UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CROW BUTTE RESOURCES, INC. (Marsland Expansion Area)	Docket No. 40-8943-MLA-2 ASLBP No. 13-926-01-MLA-BD01

Hearing Exhibit

Exhibit Number: OST014

Exhibit Title: Dr. Kreamer Rebuttal Testimony

September 6, 2018

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 – MLA - 2
	)	ASLBP No. 13-926-01-MLA-BD01
(Marsland Expansion Area)	)	
	)	September 6, 2018

REBUTTAL 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:

1. Crow Butte Resources, Inc. (CBR) and the NRC Staff indicate that a single, solitary pumping test is sufficient to characterize the subsurface hydrogeology of the proposed Marsland Expansion Area (MEA) [CBR001 at 31-32 & NRC001 at 29-30].

The single pumping test run in the Basal Chadron Formation covers only a very small part of the proposed MEA and is not representative of the entire property. The radius of influence of the single test does not produce information relevant to the majority of the property. It is unclear why only one test was run. The geologic strata in the MEA are demonstrably not of consistent thickness, nor entirely horizontal. Consistent with normal professional practice, several pumping tests across the remaining majority of the property, along with duplicate testing to determine the repeatability of the results, are necessary to properly assess the hydraulic conditions of the subsurface.

2. CBR represents, and NRC Staff accepts, that a limited monitoring well array in the heterogeneous Brule Formation is sufficient to completely measure the hydrogeological response to production pumping and injection in the Basal Chadron [CBR001 at 31, 35 & NRC001 at 30].

The monitoring wells in the overlying Brule Formation during this lone pumping test cover an even smaller area of the MEA – extrapolation of these extremely area-limited observations over many square miles of the property is inconsistent with good professional practice. The results from these area-restricted, shallow monitoring wells are said by CBR to support the notion that there is no effect of deep pumping on the shallow aquifer, and thus NRC Staff concludes that there is no need for a robust environmental evaluation of diminished quality

and quantity of groundwater in the Brule, or on impacts to surface water flows that could negatively influence habitat and wildlife. Not only is this assumption, of no impact, not clearly demonstrated for the site, data analysis from the Basal Chadron in the single pumping test is consistent with the opposite - leakage into the Basal Chadron. The Brule Formation has been consistently shown to be heterogeneous in the region and the efficacy of the exceptionally constrained Brule monitoring well array during the pumping test depends on an opposite assumption, put forward by industry, and not demonstrated in all past geological surveys of the region – that the Brule Formation is instead somehow homogeneous.

3. CBR purports, and NRC Staff accepts, that the Theis aquifer analysis is appropriate as the sole method of analysis for the single pumping test conducted at the MEA [CBR001 at 28-31 & NRC001 at 16-17].

This sole test of subsurface hydraulic properties has had a single, simple analysis (Theis) which is inappropriate considering the results of the test which show clear departure from the expected Theis curve, and are consistent with lack of aquifer confinement, and indicates potential leakage.

4. CBR claims that the Theis method is justified because it is a standard method and has wide-use and NRC Staff accepts this as sufficient[CBR001 at 15, 29 & NRC001 16-18, 26].

Theis-type approaches were the only analytical, mathematical ways the pumping test data were evaluated. A false argument is made for using only Theis analysis of pumping test data: 1. It is argued that it is a standard method and that 2. almost everyone uses it in analysis of pumping tests, no matter whether the assumptions associated with its use are violated or not. Use of a single, inappropriate standard method that is simplistic and inconsistent with observed results, being justified because it has been misapplied by many hydrogeologists in the past is like college students saying, “Sure I cheated on the data analysis in the assignment, but everyone cheats”.

This finding consistent with lack of confinement, as demonstrated by departure from the expected Theis curve from the single pumping test, coupled with low permeabilities observed in the strata immediately overlying the Basal Chadron Formation, are indicative of and consistent with the existence of secondary porosities and fracture flow. Robust fracture analysis has not been performed by CBR, nor required by NRC Staff. Fracture flow would also diminish the value of spatially limited monitoring wells in the shallow Brule Formation whose interpretation depends on homogeneous layers and not discrete fractures.

5. CBR does not address the omission of other forms of pumping test analysis, nor does NRC Staff require more scientifically appropriate analysis.

