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David Cory Frankel
ARM Aligning for Responsible Mining
P.O. Box 3014
Pine Ridge, South Dakota 57770

Re: Summary of Recommendations and Opinions on CBR

Dear Mr. Frankel:

We have conducted a limited review of the 2007 License Renewal Application for Crow Butte Resources (CBR). Overall, we found it to be a professionally written document, with a large amount of useful information.

It is our understanding that there has been some offsite contamination as a result of mining operations at the CBR site, and that there is a likelihood of further contamination of the alluvium along the White River from these mining operations. It certainly should be the goal of all concerned parties that any further migration of contaminants off site be stopped as soon as possible. This requires an understanding of the mining operations, the local geology, and how the contaminants got released. It should also be the goal to understand the nature and extent of the contaminated area, so that informed decisions can be made about any mitigation.

To that end, we make the following recommendations:

Better Monitoring and Response to Excursions

Monitor wells at the CBR site appear to be only screened in the ore-bearing part of the Chadron formation. There should be additional monitor wells that are completed in all of the water bearing formations above the Pierre Shale. In order to prevent cross contamination of aquifers, and to establish which aquifer is indicating an excursion, any one monitor well should be sealed and screened in only one aquifer. For any one location, this would require a set of wells independently monitoring the Chadron, Brule, and alluvium.

We understand that there are over 5000 wells at the CBR site. We also have been informed that anytime a lixiviant excursion is detected in the monitoring system, a person has to physically go to the well field and make some adjustment, based on that person's judgment of the situation. The complex nature of this well system suggests that this method is likely to be error prone.

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There is an Allen-Bradley PLC-5 based control system in place. However, we have no information about the level of system detail this provides. The system should have a Supervisory Control and Data Acquisition (SCADA) system that provides all water level, well pump and pipe flow telemetry data to one location, linked to a real-time well and pipe flow-modeling system. This would provide the well field operator with the best information to determine what may have caused the excursion. It could also alert the operator to a problem before it becomes an excursion.

Offsite Baseline Water Quality Sampling

The only way to quantify any contamination is to have a baseline for comparison. Historic water quality information from sources such as the USGS should be explored. Existing offsite wells in the vicinity of CBR and wells along the White River alluvium should be sampled for pertinent water quality parameters to establish this baseline. In areas with no existing wells, monitor wells should be installed. In addition, surface water quality sampling sites should be established along the White River and its tributaries.

Characterization of Contamination Pathways/Offsite Aquifer Parameters

As part of any site characterization, aquifer parameters such as transmissivity and saturated thickness should be established. Potentiometric surfaces should be mapped. This will likely require test holes, monitor wells, and pumping tests. Surface and borehole geophysical techniques and hydrophysics should be considered to characterize the system in sufficient detail.

Surface geophysical techniques can help define the geometry on the depositional environments of the White River alluvium and underlying units. Borehole geophysics can provide information about boundaries and preferential pathways. Hydrophysical examinations of the subsurface can characterize things like fracture flow to quantify secondary hydraulic conductivity. Many new techniques have emerged in recent years. For example, scanning colloidal boroscope flow meters can track naturally-occurring colloidal-sized particles in groundwater, provide very accurate measurements of speed and direction of natural flows through boreholes, aiding in identification of preferential pathways.

Depending on other investigation results, a numerical groundwater flow and contaminant transport model such as MODFLOW/MT3DMS may be needed to quantify the extent of the contamination. This type of modeling effort would require extensive field data for calibration and verification.

White River Contamination

In reference to statements from Dr. Hannan LaGarry, we agree with his assessment that an examination of the extent of contamination of the White River alluvium is warranted. Many of his suggestions can be augmented by the geophysical and hydrophysical techniques previously mentioned. We agree that the subsurface should be fully characterized in as much detail as

possible, using a Geographic Information System (GIS). Subsurface mapping in three dimensions will substantially contribute to an overall understanding of this system.

As mentioned previously, a re-examination of select boreholes could employ newer techniques to understand the overall geologic setting as well as contaminant fate and transport. Areas of concern for data gaps could be refined through the use of these newer techniques.

We understand the concerns of down-gradient water users, such as the Towns of Crawford, Chadron and Pine Ridge. The extent of contamination is unknown at this stage. Any plan for sampling and characterization should be flexible until the full extent of the problem is better understood. Any monitor wells installed should be constructed so as to be considered permanent, so that extended monitoring may be conducted indefinitely.

Respectfully,

Paul G. Ivancie, PG

W. Austin Creswell, PE