0011

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DIVISION OF OIL, GAS AND MINING

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April 6, 2000

TO: Daron Haddock, Permit Supervisor

FROM: Sharon Falvey, Senior Reclamation Specialist
Jim Smith, Senior Reclamation Specialist

RE: Birch Spring Findings for Technical Directive 005, Co-Op Mining Corporation, Bear Canyon Mine ACT/015/025, and Star Point Mine, ACT/007/006, Internal File

SUMMARY:

Directive Tech - 005 provides a process for the Division to review water quality data, identify water resource issues, and evaluate problems. A September 17, 1997 memo from the Division to both Bear Canyon and Star Point Mines identified reduced flow rates at Birch Spring as one such possible water resource problem, and initiated a study that used the directive process. The Division compiled an analysis summary regarding the observed changes in flow rates at Birch Spring and requested an analyses of the problem from Cyprus Plateau Mining Corporation (Cyprus) and Co-Op Mining Corporation (Co-Op). Co-Op and Cyprus Plateau delivered responses to the Division on April 13, 1998 and April 25, 1998, respectively. Co-Op provided information and discussion to clarify their ideas regarding the reduced flow at Birch Spring, while Cyprus Plateau requested they be removed from the directive process.

This memo summarizes the process followed by the Division under Directive 005, step G to understand the change in the Birch Spring discharge rate. The Division requested in a June 1, 1998 memo that Co-Op develop an action plan. Their action plan was received at the Division on July 09, 1998.

TECHNICAL ANALYSIS:

The Issue: The Reason for Decreased Flow at Birch Spring is Undetermined.

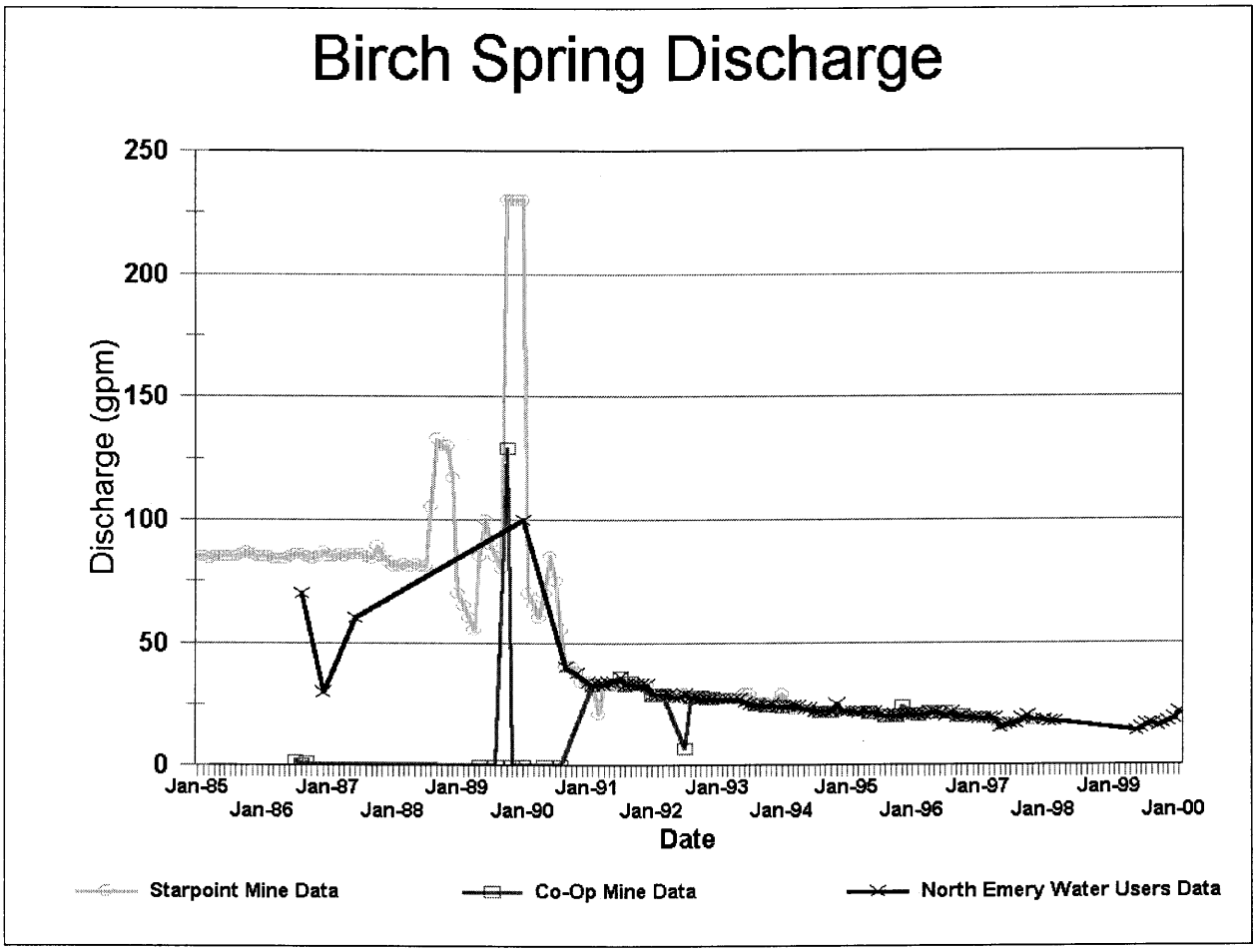
- Under Docket No. 95-025 Cause No. ACT/015/025, *In the Matter of the Five Year Permit Renewal, Co-Op Mining Company, Bear Canyon Mine, Emery County, Utah* (1995) the Board determined the evidence linking the declines in flow at the spring to

mining activities rather than to the drought was not convincing. Information and analyses presented supported earlier findings that there is no effective hydrologic connection between the mines and Birch Spring, and that mining activities were not causing material damage to the hydrologic balance outside the permit Bear Canyon Mine permit area.

The Data Record.

- Figure 1 presents current and past discharge data reported in the Star Point Mine, permit no. ACT/007/006; the Bear Canyon Mine, permit no. ACT/015/025; and the North Emery Water Users Association (NEWUA). The raw data are tabulated in Appendix A.

Figure 1.



- Flow data at Birch Spring were collected by the USGS in 1978 and 1979. Flow rates of 9.3 gpm to 23 gpm were recorded during this cycle (T.W. Danielson, M.D. ReMillard, and R.H. Fuller, U.S.G.S. Open-File Report 81-539). The spring boxes were upgraded by NEWUA in 1977, prior to the U.S.G.S. sampling but were redeveloped in 1980 and 1984. Because of these changes to the collection system, the U.S.G.S. data may be incongruous with later data.

- Based on NEWUA records, flow at Birch Spring declined from 33 gpm in February 1990 to about 19 gpm in 1997, with a 16 gpm low flow recorded May 1997, Figure 1. This decline in flow could result from the drought beginning in 1987 through early 1993. Flows continued to decline to a low of 14 gpm recorded on June 1, 1999. Flows appear to be recovering from this low and the last recorded spring discharge rate provided from NEWUA was 23 gpm on February 18, 2000.

- Data in the Star Point Mine Plan suggest a larger decrease in flow occurred at Birch Spring following the observed peak flows in 1988 through 1991. These peak flows occurred during the same period when flow from the Tie Fork Well increased, which was attributed to an earthquake occurring on August 14, 1988. The first noted change in Birch Spring water characteristics, complaints from the water users that their water had increased sediment, was documented in a memo to the Division dated October 17, 1989. Other anomalies in Birch Spring data are noted in a memo from Jeffery W. Appel to Mr. Kingston. This memo identified "odd fluxuations in the water quantities" and questioned an "unsatisfactory water sample of Birch Spring on August 1, 1991."

