QUITCHUPAH AND MUDDY CREEK CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT

(CHIA)

For

Canyon Fuel Company

SUFCO Mine
C/041/0002

In

Sevier County, Utah

December 27, 2005

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I. INTRODUCTION

The Quitchupah and Muddy Creek Cumulative Impact Area (CIA) is located in Sevier County, Utah, west of the town of Emery (Plate 1). There is currently one active mine in the Quitchupah/Muddy Creek CIA – Canyon Fuel Company's SUFCO Mine. Expansion of the SUFCO Mine with the Utah School and Institutional Trust Lands Administration (SITLA) Muddy Tract located north of the existing permit area facilitated this review and update of the Quitchupah/Muddy Creek Cumulative Hydrologic Impact Assessment (CHIA).

The Division has the responsibility to assess the potential for mining impacts both inside and outside permit areas. The CHIA is a findings document prepared by the Division that assesses whether existing, proposed, and anticipated coal mining and reclamation operations have been designed to prevent material damage to the hydrologic balance outside the permit areas. The Division cannot issue a permit to a proposed coal mining operation if the probable, anticipated hydrologic impacts will create material damage to the hydrologic balance outside the permit area. The CHIA is not only a determination if coal mining operations are designed to prevent material damage beyond their respective permit boundaries when considered individually, but also if there will be material damage resulting from effects that may be acceptable when each operation is considered individually but are unacceptable when the cumulative impact is assessed.

The objective of a CHIA document is to:

1. Identify the Cumulative Impact Area (CIA) **(Part II)**

2. Describe baseline conditions in the CIA; identify hydrologic systems, resources and uses; and document baseline conditions of surface and ground water quality and quantity **(Part III)**

3. Identify hydrologic concerns **(Part IV)**

4. Identify relevant standards against which predicted impacts can be compared **(Part V)**

5. Estimate probable future impacts of mining activity with respect to the parameters identified in 4 **(Part VI)**

6. Assess probable material damage **(Part VII)**

7. Make a statement of findings **(Part VIII)**

This CHIA complies with the federal Surface Mining Control and Reclamation Act of 1977 (SMCRA) and subsequent federal regulatory programs under 30 CFR 784.14(f), and with Utah regulatory programs established under Utah Code Annotated 40-10-et seq. and the attendant State Program rules under R645-301-729.

II. CUMULATIVE IMPACT AREA (CIA)

Reviewing Permit Application Packages (PAPs) and Mining and Reclamation Plans (MRPs) alone is not sufficient to assess impacts to the geologic and hydrologic regimes. Specific knowledge of the geology and hydrology is crucial in assessing the dynamics and interactions of chemistry, surface- and ground-water movement, and surface disturbance and subsidence impact associated with the minesites. The Division uses pertinent information from many sources, including federal and state agencies; geological and hydrological reports; textbooks and other publications; site visits; and a knowledge base built on experience and training.

Plate 2 delineates the CIA for current and projected mining in the Quitchupah/Muddy Creek area. The CIA boundary encompasses approximately 89 square miles. It is bounded on the south by Quitchupah Creek and Convulsion Canyon, from a point where Quitchupah Creek crosses State Highway 10, northeast to a point east of Christensen Wash, along Christensen Wash to the ridge that lies east of Rock Wash Canyon, then along the ridge to Muddy Creek. It proceeds northwest along the northeast side of Muddy Creek and along the South Fork of Muddy Creek. The CIA boundary then ranges south along the drainage divide separating Skumpah Canyon drainage from the Quitchupah Canyon drainage from White Mountain south to the ridge separating Mud Spring Hollow from Pine and Broad Hollow.

The SUFCO Mine's permitted coal leases generally comprise three major tracts: the Quitchupah Tract, the Pines Tract, and the SITLA Muddy Tract (Plate 2). A small part of the northeast portion of the Pines Tract extends across the Muddy Creek drainage and outside the CIA. The coal seam ends in the escarpment south of the creek, so the CIA should include all impacts. The mine facilities are located within the Quitchupah Tract and mining activities in the Pines and SITLA Muddy Tracts will take place underground with no planned breakouts or surface disturbances.

SCOPE OF MINING

The Convulsion Canyon Mine commenced operation in 1941, mining federal owned coal. Projected life of the SUFCO Mine is estimated to be about 10 years. The SUFCO permit area encompasses a total of 26,767.14 acres that includes 23,939.92 acres of Federal coal leases, 2,134.19 acres of State of Utah coal leases, 640 acres of fee coal leases, the 40-acre waste rock disposal site, and 13.03 acres under U.S. Forest Service special use permit. Most of the mine and coal processing facilities are located in the Quitchupah Creek drainage, in East Spring Canyon. A coal refuse pile is located approximately 5.3 miles west of the mine facilities. A sedimentation pond is located in East Spring Canyon directly below the mine facilities where disturbed area flow drops down a steep slope to get to the pond. A buried sewage septic system in lower East Spring Canyon treats all mine sewage. There are a total of 46.31 acres of surface area permitted to be disturbed over the life of the mine. Currently, only 27.78 acres are disturbed to be reclaimed.

The majority of coal will be extracted using continuous miner and longwall mining methods. Mining is taking place in only one coal seam, the Lower Hiawatha. Coal is moved by underground conveyor from the face to the portal and facilities in East Spring Canyon where it is loaded into trucks. Table 1 presents the annual production in millions of tons of the SUFCO mine from 1983 to 2004. The production values were obtained from the Utah Energy Office and the U.S. Mine Safety and Health Administration (MSHA). Currently, the SUFCO Mine is the highest producing coal mine in the State of Utah. The mine is currently advancing their longwall in the Pines Tract and developing longwall panels toward the SITLA Muddy Tract.

Table 1
Annual Production in millions of tons
SUFCO Mine

Year	Production	Source
2004	7.6	MSHA
2003	7.1	MSHA
2002	7.6	MSHA
2001	7.0	MSHA
2000	5.9	MSHA
1999	5.8	Utah Energy Office
1998	5.7	Utah Energy Office
1997	4.9	Utah Energy Office
1996	4.6	Utah Energy Office
1995	3.9	Utah Energy Office
1994	3.6	Utah Energy Office
1993	3.6	Utah Energy Office
1992	2.6	Utah Energy Office
1991	3.1	Utah Energy Office
1990	2.9	Utah Energy Office
1989	3.1	Utah Energy Office
1988	2.6	Utah Energy Office
1987	2.2	Utah Energy Office
1986	2.4	Utah Energy Office
1985	1.8	Utah Energy Office
1984	2.1	Utah Energy Office
1983	2.2	Utah Energy Office

III. HYDROLOGIC SYSTEM and BASELINE CONDITIONS

Elevations range from less than 5,000 feet in the lower reaches of Muddy Creek to approximately 9,000 feet in the upper plateau escarpments in the Quitchupah/Muddy Creek CIA (Plate 2). Predominant features that exist in the CIA are sandstone cliffs, narrow steep canyons, valleys, highly exposed rock formations and an extensive fracture system. Drainage in the CIA is characterized by the two major drainage systems of Quitchupah and Muddy Creeks which are perennial streams with headwaters that originate at elevations of 7,500 to 9,000 feet.

Surface-water resources in the CIA consist of streams and man-made stock watering ponds. Most of the stream flow is attributed to runoff from snowmelt or rain. Spring flow contributes the most to the baseflow of the streams in later summer and fall months. Streams appear to be perennial for most of their length, but the low flows that emanate from springs in the upper reaches leave some to question if the streams are instead intermittent.

Ground-water resources consist of springs and a mine-water discharge. The ground-water patterns have been analyzed and their flow patterns are discussed in the following sections. The latest information used to make a finding of the ground-water patterns was compiled by Mayo and Associates and Petersen Hydrologic, Inc. for the SUFCO Mine. Data were collected at springs, wells, in-mine flows, and a mine discharge site. A previous water resource study was conducted by the U.S. Geologic Survey (Thiros and Cordy, 1991).

GEOLOGY

The geology of the CIA consists of stratigraphic units of rock ranging in age from Late Cretaceous to Tertiary (Eocene) as seen in Table 2 and Plate 3. The oldest exposed rocks include members of the Mancos Shale. The Mesaverde Group overlies the Mancos Shale and consists of the Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and Price River Formation. Overlying the Mesaverde Group are the North Horn Formation, Flagstaff Limestone, Colton Formation, and Green River Formation that, in this area, constitute the Wasatch Group of Paleocene to Eocene age. The Flagstaff Limestone is the uppermost consolidated formation in the CIA. Unconsolidated deposits formed by weathering and erosion exist as soils, terrace deposits and gravels along canyon streams, and pediments at the base of escarpments.

There are no major disconformities. Dip is approximately 2^{o} to the northwest due to the rise of the San Rafael Swell located to the southeast.

North-south oriented faults are common in the Wasatch Plateau. At least 200 feet of offset on one of these faults formed the closed basin that holds Accord Lakes, located 6 miles southwest of the SUFCO Mine. Lisonbee Spring issues from this fault. Offsets on bounding faults of the Joes Valley graben, which lies only a few miles east of the SUFCO Mine, approach 1,000 feet.

Neither Spieker (1931), Doelling (1972), nor Thiros and Cordy (1991) mapped any faults within the CIA between the Accord Lakes fault and Joes Valley graben. A group of ten echelon normal faults have been mapped between East Spring Canyon and Duncan Mountain: vertical offsets are indicated on Plate H-II of Appendix 7-2 of the MRP as being greater than 2 feet. Another group of parallel faults, located north of Duncan Mountain, is shown between the South and North Forks of Quitchupah Creek on Plate 6-1: the basis for mapping these faults is unknown but is assumed to be photo geology. Two short faults mapped near the head of Box Canyon were encountered in the mine, but may not show at the surface. Strike of all these faults is approximately N 25 ^{0} W to N 30 ^{0} W.

Most faults within the SUFCO Mine have displacements of less than a foot, but a fault encountered near Duncan Draw had 16 feet of displacement (oral communication from Chris Kravits, mine geologist, reported by both Thiros and Cordy (1991), and Mayo and Assoc. (1997)).

Fractures measured in the SUFCO Mine strike generally N 26 ^{0} W. Fractures observed in the Castlegate Sandstone, Blackhawk Formation, and Star Point Sandstone are oriented N 20 ^{0} W to N 27 ^{0} W, and strongly influence surface drainage development. Orientation of a secondary set of fractures, measured at a Castlegate Sandstone outcrop, centered on N 65 ^{0} E (Thiros and Cordy, 1991).

The Castlegate Sandstone does not contain an extensive ground-water system, as evidenced by low discharge rates from springs and lack of water in some drill-holes and wells. Ground-water systems that feed Castlegate springs are localized, and recharged on the plateau. Spring discharge hydrographs show flow is strongly dependent on precipitation and snowmelt. Flow is through fractures and intergranular spaces in weathered rock. Near cliff faces and along stream bottoms, the Castlegate Sandstone becomes friable and more able to transmit ground water due to dissolution of carbonate cement.

The upper Blackhawk Formation is dominantly massive, fine- to medium- grained sandstones deposited in deltaic and floodplain environments. These sandstones are separated vertically and laterally by overbank and interdeltaic deposits of shale and mudstone. Sandstone decreases towards the base of the Blackhawk and the sandstone units become even more separated and isolated. Swelling clays throughout the Blackhawk decrease the effectiveness of fractures as conduits for water.

Mining operations are restricted to the lower Blackhawk Formation, where the main coal seam is the Upper Hiawatha. The Lower Hiawatha Seam is thick enough and is separated from the Upper Hiawatha by sufficient interburden to allow it to be mined in the western portion of the Quitchupah tract. The Duncan Seam, above the Upper Hiawatha, is of minable thickness over only 50 acres, so it is not economical to mine. Overburden thickness over the Upper Hiawatha ranges from approximately 600 feet to 1,800 feet and averages 800 feet. Large areas where coal seams have burned and fired the rock to resistant, reddish clinker are exposed in the canyon walls.

