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CO-OP MINING COMPANY

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Tom Munson
Division of Oil, Gas and Mining
355 West North Temple
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Salt Lake City,Utah 84180

July 22, 1991

RE: Drilling Program

Dear Mr. Munson;

I am submitting the amended Underground Drilling Program prepared by Earthfax Engineering Company as the Co-op Mining Company proposal to help determine the ground water level below the Bear Canyon Mine. Please match this submittal with Plate D-1 that you presently have with the original submittal to show the hole location, as I am unable to send the Plate over the fax.

Yours Truly,

Wendell Owen
Resident Agent

Wendell Owen

Co-Op Mining Company
Huntington, Utah

Underground Drilling Program
July 20, 1991

Co-Op Mining Company

Underground Drilling Program

Co-Op Mining Company (Co-Op) proposes an underground drilling program for the purpose of characterizing the groundwater system underlying the Bear Canyon Mine. This drilling is proposed to be conducted in two phases. First, a single pilot hole will be drilled to identify the subsurface conditions and the depth to groundwater below the mine. Second, if water is encountered, three additional holes will be drilled to further characterize the groundwater conditions below the mine. All of these holes are proposed for locations which will be accessible during the anticipated life of the operation.

Co-Op invites representatives of the Utah Division of Oil, Gas, and Mining (Division) to observe the drilling activities and to participate in logging of the holes. In the event that the Division wishes to participate, Co-Op will notify the Division one week prior to the commencement of the drilling activities.

Phase 1

The first phase of drilling will consist of drilling a 1-7/8" diameter borehole from the floor of the mine at location D-1 (see Plate 1). The floor of the mine is located on the base of the Bear Canyon Seam at an approximate elevation of 7,545 feet. Previous drilling for coal exploration, conducted by Co-Op, has identified that the Bear Canyon Seam is approximately 80 feet above the base of the Blackhawk Formation. Based on the data available (Doelling, 1970, and USGS, 1981), the Star Point Sandstone in the mine area is between 350-450 feet thick. In the Deer Creek Mine, approximately 5 miles to the southeast of the Bear Canyon Mine, the Star Point Sandstone consists of an interbedding of mudstone and sandstone of the Star Point Sandstone and the underlying Mancos Shale. The formation contains two mudstone tongues and three sandstone tongues. According to Spieker (1931), the three sandstone tongues are the Spring Canyon, Stores, and the Panther. In the area of the Deer

Creek Mine, the Spring Canyon tongue is 80 feet thick. It is underlain by a mudstone layer approximately 40 feet thick. The Stores tongue varies from 60 to 80 feet thick across the property. The Stores tongue is underlain by a second mudstone layer which varies in thickness across the mine property, ranging from 40 to 80 feet. The Panther tongue, which is the least important hydraulically, ranges from 140 to 180 feet thick. According to Chuck Zemborski of UP&L (1991), little water is found in the Panther tongue and it generally acts as a drain for the overlying tongues.

It is currently anticipated that the initial hole will be drilled through the entire thickness of the Star Point Sandstone to the top of the Mancos Shale Formation. Therefore, the anticipated depth for this pilot hole would be approximately 520 feet or to an elevation of 7,025 feet. According to the potentiometric surface prepared by Montgomery (1991), the depth to water, if encountered, is anticipated to be approximately 235 feet below the mine.

Drilling activities will be conducted using an underground drill. During the drilling, water and cuttings will be collected at the surface of the hole. Occurrence of water in the subsurface will be evaluated, during drilling, by measuring the relative difference of injected water and returns flow at the surface. It is planned that the amount of water and rate of injection will be monitored by use of a totalizing flow meter on the drill rig and the return flows will be collected by sandbagging around the hole and diverting the water to one point. A portable flume will be installed to measure the relative changes in the return flow rate from the collected flow. Co-Op proposes to utilize EarthFax Engineering, Inc. (EarthFax) to log the well and to monitor the water returns at the surface. Any changes in lithology and water inflows to the hole will be recorded and reported.

During the drilling, several zones will be tested to determine the hydraulic head and the aquifer characteristics. These zones will be the three anticipated sandstone tongues. The proposed drilling will be conducted to the first mudstone layer or to a depth of 100 feet into

the Star Point Sandstone. At this point, head and hydraulic testing will be conducted in the Spring Canyon tongue. Following the testing of the Spring Canyon tongue, drilling will continue to the second mudstone unit or a depth of 200 feet below the top of the Star Point Sandstone, where head and hydraulic testing will be conducted in the Stores tongue. This will be followed by drilling through the Panther tongue to the top of the Mancos Shale where head and hydraulic testing will again be conducted.

The head and hydraulic testing will be conducted by removing the drill steel from the hole and the hole will be blown with air to clean out any cuttings and to evacuate the water from the borehole. A 1-1/2-inch diameter pneumatic packer will be lowered into the borehole on a 3/4-inch flush-jointed drop pipe. This packer will be set, by inflating with compressed air or nitrogen, at the top of the Star Point Sandstone, isolating the upper sandstone layer from the overlying Blackhawk Formation. A 0 to 10 psi transducer will be passed thru the packer and will located at a depth 10 to 20 feet below the bottom of the 3/4-inch drop pipe. The recovery of the water level in the borehole will then be recorded to determine inflow rate to the borehole. This monitoring is anticipated to consist of taking readings at the time the packer is set, at the end of shift, and at the start of shift the next day. If the well recovery is very slow, this monitoring may take longer.

