Beaver Creek Coal Company

Mining and Reclamation Plan
Huntington Canyon No. 4 Mine
Volume 2

PLAN UPDATE REGISTER

VOLUME NUMBER 2

MINE NAME: Huntington #4

FILE NUMBER: ACT/015/004

			Change #	Approval Date	Page #'(s)	Plate #'(s)	Entry Date/By	Description
O Add	X Replace	O Remove	95C	11-1-95	7-87-7-91	—	3-27-96	Surface Water Monitoring Plans
X Add	O Replace	O Remove	95B	8-26-95	Apprdx 10	Plate 1+2+3	3-27-96	① Sediment Pond (existing) ② Sed Pond ③ Proposed Pond Reclamation X-sections
O Add	O Replace	O Remove						
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Section 7

HYDROLOGY

7.1 Groundwater Hydrology

Scope

The purpose of this investigation was to provide background hydrogeological data in the vicinity of the mine and to recommend a plan of action to keep the existing underground coal mining operation in compliance with the requirements of the Office of Surface Mining (OSM) and the Utah Division of Oil, Gas and Mining (DOG&M). Specifically, this investigation included an evaluation of the geologic and hydrologic setting of the Huntington Canyon No. 4 Mine, its relation to the regional groundwater hydrology, and a determination of probable hydrologic impacts of the mining activity. See Section 6 for a discussion of Geology.

7.1.1 Methods of Investigation

This study included review of available existing data and field reconnaissance. The existing data review included information supplied by Beaver Creek Coal Company, published and unpublished reports by the U.S. Geological Survey, Utah Geological and Mineral Survey, Bureau of Land Management, U.S. Forest Service and mine permit applications on file with OSM.

The field reconnaissance at the mine site permitted observation of rock types present at the mine site, the geologic setting of the springs and seeps and confirmation of the geologic observations made from aerial photo stereo-pairs supplied by Beaver Creek Coal Company. In addition, mine personnel at Beaver Creek Coal

7.1.1 Methods of Investigation (continued)

Company provided relevant information with respect to hydrologic conditions in the mine.

7.1.2 Existing Groundwater Resources

Little data are available regarding the groundwater resources of the Wasatch Plateau. Price and Arnow (1974) characterized the region as a groundwater recharge area. The regional water table is generally several hundred feet below the surface. In the area of the No. 4 Mine, the water table is probably at about the same level as Huntington Creek as this stream depends on groundwater for its perennial flow. Recharge to the regional groundwater system is from precipitation over the Plateau that infiltrates into the ground from snowmelt. It has been estimated that less than 5% of the available water enters this regional system. Most of the precipitation that falls over the area is removed by overland flow and evaporation. The water that infiltrates into the ground generally moves only a short distance before discharging as springs and seeps (Price and Arnow, 1974).

Groundwater occurs under water table, artesian, and perched conditions (Figure 7-1). Water table conditions are largely restricted to shallow alluvial aquifer systems along major streams like Huntington Creek. Although artesian conditions exist as a result of the shale confining beds that occur throughout the Cretaceous strata, pressures are generally insufficient to produce flowing wells. Perched water conditions are common in the Blackhawk Formation where the interbedded sandstone and shale units locally restrict groundwater movement.

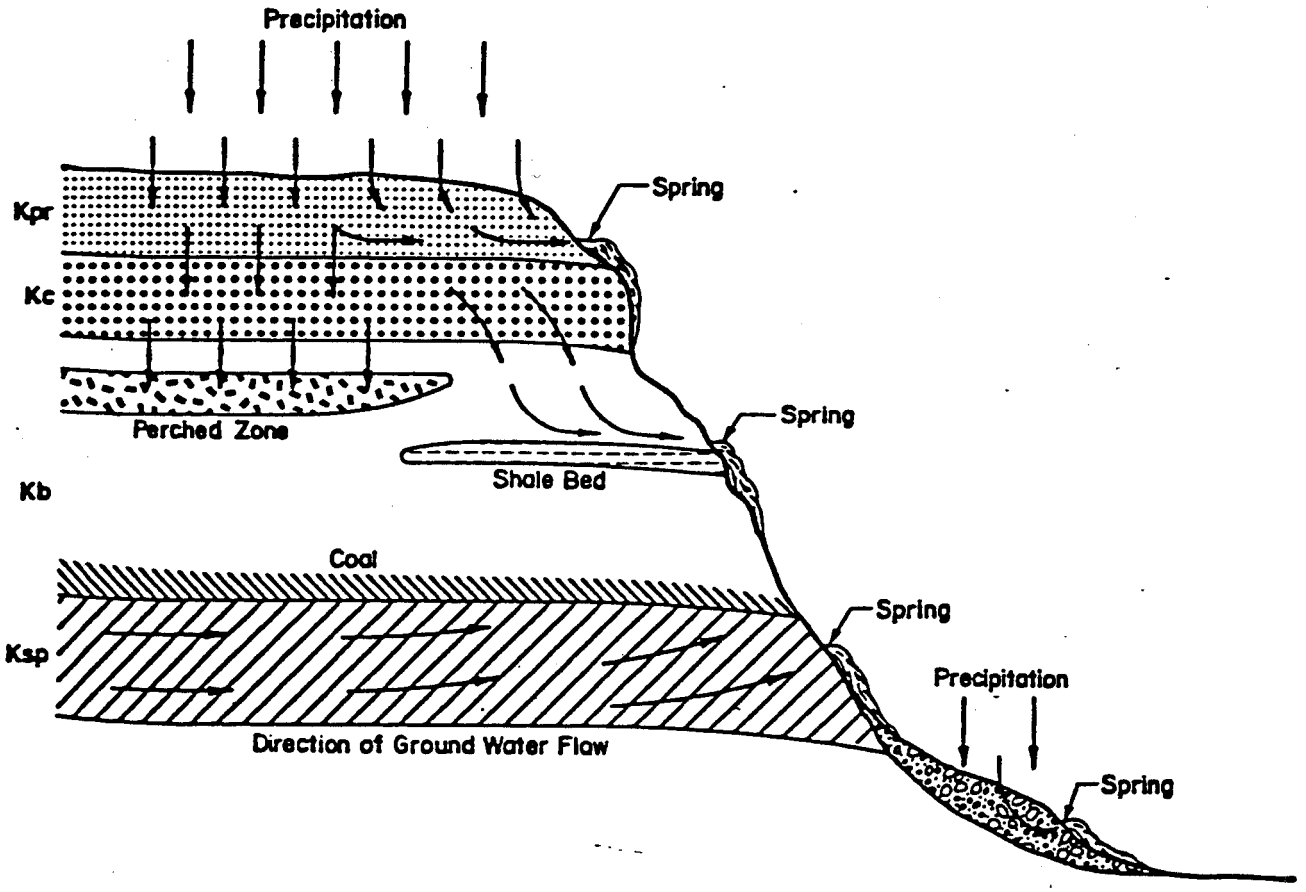

FIGURE 7-1: Schematic diagram of ground water occurrence and movement through Upper Cretaceous strata in the Wasatch Plateau.

7.1.2 Existing Groundwater Resources (continued)

In general, the strata of the Wasatch Plateau yield little groundwater. Overall, these strata have low hydraulic conductivities and specific yields have been measured between about 0.2 and 0.7 percent. Potential yields from individual wells have been estimated between 5 and 50 gallons per minute (Price and Wadell, 1973). The higher yields come from strata like the Star Point Sandstone. Yield from some of the perched water zones could also be high locally. However, because of their limited distribution, perched zones probably cannot supply dependable amounts of water over long periods of time.

In the Huntington No. 4 Mine area, the regional direction of groundwater flow appears to be in an easterly to southeasterly direction flowing down the regional dip and/or in the direction of the major stream drainages. This interpretation is in agreement with U.S.G.S. Open File Report 81-539 (Danielson, 1981), which states that "Groundwater generally moves from areas of recharge in the higher parts of the study area." Groundwater movement in the perched zones is controlled by the geology and topography. Water that enters a perched zone probably moves out of that zone either through any hydrologic connections with lower sands that may exist or discharges as a spring or seep on the surface.

Groundwater recharge seems to occur in upland areas from snow melt and discharge in low areas as stream, spring or seep flows (see Section 7.2.2.2). This is confirmed by hydrogen isotope (deuterium) studies in the Huntington Canyon Basin, conducted by the U.S. Geological Survey (Danielson, 1981). This study showed that rain water in the basin contained deuterium values that ranged from -54.4 to -84.6 and averaged -75.3, while snow samples contained deuterium values that ranged from -121.2 to -147.1 and averaged -136. Deuterium samples were also taken for spring and stream

7.1.2 Existing Groundwater Resources (continued)

samples and showed that most if not all of the groundwater is derived from snow.

In addition, Beaver Creek Coal Company conducted a one time deuterium sampling study of snow and Little Bear Spring water. This study confirmed the U.S.G.S. study. Deuterium values for snow ranged from -106 to -132 and averaged -118, while Little Bear Spring contained deuterium concentrations of -131. The U.S.G.S. concentrations for Little Bear Spring ranged from -124.1 to -124.7 confirming the snow origin of Little Bear Spring water.

7.1.2.1 Mine Plan Area Aquifers

The principal units in the Huntington Canyon No. 4 Mine area that might contain aquifers are the Star Point Sandstone and the Blackhawk Formation. The Castlegate Sandstone is generally a poor source for groundwater because of its topographic position and limited areal extent. In the Huntington Canyon No. 4 Mine area, the Castlegate crops out as vertical cliffs near the top of slopes. Water entering it moves readily through it into the underlying Blackhawk Formation. However, at those locations where a shale bed is present at the base of the Castlegate, the migrating groundwater moves along it and discharges as a seep along the base of the formation.

In the Blackhawk Formation only perched water zones have been noted in drill holes throughout the area. The degree and extent of interconnection among water bearing units is thought to be minimal. The interbedded shale units would restrict vertical groundwater movement. It is likely that the only interconnection between individual perched zones is along faults or fractures. Other work in the region indicates that the groundwater movement

7.1.2.1 Mine Plan Area Aquifers (continued)

along faults is highly restricted. The clays in the Blackhawk Formation are highly bentonitic and swell when wet. Water that might migrate along a fault zone through the Blackhawk Formation would cause the clays to swell, greatly reducing the vertical permeability of that fault zone and severely restricting groundwater flow along it (Hydrosciences, Inc. 1980). A fault crossed in the workings of the No. 4 Mine (Blind Canyon Seam) displayed dry conditions and supports this contention (Plate 6-5).

The Star Point Sandstone is probably the only aquifer in the lease block that receives recharge over a regional area, because it is the only unit known to possess a perennial (flows all year) spring. This spring is Little Bear Spring which occurs in the lower part of the Star Point Sandstone (Plate 6-8). The Star Point Sandstone is not one large sandstone, but is made up of alternating units of sandstone separated by low permeability siltstones and shales. The location of Little Bear Spring is 346 feet beneath the Hiawatha Coal Seam which supports Vaughn Hansen's 1979 statement that "the water table at Little Bear Spring is below the coal seams to be mined".

Vaughn Hansen, 1977, supports this idea with the statement that "water at Little Bear Spring originates primarily in the north, flowing through the Star Point Sandstone, rather than originating on the water shed". Vaughn Hansen supports this conclusion with the following observations:

(1) Springs throughout the area appear to be surfacing primarily above and below the Blackhawk Formation, suggesting that very little water passes through the Blackhawk Formation, which overlies the Star Point Sandstone.

7.1.2.1 Mine Plan Area Aquifers (continued)

(2) The expected yield of Little Bear Canyon should be on the order of one to two inches per year, with an upper limit of 4 inches per year. However, flow measurements of Little Bear Spring (located in the Star Point Sandstone) indicate an average annual yield of six inches from the spring alone during the course of a severe drought period. Therefore, water from outside the basin must be flowing out Little Bear Spring.

(3) The number of springs in the Huntington Creek Drainage decrease as one approaches Little Bear Spring from the northwest.

(4) Spring and surface water flow rates decrease in a southerly direction from canyon to canyon in the study area.

The idea that the Star Point Sandstone is a regional aquifer supplying water to Little Bear Spring is further supported by structure maps of the Star Point Sandstone. Figure 7-2 is a structure map of the Star Point Sandstone and shows that if water flows down dip in the Star Point it would flow from the northwest and coverage toward the syncline in Little Bear Canyon. This same syncline is reflected in the structure of the Hiawatha and Blind Canyon Seams and can be seen in greater detail on Plates 6-5 and 6-6.

7.1.3 Required Water Quality

A study by the U.S. Geological Survey (Danielson, 1981) of spring water from different geologic units was conducted in and adjacent to the upper drainages of Huntington and Cottonwood Creeks. Because of the complexity of the rock lithologies and the ground-

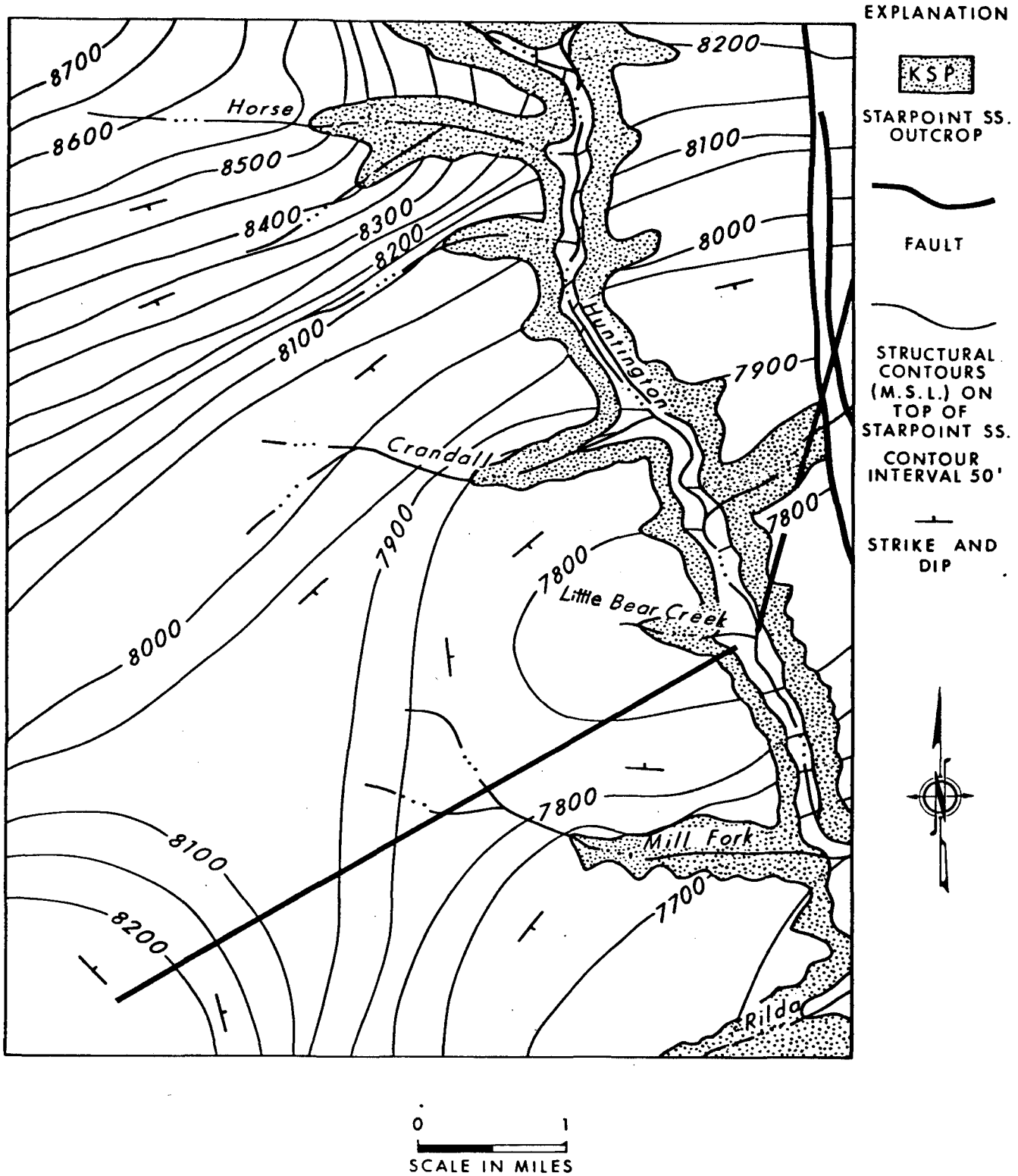

Figure. 7.2 Structural contours (M.S.L.) on top of Starpoint Sandstone (Edmund Spreker, U.S.G.S.)

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7.1.3 Required Water Quality (continued)

water system, the results of statistical tests indicate that over a large area, no geologic unit had a unique water chemistry. The results of this study are shown in Table 7-1, and prepared in stiff diagram form in Figure 7-3.

The groundwater from the Price River and Blackhawk Formations and the Star Point Sandstone is classified as fresh water, characterized by total dissolved solids (TDS) contents of generally less than 1000 milligrams per liter (mg/l). Vaughn Hansen (1977) found that TDS concentrations typically increased from north to south in the Huntington Canyon No. 4 Mine area.

Doelling (1972) reports that water from springs in the Price River Formation and the Castlegate Sandstone have low TDS, ranging from 238 to 303 mg/l. Water from wells and springs in the Blackhawk Formation show more variation, with TDS ranging between 245 and 903 mg/l.

In the vicinity of the Huntington Canyon No. 4 Mine only a limited amount of ground water quality information is available. Data on the Little Bear Springs has been collected by the U.S. Forest Service, The U.S. Geological Survey, Utah Division of Health, Beaver Creek Coal Company and formerly by Swisher Coal Company. Data collected by the Utah Department of Health and by the U.S. Geological Survey for Little Bear Spring is shown in Table 7-2. Information collected from Upper and Lower Little Bear Springs is contained in Tables 7-3, 7-4 and 7-5 (Little Bear Spring is actually composed of two springs, an upper spring and a lower spring). A summary (mean values) of all these tables is provided in Table 7-6. From this table it can be seen that Little Bear Spring Water Quality is better than U.S. Environmental Protection Agency Interim Drinking Water Criteria and Utah State

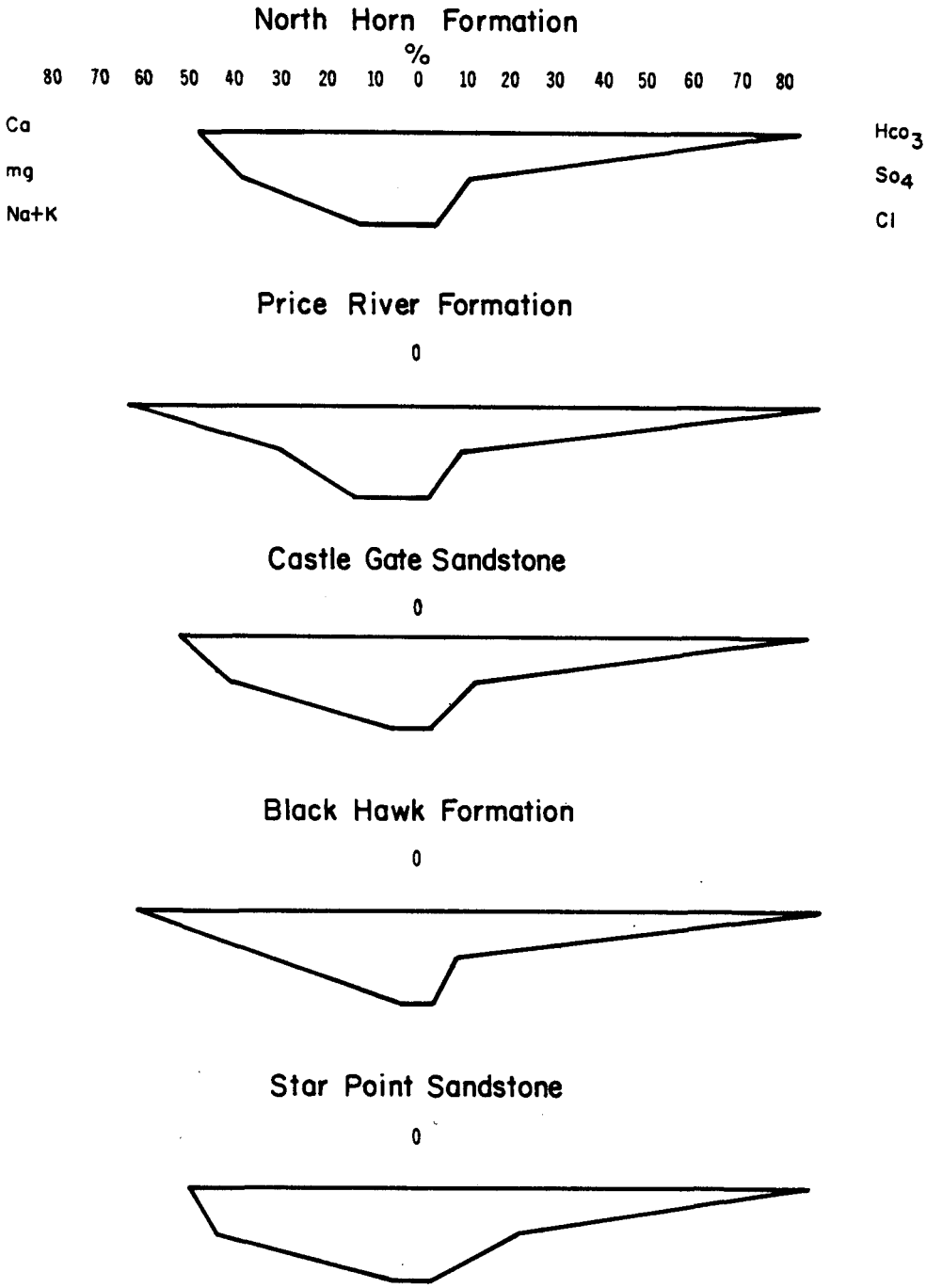

Figure 7.3 Stiff diagrams of mean spring water qualities from different water-bearing zones in and adjacent to the upper drainages of Huntington and Cottonwood Creeks.

TABLE 7-1 Summary of chemical characteristics of spring waters from different water-bearing zones in and adjacent to the upper drainages of Huntington and Cottonwood Creeks (From Danielson, 1981)

	pH (units)	Temperature (oC)	Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium	Dissolved Potassium	Dissolved Chloride	Dissolved Sulfate	Dissolved Solids	Bicarbonate
					Milligrams per liter					
North Horn Formation										
No. Samples	51	51	51	51	51	51	51	51	43	51
Mean	7.5	6.3	61	29	19	.9	9.8	32	290	320
Minimum	6.3	.1	15	2.0	1.2	.2	1.2	2.1	63	49
Maximum	8.5	17	100	63	94	1.9	54	180	633	500
Price River Formation										
No. Samples	18	18	18	18	18	18	18	18	17	18
Mean	7.5	6.3	63	18	5.7	1.3	5.1	23	220	260
Minimum	6.5	3.8	12	2.9	1.4	.4	1.5	3.7	50	39
Maximum	8.2	16	87	51	39	3.4	18	120	524	427
Castlegate Sandstone										
No. Samples	9	9	9	9	9	9	9	9	9	9
Mean	7.5	5.6	60	29	7.1	1.3	5.6	33	290	300
Minimum	7.1	2.2	41	14	2.1	.9	3.6	4.0	163	183
Maximum	81.	7.5	79	41	23	2.4	14	110	385	370
Black Hawk Formation										
No. Samples	31	31	31	31	31	31	31	31	30	31
Mean	7.4	6.1	57	19	4.1	1.1	4.3	21	220	250
Minimum	6.3	.1	15	2.0	1.2	.2	1.2	2.1	53	49
Maximum	8.1	13	98	52	16	3.5	16	120	539	460
Star Point Sandstone										
No. Samples	19	19	19	19	19	19	19	19	18	19
Mean	7.3	6.6	75	40	8.0	2.0	6.9	77	370	350
Minimum	6.8	2.8	48	3.0	.1	.9	2.7	13	213	244
Maximum	8.4	11	120	89	26	4.9	27	300	750	427
All Units										
No. Samples	128	128	128	128	128	128	128	128	132	128
Mean	7.5	6.3	62	27	11.0	1.2	7.1	34	295	300
Minimum	6.3	.1	12	2.0	.1	.2	1.2	2.1	50	39
Maximum	8.5	17	120	89	94	4.9	54	300	750	500

Table 7-2

LITTLE BEAR SPRING SAMPLES, UTAH DEPARTMENT OF HEALTH AND THE U.S. GEOLOGICAL SURVEY (D-16-7) 9 CAC-S1

	10-3-57*	8-18-76**	11-4-77*	4-28-81*
Flow (CFS)	---	0.27	---	---
pH (units)	---	7.6	7.7	8.0
Temp (C°)	---	8.3	---	---
Spec. Cord (umhos)	---	530	492	535
TDS (mg/l)	305	332	315	308
Iron (mg/l)	---	0.04	0.05	0.03
Manganese (mg/l)	---	---	0.002	0.01
Nitrate (mg/l)	0.16	---	0.09	0.15
Sulfate (mg/l)	14	35	32	35
Chloride (mg/l)	7.4	5.3	2	4
Calcium (mg/l)	75	67	66	53
Magnesium (mg/l)	25	38	36	36
Sodium (mg/l)	---	7.1	6	12
Bicarbonate (mg/l)	340.59	346	346	320
Carbonate (mg/l)	1.67	---	---	- 0 -
Fluoride (mg/l)	0.7	0.1	0.12	0.12
Hydroxide (mg/l)	0.03	---	---	---
Phosphorous (mg/l)	---	---	---	0.20
Silica (mg/l)	3.9	5.6	6	6
Total ALK as $CaCo_3$ (mg/l)	282	284	274	262
Arsenic (mg/l)	---	---	---	0.001
Barium (mg/l)	---	---	0.04	0.06
Boron (mg/l)	---	0.03	0.08	0.05
Chromium (mg/l)	---	---	---	0.005
Copper (mg/l)	---	---	---	0.01
Iron Total (mg/l)	0.25	---	0.17	---
Lead (mg/l)	---	---	---	0.005
Mercury (mg/l)	---	---	---	0.0001
Nickel (mg/l)	---	---	---	0.01
Potassium (mg/l)	---	1.5	2	1
Selenium (mg/l)	---	---	---	0.001
Silver (mg/l)	---	---	---	0.002
Strontium (mg/l)	---	0.26	---	---
Zinc (mg/l)	---	---	0.005	0.035

*Source Utah Department of Health
**Source - U.S.G.S., 1981

Table 7-3

LITTLE BEAR WATER SAMPLES, U.S. FOREST SERVICE

	Upper Little Bear Spring* 8-28-75 to 2-7-79		Lower Little Bear Spring** 8-28-75 to 2-7-79	
	No. of Samples	Mean	No. of Samples	Mean
Flow (CFS)	2	1	2	0.7
pH (unit)	10	8.9	11	8.8
Temp (^{o}C)	11	5.8	12	6.1
Manganese (mg/l)	11	0.017	12	0.019
Nitrate (mg/l)	6	0.185	6	0.14
Sulfate (mg/l)	11	56.7	12	59
Chloride (mg/l)	6	3.7	6	4
Fluoride (mg/l)	11	0.15	12	0.17
Total ALK as $CaCO_3$ (mg/l)	11	244.3	12	246.4
Arsenic (mg/l)	11	0.002	12	0.002
Barium (mg/l)	11	0.0236	12	0.023
Chromium (mg/l)	8	.0018	8	0.002
Copper (mg/l)	11	0.0051	12	0.0025
Iron (total) (mg/l)	5	0.0914	6	0.092
Lead (mg/l)	11	0.0015	12	0.001
Mercury (mg/l)	11	.0002	12	0.00019
Selenium (mg/l)	11	0.0023	12	0.002
Silver (mg/l)	11	0.0017	12	0.002
Zinc (mg/l)	11	0.0099	12	0.015

* (D-16-7) 9 CAC-S1

** (D-16-7) 9 CAC-S2

Table 7-4

LOWER LITTLE BEAR SPRING
BEAVER CREEK COAL COMPANY
(D-16-7) 9 CAC-S2

	5/13/81	6/11/81	7/22/81	8/26/81	9/8/81	11/20/81	12/10/81
Flow (CFS)	---	---	---	---	---	0.006	---
pH (units)	7.8	7.9	8.6	8.1	8.1	7.9	8.1
Temp (^oC)	---	11°C	21°C	16°C	12°C	3°C	6°C
Spec Cond (umhos)	540	540	640	570	510	550	560
TDS (mg/l)	350	345	415	375	335	380	365
TSS (mg/l)	5	10	10	11	1.0	7	16.0
Iron (mg/l)	0.01	0.02	0.028	0.001	0.01	0.03	0.01
Manganese (mg/l)	0.01	0.01	0.011	0.01	0.005	0.01	0.009
Nitrate (mg/l)	0.18	0.14	0.04	0.01	---	0.13	0.25
Sulfate (mg/l)	33	34.5	54	25.5	18	33	15
Chloride (mg/l)	12	10	11.5	7.2	25	2.25	3.79

Table 7-5

UPPER LITTLE BEAR SPRING
BEAVER CREEK COAL COMPANY
(D-16-7) 9 CAC-S1

	5/13/81	6/11/81	12/10/81	1/14/82	2/17/82	3/82
Flow (CFS)	---	---	---	0.59	0.6	0.59
pH (units)	7.9	7.7	7.6	7.2	7.8	7.4
Temp (°C)	---	10°C	8°C	7°C	10°C	8°C
Spec Cond (umhos)	540	530	560	500	450	400
TDS (mg/l)	350	345	375	325	286	260
TSS (mg/l)	9.0	2.0	14.0	4.0	1.0	2
Iron (mg/l)	0.02	0.01	0.01	0.001	0.03	0.02
Manganese (mg/l)	0.01	0.001	0.015	0.011	0.001	0.01
Nitrate (mg/l)	0.19	0.15	0.27	0.19	0.01	0.09
Sulfate (mg/l)	37.5	36	18	30	6.0	27
Chloride	12	10	4.24	2.9	4.6	3.8

7.1.3 Required Water Quality (continued)

Classifications for Domestic Water and Aquatic Life. A stiff diagram constructed from Table 7-6 is provided in Figure 7-4. Locations of springs and seeps from which samples have been collected are included on Plate 6-1.

