# CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT

**Beaver Creek Coal Company**
**Trail Mountain #9 Mine**
**ACT/015/009**

**(Federal Lease Tract)**
**Emery County, Utah**
**April 15, 1991**

## I. INTRODUCTION

The purpose of this report is to provide a Cumulative Hydrologic Impact Assessment (CHIA) for the Trail Mountain #9 Mine located in Emery County, Utah. The assessment encompasses the probable cumulative impacts of all anticipated coal mining in the general area on the hydrologic balance, and whether the operations proposed under the application have been designed to prevent damage to the hydrologic balance outside the proposed mine plan area. This report complies with legislation passed under Utah Code Annotated (UCA 40-10-1 et seq.) and the attendant State Program rules.

Beaver Creek Coal Company's Trail Mountain #9 Mine is located along the eastern margin of the Wasatch Plateau Coal Field, approximately 12 miles west of Orangeville, Utah (Figure 1). The eastern margin of the Wasatch Plateau forms a rugged escarpment that overlooks Castle Valley and the San Rafael Swell to the east. Elevations along the eastern escarpment of the Wasatch Plateau range from approximately 6,500 to over 9,000 feet.

Precipitation varies from 40 inches at the higher elevations to less than 10 inches at lower elevations. The area encompassed by the Wasatch Plateau may be classified as semi-arid to sub-humid.

<u>GEOLOGY</u>

Outcropping rocks of the Wasatch Plateau Coal Field range from Upper Cretaceous to Quaternary in age. The rock record reflects an overall regressive sequence from marine (Mancos Shale) through littoral and lagoonal (Blackhawk Formation) to fluvial (Castlegate Sandstone, Price River Formation, North Horn Formation, and lacustrine Flagstaff Formation) depositional environments. Oscillating depositional environments within the overall regressive trend are represented by lithologies within the Blackhawk Formation and the North Horn Formation. The major coal-bearing unit within the Wasatch Plateau Coal Field is the Blackhawk Formation.

VEGETATION

Vegetation varies from the sagebrush/grass community type at lower elevations to the Douglas fir/aspen community at higher elevations. Other vegetative communities include mountain brush, pinyon-juniper, pinyon-juniper/sagebrush and riparian. These communities are primarily used for wildlife habitat and livestock grazing.

HYDROLOGY

Cottonwood Creek which flows past the Trail Mountain #9 Mine is a perennial tributary to the San Rafael River. The Cottonwood Creek drainage basin encompasses about 205 square miles of mountainous country in the Wasatch Plateau. About 90 percent of the area is higher than 8,000 feet. The average channel gradient along Cottonwood Creek is about 300 feet per mile. The lower reaches of the tributaries to Cottonwood Creek typically have surface relief between the stream channel and tops of adjacent canyon walls of 2,000 feet or more.

## II. CUMULATIVE IMPACT AREA (CIA)

Figure 2 delineates the CIA for current and projected Trail Mountain #9 Mine operations. The CIA includes Cottonwood Creek, two intermittent and several ephemeral drainages. The CIA encompasses approximately 14,507 acres.

## III. SCOPE OF MINING

Mining on Trail Mountain was initiated around 1898 at the Oliphant Mine and Black Diamond Mine. These mines have been shut down since the late 1940's. Portals were sealed by the Utah Abandoned Mine Reclamation Program in 1983. Both mines are located in Straight Canyon; no further mining is anticipated in this area due to U.S. Forest Service designation of Straight Canyon as a protected area.

Mining at or near the Trail Mountain Mine began in 1898 (Doelling, 1972). Large scale operations started in 1909. Mining continued up to 1967 when the mine was shut down for 10 years (Cottonwood CHIA). The mine was reopened and is currently owned by Beaver Creek Coal Company.

The Trail Mountain #9 Mine permit area encompasses 4045.78 acres of which the Federal Lease addition is 2630.81 acres. The surface disturbance associated with this mine is approximately 8 acres.

Mining will take place in the Hiawatha coal seam. It is the only coal seam within the permit area of economic interest. The Coal Seam ranges from 7' to 13' thick. Production will be from room and pillar methods using continuous mining equipment.

Double pass or pillar extraction may be used on retreat to maximize coal recovery. Subsidence control monuments will be established to detect the effects of mining induced subsidence. A map identifying subsidence monitoring locations is seen in Figure 12-6 of the Permit Application Package (PAP).

