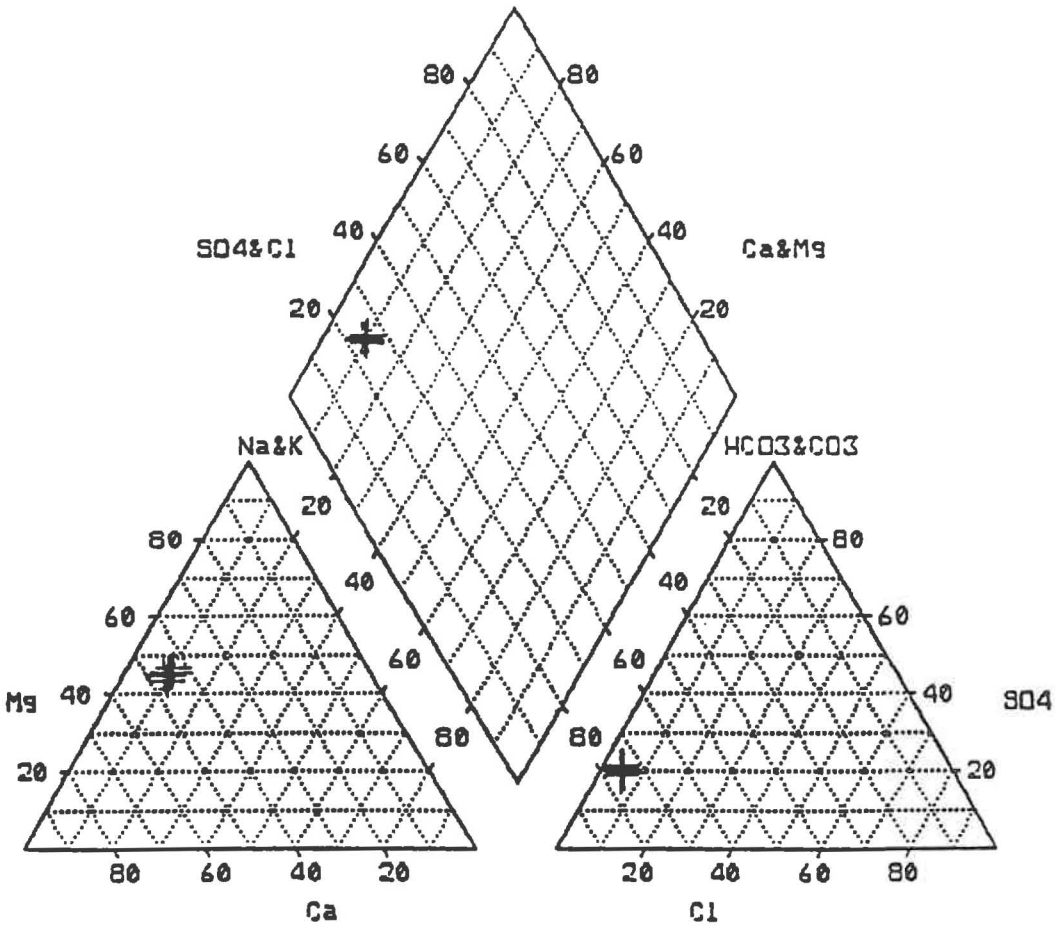
HC - GRAM

HydroChemical Graphic Representation Analysis Methods

Version: HC-GRAM 1.42

23-Sep-1991 11:37:46.02

Project: Cottonwood Spring Water Quality



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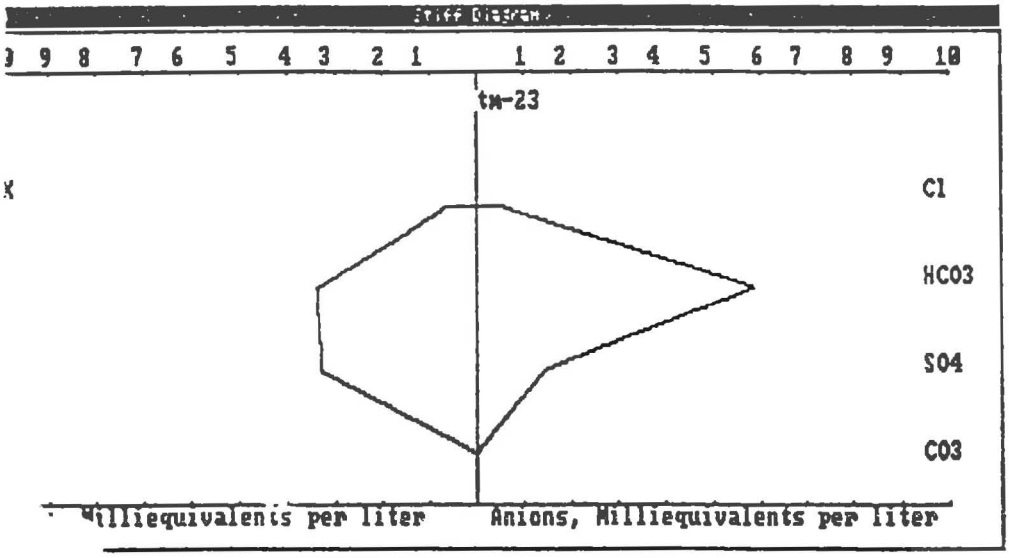
Sep-1991 10:34:01.83

Chemical Constituents in ppm

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
	9-30-86	68.00	40.00	14.00	2.00	359.00	0.00	70.00	14.80	0.00	0.00	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	9-30-86	3.39	3.29	0.61	0.05	5.88	0.00	1.46	0.42	0.00	0.00	0.00	0.00



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Report: Cottonwood Spring Water Quality

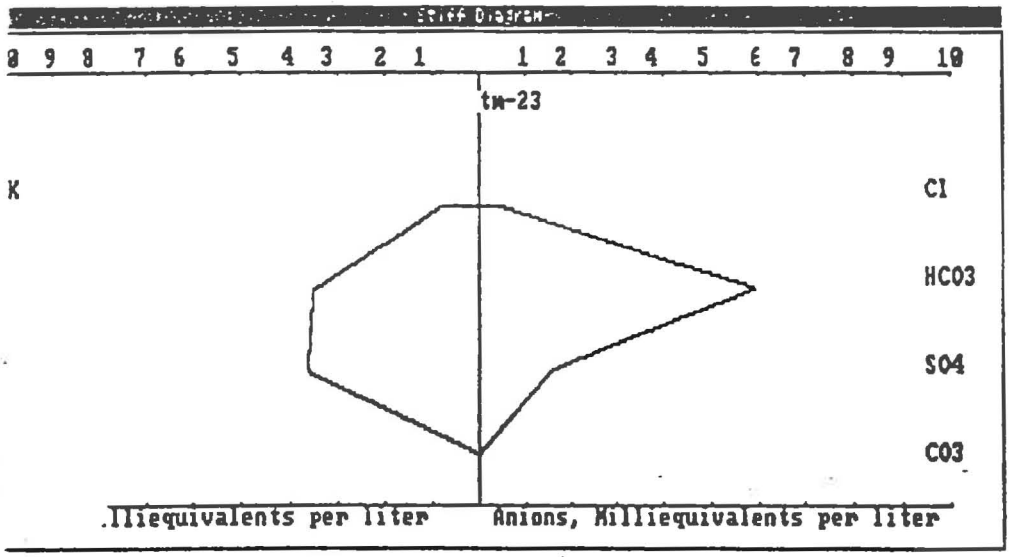
Sep-1991 10:34:27.15

Chemical Constituents in ppm

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
[illegible]	2-28-86	70.00	44.00	18.00	2.00	362.00	0.00	75.00	13.00	0.20	0.03	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	2-28-86	3.49	3.62	0.78	0.05	5.93	0.00	1.56	0.37	0.00	0.00	0.00	0.00



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Report: Cottonwood Spring Water Quality

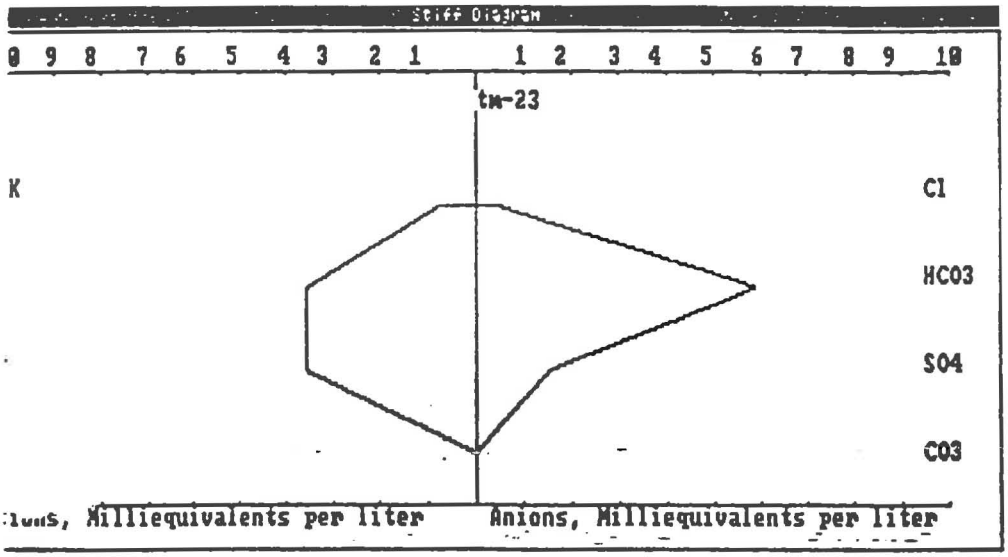
Sep-1991 10:34:52.47

Chemical Constituents in ppm

	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	3-13-86	72.00	43.00	17.00	2.00	361.00	0.00	75.00	13.00	0.22	0.06	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	3-13-86	3.59	3.54	0.74	0.05	5.92	0.00	1.56	0.37	0.00	0.00	0.00	0.00



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Report: Cottonwood Spring Water Quality

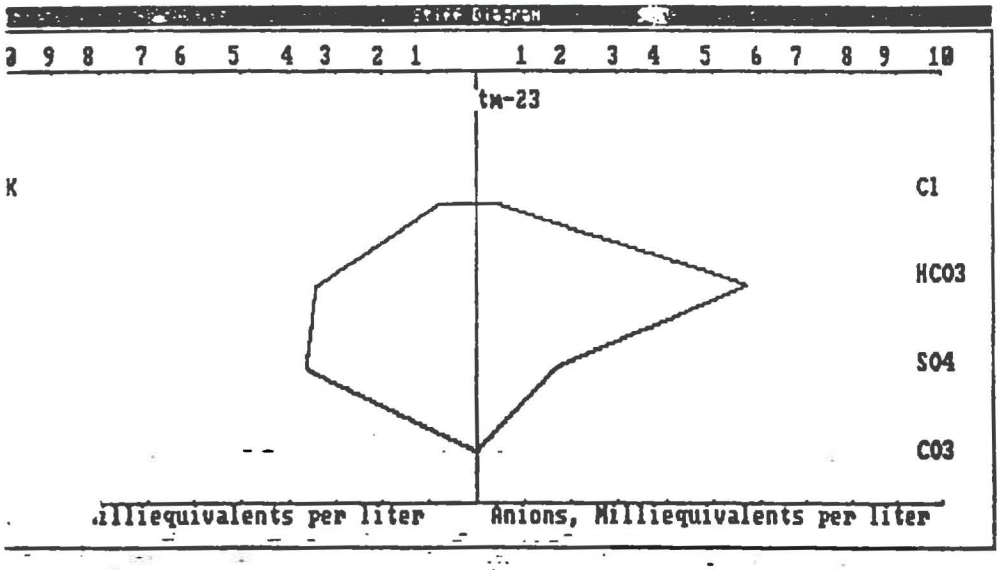
Sep-1991 10:35:17.74

Chemical Constituents in ppm

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	4-7-86	68.00	44.00	17.00	2.00	351.00	0.00	80.00	12.00	0.25	0.06	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	4-7-86	3.39	3.62	0.74	0.05	5.75	0.00	1.67	0.34	0.00	0.00	0.00	0.00



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Report: Cottonwood Spring Water Quality

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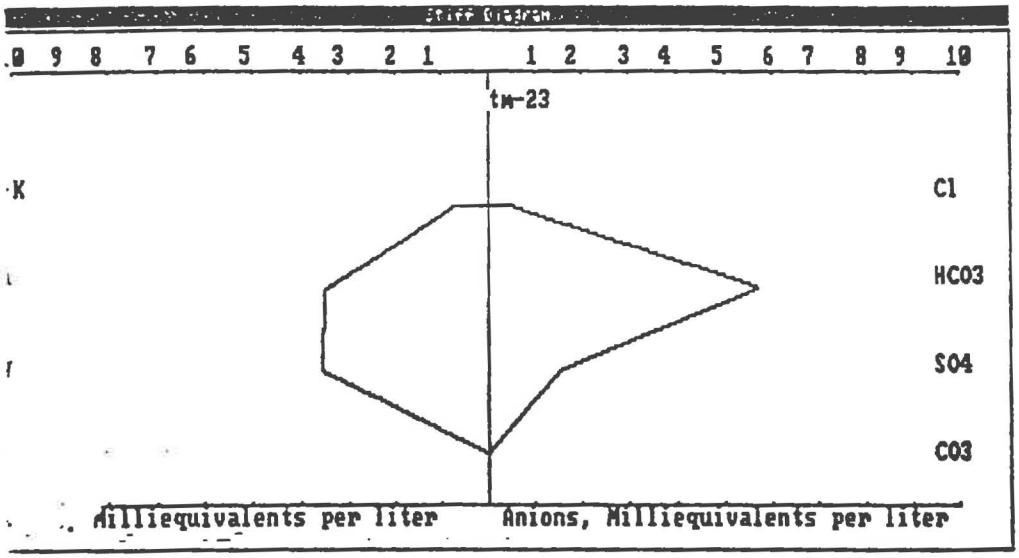
Chemical Constituents in ppm

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	5-5-86	70.00	43.00	16.00	2.00	350.00	0.00	75.00	14.00	0.25	0.02	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	5-5-86	3.49	3.54	0.70	0.05	5.74	0.00	1.56	0.39	0.00	0.00	0.00	0.00



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UTAH DIVISION

Report: Cottonwood Spring Water Quality

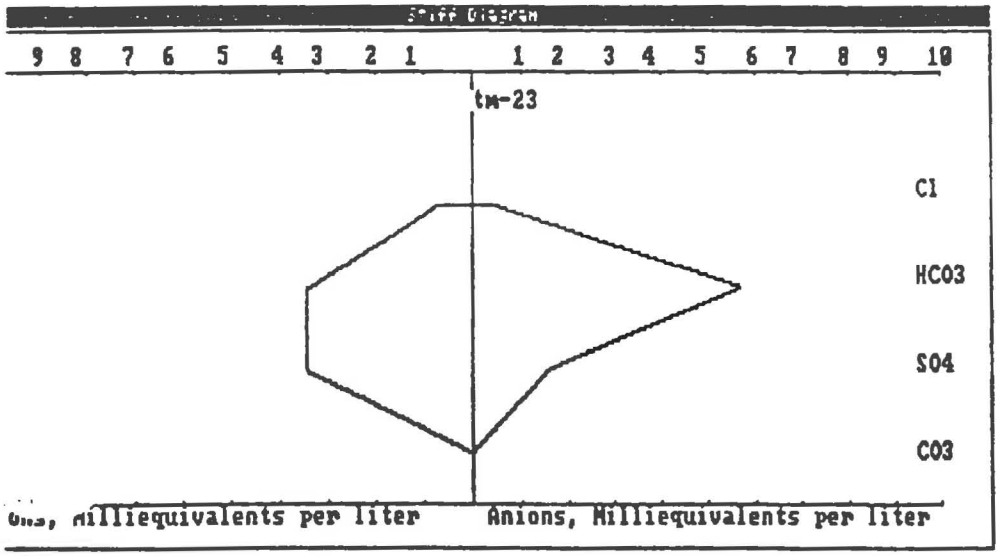
Sep-1991 10:36:08.38

Chemical Constituents in ppm

	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	6-30-86	68.00	42.00	16.00	2.00	348.00	0.00	75.00	12.00	0.44	0.07	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	6-30-86	3.39	3.45	0.70	0.05	5.70	0.00	1.56	0.34	0.01	0.00	0.00	0.00



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Report: Cottonwood Spring Water Quality

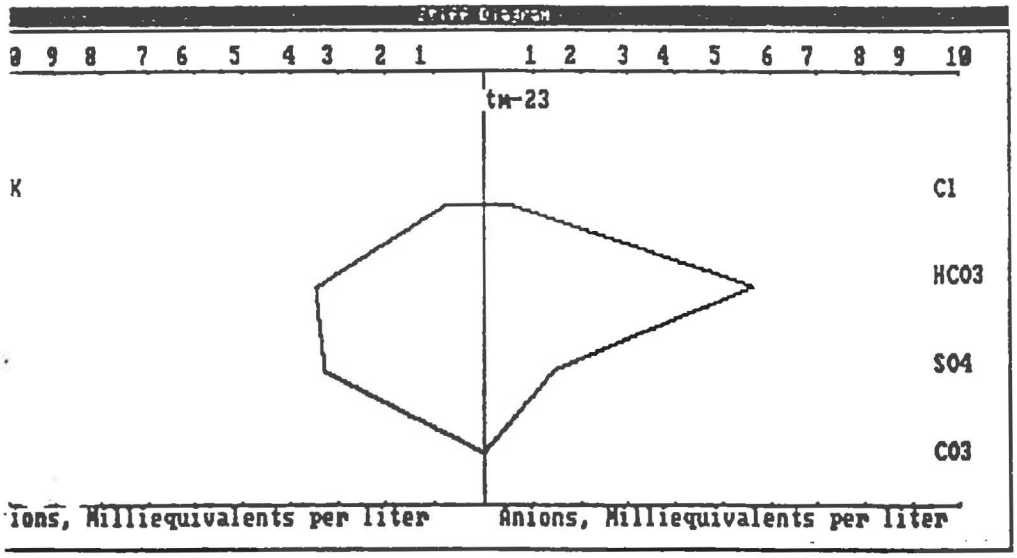
Sep-1991 10:36:33.70

Chemical Constituents in ppm

	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	7-30-86	70.00	40.00	16.00	3.00	345.00	0.00	70.00	15.00	0.00	0.00	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
tm-23	7-30-86	3.49	3.29	0.70	0.08	5.65	0.00	1.46	0.42	0.00	0.00	0.00	0.00