Beaver Creek Coal Company, following a spring and seep inventory for the Huntington Canyon No. 4 Mine, recently began collecting data from a seep at the head of Little Bear Canyon. This seep is located in the Blackhawk Formation and water quality data collected from this seep is shown in Table 7-7. From the total dissolved solids analysis the water from this seep appears to be of good quality. All of the parameters sampled meet U.S. Environmental Protection Agency Interim Drinking Water Standards.

7.1.3.1 Water Rights

With the exception of File Number 254 (Little Bear Spring) water rights in the lease block are used for stock watering purposes (Table 7-8). Water right locations are shown in Plate 7-7. No known wells exist in the area.

7.1.4 Mine Dewatering

Mining operations to date at Huntington Canyon No. 4 Mine have encountered small amounts of water from sandstones in the roof. Occasionally, damp to wet floor conditions exist. At the present time, it is not anticipated that significant quantities of water will be encountered during future mining operations therefore no negative effects on groundwater are anticipated. Consequently, no water rights have been filed for groundwater at the Huntington Canyon No. 4 Mine.

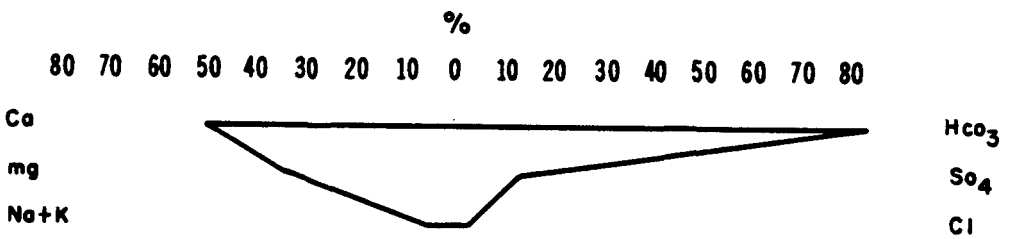

Figure 7.4 Stiff diagram of summary of Little Bear Spring data.

Table 7-6

SUMMARY OF LITTLE BEAR SPRING WATER QUALITY DATA
MAY 1, 1982

	Mean	Federal Drinking Water Criteria	Utah Division of Health Water Standards: Domestic Water Class 1A	Utah Division of Health Water Standards: Aquatic Life Class 3A
pH (units	8.2	6.5 - 8.5	6.5-9.0	6.5-9.0
Temp (C°)	8.1	----	---	less than 20
Spec Cond (umhos)	527	----	---	---
TDS (mg/l)	346	500	Case by case basis	
Iron (mg/l)(total-dissolved)	(0.13-0.03)	0.3 total	---	0.05 dissolved
Manganese (mg/l)	0.02	0.05	---	---
Nitrate (mg/l)	0.15	10	10	---
Sulfate (mg/l)	39	250	---	---
Chloride (mg/l)	7.4	250	---	---
Calcium (mg/l)	65.3	200	---	0.002
Magnesium (mg/l)	33.8	150	---	---
Sodium (mg/l)	8.4	200	---	---
Bicarbonate (mg/l)	338	500	---	---
Carbonate (mg/l)	1.67	----	---	---
Fluoride (mg/l)	0.19	0.7-1.2	1.4-2.4	---
Hydroxide (mg/l)	0.03	----	---	---
Phosphorous (mg/l)	0.20	----	---	---
Silica (mg/l)	21.5	----	---	---
Total ALK as $CaCo_3$	256	----	---	---
Arsenic (mg/l)	0.002	0.05	0.05	---
Barium (mg/l)	0.032	1.0	1	---
Boron (mg/l)	0.05	----	---	---
Chromium (mg/l)	0.03	0.05	0.05	0.10
Copper (mg/l)	0.006	1.0	---	0.01
Lead (mg/l)	0.003	0.05	0.05	0.05
Mercury	0.004	0.002	0.002	0.00005
Nickel (mg/l)	0.01	1.0	---	---
Potassium (mg/l)	1.5	----	---	---
Selenium (mg/l)	0.001	0.01	0.01	0.05
Silver (mg/l)	0.002	0.05	0.05	0.01
Strontium (mg/l)	0.26	----	---	---
Zinc (mg/l)	0.02	5.0	---	0.05

Table 7-7

SEEP - HEAD OF LITTLE BEAR SPRING CANYON
(D-16-7) 8 DCB-S2

	8/25/80	7/22/81	Federal Drinking Water Criteria
Flow (CFS)	---	0.002	----
pH (units)	7.6	8.3	6.5-8.5
Temp (°C)	---	20 °C	----
Spec Cond (umhos)	520	620	----
TDS (mg/l)	370	405	500
TSS (mg/l)	12.0	32	----
Iron (mg/l)	0.136	0.22	0.3
Manganese (mg/l)	0.032	0.03	0.05
Nitrate (mg/l)	0.03	0.33	10
Sulfate (mg/l)	57	36	250
Chloride (mg/l)	14.0	8.01	250

TABLE 7-8

FILED WATER RIGHTS
IN THE HUNTINGTON NO. 4 MINE AREA

File Number	Allotment	Class	Use	Owner
*116		Surface	Cattle	U.S. Forest Service
*192		"	"	"
*195	11.28 ac. ft.	"	"	"
*197		"	"	"
*259		"	"	"
129	-	"	"	Peabody Coal Co.
130	-	"	"	U.S. Forest Service
134	-	"	"	"
188	-	"	"	"
190	-	"	"	"
*193	1.47 ac. ft.	"	Sheep	"
*1411		Spring	Stock	"
*196	0.24 ac. ft.	Surface	Cattle	Marena Madden Hiatt
*260		Spring	"	"
1183	-	Surface	"	Utah Power & Light
*254	**150 cfs	Spring	Drinking Water	City of Huntington

*Rights that could possibly be impacted by mining in Huntington Canyon #4 Mine.

**Allotment is combined with that of 16 other certificates.
Little Bear Spring flows are normally less than 1.0 cfs.

7.1.4 Mine Dewatering (continued)

Beaver Creek Coal Company has obtained an NPDES permit to allow for discharge of groundwater from the mine, as necessary. If at such time that significant water should be encountered, it will be sampled and monitored regularly. Source, flow and quality will be determined at that time.

7.1.5 Effect of Mining Operations on Groundwater

Hydrologic Impacts

An underground mining operation like the Huntington Canyon No. 4 Mine is expected to have little, if any, effect on the groundwater system. The water-bearing unit, the Star Point Sandstone, is below the level of mining so disruption of the aquifer is unlikely. The most significant potential problem associated with the Star Point would be if, during coal removal, the Star Point were to yield significant amounts of water to the mine as a result of mining the Hiawatha Coal Seam. However, this would only occur if the water level in the Star Point Sandstone was under artesian pressure relative to the elevation of the Hiawatha Coal Seam. Fortunately an exploration drill hole that was drilled from inside the mine (Blind Canyon Seam), through the Hiawatha Coal Seam and 100 feet into the upper part of the Star Point Formation (151 feet total depth) has yielded some data on this point. In this drill hole (Hole MC-4-1) casing has been temporarily left immediately below the base of the Hiawatha Coal Seam in T16S, R7E, SEC 16, NW¼, SW¼, allowing water levels from the upper part of the Star Point Sandstone to be obtained. Water levels covering an eight month period have been obtained from this hole. At this location the depth to the top of the Star Point Sandstone is 99.5 feet. The depth to water has averaged 137.7 feet (highest water levels recorded were 136.9 feet) or 38.2 feet beneath the Hiawatha Coal

7.1.5 Effect of Mining Operations on Groundwater (continued)

Hydrologic Impacts (continued)

Seam. This indicates that in the present mining area the water level of the upper Star Point Sandstone is not under artesian conditions and no dewatering of the Star Point Sandstone should occur due to mining the Hiawatha Coal Seam. Since the entire lease block is entirely dissected by streams which may dewater the Star Point Sandstone, it is likely that this situation may exist over the whole lease block. This conclusion is supported by Vaughn Hansen, 1977, who states that Crandall Canyon north of the lease block serves as a major interceptor drain dewatering the Star Point Sandstone.

The effects of subsidence on springs that have their source in the Blackhawk Formation or Castlegate Sandstone will likely be minimal. Some small springs and seeps might be affected as a result of subsidence. Flows could increase as well as decrease but the net water yield should remain unchanged.

The potential effects on groundwater quality are also assumed to be minimal. Present data on groundwater, spring water and surface water indicate little quality difference. The rocks in the area are very similar in rock chemistry so mining or subsidence would not expose the groundwater to different chemical sources.

7.1.6 Mitigation and Control Plans

An agreement was established between the City of Huntington and Beaver Creek Coal Company so that culinary water will be replaced to the City if mining operations affect the quantity of water from Little Bear Spring, even though mining is unlikely to affect this spring.

7.1.6 Mitigation and Control Plans (continued)

Appendix 1 contains a copy of this agreement with Swisher Coal Company, which is also valid for Beaver Creek Coal Company.

Prior to mining in the Hiawatha Seam northwest of a line between DH-9 and MC-4-3 (Plate 6-6), the company will complete a ground water study. The study design shall be approved by the regulatory authority prior to commencement. Such study shall be designed to determine the depth of water in the Starpoint-Blackhawk aquifer northwest of the line between DH-9 and MC-4-3. The study will include a field investigation to ascertain whether faults and/or fractures occur in close proximity to Little Bear Spring, and the plotting of the location and trend(s) of such faults and/or fractures (if found) on a geologic map of the Little Bear Canyon Area. Upon completion of the study, mining will commence only upon written approval of the Regulatory Authority.

7.1.7 Groundwater Monitoring Plans

In the event an inflow of groundwater should be encountered, with a point source and quantity of 1 gpm or greater and with a sustained flow over a 30 day period, this point will become a regular monitoring point for groundwater; however, where more than 1 - one gpm inflow occurs within 100' in any direction, Beaver Creek will convey to the Regulatory Authority the number, source, area, flow rate and locations of such points. The number and location of sampling points at

7.1.7 Groundwater Monitoring Plans (Continued)

these areas will then be included in the "in-mine" sampling program as deemed appropriate by the Regulatory Authority. Monitoring will be on a monthly basis for flow and water quality for a base-line period of 1 year, and will be reported on the standard sampling chart. Water quality parameters shall include pH, total dissolved solids, sodium, potassium, calcium, magnesium, iron, chloride, bicarbonate, sulfate, and carbonate. In addition, a quarterly report shall be submitted to the Division including: a map of underground workings showing sample locations, identification of the source, quantity and quality data, and a table or discussion of the mine water balance. Such monitoring will continue for a base-line period of 1 year, or until the area is rendered inaccessible. Should discharge from the mine become necessary, water may be treated in the sedimentation pond if needed to meet effluent limitations. Discharged water would also be monitored for flow and water quality on a monthly basis.

A cation-anion mass balance will be performed on at least 10% of water quality samples to verify accuracy.

7.2 Surface Water Hydrology

Scope

Through a combination of field efforts by Beaver Creek Coal Company Personnel and literature review by Hydrosciences, Inc., and Anaconda Minerals, surface

7.2 Surface Water Hydrology (Continued)

water hydrology information has been assembled to satisfy regulations set forth by Utah Division of Oil, Gas and Mining and the Office of Surface Mining for the Huntington Canyon No. 4 Mine. Specifically this investigation included an analysis of surface water hydrology within the Huntington Creek Basin and a determination of the potential impacts of mining at the Huntington No. 4 Mine on surface water hydrology and water quality in Mill Fork, Little Bear, Crandall and Huntington Canyons.

7.2.1 Methodology

The hydrologic study was based on a review of literature and existing data obtained by the U.S. Geological Survey, the U.S. Forest Service, the State of Utah, the city of Huntington and Beaver Creek Coal Company. A field reconnaissance study was also conducted to locate and characterize springs, seeps and surface water courses.

7.2.2 Existing Surface Water Resources

7.2.2.1 Regional Surface Water Hydrology

The Department of the Interior drafted a regional environmental statement, published in 1978, which covers the development of coal resources in Central Utah. Within the study area lies the Huntington Canyon No. 4 Mine. The regional area is drained by tributaries to the Green and Colorado Rivers; principal tributaries are the Price and San Rafael Rivers and Muddy Creek. The Huntington Canyon No. 4 Mine area drains into Huntington Creek which is tributary to the San Rafael River. The flow is usually intermittent or ephemeral in the smaller streams and perennial in the larger streams. Snowmelt is a major contributor to streamflow and it provides the continuity of flow in the perennial streams as well as some seasonal flow to intermittent streams. Summer precipitation does not usually produce much runoff, although intense rainfall may cause high runoff in localized areas. The 100-year, 6-hour precipitation event is approximately 2.5 inches in the mountain areas (NOAA Atlas, 1973).

Surface water impacts resulting from mining at the Huntington No. 4 Mine and all mines within the general area would be expressed within the Huntington Creek Basin. Streamflow records have been

7.2.2.1 Regional Surface Water Hydrology (continued)

obtained since 1909 on Huntington Creek at gaging station 09318000 which is located approximately 2.5 miles below the Huntington Power Plant diversion.

Danielson et al. (1981) showed that about 90% of the basin is above 8000 ft. elevation. The surface below the 8000 ft. elevation is confined to the deep narrow canyon of Huntington Creek and its tributaries. The relief differences between the stream channels and the tops of adjacent canyon walls typically approach or exceed 2000 ft.

Discharge, at gaging station 09318000, on Huntington Creek averaged 96.4 CFS or 69,700 acre ft. per year over the period of record. This represents an average water yield of 6.88 inches of runoff for the 190 mi^2 basin area upstream of the gage. During water year 1979, runoff measured at this gaging station was 56,000 acre-ft. or 5.53 inches of runoff. According to Danielson et al. (1981) approximately 65% of the annual discharge occurs during the snowmelt runoff period from April through July. They also estimated that during water year 1979 approximately 30% of the precipitation left the basin as streamflow. In contrast, only about 2 percent of the precipitation was estimated to have left the adjacent Cottonwood Creek drainage during the same period. Danielson et al. (1981) speculates that this difference could, in part, be due to groundwater recharge associated with the Joes Valley Fault, in the Cottonwood Creek Basin.

A mass balance during baseflow conditions on Huntington Creek was prepared by Danielson et al. (1981) in order to determine gaining and loosing reaches of Huntington Creek. The results of this study are presented in Table 7-9.

Table 7-9

–An accounting of gains and losses in flow of Huntington Creek between Electric Lake and the diversion to the Huntington Power Plant, fall of 1978
[Springs and site numbers shown on plate 1; discharges are in cubic feet per second]

Stream or spring (tributaries to Huntington Creek and springs are indented)	Site no.	Date	Discharge of Huntington Creek	Measured gain(+) or loss(–) in discharge of Huntington Creek	Discharge of tributaries and springs	Unaccounted gain(+) or loss(–) in discharge of Huntington Creek (rounded)
Huntington Creek	2	10- 3-78	17		–	
(D-14-6)24baa-S1	–	10- 4-78	–		0.3	
(D-14-6)24adc-S1	–	10-20-78	–		.7	
North Hughes Canyon	4	10- 4-78	–	+2	.03	+0.8
(D-14-7)30bdc-S1	–	10- 4-78	–		.1	
South Hughes Canyon	6	10- 4-78	–		.02	
(D-15-7)8dab-S1	–	10-20-78	–		.1	
Huntington Creek	8	10- 3-78	19		–	
Nuck Woodward Canyon	19	10- 4-78	–	+2	.04	+1.9
Pole Canyon	20	10- 6-78	–		.04	
Huntington Creek	21	10- 3-78	21		–	
Left Fork Huntington Creek	40	10- 3-78	–	+16	14	+1.8
Horse Canyon	43	10- 6-78	–		.1	
Blind Canyon	44	10- 6-78	–		.1	
Huntington Creek	45	10- 3-78	37		–	
Crandall Canyon (gaging station 09317919)	51	10- 3-78	–	-1	.5	-2.2
Tie Fork Canyon (gaging station 09317920)	67	10- 3-78	–		.5	
Little Bear Canyon	70	10-13-78	–		.2	
Huntington Creek	71	10- 3-78	36		–	
Mill Fork Canyon	76	10- 6-78	–		0	
Rilda Canyon	78	10- 6-78	–	+3	.1	+2.8
Trail Canyon	79	11- 9-78	–		.03	
Bear Creek	81	10-25-78	–		.08	
Huntington Creek	82	10- 3-78	39		–	

7.2.2.1 Regional Surface Water Hydrology (continued)

The reaches of Huntington Creek above Crandall Canyon are identified as gaining reaches. This suggests that the Creek itself is a groundwater discharge area. The reach of Huntington Creek between Crandall and Mill Fork Canyons was identified as a possible loosing reach. It is possible that groundwater recharge occurs in this reach, but it is more likely that the loss is due to measurement error and evapotranspiration. The reach between Mill Fork and the Huntington Creek gage was identified as a gaining reach. It is possible that the gains in Huntington Creek baseflow are augmented in part, by alluvial discharge from tributary channels especially Meeting House Creek, Deer Creek, and Flood Canyon which are perennial along upper reaches but dry at their mouths during base flow.

Records from USGS gaging stations on Crandall Canyon and Tie Fork and observations by Beaver Creek Coal Company staff confirm that the minimum flow at most of the major streams and tributaries to Huntington Creek is zero.

Chemical analysis of selected surface-water samples from the Huntington Creek Basin are presented in Danielson et al. (1981). No analyzed chemical constituants exceeded the drinking water standards of the U.S. Environmental Protection Agency. At gaging station 0931000 on Huntington Creek the observed dissolved-solids concentrations ranged from 175 mg/l during a period of base flow in August 1977. During periods of base flow, there was little real change in the chemistry of water in Huntington Creek because groundwater discharge was small in comparison to the water released from reservoirs (Danielson et al., 1981).

7.2.2.1 Regional Surface Water Hydrology (continued)

Suspended-sediment concentrations vary widely in the Huntington Creek drainage basin (Table 7-10). Higher concentrations are generally associated with areas of surface disturbance. However, the extremely high suspended-sediment concentrations in Bear Creek are the result of springs in the headwaters which continuously erode the shales and mudstones of the North Horn Formation (Danielson et al., 1981).

Underground coal mining operations conducted in the Huntington Creek drainage basin through 1979 have probably had only a minor impact on the quantity and quality of surface water. The effects of mining on surface water quantity are mainly dependent on the amount of mine inflow. Danielson et al. (1981) showed that natural groundwater discharge above the Huntington Creek gaging station averages about 30 cfs. In addition, they showed that the combined discharge from the three largest water-producing mines (King, Wilberg, and Deer Creek Mines) approaches 3 cfs. Therefore, in a worst case situation, a 10 percent depletion of natural groundwater discharge in existing mines would be the upper limit of the current effect of mining on discharge of Huntington Creek.

Impacts on surface water quality may result from increase of disturbance of surface areas and surface discharge from mine dewatering operations. Increased sediment yield can be minimized with proper construction, drainage and erosion control techniques. The effects of mine dewatering are difficult to assess due tot he current understanding of the groundwater system. However, chemical analysis of mine waters from Danielson et al., (1981) indicates a chemical quality similar to the groundwater. Since the majority of the streams in the area are fed by springs, the impact of mine dewatering on surface water is not expected to be significant.

Table 7-10

SUSPENDED SEDIMENT CONCENTRATIONS AT HUNTINGTON CREEK

Stream	Site No.	Date	Concentration (mg/l)	Load (tons/day)
Huntington Creek (gaging station 09318000)	88	08-13-78	104	27.000
		11-17-78	72	2.500
		06-13-79	114	66.000
		08-07-79	44	15.000
Crandall Canyon (gaging station 09317919)	51	08-12-78	49	.140
		11-18-78	60	.080
		06-14-79	15	.410
		08-06-79	56	.150
Tie Fork Canyon (gaging station 09317920)	67	08-13-78	12	.030
		11-18-78	57	.120
		06-14-79	38	.680
		08-06-79	66	.170
Bear Creek	81	10-25-78	8,860	1.900
		06-14-79	2,140	4.000
Deer Creek	87	06-14-79	609	3.100
Cottonwood (gaging station 09324200)	104	08-15-78	5	.003
		11-19-78	130	.200
		08-05-79	63	.090

Observed suspended-sediment loads at the gaging station on Huntington Creek ranged from 1.8 tons per day on February 18, 1979, to 66 tons per day on June 13, 1979. Observed suspended-sediment concentrations ranged from 29 to 181 mg/l. Sediment concentrations generally increased with increased stream discharge, but not enough data was available to compute daily sediment discharges.

7.2.2.2 Mine Plan Area Surface Water Hydrology

Two streams are located in the vicinity of the mine; Little Bear and Mill Fork Creeks. These Creeks flow east into Huntington Creek. Both streams are thought to be intermittent. In contrast, Crandall Canyon, located to the north of the mine plan area is thought to be perennial. The orientation and channel patterns in Crandall Canyon are similar to Mill Fork and Little Bear although the drainage area is larger.

The U.S.G.S. maintained a gaging station (0917919) in Crandall Canyon during water year 1979. Discharged per unit area for the 5.7 square mile basin was 280 acre-feet per square mile or 5.25 inches of runoff. In contrast; annual discharge from the 11.7 square mile Tie Fork Canyon on the opposite side of Huntington Creek for the same period averaged 2.04 CFS — only 2.36 inches of runoff. The higher water yield from Crandall Canyon can, in part, be attributed to groundwater contributions from the Star Point Sandstone in the Crandall Canyon drainage or possible groundwater recharge or loss along the Bear Canyon Fault in the Tie Fork drainage. Comparison of the hydrographs in Figures 7-5 and 7-6 from Danielson et al. (1981) show strikingly similar hydrograph patterns. Base flow levels are similar and snowmelt runoff predominates with April through July runoff accounting for about 80% of the streamflow from both basins. Therefore, differences are also likely the result of different energy aspects and precipitation patterns for the two basins. The irregular snowmelt recession on Crandall Canyon suggests delay in snowmelt runoff from perhaps deeper snowpack accumulation on north facing slopes.

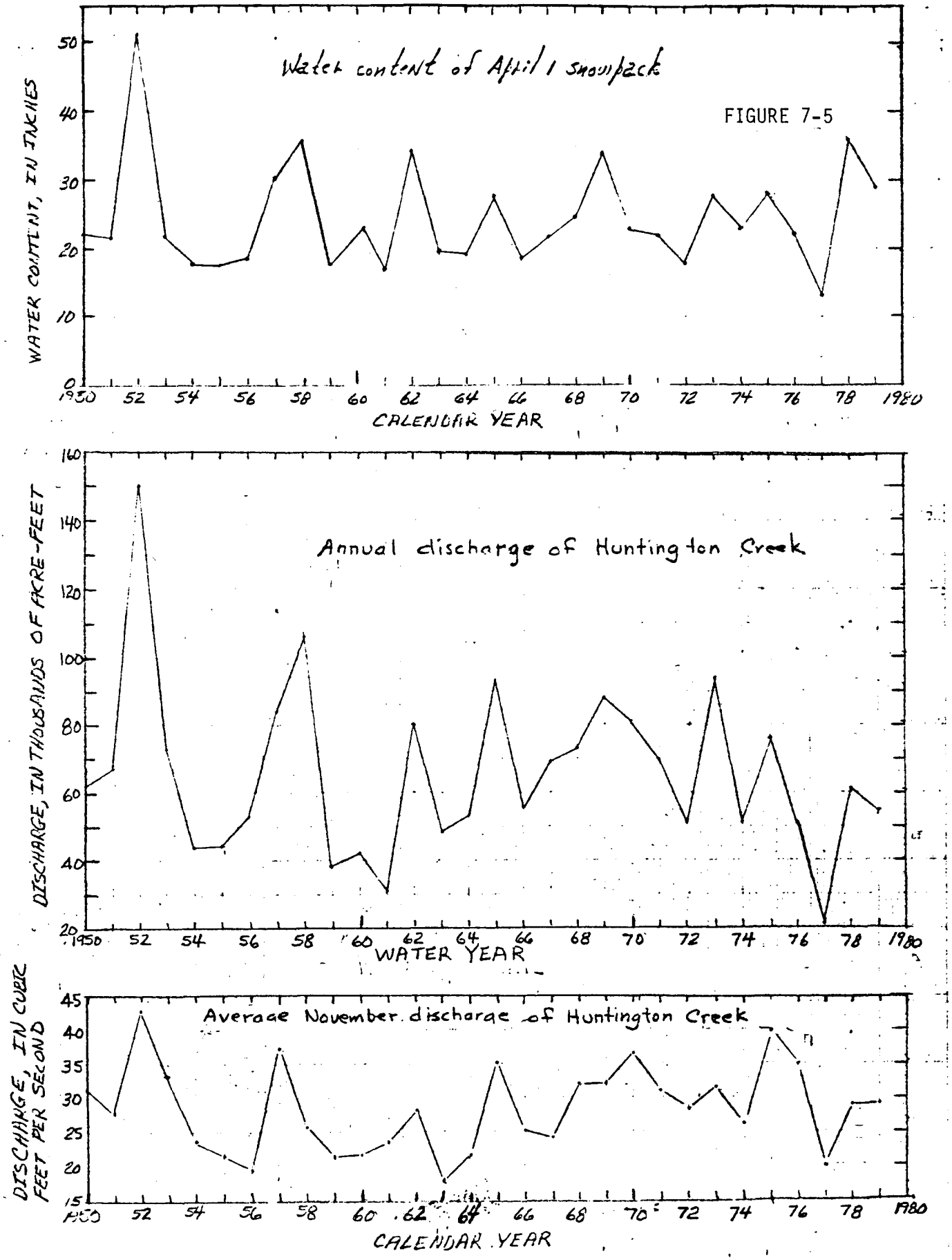

Figure 7-5 Water content of April 1 snowpack at the Huntington Horseshoe snow course and the annual discharge of Huntington Creek at gaging station 09318000, 1950-79.

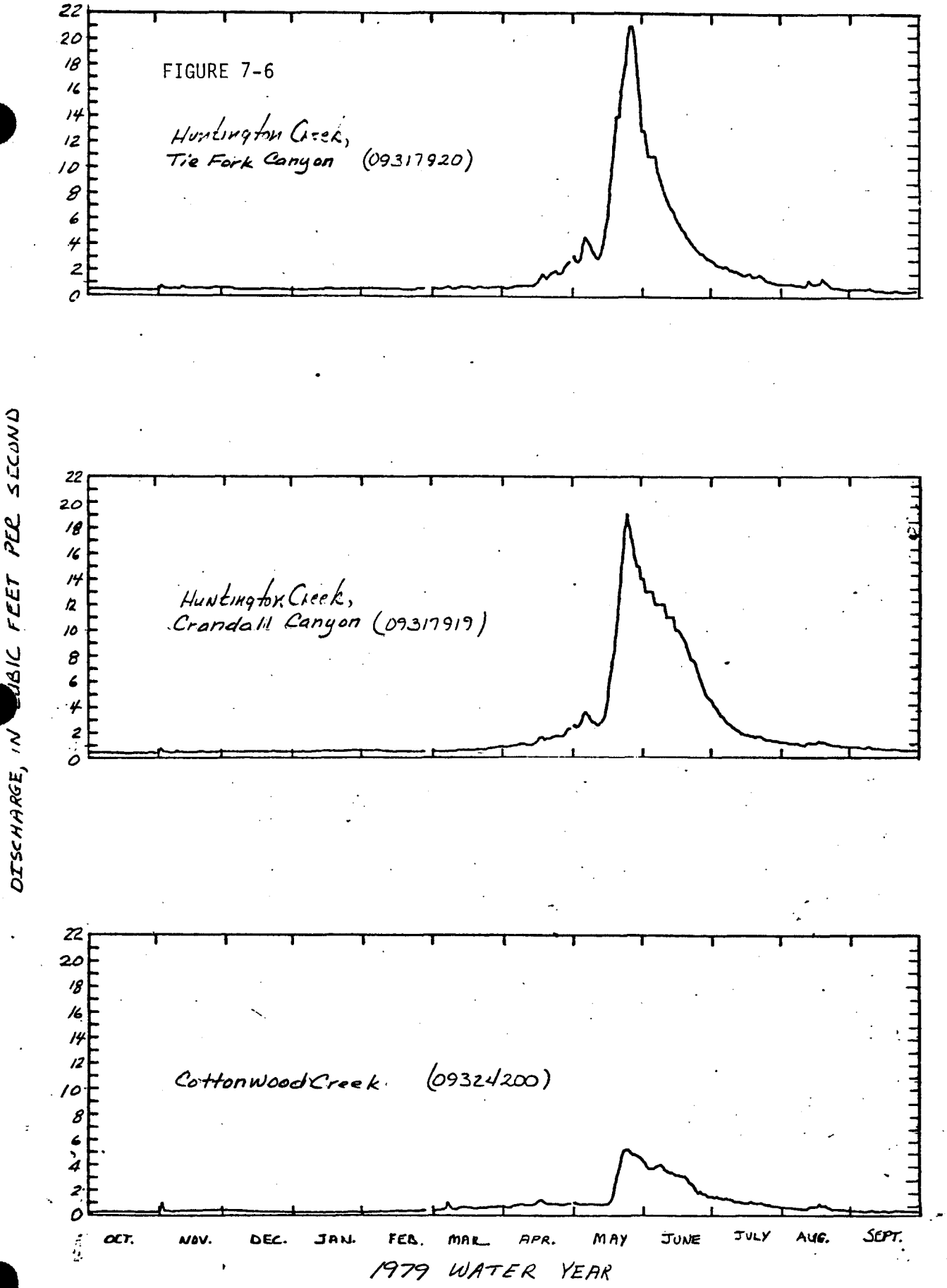

Figure 7-6 Stream discharge at three gaging stations in the drainages of Huntington and Cottonwood Creeks, water year 1979.