Table 2
Generalized Stratigraphy of the Quitchupah/Muddy Creek Area

Flagstaff Limestone	500 feet		Freshwater limestone with thin beds of shale, weathers light-gray to cream-color.
North Horn Formation	400 feet		Variegated shale and siltstone interbedded with sparse, thin sandstone, limestone, and conglomerate.
Price River Formation	550 feet	Upper Member	Medium- to coarse-grained sandstone, some conglomerate, and interbedded gray shale.
	100 to 250 feet	Castlegate Sandstone Member	Light gray, fine- to coarse-grained massive sandstone, partly conglomeratic, with interbedded siltstone and claystone.
Blackhawk Formation	700 to 900 feet	Upper	Massive, fine- to medium-grained sandstone with thin shale layers and coal seams.
		Lower (Coal seams)	Thin bedded, lenticular sandstone, interbedded with carbonaceous shales and thick coal seams. Intertongues with Star Point Sandstone at base.
	200 feet	Star Point Sandstone Member	Light gray, medium-grained massive sandstone at top. Interbedded with Mancos Shale at base.
Mancos Shale	500 to 800 feet	Masuk Member	Highly-erodible calcareous, gypsiferous, and carbonaceous dark marine shale. Intertongues with Star Point Sandstone
	800 feet	Emery Sandstone	Medium- to fine-grained sandstone with silty shale.
	2,000 + feet	Blue Gate Shale	Blue-gray shale. Only the uppermost 200 to 300 feet are exposed in the vicinity of the Quitchupah and Pines tracts.

Regional aquifer is a phrase commonly used by mine operators in the Book Cliffs and Wasatch Plateau coal fields. In such usage, regional aquifer usually refers to any water found in the Star Point Sandstone and Blackhawk Formation irrespective of quality, quantity, use, storage, flow and transport, and discharge. In preparing this CHIA, the Division has adhered to the definition of *aquifer* as found in the Coal Mining Rules (R645-100-200), and the term regional aquifer has been deliberately used or avoided, as appropriate, throughout this CHIA. Although there are local perched and fracture-related aquifers in the Quitchupah/Muddy Creek CIA, the quality, quantity, use, storage, flow and transport, and discharge of ground water do not indicate the presence of a regional aquifer or aquifer system. After evaluating the geologic and hydrologic evidence, the Division does not consider the saturated strata in the Star Point, Blackhawk and associated formations in the East Mountain CIA to be a regional aquifer.

<u>Hydraulic Conductivity and Permeability</u>

In sedimentary rocks, there is a wide range of textures or fabrics that determine the hydraulic characteristics of the unfractured medium. These textures or fabrics are related to the mineralogy or composition of the sediments, the range of sizes of the sedimentary particles (sorting), the spatial distribution of different sediment-sizes (grading), the shape and spatial orientation or arrangement of the sediment particles after compaction (packing), cementation, and properties acquired or altered as and after the sediments were lithified. Lateral and vertical variations in these characteristics can create internal low-permeability zones or barriers, so that a unit that to the eye appears to be very uniform and to have aquifer characteristics can actually be incapable of storing or transporting water in any significant amount. Such vertical and lateral inhomogeneities are common within sandstone units of the Blackhawk and Price River Formations and in the Star Point Sandstone.

Based on slug tests and determinations from core samples, hydraulic conductivity of the Star Point Sandstone is typically low, so movement of ground water through the unfractured sandstone is slow and unfractured Star Point Sandstone is not generally considered to be an aquifer. However, hydraulic conductivity values within the Star Point Sandstone vary through several orders-of-magnitude, and unfractured units in the Star Point Sandstone can locally transmit sufficient ground water to sustain small springs or wells. (As a very general rule-of-thumb, aquifers have hydraulic conductivities of 10^{-5} cm/sec or greater.) Strata above the Star Point Sandstone have hydraulic conductivities that are generally as low or lower than those in the Star Point Sandstone.

<u>Swelling Clays</u>

The interbedded claystones, siltstones, and sandstones of the Wasatch Plateau are rich in swelling clay minerals of the montmorillonite or smectite group. Swelling clays absorb water and expand to as much as 150 percent of their dry volume. These swelling clays reduce the hydraulic conductivity of the rock or soil that contains them and contribute to the rapid closing or healing of tension fractures that result from subsidence. Genwal Resources, Inc. examined six shale and siltstone samples from the Blackhawk Formation in the East Mountain region of the

Wasatch Plateau located approximately 25 miles northeast of the Quitchupah/Muddy Creek CIA. The samples were analyzed by X-ray diffraction and cross-polarized light microscopy and it was found the samples contained 3 to 34 percent smectitic clays, with an average of 24 percent. Siltstones and shales in the Castlegate (three samples) averaged 19 percent smectitic clay, and the Price River Formation (three samples) 15 percent. Non-swelling clays, which also inhibit ground-water flow, constituted an additional 1 to 6 percent of the rock volume (Crandall Canyon Mine MRP, App. 7-41).

CLIMATE

In the Quitchupah/Muddy Creek CIA, temperatures are elevation dependent and range from 32^{O} to 90^{O} F in the summer and -10^{O} to 40^{O} F in the winter. Prevailing winds are from the west and northwest. Annual precipitation ranges from 10 inches per year at lower elevations to more than 20 inches per year at higher elevations. Approximately half of the total annual precipitation falls during localized thunderstorm events from July through November (Thiros and Cordy, 1991).

The Palmer Hydrologic Drought Index (PHDI) indicates long-term climatic trends for the region. The PHDI is a monthly value generated by the National Climatic Data Center (NCDC) that indicates the severity of a wet or dry spell. The PHDI is computed from climatic and hydrologic parameters such as temperature, precipitation, evapotranspiration, soil water recharge, soil water loss, and runoff. Because the PHDI takes into account parameters that affect the balance between moisture supply and moisture demand, it is useful for evaluating the long-term relationship between climate and groundwater recharge and discharge. The Quitchupah/Muddy Creek CIA straddles the boundary between PHDI Regions 4 and 7 and is near Region 5. Figure 1 shows the PHDI for 1977 through 2004. The area was in a drought, at times extreme drought, from 2000 to the end of 2004.

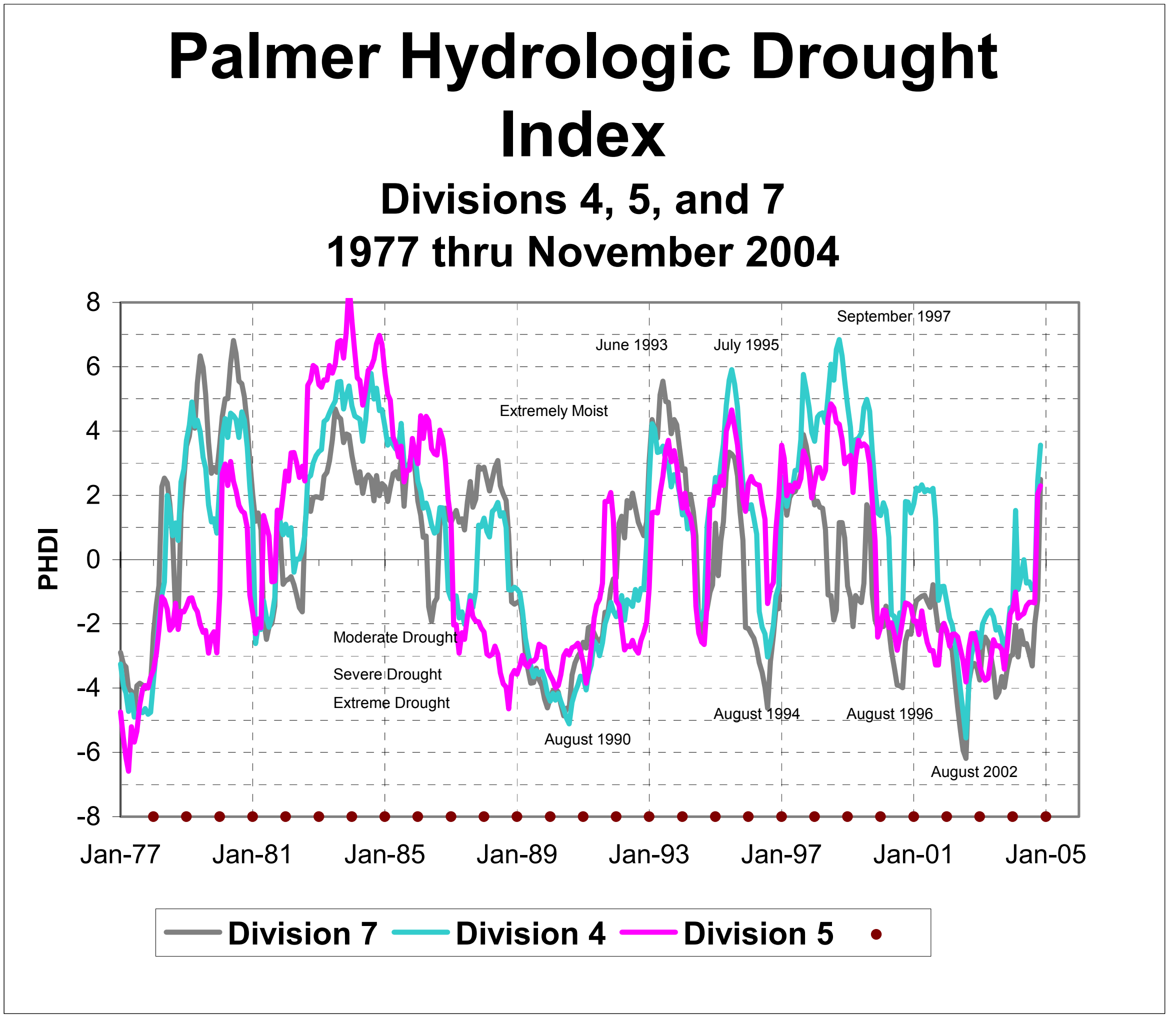

Figure 1 - PHDI, Divisions 4, 5, and 7

HYDROLOGY

As part of the SUFCO mining and reclamation plan (MRP), SUFCO has implemented a baseline and operational surface- and ground-water monitoring program for their permit and adjacent areas. The locations of the water monitoring sites are shown on Plate 4. Several studies have been conducted within the CIA in order to assess hydrologic conditions and potential effects due to coal mining in the area. These studies include Thiros and Cordy, 1991, Mayo and Associates, 1997, Mayo and Associates, 1999, Pines Tract Final Environmental Impact Statement, 1999, Cirrus Ecological Solutions, 2004, and Petersen Hydrologic, 2005. Information presented in these studies is used to describe baseline hydrologic conditions for the CIA.

Ground Water

Once recharge enters the ground, the rate and direction of ground-water flow is governed mainly by gravity and geology. Lateral ground-water flow dominates in the gently dipping Tertiary and Cretaceous strata of the Wasatch Plateau, where layers of low-permeability rock that impede downward movement are common. Both lateral and vertical flow may be channeled through faults and fractures, but plastic or swelling clays that can seal faults and fractures are present. Ground-water movement is controlled mainly by fractures, dip of the beds (dip is approximately 2 degrees to the northeast) and hydraulic conductivity of the strata.

Ground water tends to flow more readily through shallower systems where weathering and fracturing produce hydraulic conductivities that are generally larger than in deeper systems. Much of the ground-water flow continues both laterally and downward through these shallower, local systems until it intercepts the surface and is discharged at a spring or seep, enters a stream as baseflow, is transpired by vegetation, or simply evaporates to the atmosphere. However, some of the ground water follows deeper and slower flow-paths where it becomes isolated from the surface and is, in effect, stored.

The Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, Price River Formation, North Horn Formation, Flagstaff Limestone, and Quaternary deposits contain potential reservoirs or conduits for ground water in the CIA. Strata of the Mesaverde Group do not readily receive recharge from surface water because they are dominantly low-permeability claystones and siltstones. Large volumes of these rocks may be unsaturated or even dry. Sandstone aquifers occur where there is sufficient intergranular porosity and permeability in lenticular fluvial-channel and tabular overbank deposits. The sandstones are laterally and vertically discontinuous and pinch-out over short distances, and individual sandstone units are poorly interconnected, isolated by claystones and siltstones. However, these sandstones, especially where fractured, can produce significant ground-water flows from local systems.

