UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CROW BUTTE RESOURCES, INC. ,	)	Docket No. 40-8943
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal for the	)	
In Situ Leach Facility, Crawford, Nebraska)	)	April 29, 2015

EXPERT OPINION TESTIMONY OF DAVID K. KREAMER

I, David K. Kreamer, do hereby swear that the following written testimony is true to the best of my knowledge:

I. Basis for Testimony as Expert in Field.

I have been involved in hydrogeological studies and reviewed contaminated waste and pollution challenges for over 35 years, have served as an expert witness, and testified before the U.S. Congress on issues of uranium mining. I serve as a professor in the Department of Geoscience at the University of Nevada, Las Vegas, President of the Universities Council on Water Resources, and Vice President for North America for the International Association of Hydrogeologists. I have been asked by the U.S. EPA and other internationally and nationally recognized professional groups to give short courses and lecture series on issues of groundwater quantity and quality. I have published over 50 professional publications and am currently writing a new edition of the text, "Contaminant Hydrogeology".

II. Expert Opinions and Testimony Concerning Contentions #A, C, D, F, 14.

Opinion: There is inadequate hydrogeological site characterization associated with In Situ Leaching (ISL) operations at Crawford, Nebraska

Basis: Complete and appropriate hydrogeological characterization of the uranium extraction operations has not been accomplished. In particular, secondary permeability has not been sufficiently addressed, and simplifying assumptions in the site hydrologic conceptual model ignore reported field results, and could provide misinterpretations of actual conditions and subsurface flows.

A generalized and inadequately supported assumption of both the CBR and NRC hydrogeologic conceptual site models is that the groundwater system can be treated as a series of relatively horizontal, isolated, hydrostratigraphic layers, with each layer having hydraulic conductivity which can be assumed to be homogeneous and isotropic. A key factor involves calculation of the potential of horizontal and vertical groundwater migration during operations, restoration, and post-closure. Particularly, CBR has conducted limited groundwater modeling and data analysis to support claims of restricted natural vertical flow (exclusive of any added effects of emplaced arrays of invasive boreholes). These models and data analysis methods use assumptions of formation uniform thicknesses, homogeneity, isotropy, and the justification for the use of these assumptions is not reported in the EA. Also not reported is model validation, model numerical stability, uniqueness of solutions, grid intervals, and evaluation of more realistic scenarios beyond testing a single fault.

Importantly, the licensee calculates the potential for vertical flow and water quantity effects, using inappropriate and overly simplified techniques, with a high potential for misinterpretation. Old data and research is presented when more current research is available. The licensee admits using analysis techniques on aquifer testing and recovery data, which have restricted application to a homogeneous, isotropic, series of horizontal layers of unvarying thickness, although the field geological data not only do not support this, the data indicate the opposite is the case. Specifically, the licensee admits to using the Theis, Jacob, Cooper Jacob, Hantush, and Neuman and Witherspoon methods, which are all inappropriate for the stated field conditions. The use of these inappropriate approaches impacts interpretation of potential vertical flow and the extent of the influence of well pumping and injection.

Actual reported conditions of the subsurface geology indicate lack of uniformity, heterogeneities, and non isotropic subsurface conditions. However, crucially important analysis of the data by CBR and NRC assumes the opposite (ie. homogeneous, isotropic layers), and/ or are limited in considering reported field conditions.

Modeling modifications by CBR and NRC of this generalized operating assumption, of horizontal strata that are homogeneous and isotropic, do not simulate multiple fractures beyond either a single fault, or isolated and non interconnected faults in the system. The recent literature on the number and nature of the geologic faults, noted discontinuities, varying formation thicknesses, and the geologic history of the area does not rigorously support this conceptual model. Specifically, inadequate characterization of secondary permeability is presented on the faults and folds associated with the Black Hills uplift and the Chadron Arch. There is indication of post Chadron faulting (LRA, Section 2). Additionally, any effects of future or past earthquakes, tectonic activity, or large pulses of infiltrating precipitation from intense storm activity, is not adequately addressed.