7.2.2.2 Mine Plan Area Surface Water Hydrology (continued)

The next stream to the south is Little Bear Creek. The lower reaches of Little Bear Canyon is just north of the lease block. Little Bear Creek is an intermittent stream. Little Bear Spring is perennial. The bulk of the spring's discharge is diverted through a pipeline by the city of Huntington. An average of the instantaeous discharge measurements on Little Bear Spring from Table 7-11 gives an average discharge of 0.66 CFS for a total yield of 6.31 inches/year — expressed over the 869 acre Little Bear Watershed. In contrast, the instantaeous discharge measurements on Little Bear Creek reported in Table 7-12 average 0.17 CFS or 1.76 inches/year expressed over the 869 acre Little Bear Watershed. These results must be interpreted with caution, since continuous discharge measurements are not available. However, the high yield from Little Bear Spring in contrast to Little Bear Creek suggests that the source of Little Bear Spring extends outside Little Bear Basin. The lack of a predominant seasonal snowmelt component in the Little Bear Spring flow measurements of Table 7-11 supports this hypothesis.

The channel pattern within The Little Bear Creek watershed is dendritic with a more developed drainage on the north facing slopes (see Plate 7-1). The pattern is indicative of greater flow production from the north facing slopes. Snowmelt runoff and perched groundwater appear to provide a substantial component of the intermittent flow for the Little Bear Creek. Surface runoff from exposed rock and from saturated zones along Little Bear Creek and its tributaries would constitute the dominant source of storm runoff.

Little Bear Creek watershed is extremely steep. The average change in elevation along Little Bear Canyon is 1600 feet per mile. (A detailed representation of channel profiles is shown on Plate

Table 7-11

RECORD OF "LITTLE BEAR SPRING" DISCHARGE

(D-16-7) 9 CAC-S1

DATE	SOURCE	FLOW (CFS)
06/25/70	1	0.89
07/09/70	1	0.88
08/24/70	1	0.61
10/06/70	1	0.50
04/15/71	1	0.65
05/27/71	1	0.52
08/18/76	2	0.26
04/27/78	2	0.95
08/29/78	2	0.65
10/13/78	2	0.57
11/08/78	2	0.42
09/81	1	0.69
10/81	1	0.70
11/81	1	0.69
01/82	1	0.65
02/82	1	0.65
03/82	1	0.65
04/82	1	0.60
05/82	1	0.71
06/82	1	0.97
	AVERAGE FLOW:	0.66
	MAXIMUM FLOW:	0.97
	MINIMUM FLOW:	0.26

1 - Castle Valley Special Services
2 - U.S. Geological Survey

Table 7-12

RECORD OF "LITTLE BEAR CREEK" DISCHARGE

DATE	SOURCE	FLOW (CFS)
06/25/70	1	0.28
07/09/70	1	0.28
08/24/70	1	0.08
10/06/70	1	0.09
04/15/71	1	0.06
05/27/71	1	0.20
10/13/78	2	0.24
10/30/79	2	0.24
	Average Flow:	0.17
	Maximum Flow:	0.28
	Minimum Flow:	0.06

1 - Castle Valley Special Services

2 - U.S. Geological Survey

7.2.2.2 Mine Plan Area Surface Water Hydrology (continued)

7-2.) The canyon sides are steep and rocky. The stream cuts through six different geologic formations as shown on Plate 6-1. The rugged topography gives rise to a number of falls, pools and cataracts on Little Bear Creek. A number of debris dams are also evident apparently resulting from downed timber and debris following the 1964 fire.

Mill Fork, the other principal drainage, is an intermittent stream producing about 20 acre feet of water per year. Like both Little Bear and Crandall Canyon, the channels are more developed on the north facing slopes indicating the importance of evapotranspiration and snowmelt runoff to the hydrologic balance. Sparse vegetation and exposed rock on the south facing slope appear to have an important role in the production of storm runoff. Areas with high soil moisture along the stream channel also contribute to storm water runoff. The average change in elevation along the Mill Fork Creek is approximately 590 feet per mile (see Plate 7-2). Water is not concentrated as quickly in Mill Fork channel as in the steep, short, dendritic channel pattern found in the Little Bear drainage.

Surface Water Quality

Surface-water quality does not appear to be substantially different from the groundwater quality. Table 7-13 presents water quality analyses for each of the monitoring points on or near the Huntington Canyon No. 4 Mine permit area. Sample points 4-3-W, 4-4W, 4-5-W, and 4-8-W, are the surface-water quality monitoring points. Sample points 4-1-W and 4-9-W are the springwater quality monitoring points. They are used to characterize the groundwater quality. The locations of these points are shown on Plate 7-3. Sample points 4-1-W and 4-2-W were monitoring points for Upper and Lower Little Bear Spring respectively (these springs are

WATER-QUALITY Data Report for Station: UPPER LITTLE BEAR (4-1-W) Property: Huntington Canyon No.4 Mine

Latitude: Section: #9 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	06/16/76	09/15/78	06/15/79	10/11/79	08/25/80	11/06/80	01/04/81	02/03/81
Manganese, total, mg/l (Mn)	0.002	-	0.014	0.035	0.015	0.010	-	0.002
Iron, Total, mg/l (Fe)	0.003	0.210	0.182	0.010	0.022	0.025	0.040	0.020
Sulfate, mg/l (SO4)	15.9	28.0	97.5	58.0	33.0	21.0	18.0	18.0
Chloride, mg/l (Cl)	3.70	14.0	-	8.00	14.0	0.650	4.49	12.3
Nitrate as N, mg/l (NO3)	0.190	0.080	0.060	0.080	0.190	0.260	0.120	0.100
Lab pH, std. units	9.30DLA	7.10	8.40	7.80	7.20	7.20	6.80	7.80
TDS (Lab), mg/l (Lab.)	-	470	-	330	350	350	390	350
TSS, mg/l	-	1.00	-	1.00	9.00	1.00	8.00	1.00
Lab Conductivity @25C, micromhos/cm	-	720	-	-	490	500	557	530
Water Flow rate, cfs.	-	0.401	-	-	-	-	-	-
Field temperature, deg. C.	-	-	-	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-	-
Cation-anion bal. (comp. calc), %	-	-	-	-	-	-	-	-
Cation-anion bal. Percent Error	-	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	-	-	-	-	-	-
TDS Percent Error (lab/computer)	-	-	-	-	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: UPPER LITTLE BEAR (4-1-W) Property: Huntington Canyon No.4 Mine

Latitude:
Longitude:
Elevation:

Section: #9
Township: T16S
Range: R7E

County: Emery
State: Utah
Country: U.S.A.

Parameter title	03/04/81	04/09/81	05/13/81	12/12/81	01/14/82	02/17/82	03/17/82	04/22/82
Manganese, Total, mg/l (Mn)	0.010	-	0.010	0.015	0.011	-	0.010	-
Iron, Total, mg/l (Fe)	-	-	0.020	0.010	-	0.030	0.200	0.120
Sulfate, mg/l (SO4)	-	24.0	37.5	18.0	30.0	6.00	27.0	30.0
Chloride, mg/l (Cl)	9.00	14.0	12.0	4.24	2.90	4.60	3.80	2.40
Nitrate as N, mg/l (NO3)	0.130	0.130	0.190	0.270	0.190	-	0.090	0.160
Lab pH, std. units	7.40	8.40	7.90	7.60	7.20	7.80	7.40	7.50
TDS at 180C, mg/l (lab.)	310	380	350	375	325	286	260	390
TSS, mg/l	1.00	2.00	9.00	14.0	4.00	1.00	2.00	14.0
Lab Conductivity @25C, micromhos/cm	520	580	540	560	500	450	400	590
Water Flow Rate, cfs.	-	-	-	-	-	0.646	-	0.680
Field temperature, deg. C.	-	-	-	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-	-
Cation-anion Bal. (comp. calc), %	-	-	-	-	-	-	-	-
Cation-anion Bal. Percent Error	-	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	-	-	-	-	-	-
TDS Percent Error (lab/computer)	-	-	-	-	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: UPPER LITTLE BEAR (4-1-W) Property: Huntington Canyon No.4 Mine

Latitude: Section: #9 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	05/26/82	06/23/82	07/21/82
Manganese, Total, mg/l (Mn)	0.005	0.005	0.007
Iron, Total, mg/l (Fe)	0.050	0.090	0.100
Sulfate, mg/l (SO4)	24.0	21.0	6.00
Chloride, mg/l (Cl)	9.90	10.1	13.0
Nitrate as N, mg/l (NO3)	-	0.140	0.180
Lab pH, std. units	7.60	7.70	7.70
TDS @180C, mg/l (lab.)	350	367	276
TSS, mg/l	-	4.00	4.00
Lab Conductivity @25C, micromhos/cm	520	560	415
Water Flow Rate, cfs.	-	-	-
Field temperature, deg. C.	-	-	16.0
Calcium, mg/l (Ca)	-	-	-
Magnesium, mg/l (Mg)	-	-	-
Sodium, mg/l (Na)	-	-	-
Potassium, mg/l (K)	-	-	-
Carbonate, mg/l (CO3)	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-
Cation-anion Bal. (comp. calc), %	-	-	-
Cation-anion Bal. Percent Error	-	-	-
TDS (computer calc.), mg/l	-	-	-
TDS Percent Error (lab/computer)	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

Latitude: Section: #9 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	Quality Standards -- # of Times Exceeded/Value Domestic (1C)		Aquatic (3A)		Agriculture (4)		Min.	Max.	Mean	Std. Dev.
Manganese, total, mg/l (Mn)		-		-		-	0.002	0.035	0.011	0.008
Iron, total, mg/l (Fe)		-		-		-	0.003	0.210	0.071	0.072
Sulfate, mg/l (SO4)		-		-		-	6.00	97.5	28.5	20.9
Chloride, mg/l (Cl)		-		-		-	0.650	14.0	7.95	4.62
Nitrate as N, mg/l (NO3)		10.0		-		-	0.060	0.270	0.150	0.061
Lab pH, std. units	1	9.00	1	9.00	1	9.00	6.80	9.30DLA	7.67	0.566
TDS @180C, mg/l (lab.)		-		-		-	260	470	348	49.8
TSS, mg/l		-		-		-	1.00	14.0	4.75	4.61
Lab Conductivity @25C, microhos/cm		-		-		-	400	720	527	75.2
Water flow rate, cfs.		-		-		-	0.401	0.680	0.576	0.152
Field temperature, deg. C.		-		20.0		-	16.0	16.0	16.0	-
Calcium, mg/l (Ca)		-		-		-	-	-	-	-
Magnesium, mg/l (Mg)		-		-		-	-	-	-	-
Sodium, mg/l (Na)		-		-		-	-	-	-	-
Potassium, mg/l (K)		-		-		-	-	-	-	-
Carbonate, mg/l (CO3)		-		-		-	-	-	-	-
Bicarbonate, mg/l (HCO3)		-		-		-	-	-	-	-
Cation-anion bal. (comp. calc), %		-		-		-	-	-	-	-
Cation-anion bal. Percent Error		-		-		-	-	-	-	-
TDS (computer calc.), mg/l		-		-		1200	-	-	-	-
TDS Percent Error (lab/computer)		-		-		1200	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: LOWER LITTLE BEAR (4-2-W) Property: Huntington Canyon No.4 Mine

Latitude: Section: #9 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	06/15/76	09/15/78	06/15/79	10/11/79	08/25/80	11/06/80	01/04/81	02/03/81
Manganese, Total, mg/l (Mn)	0.023	-	0.014	0.055	0.052	0.018	-	0.004
Iron, Total, mg/l (Fe)	0.210	0.018	0.134	0.090	0.110	0.115	0.010	0.020
Sulfate, mg/l (SO4)	20.5	23.0	90.5	58.0	37.5	19.5	18.0	21.0
Chloride, mg/l (Cl)	-	8.00	-	8.00	14.0	0.660	4.42	8.22
Nitrate as N, mg/l (NO3)	0.140	0.030	0.060	0.050	0.140	0.310	0.160	0.090
Lab pH, std. units	9.200LA	7.40	8.30	8.00	7.50	7.30	6.70	8.00
TDS @180C, mg/l (lab.)	-	413	-	340	330	365	380	355
TSS, mg/l	-	9.00	-	1.00	8.00	1.00	2.00	1.00
Lab Conductivity @25C, micromhos/cm	441	630	-	-	480	520	543	540
Water Flow Rate, cfs.	-	0.401	-	-	-	-	-	-
Field temperature, deg. C.	-	-	-	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-	-
Cation-anion Bal. (comp. calc), %	-	-	-	-	-	-	-	-
Cation-anion Bal. Percent Error	-	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	-	-	-	-	-	-
TDS Percent Error (lab/computer)	-	-	-	-	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: LOWER LITTLE BEAR (4-2-W) Property: Huntington Canyon No.4 Mine

Latitude: Section: #9 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	03/04/81	04/09/81	05/18/81	07/22/81	08/25/81	09/03/81	12/10/81	05/26/82
Manganese, Total, mg/l (Mn)	0.010	-	0.010	0.011	0.010	0.005	0.009	0.005
Iron, Total, mg/l (Fe)	-	-	0.010	0.028	-	0.010	0.010	0.500
Sulfate, mg/l (SO4)	-	22.5	33.0	54.0	25.5	18.0	15.0	18.0
Chloride, mg/l (Cl)	10.0	10.0	12.0	11.5	7.20	25.0	3.79	46.0
Nitrate as N, mg/l (NO3)	0.120	0.190	0.180	0.040	-	2.92	0.250	-
Lab pH, std. units	7.60	7.70	7.80	8.60	8.10	8.10	8.10	7.80
TDS @180C, mg/l (lab.)	315	390	350	415	575	335	365	355
TSS, mg/l	2.00	1.00	5.00	10.0	11.0	1.00	16.0	4.00
Lab Conductivity 25°C, micromhos/cm	530	600	540	640	570	510	560	530
Water Flow Rate, cfs.	-	-	-	-	-	-	-	0.013
Field temperature, deg. C.	-	-	-	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-	-
Cation-anion bal. (comp. calc), %	-	-	-	-	-	-	-	-
Cation-anion bal. Percent Error	-	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	-	-	-	-	-	-
TDS Percent Error (lab/computer)	-	-	-	-	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

Latitude: Section: #9 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter Title	07/21/82
Manganese, total, mg/l (Mn)	0.012
Iron, total, mg/l (Fe)	0.058
Sulfate, mg/l (SO4)	<0.100
Chloride, mg/l (Cl)	12.1
Nitrate as N, mg/l (NO3)	0.150
Lab pH, std. units	7.40
TDS @180C, mg/l (lab.)	278
TSS, mg/l	9.00
Lab Conductivity 25oC, micromhos/cm	445
Water Flow Rate, cfs.	-
Field temperature, deg. C.	-
Calcium, mg/l (Ca)	-
Magnesium, mg/l (Mg)	-
Sodium, mg/l (Na)	-
Potassium, mg/l (K)	-
Carbonate, mg/l (CO3)	-
Bicarbonate, mg/l (HCO3)	-
Cation-anion Bal. (comp. calc), %	-
Cation-anion Bal. Percent Error	-
TDS (computer calc.), mg/l	-
TDS Percent Error (lab/computer)	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

Latitude: Section: #9 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	Quality Standards -- # of Times Exceeded/Value Domestic (1C)		Aquatic (3A)		Agriculture (4)		Min.	Max.	Mean	Std. Dev.
Manganese, Total, mg/l (Mn)		-		-		-	0.004	0.055	0.017	0.016
Iron, Total, mg/l (Fe)		-		-		-	0.010	0.500	0.094	0.132
Sulfate, mg/l (SO4)		-		-		-	0.100	90.5	29.6	21.7
Chloride, mg/l (Cl)		-		-		-	0.660	46.0	12.1	10.9
Nitrate as N, mg/l (NO3)		10.0		-		-	0.030	2.92	0.322	0.723
Lab pH, std. units	1	9.00	1	9.00	1	9.00	6.70	9.20DLA	7.88	0.550
TDS 180C, mg/l (lab.)		-		-		-	278	575	371	66.8
TSS, mg/l		-		-		-	1.00	16.0	5.40	4.78
Lab Conductivity @25C, micromhos/cm		-		-		-	441	640	540	57.9
Water Flow Rate, cfs.		-		-		-	0.013	0.401	0.207	0.274
Field temperature, deg. C.		-		20.0		-	-	-	-	-
Calcium, mg/l (Ca)		-		-		-	-	-	-	-
Magnesium, mg/l (Mg)		-		-		-	-	-	-	-
Sodium, mg/l (Na)		-		-		-	-	-	-	-
Potassium, mg/l (K)		-		-		-	-	-	-	-
Carbonate, mg/l (CO3)		-		-		-	-	-	-	-
Bicarbonate, mg/l (HCO3)		-		-		-	-	-	-	-
Cation-anion bal. (comp. calc), %		-		-		-	-	-	-	-
Cation-anion bal. Percent Error		-		-		-	-	-	-	-
TDS (computer calc.), mg/l		-		-		1200	-	-	-	-
TDS Percent Error (lab/computer)		-		-		1200	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: UPPER MILL FORK (4-3-W) Property: Huntington Canyon No.4 Mine

Latitude:
Longitude:
Elevation:

Section: #17
Township: T16S
Range: R7E

County: Emery
State: Utah
Country: U.S.A.

Parameter Title	06/12/80	07/16/80	08/25/80	09/19/80	10/06/80	05/26/82	06/23/82	07/21/82
Manganese, Total, mg/l (Mn)	0.010	-	0.061	0.022	0.072	0.025	0.026	0.022
Iron, Total, mg/l (Fe)	0.025	0.010	0.106	0.110	0.110	0.270	0.250	0.285
Sulfate, mg/l (SO4)	125	15.0	22.5	16.5	20.9	12.0	11.0	<0.100
Chloride, mg/l (Cl)	4.00	14.0	8.00	-	10.0	30.8	32.0	3.10
Nitrate as N, mg/l (NO3)	0.300	0.160	0.080	0.070	0.010	0.130	0.150	0.100
Lab pH, std. units	8.10	7.80	7.70	7.40	7.70	8.10	8.05	8.70
TDS @180C, mg/l (lab.)	285	260	285	279	288	280	285	230
TSS, mg/l	127	7.00	38.0	1.00	1.00	97.0	46.0	17.0
Lab Conductivity @25C, micromhos/cm	440	400	410	430	440	430	440	300
Water Flow Rate, cfs.	11.1	1.36	0.281	0.047	-	-	-	-
Field Temperature, deg. C.	-	-	-	-	-	-	-	12.0
Calcium, mg/l (Ca)	-	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-	-
Cation-anion bal. (comp. calc), %	-	-	-	-	-	-	-	-
Cation-anion bal. Percent Error	-	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	-	-	-	-	-	-
TDS Percent Error (lab/computer)	-	-	-	-	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

Latitude: Section: #17 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	Quality Standards -- # of Times Exceeded/Value Domestic (1C)	Aquatic (3A)	Agriculture (4)	Min.	Max.	Mean	Std. Dev.
Manganese, Total, mg/l (Mn)	-	-	-	0.010	0.072	0.034	0.023
Iron, Total, mg/l (Fe)	-	-	-	0.010	0.285	0.146	0.109
Sulfate, mg/l (SO4)	-	-	-	0.100	125	27.9	39.8
Chloride, mg/l (Cl)	-	-	-	3.10	32.0	14.6	12.1
Nitrate as N, mg/l (NO3)	10.0	-	-	0.010	0.300	0.125	0.086
Lab pH, std. units	9.00	9.00	9.00	7.40	8.70	7.94	0.390
TDS at 180C, mg/l (lab.)	-	-	-	230	288	274	19.8
TSS, mg/l	-	-	-	1.00	127	41.8	47.0
Lab Conductivity 25oC, micromhos/cm	-	-	-	300	440	411	47.3
Water Flow Rate, cfs.	-	-	-	0.047	11.1	3.20	5.30
Field temperature, deg. C.	-	20.0	-	12.0	12.0	12.0	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-
Cation-anion Bal. (comp. calc), %	-	-	-	-	-	-	-
Cation-anion Bal. Percent Error	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	1200	-	-	-	-
TDS Percent Error (lab/computer)	-	-	1200	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data report for Station: MILL FK ABOVE SED POND (4-4-W) Property: Huntington Canyon No.4 Mine

Latitude: Section: #21 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	08/16/78	09/15/78	11/08/78	04/18/80	05/12/80	06/12/80	07/16/80	08/25/80
Manganese, Total, mg/l (Mn)	-	-	-	0.030	0.035	0.040	-	0.012
Iron, Total, mg/l (Fe)	0.010	0.060	0.300	0.130	0.130	0.136	0.030	0.059
Sulfate, mg/l (SO4)	-	74.0	59.0	86.0	84.0	90.0	21.0	70.5
Chloride, mg/l (Cl)	-	8.00	8.00	10.0	20.0	4.00	6.00	16.0
Nitrate as N, mg/l (NO3)	-	0.080	0.020	0.140	0.220	0.260	0.150	0.170
Lab pH, std. units	8.40	8.20	8.00	7.90	7.80	7.90	7.80	7.40
TDS @180C, mg/l (lab.)	390	410	405	455	450	298	300	470
TSS, mg/l	11.0	7.00	53.0	89.5	64.0	212	9.00	16.0
Lab Conductivity @25C, micromhos/cm	600	631	620	700	700	450	460	520
Water Flow Rate, cfs.	0.135	0.002	0.037	-	0.078	11.2	1.55	-
Field temperature, deg. C.	-	-	-	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	0	-	-	-	-	-	-	-
Sodium, mg/l (Na)	0	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-	-
Cation-anion bal. (comp. calc), %	-	-	-	-	-	-	-	-
Cation-anion bal. Percent Error	-	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	-	-	-	-	-	-
TDS Percent Error (lab/computer)	-	-	-	-	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: MILL FK ABOVE SED POND (4-4-W) Property: Huntington Canyon No.4 Mine

Latitude:
Longitude:
Elevation:

Section: #21
Township: T16S
Range: R7E

County: Emery
State: Utah
Country: U.S.A.

Parameter title	09/19/80	10/06/80	11/06/80	12/02/80	01/04/81	02/03/81	03/04/81	04/09/81
Manganese, total, mg/l (Mn)	0.028	0.018	0.006	0.020	0.040	0.030	0.030	0.340
Iron, total, mg/l (Fe)	0.060	0.060	0.039	0.065	0.260	0.140	0.220	2.08
Sulfate, mg/l (SO4)	40.5	68.5	48.0	52.5	45.0	48.0	9.00	33.0
Chloride, mg/l (Cl)	1.60	14.0	3.80	2.83	9.42	12.3	15.0	16.0
Nitrate as N, mg/l (NO3)	0.140	0.150	0.120	0.160	0.130	0.060	0.050	0.210
Lab pH, std. units	7.20	7.50	7.50	7.70	7.00	7.90	7.50	7.60
TDS @180C, mg/l (lab.)	390	465	280	406	460	356	450	410
TSS, mg/l	14.0	66.0	2.00	7.00	13.0	14.0	5.00	656
Lab Conductivity @25C, micromhos/cm	600	710	400	620	657	340	640	630
Water Flow Rate, cfs.	0.047	-	-	0.011	0.011	-	0.018	-
Field temperature, deg. C.	-	-	-	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-	-
Cation-anion Bal. (comp. calc), %	-	-	-	-	-	-	-	-
Cation-anion Bal. Percent Error	-	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	-	-	-	-	-	-
TDS Percent Error (lab/computer)	-	-	-	-	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: MILL CK ABOVE SED POND (4-4-W) Property: Huntington Canyon No.4 Mine

Latitude:
Longitude:
Elevation:

Section: #21
Township: T16S
Range: R7E

County: Emery
State: Utah
Country: U.S.A.

Parameter title	05/13/81	07/22/81	08/25/81	09/08/81	12/10/81	02/17/82	03/17/82	04/22/82
Manganese, Total, mg/l (Mn)	0.010	0.012	0.030	0.033	0.033	0.075	0.040	0.220
Iron, Total, mg/l (Fe)	0.220	0.250	0.370	0.350	0.200	2.59	0.140	1.60
Sulfate, mg/l (SO4)	64.5	51.0	51.0	42.0	42.0	30.0	39.0	54.0
Chloride, mg/l (Cl)	16.0	12.9	21.6	30.0	8.98	10.6	54.9	72.1
Nitrate as N, mg/l (NO3)	0.070	0.070	-	4.86	0.270	-	0.050	0.100
Lab pH, std. units	8.00	8.00	8.00	8.20	7.60	7.80	7.60	7.80
TDS @ 180C, mg/l (lab.)	430	465	480	460	474	43.4	438	550
TSS, mg/l	18.0	85.0	62.0	43.0	15.0	124	2.00	185
Lab Conductivity 25°C, micromhos/cm	660	710	740	700	720	660	680	840
Water Flow Rate, cfs.	0.008	-	-	-	-	-	0.007	0.013
Field temperature, deg. C.	-	-	-	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-	-
Cation-Anion Bal. (comp. calc), %	-	-	-	-	-	-	-	-
Cation-Anion Bal. Percent Error	-	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	-	-	-	-	-	-
TDS Percent Error (lab/computer)	-	-	-	-	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: MILL FK ABOVE SED POND (4-4-W) Property: Huntington Canyon No.4 Mine

Latitude: Section: #21 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	05/26/82	06/23/82	07/21/82
Manganese, Total, mg/l (Mn)	0.100	0.015	0.014
Iron, Total, mg/l (Fe)	0.800	0.050	0.066
Sulfate, mg/l (SO4)	15.0	6.00	<0.100
Chloride, mg/l (Cl)	11.9	4.50	4.80
Nitrate as N, mg/l (NO3)	0.180	0.100	0.130
Lab pH, std. units	8.10	8.30	8.00
TDS @180C, mg/l (lab.)	280	279	294
TSS, mg/l	332	51.0	5.00
Lab Conductivity @25C, micromhos/cm	430	430	350
Water Flow Rate, cfs.	-	-	0.045
Field temperature, deg. C.	-	-	-
Calcium, mg/l (Ca)	-	-	-
Magnesium, mg/l (Mg)	-	-	-
Sodium, mg/l (Na)	-	-	-
Potassium, mg/l (K)	-	-	-
Carbonate, mg/l (CO3)	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-
Cation-anion Bal. (comp. calc), %	-	-	-
Cation-anion Bal. Percent Error	-	-	-
TDS (computer calc.), mg/l	-	-	-
TDS Percent Error (lab/computer)	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

Latitude: Section: #21 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	Quality Standards -- # of Times Exceeded/Value Domestic (1C)	Aquatic (3A)	Agriculture (4)	Min.	Max.	Mean	Std. Dev.
Manganese, total, mg/l (Mn)	-	-	-	0.006	0.340	0.053	0.077
Iron, total, mg/l (Fe)	-	-	-	0.010	2.59	0.386	0.649
Sulfate, mg/l (SO4)	-	-	-	0.100	90.0	47.1	24.3
Chloride, mg/l (Cl)	-	-	-	1.60	72.1	15.2	15.8
Nitrate as N, mg/l (NO3)	10.0	-	-	0.020	4.86	0.329	0.967
Lab pH, std. units	9.00	9.00	9.00	7.00	8.40	7.80	0.329
TDS @180C, mg/l (lab.)	-	-	-	43.4	550	392	102
TSS, mg/l	-	-	-	2.00	656	80.0	140
Lab Conductivity @25C, micromhos/cm	-	-	-	340	840	600	131
Water Flow Rate, cfs.	-	-	-	0.002	11.2	0.937	2.97
Field temperature, deg. C.	-	20.0	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	0	0	0	-
Sodium, mg/l (Na)	-	-	-	0	0	0	-
Potassium, mg/l (K)	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-
Cation-anion Bal. (comp. calc), %	-	-	-	-	-	-	-
Cation-anion Bal. Percent Error	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	1200	-	-	-	-
TDS Percent Error (lab/computer)	-	-	1200	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

WATER-QUALITY Data Report for Station: MILL FK BELOW SED POND (4-5-W) Property: Huntington Canyon No.4 Mine

Latitude: Section: #21 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	12/13/79
Manganese, Total, mg/l (Mn)	0.067
Iron, Total, mg/l (Fe)	0.070
Sulfate, mg/l (SO4)	59.0
Chloride, mg/l (Cl)	8.00
Nitrate as N, mg/l (NO3)	0.100
Lab pH, std. units	7.80
TDS @180C, mg/l (lab.)	330
TSS, mg/l	12.0
Lab Conductivity @25C, micromhos/cm	-
Water Flow Rate, cfs.	-
Field Temperature, deg. C.	-
Calcium, mg/l (Ca)	-
Magnesium, mg/l (Mg)	-
Sodium, mg/l (Na)	-
Potassium, mg/l (K)	-
Carbonate, mg/l (CO3)	-
Bicarbonate, mg/l (HCO3)	-
Cation-anion Bal. (comp. calc), %	-
Cation-anion Bal. Percent Error	-
TDS (computer calc.), mg/l	-
TDS Percent Error (lab/computer)	-

Units are in mg/l, unless otherwise noted.