A leaky aquifer evaluation of the pumping test data was not performed. Standard analytical methods such as the De Glee Method, the Hantush-Jacob Method, the Walton Method,

or numerical analysis were not performed but are the more appropriate approaches indicated from the observed data. Analysis with these other methods would be consistent with the lack of confinement indicated by the departure from the Theis curve observed during the solitary pumping test.

6. CBR argues that core analysis showing *Upper/Middle Chadron confining unit consists of more than 90 percent claystone and less than 10 percent coarser material (e.g. siltstone and sandstone), with the average vertical hydraulic conductivity of Upper/Middle Chadron Formation claystone, as measured in two core samples in the laboratory using a falling head permeameter, is 1.3 x 10-7 cm/sec*" indicates confinement of the Basal Chadron Formation [CBR001 at 36-37 & NRC001 at 28-29].

CBR does not even consider the possibility of fracture flow, nor does NRC Staff's uncritical analysis. Normal hydrological procedure for indurated hard-rock flow analysis relies heavily on fracture analysis. CBR's Darcian calculation of vertical flow assumes *a priori* that no fracture flow could possibly exist. The pumping test analysis, as mentioned earlier shows departure from the Theis curve consistent with vertical leakage.

7. CBR's conclusions and NRC Staff's analyses rely on the presumption that *Chemical transport processes including hydrodynamic dispersion and diffusion are insignificant relative to the velocity or advective movement of groundwater* [CBR001 at 15, 22, 36-38 & NRC001 at 28-29, 42-43].

The mention of chemical transport processes discussing hydrodynamic dispersion and diffusion also contain the *a priori* assumption of homogeneous isotopic flow through a non fractured medium. The MEA site is dominated entirely by hard-rock strata. The omission of any analysis of even the possibility of fracture flow typically associated with hard-rock geology is inconsistent with normal hydrogeological and engineering practice.

8. CBR argues, and NRC Staff accepts as established, that vertical differences in water quality indicate confinement of the Basal Chadron [CBR001 at 32, 35, 36 & NRC001 at 31].

This premise is scientifically unsound for two reasons. The first is that any downward leaking water would be expected to change chemical composition in passing through fractures in the heterogeneous claystones overlying the Basal Chadron. The second is that current water quality differences noted by CBR are under unstressed conditions, not those associated with production pumping and injection.

9. CBR's conclusions and NRC Staff's analyses rely on the presumption that *Lateral containment of mining solutions at the MEA has been demonstrated* using WinFlow to simulate conditions at the MEA site [CBR001 at 13-14, 16, 22, 26 & NRC001 at 16, 21-23].

Typically, modeling interpretations of particle flow list initial conditions, model domain, boundary conditions, contain calibration, validation, list model sensitivities, and run multiple scenarios of possible flow and movement. The presentation by CBR presents one single realization (a particle distribution map) without completely listing assumptions, pumping rates, injection rates, justification for uniform geologic and hydrologic parameters (e.g. why is the uniform porosity 20%), initial or boundary conditions, or model domain. Multiple scenarios are not presented. Further and importantly, uncertainty, error bars, precision and accuracy of the results are not indicated. The single map presented is cosmetically attractive, however, despite its lack of utility.

CBR had trouble reaching closure in its nearby mine site, abandoning its simple analytical (e.g. Theis) mathematical approaches during closure because a rudimentary modeling approach using homogeneous isotropic conditions, as used in WinFlow, was inadequate. A numerical modeling approach was used to assist analysis of flow in the demonstrably more complicated geological setting.

10. CBR and NRC Staff both argue that even if lack of confinement of the Basal Chadron Formation production zone did exist, the inward gradient during all hydraulic pressures during injection and withdrawal during production over the entire site would be maintained and contamination could not escape [CBR001 at 23-25, 38 & NRC001 at 21, 33, 40].

The argument is made by CBR that even if there is a lack of confinement (as indicated by the data from the single pumping test performed on a limited area of the site), the hydraulic gradient would be inward toward the Basal Chadron Formation and production zone, therefore no mobilized contamination could escape. If this is supposed to be the case, a robust analysis to protect the overlying heterogeneous Brule Formation should be conducted. Even so, this argument is flawed because the solitary pumping test conducted for MEA has an extremely limited coverage of the much larger site, and that maintenance of an “inward hydraulic gradient”

during production pumping and injection over the entire site has not been demonstrated.

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 Las Vegas NV, 9/6/2018, on _____, 2018.

DocuSigned by:
601895CCBB0842A...

David K. Kreamer