Three major regional water bearing units are identified in the Environmental Assessment (EA): overlying alluvium, the Brule Formation, and Basal Chadron Sandstone (now called the Chamberlain Pass Formation), underlain by what is described as low permeability Pierre Shale. Surface alluvial material is characterized as an unreliable water source occurring intermittently particularly along streambeds. Information is not made available on projected future groundwater use from alluvial sources, nor is the potential for horizontal translation of groundwater along ephemeral stream courses explicitly quantitated. Any surface spill would have the potential to reach and infiltrate into the alluvium, and become a long-term source. Any transmission of contaminants through faulted regions, or from surface expressions of the Chamberlain Pass Formation to the alluvium could also serve as a long term source.

The EA and CBR (2011) note that the Brule Formation is "significantly jointed" in several places, allowing appreciable groundwater flow in those "jointed" areas. The number, orientation and aperture size of these "joints" is not mentioned in the EA. The EA notes discontinuities in the Brule formation, and the lack of horizontal consistency, of this water bearing unit. Permeable regions of this formation are said to be of limited horizontal extent, although geophysical evidence to support this claim is not presented. The EA notes that the Basal Chadron Sandstone (now called the Chamberlain Pass Formation) varies in thickness from a minimum of 12m and doubling to 24m in places, indicating inconsistent horizontal thickness. The depth to the mineralized zone also varies greatly. This indicates significant heterogeneity, not considered in modeling efforts.

Only a limited number of faults are reported in the LRA and no rigorous hydraulic testing has been made on those identified. The EA treats "fold" features and "fault" features, such as the White River feature, as mutually exclusive, whereas folds can include many faulted regions. Little hydraulic testing of the upper confining unit is reported. Tests for the possibility of vertical migration of contaminants between formations have been restricted to limited pressure testing/ hydraulic response trials, which emphasized quick response, as opposed to any other sort of testing for the possibility of long-term vertical communication of contaminated groundwater. Past testing was not spatially or temporally extensive. Dating of groundwater age from various formations and depths, which might support the idea of vertical hydraulic isolation has not been prominently reported. Available scientific evidence shows heterogeneous conditions and a geologic history of faulting that would allow vertical migration of fugitive contaminants. In particular, CBR does not supply sufficient scientific evidence to support the claim of no vertical or horizontal hydraulic connection via faulted or jointed subsurface strata.

Projected future use and migration of deep groundwater (including the Morrison and Sundance Formations) in the areas of mine waste injection is not adequately presented and or/considered.

III. Expert Opinions and Testimony Concerning Contentions #6 & 9.

Opinion: Restoration goals for the site are inappropriate.

Basis: The sampling during stabilization/ cleanup efforts at Crawford, that is used to establish parameter-by-parameter comparison with restoration goals ("baseline" values), is very restricted and artificially constrained compared to monitoring that is more typical of industry elsewhere. In comparing monitored constituents with "restoration standards" during ongoing and post-restoration, averaged values for each parameter are used rather than comparison with a fuller and more appropriate groundwater quality data set. Additionally, a proposed "restoration" strategy is the short-term sequestration (stabilization) of contaminants by the addition of reductants. This effort is temporary, and is likely to be reversed with time, allowing the future release of contaminants.

Efforts to achieve primary restoration goals for in situ leaching (ISL) are based on returning groundwater to "baseline" water quality concentrations, as calculated on a mine unit average. This cleanup objective, a mine-averaged "baseline", also referred to as a "restoration standard", has several inherent weaknesses, including the following.