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

WATER-QUALITY Data Report for Station: MILL FK BELOW SED POND (4-5-W) Property: Huntington Canyon No.4 Mine

Latitude: Section: #21 County: Emery
Longitude: Township: T16S State: Utah
Elevation: Range: R7E Country: U.S.A.

Parameter title	Quality Standards -- # of Times Exceeded/Value Domestic (1C)	Aquatic (3A)	Agriculture (4)	Min.	Max.	Mean	Std. Dev.
Manganese, total, mg/l (Mn)	-	-	-	0.067	0.067	0.067	-
Iron, Total, mg/l (Fe)	-	-	-	0.070	0.070	0.070	-
Sulfate, mg/l (SO4)	-	-	-	58.0	58.0	58.0	-
Chloride, mg/l (Cl)	-	-	-	8.00	8.00	8.00	-
Nitrate as N, mg/l (NO3)	10.0	-	-	0.100	0.100	0.100	-
Lab pH, std. units	9.00	9.00	9.00	7.80	7.80	7.80	-
TDS @180C, mg/l (lab.)	-	-	-	330	330	330	-
TSS, mg/l	-	-	-	12.0	12.0	12.0	-
Lab Conductivity @25C, micromhos/cm	-	-	-	-	-	-	-
Water Flow Rate, cfs.	-	-	-	-	-	-	-
Field temperature, deg. C.	-	20.0	-	-	-	-	-
Calcium, mg/l (Ca)	-	-	-	-	-	-	-
Magnesium, mg/l (Mg)	-	-	-	-	-	-	-
Sodium, mg/l (Na)	-	-	-	-	-	-	-
Potassium, mg/l (K)	-	-	-	-	-	-	-
Carbonate, mg/l (CO3)	-	-	-	-	-	-	-
Bicarbonate, mg/l (HCO3)	-	-	-	-	-	-	-
Cation-anion Bal. (comp. calc), %	-	-	-	-	-	-	-
Cation-anion Bal. Percent Error	-	-	-	-	-	-	-
TDS (computer calc.), mg/l	-	-	1200	-	-	-	-
TDS Percent Error (lab/computer)	-	-	1200	-	-	-	-

D - domestic standards exceeded
L - aquatic standards exceeded
A - agricultural standards exceeded

Units are in mg/l, unless otherwise noted.

7.2.2.2 Mine Plan Area Surface Water Hydrology (continued)

Surface Water Quality (continued)

located on Plate 6-1), from May 1981 to date, samples were taken from a combined source at the City of Huntington Pipeline near the mouth of Little Bear Canyon and reported as sample point 4-1-W.

According to Wastewater Disposal Regulations, Part II, Standards of Quality for waters of the State (of Utah), Huntington Creek and tributaries above the Highway U-10 crossing are classified 1C, 3A and 4. Class 3A means that the particular stream is protected for cold water game fish and other aquatic life. Class 1A means that a particular stream is protected for domestic purposes without treatment and Class 4 means that the stream is protected for agricultural uses. Table 7-12 includes a summary table comparing water quality data for each state with the numerical standards for these classes.

With the previously mentioned exceptions, the surface water quality is within the limits set by the State of Utah.

Water Use

Surface and groundwater rights in the area of the Huntington Canyon No. 4 Mine are principally for stock watering (See Section 7.1.3). No irrigation rights are claimed at points within one mile of the mine lease area. Of all the water rights claimed, only three are springs, the remainder are located on streams. No known wells exist in the area.

7.2.2.2 Mine Plan Area Surface Water Hydrology (continued)

Springs and Seeps Characteristics (continued)

Field observation indicates that the seeps and springs discharge from three geologic settings (Plate 6-1). One is discharge from a regional groundwater source like the Little Bear Springs which is located in Little Bear Canyon (see Plate 6-1), sites 9CAS1 (4-1-W) and 9CAS2 (4-2-W). The second is discharge from a sandstone unit located just above a shale or siltstone unit that prevents further downward percolation of groundwater. Third, springs and seeps also issue from alluvial and colluvial sediments along the valley sides and bottoms.

The only domestic water supply is Little Bear Spring located in the Star Point Sandstone, below the coal seam. Due to its location it is unlikely that it will be impacted by mining activities. The spring receives its recharge from areas in the Star Point Sandstone, west and north of the watershed as indicated in the Vaughn Hansen Report, 1977. Water from the Little Bear Spring is diverted to the City of Huntington through a pipeline starting at a concrete collection box in Section 9, T16S, R7E. Overflow is discharged from the collection box into Little Bear Canyon. Table 7-11 contains the record of "Little Bear Spring" discharges from June, 1970 to April 1982. The maximum discharge observed was 0.75 (CFS), the minimum was 0.26 CFS, and the average was 0.66 CFS. Table 7-12 contains a record of Little Bear Creek discharges from June 1970, to October 1979. The maximum stream discharge recorded was 0.28 CFS, the minimum was 0.06 CFS, and the average was 0.17 CFS. When the average "Little Bear Spring" flows are compared with the average Little Bear Creek flows, Little Bear Spring supplies 79.2% of the flow in Little Bear Canyon.

7.2.2.2 Mine Plan Area Surface Water Hydrology (continued)

Springs and Seeps Characteristics (continued)

In addition to Little Bear Spring, several other springs in Little Bear Canyon may be perennial although flow rates are substantially lower and insufficient to maintain perennial flow in Little Bear Canyon. Seeps occur in all geologic formations (Plate 6-1) in the lease block and are the result of small perched aquifers. Furthermore, because the seeps are intermittent the source of recharge is probably local. Since the Star Point Sandstone has perennial springs, this suggests that the source of water for the Star Point Sandstone is probably regional, while the source of groundwater for all other geologic units in the lease block is local.

A completed spring and seep survey was conducted in 1982, for the existing lease block and adjacent areas (Plate 6-1). The survey updated and corrected previous surveys, in addition to researching new areas. Each spring and seep located by this survey, presented in Plate 6-1 and labeled using the State of Utah well and spring numbering system. Locations where flow has been observed during both summer and fall of the monitoring program are classified as springs. Table 7-14 summarizes the results of this survey.

Water quality data from the 1982 Spring and Seep Survey is presented in Table 7-15.

7.2.3 Surface Water Development, Control and Diversions

Beaver Creek Coal Company obtains their water supply from Mill Fork Creek. A concrete cutoff wall across the creek forces subsurface flow to the surface. The water is then diverted to a pumping cistern for distribution. This system is somewhat susceptible to flood flows from Mill Fork Canyon. The risk posed to

Table 7-14

HUNTINGTON #4 MINE SPRINGS AND SEEPS

Spring and Seeps in Lease Block

Number (D-16-7)	Common Name	Geologic Unit	Type
9 CAC-S1	Little Bear Spring	Star Point SS	Spring
9 DBB-S1	-	Star Point SS	Spring
16 CAD-S1	-	Black Hawk Fm.	Seep
16 CAD-S2	-	Black Hawk Fm.	Seep
9 CCC-S1	-	Black Hawk Fm.	Seep
8 DCB-S1	-	Black Hawk Fm.	Spring
8 DCB-S2	-	Black Hawk Fm.	Spring
	Springs and Seeps Outside Lease Block		
8 DAB-S1	-	Black Hawk Fm.	Spring
4 CCC-S1	-	Black Hawk Fm.	?
4 CDC-S1	-	Star Point SS	Seep
5 CDC-S1	-	Black Hawk Fm.	Seep
8 DAB-S1	-	Black Hawk Fm.	Spring
8 BBC-S1	-	Price River Fm.	Spring
17 CCB-S1	-	Black Hawk Fm.	Spring
6 DAC-S1	-	Black Hawk Fm.	Spring
7 BAD-S1	-	Price River Fm.	Spring
7 BDD-S1	-	Wasatch	Seep
7 BDD-S2	-	Wasatch	Seep

?- Spring or seep

TABLE 7-15 A

SUMMARY OF CHEMICAL CHARACTERISTICS OF SPRING WATERS FROM
THE VICINITY OF THE HUNTINGTON NO. 4 MINE PERMIT AREA

FIELD AND LAB MEASUREMENTS

STATION	DATE	DISCHARGE	TDS	HARDNESS	PH
				DATA FOR JUNE	
8 DAB S1	29/ 6/1982	4.30	612.00	581.00	7.20
9 DBB S1	29/ 6/1982	3.50	357.00	331.00	7.00
N SPAD 736	30/ 6/1982	.	352.00	428.00	7.40
MC-4-10	30/ 6/1982	.	341.00	415.00	7.10
				DATA FOR JULY	
8 DCB S1	1/ 7/1982	1.50	328.00	296.00	7.60
8 DCB S2	1/ 7/1982	22.00	371.00	356.00	7.10
9 CAC S1	1/ 7/1982	.	355.00	368.00	7.50
6 DAC S1	12/ 7/1982	16.20	280.00	279.00	7.60
7 BAD S1	12/ 7/1982	5.00	271.00	271.00	7.60
8 BBC S1	12/ 7/1982	2.40	272.00	251.00	7.40
4 CDC S1	13/ 7/1982	0.50	1015.00	858.00	7.91
8 BAB S1	14/ 7/1982	0.80	279.00	308.00	7.80
17 CCB S1	19/ 7/1982	29.00	.	215.00	7.00
				DATA FOR SEPTEMBER	
8 DAB S1	23/ 9/1982	4.50	557.00	546.00	7.50
8 DCB S1	23/ 9/1982	.	320.00	285.00	8.30
8 DCB S2	23/ 9/1982	.	315.00	310.00	7.80
9 CAC S1	23/ 9/1982	.	349.00	359.00	7.40
9 DBB S1	23/ 9/1982	2.50	390.00	354.00	7.40
8 BAB S1	24/ 9/1982	2.50	400.00	377.00	7.60
6 DAC S1	27/ 9/1982	1.50	392.00	366.00	7.30
7 BAD S1	27/ 9/1982	5.00	301.00	279.00	7.80
8 BDC S1	27/ 9/1982	2.00	289.00	258.00	7.30

DISCHARGE IS IN GALLONS PER MINUTE, PH IS STANDARD UNITS. ALL OTHER PARAMETERS ARE IN MILLIGRAMS PER LITER

L = LESS THAN

TABLE 7-15 B

SUMMARY OF CHEMICAL CHARACTERISTICS OF SPRING WATERS FROM
THE VICINITY OF THE HUNTINGTON NO. 4 MINE PERMIT AREA

MAJOR CATIONS AND ANIONS

STATION	DATE	CA	MG	NA	K	SO4	CL
				DATA FOR JUNE			
8 DAB S1	29/ 6/1982	175.00	35.00	29.00	10.00	247.00	15.20
9 DBB S1	29/ 6/1982	120.00	7.50	44.00	5.00	110.00	11.50
N SPAD 736	30/ 6/1982	122.00	30.00	20.00	5.00	156.00	13.50
MC-4-10	30/ 6/1982	120.00	28.00	21.00	6.50	123.00	14.40
				DATA FOR JULY			
8 DCB S1	1/ 7/1982	100.00	12.00	41.00	4.00	106.00	7.60
8 DCB S2	1/ 7/1982	108.00	21.00	29.00	5.50	132.00	9.00
9 CAC S1	1/ 7/1982	106.00	25.00	21.00	6.00	128.00	8.20
6 DAC S1	12/ 7/1982	100.00	7.00	29.00	4.00	115.00	3.20
7 BAD S1	12/ 7/1982	98.00	6.50	30.00	4.50	111.00	2.30
8 BBC S1	12/ 7/1982	93.00	4.50	28.00	2.00	98.20	3.10
4 CDC S1	13/ 7/1982	281.00	38.00	46.00	8.00	432.00	19.30
8 BAB S1	14/ 7/1982	110.00	8.00	30.00	5.00	123.00	5.60
17 CCB S1	19/ 7/1982	82.00	2.50	80.00	8.00	111.00	4.90
				DATA FOR SEPTEMBER			
8 DAB S1	23/ 9/1982	170.00	34.00	31.00	10.00	250.00	10.80
8 DCB S1	23/ 9/1982	95.00	11.50	36.00	5.00	110.00	7.70
8 DCB S2	23/ 9/1982	93.00	19.00	18.00	6.00	120.00	8.20
9 CAC S1	23/ 9/1982	106.00	23.00	20.00	6.00	130.00	6.70
9 DBB S1	23/ 9/1982	127.00	9.00	47.00	4.50	140.00	11.10
8 BAB S1	24/ 9/1982	136.00	9.00	43.00	4.50	200.00	7.40
6 DAC S1	27/ 9/1982	136.00	6.50	43.00	5.00	190.00	4.90
7 BAD S1	27/ 9/1982	100.00	7.00	41.00	5.00	120.00	3.20
8 BBC S1	27/ 9/1982	95.00	5.00	43.00	3.00	100.00	4.20

DISCHARGE IS IN GALLONS PER MINUTE, PH IS STANDARD UNITS. ALL OTHER PARAMETERS ARE IN MILLIGRAMS PER LITER

L = LESS THAN

TABLE 7-15 C

SUMMARY OF CHEMICAL CHARACTERISTICS OF SPRING WATERS FROM
THE VICINITY OF THE HUNTINGTON NO. 4 MINE PERMIT AREA

METALS

STATION	DATE	AS	B	CD	CR	CU	FE	PB	MN
				DATA FOR JUNE					
8 DAB S1	29/ 6/1982	0.0010L	0.2170	0.0050L	0.0500L	0.0200L	0.3900	0.0500L	0.0900
9 DBB S1	29/ 6/1982	0.0010L	0.1530	0.0050L	0.0500L	0.0200L	0.6300	0.0500L	0.1000
N SPAD 736	30/ 6/1982	0.0010L	0.1430	0.0050L	0.0500L	0.0200L	0.5300	0.0500L	0.0600
MC-4-10	30/ 6/1982	0.0010L	0.1260	0.0050L	0.0500L	0.0200L	0.0500	0.0500L	0.0600
				DATA FOR JULY					
8 DCB S1	1/ 7/1982	0.0010L	0.1380	0.0050L	0.0500L	0.0200L	0.5000	0.0500L	0.0900
8 DCB S2	1/ 7/1982	0.0010L	0.1270	0.0050L	0.0500L	0.0200L	0.4100	0.0500L	0.0600
9 CAC S1	1/ 7/1982	0.0010L	0.1640	0.0050L	0.0500L	0.0200L	0.4900	0.0500L	0.0900
6 DAC S1	12/ 7/1982	0.0010L	0.0940	0.0050L	0.0500L	0.0200L	0.3600	0.0500L	0.0700
7 BAD S1	12/ 7/1982	0.0010L	0.1160	0.0050L	0.0500L	0.0200L	0.4300	0.0500L	0.0600
8 BBC S1	12/ 7/1982	0.0010L	0.0970	0.0050L	0.0500L	0.0200L	0.4100	0.0500L	0.0600
4 CDC S1	13/ 7/1982	0.0010L	0.2820	0.0050L	0.0500L	0.0200L	0.5300	0.0500L	0.0900
8 BAB S1	14/ 7/1982	0.0010L	0.0680	0.0050L	0.0500L	0.0200L	0.0490	0.0500L	0.0600
17 CCB S1	19/ 7/1982	0.0003L	0.1380	0.0050L	0.0500L	0.0200L	0.1600	0.0010L	0.0900
				DATA FOR SEPTEMBER					
8 DAB S1	23/ 9/1982	0.0010L	0.2100	0.0050L	0.0500L	0.0200L	0.4100	0.0500L	0.0900
8 DCB S1	23/ 9/1982	0.0010L	0.1390	0.0050L	0.0500L	0.0200L	0.4300	0.0500L	0.0700
8 DCB S2	23/ 9/1982	0.0010L	0.1290	0.0050L	0.0500L	0.0200L	0.4300	0.0500L	0.0700
9 CAC S1	23/ 9/1982	0.0010L	0.1100	0.0050L	0.0500L	0.0200L	0.5500	0.0500L	0.0900
9 DBB S1	23/ 9/1982	0.0010L	0.1000	0.0050L	0.0500L	0.0200L	0.4800	0.0500L	0.0700
8 BAB S1	24/ 9/1982	0.0010L	0.0690	0.0050L	0.0500L	0.0200L	0.4300	0.0500L	0.0700
6 DAC S1	27/ 9/1982	0.0010L	0.0910	0.0050L	0.0500L	0.0200L	0.2700	0.0500L	0.0500
7 BAD S1	27/ 9/1982	0.0010L	0.1210	0.0050L	0.0500L	0.0200L	0.4500	0.0500L	0.0700
8 BBC S1	27/ 9/1982	0.0010L	0.0930	0.0050L	0.0500L	0.0200L	0.5000	0.0500L	0.0700

DISCHARGE IS IN GALLONS PER MINUTE, PH IS STANDARD UNITS. ALL OTHER PARAMETERS ARE IN MILLIGRAMS PER LITER

L = LESS THAN

TABLE 7-15 C (CONTINUED)

SUMMARY OF CHEMICAL CHARACTERISTICS OF SPRING WATERS FROM
THE VICINITY OF THE HUNTINGTON NO. 4 MINE PERMIT AREA

METALS

STATION	DATE	HG	NI	SE	ZN	AL	BA	MO
				DATA FOR JUNE				
8 DAB S1	29/ 6/1982	0.0002L	0.0400L	0.0003L	0.0930	0.0500L	0.0100L	0.1000L
9 DBB S1	29/ 6/1982	0.0002L	0.0400L	0.0004	0.1070	0.0500L	0.1000L	0.1000L
N SPAD 736	30/ 6/1982	0.0002L	0.0400L	0.0004	0.0730	0.0600	0.1000L	0.1000L
MC-4-10	30/ 6/1982	0.0002L	0.0400L	0.0003L	0.0790	0.0500L	0.1000L	0.1000L
				DATA FOR JULY				
8 DCB S1	1/ 7/1982	0.0002L	0.0400L	0.0004	0.1010	0.0500L	0.1000L	0.1000L
8 DCB S2	1/ 7/1982	0.0002L	0.0400L	0.0003L	0.0930	0.0500L	0.1000L	0.1000L
9 CAC S1	1/ 7/1982	0.0002L	0.0400L	0.0003L	0.0930	0.0500L	0.1000L	0.1000L
6 DAC S1	12/ 7/1982	0.0002L	0.0400L	0.0004	0.0960	0.0500L	0.1000L	0.1000L
7 BAD S1	12/ 7/1982	0.0002L	0.0400L	0.0006	0.1010	0.0500L	0.1000L	0.1000L
8 BBC S1	12/ 7/1982	0.0002L	0.0400L	0.0003L	0.0810	0.0500L	0.1000L	0.1000L
4 CDC S1	13/ 7/1982	0.0002L	0.0400L	0.0007	0.1160	0.0600L	0.1000L	0.1000L
8 BAB S1	14/ 7/1982	0.0003L	0.0400L	0.0004	0.0900	0.0500L	0.1000L	0.1000L
17 CCB S1	19/ 7/1982	0.0002L	0.0400L	0.0003L	0.0490	0.0600	0.1000L	0.1000L
				DATA FOR SEPTEMBER				
8 DAB S1	23/ 9/1982	0.0002L	0.0400L	0.0003L	0.1000	0.0500L	0.1000L	0.1000L
8 DCB S1	23/ 9/1982	0.0002L	0.0400L	0.0003	0.0990	0.0500L	0.1000L	0.1000L
8 DCB S2	23/ 9/1982	0.0002L	0.0400L	0.0003L	0.0950	0.0500L	0.1000L	0.1000L
9 CAC S1	23/ 9/1982	0.0002L	0.0400L	0.0005	0.1030	0.0500L	0.1000L	0.1000L
9 DBB S1	23/ 9/1982	0.0002L	0.0400L	0.0003L	0.0990	0.0500L	0.1000L	0.1000L
8 BAB S1	24/ 9/1982	0.0002L	0.0400L	0.0004	0.0810	0.0500L	0.1000L	0.1000L
6 DAC S1	27/ 9/1982	0.0002L	0.0400L	0.0005	0.0930	0.0500L	0.1000L	0.1000L
7 BAD S1	27/ 9/1982	0.0002L	0.0400L	0.0005	0.0960	0.0500L	0.1000L	0.1000L
8 BBC S1	27/ 9/1982	0.0002L	0.0400L	0.0004	0.0990	0.0500L	0.1000L	0.1000L

DISCHARGE IS IN GALLONS PER MINUTE, PH IS STANDARD UNITS. ALL OTHER PARAMETERS ARE IN MILLIGRAMS PER LITER

L = LESS THAN

7.2.3 Surface Water Development, Control and Diversions

this system by flooding is, however, very low because of the existing good watershed conditions in Mill Fork Canyon. The only depleted watershed units are located at the head of Mill Fork Canyon and thus peak flows are attenuated before they reach the mine vicinity. This stable condition is borne out by the good to excellent channel conditions in lower Mill Fork Creek. Furthermore, the wide range of slopes, aspects, and elevations also help attenuate peak discharges from rainfall and snowmelt events.

Attached is a certificate (see Appendix 4) of water rights purchased from Huntington - Cleveland Irrigation Company by Swisher Coal Company, predecessor of Beaver Creek Coal Company.

7.2.3.1 Sedimentation Pond and Diversion Construction and Maintenance Plans

The disturbed area of the No. 4 Mine is contained within a large, single drainage area which collects immediately below the lower facility yard and dumps into Mill Fork Creek (Plate 7-6). In order to minimize additional sediment loading to the stream from this disturbed area, a major portion of this drainage is diverted before it reaches the disturbed area. The runoff from the disturbed area is routed into sedimentation structures located in the canyon bottom above Mill Fork Creek.

An overall drainage of the area, including locations of the proposed structures, is shown in Plate 7-6. Listed below are specifications.

7.2.3.1 Sedimentation Pond and Diversion Construction and Maintenance Plans (continued)

Sedimentation Pond Specifications

Location: The dam locations are in the existing drainage directly below the coal stockpile loading area, (see Plate 7-6). This site offers the most effective sedimentation control with the least amount of environmental disturbance.

Design: In an effort to minimize environmental destruction, and still obtain adequate storage, we have built two smaller ponds in a series. The upper pond will function as a holding, settling facility for disturbed area runoff. The lower pond will filter, clean and discharge underground mine water as well as any overflow from the upper pond in the event of a storm exceeding the design. Mine water will pass into the upper pond and through a 12" culvert with inverted inlet into the lower pond. Here it will be filtered through a dike of coke breeze and slag and discharged to Mill Fork Creek as per the NPDES Permit.

Purpose: To comply with requirements of the Division of Oil, Gas & Mining for the control of sedimentation as listed under the Underground Mining General Performance Standards. The ponds are to

be constructed in a manner to facilitate the holding and settling of contaminated water from the mine site, as well as filtering and discharge or underground mine water. An overflow is to be provided in the event of a massive inflow of surface water exceeding the capacity of the ponds. The ponds will be cleaned as necessary and the waste material placed in an approved disposal site.

Construction: The construction of the ponds was per specifications of the State Engineer, U.S. Forest Service, Office of Surface Mining, and the Utah Division of Oil, Gas and Mining.

7.2.3.1 Sedimentation Pond and Diversion Construction and Maintenance Plans (continued)

The following construction specifications were followed:

a) In areas where any fill material was placed, the natural ground was removed for at least 12" below the base of the structure.

b) Compaction of all fill materials was at least 95%. Native material was used wherever practical. Fill was placed in lifts not exceeding 12", and was compacted prior to placement of the subsequent lift.

c) Rip-rap was placed on the water side of all outlets to prevent scouring. Inside slopes are 3:1 minimum.

d) Dams were constructed to overflow at least 1 foot below the top.

e) Overflows have a minimum depth of 1 foot and a minimum width of 3 feet. The are constructed (or lined) with at least 1 foot of rip-rap on all surfaces, and discharge into an energy dissipator to prevent scouring.

f) A filter dike, composed of coke breeze and slag, is provided in the lower pond as a final filter for water prior to discharge.

g) All construction of sedimentation ponds was performed under the direction of a qualified professional.

Capacity: The structure will have a capacity adequate to store the runoff and sediment load from a 10 year, 24 hour precipitation event, with an overflow capacity in excess of that for a 24 hour, 25 year event. The second or overflow pond will be utilized as a holding and filtering structure for the mine water discharge. The ponds shown on Plate 7-6 have a capacity of approximately 1.45 acre ft.

Safety

Precautions: The structure is regularly inspected by a licensed individual as required by law. The ponds are cleaned as necessary and any weakness or defects in the structure will be immediately corrected.

Monitoring: Two water monitoring stations have been established at the inlet and outlet of the ponds, (see water monitoring program for details).

7.2.3.1 Sedimentation Pond and Diversion Construction and Maintenance Plans (continued)

Maintenance: The sedimentation ponds are inspected after each storm and the sediment is cleaned out as necessary. In no case is sediment allowed to build beyond the point of reducing the pond capacity below 1.23 acre-ft. Sediment removed is disposed of in the C.V. Spur refuse pile or other location approved by the Utah Division of Oil, Gas & Mining.

In addition, alternative energy dissapators and erosion control devices upstream from the ponds are checked on a monthly basis with required maintenance performed at the same interval, or more often as needed.

Seeding: All feasible disturbed areas around the mine site will be reseeded with a seed mix recommended by the U.S. Forest Service for the area. Mulching will be used as necessary.

Calculations: The technique used to determine runoff volumes and peak flows for design of culverts, ditches and the sedimentation pond is the computer model SEDIMOT II. Disturbed areas were assigned a curve number of 90 and undisturbed forest lands were assigned a curve number of 75. The area draining to the sedimentation pond was divided into sub areas in order to properly determine storm

order to properly determine storm runoff and to provide peak flow estimates which demonstrate adequacy of existing ditches and culverts. Subdrainages as designated in Figure 7-7 are described in Table 7-16 including the parameters necessary to run SEDIMOT II.

Design rainfall of 2.3 inches for the 10 yr, 24 hr event was determined from the "Precipitation Frequency Atlas of the Western United States" (NOAA Atlas 2, Volume IV - Utah, 1973) for the location of the Huntington No. 4 mine. The corresponding rainfall depth for the 25 yr, 24 hr event was estimated to be 2.9 inches. The Fletcher - Farmer rainfall distribution was used to determine the rainfall distribution. Total runoff from the 10 yr, 24 hr rainfall is estimated as 1.23 acre-feet. An additional 0.18 acre-feet is regained to provide at least 1 year sediment storage for sediment yield from disturbed area as estimated below.

TABLES 7-16

Sediment Pond Drainage Characteristics

Subdrainage Designation	Area (acres)	Avg.Slope (%)	Basin Length ft.	Avg. Velocity ft/sec	Time of Concentration hrs	Curve Number
D-1	0.8	3.1	575	1.8	.084	90
D-2	0.25	1.8	220	1.4	.044	90
D-3	0.31	2.7	300	1.7	.044	90
D-4	0.44	1.2	485	1.1	.122	90
AD-1a	3.5	4.0	800	1.6	.14	76
AD-1b	0.6	6	370	2.5	.04	90
AD-2	5.1	60	400	1.9	.06	76
AD-3	3.3	50	800	1.7	.13	75
Lower Pad	3.5	20	760	4.4	.05	90
Total Drainage	**17.8**					

1) The individual areas were determined by planimeter measurements made on 1:2400 and 1:600 scale topographic base maps.
2) The average slopes were estimated from the same topographic base maps.
3) The basin lengths were measured from the same topographic base maps.
4) The average velocities were determined using the upland method, see Figure 7-8. Also see Example Problem 2.4 in "Applied Hydrology and Sedimentology for Disturbed Areas", Barfield, Warner, and Haan.
5) Time of concentration was calculated by dividing basin length by average velocity.

The Universal Soil Loss Equation (USLE) was used to estimate sediment yield from disturbed areas. Sediment yield was calculated by estimating the erosion rate from disturbed subdrainage areas. All erosion was assumed to be delivered to and deposited in the pond. Conservative assumptions were made to insure that more capacity is available than might be necessary to satisfy design standards. Erosion rate (A) in tons/acre per year is determined using the USLE as:

$$A = (R)(K)(LS)(C)(P)$$

The variables R, K, LS, C and P are defined as follows:

R is the rainfall factor which can be estimated from the empirical relation: $R=27P^{2.2}$ where P is the 2 year, 6 hour precipitate value which for the Huntington No. 4 Mine facilities area is 1.1 inches. Therefore, the estimated value for R is 33.3 which is somewhat larger than the value from an iso-erodent map provided by Wischmeyer (1977) for the approximate location of the facility.

K is the soil erodibility factor. The K value was conservatively estimated to be 0.5. This value is representative of compacted disturbed areas such as roads, embankments and parking areas and is higher than would be expected for reclaimed acres or undisturbed soils.

7.2.3.2 Sediment Control Structures and Devices (continued)

LS is the length slope factor. The LS factors determined for the subdrainage areas are listed in Table 7-17. The LS factor was determined using Figure 5.15 in Barfield et al (1981).

C is the cover factor. The C factor was conservatively estimated to be 1.0 which is suggested for a condition of zero ground cover.

P is the erosion control practice factor. P is conservatively estimated to be 1.0 which applies when no erosion control measures are applied.

Sediment Yield Calculations are developed in Table 7-17. A unit weight of 100 lb/ft^3 is used to convert sediment yield in weight per unit time to volume capacity requirements.