## IV. STUDY AREA

Lithostratigraphic units outcropping within the study area include, from oldest to youngest, the Mancos Shale, Blackhawk Formation, Castlegate Sandstone, Price River Formation, North Horn Formation, Flagstaff Limestone and Quaternary deposits. Lithologic descriptions and unit thicknesses are given in Figure 3.

Rocks in the study area strike northwest and dip from two to four degrees to the southwest. The Joe's Valley Fault occurs along the western boundary of the CIA, where an estimated 2,300 feet of vertical displacement has juxtaposed North Horn Formation (west) against Blackhawk Formation (east). The Straight Canyon Syncline axis trends and plunges southwest across the central portion of the CIA, immediately north and west of the Tract 1 and Tract 2 permit areas (Figure 4).

### TOPOGRAPHY AND PRECIPITATION

Topography ranges from less than 6,800 feet to over 9,000 feet in the southern and northern portions of the CIA, respectively.

The CIA is characterized by a southerly drainage system of perennial, intermittent and ephemeral streams (Figure 5). The North Fork of Cottonwood Creek is perennial and has headwaters above 9,000 feet. Straight Canyon maintains perennial flow due to Joes Valley Reservoir.

Average annual precipitation ranges from 14 inches to 30 inches in the CIA. The Wasatch Plateau may be classified as semi-arid to sub-humid.

Slopes in the permit and adjacent areas are dominated by the pinyon-juniper vegetative community with the conifer types present on north and west facing slopes at higher elevations. Grassland types are interspersed on knolls and benches of upper slopes and ridgetops. Canyon bottoms are covered by sagebrush vegetation types with riparian vegetation occurring as a narrow band along the streams.

## V. HYDROLOGIC RESOURCES

### GROUND WATER

The groundwater regime within the CIA is dependent upon climactic and geologic parameters that establish systems of recharge, movement and discharge.

Snowmelt at higher elevations provides most of the ground water recharge, particularly where permeable lithologies or faults/fractures are exposed at the surface. Vertical migration of ground water occurs through permeable rock units and/or along zones of faulting and fracturing. Lateral migration initiates when ground water encounters impermeable rocks and continues until either the land surface is intersected (and spring discharge occurs) or other permeable lithologies or zones are encountered that allow further vertical flow.

Ground water is present in all lithostratigraphic units that occur within and adjacent conditions (Figure 6) that often form a system of perched aquifers and associated springs and/or seeps. The U.S. Geological Survey (USGS) has identified and formally designated the Blackhawk-Star Point aquifer as the only regional ground water resource in the study area (Danielson, et al 1981 and Lines, 1984).

A total of 16 boreholes have been drilled within the CIA (Figure 3). Two boreholes (TM-1 and TM-2) were completed for the purpose of evaluating ground water resources. The fourteen (14) remaining boreholes were drilled to the west of the permit area by the U.S. Geological Survey for the purposes of assessing coal (Davis and Doelling, 1977) and ground water (Lines, 1985) resources.

TM-1 (Figure 7) penetrated the Star Point-Blackhawk aquifer as well as the Mancos Shale below the Star Point-Blackhawk aquifer. Figure 7 incorporates water-level data from TM-1, TM-2 and Lines (1985) to derive a potentiometric surface contour map for the Blackhawk-Star Point aquifer. The slope, from 7,700 to 7,100 feet, indicates a north to south direction of regional ground water flow. The hydraulically flat gradient in the permit area (Figure 7) suggests that the aquifer is being drained by Cottonwood Creek.

Lines (1985) conducted a testing on the regional aquifer and the results were simulated in a finite difference three-dimensional computer model. Several responses of the ground water resource to mine dewatering activities were generated. Lines concluded that mine inflows could be several hundred gallons per minute (gpm). In the Trail Mountain #9 Mine Probable Hydrologic Consequence (PHC), using acceptable methodologies, the applicant stated that mine inflows would range between 70 and 165 gpm. The resulting cone of depression would extend 2 miles to the north and south of the mine, and 5 miles to the east and west of the mine. The majority of mine inflow would be from aquifer storage (Lines, 1985). Several "perched" aquifer systems, or zones, are present in the CIA, most prevalently in the North Horn Formation. Approximately 80 percent of the identified springs in the CIA issue from the North Horn Formation. Water moves vertically through the permeable sandstone lenses of the North Horn Formation until intersecting less permeable shale lenses, whereupon water will begin to move in the horizontal direction and may discharge to the surface as a spring.

