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: NRC001

Exhibit Title: Testimony of David Back, Thomas Lancaster, Elise Striz, and Jean Trefethen (Aug. 17, 2018)

August 17, 2018

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NRC STAFF'S INITIAL TESTIMONY

INTRODUCTION

Q.1 Please state your name, position, and employer, and briefly describe your role in reviewing the Crow Butte Resources (CBR) application for the Marsland Expansion Area (MEA) license amendment.

A.1a My name is David Back. I am a Hydrogeologist at Sanford Cohen and Associates, Inc. (SC&A). Exhibit NRC002 provides a statement of my professional qualifications. I provided technical support for the NRC Staff's environmental review of the MEA license amendment application. I prepared the sections of the Staff's final Environmental Assessment (EA) related to geology, hydrology, and water resources in Chapter 3 (Affected Environment), Chapter 4 (Impacts), and Chapter 5 (Cumulative Impacts).

A.1b My name is Thomas R. Lancaster. I am a Hydrogeologist in the NRC's Office of Nuclear Material Safety and Safeguards, Division of Decommissioning, Uranium Recovery, and Waste Programs, Uranium Recovery Licensing Branch. Exhibit NRC003 provides a statement of my professional qualifications. I am the safety project manager for the review of the MEA license amendment application. I was the primary safety reviewer for geology- and hydrology-related sections of the MEA license amendment application and the author of sections of the NRC Staff's Safety Evaluation Report (SER) related to those topics.

A.1c My name is Dr. Elise Striz. I am a Hydrogeologist in the NRC's Office of Nuclear Material Safety and Safeguards, Division of Decommissioning, Uranium Recovery, and Waste Programs, Uranium Recovery Licensing Branch. Exhibit NRC004 provides a statement of my professional qualifications. I was not involved in the safety or environmental reviews of the MEA license amendment application; however, I have been involved in similar reviews for other in-situ uranium recovery (ISR) facilities, including the Crow Butte license renewal. I have reviewed sections of the Marsland SER and the Marsland EA related to geology and hydrology and corresponding sections of the MEA license amendment application in conjunction with the development of this testimony.

A.1d My name is Jean Trefethen. I am an Environmental Project Manager in the NRC's Office of Nuclear Material Safety and Safeguards, Division of Fuel Cycle Safety, Safeguards, and Environmental Review, Environmental Review Branch. Exhibit NRC005 provides a statement of my professional qualifications. I have served as Environmental Project Manager on NRC licensing actions involving ISRs and other materials facilities such as Independent Spent Fuel Storage Installations (ISFSIs). Since September 2017, I have served as the lead Environmental Project Manager for the NRC Staff's environmental review of the MEA license amendment application. In that capacity, I was responsible for preparation of the draft and final versions of the Marsland EA in conjunction with the NRC's contractor, SC&A.

Q.2 Are you familiar with the admitted contention (Contention 2) in this proceeding?

A.2 (D. Back, T. Lancaster, E. Striz, J. Trefethen) Yes. We have reviewed the Oglala Sioux Tribe's (OST) Contention 2, as clarified by the Atomic Safety and Licensing Board in LBP-18-3. We have also reviewed two documents that were submitted with the OST's original hearing request in January 2013: the "Expert Opinion on the Environmental Safety of In-Situ Leach Mining of Uranium near Marsland, Nebraska" by Dr. Hannan E. LaGarry (LaGarry Opinion), and the letter to the NRC dated March 3, 2010, from U.S. Environmental Protection Agency (EPA) Region 8, regarding the EPA's review of draft Supplemental Environmental Impact Statements (SEISs) for the Lost Creek, Moore Ranch, and Nichols Ranch ISR facilities in Wyoming (2010 EPA Letter). In addition, we have reviewed documents cited by the Intervenors and their experts that pertain to this contention and our testimony below.

Q.3 What is the Staff's understanding of Contention 2?

A.3 (D. Back, T. Lancaster, E. Striz, J. Trefethen) In Contention 2, the OST asserts that the application and EA do not contain sufficient information to describe the geologic setting of the MEA or to estimate the potential environmental effects of the proposed action on surface water and groundwater resources. Therefore, the OST asserts that the application and EA do not comply with Criteria 4(e) and 5G(2) in Appendix A of 10 C.F.R. Part 40, the National Environmental Policy Act (NEPA), and provisions in Sections 2.6 and 2.7 of NUREG-1569.

