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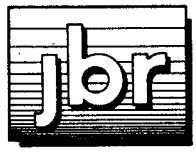

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HYDROLOGIC DRILLING STRATEGY

SUNNYSIDE MINES AREA

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HYDROLOGIC DRILLING STRATEGY

SUNNYSIDE MINES AREA

Prepared for:

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July 23, 1986

Prepared by:

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Introduction

The purpose of this document is to present a brief description of the present knowledge of the existing groundwater system, to point out the areas where understanding of the groundwater system is incomplete, and to propose an approach, through drilling, to filling in the data gaps.

Knowledge of the Existing System

Geology.

The geology in the Sunnyside area is depicted on the accompanying geology map, Plate I, and cross-sections, Plates II and III. The geologic descriptions are taken from available drill hole data and Osterwald, et. al. (1981).

The bedrock in the Book Cliffs is comprised of a series of interbedded sandstones and shales of Cretaceous and Tertiary age. The lowest formation exposed in the area is the Cretaceous Mancos Shale. It is a medium-gray to bluish-gray, locally fissile mudstone with discontinuous stringers of siltstone and claystone.

The next younger formation is the Cretaceous Blackhawk Formation. It consists of five members in the area of the proposed mine. The lowest member is the Aberdeen Member. It is a shaley siltstone and sandstone of undetermined thickness. The Aberdeen has been described as a member of the Blackhawk Formation occurring entirely within the Mancos Shale. The Kenilworth Member overlays the upper tongue of the Mancos Shale. The Kenilworth is 110 to 220 feet thick and consists of interbedded sandstones and shales. It is overlain by the unnamed lower mudstone member, which is 150 to 200 feet thick. The lower mudstone consists of dark gray clayey mudstones, shales, and sandy siltstones. The Sunnyside Member lies over the lower mudstone and is between 100 and 190 feet thick. Basically a sandstone, it grades from a coarse-grained sandstone at the base to a fine-grained sandstone at the top. In the lower section the sandstone has some interbedded siltstone lenses. The unnamed upper mudstone member is 100 to 200 feet thick and consists of mudstones and siltstones with some discontinuous sandstone beds. The total thickness of the Blackhawk Formation is between 560 and 810 feet.

The Castlegate Sandstone, also Cretaceous in age, overlies the Blackhawk Formation. The formation is a fine- to medium-grained sandstone about 200 feet thick.

The Cretaceous Price River Formation is the next formation above the Castlegate Sandstone. It consists of two members, the lower unnamed member and the Bluecastle Sandstone Member. The lower unnamed member is 150 to 300 feet thick and is made up of a weak, gray and brown argillaceous, fine-grained sandstone. The upper member is a fine- to medium-grained sandstone between 10 and 300 feet thick.

The Price River Formation is overlain by the North Horn and Flagstaff Formations. These units are undifferentiated in the Sunnyside area and are Tertiary in age. They consist of interbedded claystones, mudstones, limestones, siltstones, and sandstones. The thickness of the these combined formations has not been measured. They are thought to be 500 to 700 feet thick.

The Colton Formation is the upper most formation exposed in the Sunnyside area. It ranges from 900 to 3000 feet thick and is composed of mudstones with channel sandstone deposits in the lower portion and fluvial sandstones with some limestone beds in the upper portion.

The geologic structure of the area is controlled mainly by the San Rafael Swell. The dip of the strata is to the northeast, as Plate II shows. At the front of the Book Cliffs, the dip ranges from six to eighteen degrees, however one mile from the front of the cliffs the dip drops to an average of only four degrees (Osterwald, et al., 1981).

There have been few faults identified in the area. The Sunnyside Fault trends north-northwest throughout the Sunnyside District; however, the displacement on the fault decreases to the north. As a result, surface recognition of the fault is not possible. Several other faults have been identified in the Sunnyside No. 3 area and in the right fork of Whitmore Canyon (see Plate I).

Groundwater flow.

Studies by Waddell, et al.(1986), Waddell, et al.(1981), Sumsion,C.T.(1979), Waddell, et al. (1978), Sunedco (1981 and 1984), and Soldier Creek (1981) cover the area just north of the proposed Kaiser mine. These reports provide a description of the regional groundwater system.

Groundwater occurrence in the Book Cliffs is controlled principally by geology (USGS, 1979). Water occurs in three different materials: the alluvial deposits; the colluvial deposits; and the consolidated rocks. The Quaternary alluvium, while limited in extent (confined generally to the canyon bottoms), and weathered residual colluvium are the most permeable zones yielding most of the water to springs and streamflow. The consolidated sandstones of Cretaceous and Tertiary age have a lower permeability than the alluvial and colluvial deposits, but

are much more extensive. They contribute some water to springs and streamflow where perched water-bearing zones outcrop. When they outcrop against alluvium or streams the discharge is to streamflow. Where they outcrop higher up in the section on slopes, the discharge is to colluvium or to spring flow. The remainder of the water is confined by surrounding shale and mudstone aquitards and conveyed downgradient in the individual water-bearing zones. The shale and mudstone units pass water very slowly and are not adequate for completion of production wells (Freeze and Cherry, 1979).

