December 3, 2018

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket No. 40-8943-MLA-2
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(Marsland Expansion Area)	)	

CROW BUTTE RESOURCES' PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW

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I. INTRODUCTION

1.1 This Initial Decision pertains to Crow Butte Resources' Application for Authorization to Operate a Satellite In Situ Uranium Recovery ("ISR") Facility within the Marsland Expansion Area ("Marsland" or "MEA"), including an Environmental Report ("ER") and a Technical Report ("TR"). The Crow Butte facility is a uranium in situ recovery ("ISR") facility subject to safety requirements found in 10 C.F.R. Part 40.

1.2 This Initial Decision resolves the only remaining admitted contention in this proceeding, Contention 2.

1.3 After considering all of the evidence and arguments presented for Contention 2, we conclude that the NRC Staff's Final Environmental Assessment ("EA") complies with the National Environmental Policy Act ("NEPA") and 10 C.F.R. Part 51. The NRC Staff has taken the requisite "hard look" at potential impacts from construction and operation of the MEA. The NRC Staff evaluates the impacts of operations at the MEA in the EA and "has come to grips with all important considerations."[1] The EA adequately describes the affected environment,

[1] *Grand Gulf ESP*, CLI-05-4, 61 NRC at 13.

including the effects of the proposed MEA operation on the adjacent surface water and groundwater resources; an acceptable conceptual model of site hydrology that is adequately supported by site characterization data so as to demonstrate ability to ensure the confinement of extraction fluids and expected operational and restoration performance; and a discussion of the basis for conclusions regarding the isolation of the aquifers in the ore-bearing zones. The EA is more than sufficient to satisfy the agency's obligation NEPA and 10 C.F.R. Part 51.[2] The Licensing Board therefore resolves the environmental aspects of Contention 2 in favor of Crow Butte and the NRC Staff.

1.4 After considering all of the evidence and arguments presented for the safety aspects of Contention 2, we conclude that Crow Butte has presented information and analysis regarding the technical aspects of proposed licensed activities and demonstrated that its activities comply with 10 C.F.R. Part 40. In addition to considering the information provided to describe the effected environment and that supports the conclusions in the NRC's SER, Crow Butte (and the NRC Staff and NDEQ) considered the data presented and described effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient of site hydrogeology, along with other information relative to confinement, control of mining fluids, and prevention of excursions. The Board therefore resolves the technical aspects of Contention 2 in favor of Crow Butte.

II. PROCEDURAL HISTORY

2.1 Crow Butte filed the MEA application on June 16 and 19, 2012. On January 29, 2013, the Oglala Sioux Tribe ("OST") submitted its Petition to Intervene and Request for Hearing, which included six initial contentions with regard to the ER. The Atomic Safety and Licensing Board ("Board") issued a Memorandum and Order on May 10, 2013, admitting only

[2] *LES*, LBP-06-8, 63 NRC at 286.

two OST contentions, Contention 1 (Failure to Meet Applicable Legal Requirements Regarding Protection of Historical and Cultural Resources) and Contention 2 (Failure to Include Adequate Hydrological Information to Demonstrate Ability to Contain Fluid Migration) ("LBP-13-6"). On October 22, 2014 the Board granted the Staff's Motion for Summary Disposition of OST Contention 1.

2.2 Following the release of the Draft Environmental Assessment for the Marsland Expansion Area ("Draft EA") on December 7, 2017, the NRC Staff filed a Motion to Deny Migration of Contention 2, which the Board granted in part and denied in part in its Memorandum and Order of March 16, 2018 ("LBP-18-02"). The NRC issued the Safety Evaluation Report ("SER") in January 2018, and the Final Environmental Assessment ("Final EA") on April 30, 2018. On May 21, 2018, the Board issued a Memorandum and Order establishing May 30, 2018 as the deadline for filing any New/Amended Contention Motion/Migration Declaration in response to the Final EA. The OST Final EA Contentions, including a Migration Declaration with respect to Contention 2 as well as fourteen proposed renewed and new contentions, were filed on May 30, 2018. In LBP-18-3, dated July 20, 2018, the Licensing Board denied admission of the new and renewed contentions, but permitted Contention 2 to migrate as a challenge to the final EA.

2.3 Migrated Contention 2 is as follows:

> <u>OST Contention 2</u>: Failure to Include Adequate Hydrogeological Information to Demonstrate Ability to Contain Fluid Migration
>
> The application and final environmental assessment fail to provide sufficient information regarding the geological setting of the area to meet the requirements of 10 C.F.R. Part 40, Appendix A, Criteria 4(e) and 5G(2); the National Environmental Policy Act; and NUREG-1569 section 2.6. The application and final environmental assessment similarly fail to provide sufficient information to establish potential effects of the project on the adjacent surface and ground-water

resources, as required by NUREG-1569 section 2.7, and the National Environmental Policy Act.[3]

2.4 The Board indicated that the scope of the safety and environmental concerns encompassed by Contention 2 include the following: (1) the adequacy of the descriptions of the affected environment for establishing the potential effects of the proposed MEA operation on the adjacent surface water and groundwater resources; (2) exclusively as a safety concern, the absence in the applicant's technical report, in accord with NUREG-1569 section 2.7, of a description of the effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient of site hydrogeology, along with other information relative to the control and prevention of excursions such as transmissivity and storativity; (3) the failure to develop, in accord with NUREG-1569 section 2.7, an acceptable conceptual model of site hydrology that is adequately supported by site characterization data so as to demonstrate with scientific confidence that the area hydrogeology, including horizontal and vertical hydraulic conductivity, will result in the confinement of extraction fluids and expected operational and restoration performance; and (4) whether the final EA contains unsubstantiated assumptions as to the isolation of the aquifers in the ore-bearing zones.

2.5 In accordance with NEPA and the NRC's NEPA implementing regulations in 10 C.F.R. Part 51, the NRC Staff conducted an environmental review of the MEA application. After reviewing the MEA application, as supplemented by responses to Requests for Additional Information ("RAIs"), the Staff prepared an Environmental Assessment. The Staff issued the final EA for the MEA application in April 2018 (NRC006). The EA describes the proposed action and

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[3] LBP-18-3, 88 NRC __, __ (slip op. at 43) (July 20, 2018).

the affected environment, and assesses the potential impacts from the construction, operation, aquifer restoration, and decommissioning of the MEA.

2.6 Following receipt of the MEA application, the Staff conducted a safety review of the MEA application. The Staff conducted its review to determine whether CBR met the relevant criteria in 10 C.F.R. Parts 20 and 40. After evaluating CBR's application, as supplemented by its responses to Staff RAIs, the Staff found that Crow Butte met these criteria. The Staff documented its findings in the SER (NRC008), which was issued in January 2018.

III. LEGAL STANDARDS

A. National Environmental Policy Act

3.1 Contention 2 arises under NEPA and the NRC's implementing regulations in 10 C.F.R. Part 51. NEPA requires that an agency prepare a document evaluating the environmental impacts of the proposed action—either an EA or an Environmental Impact Statement, depending on the project and its expected environmental impacts.[4]

3.2 Under NEPA, the NRC is required to take a "hard look" at the environmental impacts of a proposed action.[5] This "hard look" is tempered by a "rule of reason" that requires agencies to address only impacts that are reasonably foreseeable, not those that are remote and speculative.[6]

3.3 Agencies are permitted to use "bounding analyses" or other conservative assessment techniques to ensure that the range of impacts and alternatives are taken into account

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4 42 U.S.C. § 4332(2)(C).