Numerous springs and seeps have been identified by the various studies conducted within the CIA. Twenty-one springs have been selected to be monitored as part of the SUFCO Mine groundwater monitoring program. The springs were selected as representative of the permit and surrounding area from baseline data and information provided in the PHC determinations of the SUFCO MRP (Appendices 7-17, 1-18, and 7-20). The monitored springs are identified with their respective stratigraphic units on Table 3. More springs and seeps appear along northeastern escarpments, which is consistent with the concept of ground water following the dip slope. There is general agreement among the studies that aquifer recharge is principally by snowmelt seeping into bedrock.

In many of the areas of the permit, the exposure of sandstone units and fractures rovides a mechanism for ground-water recharge to the Castlegate Sandstone. The Blackhawk Formation contains layers of low-permeability rock units such as shales and clays that can impede downward movement of ground water. Many of the springs and seeps found in the CIA issue from the base of the Castlegate Sandstone due to the perched effect caused by the Blackhawk Formation.

Table 3
Spring Information – SUFCO Groundwater Monitoring Plan

Formation	Spring Name		Flow (gpm)			Monitoring Period	Notes
	SUFCO	USGS [1]	Average	Max	Min		
North Horn Formation	GW-13	GW-13	0.7	2.6	0.0	1986 [1]; 1989-1995 [2]; 1996-2005 [6]	
	057A	GW-5	0.3	3.4	0.0	1978 [1]; 1987-1995 [2]; 1996-2005 [6]	Duncan Draw spring
	M-SP08		0.5	1.9	0.0	2001-2004 [5]	
	M-SP53		0.23	0.5	0.1	2002-2003 [5]	
Price River Formation	M-SP01	GW-1	1.1	4.0	0.3	1976, 1979, 1986, 1987 [1]; 2001-2004 [5]	Rough Brothers spring
	M-SP02	GW-2	7.0	50.0	0.0	1976, 1987 [1]; 2001-2004 [5]	Estimated maximum flow
	M-SP18		0.3	0.5	0.0	2001-2004 [5]	
	M-SP39		1.3	4.7	0.3	2001-2004 [5]	
Castlegate Sandstone	089		NA	NA	NA	1989-1995 [2]; 1996-2005 [6]	Pool with stage gage
	GW-20	GW-20	0.7	13.0	0.0	1986 [1]; 1998-2005 [6]	
	GW-21	GW-21	0.6	2.3	0.0	1979-1987 [1]; 1995-2005 [6]	Link Canyon spring
	Pines 100		0.5	2.5	0.0	1997-1999 [3]; 2000-2005 [6]	
	Pines 105		6.4	12.0	2.6	1997-1999 [3]; 2000-2005 [6]	
	Pines 218		0.0	0.1	0.0	1997-1999 [4]; 2000-2005 [6]	
Blackhawk Formation	001	GW-12	2.2	7.3	0.0	1980, 1986, 1987 [1]; 1983-1995 [2]; 1996-2005 [6]	
	Pines 206	GW-14	2.9	3.9	0.6	1986 [1]; 1997-1999 [3]; 2000-2005 [6]	
	Pines 209	GW-15	10.4	14.6	4.0	1986 [1]; 1997 [3]; 1999-2005 [6]	
	Pines 212		6.3	8.7	1.0	1997-1999 [4]; 2000-2005 [6]	
	Pines 214		3.7	37.0	0.2	1997-1999 [4]; 2000-2005 [6]	Impacted by subsidence
	Pines 303		1.3	3.6	0.0	1997-1999 [4]; 2000-2005 [6]	
Star Point Sandstone	047		26.2	56.3	0.1	1983-1995 [2]; 1996-2005 [6]	Pump House spring

Sources for monitoring periods: 1 = Thiros and Cordy, 1991;
2 = Mayo and Associates, 1997 (MRP Appendix 7-17);
3 = Mayo and Associates, 1999 (MRP Appendix 7-17, Addition);
4 = Mayo and Associates, 1999 (MRP Appendix 7-18);
5 = Cirrus, 2004 and Petersen Hydrologic, 2005 (MRP Appendix 7-20); and
6 = SUFCO water monitoring program (DOGM database).

Both lateral and vertical flow can be channeled through faults and fractures. Typically ground-water flow continues both laterally and downward until it intercepts the surface and is discharged as a spring or seep or enters a stream as baseflow. This scenario is more likely in the Star Point, Price River, and Castlegate Units. The coal bearing units are found in the Blackhawk Formation that underlies the Castlegate Sandstone. The Blackhawk Formation contains interbedded sequences of sandstones, siltstones, shales, mudstones, and coal. The previous statement does have exceptions, and there are undoubtably some fractures and faults in the Blackhawk that do transmit volumes of ground water to the mine or springs.

Analysis of ground-water chemistry by Mayo and Associates (1999) and in the Pines Tract Final Environmental Impact Statement (FEIS, 1999) appears to indicate that recharge to springs in the Box Canyon tributaries is derived primarily from the area extending 1,000 feet back from the canyon rims. Erosion of the canyons has reduced both vertical and lateral - or confining - stresses on the adjacent canyon walls, which has allowed rotation of blocks of fractured Castlegate Sandstone and widening of fractures and created more storage and conductivity for ground water.

Mayo and Associates have proposed a hydraulic disconnect between in-mine waters and near-surface ground water based on data from isotopic evaluation. Dr. Allen Mayo is considered a leading authority on isotopic dating of water resources by mining operators, and has identified the ground-water regimes of several mines on the Wasatch Plateau. Studies conducted by his firm are specialized. Analysis of the ground water by Mayo and Associates using tritium analysis and carbon dating reveals the mine waters to be very old (greater than 7,000 to 20,000 years) as compared to meteoric waters that replenish the near surface waters (Mayo and Associates, 1999, and FEIS, 1999). “The cause of this disconnect is attributed to shale and mudstones in the Blackhawk Formation that hinder the downward migration of water” (FEIS, 1999). Dr. Mayo has concluded, “ground-water should not be diverted from the Castlegate Sandstone into the Blackhawk Formation”.

Mine Inflow

Mean residence time (“age”) of ground water in the Pines and SITLA Muddy Tracts, and surrounding area has been determined using ^{14}C (radiocarbon dating) and tritium (^{3}H). Most near-surface systems contain abundant tritium and anthropogenic radiocarbon and are recent or modern, the greatest mean residence time being 4,000 years according to radiocarbon dating. Ground waters in the mine have a mean residence time of 7,000 to 20,000 years and contain no tritium. From these data, Mayo and Associates determined that the near-surface ground-water systems are disconnected from ground-water systems encountered in the mine, abundant shale and mudstone of the Blackhawk Formation hindering the downward migration of water.

Most water entering the mine comes through leaks from perched aquifers in the mine roof and occasionally through mine floor seeps. As the mine-face progresses, the leaks generally dry up as the perched aquifers drain. However, some leaks remain or become seeps and continue to contribute to the mine inflow.

Movement of water within the mine is managed by sumps, pumps and piping, free flow along the mine floor, and storage into gob areas for settlement. Water not used in the mine or lost to evaporation is discharged to the North Fork of Quitchupah Creek through UPDES permitted outfall 003A. (Before September 1982, mine water was discharged into East Spring Canyon.) Daily average discharge rates for each month are reported to the Division and Utah Division of Water Quality (DWQ). Figure 2 shows the monthly average discharge of the SUFCO mine from 1994 through June 2005. Average discharge in 1978 was about 200 gallons per minute (gpm). In September 1987, measurements above and below the discharge site revealed a mine discharge of 461 gpm. As of the first quarter 2005, the mine is reporting a discharge of approximately 3,403 gpm, or approximately 7.6 cubic feet per second (cfs). Mine discharge rates have increased along with production rates and to a lesser extent, the size of the mine (Table 4 and Figure 3). Discharge has increased the base flow to the North Fork of Quitchupah Creek.

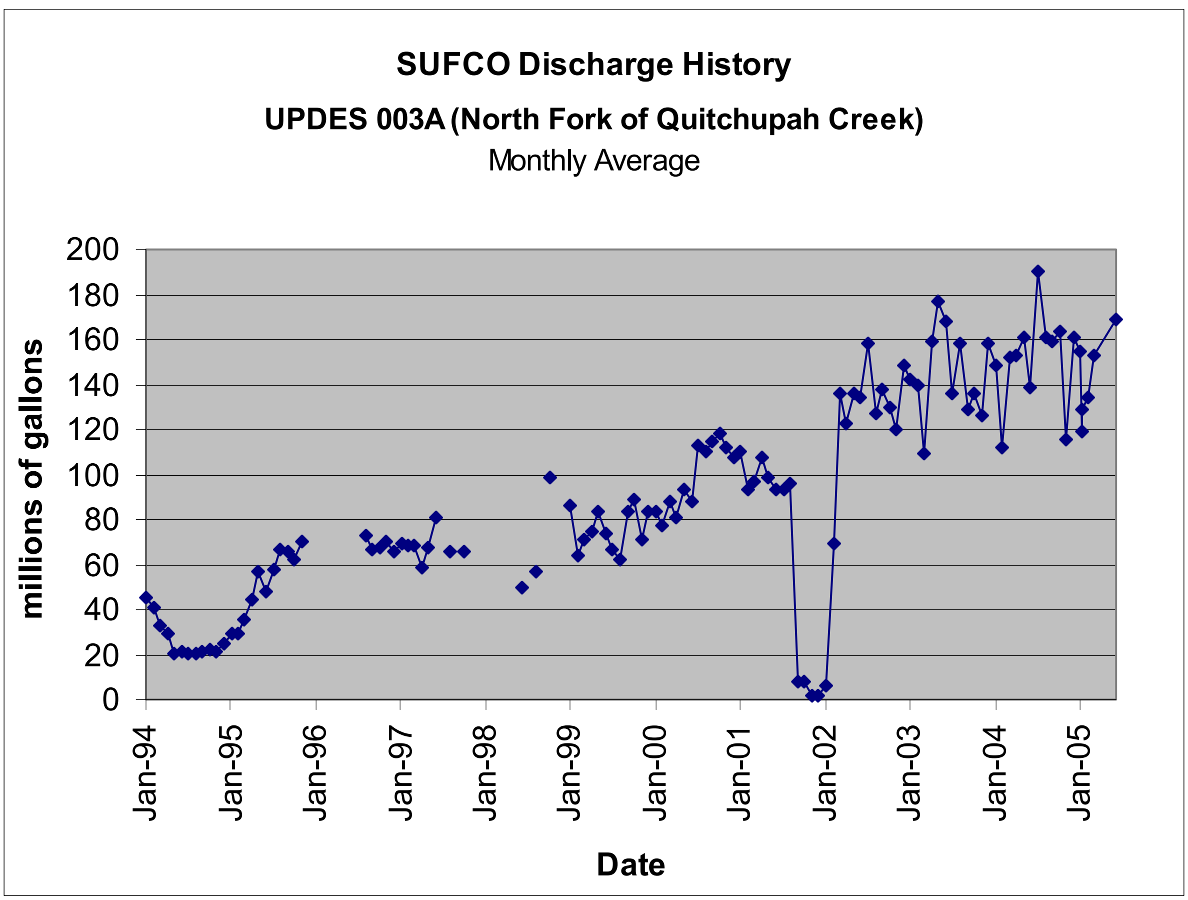

Figure 2 – SUFCO Discharge History

Table 4
Annual Coal Production and Mine Water Discharge
SUFCO Mine

Year	Annual Coal Production (million tons)	Annual Discharge (millions of gallons)	Discharge per Coal Production (gallons/ton)	Notes
2004	7.6	1,816	239	
2003	7.1	1,738	244	
2002	7.6	1,427	188	
2001	7.0	810	116	
2000	5.9	1,193	202	
1999	5.8	897	156	
1998	5.7	699	122	
1997	4.9	753	152	
1996	4.6	760	164	
1995	3.9	636	163	March 1994 to March 1995 - substantial flow diverted to the 3rd West area.
1994	3.6	276	77	
1993	3.6	518	146	
1992	2.6	505	196	
1991	3.1	434	141	
1990	2.9	389	135	
1989	3.1	576	188	November 1987 to August 1989 - flow underestimated because of a change to the weir setting.
1988	2.6	247	94	
1987	2.2	515	231	
1986	2.4	513	217	
1985	1.8	533	299	
1984	2.1	412	192	
1983	2.2	259	116	