In LBP-13-6, the Board characterized the overarching issue in Contention 2 as whether there is adequate hydrogeological information in the application and EA to demonstrate that ISR production fluids will not migrate offsite and contaminate surface or groundwater resources, and concluded that this contention challenges Section 3.4.3.2 and 3.4.3.3 of CBR's Environmental Report (ER). Within that context, in LBP-18-3, the Board identified the following four issues: (1) whether the application and EA adequately describe the affected environment for purposes of establishing the potential effects of the proposed MEA operation on adjacent surface water and groundwater resources; (2) exclusively as a safety concern, whether the application describes the effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient, along with other information relative to the control and prevention of excursions such as transmissivity and storativity; (3) whether the application presented 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 EA contains unsubstantiated assumptions as to the isolation of the aquifers in ore-bearing zones.

Q.4 Please identify the versions of the MEA environmental report (ER) and technical report (TR) that the Staff used for its environmental and safety reviews.

A.4 (D. Back, T. Lancaster, J. Trefethen) The original versions of the ER and TR were submitted in May 2012. CBR periodically submitted updates to the ER and TR. The most recent update of the ER was submitted to the NRC in April 2014. In November 2017, the NRC Staff created a compiled version of the ER to use as a reference in the draft and final EAs. The compiled ER contains the main text, figures, tables, and ER appendices that were current as of April 2014. Exhibit CBR005 contains the main text, figures, and tables from the compiled ER. Many of the ER tables, figures, and appendices relevant to Contention 2 have been superseded by updated versions in the TR.

In September 2015, CBR submitted a complete update to the TR, including main text, figures, tables, and appendices. Subsequent updates to the TR that are relevant to Contention 2 were provided in May 2016 and June 2017. The Staff's safety review is based on the 2015-2017 versions of the TR. The Staff's environmental review was based on the compiled ER but also considered and incorporated relevant updated information from the 2015-2017 TR updates. Exhibits CBR006, CBR008, and CBR009 are compiled versions of the TR main text, figures, and tables, respectively. Our testimony cites solely to TR tables, figures, and text where that information has superseded information in the ER.

Q.5 Please identify the sections of the MEA environmental report (ER) and technical report (TR) that are relevant to Contention 2.

A.5 (D. Back, T. Lancaster, J. Trefethen) As noted in A.3 above, in LBP-13-6, the Board identified Sections 3.4.3.2 and 3.4.3.3 of the ER as the sections of the application that the Intervenors are challenging. Sections 2.7.2.2 and 2.7.2.3 of the TR (Ex. CBR006 at 2-81 to 2-87) have titles identical to, and contain essentially the same information as, Sections 3.4.3.2 and 3.4.3.3 of the ER. Section 3.4.3.2 of the ER (and corresponding Section 2.7.2.2 of the TR) describes the aquifer pumping test conducted at the MEA in May 2011, including the installation of wells, measurements of water levels and pumping rates, test procedures and observations, data analysis, and CBR's conclusions about hydraulic confinement; the degree of communication between production and monitoring wells; and the hydraulic properties and behavior of the Basal Chadron Sandstone aquifer (Ex. CBR005 at 3-45 to 3-47; Ex. CBR006 at 2-81 to 2-84). Section 3.4.3.3 of the ER (and corresponding Section 2.7.2.3 of the TR) describes the groundwater hydrologic conceptual model for the MEA, including the identification of aquifers, descriptions of the upper and lower confining layers, aquifer properties, hydrologic conditions in the production zone aquifer (Basal Chadron Sandstone) and overlying aquifers (Brule and Arikaree), and a summary of the lines of evidence demonstrating adequate confinement of the Basal Chadron Sandstone aquifer (Ex. CBR005 at 3-47 to 3-50; Ex. CBR006 at 2-84 to 2-87). These sections also refer to Sections 6.1.2.2 and 6.1.2.3 of the ER (corresponding to TR Sections 2.9.3.2 and 2.9.3.3) for discussions of water level measurements and groundwater geochemistry of the production zone and overlying aquifers (Ex. CBR005 at 6-7 to 6-12; Ex. CBR006 at 2-115 to 2-119).