5 *Louisiana Energy Servs., L.P.* (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 87-88 (1998).

6 *See, e.g., Long Island Lighting Co.* (Shoreham Nuclear Power Station, Unit 1), ALAB-156, 6 AEC 831, 836 (1973).

in an EIS.[7] NEPA also does not require a fully developed plan to mitigate all environmental harm before an agency can act.[8] Instead, NEPA requires only that mitigation be discussed in sufficient detail to ensure that environmental consequences have been fully evaluated.[9]

3.4 Finally, NEPA also gives agencies broad discretion to keep their inquiries within appropriate and manageable boundaries.[10] NEPA does not demand that every impact be precisely evaluated, nor does it require perfection of detail.[11] As the Commission explained, NEPA "does not call for certainty or precision, but an estimate of anticipated (not unduly speculative) impacts."[12] When faced with uncertainty, NEPA only requires "reasonable forecasting."[13] And, while there "will always be more data that could be gathered," agencies "must have some discretion to draw the line and move forward with decisionmaking."[14]

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7 *NRDC v. NRC*, 685 F.2d 459, 486 (D.C. Cir. 1982), *rev'd on other grounds*, *Balt. Gas & Elec. Co. v. NRDC*, 462 U.S. 87 (1983). A "bounding analysis" refers to an evaluation that is based on conservative assumptions regarding environmental impacts. A bounding analysis provides an assessment of impacts that includes (or bounds) anticipated impacts of alternatives with lesser environmental impacts.

8 *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989).

9 *Laguna Greenbelt, Inc. v. U.S. Dep't of Transp.*, 42 F.3d 517, 528 (9th Cir. 1994) (citations omitted).

10 *Louisiana Energy Servs., L.P.* (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 103 (1998) (internal citation omitted).

11 *Envtl. Def. Fund v. TVA*, 492 F.2d 466, 468 n.1 (6th Cir. 1974).

12 *Louisiana Energy Servs., L.P.* (Nat'l Enrichment Center), CLI-05-20, 62 NRC 523, 536 (2005).

13 *Scientists' Inst. for Pub. Info., Inc. v. AEC*, 481 F.2d 1079, 1092 (D.C. Cir. 1973). "[I]nherent in any forecast . . . is a substantial margin of uncertainty," and therefore the forecast should be accepted if it is "reasonable." *Niagara Mohawk Power Corp.* (Nine Mile Point Nuclear Station, Unit 2), ALAB-264, 1 NRC 347, 365-67 (1975).

14 *Town of Winthrop v. FAA*, 535 F.3d 1, 11 (1st Cir. 2008). NEPA allows agencies "to select their own methodology as long as that methodology is reasonable." *Id*. at 13; *see also The*

3.5 For this reason, licensing boards do not sit to "flyspeck" the EA or to add details or nuances.[15] If the EA on its face "comes to grips with all important considerations" nothing more need be done.[16]

B. Atomic Energy Act

Technical contentions raise issues regarding compliance with AEA and NRC regulations. The NRC must license ISR operations in accordance with NRC regulatory requirements in 10 C.F.R. Part 40 to protect public health and safety from radiological hazards. Under 10 C.F.R. § 40.32, the NRC Staff is required to make the following safety findings when issuing a renewed ISR license:

- The application is for a purpose authorized by the Atomic Energy Act.
- The applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner as to protect health and minimize danger to life or property.
- The applicant's proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life or property.
- The issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.

10 C.F.R. Part 40, Appendix A, sets forth, among other things, the technical criteria for applicants and licensees relating to the siting, operation, decontamination, decommissioning, and reclamation of mills and tailings or waste systems and sites at which such mills and systems

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Lands Council v. McNair, 537 F.3d 981, 1003 (9th Cir. 2008) (finding that an EIS need not be based on the "best scientific methodology available").

15 *Hydro Resources, Inc.* (P.O. Box 15910, Rio Rancho, NM 87174), CLI-01-04, 53 NRC 31, 71 (2001).

16 *Systems Energy Resources, Inc.* (Early Site Permit for Grand Gulf Site), CLI-05-4, 61 NRC 10, 13 (2005).

are located. Although the Appendix A criteria were developed for conventional uranium milling facilities, they have since been applied in limited fashion to ISR facilities.[17]

C. Burden of Proof

3.6 An applicant generally has the burden of proof in a licensing proceeding.[18] However, in cases involving NEPA contentions, the burden belongs to the NRC Staff because it has the ultimate responsibility for complying with NEPA.[19] Nevertheless, because the Staff, as a practical matter, relies heavily upon the applicant's application in preparing the EA, should the applicant become a proponent of a particular challenged position set forth in the EA, the applicant, as such a proponent, also has the burden on that matter."[20]

3.7 The showing necessary to meet the burden of proof is the "preponderance of the evidence" standard.[21] NRC administrative proceedings have generally relied upon the preponderance standard in reaching the ultimate conclusions after a hearing to resolve the issue.[22]

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17 *See Hydro Resources, Inc.* (2929 Coors Road, Suite 101, Albuquerque, NM 87120), CLI-99-22, 50 NRC 3, 8-9 (1999) ("While, as a general matter, Part 40 applies to ISL mining, some of the specific requirements in Part 40, such as many of those found in Appendix A, address hazards posed only by conventional uranium milling operations, and do not carry over to ISL mining") (internal reference omitted).

18 10 C.F.R. § 2.325.

19 *See, e.g.*, *Duke Power Co.* (Catawba Nuclear Station, Units 1 & 2), CLI-83-19, 17 NRC 1041, 1049 (1983).

20 *Louisiana Energy Servs., L.P.* (Claiborne Enrichment Center), LBP-96-25, 44 NRC 331, 338-39 (1996) (citing *Pub. Serv. Co. of N.H.* (Seabrook Station, Units 1 & 2), ALAB-471, 7 NRC 477, 489 n.8 (1978)), *rev'd on other grounds*, CLI-97-15, 46 NRC 294 (1997).

21 The definition of "preponderance of the evidence" in Black's Law Dictionary, 6th ed. (p. 1182), is "[e]vidence which is of greater weight or more convincing than the evidence offered in opposition to it; that is, evidence which as a whole shows that the fact sought to be proved is more probable than not."

22 *Advanced Medical Systems, Inc.* (One Factory Row, Geneva, Ohio 44041), CLI-94-6, 39 NRC 285 (1994), *aff'd*, *Advanced Medical Systems, Inc. v. NRC*, 61 F.3d 903 (6th Cir.

The Licensing Board therefore must consider the evidence and testimony and determine whether the NRC Staff and Crow Butte have shown by the preponderance of the evidence that the NRC complied with the AEA and NEPA.

IV. OVERVIEW OF CONTENTION 2

4.1 Contention 2 has been grouped into four concerns and has been discussed and addressed by the parties using this four-concern convention.

4.2 Concern 1 is a safety and environmental issue that challenges "the adequacy of the descriptions of the affected environment for establishing the potential effects of the proposed MEA operation on the adjacent surface water and groundwater resources." LBP-18-2, 87 NRC 21, 37 (2018). Concern 1 as migrated is the broadest of the four concerns, encompassing 10 C.F.R. Part 40, Appendix A, Criteria 4(e) (related to local faults and earthquake risk) and 5G(2) (related to underlying soil and geological formations), and the criteria in NUREG-1569 Section 2.6 (addressing information on geology and seismology).