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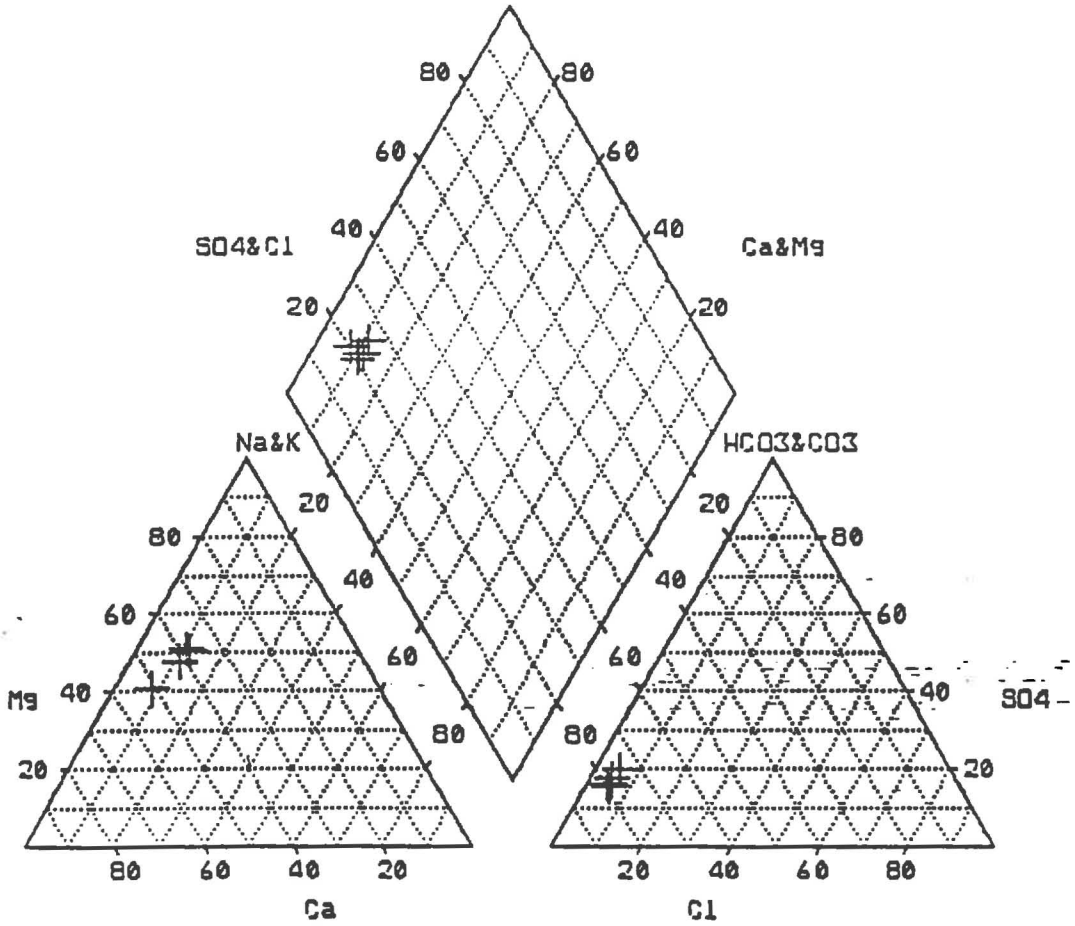
HC - GRAM

HydroChemical Graphic Representation Analysis Methods

Version: HC-GRAM 1.42

25-Sep-1991 12:03:32.12

Project: Cottonwood Creek Water Quality



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Report: Cottonwood Creek Water Quality

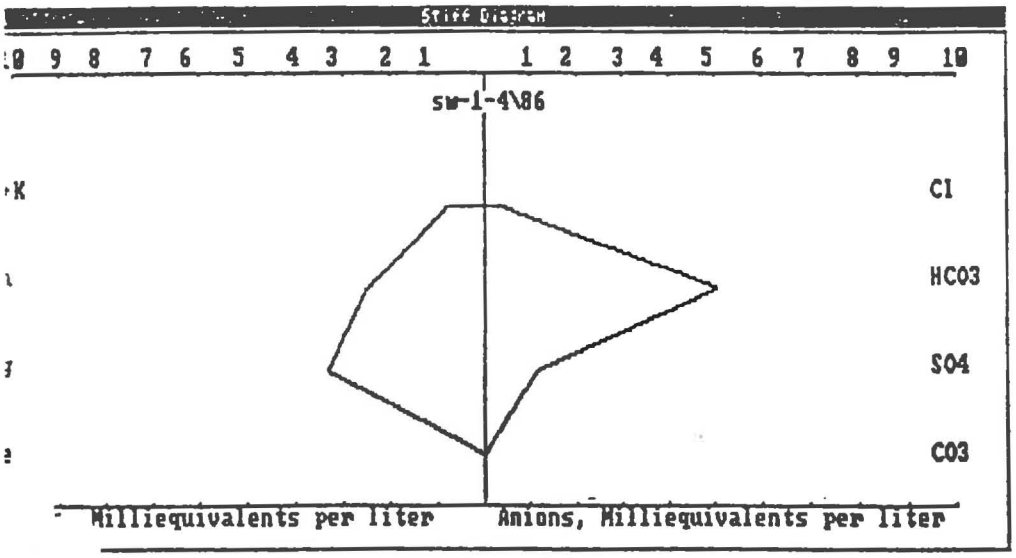
-Sep-1991 11:09:38.32

Chemical Constituents in ppm

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
	4-7-86	50.00	40.00	17.00	2.00	310.00	0.00	56.00	11.00	0.25	0.04	0.00	0.08

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
w-1-4\86	4-7-86	2.49	3.29	0.74	0.05	5.08	0.00	1.17	0.31	0.00	0.00	0.00	0.00



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Report: Cottonwood Creek Water Quality

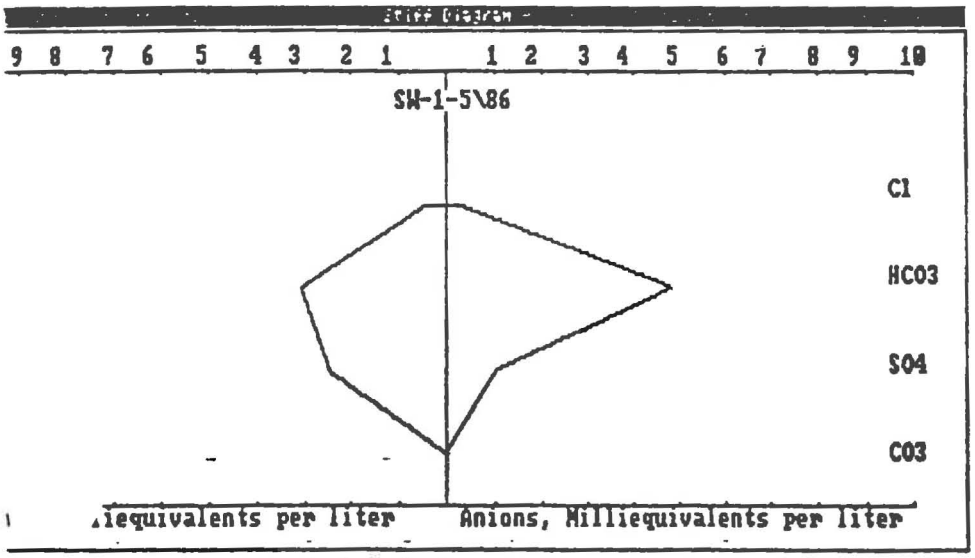
ep-1991 11:10:03.64

Chemical Constituents in ppm

	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
-5\86	5-5-86	62.00	30.00	11.00	1.00	295.00	0.00	48.00	9.00	0.22	0.06	0.00	0.28

Chemical Constituents in Equivalents per Million

ample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
-5\86	5-5-86	3.09	2.47	0.48	0.03	4.84	0.00	1.00	0.25	0.00	0.00	0.00	0.01



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Report: Cottonwood Creek Water Quality

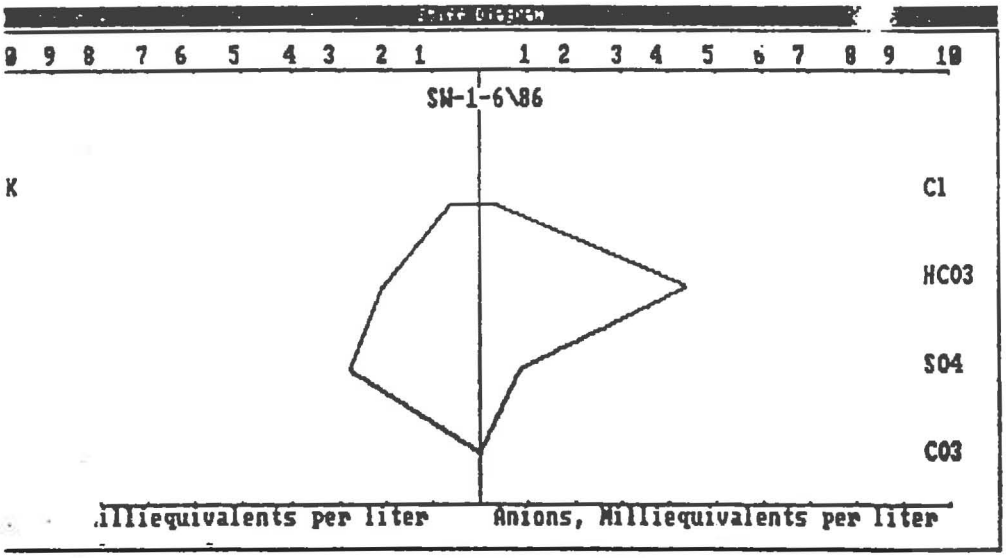
Sep-1991 11:10:28.96

Chemical Constituents in ppm

ple	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
-1-6\86	6-30-86	42.00	34.00	13.00	2.00	267.00	0.00	40.00	10.00	0.25	0.08	0.00	0.15

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
-1-6\86	6-30-86	2.10	2.80	0.57	0.05	4.38	0.00	0.83	0.28	0.00	0.00	0.00	0.01



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Report: Cottonwood Creek Water Quality

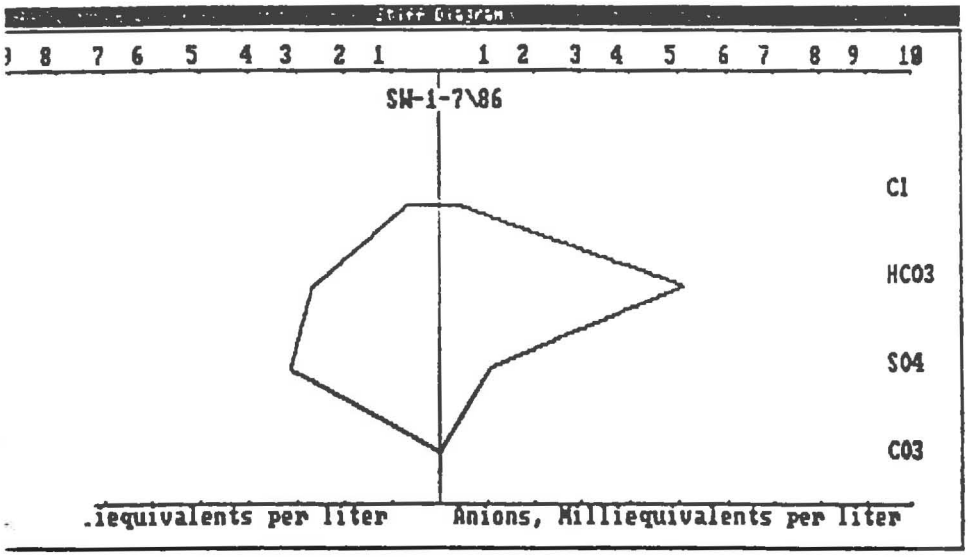
p-1991 11:10:54.23

Chemical Constituents in ppm

	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
-'\oo	7-30-86	54.00	38.00	14.00	4.00	312.00	0.00	50.00	12.00	0.00	0.00	0.00	0.20

Chemical Constituents in Equivalents per Million

mple	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
7\86	7-30-86	2.69	3.13	0.61	0.10	5.11	0.00	1.04	0.34	0.00	0.00	0.00	0.01



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Report: Cottonwood Creek Water Quality

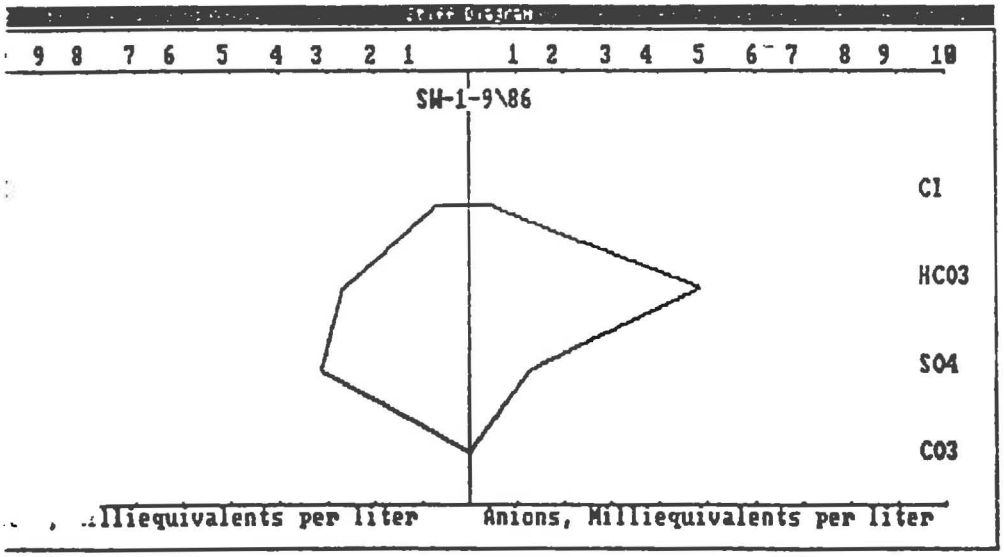
Sep-1991 11:11:19.55

Chemical Constituents in ppm

	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
1-9\86	9-29-86	54.00	38.00	13.00	7.00	298.00	0.00	62.00	13.00	0.00	0.00	0.00	0.00

Chemical Constituents in Equivalents per Million

Sample	Date	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	NO3	PO4	Si	Fe
1-9\86	9-29-86	2.69	3.13	0.57	0.18	4.88	0.00	1.29	0.37	0.00	0.00	0.00	0.00



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Utah Division Oil, Gas And Mining

JUN 17

State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING

1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, Utah 84114-5801
801-538-5340
801-359-3940 (Fax)
801-538-7223 (TDD)

Michael O. Leavitt
Governor

Lowell P. Braxton
Division Director

October 27, 1998

Alan Rabinoff, Group Leader
Bureau of Land Management
324 South State Street
Salt Lake City, Utah 84145-0155

Dear Mr. Rabinoff:

Enclosed are copies of memos to our files regarding the Cottonwood Spring citizen's complaint filed in 1991 by Mr. Jim Peacock. The Division has made an extensive review of this issue and has made findings to conclude the complaint.

By this letter and enclosed memos, the Division also concludes the issue of Cottonwood Spring. To date, no definitive connection between Cottonwood Spring has been cited or proven in relation to mining at the Deer Creek Mine. Hopefully, this documentation from our division will provide the needed paperwork for the US Forest Service and the Bureau of Land Management to move forward with the lease relinquishment for this area.

Please contact me at 801-538-5306 if I may be of further assistance.

Sincerely,

Mary Ann Wright
Associate Director, Mining

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tam
Enclosure
cc: Chuck Semborski, Energy West, w/o
Blake Webster, PacifiCorp, w/o
O:\015018.DER\FINAL\KAISER.RAB

United States Department of Agriculture
Forest Service
Manti- La Sal National Forest
Supervisor's Office
599 West Price River Drive
Price UT 84501
Phone # (435) 637-2817
Fax # (435) 637-4940

File Code: 2820-4

Date: May 5, 1999

AUG 22 2001
UTAH DIVISION OIL, GAS AND MINING

Mary Ann Wright
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

Dear Mary Ann:

This letter is in regard to the Cottonwood Spring and associated lease relinquishment issue on the Manti-La Sal National Forest (MLS). Your letter dated October 27, 1998 relates that the Division of Oil, Gas and Mining (DOGM) has concluded the issue of the spring stating that "...no definitive connection between Cottonwood Spring has been cited or proven in relation to mining at the Deer Creek Mine". The letter included documentation intended to aid us in resolving the Cottonwood Spring/Creek issue. However, we find that the information provided makes a compelling case for a connection between mining activities and loss of water at the spring. Specifically, in our review, the DOGM analysis (Cottonwood Spring Chronology and Information Related to Roans Canyon Graben Crossing, October 16, 1998) finds:

- That known information (at the time of the report) about the alluvial system of the area suggests that it is incapable of delivering the quantities of water which were once observed in flow at Cottonwood Spring.

- That known information suggests the Roans Canyon Graben and fracture system are capable of containing and transmitting sufficient quantities of water to supply observed spring flows and are geologically associated with Cottonwood Spring and Creek.

- That consistency of Stiff diagrams from Cottonwood Spring and Creek indicate a groundwater rather than alluvial source.

- That Stiff diagrams from Cottonwood Spring and Creek exhibit the same basic water chemistry as flow from a drill hole used to dewater the graben, suggesting they may be the same water.

- That mining operations utilizing drill holes in attempts to dewater the graben coincide with loss of flow at Cottonwood Spring and Cottonwood Creek.

Based on this body of evidence and particularly the coincidence of dewatering actions with loss of flow, the MLS believes that there are still valid questions remaining with respect to this issue.

Subsequent to DOGM's analysis, Energy West Mining (Energy West) retained Mayo and Associates (Mayo) to perform a hydrologic evaluation of Cottonwood Spring. At a December 18, 1998 meeting, Mayo presented findings that Cottonwood Spring is supported by a gravel lens in the alluvial deposits which receives recharge from surface flow in Cottonwood (Canyon) Creek. It is their theory that water that once emerged from Cottonwood Spring now emerges elsewhere

in the drainage, although an exact location is undefinable. The point where the gravel lens is recharged is similarly not defined. Mayo also indicated that the base flow component of the historic spring may have come from older sources, however, the missing link is the radiocarbon age of water at the spring.

According to Energy West, 1998 was the first year that there was perennial flow in Cottonwood Creek above Roans Canyon since Cottonwood Spring ceased flowing in 1989. The MLS understands from historical reports, from longtime local residents, and from studies done by the USGS and engineering firms, that Cottonwood Creek was perennial starting at the location of Cottonwood Spring. It was reported that there was never cessation of flow during the drought periods of the 1930's and 1950's. There has been an apparent loss of perennial conditions in the creek between Cottonwood Spring and Roans Canyon that coincides with the cessation of flow at Cottonwood Spring. Mayo also performed a gain/loss study on the creek in 1998 and ascertained that essentially the same quantity of water emits from the drainage now as did in 1979 (based on a USGS study). However, it is not known if perennial flow in the creek below Cottonwood Spring will continue or if year-round flow in 1998 resulted from above average annual precipitation, as no correlation to 1979 climatic conditions were made.