"Perched" aquifer zones and the Blackhawk-Star Point aquifer are separated by 1,000 to 1,700 feet of interburden. Lines (1985) noted that although there was a significant amount of interburden between aquifers, hydraulic connection occurs between aquifers. Most of the exchange of water probably occurs along fractures in perching beds where there is unsaturated flow downward (Lines, 1985). This leakage is a significant source of recharge to the Blackhawk-Star Point aquifer.

Hydraulic and lithologic data presented by Lines (1985) demonstrated large variations in porosity and hydraulic conductivity for the Blackhawk-Star Point aquifer. The Blackhawk Formation consists of interfingering lenses of fine grained sandstone, siltstone, and shale, while the Star Point Sandstone is medium-grained sandstone. Hence, the variation in the hydraulic properties of the aquifer.

Lines (1985) reported that snowmelt and rain are the main sources of recharge to the ground water system underlying Trail Mountain. Danielson (1981) reported that snowmelt was the major source of recharge to the Blackhawk-Star Point aquifer.

The Blackhawk-Star Point aquifer discharges along Cottonwood Creek Canyon. Spring flows account for 18 percent of the normal annual precipitation on the outcrop. Approximately half of the Cottonwood Creek base flow is derived from aquifer discharge from Trail Mountain, and the other half from East Mountain.

The head of Straight Canyon is a major discharge point for the Blackhawk-Star Point aquifer (Lines, 1985). Prior to the construction of Joes Valley Reservoir, several large springs emanated from the Blackhawk-Star Point aquifer in the dam site area. Streamflow measurements taken during periods of base flow along Straight Canyon detected no ground water discharge except that coming from the head of the canyon and at an abandoned mine in the canyon.

Danielson et al (1981) and Lines (1985) identify 26 springs on Trail Mountain. Of these, 82 percent (21) occur in the North Horn Formation and the remainder occur in the Blackhawk Formation and Star Point Sandstone. Water quality data indicate that springs associated with the North Horn Formation have slightly elevated calcium, magnesium, and sodium levels, whereas springs that issue from the regional aquifer have increased sulfate and TDS.

At present, mine inflow is estimated to be 72.62 gpm from roof bolts, wall weeps and channel sands in the current permit area. This water is produced from localized perched aquifers.

The operator currently monitors eleven (11) springs, six (6) ponds, one (1) well, two (2) underground sites, and three (3) surface water sites as part of the approved water monitoring plan. Of the eleven springs, nine issue from the Blackhawk Formation, one from the Price River, and one from the Castlegate Sandstone. The mine discharge and in-mine water sources issue from the Blackhawk-Star Point aquifer. One well is completed in the Star Point Sandstone. The six ponds are found in the North Horn formation.

SURFACE WATER

The Trail Mountain #9 Mine is located immediately adjacent to Cottonwood Creek, one of the major tributaries of the San Rafael River. Cottonwood Creek has had an annual flow near Orangeville of 70,700 acre-feet during the period of record that extends intermittently from 1909 through the present (U.S. Geological Survey, 1984). Approximately 50 to 70 percent of streamflow in the mountain streams of the region occurs during May through July (Waddell et al., 1981). Streamflow during this late spring/early summer period is the result of snowmelt runoff.

The quality of water in Cottonwood Creek and other similar streams in the area varies significantly with distance downstream. Waddell et al (1981) found that concentrations of dissolved solids varied from 125 to 375 milligrams per liter in major streams in the region in reaches above major diversions to 1,600 to 4,025 milligrams per liter in reaches below major irrigation diversions and population centers. The major ions at the upper sites were found to be calcium, magnesium, and bicarbonate, whereas sodium and sulfate became more dominant at the lower sites. They attributed these changes to: (1) diversion of water containing low dissolved solids concentrations; (2) subsequent irrigation and return drainage from moderate to highly saline soils; (3) ground water seepage; and (4) inflow of sewage and pollutants from population centers.

Average annual sediment yields within the Cottonwood Creek drainage basin range from approximately 0.1 acre-feet per square mile in the headwaters area to about 3.0 acre-feet per square mile near the confluence with the San Rafael River (Waddell et al., 1981).

The Trail Mountain #9 Mine area is drained entirely by ephemeral and intermittent watersheds. These watersheds are steep (with average slopes often exceeding 50 percent). Channels in the mine plan area are not generally deeply incised.