4.3 Concern 2 as admitted by the Board in this proceeding is limited to safety concerns (as addressed by the SER) regarding "the absence in the applicant's technical report [and/or NRC's SER], in accord with NUREG-1569 section 2.7, of a description of the effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient of site hydrogeology, along with other information relative to the control and prevention of excursions." Tr. at 337.

4.4 Concern 3 as migrated, like Concern 2, is specifically limited to the criteria in NUREG-1569 section 2.7, raising the question of whether an "acceptable conceptual model of

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1995); *see also Commonwealth Edison Co.* (Zion Station, Units 1 & 2), ALAB-616, 12 NRC 419, 421 (1980) (stating that applicants are not held to an absolute standard or required to prove a matter conclusively but rather, consistent with the Administrative Procedure Act, are held to a preponderance standard).

site hydrology that is adequately supported by site characterization data so as to demonstrate with scientific confidence that the area hydrogeology, including horizontal and vertical hydraulic conductivity, will result in the confinement of extraction fluids and expected operational and restoration performance." Tr. at 862.

4.5 Concern 4 addresses the issue of "whether the draft EA contains unsubstantiated assumptions as to the isolation of the aquifers in the ore-bearing zones." Tr. at 935-936.

4.6 While Crow Butte and the NRC Staff have the ultimate burden of proof with respect to compliance with NEPA, the AEA, and NRC regulations, OST has a responsibility to provide facts sufficient for the Board to question the adequacy of the analyses and conclusions reached in the underlying licensing documents. To that end, OST's witnesses present a series of discrete "opinions" purporting to identify deficiencies in the application and NRC evaluation. Each aspect of the opinion relating to a concern are addressed below. We conclude that none of the opinions of OST's experts undermines the adequacy of the conclusions in the EA and SER.

V. FINDINGS OF FACT

A. Assessment of Concern 1: Geologic and Hydrologic Setting

5.1 OST's witnesses allege that the application fails to adequately characterize the environment at the MEA. In their testimony, the NRC Staff (NRC001) and Crow Butte (CBR001-R) witnesses summarize the information available regarding the geology at the license area. The witnesses discuss information concerning extent, thickness, uniformity, shape, and orientation of underlying strata; hydraulic gradients and conductivities of the various formations based on information gathered from borings and field survey methods taken within the proposed impoundment area and in surrounding areas where contaminants might migrate to groundwater; information gathered on boreholes including both geologic and geophysical logs in sufficient number and degree of sophistication to allow determining significant discontinuities, fractures, and channeled deposits of high hydraulic conductivity; and hydrologic parameters such as permeability based on field testing (*e.g.*, pump tests). Crow Butte's testimony (CBR001-R) also identifies the information in the application that corresponds to applicable sections of NRC guidance in NUREG-1569 (NRC010).

5.2 Mr. Wireman argues (OST004-R at 2) that there is no information on sources of recharge or the primary pathways that deliver recharge to the deep, confined aquifer. To the contrary, we find that Crow Butte has provided a conceptual diagram showing areas of recharge and discharge from the Basal Chadron Sandstone (CBR021). According to Crow Butte witnesses, recharge to the Basal Chadron Sandstone occurs as direct infiltration of precipitation where the formation is exposed at distant locations west and south of the main mining area and the MEA, and also as a small amount of downward flow from the overlying confining unit. Elevations of the potentiometric surface of the basal sandstone of the Chadron Formation indicate that the recharge zone must be located above a minimum elevation of 3,715 feet amsl. *See, e.g.*, TR at Section 2.7.2.3, *Hydrologic Conditions* (CBR006); *see also* EA Section 3.3.2.1 (NRC006 at 3-27 to 3-29). Discharge from the Basal Chadron Sandstone currently occurs primarily to wells at the main mining area and flowing wells located near the town of Crawford (Tr. at 599, 685-686). Prior to ISR development and the installation of flowing wells, discharge from the Basal Chadron Sandstone occurred in drainages and by evapotranspiration in areas east and north of Crawford where the formation is exposed at and near the surface. The distance from the recharge and discharge areas from the MEA are such that they are unlikely to affect the behavior of the Basal Chadron Sandstone aquifer at the MEA. NRC014 at 3. No additional hydrogeologic mapping is necessary. *Id*.

5.3 Mr. Wireman claims that Crow Butte has not installed any Basal Chadron monitoring wells upgradient or downgradient of the license area. But monitoring wells will be installed inside the proposed license area upgradient, downgradient, and to the sides of ISR production and injection wells as part of the monitor well ring for the mine units. These monitoring wells will be used to ensure hydraulic containment and provide the necessary monitoring of groundwater quality downgradient (and in all directions) from active mining areas. There is no need to install such wells prior to operations. No monitor wells will be installed outside the license area, and no active existing wells are completed in the Chadron Formation within the area of review.

5.4 Mr. Wireman argues (OST004 at 3) that characterization of structural geology at a regional level is insufficient to develop an acceptable conceptual model of site hydrology, in particular with respect to the effects of the Pine Ridge escarpment on groundwater flow in the Basal Chadron aquifer. Mr. Wireman does not address how the structural geology that he implies may exist between the main mining and the MEA can be reconciled with the detailed hydrologic data presented by Crow Butte. We find that there is no hydrogeological conceptual model that can reconcile consistent northwestward groundwater flow between MEA and main mining area in the Basal Chadron Aquifer if there is a significant discontinuity along the Pine Ridge Escarpment. *See, e.g.*, CBR021.

5.5 Regardless, Crow Butte provided Regional Cross Sections in TR Figures 2.6-22 to -24 (CBR008-R) that extend from South of the Niobrara River (south of the MEA) northward through the Marsland Expansion Area, across the Crow Butte License Area and the North Trend License Area. Each cross section crosses the Niobrara River Fault, Cochran Arch, Pine Ridge Fault, and White River Fault. *See also* EA at 3-6 to 3-7 (NRC006). Specifically, Regional Cross Section R1-R1’ (Figure 2.6-23) crosses the Cochran Arch/Pine Ridge Escarpment with an average distance between boreholes of 1,400 feet through this 2-mile area and indicates no significant discontinuity of the Basal Chadron aquifer. Appendix Z in the TR (CBR039 at Figures 2 and 3) contains an additional five cross sections associated with the Three Crow Expansion Area. None of the cross sections substantiate a large north side down vertical displacement across the Pine Ridge Fault. In two of the cross sections, the top of the Pierre Shale surface elevations decreases southward, which is contradictory to a north side down vertical displacement. While we cannot rule out the possibility of a short/small offset, the data demonstrates that there is not a large offset fault that could act as a boundary for groundwater flow and movement that could impact production operations at the MEA.