- Data from 1985 to the early 1990's were obtained by Star Point Mine personnel directly from the individual who had measured the flows for the North Emery Water Users Association (NEWUA). These data cannot be verified: this individual passed away and his original records are not available, and data available from NEWUA do not match these data obtained by Star Point. The magnitude of flow measured may be questionable; however, inclusion of these data seems logical because the data are consistent from year-to-year, as would be expected from a spring with a large reservoir and little surface water interaction, and they indicate the abrupt increase in flow attributed to the August 1988 earthquake.

Star Point Mining Activity

The Star Point Mine was determined to be an unlikely cause of decreased flows at Birch Spring. The following points, which were based on information presented at that time, supported this determination:

1. It is unlikely a decrease in Birch Spring flow from dewatering at the Star Point Mine would be noted within the reduced flow period. Flows declined at Birch

Spring around 1990, prior to 1992 when mine dewatering began under Gentry Ridge. Dewatering ceased under Gentry Ridge in 1995: Birch Spring flow reached a record low in May 1997.

2. The Birch Spring and Star Point Mine water are believed to originate from different sources, as suggested by the deuterium and oxygen ratios. Waters from the Star Point Mine plot on or above the Meteoric Water Line, while Birch Spring waters plot below the Meteoric Water Line.

3. The rate at which water flows through the formations, from the recharge sources to the spring, is slow. Water dating suggests modern water (younger than 50 years) is not contained in Birch Spring. Carbon 14 dating techniques determined Birch Spring water has 1,100 to 1,900 years mean residence time.

Action Plan

The action plan was proposed by Co-Op in a memo dated July 6, 1998. Their plan is presented below and is followed by a discussion that includes a summary of the actions taken. The proposals are enumerated and the Division's analysis follows:

1. "Co-Op Mining Company and the North Emery Water Users Association should review historical flow data for Birch Spring and attempt to determine the accuracy of existing data and come to an agreement as to what flow records may be accurate and what flow records may be inaccurate. This will help to verify and determine historic flow patterns of the spring in order to accurately compare current flows to (sic)."

No actual written agreement or statement was made between the parties for the historic flow record. The data do agree from near the end of 1990 through the remaining period of record. The citizens complaint response memo (completed by Bill Malencik, DOGM Reclamation Specialist on November 1, 1989) states "the spring box outflow pipe was measured at about 150 gpm. This is a three fold increase over the normal flow." This statement indicates the normal flow was approximately 50 gpm . Flows were presented to be about 80 gpm prior to the fall of 1988 according to the Star Point mine plan. NEWUA does not have records of the flow data presented in the Star Point Mine Plan prior to 1988. The early data record incongruencies are not resolved.

2. "NEWUA, Co-Op and DOGM should conduct an onsite visit to review the present condition of the spring collection system and surrounding area. This would involve looking at existing seeps, vegetation, etc. in the surrounding areas of Birch Spring, as well as the condition of the collection box. This will aid in developing a plan of what investigations may be necessary to the spring collection system in order to determine its functionality."

On September 10, 1998, Division Staff Members; Charles Reynolds, Engineer for Co-Op Mining Company; and representatives of the North Emery Water Users Association gathered to review the Birch Spring development history. A summary of elements presented during the meeting are contained in the Division of Oil, Gas and Mining Field Visit Form dated 9/10/1998 in Appendix C.

The meeting resulted in the following recommendations: 1) Co-Op would conduct additional mapping of faults and fractures to determine source locations, 2) NEWUA would unearth Birch Spring sources #1 and # 2 to investigate the operation of the existing spring boxes, 3) NEWUA would try to obtain a down hole camera to determine if roots or sediment are blocking the water lines, 4) further monitoring and water characterization would be conducted by Co-Op.

1. NEWUA would unearth spring sources.

In September 1998 NEWUA opened spring boxes #1 and #2. Mr. Peter Hess from the Division of Oil, Gas and Mining accompanied Jack Stoynoff from the NEWUA. Mr. Hess noted that at box #1 the collection box was full of gravel and sediment and water ran over the top of the collection box. It was estimated that approximately 15 gpm flowed from source #1 after cleaning the box. Mr. Hess took photos of these sites on September 21 and 24, 1998. These photos are in Appendix B.

2. NEWUA would obtain a down hole camera.

NEWUA was unable to obtain a down hole camera to determine if roots or sediment are blocking the water lines.

3. "Co-Op proposes to conduct additional on-the-ground investigations of faults, fractures, and joints in the area of Birch Spring. This would include identifying and mapping faults, fractures, and joints to determine the aerial extent, orientation and associated lithologies. This would help identify which faults, fractures and joints may extend regionally beyond the immediate area of the springs and the Bear Canyon Mine, and provide a greater knowledge of the potential flow patterns in the area."

Information to address this commitment was collected during a field visit by Charles Reynolds, Environmental Engineer for Co-Op, and Jim Smith, DOGM Reclamation Geologist, on October 15, 1998. The field visit form and summary memo from Co-Op dated December 22, 1998 are presented in Appendix C. In summary the documents stated the following:

- The fractures do not completely converge, and they parallel the Blind Canyon Fault within the mapped area.

- Most of the area is jointed. Joints appear to be gradually converging up slope and may actually converge northward or upward or both.

3. "Co-Op has retained the services of Mayo and Associates to conduct a complete chemical and isotopic investigation of the Bear Canyon Mine permit and surrounding areas to attempt to determine ground and surface water flow patterns and properties. This investigation includes examining water quality and isotopic data for seasonal variations in the data. Co-Op proposes to continue this investigation, which includes Birch Spring, in order to identify potential recharge areas for the springs. This investigation began in the Spring of 1998 and will continue through the year 1998. The information collected will be used to update the Bear Canyon Mine PHC and evaluate potential recharge areas for Birch Spring, Big Bear Spring, In-mine water, and other springs."

The Wild Horse Ridge amendment provided a new PHC. The general findings and conclusions made in this document are:

Birch Spring

Source Description

- Birch Springs discharges from a fracture zone near the base of the Panther Sandstone.
- Discrete discharge occurs from several individual fractures.
- Diffuse discharge occurs along a seeping front at the base of the Panther.
- Tritium units (0.35 to 1.12) in the spring water suggest the spring is mostly hydrologically isolated from the surface (pg. 47).
- The ground-water system from which the spring originates is a large, buffered ground-water system (pg. 46).
- Radio carbon dating from 1,700 to 3,600 years indicates either a slow ground-water travel time or large distance from the recharge to discharge area (pg. 47).
- Ground water from source #1 has a radiocarbon age of 3,600 years and from Source #2 has a radiocarbon age of 2,500 years thus, individual fractures may convey water independently of each other (pg. 92).
- There is not a single flow system for Birch Spring, and it is not believed the recharge location can be ascertained. Possible recharge sources include deeply incised canyons to the north such as Tie Fork and Nuck Woodward (pg.108).

Changes in Birch Spring Discharge

- It seems likely that the fracture system from which Birch Spring discharges was impacted in some way by the 1988 earthquake (pg. 45).
- The increased discharges observed in 1989 and 1990 occurred during a drought, suggesting these changes are not climate related (pg. 46).
- Data since 1991, when a flow meter was installed, indicate a slow steady decline from 34 gpm in January, 1991 to 15.5 gpm to August 1998 without indicating seasonal or climatic influences (pg. 46).
- The Star Point Mine data suggest a baseflow component of about 80 gpm while other data indicate the baseflow is about 20 to 30 gpm. The relationship between these two apparent baseflow discharge rates is uncertain (pg. 47 and 48).
- Birch Spring Base flow of 30 gpm has not been diminished (pg. 123).
- The gradual decrease from 34 gpm in January 1991 to 15.5 gpm in August 1998 are likely the result of incomplete capture of the entire discharge due to poor maintenance of the spring boxes (pg. 123 and 126).