<u>GEOLOGIC SETTING</u>

Q.6 In Contention 2, the Intervenors assert that the application and Final EA fail to provide sufficient information regarding the geologic setting of the area. As relevant to Contention 2, please describe the information about geologic setting that must be provided in an application for an ISR facility.

A.6 (D. Back, T. Lancaster, E. Striz) The geologic setting for an ISR facility consists of the relevant geologic characteristics of the proposed site and its vicinity. There are no statutory or regulatory requirements that specify particular information about the geologic setting that must be included in an application for an ISR facility. For purposes of the Staff's safety review, an applicant must provide sufficient information to demonstrate that it will be able to comply with applicable regulations. As stated in Section 2.3 of the SER (Ex. NRC008 at 27), for the Staff's review of geology, the primary regulation is 10 C.F.R. § 40.41(c), which requires that a licensee "shall confine [its] possession and use of source or byproduct material to the locations and purposes authorized in the license." For purposes of the Staff's environmental review, 10 C.F.R. § 51.45(c) states that an applicant's environmental report "should provide sufficient data to aid the Commission in its development of an independent analysis."

Staff guidance documents address information that should be included in ISR applications and Staff environmental review documents. Section 2.6 of NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications" (Ex. NRC010), states that the Staff should examine "information on the geologic aspects of the site" and "determine whether a thorough evaluation of the geologic setting . . . has been presented" (Ex. NRC010 at 2-16 to 2-17). Based on Sections 2.6.1 through 2.6.3 of NUREG-1569, information on geologic setting for a proposed ISR facility that is relevant to Contention 2 includes a description of regional and local stratigraphy, including identification of mineralized zones and confining units; the geology and geochemistry of the mineralized zone and surrounding units; local and regional geologic structures (folds, faults and fractures); and a generalized stratigraphic column (Ex. NRC010 at 2-16 to 2-19). Along with descriptions of these topics, an applicant would typically provide supporting information such as geologic maps, structure contour maps, stratigraphic maps and cross-sections, lithological logs from core and drill cuttings, representative core and geophysical well-log data, and isopach maps (Ex. NRC010 at 2-16 to 2-19). As noted in NUREG-1569, some of the information an applicant provides on geologic setting is also relevant to the review of hydrology, particularly groundwater hydrology (hydrogeology) (Ex. NRC010 at 2-16).

The Staff guidance document for environmental reviews of materials facilities, including ISRs, is NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs" (Ex. NRC011). Section 3.4.5 of NUREG-1748 states that the description of the affected environment in an EA provides "a framework for the discussion of impacts," and should describe current environmental conditions that could be impacted by the proposed action (Ex. NRC011 at 3-9). Section 6.3.3 of NUREG-1748 describes the type of information about geologic setting that an applicant should provide in its environmental report. As relevant to Contention 2, Section 6.3.3 of NUREG-1748 states that an applicant should provide descriptions of geologic units, major structural features, and results of geotechnical investigations (Ex. NRC011 at 6-7).

The guidance in NUREG-1748 is general, but addresses the same topic areas for geology as the guidance in NUREG-1569. As relevant to Contention 2, the geologic setting, as it affects the ability to control migration of ISR production fluids, is a common aspect of both the Staff's environmental review of potential impacts to surface water or groundwater and the Staff's safety review of an applicant's ability to restrict use of licensed material to the area authorized in the license. Therefore, in its environmental reviews of ISR facilities, the Staff uses Section 2.6 of NUREG-1569 as additional guidance on information to consider during the Staff's review and the development of the Staff's environmental review document.

Q.7 The Intervenors claim that the information in the application and final EA regarding geologic setting does not meet the requirements of 10 C.F.R. Part 40, Appendix A, Criteria 4(e) and 5G(2). Could you please address this claim?

A.7 (T. Lancaster, E. Striz) These particular criteria are not applicable to the Staff's environmental review or safety review of the MEA. The environmental review is conducted under the regulations in 10 C.F.R. Part 51, not the regulations in 10 C.F.R. Part 40. And, although the safety review assesses an applicant's ability to comply with the regulations in 10 C.F.R. Part 40, including Appendix A of Part 40, the two criteria identified by the Intervenors are not applicable to the MEA.