Table 7-17

USLE Estimates of Sediment Yield for
Huntington No. 4 Mine Facilities Area

Drainage	R	K	LS	C	P	A tons/acre per yr.	Area (Acres)	Yield acre-ft. per yr.
D-1	33.3	0.5	.48	1	1	8.0	.8	0.003
D-2	33.3	0.5	.25	1	1	4.2	.25	0.001
D-3	33.3	0.5	.36	1	1	6.0	.31	0.001
D-4	33.3	0.5	.22	1	1	3.7	.44	0.001
AD-1b	33.3	0.5	1.4	1	1	23.3	.6	0.006
Lower Pad(a)	33.3	0.5	9.0	1	1	149.8	2.0	0.138
Lower Pad(b)	33.3	0.5	1.9	1	1	31.6	1.5	0.022
Total								0.172

*Note: Does not include areas AD-1a, AD-2, and AD-3 as shown on Table 7-16 and Fig. 7-7. These are undisturbed area and are not considered as sources of sediment to the ponds.

Total sediment yield from disturbed areas is estimated to be 0.172 acre-feet per year.

The ponds have a capacity of 1.45 acre-feet sufficient to store the runoff from a 10 yr, 24 hr event of 1.23 acre-feet plus one year sediment loss of 0.17 acre-feet. Since the excess capacity is only 0.05 acre-feet, the pond will require annual maintenance to maintain sediment storage. Little excess capacity is available for both mine water and storm water. Therefore, Beaver Creek Coal Company has agreed not to discharge mine water during storm runoff events. Furthermore, during discharge of mine water the drain in the upper pond will be opened so that most of the capacity of the upper pond is available should storm runoff occur following discharge of mine water.

The spillway from both ponds are designed to safely pass the runoff from a 25-year, 24-hr precipitation event. Peak discharge from a 25-year, 24-hr precipitation event from the drainage to the ponds was determined using SEDIMOT II and the input parameters in Table 7-16. The peak discharge was determined to be 3.11 cfs.

7.2.3.2 Sediment Control Structures and Devices (continued)

A cross section and profile of upper and lower pad spillways is provided in Plate 7-6.

Design specifications are provided in Table 7-18. Velocities in both spillways exceed 5 ft/sec. and would be erosive. Medium rip-rap diameter of 15 inches is used to maintain stable spillways. Rip-rap of this size would have a manning's roughness coefficient of 0.04 and would provide adequate protection for velocities in excess of 10 ft/sec.

TABLE 7-18

Spillway Design Specifications

	Lower Pond	Upper Pond
Design Discharge (25 yr, 24 hr event) (ft^3/sec)	3.11	3.11
Manning's n	0.04	0.04
Design Slope	0.25	0.75
Bottom width (ft)	3.0	3.0
Side Slope	1.5:1	1.5:1
Normal Depth (ft)	0.18	0.14
Design Velocity	5.52	8.1

Diversion Structure Specification

General: All diversions existing prior to reclamation were temporary and have been removed. In November 1988, it was deemed necessary to install a new diversion along the middle pad highwall to prevent runnoff from eroding reclaimed areas below. This diversion (and other maintenance work) was addressed in a Field Amendment on 12/8/88, and subsequently approved by the Division on January 2, 1989. The following information addresses this diversion only:

Location: The new diversion structure is located at the base of the steep slope above the middle pad (haul road area); Diversion location is shown on Figure 3-8 of this M.R.P..

Design: The diversion is constructed to be permanent, and is sized for a 100 year - 24 hour event runoff from the drainage area. Loose-rock check dams have been installed along the diversion next to the steep slope, and the southern flowing portion has been partially rip-rapped. Controls have been placed at points of expected erosion potential; however, since calculations show potentially erosive velocities for most of the diversion, the area will be monitored and Beaver Creek Coal Company will commit to install additional erosion protection as required by the Division.

Purpose: The diversion is intended to reduce the amount of runoff from the steep, natural slopes that reaches the reclaimed slope below. This will allow for better establishment of vegetation on the slope and further reducing erosion potential.

Construction:

The construction of the diversion ditch was under the direction of a certified engineer.

Maintenance: The diversion and related structures will be maintained to perform thier primary functions (diversion of runoff and erosion control). Since the area is reclaimed, cleaning of structures will be performed only as necessary to maintain function. Additional erosion control will be installed if determined necessary by the division.

Calculations: Slopes in the diversion will vary from 10% to 30%. The following sheets will indicate the flow conditions calculated for the various slopes.

HUNTINGTON NO.4 MINE DIVERSION

PLANIMETER PROGRAM

Input Summary

For W.S.: Huntington 4

STORM	WATERSHED
Distribution = SCS Type 2	Land Slope = 40.00 Pct.
	Curve Number = 75
Precip. Depth = 3.60 in.	Channel Length = 2300 Ft.
	Time of Conc. = 0.1893 Hr
Duration = 24.00 Hr.	Area = 16.30 Ac.
Number of Lines = 966	D = 0.0252 Hr.

Output Summary

Runoff Depth = 1.3701 In.

Initial Abstraction = 0.6667 In.

Peak Flow = 21.98 CFS (1.3373 IPH)

At T = 12.55 Hrs.

Channel Flow Calculation

For: Huntington No. 4 Diversion

Bed Slope =	.1	
Manning's N =	.035	
Bottom Width =	4	feet
Channel Side Slope =	.5	
Flow Depth =	.5543329	feet
Cross Sectional Area =	2.831901	square feet
Wetted Perimeter =	6.479052	feet
Hydraulic Radius =	.4370858	feet
Discharge =	21.98	cubic feet/sec
Velocity =	7.761571	feet/sec

Channel Flow Calculation

For: Huntington No. 4 Diversion

Bed Slope =	.2	
Manning's N =	.035	
Bottom Width =	4	feet
Channel Side Slope =	.5	
Flow Depth =	.4549847	feet
Cross Sectional Area =	2.233961	square feet
Wetted Perimeter =	6.034754	feet
Hydraulic Radius =	.3701826	feet
Discharge =	21.98	cubic feet/sec
Velocity =	9.839026	feet/sec

Channel Flow Calculation

For: Huntington No. 4 Diversion

Bed Slope =	.3	
Manning's N =	.035	
Bottom Width =	4	feet
Channel Side Slope =	.5	
Flow Depth =	.4048863	feet
Cross Sectional Area =	1.947411	square feet
Wetted Perimeter =	5.810707	feet
Hydraulic Radius =	.3351419	feet
Discharge =	21.98	cubic feet/sec
Velocity =	11.28678	feet/sec

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Culverts

Drainage within the permit area is directed by diversions, open ditches, and culverts. Undisturbed drainage areas are routed around the mine site by temporary diversions. Road drainage flows through culverts located and designed by the U.S. Forest Service. Disturbed area drainage is directed to the sedimentation ponds, by various culverts and ditches. The design for these culverts is described in Table 7-19.

TABLE 7-19

HUNTINGTON #4 MINE

VERIFICATION OF CULVERT CAPACITY

Inlet control applies to all culverts. Headwater was determined using Figure 7-8 (from Design of Small Dams, U.S. Bureau of Reclamation).

Culvert Location (Disturbed Areas)	Diameter (in)	Peak Discharge[1] (cfs)	H/D	H (in)
Lower Parking (part of lower pad)	24"	0.73	0.5	12"
D-1	12.0	0.17	0.5	6.0
D-2	18.0	.052	0.5	9.0
D-3	12.0	.065	0.5	6.0
D-4	12.0	.09	0.5	6.0
Bath House (D-1, AD-1a, AD-1b)	12.0	0.55	0.6	7.2
Stockpile	36.0	0.34	0.5	18.0
Road below Ponds (entire disturbed area)	24.0	2.07	0.5	12.0

1) Peak discharge was determined using SEDIMOT II with input parameters described in Table 7-16 for a 10 yr, 24 hr rainfall event with a Fletcher-Farmer distribution.

Culvert Location (Disturbed Areas)	Diameter (in)	Peak Discharge[2] (cfs)	H/D	H (in)
Diversion A	24.0	2.53	0.5	12.0
UD-2	36.0	1.41	0.5	18.0

2) Peak discharge was determined using SCS TR-20 Computer Model.

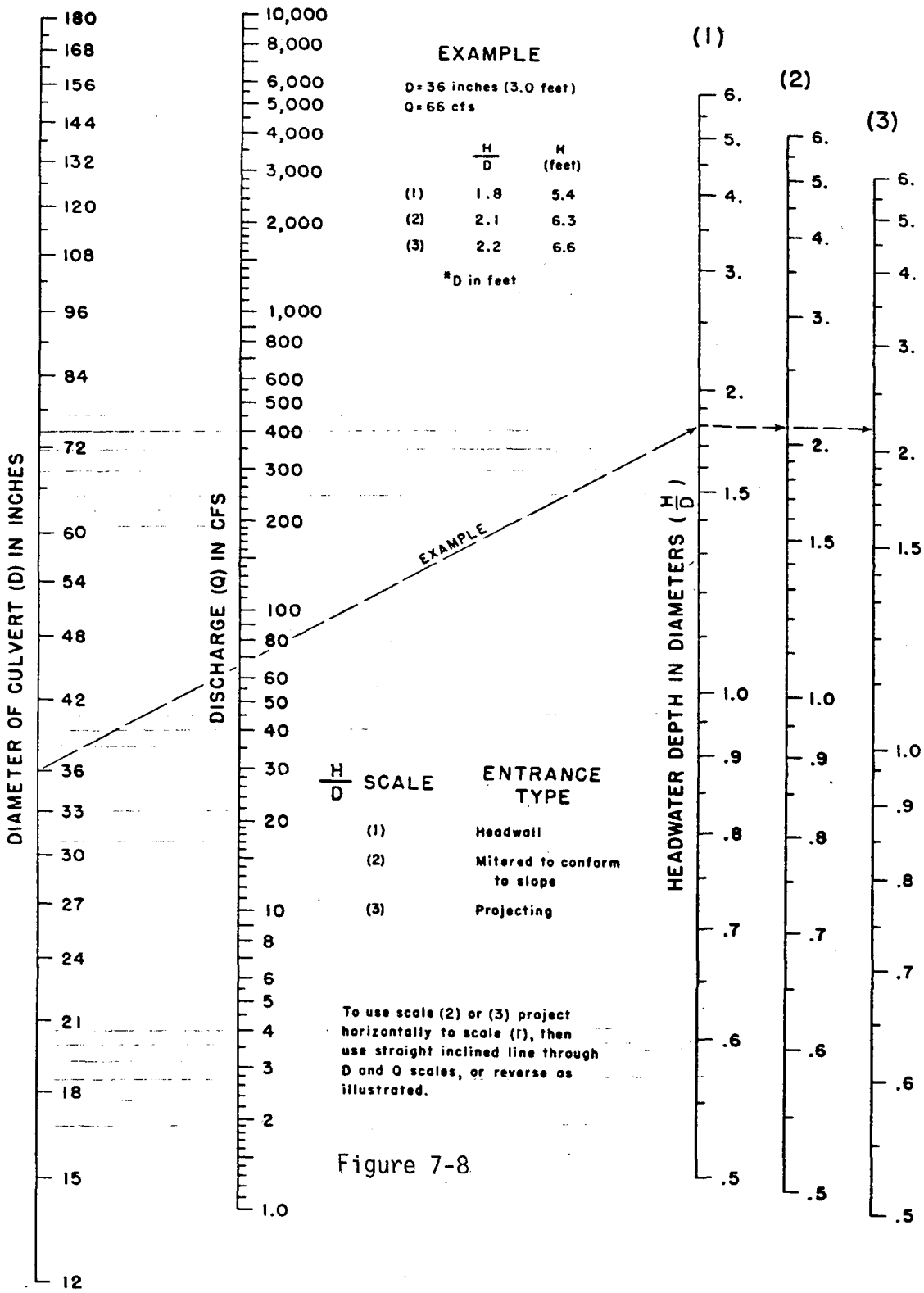


Figure 7-8

Figure 2 Headwater depth for corrugated-metal pipe culverts with entrance control. (U.S. Bureau of Public Roads.) 288–D–2909.

TABLE 7-20

HUNTINGTON #4 MINE

BASIN HYDROLOGIC CHARACTERISTICS
AND PEAK DISCHARGES

Area Name	Area (sq mi)	Average Slope (%)	Basin Length (ft)	Average Velocity (f/s)	Time of Conc. (hrs)	Peak Discharge (cfs)
UD-1A	0.061	60.0	2000.0	8.0	0.070	2.53
UD-1B	0.061	60.0	2000.0	8.0	0.070	2.53
UD-2	0.0407	60.0	2400.0	8.0	0.0833	1.41
D-1	0.00126	3.1	575.0	1.8	0.089	0.143
D-2	0.00039	1.8	220.0	1.4	0.044	0.045
D-3	0.00048	2.7	300.0	1.7	0.044	0.056
D-4	0.00068	1.2	485.0	1.1	0.122	0.076
D-5	0.00716	55.0	450.0	7.5	0.0167	0.853
Entire Dist. Area	0.00997	-	-	-	0.289	1.068

1) The individual areas were determined by planimeter measurements made on 1:2400 and 1:600 scale topographic base maps.
2) The average slopes were estimated from the same topographic base maps.
3) The basin lengths were measured from the same topographic base maps.
4) The average velocities were determined using the upland method, see Figure 1. Also see Example Problem 2.4 in "Applied Hydrology and Sedimentology for Disturbed Areas", Barfield, Warner,and Haan.
5) Time of concentration was calculated by dividing basin length by average velocity.
6) Time of concentration for the entire disturbed area was found by adding the Tc for D-5 with the longest Tc of the basins on the bench above. This happened to be for basin D-4.
7) Peak Discharge was computed by the SCS TR-20 computer model. Curve numbers of 75 and 90 were assumed for the undisturbed and disturbed areas respectively.
8) Peak Discharges are based on a 10-yr, 24-hr precipitation of 2.1".

TABLE 7-21

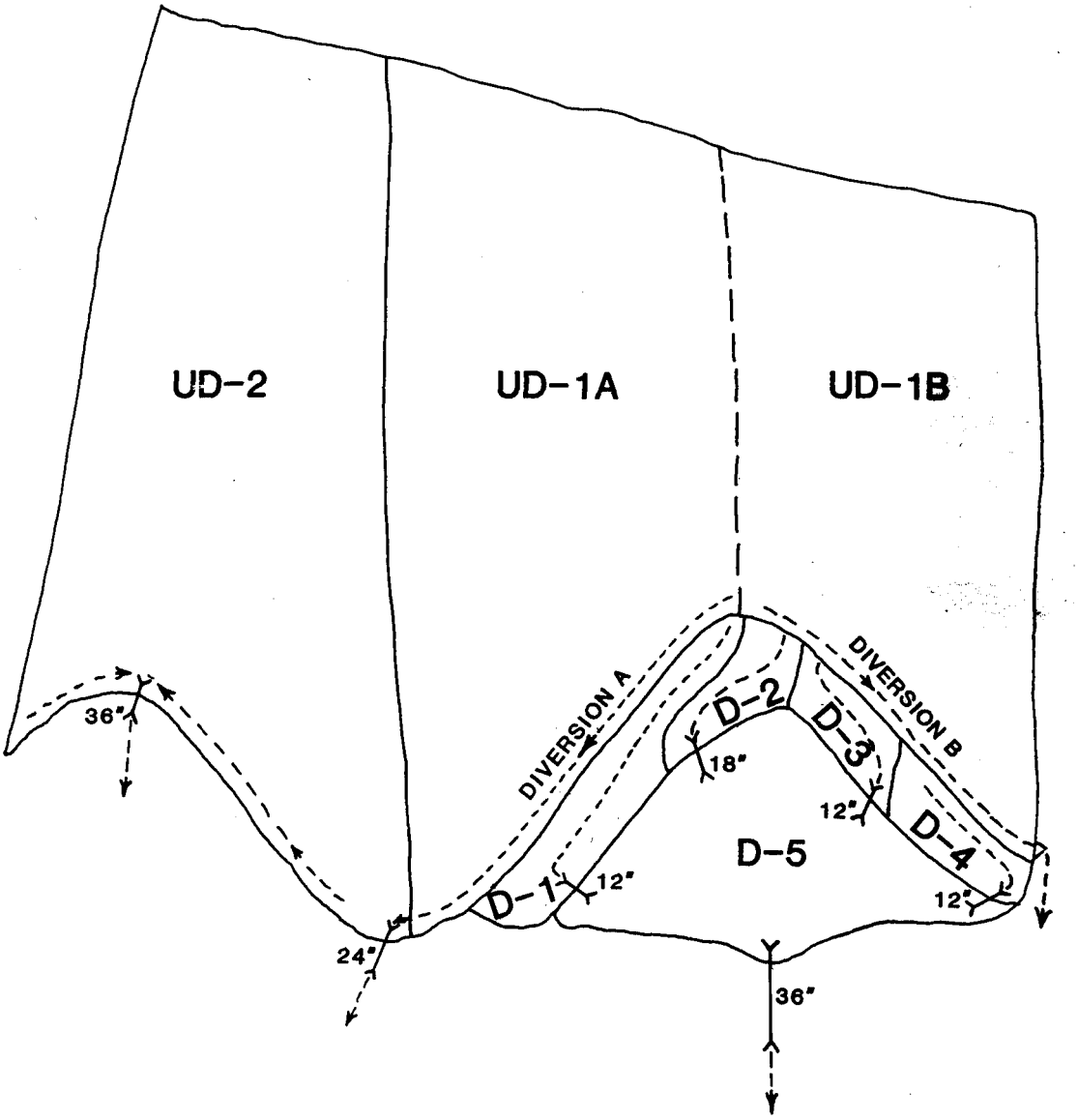
HUNTINGTON #4 MINE

VERIFICATION OF CULVERT CAPACITY

Inlet control applies to all culverts. Headwater was determined from Figure 2 (from Design of Small Dams, U.S. Bureau of Reclamation).

Culvert Location	Diameter (in)	Peak Discharge (cfs)	H/D	H (in)
Diversion A	24.0	2.53	< 0.5	< 12.0
UD-2	36.0	1.41	< 0.5	< 18.0
D-1	12.0	0.143	< 0.5	< 6.0
D-2	18.0	0.045	< 0.5	< 9.0
D-3	12.0	0.056	< 0.5	< 6.0
D-4	12.0	0.076	< 0.5	< 6.0
Stockpile	36.0	1.068	< 0.5	< 18.0

1) Peak discharge was determined with SCS TR-20 computer model.



SKETCH OF MINE PLAN AREA

1) THE ENTIRE DISTURBED AREA CONSISTS OF D-1, D-2, D-3, D-4, AND D-5

- - - - - - → INDICATES DIVERSION OR WATER CHANNEL

>——< INDICATES CULVERT

7.2.4 Effects of Mining of Surface Water

Mining operations at the No. 4 Mine are expected to have very little effect on surface water courses, springs, or seeps near the permit boundary. Mill Fork Creek, Little Bear Creek, and their tributaries are all outside of the No. 4 Mine permit boundary. Therefore, no perennial streams exist over areas mined or to be mined.

Mill Fork Creek does, however, lie down gradient from surface disturbance created by underground mining operations. Diversions and sediment ponds have been designed to control runoff from the disturbed area. A buffer area has been established between the access road and Mill Fork Creek in the vicinity of the sedimentation ponds. All road maintenance is directed away, to the north, of Mill Fork to eliminate sediment loading of the stream.

7.2.4 Effects of Mining on Surface Water

The surface water hydrology of the Huntington No. 4 Mine site is not expected to change significantly after final reclamation. The effects of erosion will be mitigated by backfilling, recontouring, slope and soil stabilization and erosion control measures.

As discussed under Effects of Mining Operation on Groundwater, the Huntington No. 4 Mine has very little potential to affect flow from Little Bear Spring. The water in the Star Point Sandstone is the source of Little Bear Spring which is well below the mine (stratigraphically).

The only seeps that have a potential to be impacted by mine subsidence are the seeps that originate from the Castle Gate and Blackhawk formations near the head waters of Little Bear Creek and above the mine in Mill Fork Canyon. Should subsidence effects develop which affect those seeps, it should not substantially change the water balance of the basins. Fractures may expand this recharge area for seeps found at lower elevations. Discharge from these lower elevations may increase at the expense of discharge from seeps found at higher elevations.

7.2.5 Mitigation and Control Plans

Beaver Creek Coal Company will continue to maintain adequate sedimentation control structures and diversions throughout the life of mining operations at No. 4 Mine. Every effort will be made to stabilize disturbed and revegetated areas that may cause sedimentation of Mill Fork Creek. In addition, the Buffer Zone along Mill Fork Creek will be maintained so that no additional surface disturbance occurs within 100 feet of the stream.

7.2.5 Mitigation and Control Plans (continued)

In general, due to the nature of underground mining activities at No. 4 Mine, it is highly unlikely that the quality or quantity of water will be affected. An ongoing water monitoring program has been established to document any changes in water characteristics so that additional control measures can be implemented within the mining operation if necessary.

In the event that effluent limitations are not met, one or more of the following measures shall be implemented within 90 days of such observation: (1) The ponds will be cleaned; (2) the filter dike will be replaced; (3) additional sediment control measures will be added upstream from the sediment pond (additional straw bale dikes, silt fences, underground settling basins); (4) mine water discharge will be piped directly to ponds, eliminating overland flow; (5) chemical treatment of influent to promote cleaning; (6) enlargement of ponds.

Prior to initiating such mitigation measures, Beaver Creek Coal Company will confer with the regulatory authority for approval.

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7.2.6 Surface Water Monitoring Plans
Stations

There are 4 surface and spring monitoring points located in the area of the Huntington No. 4 Mine. The stations will be monitored according to the specifications described in this section.

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Springs and Seeps

The only spring monitored in the past at this mine was the Little Bear Spring ;(formerly Station 4-1-W). The spring is now totally captured by the Castle Valley Special Service District and used for culinary water supply. The Service District monitors the spring flow and quality as needed, and controls access to the water by a locked box. Since the spring is adequately monitored by this agency, and data is available upon request, Mountain Coal Company has eliminated this station from its monitoring program.

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7.2.6 Surface Water Monitoring Plans

Upper Mill Fork (Station 4-3-W)

This site is monitored at the upper end of the Forest Service Road in Mill Fork Canyon. The sediment sampler, staff gage and crest gage were previously removed at the request of the Forest Service. Flow is measured by a portable flume. Monitoring will be done on a quarterly basis until Phase II Bond Release, and then on a bi-annual (2 per annum) basis until final Bond Release.

Inflow to Reclaimed Pond Area (Station 4-6-W)

This station will be monitored on a bi-annual basis and will reflect surface runoff from the site into the reclaimed sediment pond area. It is located at the previous sediment pond inlet. The station will continue to be monitored on a bi annual basis until Final Bond Release.

Out flow from Reclaimed Pond Area (Station 4-7-W)

This station is located at the previous sediment pond outlet. The station will be monitored bi-annually until Final Bond Release, to access the effectiveness of the pond area reclamation.

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Lower Mill Fork (Station 4-8-W)

This station formerly included a 2 foot width by 1.5 foot depth Parshall flume. It is located at the lower end of the Mill Fork Canyon, on U.S. Forest Service property, and is covered by a Special Use Permit with the U.S. Forest Service.

Discussion with the U.S. Forest Service have indicated no further need for the Parshall Flume at this location: therefore, upon approval from the Division and U.S.F.S., Mountain Coal Company has removed the flume and all other associated material and cleaned up the area. Also, when approved by the U.S.F.S., the Special Use Permit for this site will be canceled.

The station will continue to be monitored, with flow measured by a portable flume. Monitoring will be on a bi-annual (2 per annum) basis until final bond release.

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7.2.6 Surface Water Monitoring Plans

Water Quality and NPDES Discharges

Water quality samples are collected at designated sites on Upper Mill Fork (4-3-W) and on Lower Mill Fork (4-8-W).

Water quality samples were also collected from the in-flow to the sediment pond 4-7-W. The sediment ponds removed; however, the 2 sites will continue to monitored bi annually to assess the pond area reclamation.

A description of the Surface Water Monitoring Program is provided in Figure 7-10. Locations are shown on Plate 7-3.

Location 4-7-W was a UPDES discharge point. The UPDES Discharge Permit was canceled effective August 30, 1995.

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FIGURE 7-10

STREAMFLOW AND WATER QUALITY MONITORING PROGRAM

HUNTINGTON CANYON NO. 4 MINE

STATION:	4-3-W	4-6-W	4-7-W	4-8-W
LOCATION:	Upper Mill Fork	Inflow to reclaimed pond area.	Outflow from reclaimed pond area.	Lower Mill Fork.
TYPE:	Intermittent Stream.	Surface Runoff.	Surface Runoff.	Intermittent Stream.
FREQUENCY:	Bi-Annual	Bi-Annual	Bi-Annual	Bi-Annual
FLOW DEVICE:	Portable Flume.	Portable Flume.	Portable Flume.	Portable Flume.
RESULTS TO:	DOGM	DOGM	DOGM	DOGM

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7.2.6 Surface Water Monitoring Plans (Continued)

The stations will be monitored for the parameters and reported in the form as shown on Figure 7-11, "Mountain Coal Company Water Monitoring Report".

Sampling Devices

Streamflows are determined from flume measurements or a portable flume. Flow measurements are determined using a volume/time or portable flume measurement at Stations 4-6-W and 4-7-W.

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FIGURE 7-11
Mountain Coal Company Water Monitoring Report

Property: _____
Date Sampled: _____ Date Analyzed: _____
Station: _____
Location: _____
Type: _____
Frequency: _____

Field Measurements:

Water Level or Flow: _____
PH : _____
Specific Conductivity: _____
Dissolved Oxygen: _____
(Perennial streams only)

Laboratory Measurements (mg/1):

* *	Total Settleable Solids	:
	Total Suspended Solids	:
	Total Dissolved Solids	:
	Total Hardness (as $CACO_3$)	:
	Acidity ($CaCO_3$)	:
	*Carbonate (CO_3^{-2})	:
	*Bicarbonate $(HC)_3^{-1}$)	:
	*Calicum (Ca)	:
	Chloride (Cl^-)	:
	Iron (Fe)	:
	*Magnesium (Mg)	:
	*Total Manganese (Mn)	:
	*Potassium (K)	:
	*Sodium (Na)	:
	*Sulfate (SO_4^{-2})	:
	* * Oil & Grease	:
	Cation - Anion Balance	:

* Dissolved Form
** UPDES Samples Only

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7.2.6 Surface Water Monitoring Plans
Sampling Devices (continued)

Water temperature is determined with a thermometer in the field; pH and specific conductance are determined in the field with the appropriate meters.

The samples for T.D.S., and T.S.S., Iron, Manganese, Nitrate, Sulfate, and Chloride is collected in a clean, water-tight container of adequate volume (approximately 1 gallon) to allow for testing for all parameters needed.

If other parameters are needed at some point in time, the sampling devices used will be those recommended for those particular type samples. Recommendations can be obtained from various State water quality experts or consulting firms if needed.

Sampling Methods

Only a qualified individual performs the water sampling. The individual familiar with the operation of all devices, such as flumes, pH meters, thermometers, specific conductance meters, and with all sampling methods and containers for the various tests.

Sampling is conducted on a regular schedule, and in a consistent manner as nearly as possible. Access to certain sample points is impractical at times, mandating occasional deviation from the schedule. All points are checked when possible, and a report is submitted even when dry or inaccessible.

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7.2.6 Surface Water Monitoring Plans

Analysis Methods

All water analysis are performed by a qualified laboratory using standard methods for analyses. Whenever possible, temperature, pH, and specific conductance will be performed in the field by environmental personnel for more precise data collection. Those parameters that cannot be tested in field are run by a certified, reputable, commercial lab. Check samples on our laboratory are sent out periodically to a commercial firm.

Reports

Reports are submitted to DOGM within sixty (60) days of the end of each quarter. These reports include: station number, type, location, date of collection, and all data required for the parameters checked.

All support data, and a complete copy of all monitoring results are kept on file at the Mountain Coal Company office.

General

It should be noted that the above described sampling program does not include the UPDES sampling program for location 4-7-W. The UPDES station is sampled according to the requirements in the UPDES permit and results are sent to the EPA and State of Utah as required. A copy of each report is kept in file in the Mountain Coal Company office. A description of the streamflow and quality monitoring program is summarized in Figure 7-10. Locations of monitoring stations are shown on Plate 7-3.

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7.3 Alluvial Valley Floors

A reconnaissance investigation for Alluvial Valley Floor (AVF) assessment was performed in accordance with State and OSM Regulations. On the bases of these regulations, the first consideration in the AVF investigation is the identification of unconsolidated stream-laid deposits (alluvial deposits). Furthermore, these deposits should be located within the valley floor and should not include isolated high terraces, alluvial fans, or landslide deposits. Once alluvial valley floor deposits are identified, the capability to support flood irrigated or sub-irrigated agricultural activities must be assessed. Identification of locations where unconsolidated stream-laid deposits occur was performed using a surficial geology map of the area shown in Plate 6-1. Furthermore, an analysis of areal photographs of the mine permit site and adjacent areas was conducted in order to identify possible alluvial deposits that were not included in the surficial geology map. A break in valley side slopes producing an identifiable valley floor served as the primary criteria for selecting these possible alluvial deposits.

From a geomorphic standpoint, the rugged mountainous terrain of the mine permit site has resulted in drainages still in a youthful stage of development. The streams are confined in narrow, steep-sided, v-shaped valleys with generally steep channel gradients. Meanders and terraces normally associated with AVF development are absent. Neither the Mill Fork, Little Bear, or Crandall Creeks possess identifiable valley floors typical of an alluvial valley floor. The soils along these channels are thin and unproductive and rock outcrops are common. The valleys are too steep and narrow along their entire reach to support agricultural development.