The MLS believes that loss of water from Cottonwood Spring and Creek would indeed constitute a material damage to National Forest resources, due to impacts to wildlife and macroinvertebrate species, if mining were the causal factor. In such a case, this would necessitate water replacement/mitigation required by the mine plan and the stipulations contained in federal leases associated with the Deer Creek and Cottonwood Mines. The standard of proof is at issue. DOGM's analysis theorizes a connection of flow loss to mining operations while Mayo presents a dissenting theory that there is no connection and that perennial flow returned in 1998. Mayo's theory seems plausible but we believe it is essential that monitoring be continued to either validate or discount it, and to learn whether the effect on surface resources has been temporary or permanent.

While year-round flow was documented in 1998, the MLS is concerned that because of the high water year in 1998, these conditions may not be repeated in 1999 or subsequent years. The true test to discern if perennial conditions return to the creek and further validate that the same quantity of water circulates in the drainage, will be to continue observing the creek. Further, without perennial flow in the creek, the recharge source for any gravel lens may be absent. Therefore, the MLS believes that the flow monitoring and gain/loss flow study, as defined by Mayo, need to be continued for two additional years on Cottonwood Creek, with the data collected keyed to climatic conditions.

The MLS understands the need to resolve the Cottonwood Spring/Creek issue so the lease relinquishment process can continue, and we are committed to work with all affected parties to accomplish this task. However, the MLS cannot agree to lease relinquishment until the Cottonwood Spring/loss of water issue is resolved to our satisfaction. At a minimum Energy West must continue monitoring for two additional years as noted above. Additionally, we have identified a variety of alternative means to resolve the issue as follows:

A. Energy West can elect to wait until the additional two years of monitoring is completed. If the monitoring data and gain/loss study continue to indicate that Cottonwood Creek performs similar to the 1979 USGS Study, after adjusting for climatic conditions, and that perennial flow has been restored to Cottonwood Creek, we would agree that the

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Cottonwood Spring/Creek issue has been resolved. If the data indicate that perennial flow has not been restored, Energy West would then be required to pursue either Alternative B or C as outlined below. or

B. Restore perennial flow of like quantity and quality at or above Cottonwood Spring through artificial means, as specified in the lease stipulation. The MLS does not know how this might be accomplished, but we invite Energy West proposals for compliance with the lease stipulation. Any proposal will be subject to our approval and implementation would be Energy West's responsibility. We would then agree that the Cottonwood Spring/Creek issue has been resolved. or

C. Finance manipulation of existing watershed conditions to increase water yield and water quality sufficiently to offset impacts to wildlife and macroinvertebrate species resulting from loss of flow at Cottonwood Spring. Within the watershed, the Forest has identified approximately 660 acres of conifer encroached aspen stands that could be regenerated to increase flow as well as headcut stabilization and wetland enhancement work that would improve downstream water quality and timing of flow. These projects are outlined in greater detail in the attachment. Cost estimates have been made for planning, implementation, and monitoring of these projects which total $110,670. These estimates are coarse and actual costs could be more or less. The Forest is prepared to accept this estimated amount if Energy West prefers this alternative. We would agree that the Cottonwood Spring/Creek issue has been resolved once funds are received for the identified mitigation work.

Our preference is Alternative A as we believe this is the fairest approach, testing the Energy West/Mayo theory prior to any additional funding or resource commitments that may prove unnecessary. The other alternatives however do present the opportunity for more rapid resolution of the Cottonwood Spring/Creek issue, leading to an earlier lease relinquishment which Energy West may find preferable.

I believe this provides tangible solutions to resolve to the spring issue and allow the relinquishment process to continue. We appreciate your continued cooperation on this matter. If you have any questions, please contact me or Aaron Howe at (435) 637-2817.

Sincerely,

for
JANETTE S. KAISER
Forest Supervisor

cc:
BLM, Utah State Office

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Mitigation Projects for Water Loss at Cottonwood Spring

The projects outlined below have been designed to mitigate the loss of water from Cottonwood Spring. These projects are all located within the Cottonwood Creek drainage and have the goals of improving water yield, timing of flow, and aquatic macroinvertebrate habitat. Burning decadent aspen stands where conifer encroachment is occurring is expected to increase water yield. Headcut stabilization is expected to improve water quality which would positively effect macroinvertebrate habitat. Headwater riparian and wetland enhancement would potentially extend the perennial flow period downstream in Cottonwood Creek which would also positively effect macroinvertebrate habitat.

I. Environmental Assessment

Conducting an Environmental Assessment, in compliance with the National Environmental Policy Act (NEPA) would be part of the overall mitigation project costs. This process involves further field investigations and collaborative input from experts in the areas of wildlife biology, vegetation management, botany, hydrology, soils, engineering, fuels, and archeology. The NEPA process would also require public review and input prior to implementation of the project.

Environmental Assessment for Mitigation Projects: **$15,000**

II. Aspen Regeneration

This project is intended to mitigate the loss of water from Cottonwood Springs by increasing water yield within the drainage. Recent research has shown, when successional trends occur from aspen to mixed conifer, water yield is significantly reduced (Gifford, Humphries, and Jaynes, 1984). By conservative estimates, water yield would increase by 250 acre-feet per year, per 1000 acres of converted stands (Bartos and Campbell, 1998). This conversion factor was applied to the total treatment area of this project proposal (660 acres) and water yield is expected to increase by approximately 165 acre-feet per year (or 100 gallons per min).

Many aspen stands are present in west side tributaries to Cottonwood Canyon. Conifer encroachment is occurring and existing aspen stands are decadent. The areas proposed for treatment are approximately 40 to 100 acres in size, with some isolated treatment areas and other connected areas. The goals would be to increase aspen vigor, improve ground cover, improve soil moisture retention, and increase water yield. The treatment would consist of burning aspen to stimulate regeneration and remove encroaching conifers. Some steep slopes occur in the project area and mechanical pretreatment or hand slashing may be required before burning. Monitoring of plots within the treatment area will be established prior to treatment then reanalyzed every year for three years to demonstrate if desired effects of aspen regeneration have occurred. A report and display of data will be required at the end of the monitoring period.

Implementation Costs: (*includes project layout and pretreatment ($44.00 per acre)*		
Trail Canyon	150 acres	$ 6,600
Indian Lodge Canyon	100 acres	$ 4,400
Unnamed	110 acres	$ 4,800
Dairy Canyon	180 acres	$ 7,900
Winks Canyon	120 acres	$ 5,300
	Total acres = **660 acres**	
Monitoring ($1,000 per year)		$ 3,000
		Project Total $32,000

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III. Headcut Stabilization

Headcutting is actively occurring in the headwaters of Roans Canyon and an unnamed tributary to the North of Roans Canyon. This project will not likely effect water quantity or timing of stream flows but will likely improve water quality. The project involves a combination of hard structures mechanically placed in gullies, mechanically reshaping, and revegetation with protection from livestock grazing. Heavy equipment such as an excavator will be required to complete the project.

Project Design and Layout		$ 2,000
Roans Canyon headcuts	5 acres	$ 3,500
Unnamed Canyon headcuts	3 acres	$ 2,500
Revegetation	8 acres	$ 2,000
Treatment area protection (fencing for 8 acres)		$ 2,000
Monitoring		$ 1,000
	Project Total	**$13,000**

IV. Wetland and Riparian Enhancement

The upper segment of Cottonwood Canyon is much broader than the lower reaches and is meadow-like with some isolated willow stands along the stream. Just downstream from this meadow reach, Cottonwood Canyon is steeply incised with erodible banks and narrow riparian areas. The proposed project would consist of building a series of small earthen check dams in the lower meadow reach to prevent further upstream migration of channel erosion. The desired effect would be expansion of wetland and riparian areas upstream of the dams. The objective would be to increase retention of water in the headwaters of Cottonwood Creek so that perennial flow could be sustained later into the season.

Project Design and Layout		$ 2,000
Equipment time (includes hauling and material placement)		$ 5,000
Fill Material		$ 3,000
Fencing (Materials and Labor)	5 acres	$12,000
Monitoring		$ 1,000
	Project Total	**$23,000**

Summary of All Mitigation Costs

I. Environmental Assessment	$ 15,000
II. Aspen Regeneration	$ 32,000
III. Headcut Stabilization	$ 13,000
IV. Wetland and Riparian Enhancement	$ 23,000
Total	**$ 83,000**
Overhead (25% of total mitigation costs)	$ 27,670
Total Mitigation Costs	**$110,670**

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References

Bartos, D. L., and R. B. Campbell. Water depletion and other ecosystem values forfeited when conifer forests displace aspen communities. Rangeland Management and Water Resources, American Water Resources Association. May 1998.

Gifford, G. F., W. Humphries, and R. A. Jaynes. A preliminary quantification of the impacts of aspen to conifer succession on water yield - II. Modeling Results. Water Resources Bulletin, American Water Resources Association. April 1984.

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State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING

Michael O. Leavitt
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Kathleen Clarke
Executive Director
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November 1, 1999

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Janette Kaiser, Forest Supervisor
US Forest Service
599 West Price River Drive
Price, Utah 84501

Re: Cottonwood Spring, PacifiCorp. Deer Creek Mine, ACT/015/018, File #3, Emery County, Utah

Dear Ms. Kaiser:

This letter is in response to your May 17, 1999 letter to me regarding Cottonwood Spring. This site has been the subject of numerous discussions and field visits by many of our respective personnel. I am writing this letter to clarify a basic issue.

Foremost, the division's analysis could not make a conclusive finding concerning the potential impact of mining on Cottonwood Spring flow. A Division hydrologist was allowed a time period of about four months in 1998 to further research and review data for this site in order to prove or disprove the allegation of a connection between spring flow and mining. The work began with the premise that there was a connection between mining/ dewatering at the Deer Creek Mine and spring flow reduction.

After a critical review of amassed data and analysis as detailed in the October 16, 1998 technical memo, and after lengthy discussions among technical personnel from the BLM and the Coal Program, it was concluded by OGM management that:

1. The existing data does not support that mining and the spring are linked as a cause and effect action, and,

2. That data cannot be obtained to support a link to mining. DOGM personnel concluded at a meeting with BLM that while more data could be collected concerning the issue, the information required to prove the case of a connection between mining and the spring could not be assembled. Thus, as you iterate in page one of your May 17, 1999 letter, DOGM believes that the best that can be done is to "suggest" and "indicate" certain technical items regarding alluvial systems, Roans Canyon Graben and Stiff diagrams.

Manti-LaSal (MLS) National Forest is concerned about flow at the spring and has proposed to DOGM mitigation measures in the May 17, 1999 letter. However, in order for the Division to consider implementing your proposed mitigation measures, the MLS must present a more convincing technical case than that which we have already reviewed in our own memo.

Thank you for your comments on this matter. They have been reviewed and considered.

Sincerely,

Mary Ann Wright
Associate Director, Mining

cc: Richard Manus, BLM
P:\GROUPS\MINES\WP\AMAW\cottspg.mls.wpd

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VOLUME 9
HYDROLOGIC SECTION

Appendix C

Cottonwood Canyon Creek Hydrogeologic Investigation

Attachment 2
USGS Flume Data

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UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - UTAH DISTRICT 08/13/91

STATION NUMBER 09324200 CTNWD C AB STRAIGHT CANYON NR ORANGEVILLE, UT STREAM SOURCE AGENCY USGS
LATITUDE 391826 LONGITUDE 1111102 DRAINAGE AREA 21.90 DATUM STATE 49 COUNTY 015

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.37	.41	.44	.24	.26	.32	.64	.64	4.3	.97	.29	.17
2	.41	.44	.49	.24	.27	.32	.62	.54	3.8	.90	.26	.17
3	.44	.44	.44	.24	.29	.32	.59	.54	3.4	.81	.24	.17
4	.44	.44	.44	.24	.30	.32	.59	.54	3.1	.78	.24	.17
5	.41	.44	.41	.24	.30	.32	.59	.54	3.0	.73	.24	.15
6	.41	.44	.41	.26	.30	.34	.59	.56	2.8	.70	.24	.14
7	.41	.44	.44	.28	.30	.36	.56	.56	2.7	.62	.22	.17
8	.41	.37	.32	.28	.30	.38	.54	.51	2.8	.56	.22	.17
9	.41	.41	.24	.28	.30	.40	.56	.56	2.8	.51	.22	.17
10	.46	.46	.22	.28	.30	.40	.54	.56	2.8	.49	.22	.17
11	.44	.46	.30	.25	.30	.40	.54	.51	2.7	.49	.24	.19
12	.41	.44	.37	.25	.30	.40	.54	.51	2.5	.41	.30	.19
13	.41	.41	.39	.25	.30	.40	.59	.49	2.4	.39	.35	.20
14	.41	.44	.41	.25	.30	.40	.54	.51	2.4	.35	.28	.20
15	.41	.41	.44	.25	.30	.40	.49	.51	2.3	.37	.26	.22
16	.41	.41	.35	.25	.28	.41	.49	.49	2.1	.37	.24	.20
17	.41	.41	.29	.25	.27	.43	.46	.67	2.1	.37	.24	.19
18	.41	.41	.26	.25	.27	.45	.51	.73	2.0	.44	.24	.19
19	.41	.41	.24	.25	.27	.48	.54	.73	1.9	.39	.24	.20
20	.41	.32	.22	.25	.27	.50	.51	.97	1.9	.30	.26	.20
21	.41	.37	.20	.25	.27	.50	.51	1.6	1.7	.26	.26	.19
22	.41	.56	.20	.25	.27	.50	.51	2.0	1.6	.24	.24	.20
23	.41	.46	.20	.25	.27	.50	.51	2.5	1.6	.24	.24	.20
24	.41	.46	.22	.25	.27	.54	.54	2.9	1.5	.24	.22	.19
25	.41	.49	.24	.25	.27	.61	.51	3.0	1.5	.24	.20	.19
26	.41	.44	.24	.25	.27	.66	.51	2.7	1.4	.24	.20	.19
27	.41	.41	.24	.25	.26	.74	.51	3.0	1.3	.28	.20	.20
28	.41	.41	.24	.25	.30	.73	.51	3.2	1.2	.28	.17	.19
29	.41	.39	.24	.25	---	.70	.54	3.6	1.2	.28	.17	.19
30	.41	.37	.24	.25	---	.68	.51	4.3	1.1	.28	.17	.19
31	.41	---	.24	.25	---	.66	---	4.6	---	.32	.17	---
TOTAL	12.83	12.77	9.62	7.83	7.98	14.57	16.19	45.27	67.9	13.85	7.27	5.56
MEAN	.41	.43	.31	.25	.28	.47	.54	1.46	2.26	.45	.23	.19
MAX	.46	.56	.49	.28	.30	.74	.64	4.6	4.3	.97	.35	.22
MIN	.37	.32	.20	.24	.26	.32	.46	.49	1.1	.24	.17	.14
AC-FT	25	25	19	16	16	29	32	90	135	27	14	11

WTR YR 1978 TOTAL 221.64 MEAN .61 MAX 4.6 MIN .14 AC-FT 440

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UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - UTAH DISTRICT 08/13/91

STATION NUMBER 09324200 CTNWD C AB STRAIGHT CANYON NR ORANGEVILLE, UT STREAM SOURCE AGENCY USGS
LATITUDE 391826 LONGITUDE 1111102 DRAINAGE AREA 21.90 DATUM STATE 49 COUNTY 015

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.22	.32	.42	.26	.26	.40	.71	1.0	4.2	1.5	.66	.39
2	.22	.97	.40	.26	.27	.45	.64	.94	3.9	1.4	.65	.38
3	.24	.41	.39	.26	.29	.42	.61	.90	3.7	1.5	.63	.37
4	.24	.37	.39	.25	.28	.45	.69	.92	3.7	1.4	.61	.38
5	.24	.37	.39	.25	.27	.49	.77	.92	3.7	1.4	.60	.34
6	.26	.35	.38	.25	.26	.56	.81	.92	3.8	1.3	.58	.33
7	.28	.35	.38	.25	.29	.97	.84	.92	3.9	1.4	.57	.31
8	.28	.37	.38	.25	.32	.66	.89	.92	4.0	1.3	.54	.34
9	.28	.37	.37	.25	.30	.49	.86	.92	3.9	1.3	.53	.37
10	.28	.37	.36	.25	.30	.47	.81	.87	3.6	1.2	.51	.40
11	.28	.38	.35	.25	.32	.56	.83	.90	3.5	1.1	.51	.32
12	.28	.39	.34	.25	.32	.62	.81	.87	3.4	1.1	.55	.30
13	.28	.39	.33	.25	.34	.65	.84	.84	3.4	1.1	.69	.32
14	.28	.39	.32	.25	.33	.65	.87	.90	3.3	1.0	.70	.32
15	.30	.39	.31	.25	.35	.60	.95	.90	3.2	.99	.68	.35
16	.30	.38	.30	.25	.35	.60	1.1	.90	3.2	.95	.70	.35
17	.30	.38	.30	.25	.37	.59	1.2	1.1	3.1	1.0	.90	.33
18	.30	.39	.29	.25	.32	.56	1.1	1.4	3.1	1.1	.75	.32
19	.28	.37	.29	.25	.35	.56	.98	2.2	3.1	.94	.79	.32
20	.28	.42	.28	.25	.36	.59	.91	3.1	2.9	.95	.74	.37
21	.30	.42	.28	.25	.37	.58	.93	3.7	2.6	.95	.65	.39
22	.28	.42	.28	.24	.37	.62	.93	4.6	2.5	1.0	.57	.37
23	.28	.42	.28	.26	.34	.58	.92	5.1	2.3	.94	.50	.37
24	.28	.42	.28	.27	.38	.56	.93	5.2	2.0	.87	.46	.35
25	.28	.44	.27	.28	.38	.68	.84	5.2	1.8	.83	.47	.37
26	.28	.44	.27	.28	.41	.67	.85	5.0	1.9	.81	.47	.35
27	.30	.44	.26	.28	.44	.66	.85	4.8	1.7	.76	.47	.35
28	.30	.44	.26	.26	.41	.72	.92	4.8	1.7	.73	.45	.35
29	.30	.44	.26	.27	---	.71	.94	4.7	1.5	.71	.40	.35
30	.28	.45	.26	.26	---	.70	.90	4.6	1.5	.69	.40	.35
31	.30	---	.26	.26	---	.69	---	4.4	---	.68	.40	---
TOTAL	8.60	12.46	9.93	7.94	9.37	18.51	26.23	74.44	90.1	32.97	18.13	10.49
MEAN	.28	.42	.32	.26	.33	.60	.87	2.40	3.00	1.06	.58	.35
MAX	.30	.97	.42	.28	.44	.97	1.2	5.2	4.2	1.5	.90	.40
MIN	.22	.32	.26	.24	.26	.40	.61	.84	1.5	.68	.40	.33
AC-FT	17	25	19	16	19	37	52	148	179	65	36	21