Surface water quality data collected from Cottonwood Creek by Beaver Creek Coal Company indicate that the dominant ions in Cottonwood Creek near the mine are calcium, magnesium, and bicarbonate. Total dissolved solids concentrations in the stream vary from about 250 to 470 milligrams per liter in the mine area, with the lower concentrations normally occurring during September through January. Total dissolved solid concentrations were plotted for a period of five years (Figure 8). Data were derived at three stations on Cottonwood Creek, SW-1, SW-2, and SW-3 (Figure 5).

Total dissolved solid concentrations (TDS) show consistent variation during base flow periods. During the runoff months (Mar-Jun), TDS concentrations at the three stations diverge to extreme values (Figure 8).

Total suspended solids concentrations in Cottonwood Creek tend to vary inversely with the flow rate, as expected. Concentrations have varied during the period of record from less than 1 milligram per liter to greater than 1,000 milligrams per liter.

Additional discussions concerning the surface water regime of the Cottonwood Creek drainage basin are contained in the Cottonwood CIA.

## VI. POTENTIAL HYDROLOGIC IMPACTS

### GROUND WATER

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

Dewatering. Mine inflow is currently estimated to be 72.62 gpm. Most of the inflow is utilized underground for dust suppression. Beaver Creek Coal Company diverts water from Cottonwood Creek occasionally to meet mining equipment requirements.

Mine inflows are expected to increase as mining progresses downdip to the west. The regional aquifer fully saturates the coal seam (Figure 6) in the permit area and future development may result in additional inflow of 70 to 165 gpm for a total inflow of 130 to 220 gpm. A mining-induced cone of depression which could develop and extend, from the center of the mine, 2 miles to the north and south and 5 miles to the east and west. The drawdown of the potentiometric surface would be most detrimental to the north, south, and west, where the bedrock is saturated. Exploration of the new lease tract has not indicated any major underground aquifers or cause to believe large quantities of water will be intercepted.

Upon termination of mining operations, the workings will begin to flood. Total recovery of the intercepted recharge to Cottonwood Creek will begin when the head elevation in the abandoned workings exceeds the water level in the stream adjacent to the Tract 1 permit area. Lines (1985) indicated that most (80 percent) of the mine inflow water would come from storage in the aquifer, whereas 20 percent would be water intercepted from aquifer discharge. Mine inflows would gradually decrease and aquifer discharge would increase as the head in the mine equilibrates. Mine inflows over the equilibrium time would average 0.5 cfs; of this amount Lines estimated that aquifer discharge would be reduced by 0.1 cfs. This would result in an impact of 72 acre-feet of depleted contribution to Cottonwood Creek.

Subsidence. Subsidence impacts are related to extension and expansion of the existing fracture system and upward propagation of new fractures. Inasmuch as vertical and lateral migration of water appears to be partially controlled by fracture conduits, readjust or realignment in the conduit system will inevitably produce changes in increased flow along fractures that have "opened" and diverting flow along new fractures or permeable lithologies. Subsurface flow diversions may cause the depletion of water in certain localized or "perched" aquifers, whereas increased flow rates along fractures would reduce ground water resistance time and potentially improve water quality.

Subsidence associated with Trail Mountain #9 Mine development is projected to encompass limited vertical movement and be largely confined to the approved permit areas. Accordingly, the ground water regime within the CIA is considered to be at low risk to mining-induced subsidence impacts.

<u>SURFACE WATER</u>

<u>Cottonwood Creek</u>. No new surface facilities (i.e., extended surface disturbance) are planned for the Trail Mountain #9 Mine. Improvements to the surface facilities (paved access road, curb and gutter to sediment pond) should negate impacts to the surface water.

Water is infrequently discharged from the Trail Mountain #9 Mine. Water has been discharged from the mine during periods of low mining activities. The UPDES permit for mine water discharge ensures that the effluent meets the applicable standards.

Future development on Trail Mountain would occur along Cottonwood Creek. Straight Canyon is a Forest Service Withdrawal Area which precludes mining from occurring in Straight Canyon. Beaver Creek Coal Company holds the only federal lease on Trail Mountain requiring diligence. Leasing of federal coal could conceivably occur north of the Trail Mountain #9 Mine, impact from future operations would be dewatering of the aquifer system and minimal surface disturbances. The permitting process will require implementation of sediment control measures and impacts to surface water should be minimized.

## VII. SUMMARY

The operational design implemented at the Trail Mountain #9 Mine is herein determined to be consistent with preventing damage to the hydrologic balance outside the mine plan area.

# REFERENCES

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