Criterion 4 in 10 C.F.R. Part 40, Appendix A, specifies site and design criteria for embankments and impoundments used for permanent disposal of tailings or wastes. Criterion 4(e) requires an impoundment used for permanent tailings or waste disposal to be located away from a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. As discussed in Section 2.3.1 of the SER (Ex. NRC008 at 27), Criterion 4(e) is not applicable to the Staff's safety review of the MEA because CBR did not propose any surface impoundments for the MEA, and, in any event, there is no evidence of capable faults in the vicinity of the MEA (Ex. NRC008 at 27).

Criterion 5G (which includes Criterion 5G(2)) contains requirements for information to be supplied in support of proposals for tailings disposal systems. Such systems are only used at conventional uranium mills where tailings are generated. Therefore, as stated in Section 2.3.1 of the SER (Ex. NRC008 at 27), because tailings disposal systems are not used at ISR facilities, Criterion 5G (including Criterion 5G(2)) does not apply to the Staff's review of the MEA (or any other ISR facility).

Q.8 The Intervenors claim that the information in the application and final EA regarding geologic setting does not meet "requirements" in NUREG-1569. Can you respond to this claim?

A.8 (D. Back, T. Lancaster, E. Striz) NUREG-1569 does not contain "requirements." NUREG-1569 emphasizes that "[r]eview plans are not substitutes for the Commission's regulations, and compliance with a particular standard review plan is not required" (Ex. NRC010 at xviii). In particular, an applicant is not required to meet the acceptance criteria in NUREG-1569. NUREG-1569 explicitly states that "[a]pplicants may take approaches to demonstrating compliance that are different from the acceptance criteria in this standard review plan as long as the staff can make the requisite decisions concerning environmental acceptability and compliance with applicable regulations" (Ex. NRC010 at xxiv). As noted in A.6 above, for purposes of the environmental review, NUREG-1569 provides additional guidance to the Staff on the types of information that would be useful in describing the affected environment and evaluating potential environmental impacts at ISR facilities. But as stated above, there is no requirement to meet the acceptance criteria.

Q.9 Can you please address the Intervenor's claim that the EA and the MEA application fail to provide sufficient information regarding the geologic setting of the MEA?

A.9 (D. Back, T. Lancaster) We disagree with the Intervenor's claim. Section 3.2 of the EA contains a thorough and extensive description of the existing regional and local geologic conditions and provides a framework for discussing impacts, consistent with Section 3.4.5 of NUREG-1748 (Ex. NRC006 at 3-5 to 3-14). Section 3.2.1 of the EA discusses regional geology. Section 3.2.1.1 describes the regional topography of northwestern Nebraska, provides a regional stratigraphic chart, and describes how stratigraphic units are divided or combined into hydrostratigraphic units (aquifers or aquitards)

(Ex. NRC006 at 3-5 to 3-6). Section 3.2.1.2 discusses regional structural features of the Crawford Basin in relation to the MEA (Ex. NRC006 at 3-6 to 3-7).

Section 3.2.2 of the EA discusses local geology. Section 3.2.2.1 summarizes the local stratigraphic units and their thicknesses (Ex. NRC006 at 3-8 (Table 3.4)), describes the lithology (physical characteristics such as grain size and mineralogy), thickness, and continuity of each unit in more detail, and identifies the hydrostratigraphic role of each unit (i.e., overlying aquifer, confining unit, production zone aquifer) (Ex. NRC006 at 3-8 to 3-11). The description of the production zone aquifer (Basal Chadron Sandstone) in Section 3.2.2.1 also discusses the unit's depositional history and describes the ore body (Ex. NRC006 at 3-10). Finally, Section 3.2.2.2 discusses local structural features near the MEA and the Staff's independent evaluation of the reported Niobrara River and Pine Ridge faults, which included a review of relevant literature, CBR's regional and site-specific cross-sections, and CBR's aquifer pumping test results (Ex. NRC006 at 3-11 to 3-14).