CAL YR 1978 TOTAL 217.41 MEAN .60 MAX 4.6 MIN .14 AC-FT 431
WTR YR 1979 TOTAL 319.26 MEAN .87 MAX 5.2 MIN .22 AC-FT 633

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
10/01/1977	0.37
10/06/1977	0.41
10/11/1977	0.44
10/16/1977	0.41
10/21/1977	0.41
10/26/1977	0.41
11/01/1977	0.41
11/06/1977	0.44
11/11/1977	0.46
11/16/1977	0.41
11/21/1977	0.37
11/26/1977	0.44
12/01/1977	0.44
12/06/1977	0.41
12/11/1977	0.30
12/16/1977	0.35
12/21/1977	0.20
12/26/1977	0.24
01/01/1978	0.24
01/06/1978	0.26
01/11/1978	0.25
01/16/1978	0.25
01/21/1978	0.25
01/26/1978	0.25
02/01/1978	0.26
02/06/1978	0.30
02/11/1978	0.30
02/16/1978	0.28
02/21/1978	0.27
02/26/1978	0.27
03/01/1978	0.32
03/06/1978	0.34
03/11/1978	0.40
03/16/1978	0.41
03/21/1978	0.50
03/26/1978	0.66
04/01/1978	0.64
04/06/1978	0.59
04/11/1978	0.54
04/16/1978	0.49
04/21/1978	0.51
04/26/1978	0.51
05/01/1978	0.64
05/06/1978	0.56

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
05/11/1978	0.51
05/16/1978	0.49
05/21/1978	1.60
05/26/1978	2.70
06/01/1978	4.30
06/06/1978	2.80
06/11/1978	2.70
06/16/1978	2.10
06/21/1978	1.70
06/26/1978	1.40
07/01/1978	0.97
07/06/1978	0.70
07/11/1978	0.49
07/16/1978	0.37
07/21/1978	0.26
07/26/1978	0.24
08/01/1978	0.28
08/06/1978	0.24
08/11/1978	0.24
08/16/1978	0.24
08/21/1978	0.26
08/26/1978	0.20
09/01/1978	0.17
09/06/1978	0.14
09/11/1978	0.19
09/16/1978	0.20
09/21/1978	0.19
09/26/1978	0.19
10/01/1978	0.22
10/06/1978	0.26
10/11/1978	0.28
10/16/1978	0.30
10/21/1978	0.30
10/26/1978	0.28
11/01/1978	0.32
11/06/1978	0.35
11/11/1978	0.38
11/16/1978	0.38
11/21/1978	0.42
11/26/1978	0.44
12/01/1978	0.42
12/06/1978	0.38
12/11/1978	0.35
12/16/1978	0.30

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
12/21/1978	0.28
12/26/1978	0.27
01/01/1979	0.26
01/06/1979	0.25
01/11/1979	0.25
01/16/1979	0.25
01/21/1979	0.25
01/26/1979	0.28
02/01/1979	0.26
02/06/1979	0.28
02/11/1979	0.32
02/16/1979	0.35
02/21/1979	0.37
02/26/1979	0.41
03/01/1979	0.40
03/06/1979	0.56
03/11/1979	0.56
03/16/1979	0.60
03/21/1979	0.58
03/26/1979	0.67
04/01/1979	0.71
04/06/1979	0.81
04/11/1979	0.83
04/16/1979	1.10
04/21/1979	0.93
04/26/1979	0.85
05/01/1979	1.00
05/06/1979	0.92
05/11/1979	0.90
05/16/1979	0.90
05/21/1979	3.70
05/26/1979	5.00
06/01/1979	4.20
06/06/1979	3.80
06/11/1979	3.50
06/16/1979	3.20
06/21/1979	2.60
06/26/1979	1.90
07/01/1979	1.50
07/06/1979	1.30
07/11/1979	1.10
07/16/1979	0.98
07/21/1979	0.95
07/26/1979	0.81

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
08/01/1979	0.66
08/06/1979	0.58
08/11/1979	0.51
08/16/1979	0.70
08/21/1979	0.65
08/26/1979	0.47
09/01/1979	0.39
09/06/1979	0.33
09/11/1979	0.32
09/16/1979	0.35
09/21/1979	0.39
09/26/1979	0.35
10/01/1979	0.40
10/06/1979	0.42
10/11/1979	0.35
10/16/1979	0.49
10/21/1979	0.49
10/26/1979	0.45
11/01/1979	0.38
11/06/1979	0.33
11/11/1979	0.30
11/16/1979	0.28
11/21/1979	0.27
11/26/1979	0.27
12/01/1979	
12/06/1979	
12/11/1979	
12/16/1979	
12/21/1979	
12/26/1979	
01/01/1980	
01/06/1980	
01/11/1980	
01/16/1980	
01/21/1980	
01/26/1980	
02/01/1980	
02/06/1980	
02/11/1980	
02/16/1980	
02/21/1980	
02/26/1980	
03/01/1980	
03/06/1980	

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
03/11/1980	
03/16/1980	
03/21/1980	
03/26/1980	
04/01/1980	
04/06/1980	
04/11/1980	
04/16/1980	
04/21/1980	
04/26/1980	
05/01/1980	1.30
05/06/1980	2.50
05/11/1980	2.10
05/16/1980	2.30
05/21/1980	3.10
05/26/1980	10.00
06/01/1980	13.00
06/06/1980	16.00
06/11/1980	8.00
06/16/1980	9.70
06/21/1980	7.80
06/26/1980	6.40
07/01/1980	5.80
07/06/1980	4.80
07/11/1980	3.90
07/16/1980	3.30
07/21/1980	2.70
07/26/1980	2.40
08/01/1980	2.10
08/06/1980	1.80
08/11/1980	1.80
08/16/1980	2.00
08/21/1980	2.10
08/26/1980	2.00
09/01/1980	1.90
09/06/1980	1.60
09/11/1980	2.00
09/16/1980	1.60
09/21/1980	1.40
09/26/1980	1.40
10/01/1980	1.10
10/06/1980	1.30
10/11/1980	1.20
10/16/1980	1.40

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
10/21/1980	1.20
10/26/1980	1.20
11/01/1980	1.20
11/06/1980	1.20
11/11/1980	1.20
11/16/1980	0.73
11/21/1980	0.48
11/26/1980	0.54
12/01/1980	
12/06/1980	
12/11/1980	
12/16/1980	
12/21/1980	
12/26/1980	
01/01/1981	
01/06/1981	
01/11/1981	
01/16/1981	
01/21/1981	
01/26/1981	
02/01/1981	
02/06/1981	
02/11/1981	
02/16/1981	
02/21/1981	
02/26/1981	
03/01/1981	
03/06/1981	
03/11/1981	
03/16/1981	
03/21/1981	
03/26/1981	
04/01/1981	
04/06/1981	
04/11/1981	
04/16/1981	
04/21/1981	
04/26/1981	
05/01/1981	0.90
05/06/1981	0.95
05/11/1981	0.96
05/16/1981	1.00
05/21/1981	1.00
05/26/1981	0.99

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COD

Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
06/01/1981	0.85
06/06/1981	0.90
06/11/1981	0.68
06/16/1981	0.65
06/21/1981	0.66
06/26/1981	0.48
07/01/1981	0.56
07/06/1981	0.49
07/11/1981	0.63
07/16/1981	0.40
07/21/1981	0.35
07/26/1981	0.46
08/01/1981	0.40
08/06/1981	0.14
08/11/1981	0.31
08/16/1981	0.35
08/21/1981	0.24
08/26/1981	0.28
09/01/1981	0.31
09/06/1981	0.65
09/11/1981	0.76
09/16/1981	0.48
09/21/1981	0.39
09/26/1981	0.50
10/29/1981	0.67
12/01/1981	1.70
12/31/1981	0.00
01/18/1982	0.00
02/05/1982	0.00
03/18/1982	0.81
04/22/1982	0.87
05/28/1982	4.87
06/01/1982	4.60
07/01/1982	2.27
08/12/1982	1.06
08/13/1982	1.78
09/02/1982	0.00
09/30/1982	2.18
10/11/1982	0.83
11/23/1982	0.00
12/13/1982	1.59
01/04/1983	1.06
02/22/1983	1.40
03/15/1983	1.40

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
05/20/1983	3.32
05/27/1983	6.25
06/08/1983	6.25
06/27/1983	6.25
07/15/1983	6.25
08/19/1983	3.81
10/10/1983	2.18
10/31/1983	2.10
11/15/1983	1.94
12/12/1983	1.86
01/09/1984	1.98
02/07/1984	1.78
03/06/1984	1.74
04/05/1984	1.94
05/01/1984	4.07
06/01/1984	13.39
07/01/1984	6.47
08/01/1984	4.07
09/01/1984	2.85
10/01/1984	2.61
11/01/1984	3.02
12/01/1984	3.13
01/01/1985	2.62
02/01/1985	2.75
03/01/1985	2.75
04/01/1985	3.03
05/01/1985	14.51
06/01/1985	12.02
07/01/1985	4.49
08/01/1985	3.18
09/01/1985	2.62
10/01/1985	2.85
11/01/1985	3.56
12/01/1985	3.56
01/24/1986	3.56
02/11/1986	2.79
03/12/1986	2.61
04/07/1986	2.79
05/13/1986	4.07
06/10/1986	5.72
07/24/1986	2.67
08/13/1986	2.31
09/08/1986	2.31
10/14/1986	2.14

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
11/14/1986	2.10
12/09/1986	2.18
01/13/1987	2.14
02/24/1987	2.18
03/17/1987	2.06
04/08/1987	1.98
05/21/1987	2.40
06/16/1987	2.40
07/15/1987	1.98
08/11/1987	1.63
09/17/1987	1.52
10/21/1987	1.37
11/17/1987	1.41
12/15/1987	1.13
02/12/1988	1.82
03/23/1988	1.41
04/18/1988	1.59
05/16/1988	2.71
06/07/1988	1.63
07/14/1988	1.34
08/15/1988	1.22
09/13/1988	1.41
10/12/1988	1.37
11/14/1988	1.44
12/15/1988	1.23
01/31/1989	1.23
02/27/1989	1.22
03/30/1989	1.34
04/17/1989	1.41
05/11/1989	1.23
06/19/1989	1.23
07/19/1989	1.13
08/15/1989	1.34
09/12/1989	1.22
10/10/1989	1.30
11/14/1989	1.10
12/05/1989	1.06
01/09/1990	0.76
02/19/1990	0.76
03/05/1990	0.91
04/16/1990	0.62
05/10/1990	0.76
06/06/1990	0.49
07/11/1990	0.49

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
08/13/1990	0.26
09/07/1990	0.18
10/08/1990	0.09
11/12/1990	0.09
12/17/1990	0.04
04/09/1991	0.11
06/06/1991	0.89
07/16/1991	0.24
08/20/1991	0.24
09/12/1991	0.03
11/04/1991	0.44
12/13/1991	0.24
02/04/1992	0.17
03/19/1992	0.28
04/10/1992	0.06
05/21/1992	0.46
06/03/1992	0.09
07/22/1992	0.01
08/11/1992	0.01
10/22/1992	0.01
11/25/1992	0.00
12/01/1992	0.00
03/23/1993	0.44
04/30/1993	0.30
05/19/1993	2.98
06/10/1993	3.08
07/23/1993	0.09
08/06/1993	0.00
09/10/1993	0.00
10/30/1993	0.04
11/19/1993	0.00
12/13/1993	0.00
01/04/1994	0.00
02/07/1994	0.00
03/24/1994	0.00
04/28/1994	0.00
05/17/1994	0.00
06/22/1994	0.00
07/21/1994	0.00
08/23/1994	0.00
09/12/1994	0.00
10/31/1994	0.00
11/17/1994	0.00
12/19/1994	0.00

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
01/31/1995	0.00
02/06/1995	0.00
03/29/1995	0.00
04/21/1995	0.00
05/08/1995	0.00
06/29/1995	5.58
07/17/1995	0.49
08/30/1995	0.06
09/28/1995	0.17
11/30/1995	0.04
12/18/1995	0.03
01/31/1996	0.00
02/26/1996	0.00
03/26/1996	0.00
04/30/1996	0.02
05/23/1996	1.76
06/10/1996	1.90
07/19/1996	0.02
08/20/1996	0.00
09/04/1996	0.00
10/22/1996	0.00
11/21/1996	0.00
12/26/1996	0.00
01/31/1997	0.00
2-31-97	0.00
03/11/1997	0.00
04/07/1997	0.07
05/27/1997	2.23
06/23/1997	0.62
07/23/1997	0.91
08/25/1997	1.06
09/08/1997	0.63
10/14/1997	0.20
11/21/1997	0.45
12/05/1997	0.33
01/27/1998	0.26
02/16/1998	0.18
03/20/1998	0.49
04/13/1998	0.22
05/28/1998	5.58
06/11/1998	5.58
07/08/1998	2.23
08/19/1998	0.45
09/03/1998	0.73

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Cottonwood Canyon Creek Flow @ USGS Flume

Date	Discharge (cfs)
10/02/1998	1.06
11/03/1998	1.34
12/10/1998	0.81
01/05/1999	0.89
02/01/1999	0.76
03/01/1999	1.86
04/07/1999	1.00
05/05/1999	1.16
06/08/1999	2.79
07/16/1999	1.78
08/03/1999	0.76
09/02/1999	1.40
10/04/1999	0.53
11/01/1999	0.53
12/06/1999	0.46
01/11/2000	0.73
02/02/2000	0.49
03/06/2000	0.44
04/05/2000	1.86
05/03/2000	1.26
06/02/2000	0.26

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VOLUME 9
HYDROLOGIC SECTION

Appendix C

Cottonwood Canyon Creek
Hydrogeologic Investigation

Attachment 3
TM-23
Field Data Sheets
Historical Flow Data

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E.I.S. Hyrology
Field Measurements Form

Station #

Date 6/30/99

Company Beaver Creek

Flow/Depth D

pH

Sp. Cond.

W. Temp.

Air Temp. 81

Diss. O

Time 16:10

Type: Spring ✓ Stream___ Well___ Discharge___ NPDES___

Collection POint:

Appearance of Water: Clear___ Milky___ Cloudy___ Opaque___

Weather: Clear___ Part. Cloudy ✓ Overcast___ Rain___ Snow___

Quality Sample Taken: Yes___ No ✓

Comments

Field Monitor

Pump Reading

When Sample or Measurements Not Taken:

Reason: D

D = Dry F = Frozen N/A = Not Accessable N/R = Not Required

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E.I.S. Hyrology

Field Measurements Form

~~TM-25~~
Station #

Date 7/19/99

Company Beaver Creek

Flow/Depth ~~app 12gpm~~ *

pH 7.8

Sp. Cond. 240

W. Temp. 4°

Air Temp. 91

Diss. O N/A

Time 11:11

Type: Spring ✓ Stream___ Well___ Discharge___ NPDES___

Collection POint: Source

Appearance of Water: Clear ✓ Milky___ Cloudy___ Opaque___

Weather: Clear ✓ Part. Cloudy___ Overcast___ Rain___ Snow___

Quality Sample Taken: Yes ✓ No___

Comments * Pipe all But dry app 12gpm seeping up at base of channel

Field Monitor M. L. Connor

Pump Reading___

When Sample or Measurements Not Taken:

Reason: ___

D = Dry F = Frozen N/A = Not Accessable N/R = Not Required

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E.I.S. Hyrology

Field Measurements Form

TM1-Q2
Station #

Date 08/89

Company Beaver Creek

Flow/Depth 4 gpm

pH ~~[illegible]~~ 7.2

Sp. Cond. 750

W. Temp. 8°

Air Temp. 84

Diss. O NA

Time 12:20

Type: Spring ✓ Stream ___ Well ___ Discharge ___ NPDES ___

Collection POint: Below Pip

Appearance of Water: Clear ✓ Milky ___ Cloudy ___ Opaque ___

Weather: Clear ✓ Part. Cloudy ___ Overcast ___ Rain ___ Snow ___

Quality Sample Taken: Yes ✓ No ___

Comments (Pip Not Flowing)

Field Monitor [signature]

Pump Reading ___

When Sample or Measurements Not Taken:

Reason: ___

D = Dry F = Frozen N/A = Not Accessable N/R = Not Required

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GOD

Cottnwood Spring Flow Data

Date	Flow (GPM)	Source	Flow (GPM)	Source	Flow (GPM)	Source	Flow (GPM)	Source	Flow (GPM)	Source
06/08/1978	43.0	USGS								
06/28/1978	41.0	USGS								
07/10/1978	35.0	USGS								
07/27/1978	33.0	USGS								
08/09/1978	33.0	USGS								
09/06/1978	36.0	USGS								
10/09/1978	37.0	USGS								
10/13/1978	38.0	USGS								
10/22/1978	41.0	USGS								
12/22/1978	47.0	USGS								
03/06/1979	44.0	USGS								
05/31/1979	72.0	USGS								
06/12/1979	83.0	USGS								
07/06/1979	67.0	USGS								
07/19/1979	64.0	USGS								
08/28/1979	55.0	USGS								
07/14/1981	80.0	USGS								
07/30/1981	76.0	USGS								
08/20/1981	73.0	USGS								
09/24/1981	76.0	USGS								
05/20/1982	80.0	USGS								
06/23/1982	76.0	USGS								
07/17/1982	98.0	USGS								
08/10/1982	98.0	USGS								
09/08/1982	110.0	USGS								
10/28/1985			4.0	JBR						
09/30/1986					22.5	TMCC				
10/20/1986					20.0	TMCC				
11/11/1986					20.8	TMCC				
06/30/1987					12.6	TMCC				
07/15/1987					12.0	TMCC				
08/31/1987							12.0	BCCC		
09/25/1987							12.0	BCCC		
06/30/1988							0.0	BCCC		
09/20/1988							22.0	BCCC		
10/31/1988							21.0	BCCC		
11/29/1988							19.0	BCCC		
12/07/1988							19.2	BCCC		
03/13/1989							21.5	BCCC		
05/25/1989							18.5	BCCC		
07/19/1989							12.0	BCCC		
08/25/1989							4.0	BCCC		
09/17/1989							0.0	BCCC		
03/01/1990							0.0	BCCC		
05/28/1990							0.0	BCCC		
07/24/1990							0.0	BCCC		
08/23/1990							0.0	BCCC		
09/28/1990							0.0	BCCC		
10/26/1990							0.0	BCCC		
02/28/1991							0.0	BCCC		
06/17/1991							0.0	BCCC		
08/23/1991							0.0	BCCC		