5.6 Dr. LaGarry claims (OST010) that there are several potential faults in the Marsland area and potentially hundreds of smaller faults. At the hearing, Dr. LaGarry highlighted a figure from Swinehart (NRC012) that he had excerpted and annotated in Exhibit OST010 in support of his claims of the potential existence of a fault near the MEA site. Tr. at 713. Dr. LaGarry referenced a cross-section, A-A’, that showed the cross section to be located “30 miles west of Marsland”, even though a closer cross-section to MEA existed. Tr. at 714-715. Dr. LaGarry used the figure to posit the existence of the Niobrara River Fault near MEA and to highlight the potential for contamination to reach the High Plains Aquifer. Tr. at 727. However, as the NRC witnesses noted at the hearing, the cross-section in Swinehart (NRC012) closest to the MEA does not show the existence of the fault. Tr. at 831, 834. This is compelling evidence that neither the Pine Ridge nor Niobrara River Faults pass under the MEA, and we so find based on the evidence presented in the evidentiary hearing.

5.7 Based on the large number of boreholes and wells drilled on the site to date, and any other surficial and subsurface geological data, we conclude that, while faults exist at a regional level, there is no evidence of any faulting within the MEA that would affect confinement or that would transmit mining liquids. Any hypothetical or potential features cited by LaGarry outside of the MEA boundary provide no pathway for transport of mining solutions from within the MEA. Moreover, if any minor fractures were to appear, they would close up quickly (*i.e.*, be essentially self-sealing) as a result of overburden pressure from the weight of overlying strata. *See, e.g.*, Tr. at 801. Moreover, based on the evidence of confinement of the Basal Chadron aquifer (discussed further below), it is highly unlikely that the MEA contains a fault or a connected pathway of faults in the upper confining unit that is capable of transmitting contaminants.

5.8 Mr. Wireman alleges that there is inadequate information regarding wastewater disposal. Crow Butte has prepared a permit application for a Deep Disposal Well ("DDW") at Marsland in accordance with regulatory requirements in the NDEQ Assessment Section, Title 122 Rules and Regulations for Underground Injection and Mineral Production Wells (effective April 02, 2002). The formation receiving the injected waste fluids (the "injection zone") would be restricted to the Lower Dakota, Morrison, and Sundance Formations, which have been demonstrated to be located below the lowermost underground source of drinking water. Tr. at 737; *see also* NRC006 at 3-30; CBR006 at 4-11 and 7-20; CBR005-R at 3-99. In addition, the Lower Dakota, Morrison, and Sundance Formations exhibit water quality that is not considered (under state and federal regulations) to be underground sources of drinking water due to measured concentrations of their total dissolved solids. *Id*. The TR states that the estimated total dissolved solids ("TDS") in these formations exceeds 10,000 mg/L (CBR006 at 4-11, 7-20). In addition, as stated in the EA, SER, ER, and TR, these formations are separated from the Basal Chadron

Sandstone aquifer by several thousand feet of low-permeability units, including at least 750 feet of Pierre Shale, a regional aquitard with a very low hydraulic conductivity. NRC006 at 3-29 to 3-30, 3-32, 5-19; NRC008 at 52-53; CBR005-R at 7-24; CBR006 at 2-52 to 2-53 and 7-20).

5.9 Mr. Wireman claims that Crow Butte omitted discussion of ephemeral streams (*e.g.*, Dooley spring) located within the MEA and that baseline sampling should include the streams. But Dooley Spring is not located within the MEA. It is located approximately 1.5 miles west of the MEA boundary. As discussed in the MEA TR, section 2.7 (CBR006), site investigations found no surface water impoundments within the MEA. The lack of water flow in ephemeral drainages in the MEA has prevented collection of surface water samples (section 2.9.4). The TR also notes that rainfall runoff occasionally creates temporary small pools in a few places on the MEA site, but there is no evidence of persistent stream flow in recent times. While Crow Butte will collect data on ephemeral streams should water be available (NRC006 at 6-1 to 6.2; CBR-006 at 2-123, 2-128), it is not necessary to adequately characterize the site.

5.10 Mr. Wireman asserts that more meteorological data should be collected because 2011 (the year the data was collected) was an abnormal year. Normal annual rainfall for the MEA is expected to be around 15 inches per year, as described in TR Section 2.5-25. To demonstrate that the one-year baseline meteorological data is representative of the longer-term conditions, CBR performed regression analysis on historical wind data from the Chadron (NE of MEA) and Scottsbluff (SW of MEA). The analysis showed strong correlation. *See* CBR038 (Appendix S – Justification for use of 15 Years of Scottsbluff's Meteorological Data, MEA TR). As a result, additional data collection is not warranted or necessary.

5.11 Mr. Wireman argues that the TR provides no information on baseline restoration wells that will be used to establish the baseline. Baseline wells will be established as part of developing the mine units at Marsland. License Condition 11.1.3 (NRC009) specifically addresses the sampling necessary to establish background ground water quality data for the ore zone and overlying aquifers. This background water quality will be used to define the background ground water protection standards required to be met in 10 CFR Part 40, Appendix A, Criterion 5B(5), for the ore zone aquifer and surrounding aquifers.

5.12 Overall, nothing in OST witnesses' opinions indicates any errors in the discussion of structural geology, local hydrology, meteorology, or background water quality.

B. Assessment of Concern 2: Hydrogeologic Parameters

5.13 The MEA TR contains potentiometric contour maps showing the hydraulic gradients of the overlying Arikaree and Brule aquifers and the Basal Chadron Sandstone (CBR008 at 105-116). In addition, Section 2.9.3.2 of the TR provides average lateral (horizontal) hydraulic gradients for the Arikaree, Brule, and Basal Chadron Sandstone aquifers (CBR006 at 2-116 to 2-117). Section 2.7.2.3 of the TR discusses hydraulic conductivities of the overlying and underlying confining layers (Upper and Middle Chadron Formations and Pierre Shale, respectively). For the Upper and Middle Chadron Formations, the hydraulic conductivity values are based on estimates from particle size distribution measurements or direct measurement on core samples using falling head permeameter testing (CBR006 at 2-84 to 2-85). For the Pierre Shale, the hydraulic conductivity values are based on reported values in the literature (CBR006 at 2-85).

5.14 CBR also determined hydraulic conductivity, transmissivity, and storativity from aquifer pumping test data for the Basal Chadron Sandstone aquifer, as discussed in Section 2.7.2.2 of the TR and presented in Tables 2.7-2 to 2.7-4 of the TR (CBR006 at 2-81 to 2-84; CBR009 at 72-74). *See also* Tr. at 357 (Lewis).

5.15 CBR provided an effective porosity of 0.20 for the Basal Chadron Sandstone to calculate groundwater velocities as part of an analysis of the ability to contain fluid migration in the event of an extended power loss where all wells would be shut down (CBR006 at 3-26). The NRC agreed that 0.20 is a reasonable value for this type of application based on the description of the Basal Chadron Sandstone. NRC001 at 22.

5.16 Mr. Wireman claims that the characterization of the local/regional hydrogeology and groundwater flow is inadequate for demonstrating the ability to contain unwanted fluid migration from excursions and to adequately conduct groundwater restoration. To the contrary, we find that the MEA technical report provides a detailed and robust characterization of the local and regional groundwater flow and hydrogeology.

5.17 Mr. Wireman asserts that there is significant uncertainty about groundwater flow in the Basal Chadron downgradient of the MEA. But Crow Butte has provided information on the gradient and flow direction throughout its application. The potentiometric surface elevation at the MEA has shown consistent flow toward the north-northwest, consistent with pre-development and current regional flow direction near the main mining area (*see, e.g.*, CBR021). These observations indicate no influence (flow divide) exists due to the Pine Ridge escarpment in the Basal Chadron Aquifer, which is consistent with the conceptual model of groundwater flow indicating no significant recharge to the Basal Chadron Sandstone along the Pine Ridge Escarpment. This is not unexpected given the significant depth of the Basal Chadron Aquifer below the escarpment, and the significant thickness of the confining unit that separates the Basal Chadron Sandstone from the Brule and Arikaree aquifers.