Mine Water

Source Description

- In August 1989 mining operations approached the margins of a large sandstone channel in the mine roof, and by November 1989, large roof drips began to flow into the mine in this area (pg. 53).
- The first flow measurement at SBC-9, 120 gpm, was in February 1990 (pg. 54).
- During 1991 water was encountered in another segment of the sandstone channel at SBC-10. SBC-10 is likely isolated from the main channel at SBC-9 as discharge at SBC-9 was not impacted (p. 55).
- On April 27, 1993 mine workings intersected the main body of the channel (pg. 55).
- Analysis of discharge rates suggests that the mine has not intercepted a large continuous aquifer system or system which receives discharge from the overlying areas (pg. 56).

- That discharge of water has not increased in proportion to the size of the mine workings suggests that the mine has intercepted a series of perched ground-water systems isolated from recharge areas (pg. 56).

- Most fault related ground-water inflows to mine workings appear to be supported by water draining from a sandstone channel cut by the fault rather than by water in the fault plane itself (pg.102).

Changes in In-Mine Interception

- In mine discharge in 1988 and 1989 was from SBC-7 and SBC-8 at a combined rate of approximately 40 gpm (pg. 53).

- The fact that by February 1990 both SBC-7 and SBC-8 were dry suggest some flow was likely related to the ground water in the sandstone channel (pg. 53).

- Rapid increases in discharge from SBC-9 correlate with the timing of mining advances into the sandstone channel and changes in flow are the result of mining rather than variability in the channel conditions (pg. 55).

- The analysis to determine that the recharge - discharge rate prior to mining was 1.6 gpm at SBC-9 assumed recharge and discharge were in equilibrium and that dewatering of the sandstone channel was 50 % complete (pp. 117-121).

- Discharge at SBC-10 diminished to approximately 20 gpm by May 1995 when it became inaccessible (pg. 55).

- In 1997 water began discharging at the gob from the 1st East section and is identified as SBC-13. SBC-13 Averages 20 gpm and is believed to be water from SBC-10 (pg.55).

Surrounding Hydrogeology

Recharge

- Ground-water recharge to each member of the Star Point Sandstone occurs where the sandstone is exposed at the surface (pg. 103).

- Active ground-water flow systems extend about 500 to 1000 feet into cliff faces where flow is controlled by fractures and channel sandstones (pg.101).

- The Star Point Sandstone fractures can remain open and continuous over large distances (pg.103).

- Recharge from which a spring discharges occurs where a specific fracture set is exposed at the surface (pg.104).

- Those fracture sets that discharge water have good recharge potential due to surface drainage exposure or have a quality that allows them to convey water (pg.104).

- Bear Canyon Creek is not likely a significant source of recharge to the Panther Sandstone (pg. 79).

- Gentry Mountain is hydraulically isolated on the west, south and east from adjacent areas. To the north, Gentry Mountain can only be hydraulically connected to other portions of the Plateau through a narrow neck, approximately 2 miles wide, between Nuck Woodward Canyon on the west and Corner Canyon on the east (pg.98).

Vertical Flow

- Based on radiocarbon dating, ground water discharging from DH-2 is approximately 1,000 years old (pg. 64).

- Ground water ages suggest a lack of vertical communication. Water from DH-2, from the Spring Canyon Sandstone beneath the Blind Canyon Seam, is younger than water at SBC-9, from the sandstone channel in the Blind Canyon Seam (pg. 64).

- DH-2, completed in the Spring Canyon Tongue, shows a declining trend that Mayo and Assoc. suspects is attributed to depressurizing from mining (pg.65).

Horizontal Flow

- TDS concentrations in water obtained by drilling west across the Blind Canyon fault from 3rd West South are higher than water in the sandstone channel. Waters west of the Blind Canyon fault do not flow eastward into the Bear Canyon Mine workings (pg.78).

- Waters east of the Bear Canyon fault likely do not flow west across the fault into the workings of the Bear Canyon Mine (pg.78).

Chemistry and Isotopes

Birch Spring Chemistry

- Solute concentrations in Birch Spring #1 Source and #2 Source are similar to those in other waters in the Star Point Sandstone (pg. 81; data in Mayo's Table 3).

- Somewhat elevated concentrations in the Birch Spring Overflow are attributed to influence from the Mancos Shale rocks (pg.81).

In Mine Chemistry

- Chemical composition of water in SBC-13, a mine sump, has greater concentrations of sulfate, calcium, magnesium, and TDS that is likely a result of exposure to the mine environment and (pg.78).

- Inflow from the roof in the 3rd West Bleeder was radiocarbon dated at 500 years and had no tritium, indicating no hydrologic connection to the surface (pg.86).

- Both tritium levels and radiocarbon age have increased with time in the inflow at SBC-9. This apparently contradictory situation may result from a combination of increased flow from the surface along a small fault and inflow of older water from the paleochannel.

- Ground water discharging from the sandstone channel, which is 95% of the mine discharge, is approximately 1,500 years old (pg. 64).

Spring Canyon Sandstone Chemistry

- Water in the Spring Canyon Sandstone below the Bear Canyon mine and in Big Bear Spring have nearly identical chemical composition to the water encountered in the Blind Canyon and Tank Seams (pg 77).

- DH-1A is considered to be completed in a portion of the Spring Canyon Sandstone that is in contact with underlying or overlying tongue of Mancos Shale. The water in DH-1A has greater sulfate, magnesium, sodium, and potassium concentrations than waters from DH-2, DH-3 and DH-4, which are also completed in the Spring Canyon Sandstone but in portions not near a contact with a tongue of Mancos Shale. This difference in chemical makeup indicates water does not migrate downward through the intertongueing Mancos Shale, basal Blackhawk Formation, and Spring Canyon Sandstone (pg.77).

Other Conclusions:

- The Bear Canyon mine is hydraulically isolated from Birch Spring based on the following: 1) the Blind Canyon Fault has 200 ft of offset and it is unlikely the sandstone would be juxtaposed to the sandstone channel, 2) the fault encountered within the mine was filled with gouge and would act as a barrier to flow, 3) ground water sampled on the west side of the Blind Canyon fault at 3rd West South was older than water in the sandstone channel, which is approximately the same age as the water at Birch Spring: water flowing across the fault from the sandstone channel to Birch Spring would mix with this older water and the water at Birch Spring would be

expected to indicate a greater age than it does, 4) the isotopic composition indicates water in individual fracture planes has not mixed with water in nearby, subparallel fractures, 5) because the water in these subparallel fractures does not mix, this suggests that lateral inflow into the fractures, such as from the sandstone channel, does not occur in significant quantities (pp.121-123).

- Conditions in Birch Spring may have changed because of the earthquake before any Bear Canyon Mine mining related impacts were possible (pg. 124).
- That the peak flow in late 1990 resulted from: 1) water impounded in the Trail Canyon Mine, 2) water discharged from the Bear Canyon Mine through the Blind Canyon Fan Portal; and 3) water pumped into old workings in the southern portion of the Bear Canyon Mine, cannot be supported or refuted with discharge, solute, and isotopic data (p. 124).