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OOD

Cottnwood Spring Flow Data

Date	Flow (GPM)	Source	Flow (GPM)	Source	Flow (GPM)	Source	Flow (GPM)	Source	Flow (GPM)	Source	
11/25/1991							0.0	BCCC			
02/25/1992							0.0	BCCC			
05/13/1992							0.0	BCCC			
12/15/1992									0.0	EW	
05/19/1993									0.0	EW	
07/21/1993									0.0	EW	
07/01/1994									0.0	EW	
07/01/1995									0.0	EW	
07/01/1996									0.0	EW	
07/01/1997									0.0	EW	
11/02/1998									57.8	EW	
03/26/1999									96.7	EW	
07/13/1999									84.4	EW	
08/30/1999									49.2	EW *	* Difficulty Sealing Weir @ Below Roans Site, measuerd @ 49.2 GPM
10/06/1999									85.5	EW	
11/10/1999									98.9	EW	
06/05/2000									39.7	EW	

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HYDROLOGIC SECTION

Appendix C

Cottonwood Canyon Creek Hydrogeologic Investigation

Attachment 4
Cottonwood Canyon Creek Gain\Loss Data

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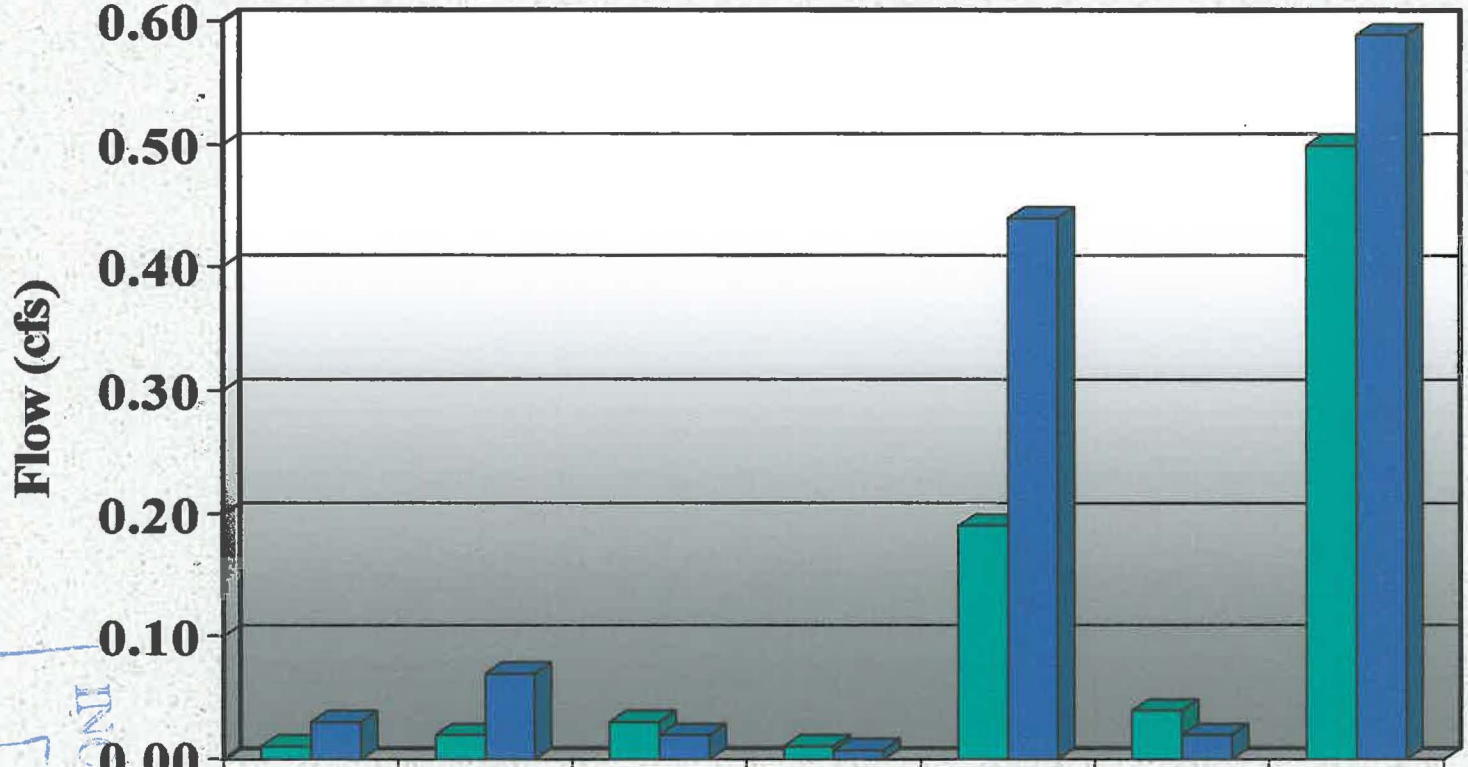
Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West November 1998



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-11/1998	0.03	0.07	0.02	0.007	0.44	0.02	0.59

* USGS Open File Report 81-539

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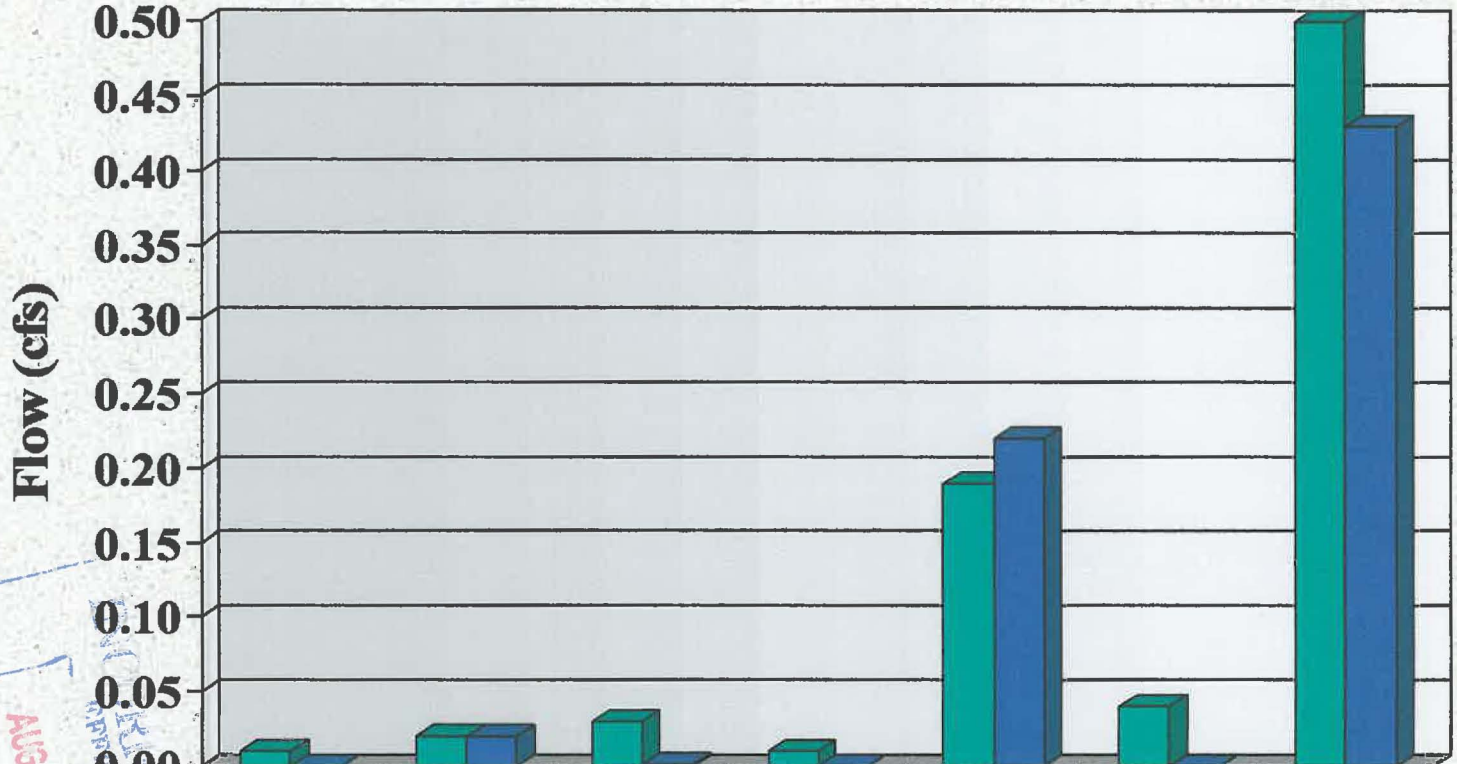
Cottonwood Spring Area Flow = 57.8 GPM/0.13 CFS

Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West March 1999



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-03/1999	0	0.02	0.0015	0	0.22	0	0.43

* USGS Open File Report 81-539

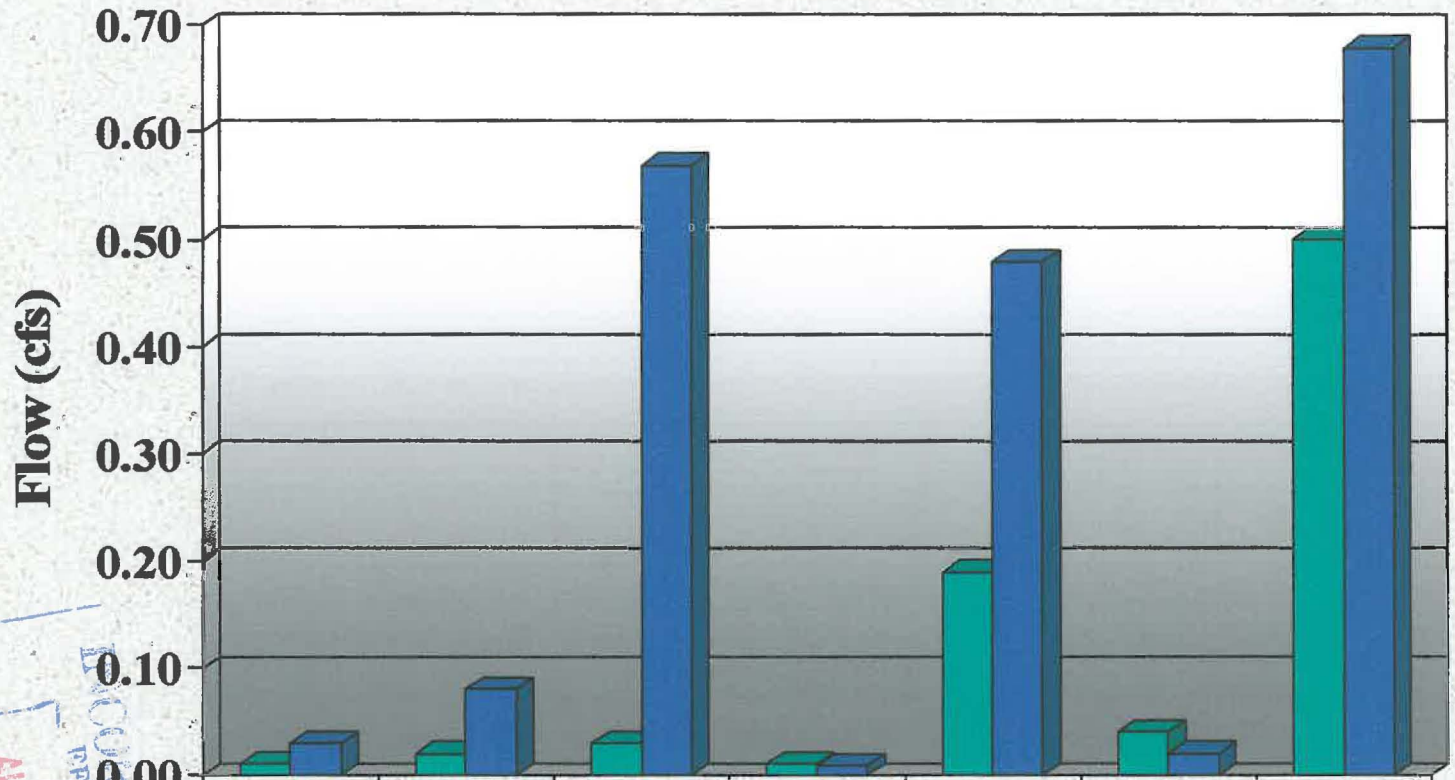
UTAH DIVISION OIL, GAS AND MINING
AUG 2 2 2001

Cottonwood Spring Area Flow =96.7 GPM/0.22 CFS

Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West July 1999



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-07/1999	0.03	0.08	0.57	0.008	0.48	0.02	0.68

* USGS Open File Report 81-539

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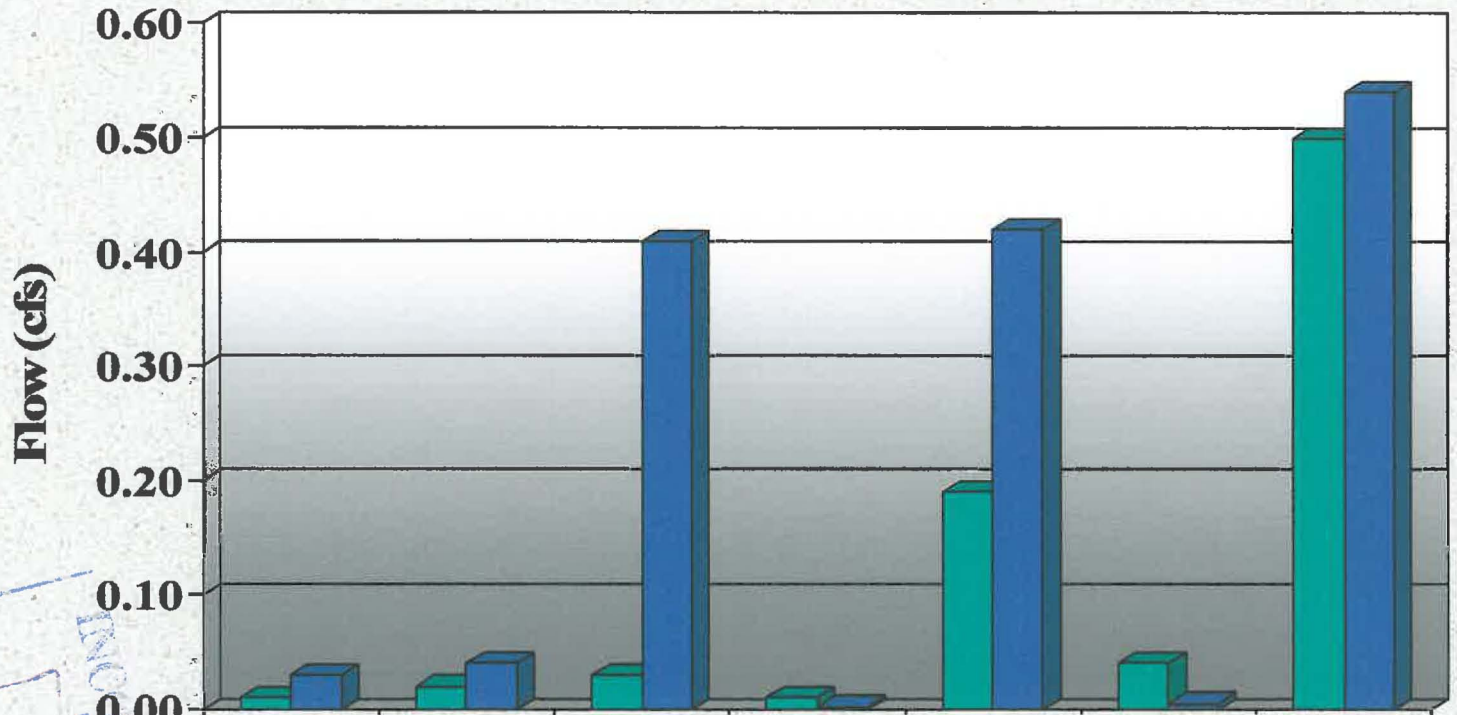
Cottonwood Spring Area Flow = 84.4 GPM/0.19 CFS

Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West August 1999



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans *
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-08/1999	0.03	0.04	0.41	0.002	0.42	0.005	0.54

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 49.6 GPM/0.11 CFS

* Difficulty Sealing Weir @ Below Roans Site

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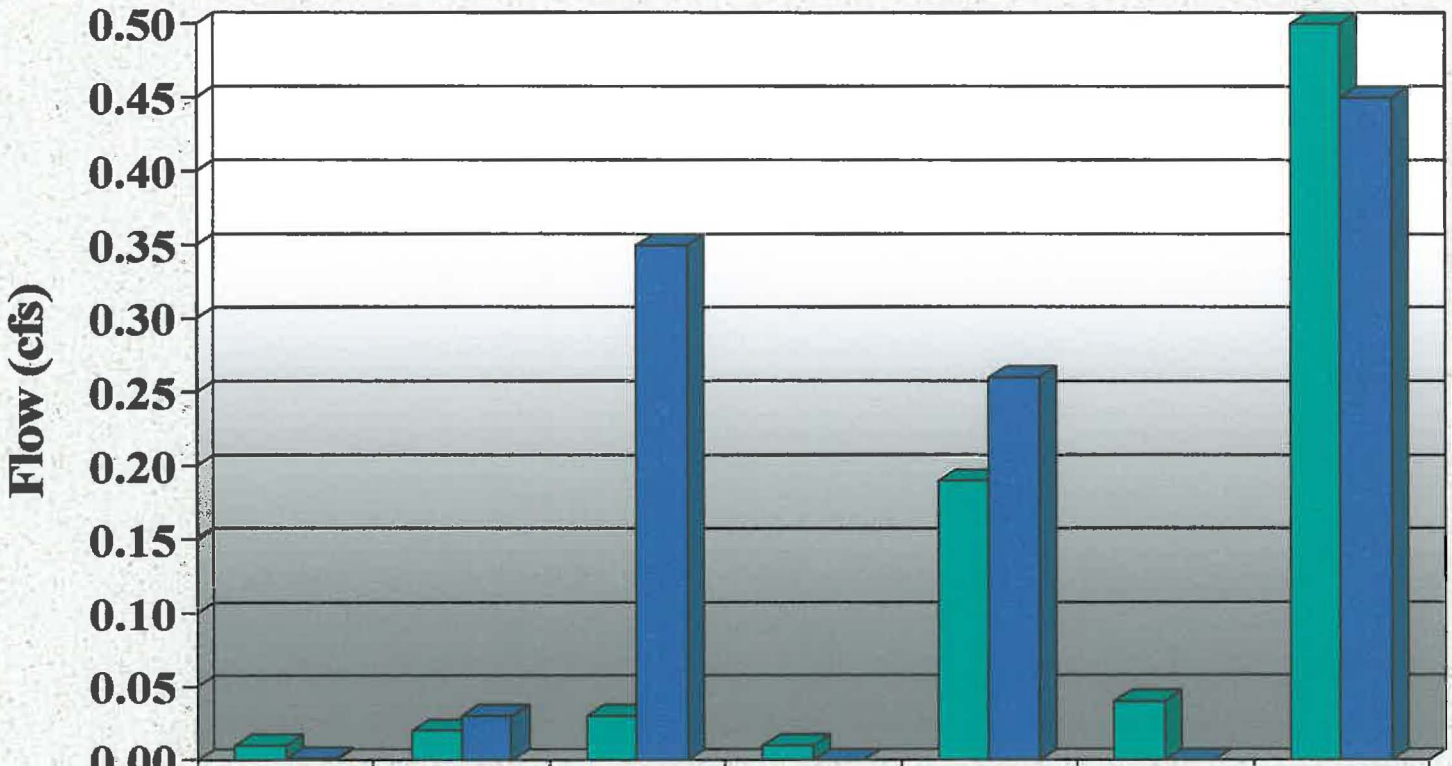
Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West October 1999