7.3 Alluvial Valley Floors (continued)

Any potential alluvial valley floors along Huntington Creek are outside the adjacent area. The alluvial aquifer and streamflow regime of Huntington Creek would not be significantly impacted by possible changes in the hydrology of the Huntington Canyon mine site.

7.4 References

Danielson, W. T., et al, 1981, "Hydrology of the Coal-Resource Areas in the Upper Drainages of Huntington and Cottonwood Creeks," U.S. Geological Survey W.R.I., Open-File Report, 81-539.

Edmond, Spieker, "Geologic Map and Sections of the Southern Part of the Wasatch Plateau Coal Field," Utah U.S. Geological Survey, Bull. 819, Plate 31.

Price, D. and Arrow, T., 1974, "Summary Appraisal of the Nation's Groundwater Resources - Upper Colorado Region," U.S. Geological Survey, Professional Paper 813-C, p. 40.

Price, D. and Wadell, K. M., 1973, "Selected Hydrologic Data in the Upper Colorado River Basin, U.S. Geological Survey, Hydrologic Investigations Atlas HA-77.

Vaughn Hansen and Assoc., 1977, "Water Quality and Hydrologic Study in the Vicinity of Huntington Creek Mine No. 4 and Little Bear Spring, Consultants Report to Swisher Coal Company.

Section 8

SOIL RESOURCES

8.1 Scope

A soil survey of the Huntington Canyon No. 4 Mine was conducted in July 1980 to provide soil resource information to meet the requirements of the Utah Division of Oil, Gas & Mining and the Office of Surface Mining. This soil survey was performed by James P. Walsh & Associates based on a contract with Beaver Creek Coal Company. Additional information was collected on the Disturbed Land designated areas in 1982 as part of a request by DOGM.

8.2 Methodology

The mine site area has not been mapped by the USDA Soil Conservation Service (SCS). Plate 8-1, Soil Inventory of Huntington Canyon No. 4 Mine area was made by James P. Walsh & Associates in July 1980. Map scale of Plate 8-1 is 1"-500' (1:6,000). At the time of mapping, a large part of the area was mapped as Disturbed Land.

Map unit descriptions are site specific. Three map units are mapped and described.

Soil series descriptions are adapted from the SCS to be site specific. Detailed pedon descriptions are presented for the three major soil series at the site. Pedons were described in fresh road cuts to 60 inches or to bedrock, whichever was shallowest.

The three major soil series were sampled in 1980 at the site. Samples were analyzed by Colorado Agricultural Consultants of Brighton, Colorado. Parameters tested were pH, electrical con-

8.2 Methodology (continued)

ductivity, saturation percent, soluble calcium, magnesium and sodium, available potassium, texture class from percent sand, silt, clay and very fine sand, organic matter percent, phosphorus, lime, boron, ammonia-nitrogen, and nitrate-nitrogen.

Additional samples were collected in July 1982 on Disturbed Land designated areas. These samples were collected to at least 30 cm and analyzed for all the parameters tested in 1980, with the exception of boron, organic matter, ammonia-nitrogen, and very fine sand. Analyses of the 1982 samples were conducted by Bookcliffs Commercial Laboratories in Steamboat Springs, Colorado.

Present and potential uses of the soils of the site have been evaluated based on SCS Soil Survey Interpretation information. The soils have no potential as cropland or pasture land. The soils have not been evaluated by the SCS for their potential production as rangeland but their capability groups are given.

The soils are evaluated as seedbed quality material for drastically disturbed land. The evaluation method used is that of the SCS. Each horizon of each pedon is rated for seedbed quality material based on the field description and the analytical data. Recommended use for each soil is given.

Soil names given in this report are tentative. The soils in this report are named for similar soils that are presently being mapped by the SCS in the area. In some cases, the described pedons are outside of the accepted range of characteristics for the series; those differences are noted in the text.

8.2 Methodology (continued)

The soils in this report have not been correlated by the SCS. Classifications are based on morphology as described in the field, and to a lesser degree on the analytical data. Where analytical data do not support the field descriptions, the soils are classified according to the field descriptions.

8.3 Soil Resource Information for the Mine Plan Area

8.3.1 Soils Identification

The soils at the Huntington Canyon No. 4 Mine were initially examined with stereoscopic aerial photographs provided by Beaver Creek Coal Company. This allowed the consultant to predetermine slopes, land forms, and vegetative patterns. Soils were then examined in the field (see Section 8.2 Methodology). The soil descriptions were compared with recorded characteristics of the soils in adjacent counties and in the official Soil Conservation Service (SCS) series descriptions. To make them site specific, map units are comprised of soil series and inclusions found within an area.

8.3.2 Soil Series Descriptions

Disturbed Land Fill Material

The disturbed land fill material consists of deep, rapidly permeable, well-drained materials. These materials are primarily fill derived from sandstone and shale. Annual precipitation is 12 to 20 inches. The mean annual soil temperature ranges from 38° to 45°F, and the frost free period is 60 to 120 days. The native vegetation has been removed.

8.3.2 Soil Series Descriptions (continued)

Disturbed Land Fill Material (continued)

The available water capacity is low, and permeability is moderate. These materials are used for fill slopes, facility areas, and roadbeds. A representative sample of fill material, 100 feet north and 100 feet east of the southwest corner of Section 16, T16S, R7E is:

> pale brown (10YR 6/3) gravelly loamy sand, brown (10YR 5/3) moist; massive, loose, nonsticky and non-plastic, calcareous, 30 percent gravels, 2 percent cobbles, 5 percent stones, 5 percent boulders.

Patmos Series

The Patmos series consists of moderately deep, moderately permeable, well-drained soils. These soils formed in colluvium derived from sandstone and shale. Annual precipitation is 12 to 20 inches. The mean annual air temperature ranges from 38° to 45°F, and the frost free period is 60 to 120 days. The native vegetation is Salina wildrye, low gray sage, and winterfat.

The available water capacity to a depth of 21 inches is about 2 to 4 inches, and permeability is moderate. These soils are used for watershed, and wildlife habitat.

The Patmos series is a member of the loamy-skeletal mixed (calcareous) frigid family of Typic Ustorthents. A representative profile of Patmos gravelly loam, strongly sloping, 1500 feet west and 700 feet north of the southeast corner of Section 16, T16S, R7E is:

8.3.2 Soil Series Descriptions (continued)

Patmos Series (continued)

02 0 to 3 inches; partially decomposed wood twig and leaf fragments.

A1 0 to 6 inches; brown (10YR 5/3) gravelly loam, brown-dark brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; calcareous; 25 percent gravels, 5 percent boulders; common fine roots; clear smooth boundary.

C1 6 to 26 inches; yellowish brown (10YR 5/4) gravelly loam; brown-dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; calcareous; 30 percent gravels, 5 percent cobbles, 2 percent stones and 2 percent boulders; common fine roots; band darkened by organic material from 6 to 9 inches; clear wavy boundary.

C2 26 to 38 inches; light yellowish brown (10YR 6/4) very cobbly loamy sand; single grain; loose, non-sticky and non-plastic, calcareous, 15 percent gravels, 15 percent cobbles, 5 percent stones and 2 percent boulders, abrupt smooth boundary.

R 38+ inches; weathered sandstone, shale and coal.

8.3.2 Soil Series Descriptions (continued)

Podo Series

The Podo series consists of shallow, somewhat excessively-drained soils. These soils formed in colluvium. Annual precipitation is 16 to 30 inches. The mean annual air temperature is less than 42°, and the frost free period is less than 60 days. The native vegetation is Salina wildrye and juniper.

The available water capacity to a depth of 11 inches is less than 2 inches, and permeability is moderately rapid. These soils are used for wildlife habitat and watershed.

The Podo series is a member of the loamy mixed (calcareous), frigid family of Lithic Ustorthents. A representative profile of Podo gravelly sandy loam, 900 feet west and 500 feet north of the southeast corner of Section 16, T16S, R7E is:

A1 0 to 2 inches; light brown (7.5YR 6/4) gravelly sandy loam, brown-dark brown (10YR 4/4) moist; weak thin platy structure; soft, very friable; non-sticky and non-plastic, calcareous, 20 percent gravels, 5 percent cobbles, 5 percent stones (not sampled separately).

C1 3 to 13 inches; light brown (7.5YR 6/4) gravelly sandy loam, brown (10YR 5/4) moist; single grain structure, loose, non-sticky and non-plastic calcareous, 15 percent gravels, 10 percent cobbles, 5 percent stone, some minor lime accumulations from 11 to 13 inches; fine earth material similar to C1 fills cracks in bedrock; abrupt wavy boundary.

R 13+ inches; weathered sandstone.

8.3.2 Soil Series Descriptions (continued)

Quigley Series

The Quigley series consists of deep, moderately permeable, well-drained soils. These soils formed in colluvium and alluvium derived from sandstone and shale. Annual precipitation is 13 to 16 inches. The mean annual soil temperature ranges from 40° to 45°F. The native vegetation is big sage, rabbitbrush, and lodgepole pine.

The available water capacity is greater than 0.1 in/in, and permeability is moderate. These soils are used for wildlife habitat, watershed and recreation.

The Quigley series is a member of the coarse-loamy mixed family of Typic Haploborolls. A representative profile of Quigley sandy loam, 400 feet west and 100 feet north of the southeast corner of Section 17, T16S, R7E is:

A1 0 to 7 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; slightly hard, very friable, slightly sticky and slightly plastic, calcareous, 10 percent fine gravels; few fine and medium roots, clear smooth boundary.

C1 7 to 20 inches; brown (10YR 5/3) sandy loam, brown-dark brown (10YR 4/3) moist; moderate coarse subangular blocky, slightly hard, very friable, slightly sticky and slightly plastic, calcareous, 10 percent fine gravels of varicolored sandstone, few fine roots; diffuse boundary.

8.3.2 Soil Series Descriptions (continued)

Quigley Series (continued)

C2ca 20 to 38 inches; brown (10YR 5/3) sandy loam, brown-dark brown (10YR 4/3) moist; weak medium subangular blocky, structure, slightly hard, very friable, slightly sticky and slightly plastic, calcareous, 15 percent fine gravels, 10 percent cobbles, 2 percent stones, few fine roots; few very fine filamentous lime threads, clear boundary.

C3ca 38 to 43+ inches; pale brown (10YR 6/3) gravelly loamy sand, dark yellowish brown (10YR 4/4) moist; loose, slightly hard, very friable; non-sticky and non-plastic; calcareous, gravels have thick undercoating of lime, 30 percent gravel, 10 percent cobblestones and boulders.

8.3.3 Map Unit Descriptions

Map Unit: DL - Disturbed Land

This map unit is on mountain sideslopes and valley bottoms. The slope is variable. The native vegetation has been removed.

This unit is about 90 percent fill material. Included in this map unit are: 1) about 10 percent small areas of Patmos and Podo soils; 2) rock outcrops; 3) road cuts; and 4) places where a thin layer of coal waste, fill or other disturbed materials overlie other soils.

The fill material is deep and well-drained. It is fill derived from sandstone and shale. Typically, it is a pale brown gravelly loam sand.

8.3.3 Map Unit Descriptions (continued)

Map Unit DL: Disturbed Land (continued)

Permeability of the fill material is moderate. Available water capacity is low. Runoff is rapid and the erosion hazard for water is high.

This map unit is in capability unit VII E and is mainly used for mining activities.

Map Unit: PpE - Patmos-Podo Association, 60 to 90 Percent Slopes

This map unit is on steep mountain sideslopes. The slope is 60 to 90 percent. The native vegetation is mainly Salina wildrye and juniper.

This unit is 50 percent Patmos gravelly loam, and 25 percent Podo gravelly sandy loam. The Patmos soil is on the mountain sideslopes, and the Podo soil is on the ridge crests and ledges above rock outcrops. Included in this map unit is about 10 percent rock outcrops, and 15 percent other soils. Included areas make up about 25 percent of the total acreage. The Patmos soil is moderately deep and well-drained. It is formed in colluvium derived from sandstone and shale.

Typically, the surface layer is a brown gravelly loam about 6 inches thick. The subsoil is a yellowish brown gravelly loam about 20 inches thick. The substratum to a depth of 38 inches is a light yellowish brown very cobbly loamy sand. Weathered sandstone bedrock is at a depth of 20 to 40 inches.

8.3.3 Map Unit Descriptions (continued)

Map Unit: PpE - Patmos-Podo Association, 60 to 90 Percent Slopes (continued)

Permeability of the Patmos soil is moderate. Available water capacity is moderate. Effective rooting depth is 40 inches. Runoff is rapid and the erosion hazard for water is high. Wind erosion hazard is slight.

The Podo soil is shallow and somewhat excessively-drained. It is formed in colluvium derived from sandstone and shale.

Typically, the surface layer is a light brown gravelly sandy loam, about 2 inches thick. The subsoil is light brown gravelly sandy loam about 11 inches thick. The substratum to a depth of 20 inches is a light brown gravelly sandy loam. Weathered sandstone bedrock is at a depth of less than 20 inches.

Permeability of the Podo soil is moderately rapid. Available water holding capacity is low. Effective rooting depth is less than 20 inches. Runoff is rapid and the erosion hazard for water is high. Wind erosion hazard is slight.

The unit is mainly used for watershed and wildlife habitat. It is also used for mining activities. This map unit is in capability unit VII E, not evaluated for range site.

The present plant community is mainly Salina wildrye and juniper. The potential productivity data is not available.

This map unit is on alluvial fans, toeslopes and valley bottoms. The slope is 5 to 25 percent. The native vegetation is mainly a sagebrush-grassland community.

8.3.3 Map Unit Descriptions (continued)

Map Unit: PpE - Patmos-Podo Association, 60 to 90 Percent Slopes (continued)

This unit is 75 percent Quigley sandy loam, and 25 percent other soils. The Quigley sandy loam soil is on the fans and toeslopes. Included in this map unit is about 20 percent other soils. Stratified alluvial soils occur on the valley bottom along the stream. Also included are soils similar to Quigley but in skeletal families (loamy-skeletal mixed Typic Haploborolls). A few bouldery areas occur on the alluvial fans. Included areas make up about 25 percent of the total acreage.

The Quigley soil is deep and well-drained. It is formed in alluvium and colluvium derived from sandstone and shale.

Typically, the surface layer is a brown sandy loam about 7 inches thick. The subsoil is a brown sandy loam about 31 inches thick. Runoff is moderately low and the erosion hazard for water is moderate. Wind erosion hazard is slight.

The unit is mainly used for watershed, wildlife habitat and recreation. It is also used for mining activities. This map unit is in capability unit VIe, not evaluated for range site.

The present plant community is mainly big sagebrush, rabbitbrush, lodgepole pine, Oregon grape, and yarrow. The potential productiicity data is not available.

8.3.3 Map Unit Descriptions (continued)

Map Unit: RL - Rockland

This map unit is on mountain sideslopes. The slope is 60 percent to vertical. The native vegetation is mainly scattered Salina wildrye and juniper.

This unit is 90 percent rock outcrop, talus, and very shallow soils over sandstone bedrock. Included in this map unit is about 10 percent Podo soils.

This unit is mainly used for wildlife habitat and watershed. This map is in capability unit VIII s.

8.3.4 Present and Potential Productivity

Crops and Pasturelands

None of the soils mapped at the site have potential for crops or pastureland.

The U.S. Department of Agriculture has the authority to identify farmlands of national, state, or local importance. These farmlands are referred to as prime farmlands, farmlands of statewide importance, and unique farmlands. The SCS has determined that there are no prime farmlands of statewide importance, or unique farmlands within the permit area.

8.3.4 Present and Potential Productivity (continued)

Rangelands

The soils within the lease boundary have been used as rangeland in the past. Predicted forage production for rangeland soils during favorable,

normal, and unfavorable years for various sites are not available for the soils. Capability classes for the rangeland soils (Table 8-1) are VII and VIII. The principal limitation is erosion. Capability units show, in a general way, the ability of soils to support cultivated crops. Soils in Class VII have very severe limitations that make them unsuited to grazing, and woodland or wildlife. Soils in Class VIII have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife or water supply or to aesthetic purposes.

8.4 Prime Farmland Investigation and Determination

In July 1980, Beaver Creek Coal Company requested that SCS personnel in Price, Utah review all the soils present within the Huntington Canyon No. 4 Mine coal property boundary to determine if any qualified as Prime Farmland. At that time, the SCS made a field reconnaissance to confirm soil types. The field information was then checked against a state listing of prime farmland soils. At this time the State Soil Scientist determined that there are no prime farmlands on Huntington Canyon No. 4 Mine property.

Table 8-1

ESTIMATED POTENTIAL PRODUCTION - FORAGE

Soil Series	Potential Production Favorable/Normal/ Unfavorable Years (lbs/ac)	Sites	Soil Capability Class
Patmos	NA	50-70% slopes	VIIE
Podo	NA	60% slopes	VIIIE
Quigley	NA	NA	NA

NA - data not available

United States
Department of
Agriculture

Soil
Conservation
Service

P. O. Box 11350
Salt Lake City, UT 84147

October 27, 1983

Mr. Dan Guy
Beaver Creek Coal Co.
P. O. Box AU
Price, UT 84501

Dear Mr. Guy:

Gary Moreau, Soil Conservationist, Soil Conservation Service, Price, Utah, has made a field investigation of those sites described in your correspondence concerning Mine #4, located in Mill Fork Canyon surface area, sec. 16, 17, T. 16 S., R. 7 F. Rilds Canyon USGS quad. This location is in Huntington Canyon, Emery County, Utah.

According to Mr. Moreau's investigation, the soils in this site do not qualify as prime farmland because the site is in elevations above irrigation delivery systems, where no irrigation water is available and the toprography precludes any irrigation possibilities. Also, the growing season is too short for prime farmland.

Sincerely,

Ferris Allgood

FERRIS P. ALLGOOD
State Soil Scientist

8.5 Physical and Chemical Properties of Soils

Method of Evaluation

The criteria for evaluating topsoil as seedbed quality material are given in Table 8-2. References to topsoil means only those soil horizons suitable for use as seedbed quality material. The criteria include sodium absorption ratio (SAR), electrical conductivity or salinity (EC), toxic materials, soil reaction (pH), available water holding capacity (AWHC), erosion factor (k), wind erosion group, texture, and percent coarse fragments.

Criteria are given for good, fair or poor sources of seedbed quality material (Table 8-3).

> "A good rating means vegetation is relatively easy to establish and maintain, the surface is stable and resists erosion, and the topsoil has good potential productivity. Material rated fair can be vegetated and stabilized by modifying one or more properties. Top-dressing with better material or application of soil amendments may be necessary for satisfactory performance. Material rated poor has such severe problems that revegetation and stabilization is very difficult and costly. Top-dressing with better material may be necessary to establish and maintain vegetation," (USDA, 1978).

Soil Chemistry and Physical Properties

Chemical and physical data for project area soils (Table 8-4) were collected to evaluate the soils as seedbed quality material for reclamation. Soil chemical and physical data from 1980 were derived from analysis by Colorado Agricultural Consultants in Brighton, Colorado. Other sources of information used to evaluate soils for reclamation were manuscript SCS soil survey information and soil survey interpretation records. 1982 data were derived from analyses by Bookcliffs Commercial Laboratories in Steamboat Springs, Colorado.

Table 8-2

SEEDBED QUALITY MATERIAL FOR RECLAMATION

Property	Limits Good	Limits Fair	Limits Poor	Restrictive Feature
1. Sodium Adsorption Ratio (SAR)	5	5-12	12	Excess Sodium
2. Salinity (EC) mmhos/cm	8	8-16	16	Excess Salt
3. Toxic Materials	Low	Medium	High	Toxicity
4. Soil Reaction (pH)[a]	5.6-7.8	4.5-5.5	4.5	Too Acid
5. Soil Reaction (pH)	7.9	7.9-8.4	8.4	Excess Lime
6. Available Water Capacity (AWC) in/in	.10	.05-1.0	.05	Droughty
7. Erosion Factor (K)	.37	.37	---	Erodes Easily
8. Wind Erod. Group	3	3	1, 2	Soil Blowing
9. USDA Texture	—	SCL, CL SICL	C[b] SIC[b] SC	Too Clayey
10. USDA Texture	—	LCOS, LS LFS, LVFS	COS, S FS, VFS	Too Sandy
11. Coarse Frag. (wt %)				
3-10 in. (7.6-25.4 cm)	15	15-35	35	Large Stones
10 in. (725.4 cm)	3	3-10	10	Large Stones

[a]Layers with high potential acidity should be rated poor.

[b]If in kaolinitic family, rate one class better if experience confirms.

From National Soils Handbook, NSH - Part II (403.6(2)), 1978.

Table 8-3

EVALUATION OF TOPSOIL MATERIAL

Series	Map Sample Point	Depth (in)	SAR	Salinity (EC)	Materials (Boron)	Toxic[a] Reaction (pH)	Soil Erosion Factor	Erodibility Group	Wind[b] USDA Texture	Coarse[d] Fragments	Water Capacity	Available[e] Overall Rating
Quigley-like	2	0-7	good	good	good	good	NA	NA	good[c]	good	good	GOOD
		7-20	good	good	good	good-fair	NA	NA	good[c]	good	good	FAIR
		20-38	good	good	good	good-fair	NA	NA	good[c]	good	good-fair	FAIR
		38-43	good	good	good	good	NA	NA	fair[c]	good	poor-fair	POOR
Patmos	8	0-6	good	good	good	good	good	good	good[c]	fair	good	FAIR
		6-26	good	good	good	good	good	NA	good[c]	fair	good	FAIR
		26-38	good	good	good	good	good	NA	fair[c]	fair	fair	FAIR
Podo	9	0-13	good	good	good	fair	fair	good	good[c]	fair	fair-good	FAIR
Disturbed Land Fill Material	1	—	good	good	—	good	NA	NA	good	NA	NA	FAIR[f]
Disturbed Land Fill Material	3	—	good	good	—	good	NA	NA	fair	NA	NA	FAIR[f]
Disturbed Land Fill Material	4	—	good	good	good	good	NA	NA	fair[c]	fair-poor	fair-poor	FAIR
Disturbed Land Fill Material	5	—	good	good	—	good	NA	NA	fair	NA	NA	FAIR[f]

Table 8-3 (continued)

EVALUATION OF TOPSOIL MATERIAL

Series	Sample Point	Depth (in)	SAR	Salinity (EC)	Toxic[a] Materials (Boron)	Soil Reaction (pH)	Erosion Factor	Wind[b] Erodibility Group	USDA Texture	Coarse[d] Fragments	Available[e] Water Capacity	Overall Rating
Disturbed Land Fill Material	6	—	good	good	—	good	NA	NA	good	NA	NA	FAIR[f]
Disturbed Land Fill Material	7	—	good	good	—	good	NA	NA	good	NA	NA	FAIR[f]

[a]-evaluation based on WQEQ Guideline No. 3 for boron limits - less than 5 ppm boron is good; 1982 samples not analyzed.

[b]-from soil survey interpretation records, USDA SCS

[c]-from field description of soil texture; not taken from lab analysis.

[d]-from field description

[e]-evaluated based on field textures and estimated coarse fragments from U.S. Forest Service (1974).

[f]-based on field evaluations and supporting laboratory analyses.

NA - data not available.

8.5 Physical and Chemical Properties of Soils (continued)

Soil Chemistry and Physical Properties (continued)

Soils were sampled by horizon and analyzed using standard agricultural techniques. The parameters tested in 1980 were paste pH, electrical conductivity, moisture saturation percentage, SAR, organic matter, plant available phosphorus and potassium, particle size distribution, nitrate nitrogen, ammonia nitrogen, lime and boron. The techniques used were those of USDA Handbook 60 (1954), and American Society of Agronomy Monograph #9 (Black, 1965). The parameters tested in 1982 paralleled those in 1980, with the exclusion of boron, organic matter, ammonia-nitrogen, and very fine sand.

Suitability as Seedbed Quality Material for Reclamation of Disturbed Lands

Table 8-3 is an evaluation of topsoil for each horizon on each project area soil type. The evaluation is based on the soil chemical and physical data in Table 8-4 and the criteria of Table 8-2. The soils are rated good, fair, or poor sources of seedbed quality material. The overall rating given for each horizon is the rating for the most limiting criteria.

Vegetation is difficult to establish on soils with high SAR which indicates potential instability and water transmission problems (USDA, 1978). None of the soils tested have high SAR; all are rated good for this parameter.

Electrical conductivity is a measure of soil salinity. Excessive salts restrict plant growth, create problems in establishing vegetation and therefore also influence erosion and the stability of the

Table 8-4

SOIL CHEMICAL AND PHYSICAL PROPERTIES

Sample depth (in)	pH	EC	SAT%	N	C	M	SAR	AK	TEXT	SN	SI	CL	VFS[a]	N03	NH3[a]	OM[a]	P	LM	B[a]
Quigley-like / Hole: 2																			
0-7	7.7	2.0	36.0	3.86	12.17	1.85	1.5	310	SL	72	21	7	11	3	0.2	2.5	0	9.0	0.16
7-20	7.9	1.7	37.0	2.82	9.73	1.80	1.2	260	SL	63	25	12	14	2	0.1	1.8	0	9.1	0.10
20-38	7.9	1.7	36.1	2.89	9.98	1.85	1.2	260	SL	63	25	12	8	2	0.3	1.7	0	9.2	0.12
38-43	7.8	1.9	36.8	2.83	10.86	1.81	1.1	250	SL	74	18	8	7	3	0.4	1.2	0	9.2	0.05
Patmos / Hole: 8																			
0-6	7.7	3.0	38.0	4.58	14.14	5.27	1.5	690	L	50	39	11	18	14	0.9	13.1	5	9.1	0.48
6-26	7.4	5.0	37.0	2.82	14.89	27.01	0.6	330	SL	70	25	5	7	53	2.4	2.7	12	9.1	0.28
26-38	7.7	3.4	47.0	6.65	11.41	15.59	1.8	820	SCL	58	26	16	6	64	1.2	2.5	0	9.2	0.39
Podo / Hole: 9																			
0-13	8.0	3.1	27.2	5.11	13.21	7.34	1.6	230	LS	80	14	6	8	4	0.6	2.3	0	9.2	0.17
Disturbed Land Fill / Hole: 1																			
Grab	7.0	1.4	24.3	3.1	7.1	7.1	1.2	30	SL	61	26	13		11.6			0.2	27.7	
Disturbed Land Fill / Hole: 3																			
Grab	7.4	3.4	32.2	2.9	29.5	19.7	0.6	63	CL	40	37	23		11.6			3.1	50.7	

[a] -Not tested for during 1982 sampling.

Table 8-4 (continued)

SOIL CHEMICAL AND PHYSICAL PROPERTIES

Sample depth (in)	pH	EC	SAT%	N	C	M	SAR	AK	TEXT	SN	SI	CL	VFS[a]	N03	NH3[a]	OM[a]	P	LM	B[a]
Disturbed Land Fill / Hole: 4																			
Grab	7.6	2.1	34.7	4.00	12.07	3.84	1.4	210	SL	59	29	12	11	43	0.3	2.2	0	9.2	0.07
Disturbed Land Fill / Hole: 5																			
Grab	7.7	1.5	34.5	6.5	2.9	8.0	2.8	71	SCL	25	55	25		14.2			0.5	24.6	
Disturbed Land Fill / Hole: 6																			
Grab	7.5	4.4	30.3	11.1	22.1	33.6	2.1	104	L	45	36	19		18.2			0.5	21.6	
Disturbed Land Fill / Hole: 7																			
Grab	7.3	2.7	29.0	3.2	23.4	12.3	0.8	62	L	41	44	15		8.5			0.4	18.4	

[a] -Not tested for during 1982 sampling.

8.5 Physical and Chemical Properties of Soils (continued)

Suitability as Seedbed Quality Material for Reclamation of Disturbed Lands (continued)

surface. Toxic materials such as boron get into the food chain and are toxic to animals who eat the vegetation. Excessively high or low pH causes problems in establishing vegetation and as a result influence erosion and stability of the surface (USDA, 1978). All of the soils tested are low in salts and boron. pH of the Podo soil and of the subsoil of the Quigley soil is rated fair. pH of the other soils tested is rated good.

The available water capacity also is important in establishing vegetation. Soils with low available water capacity may require irrigation for establishment of vegetation (USDA, 1978). Available water holding capacity (AWHC) is evaluated according to the U.S. Forest Service (USDA, 1974) based on field texture and coarse fragments. AWHC is fair-poor for the fill material. It is rated fair to poor for the subsoil of the Quigley soil and Patmos soil. The Podo is rated fair-good for AWHC.

The stability of the soil depends upon its erodibility by water and wind and its strength. Water erodibility is indicated by the k factor; wind erodibility is rated according to the wind erodibility group. K values for soils of the project area are from the best data available in the SCS Soil Survey Interpretation Records. Wind erodibility is based on SCS Soil Survey Interpretation Records for the surface horizons. Wind erodibility data are available for only the surface soils of the site. Data for these factors are not available for the Quigley soil or the fill material. The Patmos is rated good for both factors. Podo is rated fair and good for the erosion factor and wind erodibility group, respectively.

8.5 Physical and Chemical Properties of Soils (continued)

Suitability as Seedbed Quality Material for Reclamation of Disturbed Lands (continued)

USDA texture also influences available water capacity and erodibility by wind or water. Texture influences soil structure, consistence, water intake rate, runoff, fertility, workability, and trafficability. Potential slippage hazard is related to soil texture, and although other factors also contribute, the ratings of soil texture represent one important factor (USDA, 1978). Texture is rated fair for the subsoils of the Patmos and Quigley soils and for the fill material. The other horizons tested are all rated good.

