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)	)	September 28, 2015

REBUTTAL STATEMENT OF DR. DAVID K. KREAMER

Rebuttal to CBR Claims of Correlation Between Precipitation and Excursion Events (and/or Water Level Changes In Brule Monitoring Wells)

Crow Butte Resources (CBR), also self-referred to as Cameco Resources, Crow Butte Operations (CBO), has consistently claimed and explained excursions in the Brule aquifer in some variation of the following, *"CBO believes that this apparent excursion is due to increased groundwater levels caused by the significant amount of precipitation and snow melt at the facility this spring and is not caused by mining activity*" (BRD-010L page one). CBR has consistently inferred that the dominant cause of water table fluctuations in the Brule are correlated to precipitation, but have provided no statistical or numerical support for this claim. In fact, the data show the opposite is true, that there is no consistent correlation between water levels in the Brule and either monthly or annual precipitation records. CBR also claims that water level changes in the Brule are not significant, providing Exhibits CBR-063 and CBR-064 (requested by Judge Wardwell) which show the water level changes in monitoring wells SM 7-22 and SM 7-17 from 1999 to 2015, but not water level changes in the critical period between 1991 when operations began and 1999.

In reviewing monthly and annual precipitation data for Crawford, Nebraska claims of a relationship between precipitation totals and water level changes in the Brule Aquifer cannot be substantiated. For example, in randomly chosen excursion information provided by CRB in document BRD-010L, Brule water levels in the last figure SM08-006 on page 8, listed as 4 of 4, show steady or rising water levels of 2 ft. in the period of November through March 2014, which conversely were drier months than is usual. November's 2014 recorded precipitation (according to http://weather-warehouse.com/WeatherHistory/PastWeatherData_FortRobinson_Crawford_NE_November.html and http://www.usclimatedata.com/climate/crawford/nebraska/united-states/usne0121) was 59% of the normal average, December 2014 precipitation was 46.% of average, January had no precipitation (monthly average is 0.59 inches), February had 95% of average, and March 2014 had 41% of the average precipitation. These dry conditions were not reflected in the steady or rising water table.

In another randomly chosen example, using these same sources, the excursion document BRD-010D shows water level changes in figure SM6-20 on page 10. Data on this figure show water levels steady in the Brule in August through the beginning of September 2009, and gradually rising water levels in the Brule from mid-September 2009 to March 2010. However, this was another low precipitation period recorded at Crawford. Importantly, the low total precipitation over those months does not correlate to the recorded water table rise, a rise which would be expected according to CBR in wet periods. Specifically, August 2009 precipitation was 70% of the average amounts normal for that month, September was 54%, October was 80% of normal, November had no recorded precipitation (average is 0.83 inches), December was 32% of normal, January of 2010 had no recorded precipitation (average is 0.59 inches for that month), February 73% of normal, and March had 24% of the normal precipitation for that month. Clearly, the precipitation over this period does not correlate with water levels in the Brule aquifer. CBR claims excursions were not related to mining activities. This assumes water level change in the Brule was not related to mining activities. The Intervenors could not evaluate correlation of Brule water levels with mining activities (water levels hypothetically could go up with curtailment of mining activities during that period), because the pumping schedules of CBR wells were not released or available for external review.

CBR also provides Exhibits CBR-063 and CBR-064 which show the water level changes in monitoring wells SM 7-22 and SM 7-17 in the Brule aquifer from 1999 to 2015, (note: data from 1991 to 1999 is not included by CBR). These data also do not reveal trends relating precipitation to water level in the Brule; it shows the opposite, that there is no consistent relation between the two. For example, SM 7-22 shows a 2 foot drop in water level in 2010 and 2011 in which the annual rainfall averages in Crawford were normal and close to average (using the same precipitation data sources listed above). The following year 2012 was an extreme drought year with very low precipitation, yet the recorded water levels in SM 7-22 for 2012 show a dramatic water table rise of six feet. Looking at other well, SM 7-17, a sudden seven foot drop in water levels is recorded in 2011 which was a normal precipitation year with amounts near average, and in the following drought year of 2012, the was little change in water levels. Again the relationship of water level changes in these wells to mining activities, including sudden water level drops and rises unrelated to precipitation amounts, could not be independently evaluated because mine pumping schedules were not disclosed.

Rebuttal To Claims In NRC-095 That Differences In Pre-Mining To Post-Mining Water Levels In The Brule Aquifer Were Similar.