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-10/1999	0.002	0.03	0.35	0	0.26	0	0.45

* USGS Open File Report 81-539

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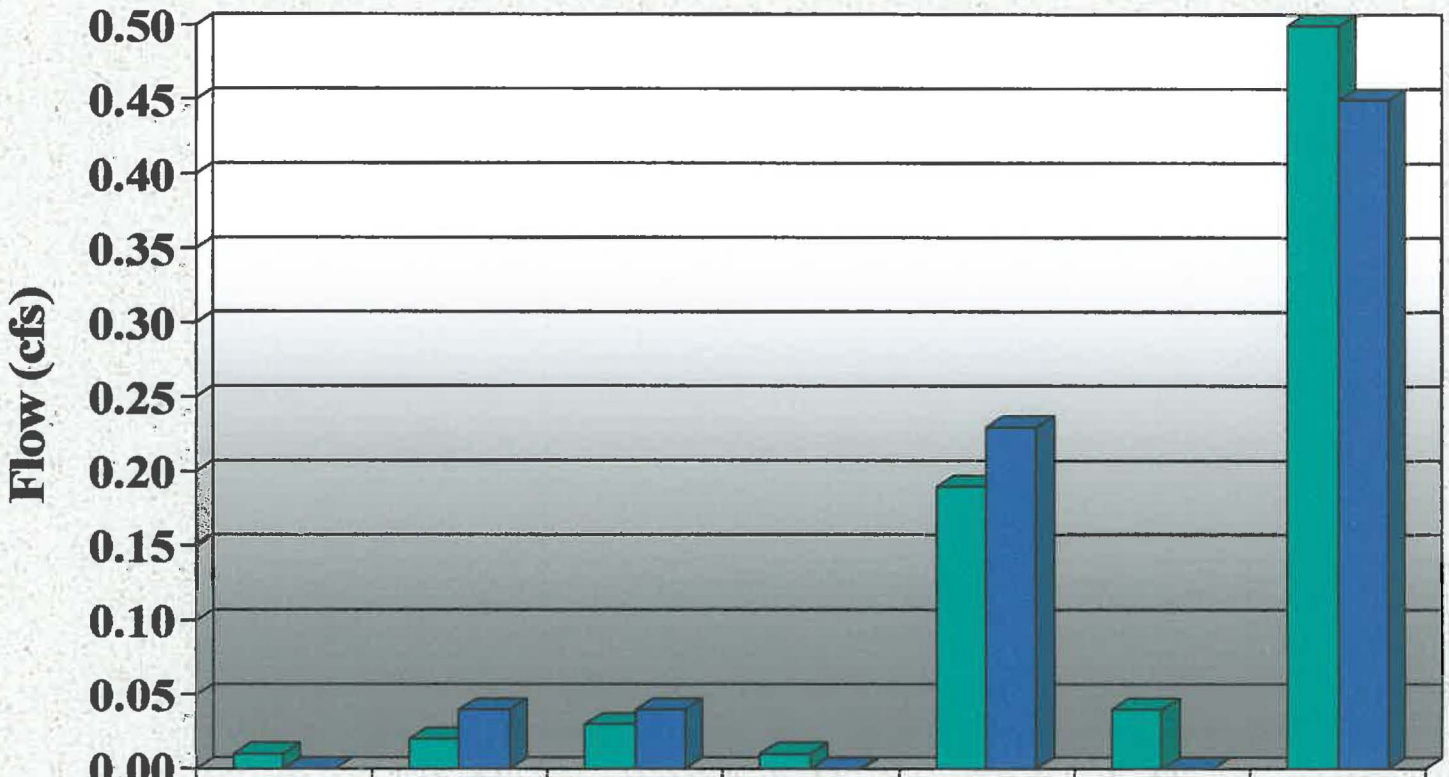
UTAH DIVISION OIL, GAS AND MINING

Cottonwood Spring Area Flow = 85.5 GPM/0.19 CFS

Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West November 1999



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-11/1999	0	0.04	0.04	0	0.23	0	0.45

* USGS Open File Report 81-539

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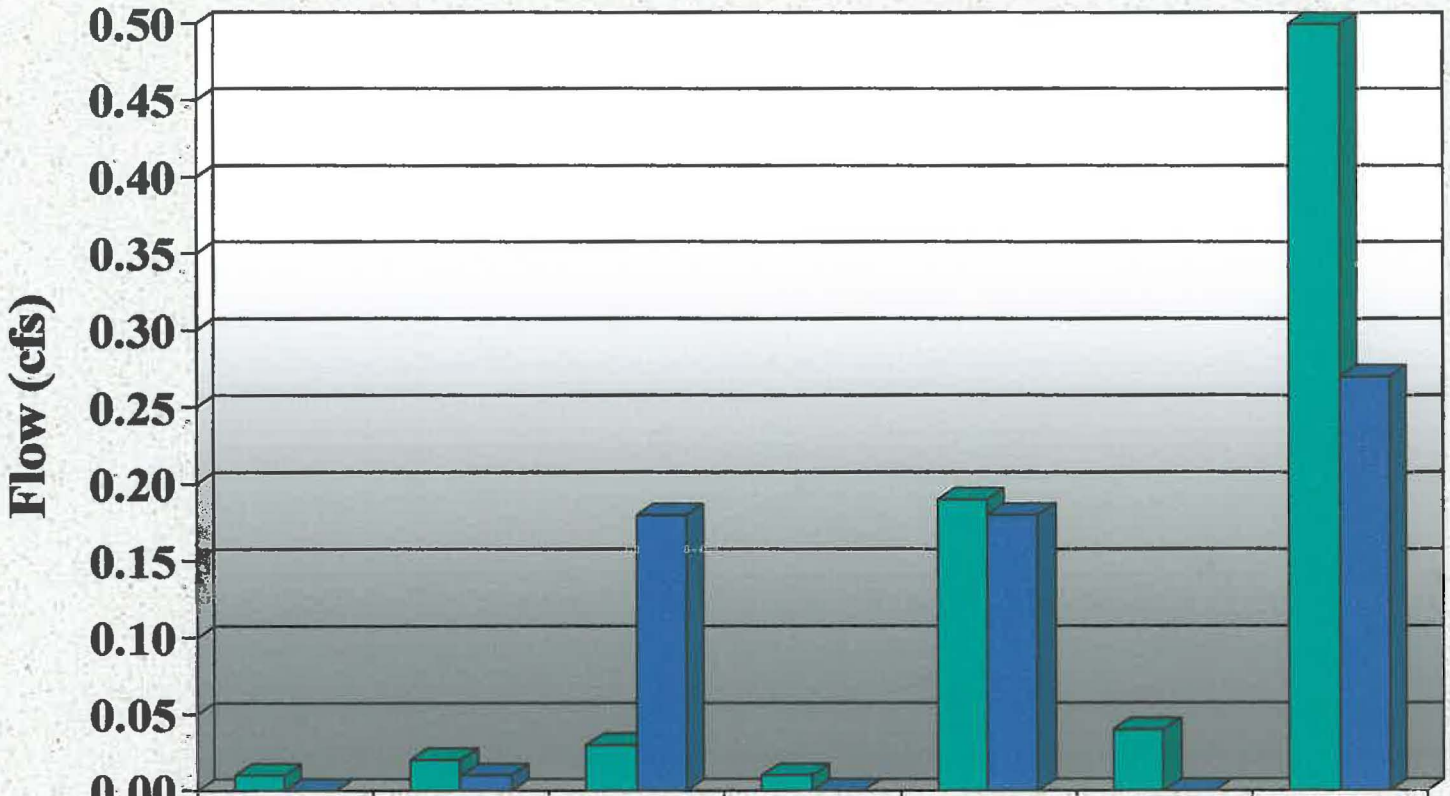
Cottonwood Spring Area Flow = 98.89 GPM/0.22 CFS

Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West June 2000



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-06/2000	0	0.01	0.18	0	0.18	0	0.27

* USGS Open File Report 81-539

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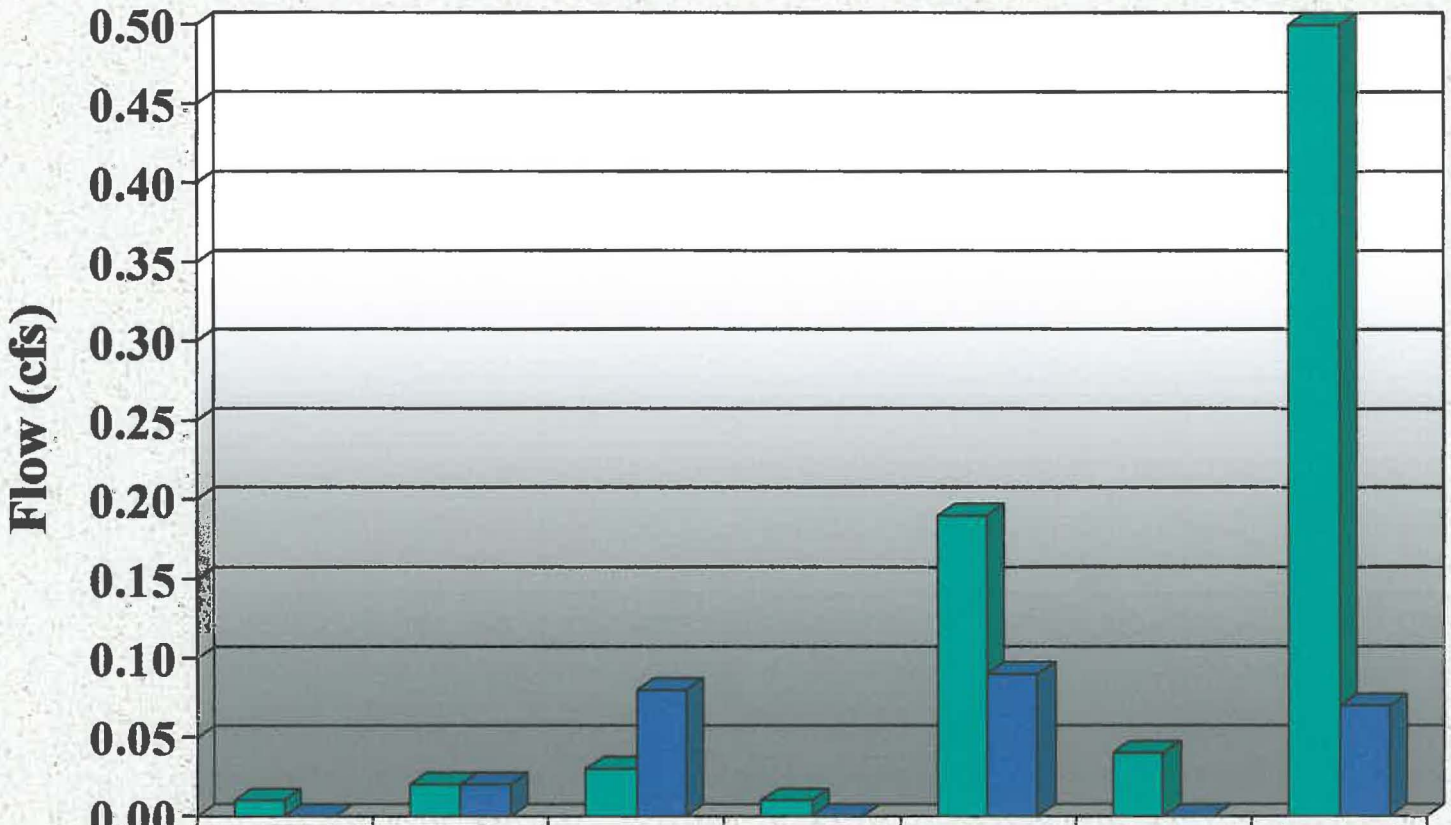
Cottonwood Spring Area Flow = 39.7 GPM/0.09 CFS

Cottonwood Canyon Creek

Flow Data Comparison

USGS August 1979* Energy West October 2000



	@ Mill Canyon	Dairy Canyon	@91-72	Trail Canyon	Cottonwood Creek-TM-23	Roans Canyon	Cottonwood Creek - Below Roans
USGS-1979	0.01	0.02	0.03	0.01	0.19	0.04	0.50
EW-10/2000	0	0.02	0.08	0	0.09	0	0.07

* USGS Open File Report 81-539

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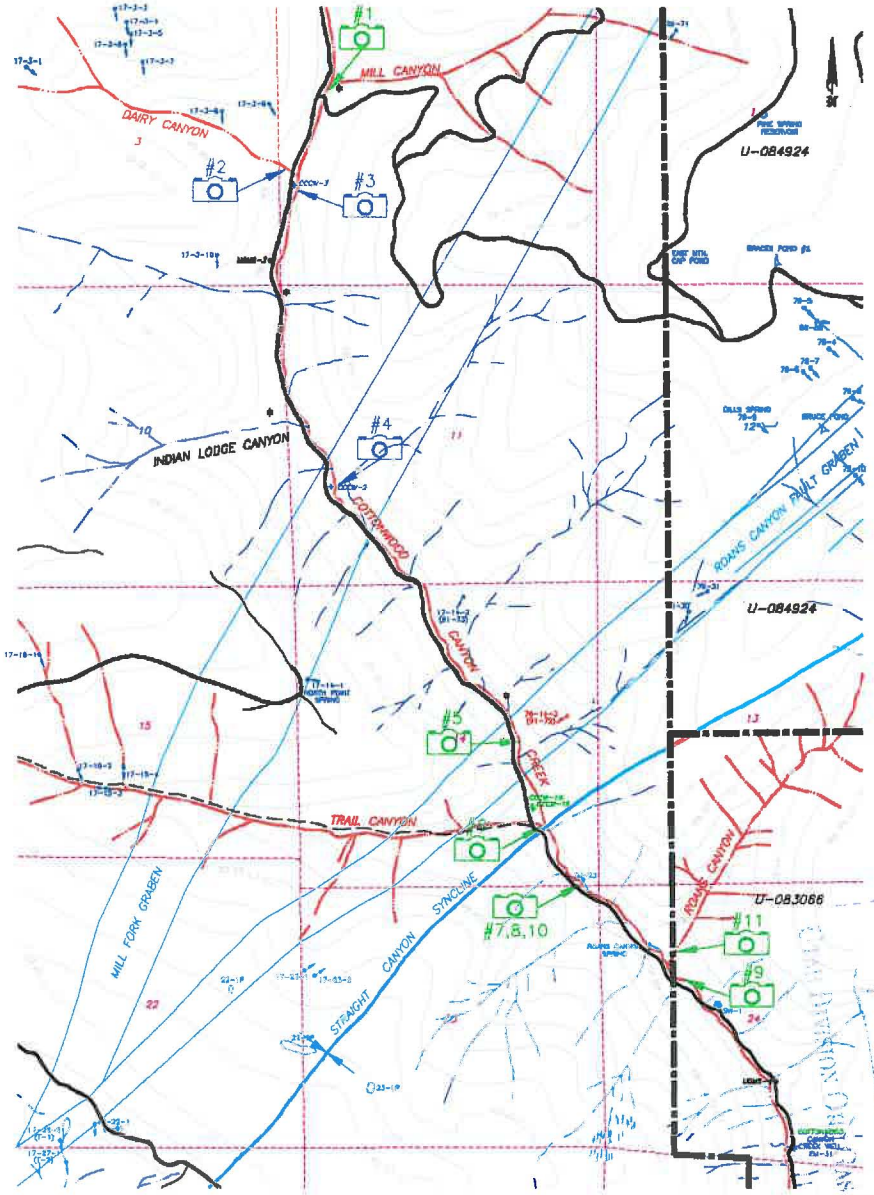
Cottonwood Spring Area Flow = 0.0 GPM/0.0 CFS



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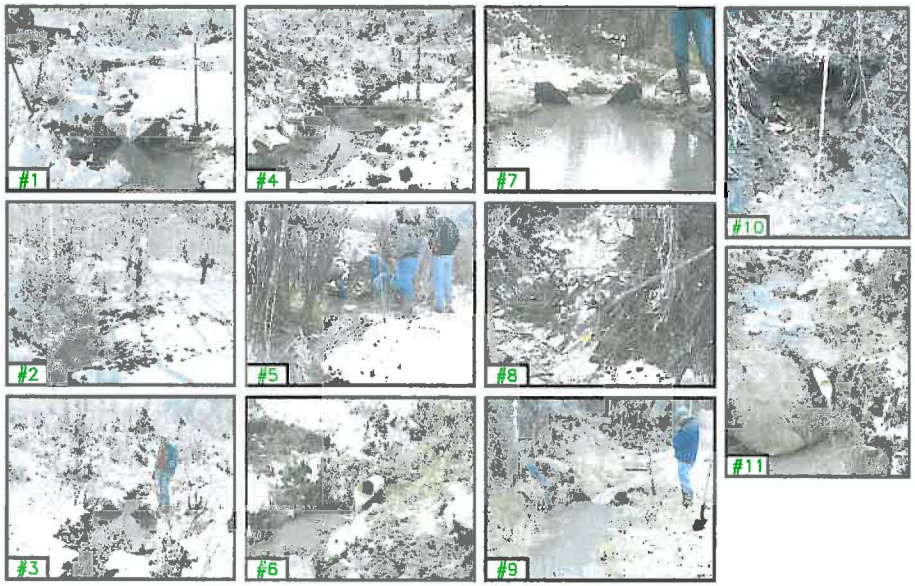
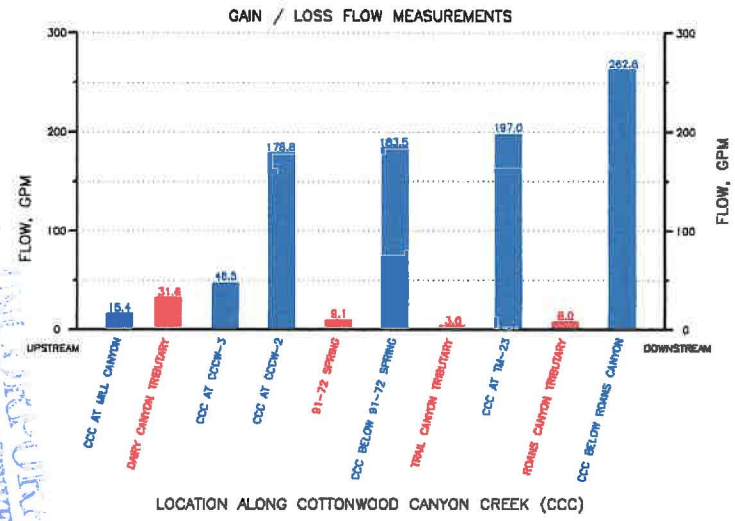