Textures for soils of the site were described in the field and the evaluations are based on the field determinations. Lab data on soil textures have been disregarded because it is thought that dispersion of silt and clay particles was not adequate, possibly because of high gypsum contents.

Coarse fragments influence the ease of excavation, stockpiling and respreading, and suitability for the final use of the land. A certain amount of coarse fragments can be tolerated depending upon the size and intended use of the reclaimed area. If the size of rock fragments exceeds 10 inches (25 cm) the problems are more severe (USDA, 1978). Coarse fragments are evaluated based on pedon descriptions for soils of project areas. Coarse fragments are rated fair for the Patmos and Podo soils and for the fill material. Coarse fragments are rated good for the Quigley soil.

8.6 Use of Selected Overburden Materials or Substitutes

Very little seedbed quality material exists within disturbed and adjacent areas in the Huntington Canyon No. 4 Mine. (See previous Section 8.5 for physical and chemical analysis and Section 8.8 for available topsoil for reclamation). Therefore, Beaver Creek Coal Company proposed to use the in-place disturbed land fill as the seedbed medium.

Comparison of the three natural soils and the disturbed land fill revealed similar chemical and physical characteristics. In some disturbed land fill material, coal fines or coal waste were encountered. In addition, the disturbed land fill has some restrictive features such as large stones and low water holding capacity. However, based upon the requirements for seedbed quality material published in the National Soils Handbook, NSH-Part II (403.6(2)), 1978, the disturbed land fill material has been determined to have a fair rating as topsoil material. The coal fines within the disturbed land fill material contribute to its organic matter content. Much of the in-place soils are rated as fair also. Refer to Table 8-3.

A full discussion of the redistribution and handling of the disturbed land fill conducive to successful establishment of vegetation during reclamation is given in Section 8.8 and 8.9, respectively.

8.7 Removal, Storage, and Protection of Soil Plans Topsoil Removal

At the present time, it is not anticipated that any additional areas will be disturbed at the Huntington Canyon No. 4 Mine. Therefore, no additional topsoil will be removed.

8.7 Removal, Storage, and Protection of Soil Plans Topsoil Removal (continued)

Should the need to disturb additional land arise, an inventory of available suitable topsoil surrounding the present surface facilities has been made. A discussion of depths of suitable topsoil for reclamation and the in-place volumes is given below. Beaver Creek Coal Company would remove and preserve topsoil based on this criteria if necessary. Unforeseen disturbance will be addressed to the Division in a revision to the Mining and Reclamation Plan.

Depths of Suitable Topsoil Available for Reclamation

The depths of seedbed quality material available for reclamation of project areas are listed on Table 8-5 by map unit. The table includes the map unit, map unit components, depth of horizon, rating (from Table 8-3), percent of map unit, and the recommended depth of stripping and the restrictive features of the suitable material. Volumes of seedbed quality material available can be found in Table 8-6.

The disturbed land fill material has fair characteristics for reclamation. The restrictive features of the suitable material are large stones, sandy textures, low water holding capacity, and steep slopes. Reclamation of areas mapped as DL will contend with these restrictive features. Included in the map unit DL are areas of excessive large stones, rock outcrops and road cuts that will be difficult to reclaim without covering with better material. There are areas of coal waste that will be removed and disposed of properly. If the Division concurs with Beaver Creek Coal Company, Map unit DL will be used for reclamation as no better topsoil material is available for reclamation.

Table 8-5

DEPTHS OF SUITABLE SEEDBED MATERIAL AVAILABLE

(BY MAP UNIT)

Mapping Unit	Component	Depth (in)	Rating	Percent of Map Unit	Available Depth Suitable Material (restrictive feature)
DL	Disturbed Land Fill	Variable	fair	90	variable (droughty) large stones, sandy slopes
	Inclusions	Variable	poor	10	0 inches
PpE	Patmos	38	fair	50	0 inches (slopes)
	Pado	13	fair	25	0 inches (slopes)
	Inclusions	Variable	poor	25	0 inches
QiC	Quigley	0-7 7-38 38-43	good fair poor	75	7 inches (none) 31 inches (excess lime) droughty
	Other	Variable	poor	25	0 inches (see discussion)
RL	Rockland	0	poor	90	0 inches
	Podo	13	fair	10	0 inches

Table 8-6

SEEDBED QUALITY MATERIAL - APPROXIMATE VOLUMES

Mapping Units	Suitable Stripping Depth	Acreage	Volume - Bank Cubic Yards (BCY)
Quigley - QiC	7"[a]	14	13,175
Quigley - QiC	38"[b]	14	73,524
Disturbed Landfill[c]			20,000
Stockpiled			200
Total Seedbed Quality Material Available			106,899

a - In-place topsoil.
b - In-place subsoil.
c - See Figure 8-1.

8.7 Removal, Storage, and Protection of Soil Plans Topsoil Removal (continued)

Depths of Suitable Topsoil Available for Reclamation (continued)

The amount of disturbed landfill material available for reclamation is also found in Table 8-6. This volume was derived assuming a 15-foot reach on the backhoe used to pull the material up from the scree/fill slopes and a road length of 4800 feet. This material will be pulled up from the fill slope to be placed into the original cut. (Figure 8-1)

Map unit PpE, Patmos-Podo associations, 60 to 90 percent slopes is too steep for salvage of any topsoil with conventional machines. Efforts will be made to minimize disturbance on these slopes.

The Quigley soil in map unit QiC occurs on 5 to 25 percent slopes and is rated good to 7 inches and fair from 7 to 38 inches. If areas of QiC are to be disturbed, the top 7 inches should be salvaged and used as seedbed quality material. The layer from 7 to 38 inches does not need to be saved unless it is borrowed and used to reclaim road cuts or excessively stoney areas that lack fine earth material. The alluvial soils in map unit QiC are subject to flooding and disturbance of these soils should be avoided. Skeletal soils and bouldery areas in map unit QiC are not sources of usable materials.

Map Unit RL consists primarily of rock outcrops and talus and the unit is not a source of seedbed material. Small soil bodies do occur as inclusions in the unit but they are shallow, stoney and too steep to be of any use.

8.7 Removal, Storage, and Protection of Soil Plans Topsoil Removal (continued)

Topsoil Storage and Protection

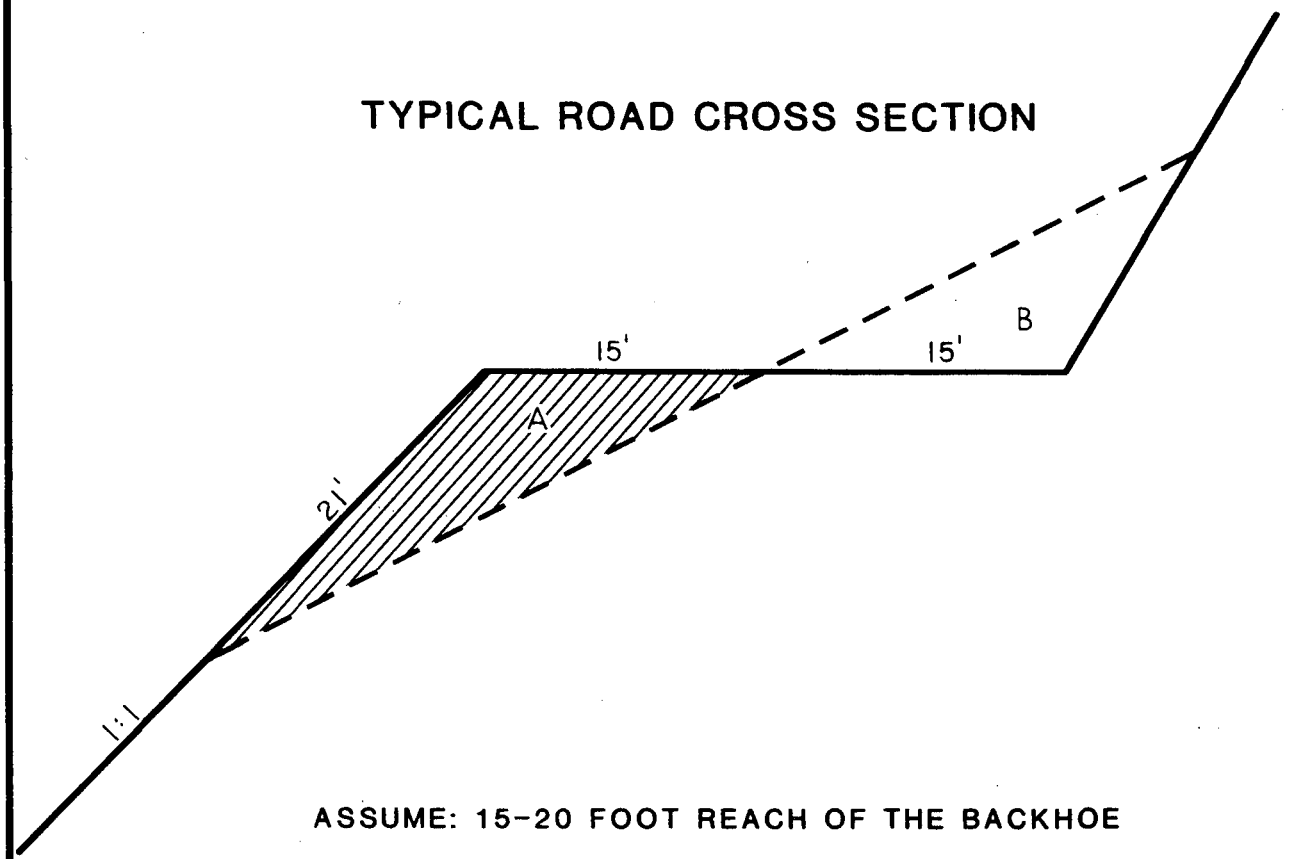
The need for topsoil storage and protection is confined to the potential disturbance of the Quigley soil which is the only soil having suitable qualities for salvaging. If this should occur, the soil will be stockpiled on a stable surface area within the permit area. Stockpile(s) will be protected with a quick growing cover of vegetation seeded or planted during the first desirable seeding period after removal.

8.8 Soil Redistribution

As discussed in Section 8.6, Beaver Creek Coal Company proposed to use the disturbed land fill as a substitute for topsoil for reclamation. Coal waste and excessive rocks (+8"), will be removed and disposed of prior to reclamation. The disturbed land fill will be final graded to approximate original contour, then deeply scarified to reduce compacted zones. If necessary, cloddy surface areas will be pulverized to create a smooth seedbed. Appropriate wind and water control technology will be implemented before and after seeding. Refer to the Reclamation Plan, Section 3.5.

8.9 Nutrients and Soil Amendments

Soil tests will be taken in materials to be used for final reclamation to determine nutrient status and to evaluate the need for soil amendments. Soil testing will be performed by a qualified laboratory which uses accepted analytical procedures. Soil tests will include, but not be limited to, pH, texture, ammonia-nitrogen, nitrate-nitrogen and phosphorus.



ASSUME: 15-20 FOOT REACH OF THE BACKHOE

4800 FOOT ROAD LENGTH

1:1 ORIGINAL OUTSIDE FILL SLOPE

$$\text{X-SECTIONAL AREA (SHADED)} = \frac{\text{BASE} \times \text{HEIGHT}}{2} = \frac{15' \times 15'}{2}$$

$$= 112.5 \text{ FT}^2$$

(X-SECTIONAL AREA)(ROAD LENGTH) =

$$(112.5 \text{ FT}^2)(4800 \text{ FT}) = 540{,}000 \text{ FT}^3$$

VOLUME = 540,000 FT^3 OR 20,000 YD^3

(VOLUME A TO BE PLACED AT B)

FIGURE 8-1: ROAD FILL REPLACEMENT CALCULATION

8.10 Effects of Mining Operations on Soils, Nutrients and Soil Amendments to be Used

The disturbed land fill which has been impacted by mining operations has some inherent problems that will be addressed prior to reclamation. These include large stones, sandy textures, and low water holding capacity. The large stones will be removed by standard earth moving equipment and commercial rock-picker implements if necessary. Sandy textures are common in every soil at the No. 4 Mine and cannot be changed. However, excess sands that have been applied to the surface of the roads for traction in snowy conditions will be removed. The low water holding capacity relates to the sandy texture of the soils. A vegetative cover will provide soil organic matter which in turn will increase infiltration and water holding capacity. To some degree this material will always have some problems with water holding capacity.

All soils will be properly fertilized to bring them up to the level necessary for vegetation establishment. Fertilizer application will be based on soil test analysis as discussed in Section 8.9.

8.11 Mitigation and Control Plans

No future disturbance is planned within the Huntington No. 4 permit area. However, in the event additional disturbance is required, all suitable seedbed quality material (topsoil) will be stripped and stockpiled prior to such disturbance. Every effort will be made to minimize the extent of any additional disturbance.

The existing topsoil stockpile has been placed on a stable surface to limit wind and water erosion which would lessen the capability of the material to support vegetation. The stockpile has been

8.11 Mitigation and Control Plans (continued)

revegetated according to the seeding requirements listed in the Reclamation Plan, Section 3.5. It will remain in-place and undisturbed until the material is redistributed on to reclaimed areas.

8.12 Bibliography

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Section 9

VEGETATION RESOURCES

9.1 Scope

The vegetative resources data information for the Huntington Canyon No. 4 Mine was prepared by Beaver Creek Coal Company based upon studies performed by Espey, Huston and Associates, Inc. during July, August and September 1980. The study area included the entire lease area located in Emery County approximately 29 miles southwest of Price, Utah.

The major components of this study were the preparation of a vegetation map of the permit area, a qualitative and quantitative description of the vegetation within the study area, and the establishment of a vegetative reference area. The study also included a site wide examination to identify any threatened or endangered species which may be present on the lease area.

Based on a review of the results of those studies, it was decided by Atlantic Richfield Company personnel that some additional information was needed to supplement the initial quantitative work. The scope of work to be accomplished during 1981 was discussed with the Utah Division of Oil, Gas and Mining (DOGM) in early July to obtain their input and approval to ensure that the studies would be appropriate and acceptable to them.

The 1981 studies performed by Stoecker-Keammerer and Associates consisted of obtaining cover, frequency, and production data for a pinyon-juniper woodland reference area at the Huntington Canyon No. 4 Mine. All the data were collected during the second week of July, 1981.

9.1 Scope (continued)

The vegetation of the Huntington No. 4 permit was remapped July 1982 by Stoecker-Keammerer & Associates.

9.2 Methodology

9.2.1 Floristics

A floristic survey was conducted at the same time as the 1980 quantitative vegetation sampling. The purpose of the floristic survey was to determine and list the plant species present within the lease area including any threatened or endangered species. This was accomplished by a walking reconnaissance of the mine area noting species occurrence and their distribution in the various communities.

9.2.2 Vegetation Map

The original vegetation map of the Huntington Canyon No. 4 Lease and adjacent areas was prepared in 1980 by Espey, Huston and Associates, Inc. from black and white aerial imagery obtained from Atlantic Richfield Company. After review of this initial work, it was determined by Atlantic Richfield personnel that the original community types mapped were too inclusive. Additional work was completed in July 1982 by Stoecker-Keammerer & Associates to provide a more detailed map that better represented the vegetative resources on the lease. The 1982 vegetation map for the Huntington No. 4 Permit Area was prepared using a combination of air photo interpretation and field checking. Stereo pairs of color photographs at a scale of 1:4,800 (1 inch = 400 feet, approximately) and black and white photographs at a scale of 1:18,000 (1 inch = 1500 feet, approximately) were used to prepare a

9.2.2 Vegetation Map (continued)

preliminary vegetation map at a scale of 1:6,000 (1 inch = 500 feet, approximately). The photographs and the preliminary map were taken into the field and checked for accuracy and reliability of interpretation. Because of the rugged topography and impassable road conditions, field checking was accomplished using a helicopter. With this technique, it was possible to obtain access to even the most remote portions of the lease. Based on the field observations, corrections were made on the preliminary map and a final map was prepared.

The vegetative types were quantified in terms of acreage and percentage of the study area. Refer to Table 9-1. The community types recognized as being of sufficient extent or importance to warrant separation into individual communities are Aspen Woodland, Mixed Coniferous Forest, Burned Mixed Coniferous Forest, Pinyon-Juniper-Curl leaf Mountain Mahogany Woodland, Manzanita Shrubland, Big Sagebrush Shrubland, Riparian Community, and Mountain Grassland. Burned over areas were also roughly dated and mapped. Only the Pinyon-Juniper-Curl leaf Mountain Mahogany Woodland community occurs in the area of disturbance.

9.2.3 Reference Area

Reference areas are land areas that are selected to represent the species composition, topography, soils and aspect of a disturbed area within the permit area. A reference area on the mine was selected by the ocular method, i.e., by visual comparisons of the above attributes to that of the affected area, and by examining topographic and soils maps. The reference area selected in the 1981 study was located within the permit area on a site which would not be disturbed throughout the life of the mine. The

Table 9-1

AREAL EXTENT OF VEGETATION ON
HUNTINGTON CANYON MINE NO. 4 LEASE AREA
EMERY COUNTY, UTAH

Vegetation Type	Lease Area (Acres)	Affected Area (Acres)	Lease Area Percentages (excluding Affected Area)
Aspen	239.7	-	18.1
Mixed Coniferous Forest	150.0	-	11.4
Burned Mixed Coniferous Forest	206.3	-	15.6
Pinyon-Juniper-Curl leaf Mt. Mahogany Woodland	348.2	78	26.4
Manzanita Shrubland	3.8	-	0.3
Big Sagebrush Shrublands	264.7	-	20.0
Riparian Community	1.4	-	0.1
Mountain Grassland	93.2	-	7.1
Rock Outcrop	12.7		1.0
TOTAL	1320.0	78	100.0

9.2.3 Reference Area (continued)

reference area was one hectare (2.5 acres) in area (200m by 50m) and was selected to be characteristic of the Pinyon-Juniper-Curl leaf Mountain Mahogany vegetation type (Plate 9-1). The SCS has determined that the established reference area is in good condition. Refer to Exhibit 9-1.

9.2.4 Vegetative Cover and Production

The only vegetation type which has been affected by mining operations is Pinyon-Juniper-Curl leaf Mountain Mahogany; therefore, only this type was quantitatively sampled for cover and productivity. All surface disturbances at this mine have taken place, no further disturbance is planned. Therefore quantitative surveys on the current affected areas and other vegetation types were not deemed necessary.

9.2.4.1 Cover

Cover data were collected using a quadrat approach. Individual 1.0 m^2 quadrats were randomly located in the reference area. Random sampling was accomplished by using pairs of random coordinates. The first number of the pair was the measured distance along one side (long axis) of the reference area, and the second number was the paced distance perpendicular to the tape at the position of the first number. Random sampling locations within each of the reference areas are shown in Figure 9-1. In each quadrat, total vegetation cover (canopy cover) including shrub canopy, cover by bare soil, and cover by litter and rock were visually estimated. For each quadrat these three components added to 100 percent. Canopy cover for each species and cover by litter, rock, bare soil, lichens, and mosses in the ground layer were also visually

United States Department of Agriculture
Soil Conservation Service
Box 754
Castle Dale, UT 84513

December 8, 1981

Mr. Dave Meyer
Beaver Creek Coal Co.
1109 S. Carbon Ave.
Price, UT 84501

Dear Dave,

At your request, George Cook reviewed the vegetation data collected by your company on the two reference areas. He estimates good condition range sites for both the Huntington #4 P-J woodland community and the Gordon Creek #2 bunchgrass/mixed mountain shrubland communities.

Since the browse was not clipped for production on either site the SCS will not be able to use the data in our reports. We appreciate helping you and please call if questions arise.

Sincerely,

Gary

Gary D. Moreau
District Conservationist

GDM/lhb

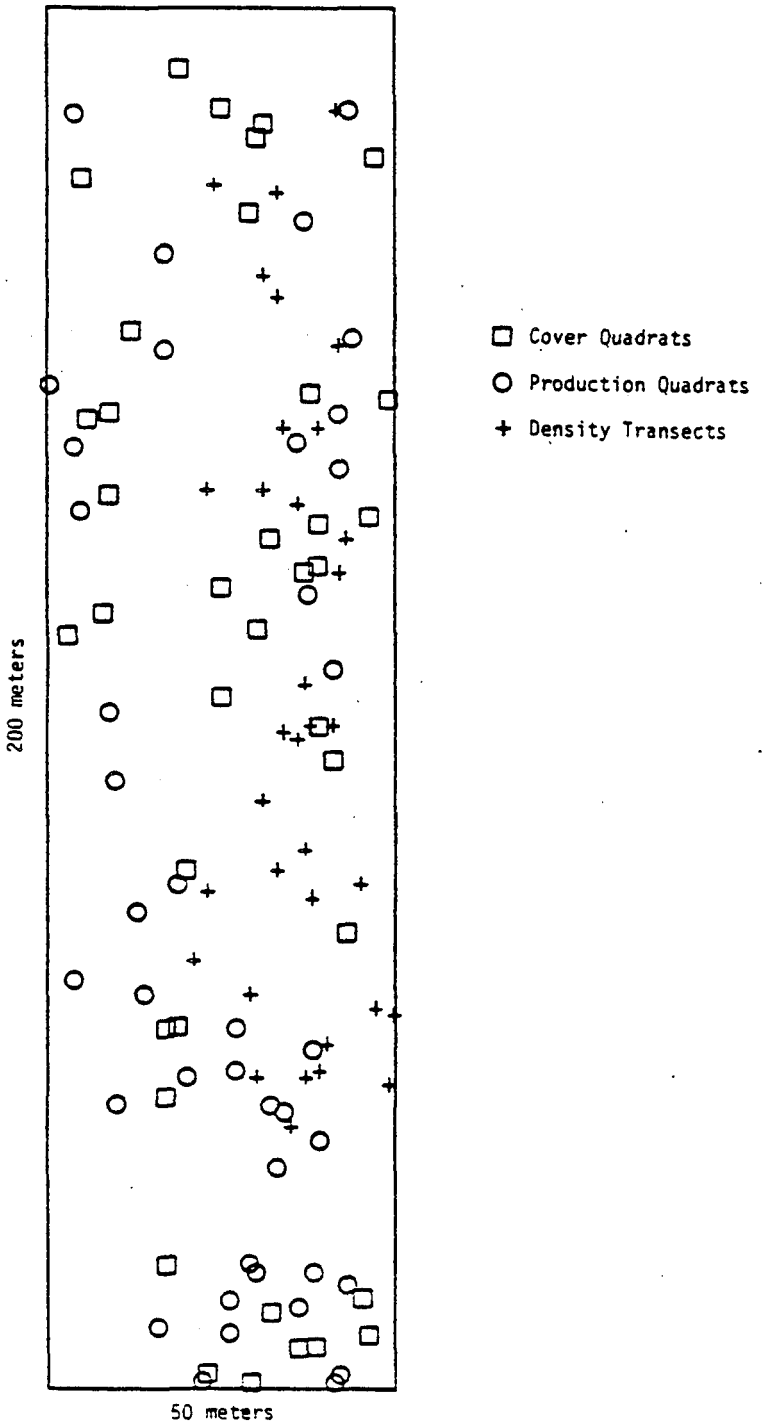

Figure 9-1. Sampling locations in the Pinyon-Juniper Woodland Reference Area at Huntington Canyon No. 4 Mine

9.2.4.1 Cover (continued)

estimated. Because of overlap, these components added to more than 100 percent. Cover data were summarized by calculating mean values for each species and each component. Relative cover (percent of total cover) and frequency values were also determined.

9.2.4.2 Production

Production data were collected using a harvest method. Individual $1.0m^2$ quadrats were randomly located throughout each of the reference areas (Figure 9-1). Random locations were determined using pairs or random coordinates in the same manner used for locating cover quadrats. In each of the clipped quadrats, grasses and semi-shrubs were fractionated on the basis of species; forbs were separated into annuals and perennials. Shrubs were not clipped, except for low-growing species such as Oregon grape (*Mahonia repens*) and mountain lover (*Pachystima myrsinites*). Clipped samples were oven-dried for 24 hours at $100^{o}C$ and were weighed to the nearest milligram. Data were summarized by obtaining mean production values for each species or species group.

9.2.4.3 Tree and Shrub Density

Density data for trees and shrubs were obtained using a line-strip transect approach. Randomly located transects 15m by 3m were used to obtain shrub density data, and transects 15m by 7m were used to obtain tree density data (Figure 9-1). Foliar cover data for the shrub layer and for the tree canopy were obtained using a line intercept approach along the 15m line defining the centerline of each line-strip transect.

9.2.4.3 Tree and Shrub Density (continued)

Within each of the shrub line-strip transects, individual shrubs were tallied on the basis of height class in order to obtain some measure of community structure. For individuals with multiple stems, separate counts were made for the member of individuals per transect as well as the number of stems per individual. Total density was calculated both on the basis of the number of individuals per hectare as well as the number of stems per hectare.

In each of the tree transects, the diameter at breast height was measured for each tree trunk. Trees with multiple trunks were tallied separated so that both trees per hectare and trunks per hectare values could be calculated.

Sample adequacy during the 1981 work was evaluated using the following formula:

$$n_{ade} = \frac{t^2 s^2}{d^2 x^2}$$

where

n_{ade} = adequate number of samples

t = t value (t-distribution) for a given level of confidence and n-1 degrees of freedom where n = actual sample size

s^2 = sample variance estimate

d = the level of accuracy desired for the estimate of the mean, for grassland d = 0.1, for shrublands d = 0.2

x = sample mean

Sampling adequacy for future woody plant density will be computed using a two-tailed "t" value at appropriate confidence levels and a "d" value of 0.1.

9.3 Existing Vegetative Resources

9.3.1 General Site Description

The mine lease area is in a region of deeply dissected sedimentary rocks. The elevation ranges from approximately 7,200 feet to 9,580 feet.

Temperature is quite variable due to the wide range of exposures and elevations present. The mean annual temperatures in the area ranges between 33° to 44° Fahrenheit. The frost-free period ranges from 40 to 100 days each year. Freezing is most common from November through March.

Precipitation varies with elevation and ranges from approximately 15 to 20 inches, with 60 to 70 percent as snow during the months of October through May.

The Huntington Canyon No. 4 Mine is generally located within the Pinyon-Juniper Vegetation Zone as described by Cronquist, et al (1972). This forest type occupies extensive areas in the Intermountain Region. Where the valleys are low in elevation these woodlands are restricted to the slopes of mountains. However, they form a continuous expanse from mountain to mountain in eastern Nevada, the Uinta Basin, and the Canyon Lands of eastern Utah where the elevation is higher.

9.3.2 Vegetation Types

The vegetation map of the Huntington No. 4 permit area depicts eight vegetation types and one additional landscape unit (Rock Outcrops) (see Plate 9-1 and Table 9-1). Each of these mapping units is described briefly in the discussion which follows.

9.3.2 Vegetation Types (continued)

Aspen Woodland. The aspen woodland type occurs primarily on north facing and sheltered slopes. The major species is quaking aspen (Populus tremuloides) which forms dense stands especially in those areas which have been burned in the past. Common understory species include silver buffaloberry (Shepherdia canadensis), mountain snowberry (Symphoricarpos oreophilus), currant (Ribes cereum and Ribes viscossissimum), and peavine (Lathyrus sp.).

Mixed Coniferous Forest. The mixed coniferous forest type occurs on sheltered slopes, along ridges, and along drainages. The major species include douglas-fir (Pseudotsuga menziesii), white fir (Abies concolor), Engleman spruce (Picea englemannii), and subalpine fir (Abies lasiocarpa). On ridges, bristlecone pine (Pinus aristata) and limber pine (Pinus flexilis) commonly occur. Along drainages Colorado blue spruce (Picea pungens) occurs as a secondary dominant. Common understory species include mountain lover (Pachystima myrsinites) and heart-leaf arnica (Arnica cordifolia).

Burned Mixed Coniferous Forest. The burned mixed coniferous forest type occurs on the same kinds of landforms as the previous type. Fire appears to be a frequent event within the permit area; many of the mixed coniferous forest stands have been burned.

At least two fire dates have been identified, 1964 and pre-1964. A 1964 fire occurred during 5-8 July. The area is within the Little Bear Canyon drainage; part of the fire occurred on the Manti-LaSal National Forest. After the fire, the area was aerial seeded by helicopter. The seed mix consisted of brome (Bromus sp.), slender wheatgrass (Agropyron trachycaulum), stiffhair wheatgrass (Agropyron trichophorum), tall grass (Arrhenatherum elatius), orch-

9.3.2 Vegetation Types (continued)

ard grass (Dactylis glomerata), timothy (Phleum pratense), alfalfa (Medicago sativa), and sweet clover (Melilotus sp.). Inspection of the 1964 burned area revealed that the seeding job was spotty.

The fires in the burned mixed coniferous type have been extreme enough to destroy the trees, however, the charred trunks have remained standing. The current vegetation consists of seedlings and small saplings of the above mentioned coniferous species as well as numerous shrub and herbaceous species. Mountain snowberry, elderberry (Sambucus sp.), and mountain lover commonly occur.

On the vegetation map (see Plate 9-1), past burns are shown as shaded areas. It was felt that portrayal of the burns in this manner was more informative than simply mapping them as burned over areas. The map shows the existing vegetation within the burned areas as well as defining the limits of past fires.

Pinyon-Juniper-Curl Leaf Mt. Mahogany Woodland. The pinyon-juniper-curl leaf mountain mahogany woodland type occurs on dry south and west facing slopes. Major species include pinyon pine

(Pinus edulis), Utah juniper (Juniperus osteosperma), Rocky Mountain juniper (Juniperus scopulorum), and curl leaf mountain mahogany (Cercocarpus ledifolius). These four species occur to varying amounts. In some areas pinyon pine dominates while in other sites the junipers occur as dominants. Curl leaf mountain mahogany usually occurs as a secondary dominant in most stands, however on certain sites it occurs almost to the exclusion of the other three species. The trees usually occur as scattered individuals, and areas with a closed canopy are uncommon. The understory is usually

9.3.2 Vegetation Types (continued)

sparse with salina wild rye (Elymus salinus) occurring as the major understory species. The mine portal, associated facilities, and disturbed areas are located entirely within this community type.