- If the sandstone channel were the source of ground water for Birch Spring, it would be anticipated that discharge from the spring would have declined rapidly after the sandstone was first encountered and depressurized in 1991 (pg. 123).

- No new data could be collected to answer the question of diminished flow (pg. 126).

Other Information

Information from the thesis "Groundwater flow systems in the Star Point Sandstone - Wasatch Plateau, Utah" presented to the Department of Geology, Brigham Young University by Tamara Bills, April 2000 was not considered in the applicants PHC. Some of the information presented in this thesis and pertinent to Birch Spring are summarized below:

- It is possible that mining activity has had some effect on local fractures (pg.57).

- Birch Spring water has an isotopic composition similar to the mine discharge water(pg. 65).

- Isotopic similarities suggested that DH-2 and Birch Spring are part of the same ground-water system (p. 68).

- Birch Spring ground water could recharge along the north side of Gentry Mountain (pg.74).

- The ^{14}C and tritium contents of Birch Spring ground water means that it is recharged from mixed sources some older than the ^{14}C content and some less than 50 years by matrix and fracture flow (pp.76-79).

- The small tritium content suggests most recharge water is older than 50 years and the recharge is considerably closer than the outcrop south of the Scofield Reservoir Area (pg.79).

- Wells completed in the Spring Canyon Tongue of the Star Point formation may be part of the same ground-water flow system as Birch Spring (pg. 81).

Division Interpretation:

- The suggestion that Birch Spring water was depressurized when the sandstone was first encountered in 1991 is not likely. The permittee has established that recharge from formations overlying the mined area is not probable (with the possible exception of potential fracture flow interaction within a localized active zone). Because the rate of flow from the sandstone channel is controlled by transmissivity, and because the most plausible potential recharge area is to the north, the mine most likely did not intercept water in an area where the potentiometric surface would be affected. Thus, even if Birch Spring had been receiving recharge from the channel sandstone, the spring would not necessarily have been quickly depressurized.

- Measured declines at Birch Spring could be a result of incomplete capture by the NEWUA collection system. However, no information on flow was collected in the downstream seep area, which is stated to have isotopic characteristics similar to Birch Spring, to support the conclusion that there was a shift of flow from Birch Spring to this seep area over time.

- Measured declines at Birch Spring could have resulted from the earthquake event that occurred in August 1988. Data suggesting the earthquake was the cause of decreased flow is contained in the Star Point Mine plan. Birch Spring discharge was 105 gpm for August, 1988. The first change in Birch Spring water characteristics was noted on October 17, 1989 by the water users, who complained that their water had increased sediment. If changes in the ground-water flow resulted from the earthquake, a new equilibrium should eventually be reached. Changes to the system could include increased surface communication through fractures or a change in the steady state flow when post earthquake equilibrium conditions are reached.

- The information in the PHC does not definitively exclude Birch Spring from being in hydrologic communication with the channel sandstone at the north end of the mined area.

  1) Although the Blind Canyon Fault has 200 ft of offset, the likelihood of juxtaposition of the channel sandstone against another sandstone body on the opposite side of the fault was not examined. The Division completed the following analyses from information in the Bear Canyon mine plan. Plate 6-4, the Blind Canyon Structure map, shows the Blind Canyon Seam to be at an elevation between 7651 feet and 7575 feet near the sandstone channel, east of the Blind Canyon Fault. West of the Blind Canyon Fault at bore hole T-4, the Blind Canyon Seam is at 7430 feet to 7400 feet. The log for T-4 shows an overlying sandstone unit at approximately 7700 feet to 7625 feet. It appears there is a possible connection or flowpath across the fault from the sandstone channel to another sandstone unit in the vicinity of the sandstone channel.

2) The region in the mine where the exposed fault is filled with gouge and appears to act as a barrier to flow is south of the sandstone channel. There may be sections of the fault where gouge is not a barrier to flow.

3) The ground water sampled on the west side of the Blind Canyon fault at 3rd West South was older than that in the sandstone channel and at Birch Spring, which indicates that the younger water from the channel sandstone does not flow across the fault at this location. In addition, the geologic map shows two faults converging near this sample location. It is highly likely the water obtained from west of the fault at 3rd West South is isolated and disconnected from ground-water systems outside the wedge created by the two faults.

4) The waters in adjacent, parallel to subparallel fractures are distinct from one another, suggesting that there is little mixing of waters between fractures and that lateral inflow to the fractures does not occur in significant quantities. The sandstone channel could be in hydrologic connection with one or more fractures without being in connection with all fractures.

CONCLUSION:

The last recorded discharge rate provided by NEWUA for Birch Spring was 23 gpm on February 18, 2000. Flow has increased from the low of 14 gpm reported on June 1, 1999. Mining ceased at the north end of the 1st North section, near SBC-9 and the sandstone channel, in October 1999, and this area was sealed in November 1999. A final sample was collected from SBC-9 on October 12, and the flow recorded at that time was 55 gpm. The closure of this section of the mine confounds further investigation of the possible connection between the channel sandstone and Birch Spring and whether dewatering the sandstone channel added to reduction in discharge at Birch Springs.

Because recent data supplied by NEWUA indicate flow is presently increasing, continued isotopic dating could over time help define whether the recent increases are due to the sandstone channel flow path being re-established following mining, or are due to fracture communication between ground and surface waters having been enhanced by the earthquake. It is recommended that isotopic dating of waters from each fracture source, if possible, continue until it is demonstrated that flow at Birch Spring has reached equilibrium. Because there was a significant change in flow following the earthquake, it may not be feasible to determine the impact that may have resulted from the earthquake and that which may have resulted from dewatering the sandstone channel. All information collected to date provides a clearer understanding of the Birch Spring system. Therefore it is not appropriate to discontinue monitoring at Birch Springs until equilibrium is reached. At that point conclusions might be drawn from the isotopic and flow data collected.

RECOMMENDATION:

It is recommended discharge from Birch Spring continue to be measured as part of the Bear Canyon operation plan. Monitoring for isotopic characteristics should be maintained, either until discharge from the spring achieves equilibrium or bond is released for the related permit area.

sm
cc: Mary Ann Wright,
North Emery Water Users Association
Price Field Office
Division of Water Rights
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Appendix A : Birch Spring Data

Table 1. Data used for Birch Springs Discharge: Figure 1				
DATE	Star Point Mine Flow (GPM)	Bear Canyon Flow (GPM)	NEUWA Flow (GPM)	Comments
Jan-85	85			
Feb-85	85			
Mar-85	84			
Apr-85	85			
May-85	85			
Jun-85	85			
Jul-85	85			
Aug-85	85			
Sep-85	86			
Oct-85	87			
Nov-85	86			
Dec-85	85			
Jan-86	85			
Feb-86	85			
Mar-86	84			
Apr-86	84			
May-86	84			
Jun-86	85			
Jul-86	86	2.1		
Aug-86	86	0.5	70	
Sep-86	85	1.2		
Oct-86	84			
Nov-86	85			
Dec-86	87		30	Extended drought begins
Jan-87	85			
Feb-87	85			
Mar-87	86			
Apr-87	85			
May-87	86			
Jun-87	86		60	
Jul-87	86			
Aug-87	85			
Sep-87	84			
Oct-87	89			
Nov-87	85			
Dec-87	83			
Jan-88	81			
Feb-88	81			
Mar-88	82			
Apr-88	81			
May-88	82			