> Demonstrable and verifiable regional background concentrations are a more accepted remediation goal than artificially contrived and averaged "baseline" restoration standards. The restrictive use of average of mine unit values to establish baseline goals, rather than using more complete background values from surrounding sources of groundwater, and more robust averages, has the potential to misdirect restoration efforts. Averaged values from the mine site can perhaps be used to spot trends, but are essentially meaningless as restoration standards, as these can be highly unrepresentative of actual concentrations in thin, laterally extensive plumes.
>
> The calculation of "baseline" values, and therefore restoration goals, relies on early measured values and groundwater attributes. These values and attributes, that were used to establish "restoration standards", were not exclusively sampled and measured in a pre-mining, pre-drilling, and unperturbed environment. The potential mining influence on the creation of "baseline", coupled with the relative paucity of spatial and temporal monitoring in groundwater adjacent to the mining area, leads to the high probability that "baseline" values of individual parameters are non representative of typical background conditions. The potential for perturbation of the groundwater system by typical mining activities such as increasing oxidizing conditions, and addition of lixiviants, and/or mobilizing agents can have the added effect of artificially raising the "baseline", creating a less stringent and less appropriate cleanup objective.

Part of the proposed short-range restoration strategy is reductant addition to the subsurface, as well as the addition of other stabilizing materials. Complete reductant life-cycle and distribution-efficiency calculations, detailed descriptions of reductant and stabilization chemistry, and potential side effects such as biocidal impact on groundwater microbiology, are not adequately addressed. Importantly, addition of reductant to sequester pollutants can be reversed with time and the continual, natural flow of more oxidized groundwater through the site.

IV. Expert Opinions and Testimony Concerning Contentions #A, C, F.

Opinion: Site monitoring has the potential to provide information that does not accurately reflect levels and spatial orientation of any potential pollutant release, synergistic effects of multiple contaminants, and does not provide early warning of contaminant migration.

Basis: EPA monitoring well guidelines emphasize short screened intervals and several adjacent, nested monitoring wells with screens at different and restricted vertical depths to reduce the common problem of concentration dilution, and those guidelines never suggest averaging of concentration around a site to serve as a restoration goal. At Crawford in particular, groundwater sampling during restoration has a likelihood of "false negatives" through dilution in monitoring well bores. This is manifest with mixtures of low concentrations of aqueous parameters of concern, in regions or sections of a borehole that should not be sampled, with zones of deleterious high concentrations in other sections of a borehole. False negatives can occur through misplacement of monitoring wells, inappropriate screened intervals, vertical migration of fluids in the annular space due to failed packers or shale traps, poor well construction, migration in the aquifer material outside the borehole due to fracturing of the surrounding medium during the drilling process. Alternatively, placement of a monitoring well outside the path of a projected contaminant plume would also produce a false negative, and when averaged with correctly functioning monitoring, producing higher concentrations would mislead restoration efforts.

The monitoring program investigates a very limited number of potential pollutants and water quality parameters, atypical of most rigorous monitoring programs. This leaves no solid basis for assessing the potential migration and impacts of potential groundwater contaminants, both radiological and non radiological, nor for assessing their potential synergistic health impacts. Increased monitoring contingencies and plans for any future, identified spills are not well addressed by CBR. In addition, mining activities release potential "tracers" that can be used to determine the potential influence of ISL on groundwater, often sequentially in advance of the arrival of any contaminants. Use of these indicators of mining's influence on groundwater are potentially very beneficial and can act as an early warning system, but are largely ignored in stated future efforts at the

site.

V. Expert Opinions and Testimony Concerning Contentions #6.

Opinion: There is insufficient evidence to support the industry's estimates of the impact of current and future water use

Basis: As discussed above, the basic equations used to describe the impacts and drawdown of water tables and piezometric surfaces in the mining area are inappropriate for the indicated heterogeneous, anisotropic conditions. Coupled with the lack of detailed description of future water use and consumption, including uses for restoration and decommissioning, these impacts are not reasonably projected.

Pursuant to 10 CFR 2.304(d) and 28 USC 1746, I declare under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Signed in _____Stroud_____, ___England_____, on __April 29,_____, 2015.

_____/s/_____

DAVID K. KREAMER