5.18 In contrast, groundwater flow in the overlying Brule and Arikaree aquifers is northwest near the main mining area, and southeast near MEA. This observation indicates a flow divide exists between the main mining area and MEA in the shallow aquifers, due to significant recharge to the shallow formations exposed along the Pine Ridge Escarpment.

5.19 Hydraulic gradient data, at both regional and local levels, is presented in potentiometric maps provided as TR Figures 2.9-4a through 2.9-4d, 2.9-5a through 2.9-5d, and 2.9-6a through 2.9-6d (CBR008); *see also* Tr. at 751-763 (CBR witnesses); Tr. at 765-766 (NRC Staff witnesses). OST's witnesses did not disagree with the presentation of this information. Tr. at 763.

5.20 Overall, we conclude that Crow Butte and the NRC Staff have provided a description of the effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient of site hydrogeology, along with other information relative to the control and prevention of excursions such as transmissivity and storativity.

C. <u>Assessment of Concern 3: Conceptual Model and Pumping Test Results</u>

5.21 Concern 3 addresses the site conceptual model for hydrogeology. At the hearing, most of the discussion focused on the results of the aquifer pumping test. Crow Butte and the NRC Staff relied, at least in part, on the results of the aquifer pumping test performed at the site to show the absence of faults, fractures, or other hydraulic connections between the mined aquifer and the Brule aquifer.

5.22 Aquifer pumping tests are used to estimate hydraulic properties of an aquifer system. An aquifer pumping test evaluates aquifer properties by stimulating (or stressing) the aquifer (*e.g.*, via pumping) and observing the aquifer's response by measuring water levels in observation wells. An aquifer pumping test typically involves pumping groundwater from a pump well at a specific rate for a specific time while monitoring for changes in the water levels of the pumping well and of surrounding observation wells. The level of "drawdown" observed in a well refers to how much (if any) the groundwater level in the well dropped during the pumping. Drawdown curves can be plotted to show the drawdown versus log time. Once the pumping stops, water levels again are monitored to determine the aquifer's recovery time. Aquifer test results, including the drawdown and recovery data, are used to assess the aquifer's hydraulic conductivity, transmissivity, and storativity. *See, e.g.*, Tr. at 357 (Lewis).

5.23 Dr. Kreamer claims (OST003) that the site characterization is deficient and mischaracterizes the hydrogeologic environment at the MEA site. He alleges that "much of the collected pumping test data was selectively ignored, the solitary pumping test covered very little of the of the MEA site leaving the majority of the site hydrogeologically undefined, and the single pumping test that was analyzed was influenced by conditions outside the site boundary." OST003 at 1. Dr. Kreamer goes on to argue that the "failed" Marsland pumping test that went on for 19 hours had a long enough duration to be "possibly analyzed and perhaps could have be [sic] included as a second analysis." *Id*. at 2. He also claims that, "[i]f this occurred at the end of the test, the information recorded is still valid." *Id*.

5.24 Dr. Kreamer did not analyze the data himself or present it as testimony or evidence in this proceeding. Contrary to Dr. Kreamer's unsupported assertions, we find that analysis of the failed pump test data would not have been useful or insightful. The well CPW-1 test was terminated after only 19 hours, a small fraction of the time necessary to measure significant drawdown in more distant wells, and far short of the 4.3 days needed to reach all drawdown targets and terminate the test. CBR001-R at 4. Failed test well CPW-1 was also shown to be very inefficient (abnormally high drawdown) that prevented more ideal higher pumping rates. Well CPW-1 was subsequently replaced by well CPW-1A for the final test. *See* Revised Pumping Test Plan (CBR023) at 1.

5.25 Dr. Kreamer also claims that the report only analyzed selective portions of the data from pumping test and that the excluded data shows lack of confinement. OST003 at 2. This conclusory statement is not supported by evidence in the record. As Crow Butte and the NRC Staff witnesses noted, certain data collected from the test are considered more reliable than others for purposes of data analyses. For example, early-time data, such as that collected during the failed pumping test, does not characterize the aquifer response as accurately as do mid- and late-time data. Early-time drawdown data are negatively influenced by a number of factors not related to the aquifer response to pumping and, therefore, are inappropriate for estimating aquifer behavior.

5.26 First, theoretical equations rely on the assumption that the well discharge remains constant and that the release of water from the aquifer is immediate and directly proportional to the rate of decline of pressure. CBR033 at 5. This leads to initial disagreement between theory and actual flow, though, as the time of pumping extends, these effects are minimized, and closer agreement may be attained. *Id*.

5.27 Second, wellbore storage can also affect the early-time data, especially large diameter, deep production wells with large water column height. CBR033 at 5. Because the amount of water stored within the wellbore can be substantial, it must be removed before the aquifer can respond properly to the induced drawdown, which further reduces the value of early-time data. The pumping test report provides the detailed discussion and explanation for how data was used to characterize the aquifer response, including the basis for concluding that adequate confinement exists. For example, no drawdown was observed in overlying Brule Formation observation wells during the test period (CBR016 at 1). This observation supports the conclusion that adequate confinement exists between the overlying Brule Formation and the Basal Chadron production zone.

5.28 In addition, drawdown data vs. time were plotted for each observation well. *See* CBR016 at Appendix C. Based on the character of the curves, confined aquifer analytical methods were appropriate for the analysis of water level data (CBR016 at 11). At the evidentiary hearing, the parties discussed the use of various analytical techniques. The results from all but one of the well yielded reasonably consistent estimates of transmissivity. Dr. Kreamer focused on one well, well C3, that he claimed showed a recharge boundary.[23] Mr. Lewis explained that, in his view, the flattening of the curve is a result of transmissivity variations. Tr. at 395, 404-405. As NRC witness Dr. Stritz indicated at the evidentiary hearing, if the later-time data is fit to the curve, because of the effects of the very efficient well that has a lot of drawdown and the proximity of the observation well to the pumping well that creates the potential for vertical flow effects, there appeared to be well effects for about 800 minutes, and that fully developed radial flow yields a transmissivity that is in line with the results for the other wells. Tr. at 503-505. Another potential explanation is that water is being released from storage in the first several feet of the aquitard immediately overlying the Basal Chadron Sandstone aquifer, which can mimic a recharge boundary. NRC014 ta 19. Based on the record evidence and testimony at the hearings, we find that the flattening of the curve at well C3 does not represent significant recharge, but rather reflects some combination of transmissivity variations, water released from storage in the aquitard, and well effects.

5.29 Dr. Kreamer claims that, even though the report states that Cooper-Jacob semi-logarithmic evaluations were performed on the data, these analyses did not appear in the report and, further, can identify a recharge boundary that is consistent with lack of confinement of

23 The term "recharge" refers to water entering an aquifer. A "recharge boundary" reflects an area or zone of the aquifer with increased groundwater flow.

the aquifer. OST003 at 2. Dr. Kreamer's assertion is incorrect. The Cooper-Jacob semi-logarithmic distance-drawdown analysis was performed as stated in the report. Results are shown in Figure 18 and discussed in Section 7.6.1 in the test report (CBR016 at 12-13, Figure 18).