Discharge data from SUFCO DMRs

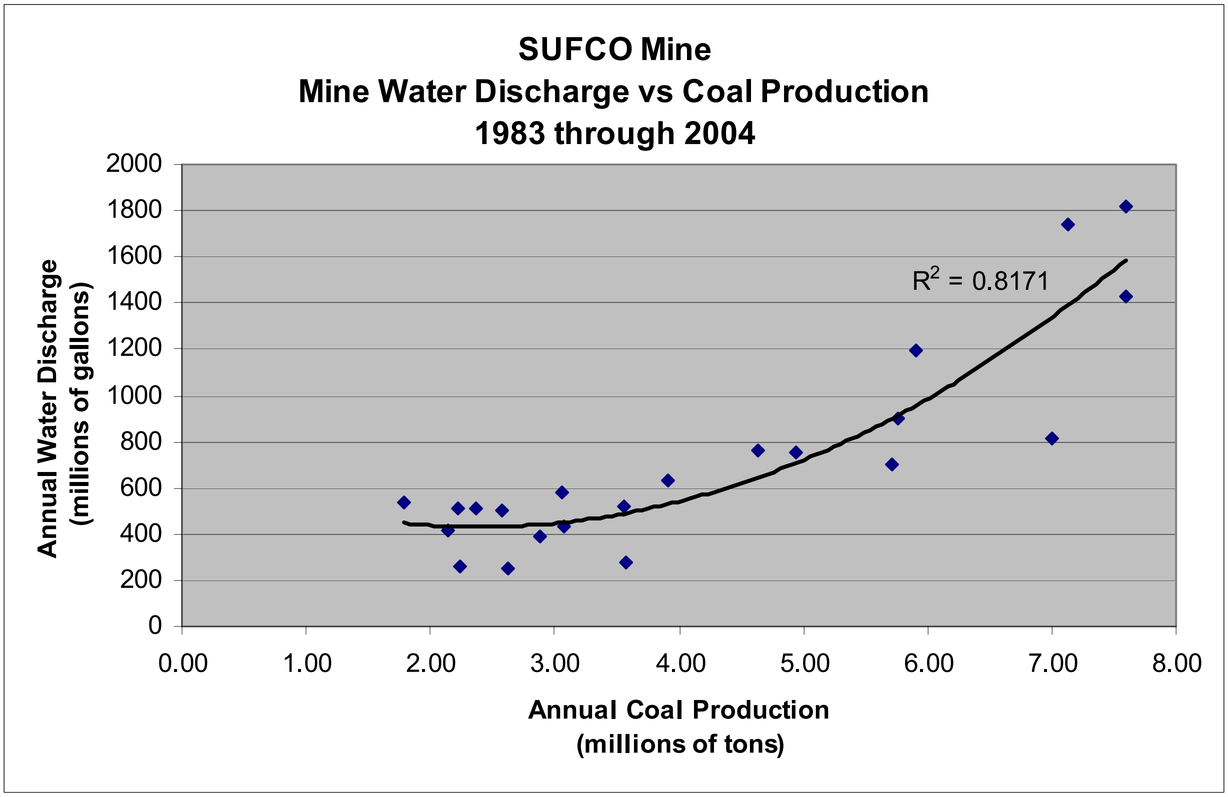

Figure 3 – SUFCO Mine Water Discharge vs Coal Production

Ground-water Quality

A generalized ground-water quality data summary of the CIA is presented in Table 5. The data was compiled from the PHC determinations presented in the SUFCO MRP (Appendices 7-16, 7-17, and 7-20).

Average total dissolved solids (TDS) concentrations for springs in the CIA range from 140 to 722 mg/L. Concentrations of TDS are lowest in springs of the Castlegate Sandstone, averaging well under 200 mg/L, because there are few soluble minerals in the Castlegate Sandstone. The waters are under saturated with respect to carbonate minerals, which along with the low TDS indicates that recharge takes place where soil zone CO_2 is low. This is most likely the exposed, relatively barren Castlegate Sandstone surface of the Old Woman Plateau where soil development is poor.

Table 5
Summary of Ground-Water Quality Data
SUFCO Mine

Formation	Tract	# of sites	# of samples	TDS mg/L	Ca^{+2} mg/L	Mg^{+} mg/L	$Na^{+} + K^{+}$ mg/L	HCO_3^{-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	* Total Anions	* Total Cations
North Horn	Quitchupah	NA	3	722	79	24	193	431	89	107	NA	NA
	Pines	0	0									
	Muddy	5	25	483	58	36	92	491	24	39	10.8	10.2
Price River	Quitchupah	0	0									
	Pines	0	0									
	Muddy	5	25	545	77	38	68	425	82	64	10.1	9.9
Castlegate	Quitchupah	NA	8	140	23	6	21	94	15	8	NA	NA
	Pines	7	19	163	21	5	9	85	13	9	NA	NA
	Muddy	0	0									
Blackhawk	Quitchupah	NA	17	422	80	41	41	339	90	16	NA	NA
	Pines	9	24	305	56	29	24	273	82	14	NA	NA
	Muddy	0	0									
Star Point	Quitchupah	2	78	593	100	48	68	406	123	38	NA	NA
	Pines	0										
	Muddy	0										

* Total anions and total cations might not balance closely because this table is based on average values.

Ground water from springs that issue from the Blackhawk Formation are similar to those from the Castlegate. Most of these springs are in the upper Blackhawk. Ca^+ and HCO_3^- are the dominant ions in both the Castlegate and Blackhawk. However, the average TDS concentrations in the Blackhawk Formation are approximately 305 and 422 mg/L for the Pines and Quitchupah Tracts, respectively. TDS in samples from in-mine roof drips from the lower Blackhawk Formation averages approximately 400 mg/L. Average TDS concentration reported for mine water discharged at UPDES outfall 003A is approximately 777 mg/L. The higher TDS concentration for mine water is likely due to the longer residence time of water encountered in perched aquifers not in direct communication with surface-water recharge zones. Recharge to the Blackhawk appears to be downward percolation from the Castlegate Sandstone.

TDS levels in ground waters flowing from the overlying North Horn and Price River Formations and the underlying Star Point Sandstone are higher, averaging greater than 550 mg/L. Dominant ions in these formations are Na^+ and HCO_3^- in the North Horn and Ca^+ and HCO_3^- in the Star Point. Dominant ions of the Price River Formation are sodium, bicarbonate, and sulfate. Calcite and clay minerals with exchangeable sodium probably produce this sodium enriched water (Thiros and Cordy, 1991).

Wells WRDS-B3, WRDS-B5, WRDS-B6, WRDS-B8, and WRDS-B9 monitor water quality at the waste rock disposal site (WRDS). They are completed in the upper Price River Formation. TDS concentrations are high, averages in the different wells ranging from 1,700 mg/L to 6,200 mg/L. Concentrations increase down gradient beneath the WRDS, a condition that predates construction of the site.

The waters are of mixed composition, no ions dominating consistently. There is some indication of seasonal variation, but data are insufficient to make a valid determination. Only a small amount of water-quality data has been collected from the other wells around the SUFCO Mine because these wells were intended mainly to monitor water levels.

Surface-Water

Quitchupah and Muddy Creeks, both perennial streams, are the two major drainages in the CIA. East Spring, Greens, Box, and Wash Rock Canyons and Wileys Fork are the source of small perennial, intermittent or ephemeral streams that feed Quitchupah and Muddy Creeks (Plate 4 and Table 4). The small draws that feed these canyons streams are numerous and some originate as springs, which continue to flow perennially but most often filter into the surrounding channel deposits. Most springs on the CIA emit low volumes.

Snowmelt is the major source of water for the perennial streams of the Quitchupah and Muddy Creek Basins. Intermittent and ephemeral tributaries are abundant, existing primarily at lower elevations where potential evapotranspiration exceeds precipitation. Intense summer thunderstorms may cause short-term flooding, but not large volumes of runoff.

Water use in the higher elevations of the Muddy Creek drainage basin is primarily for wildlife and stock watering purposes, although they tend to be low yielding springs and streams. The upper watershed provides most of the domestic water needs for the lower valley. Within the lower valley area, agricultural activities utilize some of the water. Minimum flows in the gauged streams and rivers in the basin occasionally reach zero. During warm snow melts and heavy rain storms erosion takes place and the streams become loaded with sediments especially in the lower reaches where vegetation is sparse and hillsides of the Blackhawk Formation and Mancos Shale are exposed. Storage reservoirs are common at higher elevations.

There are no major reservoirs located within the CIA. Three reservoirs are located adjacent to the CHIA boundary: 1) Julius Flat Reservoir (approximately 725 acre-feet) located northwest of the CHIA, 2) Skumpah Reservoir (less than 500 acre-feet) located west of the CHIA; and 3) Accord Lakes (less than 500 acre-feet) located southwest of the CHIA.

Soil cover varies with slope. There are areas on top of Pines Tract Lease that are bare of soil or only contain a few sparse inches of soil, which reveal the surface and fracture pattern of the Castlegate Sandstone. There are shallow silty soils on the milder slopes and shallow sand-gravel alluvium in the channel bottoms. The soils classify as hydrologic soils group C and D. The infiltration rates of the soil results in moderately low infiltration capacity.

Watersheds

The subdrainage volumes for the Quitchupah Creek and Muddy Creek watersheds are listed on Table 6. Descriptions of the larger subdrainages are presented below.

Quitchupah Creek Drainage

1) <u>East Spring Canyon</u>

East Spring Canyon drainage consists of 5,316 acres. SUFCO's mine and surface facilities are located at the confluence where Mud Spring Hollow and East Spring Hollow connect. About ½ mile below the facilities, East Spring Canyon connects with Convulsion Canyon. Convulsion Canyon runs southeast where it connects with Water Hollow to form the main channel of Quitchupah Creek.

Construction of the mine facilities required extensive cut and fill operations. Average channel gradient of East Spring Canyon is 6.7 %, but 13 % through the facilities area. That makes the outslope of the mine pad very steep. The sedimentation pond sits at the toe of the fill. All disturbed drainage is collected using berms, culverts, and ditches. Runoff from the disturbed area is first run to a sediment basin on the pad to allow sediment and coal fines to settle and to skim most of any oils that are trapped. Any disturbed drainage overflowing the basin runs down a culvert to the sedimentation pond where it is contained and discharged in accordance with requirements under a UPDES discharge permit.

Table 6
Subdrainages of the Quitchupah/Muddy Creek CIA

Number	Drainage	Square Meters	Acres	Square Miles
QUITCHUPAH CREEK WATERSHEDS				
1	East Spring Canyon	21,545,987	5,324	8.32
2	N. Fork Quitchupah	61,770,925	15,264	23.85
3	Link Canyon	30,921,703	7,641	11.94
4	Christiansen Wash	13,269,195	3,279	5.12
5	Quitchupah Creek Un-named Tributary	6,186,105	1,529	2.39
6	Quitchupah Creek Un-named Tributary	7,671,504	1,896	2.96
7	Quitchupah Creek Un-named Tributary	2,380,927	588	0.92
	TOTAL Quitchupah Creek Watershed	**143,746,946**	**35,521**	**55.50**
MUDDY CREEK WATERSHEDS				
8	Greens Canyon	23,540,156	5,817	9.09
9	Box Canyon	31,514,000	7,787	12.17
10	Wileys Fork	6,624,784	1,637	2.56
11	Wash Rock Canyon	5,663,696	1,400	2.19
12	Muddy Creek Un-named Tributary	15,818,553	3,909	6.11
13	Muddy Creek Un-named Tributary	8,760,269	2,165	3.38
14	Muddy Creek Un-named Tributary	1,691,910	418	0.65
15	Muddy Creek Un-named Tributary	5,362,570	1,325	2.07
16	Muddy Creek Un-named Tributary	2,135,364	528	0.82
	TOTAL Muddy Creek Watershed	**101,111,302**	**24,986**	**39.04**
	TOTAL CIA from Watersheds	**244,858,248**	**60,504**	**94.54**

Undisturbed drainage is routed around the disturbed area using berms, ditches, and culverts. A 60-inch culvert transports streamflow from Mud Spring Hollow and East Spring Canyon under the minepad downstream.