The descriptions of the geologic setting in the EA are based on the Staff's independent review of the descriptions and supporting data provided in the MEA application, primarily Section 3.3 of the ER and corresponding Section 2.6 of the TR. These sections describe the regional and local geologic setting, including regional and local stratigraphy, the geochemistry of the mineralized zone, and structural geology (regional and local structure) (Ex. CBR005 at 3-5 to 3-21; Ex. CBR006 at 2-41 to 2-59).

CBR's discussions of geologic setting in the ER and TR are based on a review of relevant literature and its field investigations of geology at the MEA site and vicinity (Ex. CBR005 at 3-16; Ex. CBR006 at 2-42). During its field investigation, CBR obtained geophysical logs and drill cuttings from over 1600 boreholes within the MEA boundary to characterize the subsurface geology (Ex. CBR006 at 3-7). Using the geophysical logs and observations of drill cuttings from 57 boreholes, CBR constructed stratigraphic cross-sections of the MEA site showing thickness, continuity, and areal extent of stratigraphic units at the site (Ex. CBR008 at 48-62 (Figures 2.6-2 and 2.6-3a to 2.6-3n)). CBR also provided structure contour maps (depicting top elevations of stratigraphic units) and isopach maps (depicting thicknesses of stratigraphic units) based on borehole data (Ex. CBR008 at 72-80 (Figures 2.6-6 to 2.6-14)). In addition, CBR provided regional cross-sections based on its subsurface investigations at the existing Crow Butte license area and other proposed expansion areas (Ex. CBR008 at 87-90 (Figures 2.6-21 to 2.6-24)), as well as geophysical logs from oil and gas exploration wells drilled by others in the vicinity of the MEA (Ex. CBR005 at 3-16 to 3-17; Ex. CBR006 at 2-52 to 2-53; Ex. CBR013 at 60-61).

As part of its field investigation, CBR obtained core samples from seven locations at the MEA to provide information on chemical and physical properties of the overlying aquifers, upper and lower confining units, and the mineralized zone (Ex. CBR005 at 3-6 and 3-127; Ex. CBR006 at 2-42; Ex. CBR009 at PDF 64 (Table 2.6-3)). The cores were analyzed for particle size distribution and the results were used to classify the material type (i.e., sand, silt, clay) and to estimate hydraulic conductivity using the Kozeny-Carman equation (Ex. CBR005 at 3-43; Ex. CBR006 at 2-79 to 2-87; Ex. CBR015; Ex. CBR031, Ex. CBR032). CBR also measured hydraulic conductivity on two cores from the Upper and Middle Chadron Formations (upper confining layer) using the falling-head permeameter method (ASTM D5084) (Ex. CBR006 at 2-79 to 2-80). The mineralogy of core samples from the Upper and Middle Chadron Formations, Basal Chadron Sandstone aquifer, and Pierre Shale was evaluated using X-ray diffraction (Ex. CBR005 at 3-12 and 3-48; Ex. CBR006 at 2-47 to 2-52; Ex. CBR031; Ex. CBR032).

The information related to geologic setting in the MEA application covers the applicable topic areas in Section 6.3.3 of NUREG-1748 and is consistent with the guidance in Section 2.6 of NUREG-1569. In Section 2.3.3 of the SER, the Staff found the TR presented a thorough evaluation of the geologic setting, along with sufficient supporting data, and concluded that the application met the acceptance criteria in Section 2.6.3 of NUREG-1569 (Ex. NRC008 at 28-38). Specifically, the Staff found that (1) CBR's description of regional geology (stratigraphy and structural features) is consistent with independent published information (Ex. NRC008 at 28-29); (2) CBR provided comprehensive geologic data (including geophysical logs, core sample analyses, cross-sections, isopach maps, and structure contour maps) to support its discussion of stratigraphy at the MEA site (Ex. NRC008 at 29); (3) CBR adequately documented the lithologic and stratigraphic characteristics (including thickness, composition, and lateral continuity) of the geologic units at the MEA site (Ex. NRC008 at 30-33); and (4) CBR characterized local structure and adequately demonstrated, based on site-specific and regional cross-sections, that there are no significant offsets associated with the reported Pine Ridge fault near the MEA, and no direct evidence of the reported Niobrara River fault at or near the MEA (Ex. NRC008 at 33-36).