LEGEND

#1

PHOTOGRAPH LOCATION

Main Stream Drainage (Red)

Water Producing Tributary (Red)

Dry Tributaries (Blue)

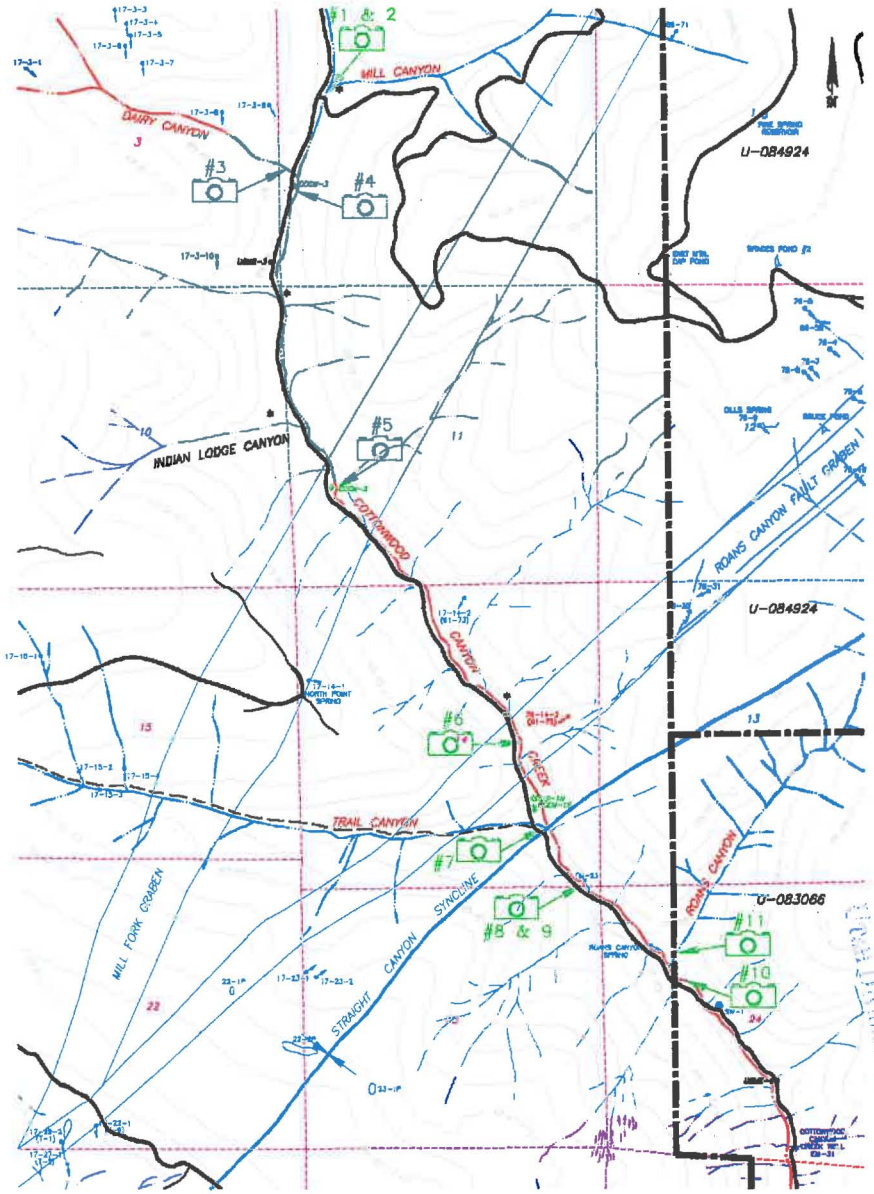
DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY NOVEMBER 10, 1998

K. LARSEN

CENS1774D



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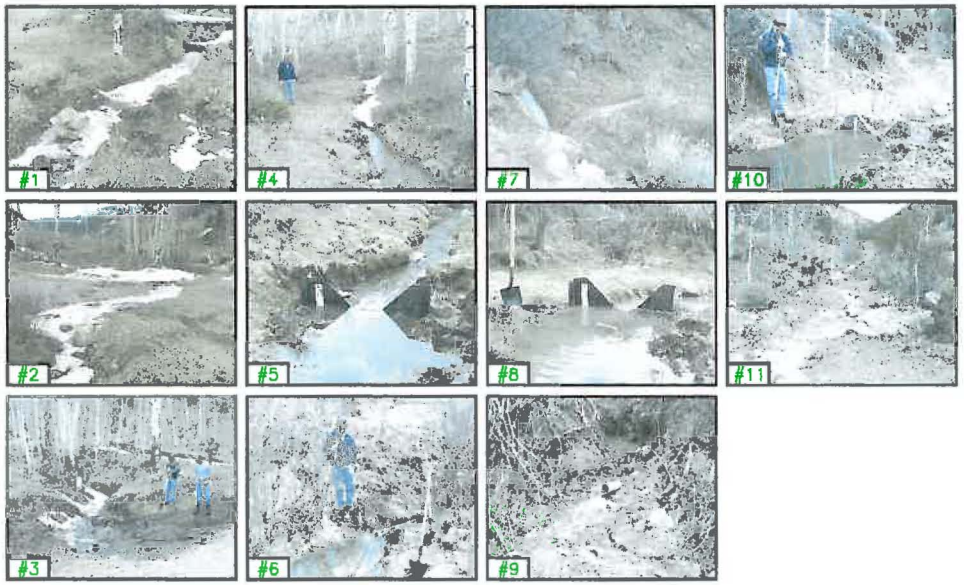
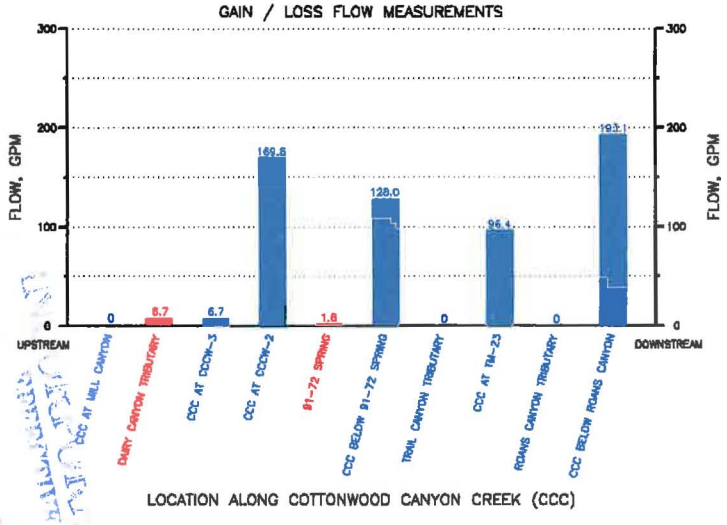




LEGEND

#1

PHOTOGRAPH LOCATION

Main Stream Drainage (Red)

Water Producing Tributary (Red)

Dry Tributaries (Blue)

DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY MARCH 26, 1999

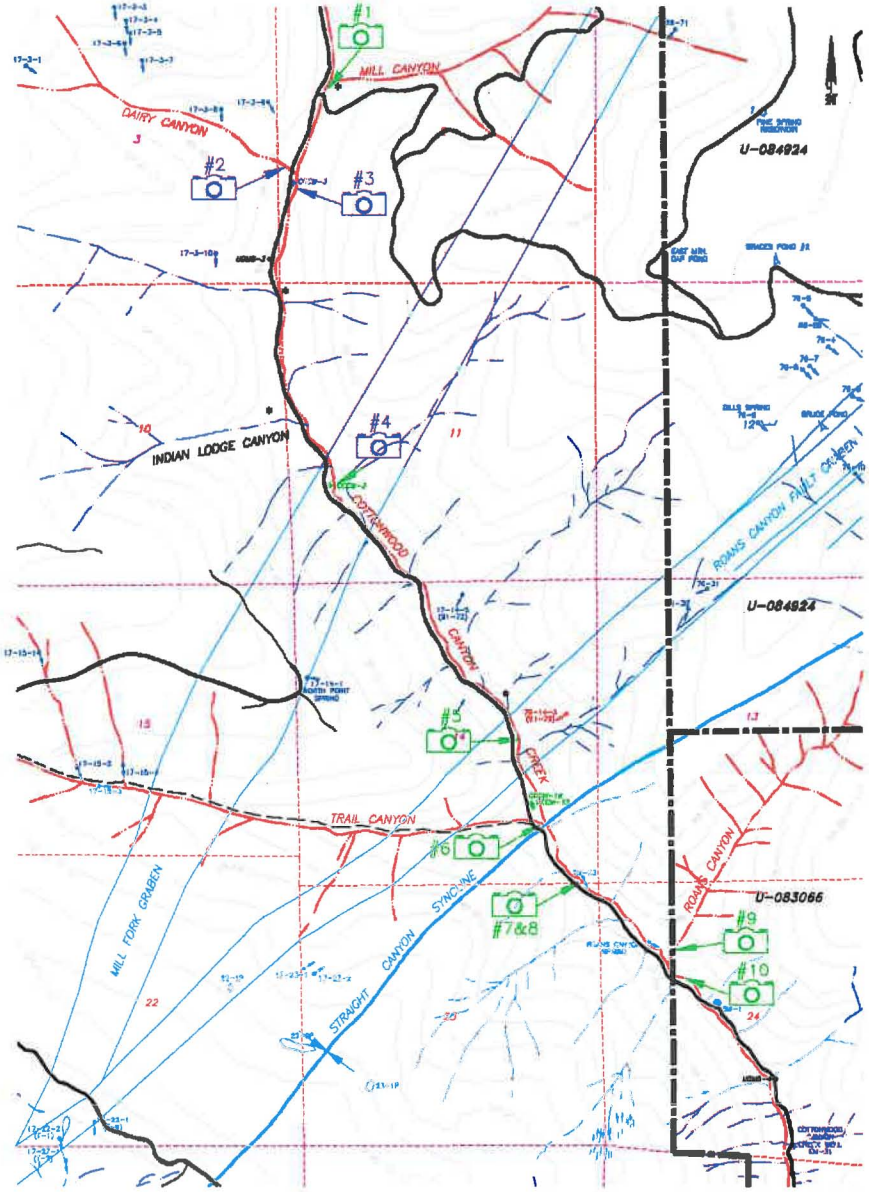
K. LARSEN

GENS1778D

AS NOTED

MARCH 26, 1999

UTAH DIVISION OIL, GAS AND MINING
AUG 22 2001
OOD



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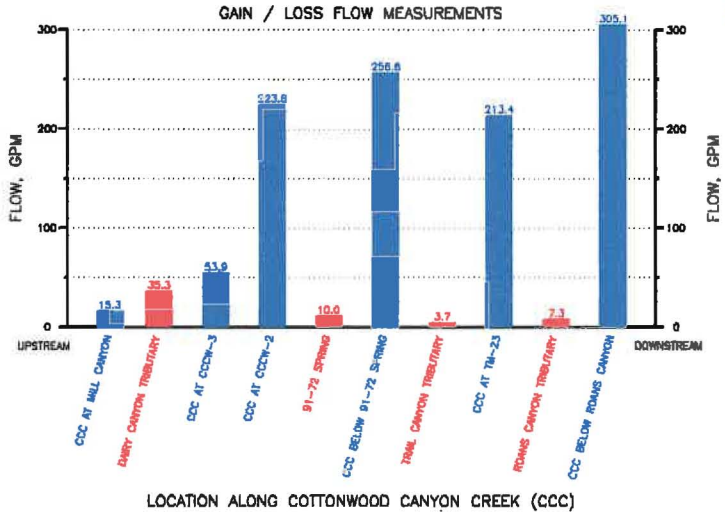


UTAH DIVISION OIL, GAS AND MINING
AUG 22 2001
INCORPORATED
EFFECTIVE

OOD

LEGEND

#1 PHOTOGRAPH LOCATION

Main Stream Drainage (Red)

Water Producing Tributary (Red)

Dry Tributaries (Blue)

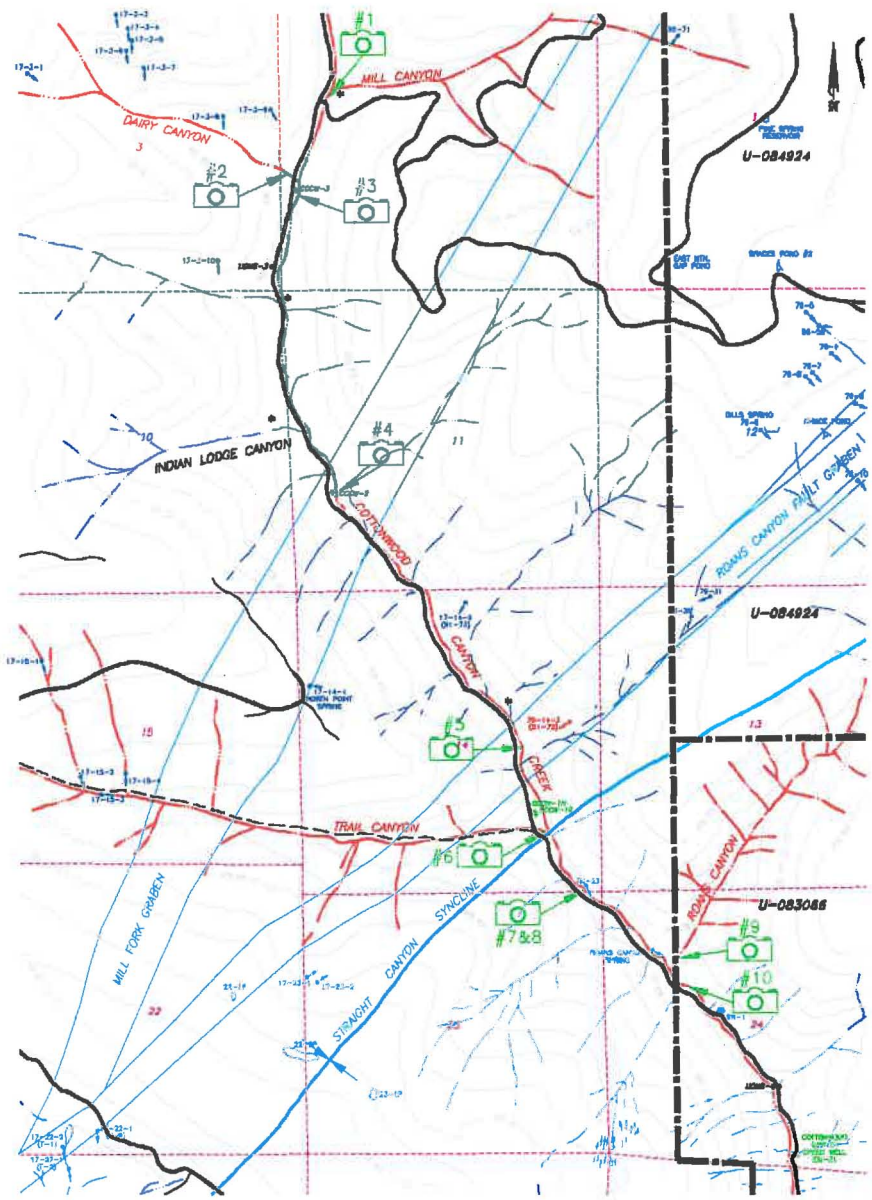
DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY JULY 13, 1999

K. LARSEN

GENS1774D



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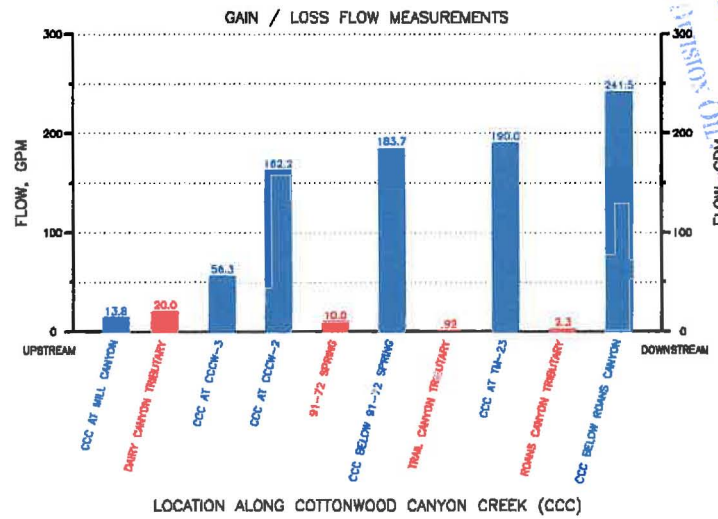
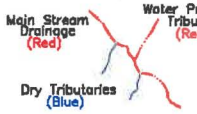