2) North Fork of Quitchupah Creek

The North Fork of Quitchupah Creek drainage consists of 15,212 acres. The North Fork of Quitchupah Creek is a perennial stream that flows in a deep canyon which bisects the Quitchupah Lease. Dry Fork enters Quitchupah Canyon from the northeast about half the length of the canyon. The Main Fork of Quitchupah Creek enters the canyon from the west on its upper end. The Blackhawk Formation forms the steep canyon walls and the Castlegate Sandstone forms the canyon rim.

Thiros and Cordy (1991) conducted a seepage study that identified flow patterns in the canyon. During the study, starting upstream, flow had a quick increase over a short distance in the Price River Formation. There is only a gradual increase through the Castlegate Sandstone The creek loses flow in the upper Blackhawk Formation, then picks up a minor amount in the lower part of the formation. Flow is substantially increased by the mine breakout discharge (UPDES 003A). Flow is again increased as it flows through the Star Point Sandstone. As the stream flows over the Mancos Shale flow is decreased.

The continuous flows from the mine discharge can be several times the normal flows during drier periods. The increased base flow can and probably has changed some of the channel configuration. Baseline riparian information is not available to verify any changes, however likely changes could be in sediment and bank configuration, change (increase) in riparian zone, and more water for downstream users. A drawback could be that the discharge could cease when mining is finished and reverse changes would take place.

3) Link Canyon

Link Canyon drainage is ephemeral and consists of 7,569 acres. SUFCO has constructed an electrical sub-station in the canyon to supply power for the Pines Tract operations. There are no discharges from the substation breakout and all runoff will be contained on site or treated by way of alternate sediment control measures, berms, and silt fences.

Link Canyon also contains the old Link Canyon Mine. Seepage issuing from the former mine portals has ceased upon SUFCO reopening the west portal as an emergency escapeway, ventilation portal, and entry for electrical lines from the Link Canyon substation.

There are two springs in the upper end of the canyon, GW-21 and Pines 100, that are monitored by SUFCO and the Emery County Water Users. The spring flow is diverted into a trough for cattle, then flows down the canyon. There is riparian vegetation for the first 100 yards of flow until it seeps into the channel.

Muddy Creek Drainage

8) Greens Canyon

Greens Canyon is a perennial drainage encompassing 5,878 acres. The drainage is split into the Greens Hollow and Cowboy Creek drainages north of the SITLA Muddy Tract. Cowboy Creek is considered a perennial stream that drains the north side of Big Ridge of the SITLA Muddy Tract.

Cowboy Creek flows over the Price River Formation at its headwaters and then cuts steeply into the Castlegate Sandstone and Blackhawk Formation before joining with Green Hollow. The creek flows across the northwest corner of the tract and was monitored at two sites for baseline flow and water quality parameters for the SITLA Muddy Tract PHC determination. Maximum flow of the creek was reported at 717 gpm during the spring of 2004 and baseline flow during the fall ranges between 0 and 3 gpm. Average TDS concentration at the two monitoring sites is reported as 350 and 420 mg/L.

Longwall mining is not anticipated beneath Cowboy Creek, however, SUFCO has committed in their MRP to implement a monitoring and mitigation plan for the creek if longwall mining beneath the creek is planned in the future. The monitoring and mitigation plan will be approved by the Division with concurrence by the Manti-La Sal Forest Service.

9) Box Canyon

The Box Canyon drainage encompasses 7,759 acres. The massive Castlegate Sandstone forms the consolidated rim of Box Canyon and Muddy Creek Canyon. The Blackhawk Formation is exposed in the bottom of the canyon below the boundary of the Quitchupah Lease. The surface rock forms near level outcrops that rims the area around to steep gorges of Box Canyon and Muddy Creek Canyon.

Using ground-water chemistry analysis, the recharge to the springs is believed to result primarily from flows in the Castlegate Sandstone as compared to the overlying Price River Formation. This appears to indicate that recharge to the springs in the Box Canyon tributaries is derived primarily from the area within 1,000 feet of the canyon rims (FEIS, 1999, and Mayo and Associates, 1999).

The headwaters of the Main (west) Fork of Box Canyon are located in the Quitchupah Tract and the headwaters of the East Fork are located in the Pines Tract. Several springs are located in the forks of Box Canyon. More springs are located in the Main Fork of Box Canyon, which eventually flows into Muddy Creek. Most of the lower sections of Box Canyon Creek are perennial, but involve low baseflow volumes. The term “perennial functioning” has been used by the U.S. Forest Service to describe the upper reaches of the East Fork of Box Canyon where it is considered intermittent flow based on baseline monitoring of the PHC determination (Appendix 7-18 of the SUFCO MRP) and ongoing SUFCO water monitoring.

The perennial flows in the West and East Forks of Box Canyon as well as the main channel are allocated. Although the flows are generally low during the summer months, wildlife and cattle use the riparian and water resources. Using ground-water chemistry analysis, the recharge to the springs is believed to result primarily from flows in the Castlegate Sandstone as compared to the overlying Price River Formation. This appears to indicate that recharge to the springs in the Box Canyon tributaries is derived primarily from the area within 1,000 feet of the canyon rims (FEIS, 1999, and Mayo and Associates, 1999).

Water rights have also been issued on Muddy Creek, a receiving stream of Box Canyon. Vegetation communities are mapped on Plate 3-1 of the MRP. This map shows riparian communities along both forks of Box Canyon Creek and next to Muddy Creek. There are important riparian communities along both forks of Box Canyon Creek and next to Muddy Creek. In the West Fork of Box Canyon, seeps support some hanging garden communities of ferns, including one sensitive species, the Link Canyon Columbine. Muddy Creek and the lower portion of Box Canyon Creek support fish populations.

Longwall mining has been conducted in the Pines Tract Lease beneath portions of the East and West Forks of Box Canyon. Overburden above the stream channels ranges between 400 feet to a little over 900 feet. Areas where overburden is less than 400 feet were not mined by the permittee. The USDA Forest Service (USFS) initially stipulated in the Record of Decision (ROD) that areas under perennial streams would not be mined. However, due to constraints caused by a sandstone channel encountered during mining in the Pines Tract, SUFCO requested a permit to undermine perennial portions of the East Fork of Box Canyon. The permit was issued with concurrence of the Manti-La Sal Forest Service under the condition of implementing a monitoring and mitigation plan. The plan consists of baseline and ongoing vegetation, subsidence, and water monitoring to determine if damage occurs to the stream channel due to mining. Mitigation consists of repair of the stream channel and/or riparian vegetation if it is determined that damage has occurred. The plan is found in Appendix 3-10 of the SUFCO MRP and is discussed in sections below in this CHIA.

10) Wileys Fork Canyon

Wileys Fork Canyon is an ephemeral drainage encompassing 1,625 acres located east of the Pines Tract. Although part of the CIA, it has not been evaluated for hydrologic parameters. Proposed coal mining in the Pines Tract show the mine layout to end approximately ½ to one mile from the canyon. The mine workings are down-dip from the canyon. Hydrologic impacts to the canyon are unlikely.

11) Wash Rock Canyon

Wash Rock Canyon is an ephemeral drainage encompassing 1,390 acres and lies west and south of Wileys Canyon. It is also included in the CIA for future mining. Similar conditions exist as with Wileys Canyon, except the canyon is one to two miles away. No hydrologic impacts are expected to take place in the canyon because the SUFCO Mine projections do not extend into the canyons.

Stream Monitoring

Stream monitoring sites are identified on Plate 4 and all surface monitoring sites are listed in Table 7. Monitoring also includes three UPDES sites and stock pond sites. Two UPDES sites, 001and 002, are located in East Spring Canyon and a third, 003A, is located in the North Fork of Quitchupah Creek.

The following streams within the SUFCO permit area are considered perennial:

North Fork of Quitchupah Creek as measured at SUFCO-007 and SUFCO-042;

South Fork of the North Fork of Quitchupah Creek as measured at SUFCO-006;

Quitchupah Creek as measured at SUFCO-041 and SUFCO 046;

Box Canyon as measured at stations SUFCO-090, Pines 403, and Pines 407;

East Fork of Box Canyon as measured between stations Pines 106 and 408;

Cowboy Creek as measured at station M-STR4; and

Muddy Creek as measured at stations Pines 405 and Pines 408.

Link Canyon is considered intermittent because it is often dry except for about 100 feet that is fed by the monitored springs GW-21 and Pines 100 located at the head of the canyon.

Surface monitoring sites are sampled three times per year. Data is submitted to the Division’s electronic database by the end of the quarter following the sampling and submitted in an annual summary by March 31 each year. Surface-water monitoring will continue through the operational and reclamation phases until bond release.

Sites identified as FP-1 and FP-2 will be monitored on or near October 1 each year to determine the extent of perennial stream flow in the upper reaches of Box Canyon. Site 047 is now monitored as a surface monitoring site. Monitoring sites 407 and 408 will be monitored in gallons per minute during June through October for a five year period to identify any mining effect to the streams in the east and west forks of Box Canyon.

Several stock water monitoring ponds are located in the permit area (Plate 5). Surface cracking due to mining induced subsidence has affected a few of the ponds on the Quitchupah and Pines Tracts. SUFCO has tried to mitigate the fracturing by applying bentonite into the cracks and hauling water to livestock. SUFCO is currently negotiating with the Manti La Sal Forest Service to create a workable mitigation plan. SUFCO has committed to visiting the ponds to photograph them to establish any evidence of cracking, marking their depth, and noting general soil moisture conditions and pond condition. More information is provided in sections below.

SUFCO has established a monitoring plan to collect water quality data of surface waters. The monitoring plan meets the requirements of the state and federal regulations, and guidelines established by the Division. Flow monitoring data for the stream monitoring sites is presented in Table 7.