Q.10 On page 4 of the LaGarry Opinion, Dr. LaGarry states that pre-1990's mapping of geology of the area relied on a simplified "layer cake" concept that overestimated thickness and areal extent of many units by 40-60 percent. Is this statement relevant to the stratigraphic information provided in the MEA application and discussed in the Staff's review documents?

A.10 (D. Back, T. Lancaster) No. As discussed in A.9, CBR conducted extensive subsurface investigations at the MEA using standard techniques (i.e., geophysical logs, drill cuttings) to assess the stratigraphy at the site. Based on the borehole data collected during those investigations, CBR created cross-sections depicting the stratigraphy at and in the vicinity of the MEA (Ex. CBR008 at 49-62 (Figures 2.6-3a to 2.6-3n)). These cross-sections cover the entire site (Ex. CBR005 at 3-255 (Figure 3.3-2); Ex. CBR008 at 48 (Figure 2.6-2)) and demonstrate the extent and thickness of the stratigraphic units present at the site. Because the geophysical logs were obtained from boreholes at the MEA site, they represent the actual subsurface conditions at the MEA and accurately depict the thickness and areal extent of the stratigraphic units. The discussions of stratigraphy in the MEA application and the EA are based on these site-specific data and thus provide accurate information about thickness and areal extent of stratigraphic units.

INFORMATION TO ESTABLISH POTENTIAL EFFECTS ON SURFACE AND GROUNDWATER RESOURCES

Q.11 In Contention 2, the Intervenors assert that the application and Final EA fail to provide a sufficient description of the affected environment to establish potential effects of the MEA on adjacent surface and groundwater resources. As relevant to Contention 2, please describe the information on affected environment that is needed to establish potential effects on adjacent surface water and groundwater resources.

A.11 (D. Back, T. Lancaster, E. Striz) As we noted in A.3 above, the Board characterized the overarching issue in Contention 2 as whether CBR has demonstrated that ISR production fluids will not migrate offsite and contaminate adjacent surface water and groundwater (i.e., affect surface water quality or groundwater quality). Within the scope of Contention 2, the information on affected environment that is needed to establish potential effects on surface water and groundwater quality includes information on (1) the geologic setting, (2) surface water hydrology, and (3) groundwater hydrology (hydrogeology).

In A.6 above, we described the information that is needed to characterize the geologic setting. With respect to the other two aspects of the affected environment, Section 2.7 of NUREG-1569 provides guidance on information that should be used to characterize hydrology at ISR facilities (Ex. NRC010 at 2-20 to 2-26). Based on Sections 2.7.1 to 2.7.3 of NUREG-1569, information on surface water hydrology that is relevant to Contention 2 includes the location, type, size, hydrologic characteristics, and uses of surface water features on and near the ISR site, the potential for erosion and flooding at the site, and surface water quality (Ex. NRC010 at 2-20 to 2-26) Information on groundwater hydrology that is relevant to Contention 2 includes a description of local hydrostratigraphy (i.e., aquifers and aquitards), the hydraulic properties of aquifers (e.g., hydraulic conductivity and hydraulic gradients used to infer direction of flow) and aquitards (e.g., thickness, areal extent, and vertical hydraulic conductivity), and subsurface water quality (Ex. NRC010 at 2-20 to 2-26). This information is consistent with the guidance in Section 6.3.4 of NUREG-1748 on information related to surface water hydrology and groundwater hydrology that should be provided in an environmental report for a materials facility (Ex. NRC011 at 6-7 to 6-10).

Q.12 The Intervenors assert that the application and EA provide insufficient information on affected environment to establish potential effects on surface and groundwater resources at the MEA. Could you please address this claim?

A.12 (D. Back, T. Lancaster) As stated in A.11, the information required to establish potential effects on surface water and groundwater quality includes information on three aspects of the affected environment: geologic setting, surface water hydrology, and groundwater hydrology. In A.9 above we explained why the information on geologic setting provided in the EA and application was sufficient. With regard to surface water hydrology and groundwater hydrology, as discussed below, the EA contains an extensive discussion of the existing surface water and groundwater conditions for the MEA and vicinity, and provides a framework for discussing impacts to those resources, consistent with Section 3.4.5 of NUREG-1748 (Ex. NRC011 at 3-9).