NRC-095 testimony of D. Back, T. Lancaster, and E. Striz on page 3 notes that information from Exhibits CBR-063 and CBR-064 (requested by Judge Wardwell) which show what they consider to be small water table changes (up to 5 feet) in the Brule aquifer in monitoring wells SM 7-22 and SM 7-17 from 1999 to 2015, but as mentioned previously, these graphs do not show water level changes in the critical period between 1991 when operations began and 1999. The lack of consideration by CBR and NRC of the mine's pumping effects on the Brule Aquifer from 1991 to 1999 is inconsistent with professional standards and basic hydrological practice. It is a basic principle of hydrogeology and the mathematics of aquifer mechanics that the drawdown of water tables and or piezometric surfaces, in response to a pumping well, exhibit relatively rapid decline in water levels at first in a non-steady state systems. These more rapid declines are followed by continued but slowing rates of drawdown. After a certain period of time in these transient state pumping systems, with constant pumping, the initial large and rapid drawdown slows to near steady state. The large hydraulic head changes at first can induce large vertical leakage if fractures or zones of preferential flow exist. With time, induced leakage causes hydraulic head declines in overlying and/or underlying strata. Initial rapid leakage will slow with time as the hydraulic head is reduced in these overlying and/or underlying strata, and the once-larger head gradients during early pumping are diminished. Therefore the initial period of pumping of these mining operations, where head gradients are expected to change most rapidly and induced leakage is expected to be greatest, is crucial, but unreported by CBR and unevaluated by NRC.

NRC-095 testimony of D. Back, T. Lancaster, and E. Striz on page 4 states that the 3883 foot water level indicated in well #11 and circled on NRC-096 (which shows water levels in the Brule aquifer pre-mining from 1982-1983) is most likely a transcription error, and he further states *"But according to Table 2.7-5 of the LRA, the 12 water level measurements collected between January and December 1982 varied between 3830 and 3834 feet (Ex. CBR-011 at 2-194)*". However, NRC-096 shows the water levels of **eight wells** in the Brule aquifer pre-mining from 1982-1983 which exceed 3834 feet above sea level. Specifically the height of these eight wells above mean sea level (amsl) are 3883.7 feet amsl (Well 11 designated by Mr. Back as a likely transcription error), 3962.8 feet amsl, 3921.0 feet amsl, 3907.1 feet amsl, 3870.2 feet amsl, 3882.3 feet amsl, 3863.8 feet amsl, and 3881.8 feet amsl, and these wells are within a circle of approximately a mile radius near the area of dominant mining activity from 1991 to 2008 .

NRC-095 testimony of D. Back, T. Lancaster, and E. Striz state on page 5, "*The pre- and post-mining water levels collected in the vicinity of well 27, as indicated by a green square in Exhibit NRC-096, substantiate this interpretation. The pre-mining water level for well 27 was 3808.2 feet (Ex. NRC-096 at 1). Contours of the 2008 water level data showing post-mining water levels indicate a water level between 3805 and 3815 feet (Ex. NRC-096 at 2)."* ~~What NRC fails to mention is that this location is over 7 miles downgradient of the mining area under consideration, and could not have been affected by mining activities.~~ NRC goes on to list information from Aquifer test one monitoring wells in the Brule aquifer stating, *"Additional evidence demonstrating that water levels in the Brule aquifer have not been impacted by mining activities is provided by the pre-pumping water levels collected in PM-6 and PM-7 during the first aquifer test. As indicated in Table 2.7A-2 of the first aquifer test report, the water level elevations in 1983 for PM-6 and PM-7, both completed in the Brule aquifer, were 3843.5 and 3845.9 feet, respectively (Ex. BRD-002A at 2.7A(5)). The approximate location of these wells is indicated by a pink circle on page 2 of Exhibit NRC-096. Of particular significance is that the 1983 water level elevations for these wells are very similar to the elevations measured in the Brule aquifer in 2008. This provides another line of evidence that mining activities have not impacted water levels in the Brule aquifer and that the aquifers are hydraulically isolated."*

What the NRC does not mention are that these wells are~~ again considerably~~ downgradient from ~~the~~ some major areas of mining activity, and particularly the area where the major discrepancies exist between pre-mining water levels in 1982-1983 and post mining water levels in 2008. The locations indicated by NRC and CBR for PM-6 and PM-7 (pink circle) are not correct according to the map provided for Aquifer (pumping) Test One, BD-02a page 3. The map shows the location to be ¼ mile west of a north south section of Squaw Creek Road, nowhere near the indicated location for PM-6 and PM-7 by NRC and CBR. There is no justification as to why only these 3 wells (green square and pink circle) were selected by CBR and NRC. Confirmatory 1982 water levels from nearby Brule Monitoring Wells 26, 8, 57, 133, and 28 have not been included by CRB or NRC, and importantly, 1982-83 water levels from Brule Monitoring Wells 19 and 129 where apparent discrepancy exists (southeast near the green square and circle), are not provided by CBR or NRC. Selected historical water level information is supplied for Brule monitoring wells SM10-26, SM10-22, SM8-18, SM5-14, SM1-2, SM4-9, SM9-3, SM7-22 and SM7-17 (with records starting years after mining operations began), however only SM1-2 is in the area of intense mining activity and closest to the green square and circle (indicating Brule wells 27, PM-6, and PM-7), and the record for this well SM1-2 inexplicably stops at 2005, whereas all other SM wells presented show records to near present day. The "lines of evidence" that NRC presents are incomplete and misleading ~~and somewhat irrelevant~~ because of the paucity of monitoring information provided, and the down gradient distance of wells 27, PM-6, and PM7 ~~of this information~~ from the real area of concern and discrepancy between 1982-83 and 2008 water levels.