Work done in the area north of the Sunnyside No.5 by Waddell, et al.(1986), Sunedco (1981 and 1984), and Soldier Creek (1981), has identified separate water-bearing zones in the Flagstaff, Price River, and Blackhawk Formations. Initial attempts by Sunedco (then known as Eureka Energy)(1981) to evaluate whether or not a potentiometric surface exists across the Price River, Castlegate, and Blackhawk Formations did not produce meaningful results and was determined inadequate by the Division of Oil, Gas, and Mining (memo in Division files, 1982). Work undertaken by Waddell, et al. (1986), in the Flagstaff Limestone, by Sunedco (1984), in the Price River Formation, and by Soldier Creek (1981), in the Blackhawk Formation, indicates that a separate water-bearing zone with a separate potentiometric head has been identified for each unit. Waddell et al. (1986), Soldier Creek (1981), and Sunedco (1984) all indicate that these perched aquifers have gradients to the north-northeast in the direction of dip of the formations.

Laterally persistent sandstone beds are the principal water-bearing units (see Plate I, Geology Map). Their water-yielding capability is limited by the structure of the sandstone (grain size, amount of cementation, and degree of fracturing) and the intervening beds of shale and mudstone. The shale and mudstone stringers act as barriers to vertical movement of water in the water-bearing beds. They also prevent precipitation recharge from entering the deep groundwater system.

Along with the consolidated rocks, water-bearing alluvium and colluvium is found in the Book Cliffs. Waddell, et al. (1986), Sunedco (1981 and 1984), and Soldier Creek (1981) indicate that the alluvial deposits are the most permeable, but the most limited in extent (generally confined to the canyon bottoms). Estimates of the depth of the alluvium are on the order of tens of feet making them quite shallow. Colluvial deposits, found on the hillslopes and draws of the main canyons, are also quite shallow and while of greater extent than alluvial deposits are still limited in extent. Estimates of the general colluvial depth is approximately 3 to 5 feet, with some local areas varying above and below this value.

Locally, in the area of the proposed Sunnyside No. 5 Mine, groundwater occurrences has been identified as follows:

- Data collected from the spring and seep data from both the fall 1985 and spring 1986 suggest the North Horn/Colton Formations represent perched aquifers. Also, Waddell, et. al. (1986) indicates that the waters in the Flagstaff Formation, locally undifferentiated from the North Horn Formation, are perched in relation to the waters in the Price River, Castlegate, and Blackhawk Formations.

- The Price River Formation has been suggested, by Rick Smith of the Division of Oil, Gas & Mining to provide a possible water-bearing zone in the mine plan area. During the spring and seep surveys, some springs and seeps were found in the Bluecastle Sandstone Member of the Price River Formation on the northwest end of West Ridge. The remaining springs were located on undivided Price River Formation in the south end of West Ridge. Of the springs located in the Price River Formation, 10 springs were located in or discharging from colluvium, while the remaining 6 springs were discharging from bedrock. Four of the bedrock springs appear to represent locally perched aquifers. The remaining two springs appear on the northwest side of west ridge in the Bluecastle Sandstone. It is uncertain whether the flow from these two springs is from bedrock or if it is from colluvium flowing over the surface of the bedrock.

- The survey data provided no evidence that the springs and seeps found in the lower Price River Formation or the Castlegate Sandstone result from other than colluvial or perched systems.

- Water occurrences have been noted in two places in the Blackhawk Formation: from springs low on the west side of West Ridge; and in the existing workings of the No. 3 Mine. Evaluation of the strata underlying the coal seam in the No. 3 Mine Bunker, indicate that no water or at best very little water exists in the Sunnyside Sandstone Member below the coal. This suggests that the coal and resinous bone coals and shales may act as aquicludes and be locally perching the water.

- The Mancos Shale has limited water, based on the spring and seep data. No significant groundwater development of the Mancos Shale have been noted and the water use appears to be limited to stock watering at the three springs identified.

Information Gaps

There are two stratigraphic horizons where the understanding of the groundwater hydrology of the No. 5 mine plan area is not complete. These horizons are the Bluecastle Sandstone Member of the Price River Formation and the Sunnyside Sandstone Member of the Blackhawk Formation.

As noted previously, there is no positive evidence that the Bluecastle Sandstone is a water-bearing unit. The springs that have been identified appear to be colluvial or perched groundwater occurrences, with the exception of two. The mode of occurrence of water in the Bluecastle Sandstone is, therefore, not clearly understood.

Within the Blackhawk Formation, the waters differ considerably as to quality and the investigation of the No. 3 Mine Bunker decline, locally at least, demonstrates that the formation is not completely saturated. This raises the possibility that the waters are perched above the coals and are not being conveyed through the formation.