Table 7
Stream Monitoring Locations
SUFCO Surface-Water Monitoring Program
(see Plate 4)

SUFCO IDENTIFICATION	LOCATION	ElevationElevation	UTM Coordinates X - Coordinate	UTM Coordinates Y - Coordinate	Flows in GPM Maximum	Flows in GPM Minimum	Flows in GPM Number of samples	Monitoring Period	NOTES and COMMENTS (1 - SUFCO Mine monitoring data; 2 - Mayo and Associates 1993, 1995, and 1996 sampling reported in Mayo and Associates, 1997a; 3 - SUFCO MRP; 4 - UDOGM Database; 5 – Petersen Hydrologic, 2005)
006	South Fork Quitchupah	8560	463680	4312890	933.5	0.31	43	6/21/83 - present	1, 2, 3
007	North Fork Quitchupah	8240	464750	4315090	5772	44.9	43	6/21/83 - present	1, 2, 3
041	Lower Quitchupah	6400	469100	4305400	3,110	0.2	52	4/20/83 - present	1, 2, 3
042	Lower Quitchupah	6350	469160	4305420	9,371	1.6	52	4/20/83 - present	1, 2, 3
046	Middle Quitchupah above	7240	463820	4306430	358	0.0	46	6/22/83 - present	1, 2, 3
047A	Lower East Spring Canyon	7160	464030	4306450	4,488	0.1	40	10/5/79 - present	3, 4
090	Box Canyon Creek at lease	8320	469470	4316820	62.8	0.0	28	7/27/89 - present	1, 2, 3
106	Upper East Fork Box Canyon	8200	471550	4316990	4.0	0.1	14	8/23/2000 - present	3, 4
302	Muddy Creek-Last Water Creek	7140	472140	4319900	33.7	0.0	15	1/6/2000 - present	3, 4
403	Lower Box Canyon	7270	471500	4320000	248	26.6	15	1/6/2000 - present	3, 4
405	Muddy Creek-Box Canyon	7260	471480	4320110	7,854	14.1	15	8/21/2000 - present	3, 4
406	Lower Muddy Creek	6870	474500	4318210	68,666	76	15	1/6/2000 - present	3, 4
407	Box Canyon Creek	7685	470430	4318320	162	38.4	15	1/6/2000 - present	3, 4
408	East Fork of Box Canyon Creek	7685	470530	4318330	38.4	0.1	15	1/6/2000 - present	3, 4
USFS 109	Upper Main Fork of Box Canyon	8280	469680	4315590	0.2	0.0	16	8/12/1999 - present	3, 4

Table 7
Stream Monitoring Locations
SUFCO Surface-Water Monitoring Program
(see Plate 4)

	LOCATION								NOTES and COMMENTS
SUFCO IDENTIFICATION		ElevationElevation	UTM Coordinates		Flows in GPM			Monitoring Period	1 - SUFCO Mine monitoring data; 2 - Mayo and Associates 1993, 1995, and 1996 sampling reported in Mayo and Associates, 1997a 3 - SUFCO MRP 4 - UDOGM Database 5 – Petersen Hydrologic, 2005
			X - Coordinate	Y - Coordinate	Maximum	Minimum	Number of samples		
FP-1	East Fork of the Main Fork of Box Canyon Creek	8260 to 8360	470010	4315570	0.3	0.0	4	10/6/2000 - present	3, 4
FP-2	East Fork of the East Fork of Box Canyon Creek	8200 to 8260	471810	4316910	2	0.0	4	10/6/2000 - present	3, 4
M-STR4	Cowboy Creek	8164	NA	NA	717	0.0	20	2001 - present	3, 4, 5

IV. IDENTIFY HYDROLOGIC CONCERNS

General hydrologic concerns include changes of flow rates and chemical composition that could physically affect the off-permit hydrologic balance. Changes to the existing hydrologic regime or balance need to be limited in order to prevent economic loss to existing agricultural and livestock enterprises, prevent significant alteration to the channel size or gradient, and maintain adequate capacity for existing fish and wildlife communities. The basis for the limiting value of a parameter may differ according to specific site conditions.

SUBSIDENCE

Subsidence impacts are largely related to extension and expansion of existing fracture systems and upward propagation of new fractures. Inasmuch as vertical and lateral migration of water appears to be partially controlled by fracture conduits, readjustment or realignment in the conduit system will inevitably produce changes in the configuration of ground-water flow. Potential changes include increased flow rates along fractures that have "opened", and diverting flow along new fractures or within permeable lithologies. Increased flow rates along fractures would reduce ground-water residence time and potentially improve water quality. Subsurface flow diversion may cause the depletion of water in certain localized aquifers and potential loss of flow to springs that will be undermined.

Mining at the SUFCO Mine has been by both room-and-pillar and longwall methods, and both will be used in future mining. Surface cracks are common above the mine, especially in shallow overburden areas. Subsidence is likely only over longwall panels, over room-and-pillar areas where second mining is done, and in surrounding areas within the expected angle-of-draw. The Castlegate Sandstone is a massive, rigid, and brittle sandstone unit that crops out over large portions of the permit area. The fracture pattern, described in the geologic section, is accentuated in the rock outcrop. When subsidence occurs, compressive and tensile stresses are relieved by movement along the fractures. Mine panel alignment and surface topography play a significant role in the amount and type of fracturing and/or movement that takes place. If fracturing extends deep or over a long distance, then surface and ground water can be diverted away from its original flow path, which could result in dessication of springs, streams, ponds, and vegetation.

The predicted angle-of-draw is 15 degrees for the SUFCO Mine, which is based largely on the experience of past mining at SUFCO and other coalmine operators in the Wasatch Plateau.

East Fork of Box Canyon

Because of concerns of the effects of subsidence from longwall mining beneath the East Fork of Box Canyon, a lease stipulation was added to the SUFCO permit to include a monitoring and mitigation plan. The Monitoring and Mitigation Plan is in place for the East Fork of Box Canyon (Appendix 3-10, SUFCO MRP). The plan consists of baseline hydrologic, macroinvertebrate, and vegetation surveys, weekly hydrologic monitoring while mining within the angle-of-draw, bi-yearly qualitative vegetation surveys through 2007 and 2009, and macroinvertebrate surveys in 2004 and 2005. In addition, the pre-mining conditions of the East Fork of Box Canyon were documented on video which is available for the public in the Division Public Information Center (PIC). The SUFCO Mine has been diligent at following their monitoring plan to date and have applied reasonable and effective mitigation efforts when needed.

Affects from undermining the stream channel were observed shortly after mining. Approximately 60 percent of the surface flow was lost during the summer of 2004 from the mining of the 3LPE panel. Subsidence caused extension fractures and buckling due to compression within sandstone layers that allowed the stream to flow subsurface for distances up to 200 feet before reappearing on top of a shaley outcrop exposed within the bottom of the stream channel. Some platey surface fracturing of sandstone bedrock was observed within the stream channel approximately 200 feet outside of the 15-degree angle-of-draw. Several monitored springs located in the canyon above the stream have dried up or were diverted to the sandy alluvial banks causing slumping. Most of the subsidence damage was located within the Blackhawk Formation above the 3LPE panel. Subsidence related damage above the 4LPE panel was less extensive within the Castlegate sandstone. Repairs made to surface fractures within the stream channel using hand tools and bentonite pellets have been successful so far. Loose rock was pushed aside and bentonite was used to seal fractures and channelize the stream. It appears that all surface flow has been successfully reestablished as of fall 2005.

Cowboy Creek

Longwall mining is not anticipated beneath Cowboy Creek for the SITLA Muddy Tract mining projections, however, SUFCO has committed in their MRP to implement a monitoring and mitigation plan for the creek if longwall mining beneath the creek is planned in the future. The monitoring and mitigation plan will be approved by the Division with concurrence by the Manti-La Sal Forest Service.

Stockwatering Ponds

The Forest Service and cattlemen use and maintain several stock watering ponds located on Forest Service Land within the undisturbed area of the SUFCO permit area. The water rights to the stock watering ponds are owned by the Forest Service and used by cattlemen with leases to run cattle on the Forest Service land. Claims have been made by the Forest Service and cattlemen that surface cracking due to mining related subsidence within the Quitchupah and Pines Tracts has had impacts on some of the ponds. The Division investigated this issue in 2004 and 2005. Because no baseline data was collected on the ponds in previous years, and because drought conditions have existed from 1999 through 2004, it was not clear the Division that the ponds had been adversely impacted. In order to mitigate the potential damage to the ponds, SUFCO has taken action by monitoring pond conditions, applying bentonitic clay seals to the pond floors, and hauling water in for livestock. SUFCO is also working with the Forest Service to install guzzlers for wildlife and developing a plan to establish a water system between ponds for cattle. The Division is keeping track of the negotiations between SUFCO, the Forest Service, and cattlemen to make sure that the potentially affected parties are satisfied. If the Forest Service and cattlemen are not satisfied with the situation and make a formal complaint to the Division, then the Division will make a finding at that time. The Forest Service was consulted by the Division and did not request that baseline data be collected for ponds within the SITLA Muddy Tract.

GROUND WATER

The greatest mining-related potential for impacting ground-water resources in the CIA comes from dewatering and subsidence. Following spring and seep surveys and baseline studies prior to mine permitting, representative springs and seeps are chosen for a mine's monitoring plan to aid in the determination of mining-related impacts to the hydrologic balance and water rights.

Twenty-one springs and seeps are being monitored within and adjacent to the SUFCO Mine permit area. With the exception of several springs within the East Fork of Box Canyon, monitoring of springs for the SUFCO Mine has not identified any mining-related impacts and future diversion of spring flow is considered to be an overall low risk.

Water users have expressed concerns that water intercepted underground may be discharged into a watershed other than the one where the ground water was originally destined. In particular, the water users are concerned that water discharged by the mine into the North Fork of Quitchupah Creek originated from perched aquifers in the Pines Tract within the Muddy Creek watershed. According to the Utah Coal Mining and Reclamation Act and rules, a mine may divert water underground and discharge to the surface if material damage to the hydrologic balance outside of a permit area is prevented and disturbance to the hydrologic balance within the permit area is minimized (R645-301-731.214.1). Furthermore, any state-appropriated water affected by contamination, diminution, or interruption resulting from underground mining must be replaced (R645-301-731.530). The Division evaluates a mine's Probable Hydrologic Consequences Determination (PHC) and updates the CHIA prior to permitting, and reviews water monitoring data during mining and following reclamation to determine if adverse hydrologic impacts, as defined by the rules, can be demonstrated. Underground mining may result in some diversions of intercepted ground water into drainages that are not topographically within (above) the area where the water was encountered. The SUFCO PHC has demonstrated that water that is projected to be intercepted is mostly ancient and therefore hydrologically isolated from springs, seeps, and streams. If it is subsequently demonstrated that the mining has caused or will cause a diminution, contamination, or interruption of an appropriated water right or a material impact to the hydrologic balance either within or outside of the permit area, the permittee will be required by the Division to address means of minimizing the impact and replacing any appropriated water rights.

It is not known how much water will be generated from the mine workings once mining stops. The current mine plan shows that the mine will be sealed. Ground water should back up behind the seals and fill the voids remaining from the collapsed mine.

Aquifer Dewatering

Using isotopic analysis, Mayo and Associates (1999) have identified that the waters from the mine workings are older than waters from springs located in the Castlegate Sandstone. They concluded that water in the Blackhawk Formation is disconnected from that of the Castlegate Sandstone. Considering the amount of shales, siltstones, and mudstones and their information from isotopic analysis, their conclusions have substantial basis. However, substantial fracturing is taking place because of subsidence, with subsidence generally up to 5 or 6 feet. Rock fracturing can propagate long distances horizontally and laterally, affecting aquifers and surface-water sources. Only future monitoring can provide the information to assess changes in the hydrologic balance and impacts off the permit area.

SURFACE WATER

Increased discharge, especially runoff from disturbed areas, could alter flow volumes, water quality, and runoff and flood patterns in creeks. Mining in the SUFCO permit area is not expected to increase discharge of surface or ground water beyond current levels. Creeks and drainage areas discussed are shown on Plate 4, Surface Water Drainage Map.

Subsidence could affect the character of drainages by altering the natural slope of the channel. However, large-scale impacts are unlikely because of the thick overburden (typically projected to be from 600 to 2,000 feet thick) between the mine operations and the surface drainages. With the exception of the East Fork of Box Canyon, full extraction mining is not planned under any perennial reaches of streams within the CIA.

The potential for cracks to divert water underground is limited by the self-healing characteristics of the formations, which consist of interbedded claystone, siltstone, and sandstone that are rich in montmorillonite clays. Fractures at the surface are prone to heal rapidly because of the expanding nature of these clays. Material from the Blackhawk Formation was examined by X-ray diffraction and found to contain up to 58 percent montmorillonite clays (Crandall Canyon Mine MRP, App. 7-41). These clays absorb water and their volume can expand as much as 50 percent even when they are associated with other soil and rock materials.

Twenty stream sites are being monitored within and adjacent to the SUFCO Mine permit area. With the exception of a temporary decrease of flow and increase of TDS concentrations for the East Fork of Box Canyon Creek, monitoring of streams for the SUFCO Mine has not identified any mining-related impacts and future diversion of stream flow is considered to be an overall low risk.

V. IDENTIFY RELEVANT STANDARDS

RELEVANT STANDARDS

The CHIA is based on the best currently available data and is a prediction of mining related impacts to the hydrologic balance outside of the specific permitted coal mine areas. To verify that conditions remain within acceptable limits, the mine operator is required to monitor water quality and quantity as part of the permit requirements. The plans for monitoring are set forth in the Mining and Reclamation Plans (MRP) for the SUFCO Mine and have been determined adequate by the Division to meet regulatory requirements. If monitoring results show significant departures from the values established in the MRP and in this CHIA, or exceed UPDES discharge requirements, immediate remedial actions are provided for by SMCRA.