LEGEND

#1

PHOTOGRAPH LOCATION

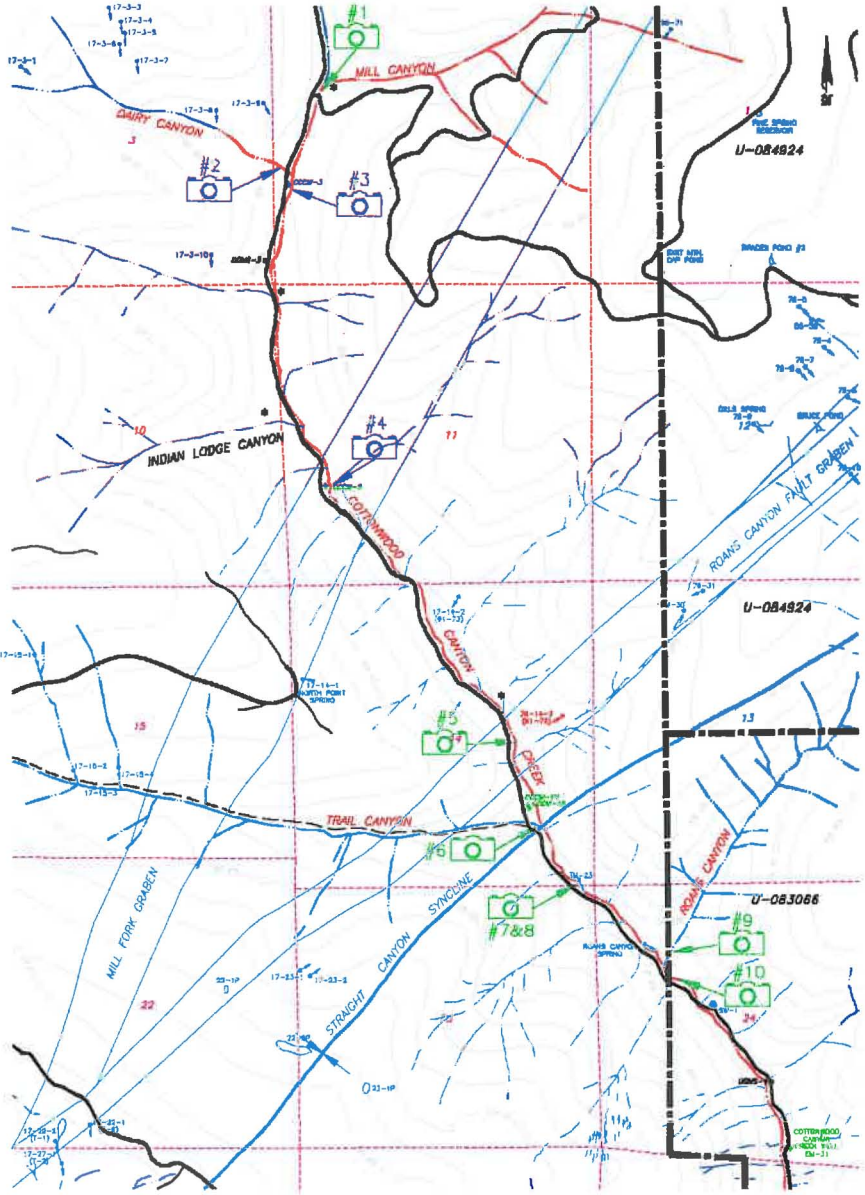


DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY AUGUST 30, 1999

GENS1791D



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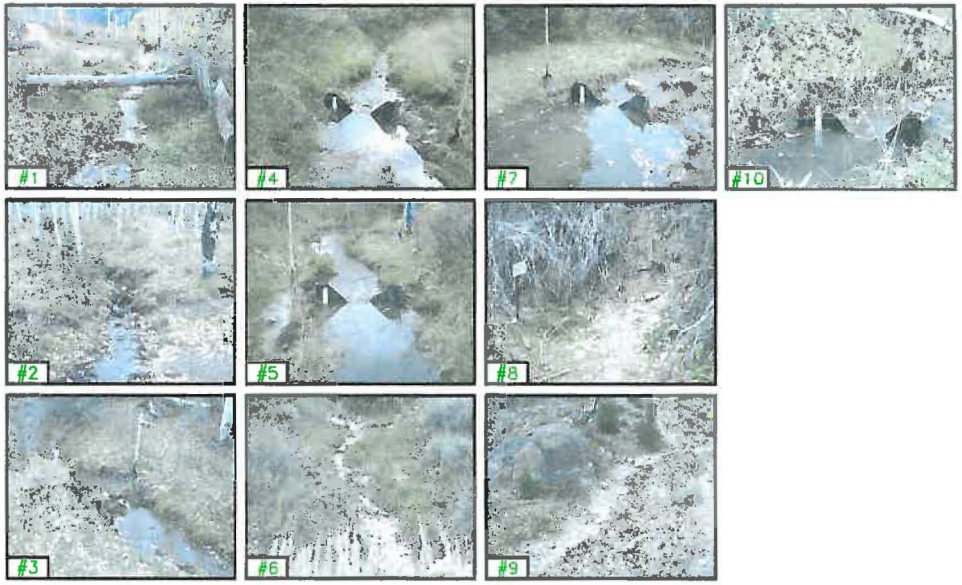

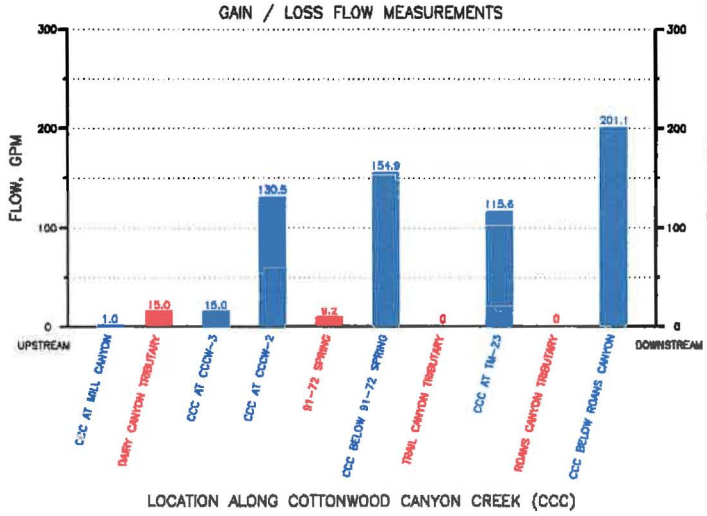

LEGEND

#1

PHOTOGRAPH LOCATION

Main Stream Drainage (Red)

Water Producing Tributary (Red)

Dry Tributaries (Blue)

DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY OCTOBER 6, 1999

K. LARSEN

AS NOTED

GENS1791D

OCTOBER 14, 1999

AUG 22 2001

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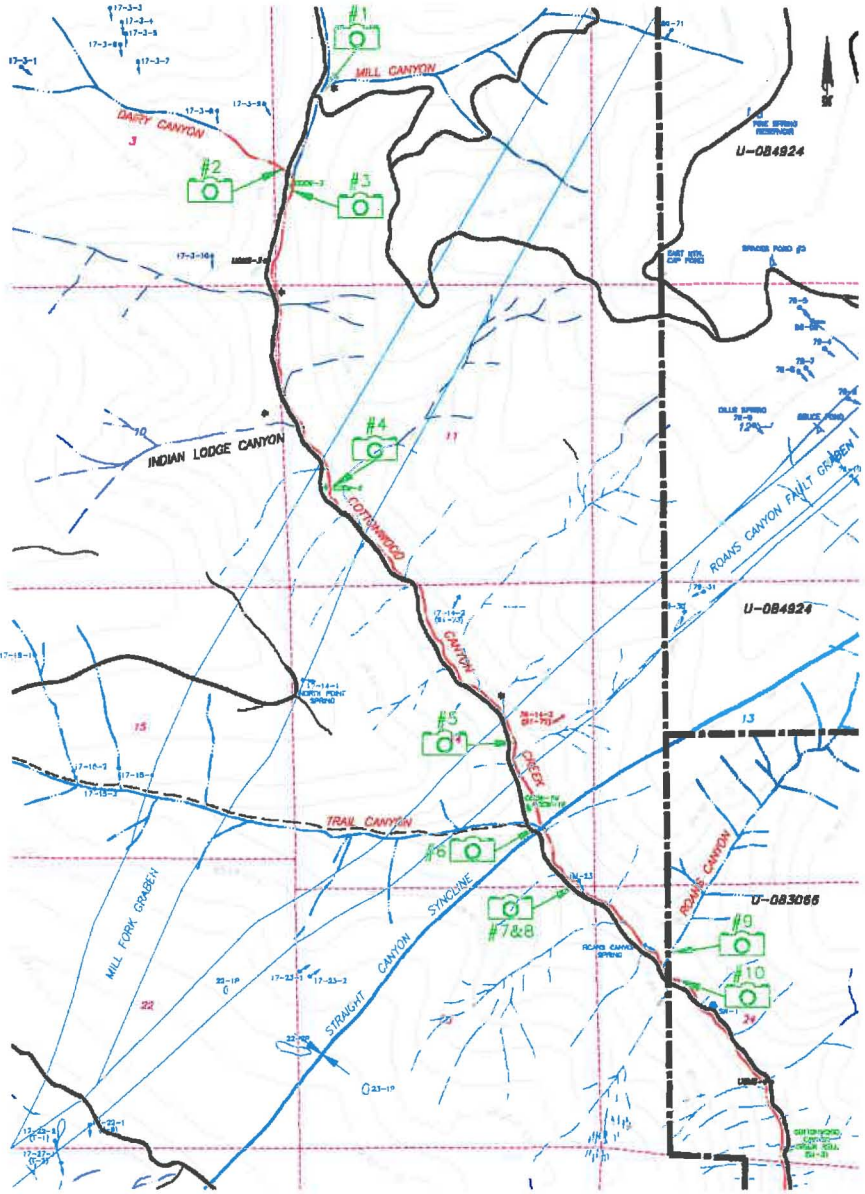
OGD



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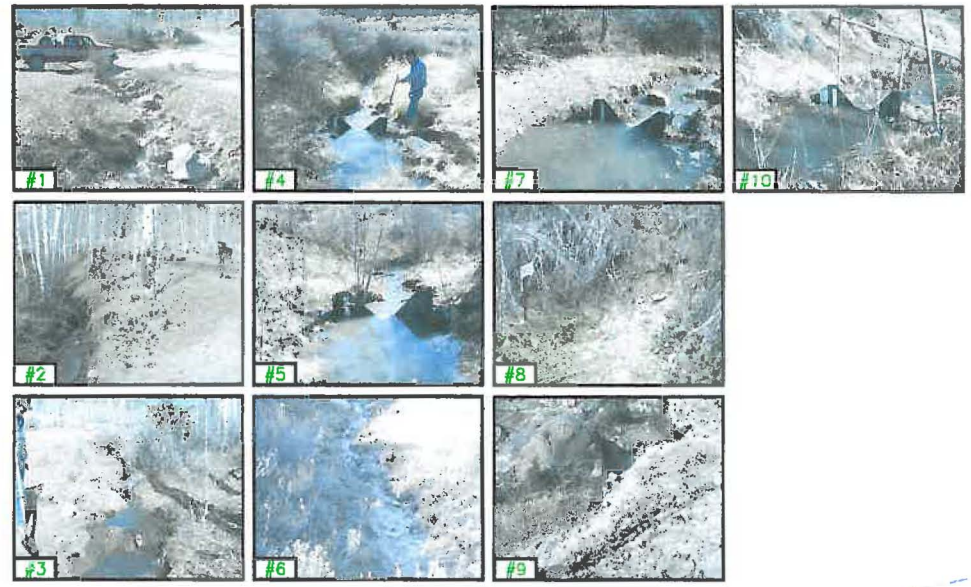
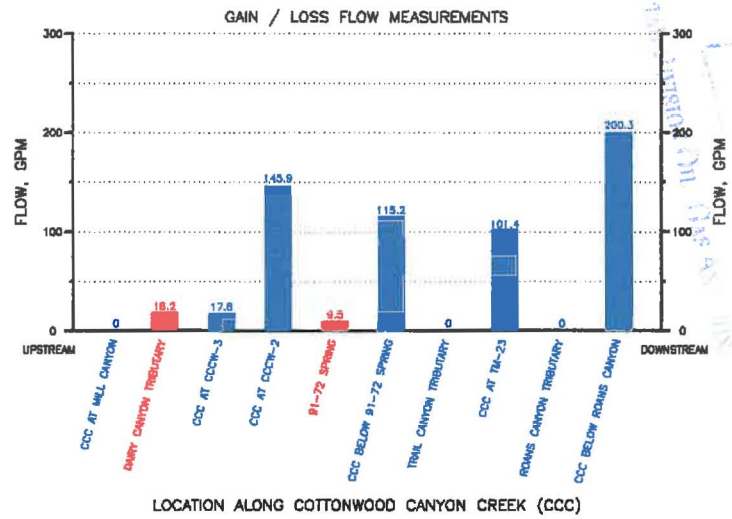
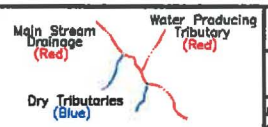




LEGEND

#1

PHOTOGRAPH LOCATION



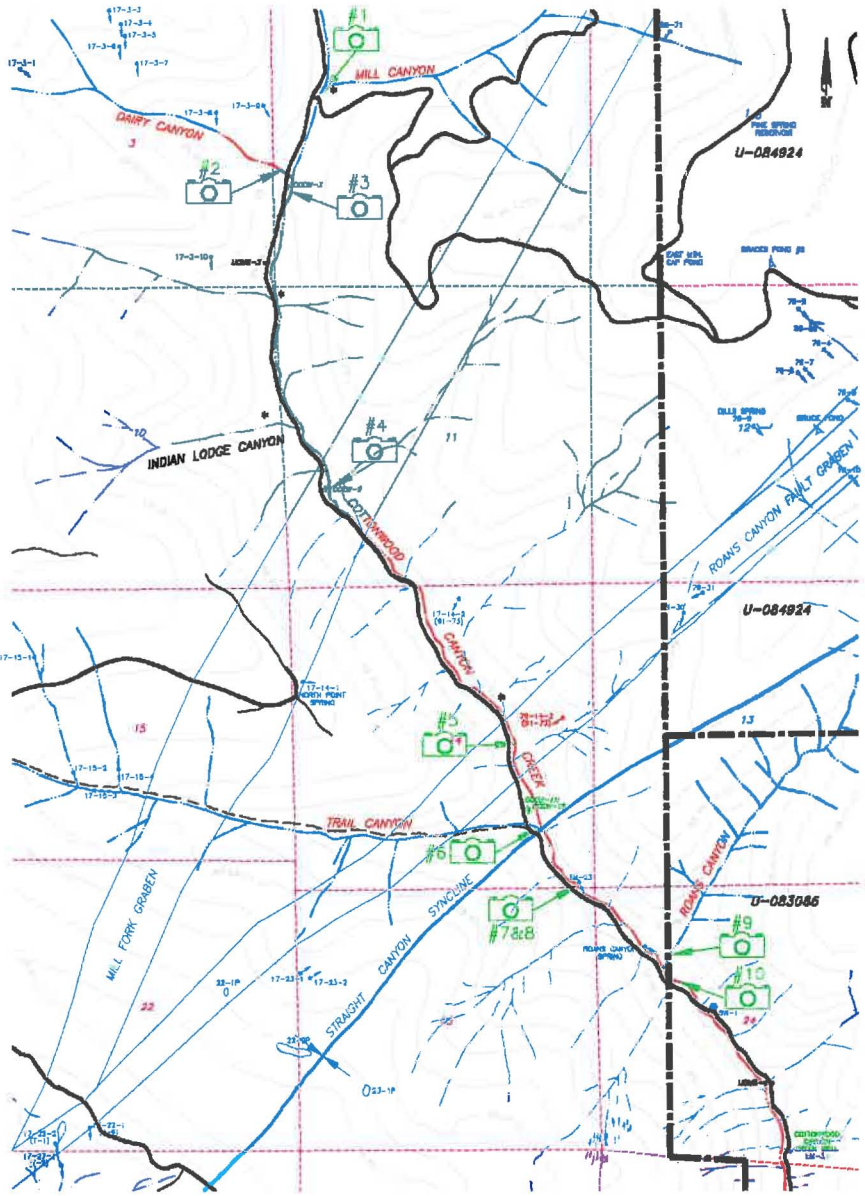
DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY NOVEMBER 10, 1999

CENS1793D

RECEIVED AUG 22 2001 DIVISION OF OIL, GAS AND MINING



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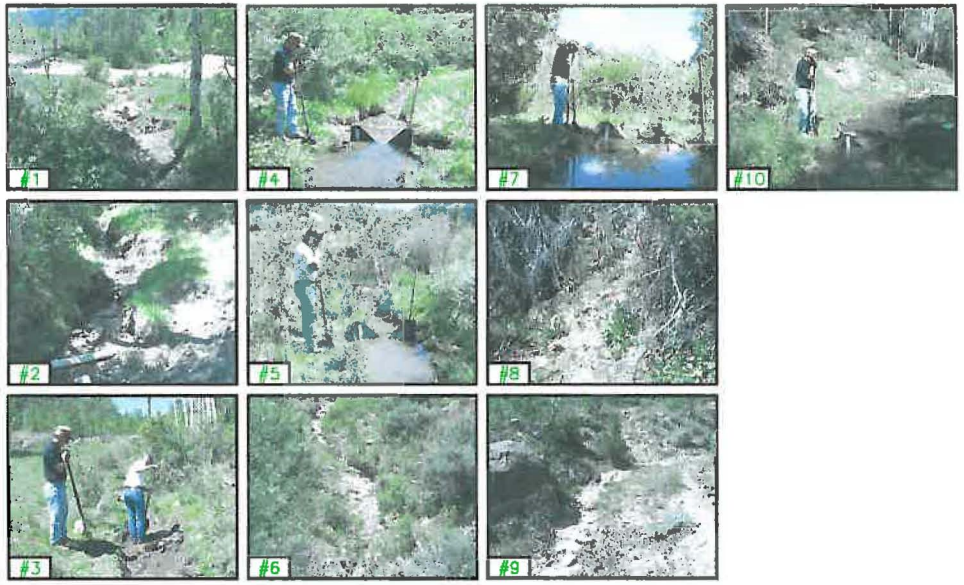

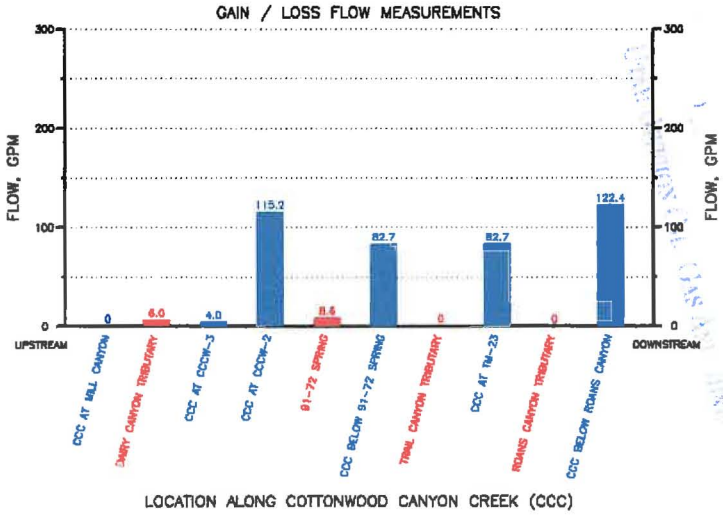

LEGEND

#1

PHOTOGRAPH LOCATION

Main Stream Drainage (Red)

Water Producing Tributary (Red)

Dry Tributaries (Blue)

DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY JUNE 2, 2000

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