Following the determination of static water level, a determination of the hydraulic characteristics of the specific tongue will be conducted. A set of slug and bail tests will be conducted in the borehole. A slug test consists of rapidly raising or lowering the water level in a well and then monitoring the recovery of the water level through time. Although this is often accomplished by rapidly introducing or withdrawing a known volume of water to or from the well, such methods result in either dilution of the well water or the need for proper disposal of potentially contaminated water, respectively. Thus, slug and bail tests will be performed during this investigation by use of a 316 stainless steel bar (referred to herein as a slug). When the slug is rapidly lowered into the water column, the water level rises abruptly

(slug test portion). Rapid withdrawal of the slug after the water level has recovered and stabilized causes the water level to drop abruptly (bail test portion).

Two slug lengths can potentially be used (one five feet and one ten feet) in the testing. The selection of slug length will be dependent on the static depth of water in the borehole to ensure complete submergence of the slug and the height of the roof above the collar of the borehole. Both slugs will be 1/2-inch in diameter. The five-foot long slug displaces 0.007 cubic feet of water, and the ten-foot long slug displaces 0.014 cubic feet of water. These displacements correspond to initial changes in the water elevation in the 3/4-inch diameter drop pipe of approximately 2.28 feet and 4.67 feet, respectively.

A pressure transducer with an operating pressure range of 10 pounds per square inch (23.1 feet of water) will be used to measure water levels during the slug and bail tests. Data derived from the transducer will be recorded by a model 21X Micrologger manufactured by Campbell Scientific. The micrologger will be programmed to record water-level changes to within 0.001 foot at either one-half or one second intervals depending on the response of the aquifer.

As described in the placement of the packer, the pressure transducer will be lowered into the borehole to a depth that was 10 to 20 feet below the lowest point of the 3/4-inch drop pipe but within the depth range of the transducer. The slug will then be rapidly lowered into the water column in the monitoring well.

The water level response to the slug will be collected by the micrologger. The water-levels displayed by the micrologger will be examined to monitor trends and the progress of the test. Each test will be allowed to proceed until the water level recovers to at least 95% of initial water level.

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Following completion of the slug test (injection of the slug) and stabilization of the water-level, a bail test (removal of the slug) will be performed. Hence, a minimum of two tests will be conducted in each well. Where recovery is rapid, additional slug and bail tests will be performed.

Data recorded in the field will be transferred to diskette and analyzed using a recently published microcomputer software (AQTESOLV™, Duffield and Rumbaugh, 1989), which aids in the analysis hydraulic data. The AQTESOLV™ software utilizes the analytical methods of Bouwer and Rice (1976), which determines hydraulic conductivity for wells penetrating unconfined aquifers, and Cooper, Bredehoeft, and Papadopolas (1971), which determines hydraulic conductivity for wells penetrating confined aquifers.

Following the completion of the aquifer testing, the packer and test equipment will be removed from the borehole and the borehole will be advanced to the next tongue of the Star Point Sandstone.

In the event that drilling problems are encountered, Co-Op will contact the Division to discuss the problems encountered and to determine an alternative course of action.

Following completion of the drilling, if groundwater is encountered, the hole will be completed with 1-inch I.D. threaded PVC pipe from the floor of the mine to the bottom of the most productive tongue of the formation. The lower 20 feet of the hole will be completed with a No. 10 slot screen.

As the Star Point Sandstone is anticipated to be a competent formation, the completion will consist of a flush surface casing and will be sealed with a neat cement only in the top 20 to 30 feet. This cement seal will be to both prevent material from the mine from entering the well and to prevent damage to the well resulting from floor heave from the mining operation. Cementing will be accomplished using a cement basket placed on the 1-inch casing at least

20 feet below the mine floor. The neat cement will be triemed via a 1/2-inch trieme line until return of cement is observed at the surface of the hole.

Phase 2

If water is encountered during the Phase 1 drilling, Co Op proposes to drill three additional holes. The locations of these holes are shown as D-2, D-3, and D-4 on Plate 1. These holes will also be drilled with a 1-7/8-inch diameter drill and will be monitored by EarthFax for lithology and water inflows. The holes will be advanced to a depth at least 50-feet below the top of the saturated zone. Completion of the holes will be similar to well D-1, with 1-inch I.D. threaded PVC pipe, a flush surface casing, and a cement seal in the top 20 to 30 feet of the hole.

The four wells will be sampled for water quality using a bailer. Bailing will continue until subsequent bailers yield similar results on pH, conductivity, and temperature measurements prior to sample collection. The water quality parameters to be analyzed are the baseline list of parameters presented in the Bear Canyon Mine M&RP. These wells will be sampled on a quarterly basis until baseline conditions have been identified.

To assist in the determination of aquifer characteristics, slug tests will be conducted in each well. This testing will consist of injection tests, where a slug of known volume is injected into the well and the subsequent rise and recovery in the water level of the well is recorded. The water level will be recorded using a datalogger and a 0-10 psi pressure transducer. These data will then be reduced and analyzed using the appropriate method of either Bower and Rice (1976) or Cooper, Bredehoeft, and Papadopulos (1967). This information will be used with the development of a potentiometric map to provide a determination of the direction and rate of groundwater flow.

As part of the second phase, the elevation of the Big Bear and Birch Springs will be determined. Additionally, the stratigraphic section where water at the springs originates will be determined and a correlation of the depth of water encountered in the subsurface will be conducted. This will assist in the determination of the connection of the waters underlying the mines with the spring flows.

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