Manzanita Shrubland. The manzanita shrubland type is restricted in extent and occurs on an east facing slope on the ridge between Crandall and Little Bear Canyons. The type is characterized by the dominance of manzanita (Arctostaphylos patula). Mountain lover grows in the understory of the manzanita. The dense stands of manzanita tend to limit the growth of herbaceous species.

Big Sagebrush Shrubland. The big sagebrush shrubland type occurs on steep slopes at higher elevations. These slopes appear to be somewhat drier than the slopes that support aspen woodlands and mixed coniferous woodlands, but appear to be more moist than slopes that support the mountain grassland type. The major shrub species is big sagebrush (Artemisia tridentata). Common herbaceous species include muttongrass (Poa fendleriana), Lettermann needlegrass (Stipa lettermannii), Indian paintbrush (Castilleja spp.), and groundsel (Senecio cymbalarioides).

Riparian Community. The riparian community occurs along the major drainage ways within the permit area. The major species in these areas are willow (Salix spp.), red-osier dogwood (Cornus stolonifera), river birch (Betula occidentalis), and wood's rose (Rosa woodsii). This type tends to occur as a narrow band which is restricted to the areas immediately adjacent to the stream courses.

9.3.2 Vegetation Types (continued)

Mountain Grassland. The mountain grassland type occurs on steep, dry slopes intermixed with the pinyon-juniper-curl leaf mountain mahogany and sagebrush types. At lower elevations Salina wild rye occurs as the dominant species. At higher elevations major species include muttongrass, Lettermann needlegrass, and broom snakeweed (*Gutierrezia sarothrae*).

Rock Outcrop. The rock outcrop type was used to map the extent of essentially non-vegetated rock outcrops. The rock outcrops mainly consist of massive sandstone. In these areas plants are restricted to the small cracks in the rocks.

Fire appears to be a frequent event near the Huntington No. 4 permit area. Based on vegetation characteristics, at least two fire dates have been identified and mapped, 1964 and pre-1964. Refer to the Vegetation Map, Plate 9-1. Since the 1964 fire there has been considerable recovery of the burned areas. Stands of aspen woodlands which were burned have become partially re-established and are dominated by dense stands of aspen saplings. Fires in the aspen woodland type tend to totally destroy the canopy. However, unlike the coniferous species, aspen regenerates quite quickly by the development of root sprouts. For this reason many of the burned aspen stands have already developed into low woodlands and were not mapped as a separate type.

Evidence of fire in the mountain grassland and big sagebrush shrubland types is limited, since these types recover more quickly than the coniferous forest type. Some grassland stands show little or no evidence of past burns, while others have dead coniferous snags still standing with very little regrowth of coniferous saplings. In these areas it appears that the recovery from past fires is quite slow.

9.3.2 Vegetation Types (continued)

The mixed coniferous forest stands which were burned prior to 1964 still show limited recovery with the sites being dominated by saplings and small individuals of the major coniferous species. For these reasons, an additional vegetation type called burned mixed coniferous forests was included to more accurately portray the vegetation in the burned areas.

However, since much of the vegetation within the other burned areas has recovered to some extent, those areas were mapped on the basis of the communities which are currently developing.

9.3.2.1 Cover Data

All of the surface area which as been disturbed is within the Pinyon-Juniper-Curl Leaf Mountain Mahogany vegetation type, therefore the reference area cover data was taken only for this type.

Three species reach tree status in this stand (Table 9-2). The canopy vegetation is dominated by pinyon pine with a mean canopy cover of 3.0%. Utah juniper is the second most important species with a canopy cover of 0.6%. The number of trees per ha is 230 with a total basal area of 13.01 m^2/ha.

Four species of shrubs make up the shrub layer (Table 9-3). Curl-leaf mountain mahogany and pinyon pine are the most common shrubs having % frequency of 32.5 and 25.0, respectively. There are 239 shrubs/ha having a total cover of 40.0+ m^2/ha.

TABLE 9-2. PINYON-JUNIPER WOODLAND. Reference Area. Cover, frequency, density, and basal area summaries for tree layer species. Based on data from 40 7m x 15m line-strip transects. 1981 data.

Species	No. of Trees	Frequency (%)	Mean Canopy Cover	Density Individuals per hectare	No. of Stems per hectare	Mean Stem Diameters + S.D. (cm)	Mean Basal Area per Stem + S.D. (cm^2)	Basal Area per hectare (m^2)
Cercocarpus ledifolius	30	45.0	0.5	71	107	11.01 + 4.86	113.36 + 94.54	1.21
Juniperus osteosperma	17	37.5	0.6	40	57	21.27 + 8.75	412.80 + 303.61	2.36
Pinus edulis	50	70.0	3.0	119	140	26.06 + 13.39	617.70 + 652.44	9.44
TOTAL			4.1	230	304			13.01

Table 9-3. PINYON-JUNIPER WOODLAND. Reference Area. Cover, frequency, and density summaries for shrub species. Based on data from 40 3m x 15m line-strip transects. 1981 data.

Species	Height Class*	Mean Cover (%)	Relative Cover (%)	Frequency (%)	Density (no. ind. per hectare) By Height Class	Density (no. ind. per hectare) Total ± S.D.	Density (no. stems per hectare) By Height Class	Density (no. stems per hectare) Total ± S.D.
Cercocarpus ledifolius	Total	0.2	50.00	32.5		89 ± 158		106 ± 220
	I				28		28	
	II				17		17	
	III				22		22	
	IV				22		39	
Chrysothamnus viscidiflorus	Total	0.1	0.01	2.5		6 ± 36		6 ± 36
	I				6		6	
Juniperus osteosperma	Total	0.1	25.00	17.5		72 ± 204		72 ± 204
	I				33		33	
	II				22		22	
	III				17		17	
Pinus edulis	Total	0.1	25.00	25.0		72 ± 138		72 ± 138
	I				22		22	
	II				22		22	
	III				11		11	
	IV				17		17	
TOTAL		0.4+%				239 ± 300		256 ± 329

*Height Class I = 0.25 m - 0.75m, Class II = 0.76m - 1.50m, Class III = 1.51m - 2.25m, Class IV = 2.25m

9.3.2.1 Cover Data (continued)

The herbaceous ground cover consisted of 4 graminoid, 2 shrub, and 6 forb species (Table 9-4). Seedlings of both pinyon pine and curl-leaf mountain mahogany were noted. The total percent vegetative ground cover including lichens and mosses was approximately 12.2%. Approximately 95.9% of this cover consisted of graminoids. Salina wildrye dominates the layer, making up 88.9% of the total herbaceous cover. The non-vegetative ground cover consisted of 15.8% rock and 66.9% litter.

9.3.2.2 Production Data

Despite the fact production data for a reference area need not be taken until the time of comparison with a revegetated area, production figures were taken in 1981. Such information expands Beaver Creek Coal Company's data base and will be compared with those figures derived at the time of final reclamation.

The total average dry weight production for 40 $1m^2$ quadrats in reference area was 30.8 g/m^2. (Table 9-5). Salina wildrye makes up approximately 98.1% of the production in the ground layer.

9.3.2.3 Sample Adequacy

Sample adequacy was attained for vegetation cover, for shrub density, and for tree density (Table 9-6). Based on the sample adequacy equation, an additional 29 production samples would be required to obtain adequacy. However, the maximum number of 40 samples required by the Utah DOGM was obtained.

TABLE 9-4. PINYON-JUNIPER WOODLAND. Reference Area. Cover, frequency, and species diversity summaries for herb layer components. Based on data from 40 1m quadrats. 1981 data.

	Mean Cover (%)	Relative Cover (%)	Range of Cover Values	Percent Frequency	Relative Frequency (%)	I.V.*	Rank
PERENNIAL GRASSES AND SEDGES							
Agropyron trachycaulum	0.3	2.38	0- 5	7.5	3.80	6.18	6
Carex rossii	0.2	1.59	0- 2	20.0	10.13	11.72	3
Elymus salinus	11.2	88.89	4- 19	100.0	50.63	139.52	1
Oryzopsis hymenoides	0.1	0.01	0 - 1	2.5	1.27	1.27	7
Sub-Total	11.7	92.86					
FORBS							
Astragalus diversifolius	0.1	0.01	0- 1	2.5	1.27	1.27	7
Cryptantha humilis	0.2	1.59	0- 1	32.5	16.46	18.05	2
Phlox longifolia	0.1	0.01	0- 1	2.5	1.27	1.27	7
Salsola kali	0.1	0.01	0- 1	2.5	1.27	1.27	7
Senecio sp.	0.1	0.01	0- 1	2.5	1.27	1.27	7
Sisymbrium linifolium	0.1	0.01	0- 1	15.0	7.59	7.59	5
Sub-Total	0.2	1.59					
SHRUBS							
Cercocarpus ledifolius	0.7	5.56	0- 25	7.5	3.80	9.36	4
Pinus edulis	0.1	0.01	0- 1	2.5	1.27	1.27	7
Sub-Total	0.7	5.56					

TABLE 9-4 (Continued) PINYON-JUNIPER WOODLAND. Reference area.

	Mean Cover (%)	Range of Cover Values
Sum of Species Cover	12.5	4- 33
Total Woody Cover	0.7	0- 25
Total Herbaceous Cover	6.0	5- 21
Lichens	1.0	0- 9
Mosses	0.1	0- 3
Litter	66.9	12-100
Rock	15.8	0- 78
Bare Soil	17.2	0- 36
Evaluation of the herb layer and ground layer as a single unit. The values in this section add to 100 percent for each quadrat.		
Total Vegetation	12.2	4- 25
Litter/Rock	70.6	51- 91
Bare Soil	17.2	0- 36
Number of Species per Square Meter	Mean ± S.D.**	Range
Herb Species	1.88 ± 0.97	1-5
Woody Species	0.10 ± 0.30	0-1
Total Species	1.98 ± 1.07	1-5

* Importance Value (I.V.) = Relative Cover + Relative Frequency
** + values equal the standard deviation (S.D.)

TABLE 9-5. PINYON-JUNIPER WOODLAND. Reference area. Mean production ± the standard deviation (S.D.). Based on data from 40 $1m^2$ quadrats. 1981 data.

Species	Mean ± S.D. (grams/m^2)	Mean ± S.D. (lbs/acre)	Percent of Total Biomass
PERENNIAL GRASSES AND SEDGES			
Agropyron trachycaulum	0.11 ± 0.072	1 ± 1	0.04
Carex sp.	0.394 ± 1.155	4 ± 10	1.28
Elymus salinus	30.218 ± 19.842	270 ± 177	98.05
Poa sp.	0.018 ± 0.111	1 ± 1	0.06
Sub-Total	30.641 ± 19.529	274 ± 174	
ANNUAL FORBS	0.002 ± 0.007	1 ± 1	0.01
PERENNIAL FORBS	0.175 ± 0.310	2 ± 3	0.57
TOTAL PRODUCTION	30.818 ± 19.538	275 ± 174	

TABLE 9-6. Evaluation of sample adequacy for the Pinyon-Juniper Woodland reference area sampled at the Huntington Canyon No. 4 Mine.

	Sample Size (n)	Mean + Standard Deviation	Degrees of Freedom (n-1)		Value of t (one-tailed)	Computed Adequate Sample Size (n_{ade})
VEGETATION COVER	40	12.18 ± 4.63	39	0.1	1.304	25
HERBACEOUS LAYER PRODUCTION (grams/m^2)	40	30.818 ± 19.538	39	0.1	1.304	68
DENSITY (No. Ind./Plot)						
Shrubs						
Stems	40	1.15 ± 1.48	39	0.2	0.851	30
Individuals	40	1.08 ± 1.35	39	0.2	0.851	29
Trees						
Stems	40	3.20 ± 2.34	39	0.2	0.851	10
Individuals	40	2.43 ± 1.50	39	0.2	0.851	7

9.3.2.4 Species List

The plant list resulting from the survey is presented in Table 9-7. The table is arranged an alphabetical order by plant family. Species are identified in the table according to common name, scientific name, growth form, and occurrence by plant community. Species identification was from Cronquist et al (1972, 1977), Welsh and Moore (1973) and Weber (1976).

The list includes 71 species, 58 genera, and 24 families of vascular plants. The families with the most numerous species in the list are the Poaceae, grass family, (16) and the Asteraceae, sunflower family, (7). The flora of the lease area consists of 31.0% forbs, 23.9% shrubs, 26.8% graminoids, and 18.3% tree species.

9.3.2.5 Mine Plan Area Acreage, Acreage by Vegetation Types and Acreage of Types Affected

There are approximately 1,320 acres within the lease area. A list of approximate acres of each vegetation type as planimetered was given earlier in Table 9-1.

The 78 acres of affected land was all previously covered by a Pinyon-Juniper type of vegetation.

9.3.2.6 Reference Area Supporting Data

The reference area is located in an area above the mine portal (Plate 9-1). The majority of this area has been mapped as part of the Patmos-Podo soil association with a portion in the northwest section mapped as Rockland. These same units are the predominant remaining undisturbed units mapped within the disturbed area. The slopes, topography and aspect of the reference area are

Table 9-7

PLANT SPECIES OBSERVED ON
HUNTINGTON CANYON MINE NO. 4 LEASE AREA
EMERY COUNTY, UTAH, 1980

Common Name	Family/Scientific Name	Growth Form	Pinyon-Juniper Woodland	Sagebrush-Grassland	Oak Shrubland	Douglas Fir	Wetland Riparian
MAPLE FAMILY	ACERACEAE						
Bigtooth maple	*Acer grandidentatum*	Tree			X		
BARBERRY FAMILY	BERBERIDACEAE						
Oregon grape	*Mahonia repens*	Shrub	X	X	X	X	
BORAGE FAMILY	BORAGINACEAE						
Catseye	*Crypthantha abata*	Forb	X				
Houndstongue	*Cynoglossum officinale*	Forb	X	X	X	X	
Stickseed	*Lappula occidentalis*	Forb	X	X	X	X	
Puccoon	*Lithospermum* sp.	Forb	X				
CACTUS FAMILY	CACTACEAE						
Aggregate cactus	*Echinocereus triglochidiatus* var. *melanacanthus*	Shrub	X	X			
HONEYSUCKLE FAMILY	CAPRIFOLIACEAE						
Elderberry	*Sambucus coerulea*	Shrub	X			X	
Snowberry	*Symphoricarpos vaccinoides*	Shrub			X	X	
GOOSEFOOT FAMILY	CHENOPODIACEAE						
Halogeton	*Halogeton glomeratus*	Forb	X				
Summer cypress	*Kochia scoparia*	Forb	X				
Russian thistle	*Salsola kali*	Forb	X				

Table 9-7 (continued)

PLANT SPECIES OBSERVED ON
HUNTINGTON CANYON MINE NO. 4 LEASE AREA
EMERY COUNTY, UTAH, 1980

Common Name	Family/Scientific Name	Growth Form	Pinyon-Juniper Woodland	Sagebrush-Grassland	Oak Shrubland	Douglas Fir	Wetland Riparian
SUNFLOWER FAMILY	ASTERACEAE						
Yarrow	Achillea millefolium	Forb		X	X	X	
Big sagebrush	Artemisia tridentata	Shrub		X			
Rabbitbrush	Chrysothamnus nauseosus var. albicaulis	Shrub		X	X		
Rabbitbrush	Chrysothamnus viscidiflorus	Shrub		X	X		
Thistle	Cirsium undulatum	Forb	X	X	X		
Snakeweed	Gutierrezia sarothrae	Shrub	X	X	X		
	Machaeranthera grindelioides	Forb	X				
	Machaeranthera sp.	Forb	X	X			
DOGWOOD FAMILY	CORNACEAE						
Red osier dogwood	Cornus stolonifera	Shrub					X
CYPRESS FAMILY	CUPRESSACEAE						
Mountain common juniper	Juniperus communis	Shrub	X			X	
Utah Juniper	Juniperus osteosperma	Tree	X				
Rocky Mountain juniper	Juniperus scopulorum	Tree	X		X	X	
SEDGE FAMILY	CYPERACEAE						
Sedge	Carex sp.	Graminoid					X
Spikerush	Eleocharis sp.	Graminoid					X
HEATH FAMILY	ERICACEAE						
Greenleaf manzanita	Arctostaphylos patula	Shrub			X		

Table 9-7 (continued)

PLANT SPECIES OBSERVED ON
HUNTINGTON CANYON MINE NO. 4 LEASE AREA
EMERY COUNTY, UTAH, 1980

Common Name	Family/Scientific Name	Growth Form	Pinyon-Juniper Woodland	Sagebrush-Grassland	Oak Shrubland	Douglas Fir	Wetland Riparian
BEECH FAMILY	FAGACEAE						
Gambel oak	Quercus gambelii	Tree			X		
GRASS FAMILY	POACEAE						
Crested wheatgrass	Agropyron cristatum	Graminoid	X	X			
Tall wheatgrass	Agropyron elongatum	Graminoid	X	X			
Bluebunch wheatgrass	Agropyron spicatum	Graminoid	X				
Slender wheatgrass	Agropyron trachycaulum	Graminoid	X	X			
Redtop	Agrostis stolonifera	Graminoid					X
Nodding brome	Bromus anomalus	Graminoid	X				
Reedgrass	Calamogrostis scopulorum	Graminoid	X			X	
Salina wildrye	Elymus salinus	Graminoid	X	X	X		
Wildrye	Elymus simplex	Graminoid	X				
Meadow barley	Hordeum brachyantherum	Graminoid		X			X
Junegrass	Koeleria nitida	Graminoid	X				
Foxtail muhly	Muhlenbergia andina	Graminoid					X
Indian ricegrass	Oryzopsis hymenoides	Graminoid	X				
Timothy	Phleum pratense	Graminoid	X				
Leiberg bluegrass	Poa leibergii	Graminoid	X				
Nodding bluegrass	Poa reflexa	Graminoid	X				
RUSH FAMILY	JUNCACEAE						
Rush	Juncus ensfolius	Graminoid					X
PEA FAMILY	FABACEAE						
Milkvetch	Astragalus sp.	Forb	X	X			
Silky lupine	Lupinus sericeus	Forb		X			
Alfalfa	Medicago sativa	Forb		X	X		

Table 9-7 (continued)

PLANT SPECIES OBSERVED ON
HUNTINGTON CANYON MINE NO. 4 LEASE AREA
EMERY COUNTY, UTAH, 1980

Common Name	Family/Scientific Name	Growth Form	Pinyon-Juniper Woodland	Sagebrush-Grassland	Oak Shrubland	Douglas Fir	Wetland Riparian
LILY FAMILY	LILIACEAE						
Mariposa lily	Calochortus sp.	Forb		X			
False Solomonsseal	Smilacina racemosa	Forb					X
EVENING PRIMROSE FAMILY	ONAGRACEAE						
Willoweed	Epilobium halleanum	Forb					X
PINE FAMILY	PINACEAE						
Subalpine fir	Abies lasiocarpa	Tree				X	
Englemann spruce	Picea engelmannii	Tree				X	
Pinyon pine	Pinus edulis	Tree	X				
Intermountain bristlecone pine	Pinus longaeva	Tree				X	
Ponderosa pine	Pinus ponderosa	Tree	X			X	
Douglas fir	Pseudotsuga menziesii	Tree	X			X	
BUTTERCUP FAMILY	RANUNCULACEAE						
Virgin's bower	Clematis pseudoalpina	Forb				X	
Columbine	Aquilegia sp.	Forb	X				
ROSE FAMILY	ROSACEAE						
Curl-leaf mountain mahogany	Cercocarpus ledifolius	Shrub	X				
Alder-leaf mountain mahongany	Cercocarpus montanus	Shrub	X				

Table 9-7 (continued)

PLANT SPECIES OBSERVED ON
HUNTINGTON CANYON MINE NO. 4 LEASE AREA
EMERY COUNTY, UTAH, 1980

Common Name	Family/Scientific Name	Growth Form	Pinyon-Juniper Woodland	Sagebrush-Grassland	Oak Shrubland	Douglas Fir	Wetland Riparian
ROSE FAMILY (cont'd)	ROSACEAE						
Ninebark	Physocarpus capitatus	Shrub	X				
Chokecherry	Prunus virginiana	Tree					X
Bitterbrush	Purshia tridentata	Shrub	X		X		
WILLOW FAMILY	SALICACEAE						
Narrow leaf cottonwood	Populus angustifolia	Tree					X
Aspen	Populus tremuloides	Tree				X	
Willow	Salix sp.	Shrub					X
SAXIFRAGE FAMILY	SAXIFRAGACEAE						
Gooseberry	Ribes cereum	Shrub	X		X	X	
	Ribes sp.						
FIGWORT FAMILY	SCROPHULARIACEAE						
Indian paintbrush	Castilleja sp.	Forb		X			
Beardstongue	Penstemon sp.	Forb		X	X		
CARROT FAMILY	APIACEAE						
Chimaya	Cymopterus fendieri	Forb	X				

9.3.2.6 Reference Area Supporting Data (continued)

very similar to those on the disturbed area. Vegetation is also very similar, with both areas mapped as being within the Pinyon-Juniper-Curl leaf Mountain Mahogany vegetation type.

9.4 Threatened and Endangered Plant Species

Currently, eight species are listed as endangered or threatened in Utah. None of these threatened or endangered species, as defined and identified by the U.S. Department of Interior, Fish and Wildlife Service (USDI, 1980), were observed at Huntington Canyon No. 4 Mine. *Sclerocactus wrightiae*, is known to occur in Emery County. This species occurs on the Emery Sandstone Member of the Mancos Shale Formation at elevations of 3000 to 5000 feet (USDI, 1979). This formation and range of elevations do not occur on the Huntington Canyon No. 4 Mine.

No species are currently proposed as endangered or threatened in Utah (USDI, 1980). One hundred and sixty-nine plant taxa are currently considered candidate species (USDI, 1980). At some future date, some of these species may be proposed for endangered or theatened status. Of these species, five are known to occur in Emery County. The San Rafael milkvetch (*Astragalus rafaelensis*) occurs in central Emery County in salt desert shrub and scattered juniper communities at elevations of 4500 to 5300 feet. The Johnston catseye (*Cryptantha johnstonii*) also occurs in central Emery County on the Carmel Formation at elevations of 5200 to 6000 feet. Jones catseye (*Cryptantha jonesiana*) occurs in central Emery County on the Sinbad Member of the Moenkopi Formation in pinyon-juniper and mixed desert shrub communities at 5200 to 6200 feet in elevation. Smith buckwheat (*Eriogonum smithii*) occurs in southern Emery County in the desert shrub community at an

9.4 Threatened and Endangered Plant Species (continued)

elevation of 4500 to 5500 feet. Yellow blanket flower (*Gaillardia flava*) occurs in eastern Emery County on the Mancos Shale Formation along alluvial fans and river terraces. It occurs in *Salix-Populus* communities at elevations of 4200 to 5400 feet. These elevations, geologic formations, and/or vegetational communities do not occur on the Huntington Canyon Mine No. 4 lease area.

9.5 Effects of Mining Operations on Vegetation

All anticipated surface disturbance and effects on vegetation have already taken place.

A total of 78 acres of pinyon-juniper vegetation as been removed as a result of mining. An additional 9.2 acres was disturbed prior to mining by the construction of a National Forest Service Road through the area of the lease which has also been disturbed by mining.

9.6 Mitigation and Management Plans

As noted previously the Huntington Canyon No. 4 Mine is an existing operation. Therefore, mitigation and management measures have been designed to prevent additional impacts of continued mining and to facilitate rapid return of the site to productive use after decommissioning.

The relatively small-scale disturbance associated with the mining operation will be mitigated upon completion of the project by reclaiming the disturbed sites with an approved seed mix. The plant mix was selected to offer a diverse assemblage of herbaceous and woody species that are adapted to onsite conditions and are of

9.6 Mitigation and Management Plans (continued)

known value to wildlife for cover, forage, or both. The comprehensive reclamation procedure is fully described in Section 3.5, Reclamation Plan.

Disturbance of the riparian vegetation along Mill Fork Canyon is being controlled by maintaining (1) a buffer strip adjacent to the stream, and (2) a diversion system to keep mine runoff away from the stream. A reclamation plan is provided in Appendix 8, for this area.

No domestic grazing will be allowed on final reclaimed areas for at least three growing seasons after planting.

9.7 Revegetation Methods

Seeding

Disturbed areas in or adjacent to the mine site will be temporarily reclaimed in anticipation of final site reclamation. The temporary seed mix will consist of the grass and forb species mentioned in Section 3.4.5. No shrubs will be planted to discourage wildlife utilization of such species in close proximity to the mine site.

Disturbed areas within the permit area, but not adjacent to the mine site, will be revegetated with the grass-forb mix mentioned in Section 3.4.5. In addition, areas requiring future access will be planted with low-growing shrubs. Areas not requiring future access will be planted with the stratified shrubs listed in Section 3.4.5.

Areas of final site reclamation will be seeded with the grass-forb mixture listed in Section 3.4.5 with the stratified shrubs.

9.7 Revegetation Methods (continued)

Seeding

This species list and arrangement may be modified as additional knowledge becomes available and on-site experience is gained through temporary reclamation. On-site personnel will maintain records of actual methodology. Practical and effective seeding of shrubs will be determined through on-site experience and related research at comparable minesites. Shrubs will be planted as seeds, bare rootstock and/or containerized shrubs. Options to plant with the initial mix or interseed at a later date will remain open.

The suggested Forest Service rate will be applied to selected temporary reclaimed areas, in addition to the Beaver Creek Coal Company proposed rate. Through visual comparison, the better seeding rate may be determined.

Seeding of grasses and forbs as well as planting of any shrub seedlings will occur during the first desirable planting season after final grading either during the spring (March 15-June 15) or fall (September 15-November 15). Planting and seedbed preparation will occur only when soils are not frozen or extremely wet or dry. Air temperatures should be above freezing during the night. Soil should be friable and not wet or cloddy.

Mulching

To protect newly reclaimed areas against erosion, excessive drying or frost heaving, seeded areas will be mulched unless it is determined by the Division of Oil, Gas and Mining that the requirement be suspended.

9.7 Revegetation Methods (continued)

Mulching (continued)

Mulches will be mechanically or chemically "anchored" to the soil surface depending upon the type of mulch used. Since most recontoured slopes at the mine are steep and access is limited, mulching will take place through the use of a hydroseeder.

Various stabilizing schemes may be utilized, depending upon site conditions at the time of seeding. Natural fiber mulches such as straw or wood, in addition to various other organic mulches, may be utilized. Erosion control devices such as excelsior, jute-netting, synthetic netting or other appropriate means may be utilized solely or in conjunction with mulching on selected areas.

Where synthetic materials are not used, organic mulches will be applied at a rate ranging from 1500-2500 pounds per acre, dependent upon site conditions. Synthetic devices will be installed according to the manufacturer's recommendations.

Revegetation Management

Observations of the reclaimed areas will determine if maintenance is necessary for areas of soil erosion, weed control, pest control, reseeding of small areas and maintenance fertilization.

Soil on eroded areas will be reworked and subsequent soil erosion controlled through the use of mulch, chemical stabilizers, or other appropriate techniques. Gullies will be filled and stabilized. During revegetation, activities will be conducted parallel to the contour.

9.8 Revegetation Monitoring

Observations on temporarily reclaimed surfaces will determine necessary maintenance requirements. No formal quantitative assessments on temporarily reclaimed surfaces will be made. Final revegetated area success will be compared with an established reference area as shown on Plate 9-1 and described in Section 9.3.2.6.

Final reclaimed areas will be monitored at least every two years following plant establishment until bond release. Both the final reclaimed area and reference area will be sampled for cover, density (woody plants), species composition, and production during each monitoring period. Sampling methodology and sampling adequacy will meet all applicable DOGM guidelines.

The riparian area, along the Mill Fork drainage at the pumphouse and pond location, will be reclaimed as per Appendix 8. The area to be reclaimed is relatively small, only approximately 35 ft along the Mill Fork drainage. Because the area is considerably less than one acre, a reference area for comparison is not needed.

Sampling methods in the riparian area to monitor revegetation success will be similar to other reclaimed areas. However, an area 100 ft. above and 100 ft. below the reclaimed riparian area along the drainage will be used as a "cover comparison area". The success of the reclamation effort for cover will be evaluated by detailed quantitive sampling. These data will then be statistically compared with data collected from the cover comparison area.

The data from the reclaimed riparian and comparison area will be collected during the same growing season. When compared statistically, if the living cover of the reclaimed area meets or exceeds that of the comparison area with a 90% confidence level (i.e. one sided t-test at the 10% level), the reclaimed area will be considered adequate to meet the success standards. In other words, for cover, the reclaimed area will be equal to or greater than the reference area.

Density of woody species will also be sampled in the reclaimed riparian area. To do this, all woody species to a given width will be counted on both sides of the creek for the entire length of the reclaimed area (approximately 35 linear feet). The sample value unit will then be converted to the number of individuals per acre. The success standard goal will be to reach the equivalent of at least 2,000 woody species individuals per acre along the reclaimed riparian corridor.

In addition, it was necessary to consult the USDA Forest Service for approval to cancel their Special Use Permit in the area. In order to receive Forest Service approval, the area must have been deemed appropriately reclaimed by their standards. This Special Use Permit was cancelled by the USFS and the fence removed approximately 2 years after reclamation.

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9.9 Bibliography

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