Consumptive use

In document NRC-095 pages 6, 7 and 8, The NRC staff make calculations about consumptive use and drawdown in the absence conducting of a complete water balance. The calculations do not include robust uncertainty analysis and assume, *a priori,* the hydraulic isolation of Chamberlain Pass (Basal Chadron) formation. These calculations are geared toward short time-frame analysis of aquifer response. Analysis of long-term effects requires full water balance which is not provided, including recharge source and regional groundwater movement.

Impact of Chamberlain Pass (Basal Chadron) Pumping and Withdrawal on the Brule Aquifer, Surface Water Flow, and Wetlands

On page 8 of NRC-95 the following statement is made *"Since ground water from the Basal Chadron Sandstone is not important with respect to maintaining surface water flow or wetlands, the primary impacts of lowering the head will be related to the energy costs to lift the water higher to the surface."* This statement is based on NRC interpretation of the results of: 1. inadequate monitoring in the Brule Formation during aquifer testing by CBR and their subcontractors, 2. false *a priori* assumptions of layer-cake geology at the site, 3. geologic testing of very few, isolated, and selected samples of the overlying "confining" material without regard to heterogeneity or secondary porosity, and 4. NRC's ignoring recharge boundaries in the Chamberlain (likely an indication vertical flow and vertical groundwater communication) clearly evident during aquifer (pumping) tests conducted at the site. It is notable that NRC staff noted these recharge boundaries early on in their evaluation of the site pumping tests, but now does not. There are clear multiple lines of evidence that vertical flow can clearly exist and that mining activities have impacted water levels in the overlying Brule aquifer, which is connected to surface flows and wetlands

The importance of this evidence (of vertical groundwater communication, and Brule water level changes in response to pumping in the Chamberlain associated with mining activities) is clear. The observed changes in the Brule water table concurrent with underlying pumping have the unambiguous potential to affect surface flows and wetlands, as does the potential upwelling of contaminants during excursion events observed in the Brule. The surface water at the site and flowing away from the site is largely unmonitored, particularly during surface flooding events which carry large sediment loads in the surrounding creeks. Surprisingly, when evaluating potential contamination of the Pine Ridge Reservation in the evidentiary hearings, discussion has only centered on the potential for groundwater transfer of contaminants north and eastward, not on surface flows to Pine Ridge. Video of the large sediment-discolored runoff flows in the area of Crawford from recent years are available on You Tube.

NRC Modeling of the White River "Structural Feature"

On page 20 of NRC-095, the following statement is made:

> *"….. the person who did the modeling left the agency over two years ago. Therefore, we have no information on which to evaluate the selection of the design of the models or evaluate their calibration. The purpose of the ground water modeling and BMLA for the White River structural feature was to assess the uncertainty associated with defining the feature in various ways: as a sealing fault with little to no flow, as a conductive fault with low or high flow, or the absence of any fault or feature. As discussed in A.D.20 of our initial testimony (Ex. NRC-001-R at 46) and*

> *A.D.10 of our rebuttal testimony (Ex. NRC-076- -20- - 21 - R2 at 32-33), the data used in the model was derived from measured field data at the North Trend Expansion Area (NTEA) site, including boring logs, the aquifer pumping test conducted in 2006, and measured water levels. We are only able to assess the final models available by reviewing the model design and data which is present in the model files. We are not, however, able to determine why the modeler chose specific values for input parameters or explain the iterative approach the modeler used to calibrate the models."*

The model uses selected information to address an issue whose relevance is questionable. The many aquifer tests have shown many potential recharge boundaries/ potential faults beyond the obvious "White River Structural Feature". The model has many input parameters, assumptions, and boundary conditions that remain unjustified. For example, it uses information from one aquifer test in 2006, while ignoring five other aquifer (pumping) tests in the same area that showed vertical groundwater movement. No validation or repeatable calibration of the model was done. The model is set up to consider only a distant, single, large structural feature (the White River fold/fault) while largely ignoring possible smaller faults and fractures, and the causes and manifestations of the leakage that the USNRC noted in early aquifer (pumping) tests, much closer to current mining activities.

NRC staff also seemly ignores all modeling discoveries and appreciations associated with remedial and closure modeling at the site.

Pursuant to 10 C.F.R. § 22.304(d) and 28 U.S.C. § 1746, I declare, under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Dated this 28th day of September, 2015.

Respectfully submitted,

David K. Kreamer

David K. Kreamer, Ph.D.