5.30 Dr. Kreamer complains that the pumping test report did not include an analysis of pumping test data from water level changes at Monitoring Wells 2 or 8 in the analysis, although these wells were reported to be in the radius of influence of the pumping test and those water level changes were used to define an extended radius of pumping well influence. OST003 at 2. As described in the aquifer pumping test report and revised pumping test workplan (CBR016, Section 5, *Monitoring Well Locations, Installation and Completion*, at 12; CBR023 at 1), Monitor Wells 2 and 8 were <u>not</u> part of the formal monitoring well network. The radius of influence for the test did not include data from Monitor Wells 2 or 8 since they were not part of the formal monitoring network. CBR033 at 7. In accordance with NDEQ requirements that were incorporated into the testing workplan, monitor wells that are part of the formal monitoring network should have greater than 0.5 feet of drawdown at the end of the test. *Id*. Even though Monitor Wells 2 and 8 were not part of the formal monitoring network, water level data from these wells were collected and analyzed for completeness, as both wells showed measurable drawdown due to pumping of approximately 0.5 feet. *Id*. Data from Monitor Wells 2 and 8 were analyzed as other monitoring wells, and results are presented in Table 8 of the testing report (CBR016 at Figures page 10).

5.31 Dr. Kreamer claims that performing a single pumping test covered only a relatively small portion of the site "is poor professional practice." OST003 at 2. However, Crow Butte's approach is consistent with industry practice and with NRC guidance for initial licensing. NUREG-1569 (NRC010 at 2-24) states that "[a]ny of a number of commonly used aquifer pumping tests may be used including single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pumping tests using multiple observation wells." With respect to Marsland specifically, Pump Test #8 was designed to characterize the area of the MEA that would be the location of the first four mine units to be developed. We find that additional pumping tests would provide little incremental value with respect to those mining units given the quality and reliability of existing data and analyses. Additional site-specific pumping tests will be performed as additional mine units are added. License Condition 11.3.4 (NRC009 at 19) states that, as part of developing its wellfield packages for any new mine units at the MEA, the applicant shall perform an aquifer pumping test for each new mine unit. The licensee must submit its plan for conducting the aquifer pumping test for NRC review and written verification at least 60 days prior to the planned date for performing the aquifer pumping test.

5.32 OST's witnesses argued that the pumping test was impacted by hydrogeologic influences off-site that were not part of the area to be evaluated, claiming that the cone of depression's radius of influence extended off-site. OST003 at 2. Crow Butte acknowledged that the radius of influence extended offsite (*see, e.g.*, Tr. at 448, CBR033 at 8). Crow Butte and OST witnesses also concurred regarding the regional nature of the Basal Chadron. Tr. at 448 (Lewis); Tr. at 449 (LaGarry). We find that the aquifer test results are representative of average aquifer conditions over the radius of influence of test, which includes all monitoring wells that were evaluated as part of the test.

5.33 According to Dr. Kreamer, the report does not make clear if the actual aquifer thicknesses were used to calculate transmissivity or only the average aquifer thickness. OST003 at 2. However, we find that an average net sand thickness of 40 feet was used to calculate transmissivity of the Basal Chadron Sandstone at Marsland. S*ee, e.g.*, CBR016 at 5, 13, 14, and Table 8, Tr. at 458. Ore-grade uranium deposits underlying the Marsland Expansion Area are located in the Basal Chadron Sandstone, which averages 50 feet in thickness (typically 40 feet net sand). Tr. at 458-459. While there is some variability, we agree that the assumption is reasonably satisfied over the test area. CBR016 at 11.

5.34 Dr. Kreamer states that the thickness of the Basal Chadron Sandstone varies across the site and that the screened intervals of the monitoring wells may not reflect the entire thickness of that aquifer. OST003 at 2. We find that the monitoring wells installed as part of the aquifer pumping test penetrated all or the majority of the Basal Chadron Sandstone thickness and are sufficient to characterize the full thickness of the aquifer. Tr. at 456, 458-459. In any event, given the relatively large distances from the pumped well to monitoring wells, partial penetration effects in observation wells are negligible.

5.35 Dr. Kreamer claims that Crow Butte "mischaracterizes results of previous testing of the Basal Chadron Sandstone" when it states that the Basal Chadron is relatively homogeneous and isotropic within the current Class III UIC area. OST003 at 3. While we recognize that, at some scale, all geologic systems exhibit heterogeneity and anisotropy (*see, e.g.*, NRC014 at 25), we find that the Basal Chadron Sandstone at the MEA is relatively homogeneous, isotropic, and confined for purposes of aquifer characterization. Crow Butte used appropriate analytical techniques for such aquifers.

5.36 Dr. Kreamer includes several hand-drawn plots in his testimony. OST003 at 3-5. But the drawings included in his testimony are those that he used to try to reanalyze aquifer pumping test data for the central processing area in the license renewal proceeding. Those drawings are specific to pumping tests performed at the main mining area, and not to the pumping test performed in connection with the Marsland application. They therefore are irrelevant to the application at hand.

5.37 In his Opinion 3, Dr. Kreamer states that Crow Butte omitted its analysis of the pumping test using the Cooper-Jacob technique and asserts that a change in the level of water from the Theis curve is consistent with a lack of confinement of the aquifer. OST003 at 6. Crow Butte did perform a Cooper-Jacob semi-logarithmic distance-drawdown analysis was performed as stated in the report, and results are shown in Figure 18 and discussed in Section 7.6.1 in the test report (CBR016 at 12-13, Figure 18). Results of that analysis are consistent with Theis drawdown analyses also provided in the report. Given the great thickness, low permeability, and depth of the Basal Chadron Sandstone confining unit, there is no conceptual basis for additional aquifer test analyses. Significant local variations in aquifer thickness and hydraulic conductivity (transmissivity) described in the report are conceptually consistent with observed drawdown responses in a highly confined aquifer.

5.38 Crow Butte's witness further analogized the long-term operations at the main Crow Butte mining area as the "biggest pump test that has been conducted for the Marsland facility" since drawdown at the Marsland site has been observed as a result of pumping at the main mining area nine miles away. Tr. at 395 (Lewis). Crow Butte's witnesses calculated that, with that kind of a radius of influence, any recharge rate or leakage rate resulting is less than the pumping rate at Crow Butte of 200-250 gallons/minute, which is a very small amount of leakage over a 13 square mile area radius of influence. Tr. at 395-396. In short, there is no reason to perform hypothetical aquifer leakage analyses when no conceptual basis for such leakage exists. Tr. at 498-499 (Mr. Lewis).

5.39 Dr. Kreamer argues that the assumption that the Basal Chadron is homogeneous and isotropic, and of uniform effective thickness over the area influenced by pumping, is inconsistent with data and evidence. Of course, actual hydrogeological conditions always vary from ideal conditions in natural systems. Tr. at 325, 529 (Mr. Lewis). The variability in aquifer transmissivity and storativity here are not unusual, are relatively small, and well within the expected range of variability of a sandstone aquifer. The observed variation in subsurface conditions at MEA does not preclude analysis of the data using analytical models with ideal boundary conditions. As noted in the pumping test report (CBR016 at 11), "[l]ocally, the Basal Chadron Sandstone is not homogenous and isotropic; however, over the scale of the pumping test, it can be treated as such for analytical purposes." (The relative homogeneity of the aquifer is further evidenced by relatively constant hydraulic gradient. CBR008-R at 113-116.)