Water quality standards for surface waters in the State of Utah are found in R317-2, Utah Administrative Code (UAC). The standards are intended to protect the waters against controllable pollution. Waters, and the applicable standards, are grouped into classes based on beneficial use designations. The Utah Division of Water Quality of the Department of Environmental Quality has classified surface waters in the CIA as:

- 2B - protected for recreational uses except swimming,
- 3C - protected for nongame fish and aquatic life, and
- 4 - protected for agricultural uses.

Flow: There is no standard for flow in either the SUFCO Mine permit nor in Utah water quality standards. At the SUFCO mine, UPDES discharge is to be recorded twice monthly. It is not expected that the SUFCO Mine UPDES permit will have a flow limitation. Characteristics such as stream morphology, vertebrate and invertebrate populations, and water chemistry can be affected by changes in flow and therefore can provide an indirect standard for flow.

Oil and Grease: There is no State water quality standard for oil and grease, but the UPDES permit limit for the SUFCO Mine is a daily maximum of 10 mg/L; only one sample a month, either grab or composite, is required to measure this, but weekly visual monitoring is required. A 10 mg/L oil and grease limit does not protect fish and benthic organisms from soluble oils such as those used in longwall hydraulic systems, and UDWR has recommended soluble oils be limited to 1 mg/L (Darrell H. Nish, Acting Director UDWR, letter dated April 17, 1989 to Dianne R. Nielsen, Director UDOGM).

Total Dissolved Solids (TDS) concentrations: The concentration of dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. There is no state water quality standard for TDS for Classes 1, 2, and 3, but 1,200 mg/l is the limit for agricultural use (Class 4). The SUFCO Mine UPDES permit limits instantaneous TDS concentration to 1,200 mg/L, determined by two grab samples a month. The total amount of dissolved solids discharged from all SUFCO Mine operations is limited to 5 tons per day, determined by the twice monthly measurements of flow and TDS.

pH: Allowable pH ranges are 6.5 to 9.0 under the SUFCO Mine UPDES permit and State water quality standards for all Classes.

Total Suspended Solids (TSS) and Settleable Solids: There is no State water quality standard for suspended solids in the water, but an increase in turbidity is limited to 10 NTU for Class 2A, 2B, 3A, and 3B waters and to 15 NTU for Class 3C and 3D waters. The SUFCO Mine UPDES permit allows a daily maximum of 70 mg/L TSS, but limits the 30-day average to 25 mg/L: two grab samples a month are used to determine TSS. Under the SUFCO Mine UPDES permit, all samples collected during storm water discharge events are to be analyzed for settleable solids. Samples collected from increased discharge, overflow, or bypass that is the result of precipitation that does not exceed the 10-year, 24-hour precipitation event can comply with a settleable solids standard of 0.5 mL/L daily maximum rather than the TSS standard, although TSS is still to be determined. If the increased discharge, overflow, or bypass is the result of precipitation that exceeds the 10-year, 24-hour precipitation event, then neither the TSS nor settleable solids standard applies.

Iron and Manganese: The SUFCO Mine UPDES permit allows a daily maximum of 1.0 mg/L total iron, which is based on an assumption that total and dissolved iron concentrations are the same. Grab samples are taken twice a month from the UPDES sites to determine iron concentration. With approval from the Division of Water Quality, up to 2 mg/L total iron can be discharged under certain circumstances, which include maintaining dissolved iron at or below 1 mg/L. State water quality standards allow a maximum of 1,000 mg/L dissolved iron in Class 3A, 3B, 3C, and 3D waters, with no standard for Class 1, 2, and 4 waters.

Monitoring of total manganese is required by SMCRA and the Utah Coal Mining rules, but there is no UPDES or water quality standard for either total or dissolved manganese.

Macroinvertebrates: Macroinvertebrates are excellent indicators of stream quality and can be used to evaluate suitability of a stream to support fish and other aquatic life. Baseline studies of invertebrates provide standards against which actual conditions in Box Canyon and Muddy Creeks can be evaluated if desired. Price and Plantz (1987) summarized invertebrate data. There are no current plans to monitor invertebrate populations in the streams of the CIA.

Utah water quality standards exist for numerous parameters other than those already mentioned above, but at this time there is no evidence or reason indicating they are of concern or have a reasonable potential to affect the hydrologic balance of the CIA. However, those parameters that may have a reasonable possibility of affecting the hydrologic systems are included in routine water quality monitoring of the mine operations. Review of monitoring results by the mine operators and the Division will identify concerns or problems and generate revisions of the mine operations to mitigate those problems.

Sediment is a common constituent of ephemeral stream flow in the western United States. The quantity of sediment in the flows affects stream-channel stability and most uses of the water. Excessive sediment deposition is detrimental to existing aquatic and wildlife communities. Large concentrations of sediment in streamflow may preclude use of the water for irrigating crops because fine sediment tends to reduce infiltration rates in the irrigated fields, and the sediment reduces capacities of storage facilities and damages pumping equipment. Mean sediment load is the indicator parameter for evaluating the sediment hazard to stream-channel stability and irrigation.

The concentration of dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. The quality of water from underground sources reflects the chemical composition of the rocks it passes through. That quality may be degraded by intrusion of poorer quality water from wells or mines, by leakage from adjoining formations, or by recharge through disturbed materials. Ground water discharging from seeps and springs is used by wildlife and livestock. The state standard for TDS for irrigation of crops and stock watering (Class 4) is 1,200 mg/L.

The Utah Department of Environmental Quality, Division of Water Quality can authorize a coal mine to discharge into surface waters under the Utah Pollutant Discharge Elimination System (UPDES). At the time this CHIA was prepared, the SUFCO Mine had applied for three UPDES permits, one to discharge from the planned sediment pond, a second to discharge from the treatment facility to East Spring Hollow, and a third to discharge from the mine to North Fork of Quitchupah Creek.

The SUFCO Mine UPDES permit contains site-specific limitations on TDS, total suspended solids, total settleable solids (for discharges resulting from precipitation events), total iron, oil and grease, and pH. There is no limit on flow but it is to be measured monthly. Additionally, there can be no more than a trace amount of visible sheen, floating solids, or foam and no discharge of sanitary waste or coal process water.

Macroinvertebrates are excellent indicators of stream quality and can be used to evaluate suitability of a stream to support fish and other aquatic life.

MATERIAL DAMAGE

Material damage to the hydrologic balance would possibly manifest itself as an economic loss to the current and potential water users, would result in quantified reduction of the capability of an area to support fish and wildlife communities, or would cause other adverse change to the hydrologic balance outside the permit area. The basis for determining material damage may be found to differ from site-to-site within the CIA according to specific site conditions. Surface-water and ground-water concerns have been identified for CHIA evaluation.

Parameters for surface-water quantity and quality

The potential material-damage concerns this CHIA focuses on are changes of surface flow rates and chemical composition that would physically affect the off-permit stream channel systems as they presently function and affect aquatic and wildlife communities and agricultural and livestock production. Therefore, criteria are intended to identify changes in the present discharge regime that might be indicators of economic loss to existing agricultural and livestock enterprises; of significant alteration to the channel size, or gradient; and of a loss of capacity to support existing fish and wildlife communities. In order to assess the potential for material-damage to these elements of the hydrologic system, the following indicator parameters were selected for evaluation at each evaluation site: low-flow discharge rate, TDS, and sediment load.

<u>Low-Flow Discharge Rate</u>

Measurements provided by mine operators are generally of instantaneous flow and provide some indication of long-term trends. In the Wasatch Plateau Waddell and others (1981) found that correlating three years of low-flow records (September) at stream sites against corresponding records from long-term monitoring sites would allow the development of a relationship that could be used to estimate future low-flow volumes at the stream sites within a standard deviation of approximately 20 %. Ten years of record reduced the standard deviation to 16 % to17 %, and 15 years of data to about 15 %.

Monitoring of low-flow discharge rates will also provide a means to evaluate effects of mine discharge on the receiving streams. SUFCO Mine discharge will be monitored at UPDES discharge points at the sediment pond and the direct discharge from the mine. The potential for material damage by mine discharge water is tied to the effect on the flow in the receiving streams.

<u>Total Dissolved Solids (TDS)</u>

The concentration of dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. Ground water discharging from seeps and springs is used by wildlife and livestock. Because wildlife and livestock use is the designated post-mining land use, established dissolved solids tolerance levels for wildlife and livestock have been adopted as the thresholds beyond which material damage may occur. The state standard for TDS for irrigation of crops and stock watering (Class 4) is 1,200 mg/L. If TDS concentrations persistently exceed 1,200 mg/L it will be an indication that evaluation for material damage might be needed. It must be kept in mind that there have been single samples from outfalls UPDES

003A (North Fork of Quitchupah Creek) and UPDES 001 (East Fork of Quitchupah Creek) in which TDS has exceeded this 1,200 mg/L threshold.

Sediment Load

Sediment is a common constituent of ephemeral stream flow in the western United States. The quantity of sediment in the flows affects stream-channel stability and most uses of the water. Excessive sediment deposition is detrimental to existing aquatic and wildlife communities. Large concentrations of sediment in streamflow may preclude use of the water for irrigating crops because fine sediment tends to reduce infiltration rates in the irrigated fields, and the sediment reduces capacities of storage facilities and damages pumping equipment. Sediment load measurement error is, at a minimum, the same as the flow measurement error because sediment load is directly dependent on flow and in practice cannot be measured more accurately than the flow.

TSS is the indicator parameter initially chosen for evaluating the sediment hazard to stream-channel stability and irrigation. Threshold values have initially been set as the greater of 1 standard error above the baseline mean TSS value or 120 % of the baseline mean TSS value (by analogy with the low-flow discharge rate measurement accuracy and assuming that the error in TSS will contribute equally to the error in flow when determining mean sediment load). If TSS concentrations persistently exceed these threshold values it will be an indication that evaluation for material damage from sediment load in the streams might be needed.

Parameters for ground-water quantity and quality

The potential material-damage concerning this CHIA are intended to limit changes in the quantity and chemical composition of water from ground-water sources to magnitudes that: will not cause economic loss to existing or potential agricultural and livestock enterprises and maintain the hydrologic balance.

Seasonal flow from springs

Maintain potentiometric heads that sustain average spring discharge rates, on a seasonal basis, equal or greater than 80 % of the mean seasonal baseline discharge, in other words baseline minus 20 % probable measurement error. The 20 % measurement error is based on analogy with the accuracy of measuring low-flow surface discharge rates. A 20 % decrease in flows, determined on a seasonal basis, will indicate that decreased flows are probably persisting and that an evaluation for material damage is needed.

TDS concentration

The concentration of total dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. The quality of water from underground sources reflects the chemical composition of the rocks it passes through. Ground-water quality may be degraded by intrusion of poorer quality water from wells or mines, by leakage from adjoining formations, or by recharge through disturbed materials. Ground water discharging from seeps and springs is used by wildlife and livestock, and those are the designated post-mining land uses. There is no water quality standard for TDS for aquatic wildlife. The state standard for TDS for irrigation of crops and stock watering (Class 4) is 1,200 mg/L. If TDS concentrations persistently exceed 1,200 mg/L it will be an indication that evaluation for material damage might be needed.

VI. ESTIMATE PROBABLE FUTURE IMPACTS OF MINING ACTIVITY

GROUND WATER

Dewatering and subsidence related to mining have the greatest potential for impacting ground-water resources in the CIA.

Dewatering

Underground mining removes the support to overlying rock causing caving and fracturing of the overburden. In most mining areas it is unlikely that fractures will reach shallower perched aquifers because of the thickness of the overburden, but in areas where fracturing is extensive, subsidence induced caving and fracturing can create conduits that allow ground water to flow into the mine. Dewatering caused by fracturing may decrease aquifer storage and ground-water flow to streams and springs (Figure 4). Water quality downstream from the mines could improve because water being discharged from coal mines in the Wasatch Plateau is often of better quality than natural spring flow or base flow.