Table 1. Data used for Birch Springs Discharge: Figure 1				
DATE	Star Point Mine Flow (GPM)	Bear Canyon Flow (GPM)	NEUWA Flow (GPM)	Comments
Jun-88	81			
Jul-88	81			
Aug-88	105			Unsatisfactory sample-Aug 1,1998. Earthquake- Aug 14, 1998.
Sep-88	133			
Oct-88	130			Increased sediment complaint.
Nov-88	130			
Dec-88	117			
Jan-89	70			
Feb-89	65			
Mar-89	60			
Apr-89	55			
May-89	85	0		
Jun-89	100			
Jul-89	90			
Aug-89	85	0		
Sep-89	80			
Oct-89	230	129		
Nov-89	230	0		
Dec-89	230			
Jan-90	230	0	100	
Feb-90	70			
Mar-90	65			
Apr-90	60			
May-90	70	0		
Jun-90	85			
Jul-90	75			
Aug-90	55	0		
Sep-90	40		40	
Oct-90	40			
Nov-90	38		37.5	
Dec-90	34			
Jan-91	34		34	
Feb-91	33	33	33	
Mar-91	21		33	
Apr-91	33		33	
May-91	33		34	
Jun-91	33		34	
Jul-91	33	36	36	
Aug-91	33	33	33	

Table 1. Data used for Birch Springs Discharge: Figure 1				
DATE	Star Point Mine Flow (GPM)	Bear Canyon Flow (GPM)	NEUWA Flow (GPM)	Comments
Sep-91	33	34	33	
Oct-91	33		33	
Nov-91	33		33	
Dec-91	33		33	
Jan-92	29	29	29	
Feb-92	29	29	29	
Mar-92	29	29	29	
Apr-92	29		29	
May-92	28		28	
Jun-92	28		28	
Jul-92	29	7	29	
Aug-92	28	28	28	
Sep-92	28	28	28	
Oct-92	27	28.2	27	
Nov-92	27	27.4	27	
Dec-92	27	27.5	27	
Jan-93	27		27	Extended drought period ends
Feb-93	27		27	
Mar-93	27		27	
Apr-93	27		27	
May-93			27	
Jun-93	29		26	
Jul-93	29		25	
Aug-93	25	24.75	24.5	
Sep-93	25		24.5	
Oct-93	25	24.5	24	
Nov-93			25	
Dec-93			24	
Jan-94	29	24	24	
Feb-94			24	
Mar-94	23		24.5	
Apr-94			24	
May-94			23	
Jun-94			23	
Jul-94			22	
Aug-94		22	22	
Sep-94			22	
Oct-94		22	22	
Nov-94			25	
Dec-94			22	

Table 1. Data used for Birch Springs Discharge: Figure 1				
DATE	Star Point Mine Flow (GPM)	Bear Canyon Flow (GPM)	NEUWA Flow (GPM)	Comments
Jan-95			22	
Feb-95	22		22	
Mar-95			21.5	
Apr-95			22	
May-95	21.5	21.5	21.5	
Jun-95			21.5	
Jul-95			20.5	
Aug-95	20	20	20	
Sep-95			20	
Oct-95	20	20	20	
Nov-95		24	20.5	
Dec-95			21	
Jan-96			20.5	
Feb-96	20.5	20.5	20.5	
Mar-96			20.5	
Apr-96		21.5	21.5	
May-96	21.5		21.5	
Jun-96			21	
Jul-96		21.5	20	
Aug-96	21.5		21.5	
Sep-96			19.5	
Oct-96	20	20	20	
Nov-96			19.5	
Dec-96			19.5	
Jan-97			19	
Feb-97	19		19	
Mar-97			19.5	
Apr-97			19	
May-97	16		15.3	*Averaged Two values
Jun-97	16.5		16.5	*Averaged Two values
Jul-97			17	
Aug-97			17	
Sep-97			19	
Oct-97			20.25	*Averaged Two values
Nov-97	18.5		18.5	
Dec-97				Water turned out of service
Jan-98			18.5	*Averaged Two values
Feb-98			18	
Mar-98			18	
Apr-98				Water turned out of service

Table 1. Data used for Birch Springs Discharge: Figure 1				
DATE	Star Point Mine Flow (GPM)	Bear Canyon Flow (GPM)	NEUWA Flow (GPM)	Comments
Jun-99			14	Water turned into service
Jul-99			15	
Aug-99			16.5	*Averaged Two values
Sep-99			17	
Oct-99			16	
Nov-99			17	
Dec-99			18	
Jan-00			19	
Feb-00			21.5	

Co-Op obtained data from the North Emery Water Users Association (NEWUA) during 1/91 through10/2/97.
NEWUA data was obtained by phone from Laura Filmore NEWUA secretary from 10/2/97 to 2/18/00.

Appendix B. Birch Spring Source Investigation

Birch Spring Investigation: Spring Source #1

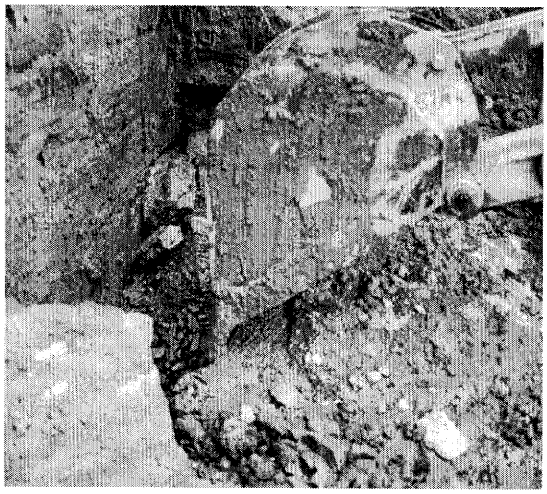


Figure 1
Date:9/21/98

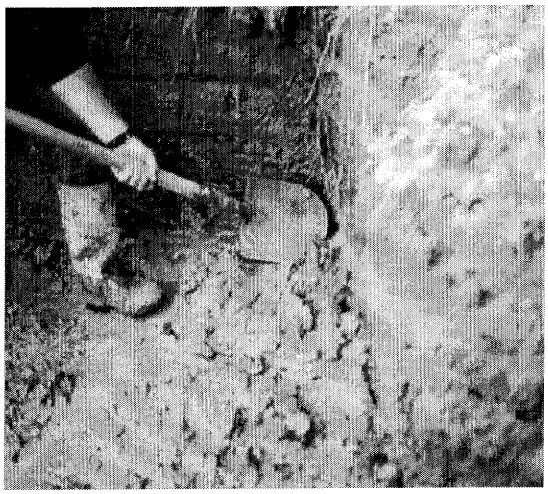


Figure 2
Date: 9/21/98

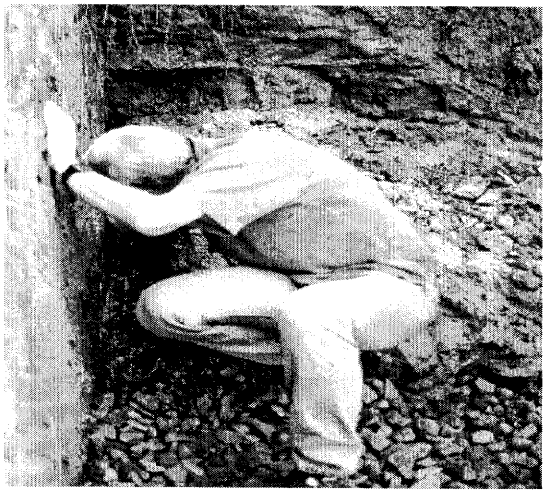


Figure 3
Date: 9/21/98

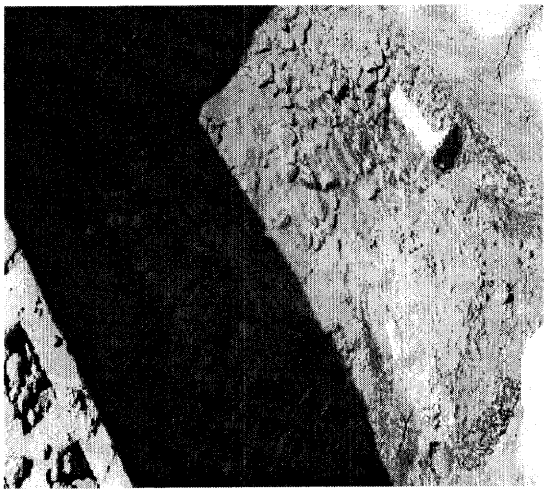


Figure 4
Date: 9/24/98

Spring Source #1, as shown on Map 1, is located on the west side of the alcove and is the down gradient source (Figures 1-4). Water was running over the collection box in (Figure 2) prior to opening the box. Silt and sediments were noted in the fracture and collection box when it was unearthed (Figures 3 and 4). Charles Reynolds is removing silt from the fracture in Figure 3.