5.40 Dr. Kreamer also alleges that no "rigorous" analyses for anisotropy were undertaken. OST003 at 7. We find that the cone of depression observed during the pumping test did not show significant horizontal anisotropy as demonstrated by the relatively circular drawdown cone at the end of the pumping test, utilizing drawdown data from all monitoring wells. CBR016 at 14 and Figure 16; CBR033 at 12. If vertical anisotropy exists within the production zone aquifer, that condition is considered beneficial for ISR operations because it creates the preferred horizontal flow. NRC014 at 29. More detailed analyses of anisotropy are not necessary given lack of conceptual basis in the geometry of the drawdown cone.

5.41 Mr. Wireman also asserts that the aquifer testing at MEA was inadequate and that data indicate that hydraulic conductivity and transmissivity of the Basal Chadron near the pumping well is an order of magnitude lower than at the outlying monitoring wells. OST004-R at 4. We have previously addressed the basis for concluding that the aquifer pumping test is sufficient to characterize the portions of the site that would be affected by development of the first four mining units at Marsland. Beyond that, we disagree with Mr. Wireman's characterization that transmissivity and hydraulic conductivity near the pumped well is an order of magnitude lower than outlying monitor wells. Transmissivity and hydraulic conductivity of monitor wells are within a factor of 2 to 4, suggesting relative homogeneity, with the exception of Monitor 3, which is 2 to 9 times lower than other monitor well locations, according to the aquifer pumping test report. CBR033 at 18. There is no evidence of the hypothetical structural heterogeneities cited by Mr. Wireman.

5.42 We find that the analyses performed as part of the MEA pump testing program are consistent with standard professional practice and provide reasonable estimates of aquifer properties for the intended purpose. We find that there is no evidence of aquifer leakage or recharge boundaries in time-drawdown data or type-curve matches in the aquifer testing report.

5.43 Mr. Wireman further claims that there is "too much" uncertainty regarding applicable groundwater restoration standards, citing references to NDEQ restoration standards. OST004-R at 5. We find that the standards that Crow Butte must meet are clear. As the EA (NRC006 at 37) and TR (CBR006 at 297) recognize, the primary goal of the groundwater restoration program is to return groundwater affected by uranium recovery operations to pre-injection baseline values on a mine-unit average, as determined by the baseline water quality sampling program. Licensees and applicants must commit to achieve the ground water quality standards in 10 C.F.R. Part 40, Appendix A Criterion 5B(5) for all restored aquifers, which conforms to the standards promulgated by the U.S. EPA in 40 C.F.R. Part 192 Subpart D 192.32(2). NRC014 at 11-12. These standards state the concentration of a hazardous constituent (Criterion 5B(5)) must not exceed: (a) the Commission approved background concentration of that constituent in ground water; (b) the respective value in the table in paragraph 5C if the constituent is listed in the table and if the background level of the constituent is below the value listed or; (c) an alternative concentration limit established by the Commission. If an ACL is necessary, an application for an amendment to use ACLs will include consideration of factors listed under Criterion 5B(6) of 10 CFR Part 40, Appendix A and approval by NRC pursuant to Criterion 5B(5)(c). NRC014 at 12. NDEQ restoration standards exist separate and apart from NRC requirements. Crow Butte must meet the more stringent of the NRC or NDEQ requirements. Tr. at 690-692.

5.44 Mr. Wireman asks what criteria will be applied to determine whether best available technology has been used if an application for an ACL is necessary. OST004-R at 5. The NRC Staff explained that applicability of best available technology to be applied will be considered as part of the review process to determine that a mine unit is restored or in consideration of an ACL. The outcome of that review will depend on the efforts undertaken to restore the aquifer once mining ends and may not be necessary depending on the status of restoration efforts. Tr. at 698-700. CBR will conduct stability sampling to meet both NDEQ and NRC regulations regarding stabilization phase monitoring. Tr. at 702. Long term monitoring is determined by NRC as a part of issuing an ACL, if one is required. CBR033 at 19.

D. <u>Assessment of Concern 4: Isolation of Aquifer</u>

5.45 Concern 4 questions the assumption as to the isolation of the aquifers in ore-bearing zones. The relative confinement of the Basal Chadron was discussed extensively with respect to the pumping test and Concern 3. Crow Butte and NRC Staff witnesses testified that there are multiple lines of evidence supporting adequate confinement of the mined aquifer, including borehole log data, laboratory tests of soils and rocks, water level data, water sampling data, aquifer pump tests, and operating experience. CBR033 at 6; NRC001 at 28. The intervenors witness, in contrast, argues that there may be a hydraulic connection between the mined aquifer and the Brule aquifer through fractures, faults, or other preferential flow paths. OST016-R at 1-2.

5.46 Dr. LaGarry asserts that mining in the Marsland area would contribute to contamination that would migrate laterally into the White and Niobrara rivers. OST010 at 4. We find that this concern is speculative and unsupported by data or evidence.

5.47 Spills can take two forms within an ISR facility: subsurface releases such as an excursion, in which mining fluids threaten to migrate beyond the wellfield; or surface spills, such as pond leaks or piping ruptures, that result in a release of waste solutions. During the hearing, Crow Butte witnesses described the engineering and administrative controls that are in place to prevent both subsurface and surface releases to the environment and also to mitigate the effects should a release occur, as well as the site conditions (*e.g.*, existence of claystones and siltstones in the alluvium). Tr. at 773-775. In other words, Crow Butte's excursion monitoring program encompasses actions both to detect and to terminate excursions.

5.48 Dr. LaGarry claims that surface leaks and spills at Marsland could be transmitted to the High Plains aquifer "within a few years." OST010 at 4. This statement also is speculative and not supported by any evidence or transport analysis. Boring and well logs of surficial soils and shallow subsurface sediments at MEA indicate the site is underlain by 30 to more than 100 feet of unsaturated sediments between the ground surface and underlying water table, including a significant thickness of low permeability materials (*i.e.*, siltstones and claystones of the Brule Formation and/or formations of the Arikaree Group) across much of the site. CBR033 at 21. Further, many of the potential water-bearing units in the Arikaree Group have limited lateral extent and are interbedded with low-permeability mudstone units. *Id*. The significant thickness of the unsaturated zone and the presence of a significant amount of low permeability materials would significantly reduce the likelihood of downward migration of any spilled mining solutions into the underlying water-table. *Id*. In the unlikely scenario of a surface spill migrating through unsaturated sediments into Arikaree Group water-bearing sands, the leak would be extremely limited in extent, both laterally and vertically. *Id*.