Total ground-water storage above the Upper Hiawatha seam has not been calculated, however the rate of current discharge with respect to the area mined indicates an extensive storage capacity or that recharge is entering the mine from another area. The SUFCO Mine is currently discharging approximately 5 million gallons per day. An average inflow calculation would not justify the real hydrologic functions, however it could correlate the rate of discharge to area mined. The rate of discharge with coal production is shown on Table 4 and in Figure 3, which could provide a useable ratio, except panel orientation and size varies within the mine to yield discrepancies.

Ground-water dewatering verses ground-water recharge needs to be studied more if impacts to springs and streams are identified.

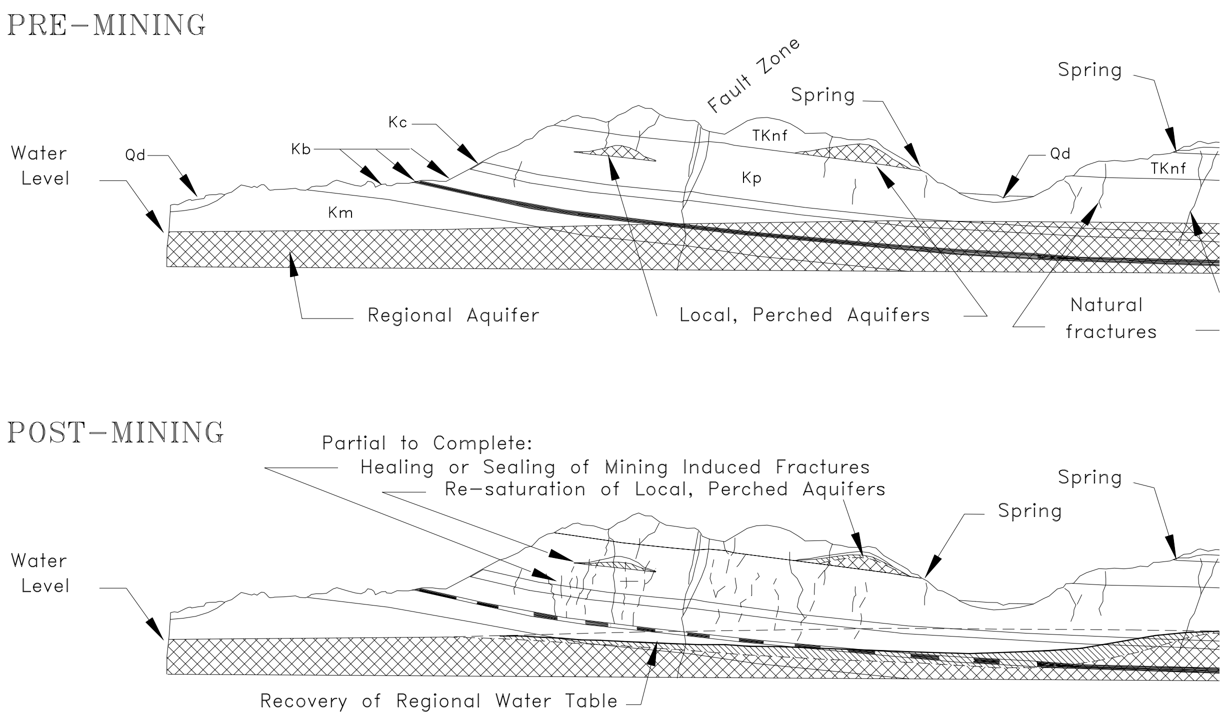

Figure 4 - Potential Long-term Effects of Coal Mining on Ground-water Resources

Subsidence

Subsidence impacts are largely related to extension and expansion of existing fracture systems and upward propagation of new fractures. Inasmuch as vertical and lateral migration of water appears to be partially controlled by fracture conduits, readjustment or realignment in the conduit system will inevitably produce changes in the configuration of ground-water flow. Potential changes include decreased flow through existing fractures that close, increased flow rates along existing fractures that open further, and the diverting of ground-water flow along new fractures or within newly accessible permeable lithologies. Subsurface flow diversion may cause the depletion of water in local aquifers and loss of flow to springs that are undermined. Increased flow rates along fractures could potentially improve water quality by reducing ground-water residence time.

Subsidence surveys have been conducted at SUFCO Mine on an annual basis since 1988 using ground surveying supplemented with photogrammetric methods if needed. Annual subsidence reports are provided to the Division. Annual reports for 1988 through 2005 indicate extensive subsidence over the current SUFCO Mine permit area. The relatively moderate thickness of the overburden and the fracture system are major contributors to the amount of subsidence.

Mining at the Pines and SITLA Muddy Tracts is currently planned for the upper Hiawatha coal seam only, and overburden thickness will generally be 1,000 feet. The potential for subsidence related surface impacts has been reviewed and estimated, but still needs to be studied to completely identify all aspects of the impacts.

SURFACE WATER

Changes in flow volume and in water quality have the greatest potential for impacting surface-water resources in the CIA. The monitoring plan should help identify variations in flow caused by mining. Monitoring is a benefit to both the public and the operator, because it can identify and separate natural and anthropogenic variations to the environment or ecosystem. A good monitoring plan can provide the necessary data to establish the necessary mitigation or show the variations are following a natural sequence.

Water Quality

The quality of the local surface waters can be affected by two basic processes. First, the runoff from the disturbed lands and waste piles could increase sediment concentrations and alter the distribution and concentration of dissolved solids in the receiving streams. This potential has been shown to be minimized. The second potential cause of surface-water quality changes is related to the location and chemistry of ground-water discharges, both from the mines and from springs and baseflow.

Water Quantity

Water not used in the SUFCO Mine or lost to evaporation is discharged to the North Fork of Quitchupah Creek through UPDES 003A. Discharge rates have increased over the life of the mine. Ongoing monitoring will indicate total ground-water discharge due to mining.

Upon termination of mining operations, discharge of ground water from the SUFCO Mine will be discontinued and the mine will begin to flood. There will be a reduction in flow in the North Fork of Quitchupah Creek because of the loss of the mine discharge. The time required for mine flooding will depend not only on the rate of water inflow but also on the amount of caving and the void space remaining after caving. Complete flooding of the mine may never occur because flow out of the mine through the roof, floor, and ribs and into the surrounding rock will increase as flooding increases the hydraulic head within the abandoned workings.

ALLUVIAL VALLEY FLOORS

A negative Alluvial Valley Floors (AVF) determination has been made based on the studies conducted by Canyon Fuels Company, LLC for the approved SUFCO MRP. These studies have not confirmed the existence of unconsolidated stream laid deposits holding streams and sufficient water to support agricultural activities within the mine plan area.

VII. ASSESS PROBABLE MATERIAL DAMAGE

The probable hydrologic impacts are summarized below under the headings entitled Next Five Year Permit Term and Future Mining.

FIVE YEAR PERMIT TERM - SUFCO MINE

Planned operational monitoring will document any measurable changes in the surface- and ground-water systems. Surface disturbances and UPDES permitted discharges are not expected to degrade surface- or ground-water quality. There is no AVF to be impacted. Sediment control measures should continue to effectively prevent diminution of water quality in the receiving drainages.

The rate of dewatering will likely increase, because more mine area is being exposed. Previous dewatering trends have continued to increase as new mining areas have developed. Overburden thickness is 700 to 900 feet, yet surface manifestations of subsidence are present. Subsurface propagation of fractures may produce changes in ground-water flow that could affect local aquifers and springs. Future monitoring will provide data applicable to documenting changes in the ground-water system.

Surface disturbance and the discharge of SUFCO Mine water have not significantly degraded water quality in East Spring Canyon. Sediment control measures such as those intended for use at the SUFCO Mine have served to reduce contaminants and stabilize water quality at acceptable discharge levels.

Mining in the Pines Tract is ongoing and will begin in the SITLA Muddy Tract in 2006. There will be no new surface disturbance for mining in either tract. A monitoring and mitigation plan for longwall mining beneath the East Fork of Box Canyon Creek is ongoing. The SUFCO Mine has been diligent at following their monitoring plan to date and have applied reasonable and effective mitigation efforts when needed. No material damage within or outside of the permit area is believed to have occurred. Material damage in this case would take the form of significant loss of natural habitat (the current or reasonably foreseeable use of land). Stream channel repairs have returned surface flows and dry springs have likely diverted to other areas within the drainage. However, monitoring of the stream, springs, and vegetation for significant loss of natural habitat is still ongoing. A similar plan will be developed for Cowboy Creek in the event that longwall mining beneath Cowboy Creek is planned.

FUTURE MINING

Underground mining may result in some diversions of intercepted ground water into drainages that are not topographically within (above) the area where the water was encountered. If it is demonstrated that mining has caused or will cause a diminution, contamination, or interruption of an appropriated water right or a material impact either within or outside of the permit area, the permittee will be required by the Division to address means of minimizing the impact and replacing any appropriated water rights. Evaluations of PHCs and the preparation of this CHIA do not indicate that there is any evidence that such impacts will result from the proposed mining in the Quitchupah/Muddy Creek CIA, and as a consequence, there is no reason to require operators to propose alternatives for disposing of the displaced water or other possible actions as part of the PAP.

Increased rates of dewatering may, in the future, result in depletion of ground-water storage. Depletion of storage may terminate certain spring flows and base flow recharge to streams. Upon cessation of mining, mine water discharge should cease, according to the current mine plan. Mine flooding will probably result in reestablishment of the preexisting ground-water systems that, most likely, provided base flow to the streams.

Drainage from future surface disturbance will be managed through appropriate sediment controls. Future SUFCO disturbed area discharges will be directed through treatment facilities.

At the termination of mining, downstream potential AVFs will experience decreased flow. The duration and extent of this impact cannot be accurately assessed at this time. However, flow rates may be partially to fully restored when the ground-water system is reestablished by flooding of the abandoned mines.

The operational designs for the SUFCO Mine are determined, based on the information submitted in the mine plans and referenced literature, to be consistent with preventing damage to the hydrologic balance outside the mine plan areas.

Subsidence fracturing has already occurred over the minesite, on and adjacent to the Pines Tract. The rates of healing at depth are for the most part unknown. Future studies are planned by SUFCO mine, the Division, and USFS to determine the healing rates. Best technology currently available (BTCA) will be used in fracture mitigation and fracture propagation with respect to surface features.

VII. STATEMENT OF FINDINGS

Based on the information presented in this CHIA, the Utah Division of Oil, Gas and Mining finds that the proposed coal mining and reclamation operations of the SUFCO Mine including the SITLA Muddy Tract have been designed to prevent material damage to the hydrologic balance outside the permit areas. The possibility of material damage within the CIA exists from the undermining of the East Fork of Box Canyon and from effects of subsidence fractures on stockwatering ponds. Because of ongoing monitoring and mitigation, no evidence of material damage from actual mining operations in the CIA has been found thus far. No other probability of material damage has been identified from existing and anticipated mining operations in the CIA.

The operator has been cooperative in conducting environmental evaluations and operations to lessen impacts to the hydrologic environments.

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ABREVIATIONS

AVF	Alluvial Valley Floor
BLM	Bureau of Land Management
BTCA	Best Technology Currently Available
CIA	Cumulative Impact Area
CHIA	Cumulative Hydrologic Impact Area
DWQ	Utah Division of Water Quality
DWR	Utah Division of Wildlife Resources
FEIS	Final Environmental Impact Statement
mg/L	milligrams per liter
MRP	Mining and Reclamation Plan
MSHA	Mine Safety and Health Administration
NTU	Nephelometric Turbidity Units
PAP	Permit Application Package
PHC	Probable Hydrologic Consequences
PHDI	Palmer Hydrologic Drought Index
ROD	Record of Decision
SITLA	Utah School and Institutional Trust Lands Administration
SMCRA	Surface Mining Control and Reclamation Act of 1977
SUFCO	Southern Utah Fuel Company
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UDOGM	Utah Division of Oil, Gas and Mining
UDWR	Utah Division of Water Resources
UDWQ	Utah Division of Water Quality
UPDES	Utah Pollution Discharge Elimination System
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WRDS	Waste Rock Disposal Site