Birch Spring Investigation: Spring Source #2

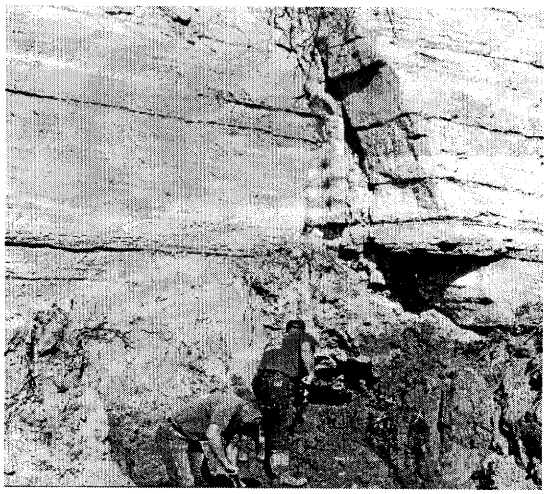


Figure 1
Date:9/24/98

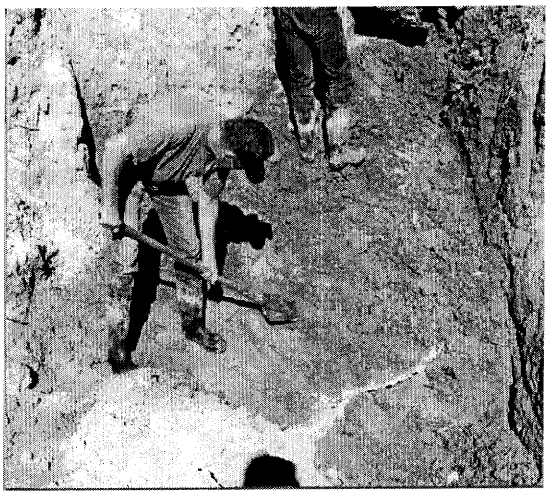


Figure 2
Date: 9/24/98

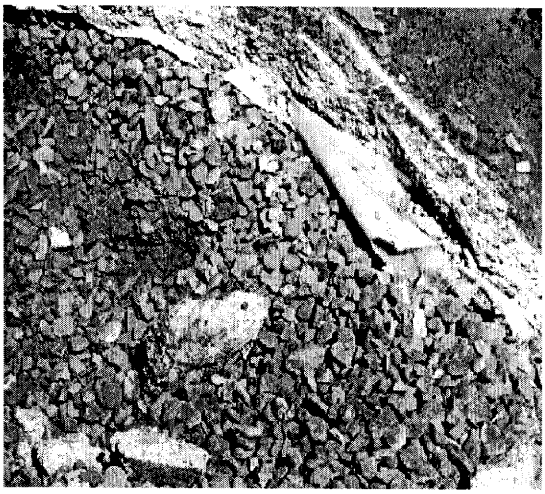
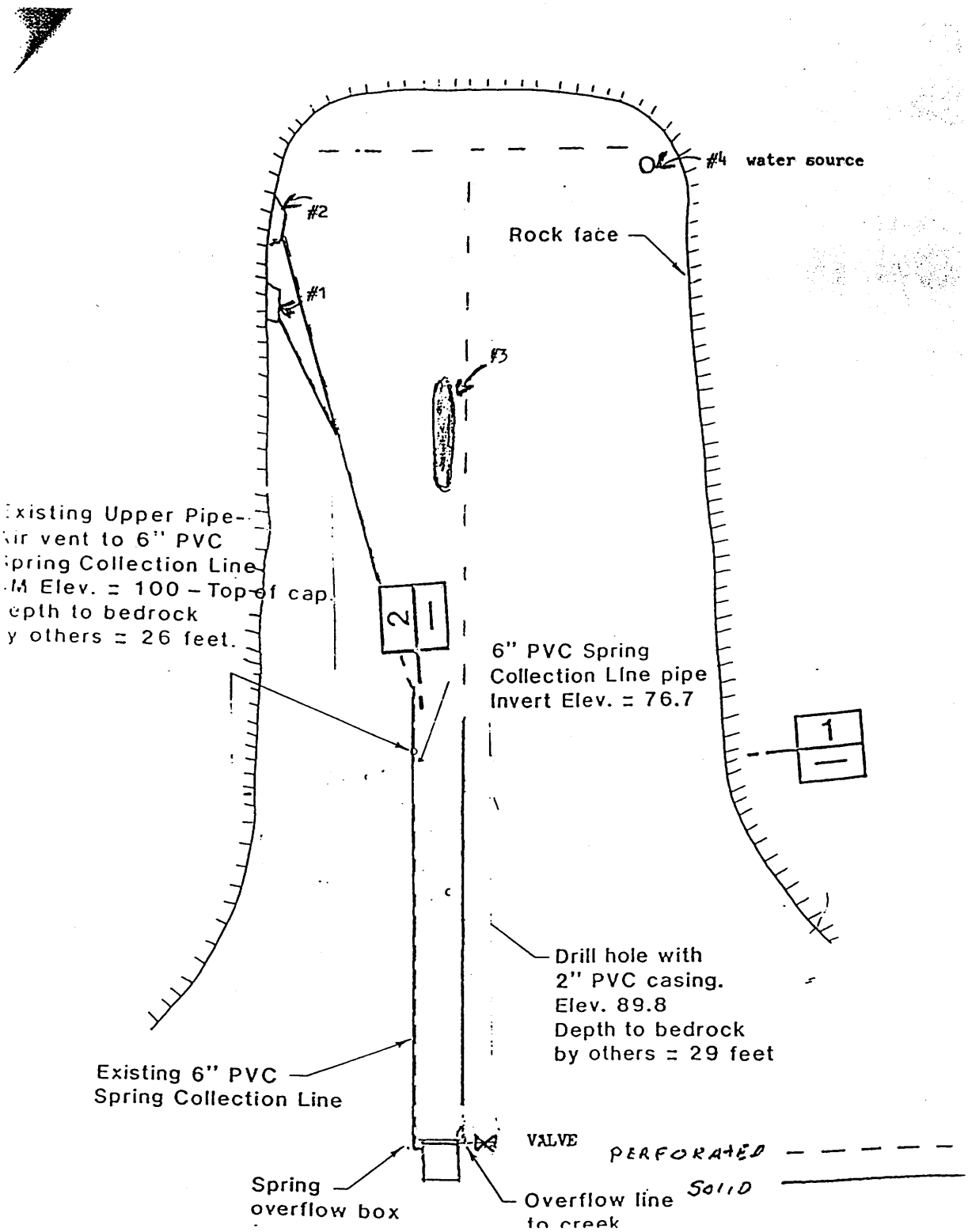


Figure 3
Date: 9/24/98

Spring Source #2 is located on the west side of the alcove and is the up gradient source #2 as shown in Map 1. Silt and sediments were noted in the gravel filter.