The resolution of the uncertainties regarding the occurring water in the Blackhawk Formation and in the Bluecastle Member of the Price River Formation are proposed to be accomplished by the strategy presented below.

Data Collection

In an effort to address the above concerns, Kaiser plans to drill two boreholes and completing them as monitoring wells. The first borehole is proposed to be a 700 foot hole located in Whitmore Canyon (see Plates I and III). This hole, located on the east side of West Ridge, will attempt to determine if any water exists in the Bluecastle Sandstone.

The second hole is planned to be 300 feet deep and will be drilled from just above the Sunnyside coal seam in C canyon. This hole will provide an evaluation of saturation in the Sunnyside Member of the Blackhawk Formation to compare the characteristics of the unit in the No. 5 area to those in the No. 3 area as described from the bunker decline. The Sunnyside is the thickest and most persistent sandstone in the Blackhawk Formation. If an aquifer exists beneath and proximal to the coal seam, it is likely to occur in the Sunnyside Sandstone.

Completion details for both boreholes are as follows:

- 8 inch diameter holes are to be drilled by air rotary, using a foam additive (biodegradable) as necessary.
- 4 inch I.D. steel casing will be installed.
- Target zones will be sealed-off and screened.
- Screened intervals will be sealed-off with bentonite above and below the target zone and a gravel pack will be installed.
- Well development will be conducted by bailing the completed well for a sufficient period to remove fines from the well and the gravel pack.

Testing of the wells will be conducted for quality and aquifer characteristics. Water quality sampling will consist of bailing water samples for parameters in the Divisions guidelines. The sampling will be conducted initially, following the well completion and development and then on a quarterly basis for the duration of the two-year baseline period thereafter in accordance with the Divisions guidelines.

Aquifer testing to determine groundwater flow characteristics will be conducted in each monitoring well by either slug or injection tests. The results of the aquifer tests will be analyzed using the methods of Cooper, Bredehoeft, and Papadopulos (1967), for confined conditions, or Bouwer and Rice (1976), for unconfined conditions. Results from the aquifer test analyses will be compared to the regional characteristics determined by Waddell, et al. (1986).

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July 23, 1986

Mr. Lowell P. Braxton
Administrator
Mined Land Reclamation Program
Utah Division of Oil Gas and Mining
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

Dear Mr. Braxton:

Kaiser Coal Corporation (Kaiser), through its Sunnyside Mines Permit (ACT 007-007) has committed to five drill holes in the permitted Sunnyside Mines area by the end of September, 1986. Three of these holes were proposed to be drilled underground and two were proposed to be drilled on the surface. The surface holes were planned to be coal exploration drill holes from which hydrologic data would be obtained.

Kaiser has determined that no exploration drilling is required now nor is it likely to be required in the near term to meet the needs of mine development either in the existing Sunnyside Mines area or in the planned Sunnyside No. 5 area. In addition, a bunker decline located in the lower portion of the Sunnyside No. 3 mine penetrates a 164-foot thickness of Sunnyside Sandstone beneath the coal seam. This decline has not been previously examined by DOGM personnel. During the course of geologic and hydrologic baseline studies for the No. 5 mine PAP, it was mapped geologically and it was found to have only minor water occurrences. The combined water flow for the entire bunker decline was 1.5 gpm in Spring of 1986. Kaiser has therefore concluded that given the lack of water in the down-dip portion of the Sunnyside Sandstone in the bunker decline, combined with the severe floor-heave problems that are ubiquitous throughout the mine, underground drilling to examine the Sunnyside Sandstone will not be fruitful or of benefit in achieving the intended goals.

Recently gathered geohydrologic information, summarized in the attached report, indicates that the geohydrologic regime in the greater Sunnyside area is well understood with the exception of two areas. The attached report presents Kaiser's intended approach in filling the recognized geohydrologic data gaps: a

two-hole groundwater monitoring drilling program. Kaiser believes that data from this drilling program, when combined with other available regional and site-specific data, will provide a hydrologic baseline database that is as complete as can reasonably be expected.

Kaiser proposes that the current stipulation for drilling as stated in the Sunnyside Mines Permit (ACT ØØ7-ØØ7) be stricken and that the drilling proposed in the attached document be undertaken in lieu of the existing stipulation. Please let me know if this approach meets with your approval and if it is necessary for Kaiser to provide any additional information in order to effect this change.

Kaiser would like to begin plans for the logistics involved with the drilling which is tentatively scheduled to commence on September 1, 1986. As such, I would appreciate receiving any comments the Division might have by mid-August. If no comments have been received at that time, Kaiser will proceed with the drilling as planned, and assume that the Division concurs with the program.

Sincerely,

Martin P. Holmes

Martin P. Holmes
Manager Permits and
Regulatory Compliance

cc: J. Whitehead
R. Smith
B. Buck, JBR