5.49 This concern ignores operational practices, well-construction requirements, and site-specific conditions that would tend to prevent upward contamination. Crow Butte must take steps to minimize the potential for leaks and spills and perform appropriate mitigation, if necessary. First, Crow Butte must have a comprehensive monitoring program (including a monitoring well ring and corrective actions) in place to detect and correct any such leaks or spills should they occur. Crow Butte's excursion monitoring program is an established program, set forth in detail, and governed by prescriptive license conditions. *See, e.g.*, NRC009 at 10 (LC 10.1.2). Second, the possibility of a pipe failure and related release of injection of recovery solutions is minimal, as the wells are installed using standard techniques and all piping will be leak-checked before initial placement into service. CBR033 at 22. Piping from the wellfield will be buried, minimizing the possibility of an accident. *Id*. Third, the flows through the wellfield, piping and manifold pressure gauges in the wellhouses are monitored 24 hours per day, 7 days per week by control room operators using visual and audible alarms. *Id*. Flow monitoring systems will alarm in the event of a significant piping failure, which will allow flow to be stopped, preventing any significant migration of process fluids. *Id*. Wellfield buildings will also be equipped with wet alarms for early detection of leaks. *Id*. Lastly, the strongly downward hydraulic gradient at Marsland and the large thickness of confining units at the Marsland would prevent upward movement of mining solutions into overlying aquifers. *See, e.g.*, TR Appendix AA-3 (CBR012); CBR033 at 22-23.

5.50 More broadly, Crow Butte has considered migration of fluids to overlying aquifers and has put in place multiple controls to prevent such an occurrence. CBR033 at 21. For example, Crow Butte will plug all exploration holes to prevent commingling of the Brule and Chadron Aquifers and to isolate the mineralized zone. *Id*. In addition, mechanical integrity will be tested prior to placing a well into service. *Id*. This requirement of the NDEQ UIC Program ensures that all wells are constructed properly and are capable of maintaining pressure without leakage. *Id*. at 21-22. Monitor wells completed in the overlying aquifer will be sampled every two weeks for the presence of leach solution. *Id*. at 22.

5.51 Dr. LaGarry acknowledged that he had performed no transport analysis to assess the effects of a spill or leak. Tr. at 818.

5.52 Accordingly, we conclude that Dr. LaGarry's claims are not based on any transport calculations or historical evidence. Contaminant transport pathways to the White River and Niobrara Rivers from the Marsland site are unlikely given the site conditions and operational practices at an ISR facility. But, in any event, Crow Butte has in place measures to mitigate and address any contamination prior to it reaching surface waters.

5.53 In addition, given strongly downward hydraulic gradients between shallow aquifer and the Basal Chadron Sandstone, migration of fluids along any fault or fracture in the system would likely be downward, precluding any impacts to surficial aquifers. *See, e.g.*, Appendix AA-3 (CBR012).

5.54 We therefore find that Crow Butte has taken comprehensive steps to prevent and mitigate leaks and spills in order to minimize the risk of significant impacts to surface water and groundwater features at the MEA site. In light of the protection measures in place, ongoing monitoring, and requirement to take corrective actions, we find that the risk of contamination of nearby surface water and groundwater features is minimal.

5.55 Dr. LaGarry also speculates that contaminated water or mining fluid could be drawn into agricultural wells or released into rivers. OST010 at 5. Dr. LaGarry assumes a series of highly unlikely hypothetical events and relies on erroneous technical conclusions. There is no evidentiary or data-driven basis for his statement of concern. The comment that if the High Plains aquifer was impacted it could contaminate supply wells "within a few years" (OST010 at 5) is not supported by any available data. Groundwater in the shallow aquifer does not migrate eastward toward the White River, it migrates primarily southward toward the Niobrara River. Statements suggesting migration of contaminates more than 15 miles to the White River are completely without technical basis and wholly implausible. CBR033 at 24. Statements suggesting rapid contamination of the Niobrara River are also without technical basis and implausible given the distances involved and the nature of uranium transport (*i.e.*, the physical processes at work that would retard any transmission and reduce the concentration of radioactive contaminants, including dispersion, attenuation, and chemical dilution).

5.56 With respect to the existence of irrigation wells near the MEA, Crow Butte used its calibrated groundwater flow model to calculate the 30-year capture zone of a nearby irrigation well (well 732). CBR033 at 24. Particle-tracking techniques were used to illustrate the 30-year capture zone of irrigation well 732 to assess whether a hypothetical shallow casing leak from the MEA wellfields could potentially impact the irrigation well. *Id*. A conservative (worstcase) scenario was assumed in which irrigation well 732 pumps the maximum allowable amount of groundwater (251 acre-ft/year, 373 gpm for 5 months) and a hypothetical shallow casing leak occurs at some time along the downgradient portion of the adjacent wellfields at the MEA. *Id*. at 24-25. The revised 30-year capture zone of irrigation well 732 is illustrated in Appendix AA-2 (CBR011). Based on the results of this analysis, MEA wellfields are not located within the capture zone of irrigation well 732. We find that a shallow casing leak within the MEA wellfields will not impact irrigation well 732 at any time in the future given expected operating conditions. CBR006 at 2-118.

5.57 Overall, we find that there is strong evidence for hydraulic isolation and a competent upper confining unit at the site, indicating that groundwater flow pathways between the production zone and overlying aquifers are not present. This conclusion is based on site specific data and is supported by multiple lines of evidence, including: (1) hydrologic characteristics of the upper and lower confining units; (2) aquifer pumping test results; (3) the potentiometric surface of the Basal Chadron Sandstone aquifer; (4) differences in potentiometric surfaces between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer; (5) water quality differences between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer; and (6) isotopic age differences between water in the Brule and Basal Chadron Sandstone. *See also* TR Appendix AA-3 (CBR012). The data confirm that low permeability layers confine the Basal Chadron Sandstone both above and below. There is also no evidence to suggest faulting or fracturing at the MEA site.

VI. CONCLUSIONS OF LAW

6.1 For the reasons set forth above, as supported by the testimony and evidence in the record in this proceeding, we conclude that the NRC Staff has taken the requisite "hard look" at potential impacts from construction and operation of the MEA. The NRC Staff evaluated the impacts of operations at the MEA in the EA and "has come to grips with all important considerations."[24] The EA adequately described the affected environment, including the effects of the proposed MEA operation on the adjacent surface water and groundwater resources; an acceptable conceptual model of site hydrology that is adequately supported by site characterization data so as to demonstrate ability to ensure the confinement of extraction fluids and expected operational and restoration performance; and discussion of the basis for conclusions regarding the isolation of the aquifers in the ore-bearing zones. The Licensing Board therefore should resolve the environmental aspects of Contention 2 in favor of Crow Butte and the NRC Staff.

6.2 Crow Butte also has presented information and analysis regarding the technical aspects of proposed licensed activities and demonstrated that its activities comply with 10 C.F.R. Part 40. In addition to considering the information provided to describe the effected environment and that support the conclusions in the NRC's SER, Crow Butte (and the NRC Staff and NDEQ) considered the data presented and described effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient of site hydrogeology, along with other information relative to confinement, control of mining fluids, and prevention of excursions. The Board therefore should also resolve the technical aspects of Contention 2 in favor of Crow Butte.

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[24] *Grand Gulf ESP*, CLI-05-4, 61 NRC at 13.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

CERTIFICATE OF SERVICE

I hereby certify that copies of "CROW BUTTE RESOURCES' PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW" in the captioned proceeding have been served on this 3rd day of December 2018 via the Electronic Information Exchange ("EIE"), which to the best of my knowledge resulted in transmittal of the foregoing to all those on the EIE Service List for the captioned proceeding.

/s/ signed electronically by
Tyson Smith
889 Marin Drive
Mill Valley, California 94941

COUNSEL FOR CROW BUTTE RESOURCES, INC.