Map 1.


#4 water source
#2
Rock face
#1
#3
Existing Upper Pipe-
ir vent to 6" PVC
pring Collection Line
M Elev. = 100 – Top of cap
epth to bedrock
y others = 26 feet.
2
1
6" PVC Spring
Collection Line pipe
Invert Elev. = 76.7
1
Drill hole with
2" PVC casing.
Elev. 89.8
Depth to bedrock
by others = 29 feet
Existing 6" PVC
Spring Collection Line
VALVE
PERFORATED
SOLID
Spring
overflow box
Overflow line
to creek

Appendix C. Birch Spring Documents

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

DIVISION OF OIL GAS & MINING
FIELD VISIT FORM
TECHNICAL

Date : 9/10/1998

Time: 9:30 a.m.- 1:00 p.m.

Mine: Bear Canyon Mine

File Number: ACT 007/006, Folder #2

DOGM Staff: Ken Wyatt, Jim Smith, Sharon Falvey

Other Attendees: Charles Reynolds, Co-Op Mining Corporation, Kay Jensen, Scott Allred Jack Stoyanoff, Menco Copinga, and Laura Filmore, North Emery Water Users Association.

Purpose:
To commence with the Birch Spring action plan as identified under Technical Directive 005.

Observations:

The meeting held at the North Emery Water Users Association (NEWA) reviews the spring development conducted in 1984. Photographs documenting the spring development were presented. Information of interest included the following;

- During spring development calcite deposits were removed from the spring,
- To remove the calcite deposits explosives were used
- Fracture source number one and source number two contributed the majority of flow estimated to be 65 gpm following development (see attached drawing)
- Source number 1 has a spring box developed around it and source number 2 has a pipe pushed into the fracture
- The east wall in the Birch Spring alcove flowed approximately 7 gpm during development
- The east wall and the north rock face were trenched filled with clean 2" gravel and perforated pipe.
- Source #4, adjacent to and west of the stream channel, was reported to have significant water issuing from it but the water was not captured during development
- The final flow rate measured following development was slightly over 70 gpm

To clarify some issues a phone call was made to Jack Stoyanoff. Previous information provided

by Co-Op indicated the development and blasting was completed in 1986, however Jack indicated the development took place in 1984. The NEWUA tried to capture flows from source #4 in 1986. However, they dug 26 feet below the calcite layer and no water was available.

Recommendations/Conclusions:

During this site visit the North Emery Water Users Association committed to unearth the spring sources number 1 and number 2 and observe the existing spring condition. The Division and Co-Op will be informed so all parties can observe the spring condition when they are uncovered. The water users will also try to obtain a down hole camera from PacifiCorp to determine if roots and/or sediment are blocking the springs water lines. Co-Op will conduct additional mapping of faults and fractures associated with the spring to determine the source locations for the Birch Spring waters. Further monitoring and water characterization is being conducted by Co-Op.

Signature: _____ **on** September 29, 1998
Sharon Falvey, Senior Reclamation Specialist

Signature: _____ **on** September 29, 1998
Jim Smith, Senior Reclamation Specialist

Signature: _____ **on** September 29, 1998
Ken Wyatt, Senior Reclamation Specialist

cc:

H:\MINES\911BIRCH.WPD

COOP MINING COMPANY

P.O. Box 1245
Huntington, Utah 84528

Office (435) 687-2450
FAX (435) 687-2084

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DEC 28 1998
DIV. OIL, GAS & MIN.

December 22, 1998

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

ACT/015/025 #2
Pam, Ken, Sharon

To Whom It May Concern,

Re: Birch Spring Action Plan, Tech Directive 005, Bear Canyon Mine, ACT/015/025, Emery County, Utah

This letter is to summarize the progress of the work which has been accomplished on Steps 3 and 4 of the Action Plan which was approved by the Division per letter dated August 7, 1998.

Step 3 consisted of conducting additional on-the-ground investigations of faults, fractures, and joints in the area of Birch Spring. On October 15, 1998, afield survey was conducted involving myself and Jim Smith, Division representative.

The survey included identifying the faults and fractures associated with and adjacent to Birch Spring. The survey began at Birch Spring. Birch Spring No. 1 and 2 sources flow from the South joint of a double fracture. A significant fracture was also identified 20 feet West of the Birch Spring fracture. A fault was observed East of Birch Spring having at least three points of offset totaling approximately 15 feet. These three geologic structures were then tracked simultaneously to the North.

During the survey, additional faults and fractures were identified East of these three structures. Two additional fractures and one additional small fault was observed East of Birch Spring and West of the Blind Canyon Fault. The total distance across this area was approximately 600 feet, with each structure being separated by what appeared to be competent blocks of formation with no significant fracturing, some as wide as 50'.

The two fractures and the fault surrounding Birch Spring were mapped Northward to the Ridge between the Birch Spring drainage and Blind Canyon (approximately 1,000 ft). The lack of outcrop prevented following the fractures beyond this point.

In mapping these fractures northward, the mapping simultaneously progressed up through the tongues of the Starpoint Sandstone. The following observations were made:

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1. The joints and faults were consistently aligned North-South ± 5°. One joint of the double fracture was observed in the Spring Canyon tongue striking N 20° W. The fractures appeared to be present in all three tongues of the Starpoint Sandstone, indicating good continuity vertically, but with few exceptions were not prominently observable within the shale layers as they were within the sandstone formations.

2. The spacing between the faults and fractures showed limited variation, but appeared to be steadily converging Northward and/or upward. Due to the terrain in the area, no determination could be made on what component of the convergence might be horizontal or vertical. The fractures did not completely converge within the mapped area, and none of the fractures converged with the Blind Canyon fault, but seemed to parallel the fault.

3. All of the joints and faults were nearly vertical and planar, and interconnectivity was not well developed or apparent.

The attached map delineates the fractures which were mapped in relation to the Blind Canyon fault and the Spring. From the mapping, it appeared that the joints and fractures have good continuity and may conduct water horizontally in a North/South direction and vertically. Vertical conductivity, however, could potentially be limited by the shale layers, which appear to heal the fractures within the shale formations. None of the fractures converge with the Blind Canyon fault in the vicinity of Birch Spring, and no apparent flow paths were observed to facilitate East/West movement of water from the Blind Canyon Fault to Birch Spring. The fracture system could allow local recharge from precipitation and snowmelt into Birch Spring, which may be enhanced by surficial fractures and/or restricted by shale layers.

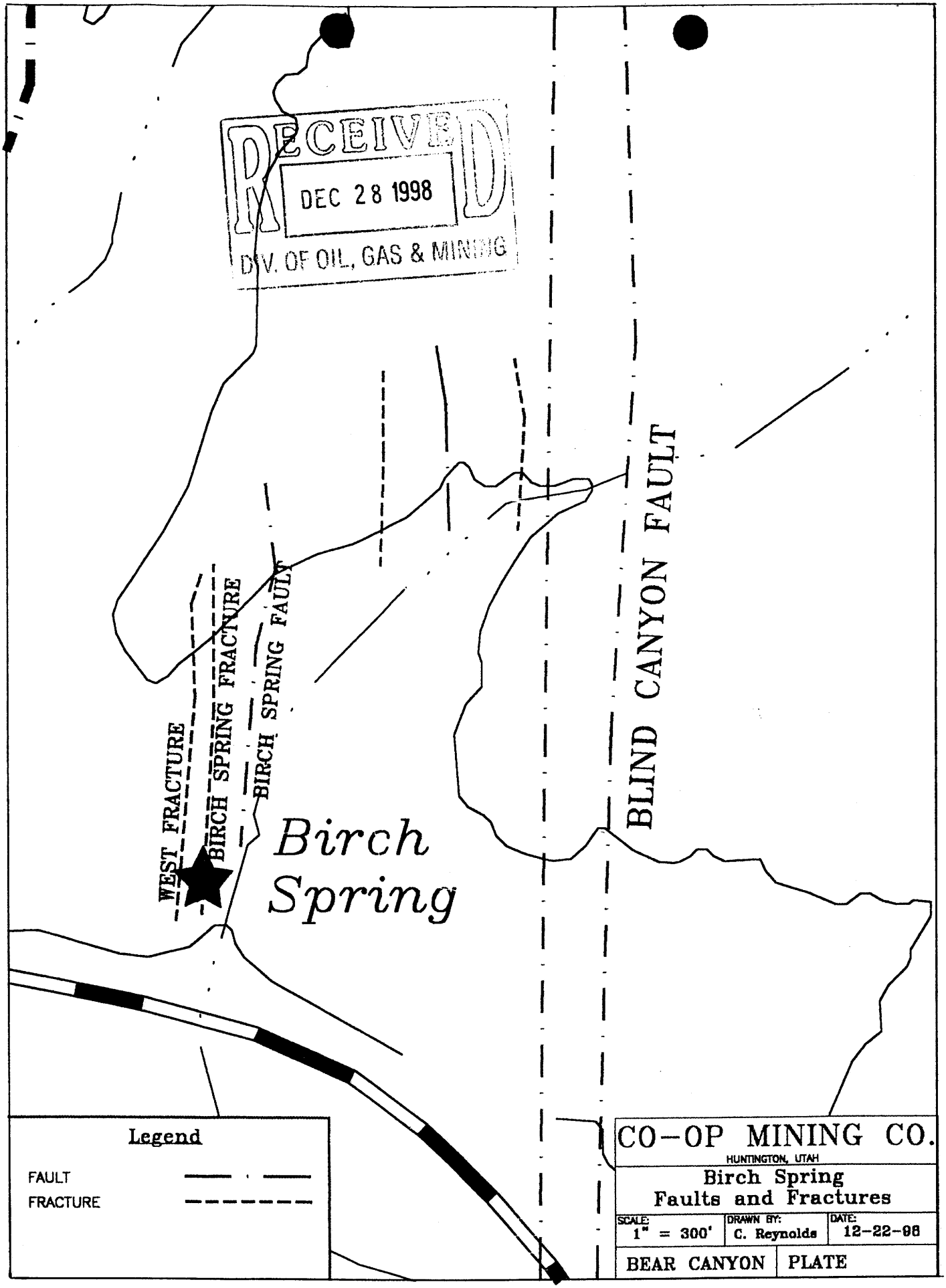
Item 4 of the Action Plan involved conducting a complete isotopic and chemical investigation of the Bear Canyon Mine permit and surrounding areas. This is to inform the Division that all data has been collected by Mayo and Associates. The information will be compiled into a revised "Probable Hydrologic Consequences" document which will be submitted to the Division upon completion for inclusion in the Bear Canyon Mine PAP.

If you have any questions, please call me at (435) 687-2450.

Thank You,

Charles Reynolds, PE
Mining Engineer/Environmental Coordinator

Attachment(s)


RECEIVED
DEC 28 1998
DIV. OF OIL, GAS & MINING
WEST FRACTURE
BIRCH SPRING FRACTURE
BIRCH SPRING FAULT
BLIND CANYON FAULT
Birch Spring
Legend
FAULT
FRACTURE
CO-OP MINING CO.
HUNTINGTON, UTAH
Birch Spring
Faults and Fractures
SCALE: 1" = 300'
DRAWN BY: C. Reynolds
DATE: 12-22-98
BEAR CANYON
PLATE

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

DIVISION OF OIL GAS & MINING
FIELD VISIT FORM
TECHNICAL

Date : 15 October, 1998

Time: 9:00 a.m. to 3:00 p.m.

Mines: CO-OP Bear Canyon Mine.

File Number: ACT/015/025

DOGM Staff: Jim SMITH

Other Attendees: Charles REYNOLDS, CO-OP

Purposes:

1. To examine the 3-dimensional orientation, continuity, and interconnectivity of joints (fractures) associated with Birch Spring.

2. To examine the relationship of the Blind Canyon fault to Birch Spring and associated joints.

3. To examine possible relationships between Birch Spring and the geology and geography of the terrain immediately surrounding the spring.

Observations:

1. Birch Spring is not a single source but several sources flowing from fractures and a fault, mainly on the west side of the box canyon containing the springs.

2. The Blind Canyon fault is evident on aerial photos and on the ground: the fault in the box canyon is not the Blind Canyon fault.

3. Joints and faults appear to strike consistently N-S $\pm$ 5°, but there are a few joints that strike approximately N 20°W.

4. Joints and faults appear to be basically vertical and planar, but on large vertical exposures the joints are often seen to be gently curved or even sinuous.

5. Observed faults are characterized by zones, several feet wide, of large, blocky rubble or breccia. Fracturing in the zone is dominantly vertical to near vertical, for example the fault at the west side at the head of the box canyon containing Birch Spring.

6. Faults and large joints can be followed vertically from the Storrs Sandstone, up through the overlying shales, and into the Spring Canyon Sandstone; however,

7. Some large adjacent joints, such as those exposed above sources #1 and #2 at Birch Spring, are connected by sets of steeply dipping fractures, similar to the fault zones only not vertically extensive.

8. Large joints can be followed or projected for hundreds of feet along strike.

9. Joints appear to be gradually converging upslope (north) and may actually converge northward or upwards or both.

10. Most of the area is jointed, the distance between joints ranging from 2 or 3 feet to 35 feet; one section between the Blind Canyon fault and Birch Spring is not visibly jointed across an exposure approximately 50 feet wide.

11. Vegetation is growing on the three reclaimed breakout/subsidence areas in Section 28, but the easternmost has continued to settle or subside.

Conclusions:

1. Birch Spring does not issue from the Blind Canyon fault, but the several water sources that constitute Birch Spring issue from large joints and a fault zone.

2. Joints and faults have good continuity vertically and along strike, which is roughly N-S. Ground-water flow from north to south would be facilitated along these fractures.

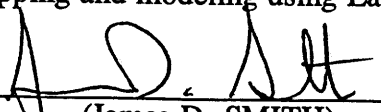
3. There are thick unfractured sections, and lateral interconnectivity between joints and faults is not as well developed. East-west flow would be impeded relative to north-south flow.

4. Although the terrain is steep, the extensive jointing could allow local recharge from precipitation and snowmelt.

5. Additional reclamation work is needed at the subsidence area in Section 28.

Recommendations:

No further action at this time. Charles REYNOLDS is preparing a response to the complaint from NEWUA, as outlined in Tech-005, that will include his interpretation of the geology and geography of the area around Birch Spring. Further action will depend on the acceptability of CO-OP's response and on the time and effort UDOGM can allocate to the problem. Further actions could include detailed geologic interpretation from low-altitude aerial photos and 3-dimensional mapping and modeling using EarthVision.

Signature:  , Reclamation Specialist, October 20, 1998
(James D. SMITH)

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