Section 3.3.1 of the EA describes surface water hydrology, including the Niobrara River basin (the watershed that encompasses the MEA), major regional surface water features and their size, flow and water quality, and local surface water features at the

MEA (Ex. NRC006 at 3-18 to 3-20). Section 3.11.3 contains additional discussion of surface water characteristics (Ex. NRC006 at 3-72), and Section 4.2.2 of the EA discusses CBR's flooding and erosion studies conducted for the MEA (Ex. NRC006 at 4-6 to 4-7).

Section 3.3.2 describes groundwater hydrology, including regional hydrostratigraphy and regional groundwater flow characteristics, characteristics of local groundwater resources in the vicinity of the MEA, characteristics of the proposed production zone aquifer (Basal Chadron Sandstone), local groundwater quality, and the bases for vertical confinement of the production zone aquifer (Ex. NRC006 at 3-23 to 3-34). More specifically, Section 3.3.2.1 of the EA identifies the regional hydrostratigraphic units, including overlying aquifers, upper confining layers, the production zone (Basal Chadron Sandstone), and the lower confining layer, and describes, at the regional level, the extent, characteristics, velocity, and flow directions for the overlying aquifers and the Basal Chadron Sandstone aquifer (Ex. NRC006 at 3-23 to 3-30). Section 3.3.2.2 of the EA provides similar discussions of the overlying and production zone aquifers within the vicinity of the MEA (Ex. NRC006 at 3-30 to 3-31). Section 3.3.2.3 of the EA describes the aquifer pumping test conducted at the MEA and the hydraulic properties of the Basal Chadron Sandstone aquifer determined from the results of that test (Ex. NRC006 at 3-31). Section 3.3.2.4 of the EA describes groundwater geochemistry of the Basal Chadron Sandstone aquifer and overlying aquifers based on tests of water samples from private wells and MEA monitoring wells (Ex. NRC006 at 3-31 to 3-32). Finally, Section 3.3.2.5 discusses the bases that support the conclusion that the Basal Chadron Sandstone aquifer will be sufficiently confined from the overlying aquifers (these bases are discussed in detail in A.21 below) (Ex. NRC006 at 3-32 to 3-34).

Additional information related to groundwater hydrology is found in Section 3.3.3 of the EA, which presents information on the locations, depths, and screened intervals of private wells (Ex. NRC006 at 3-34 to 3-36), and Section 3.11.2, which provides information on baseline groundwater quality based on testing in private wells and CBR monitoring wells (Ex. NRC006 at 3-70 to 3-71).

The Staff's descriptions of the surface water and groundwater hydrology in the EA are based on descriptions and supporting data provided in Section 3.4 of the ER and corresponding Section 2.7 of the TR. As relevant to Contention 2, Section 3.4.1 of the ER (corresponding to Sections 2.2.3 and 2.2.4 of the TR) includes a description of regional and local surface water and groundwater use (Ex. CBR005 at 3-37 to 3-40; Ex. CBR006 at 2-8 to 2-11). Section 3.4.2 of the ER (corresponding to 2.7.1 of the TR) discusses surface water features (Ex. CBR005 at 3-41 to 3-42; Ex. CBR006 at 2-77 to 2-78). Section 3.4.3 of the ER (corresponding to 2.7.2 of the TR) discusses groundwater occurrence and flow direction, aquifer and aquitard properties, the regional aquifer pumping test that was used to determine hydraulic properties of the production zone aquifer and demonstrate confinement, and the hydrologic conceptual model for the MEA (Ex. CBR005 at 3-42 to 3-52; Ex. CBR006 at 2-78 to 2-89).

CBR provided extensive supporting information for its discussions of surface water hydrology and groundwater hydrology. Some of the information from CBR's subsurface geological investigations at the MEA, such as cross-sections and results of core sample analyses discussed in A.9 above, also supports the discussion of groundwater hydrology. In addition, CBR measured water levels in monitoring wells installed in the Arikaree, Brule, and Basal Chadron Sandstone aquifers to construct potentiometric surface contour maps indicating hydraulic gradients (Ex. CBR005 at 6-155 to 6-163; Ex. CBR006 at 2-115 to 2-119; Ex. CBR030; Ex. CBR008 at 105-116). CBR also collected water quality data from its monitoring wells and from private water supply wells within two kilometers of the MEA (Ex. CBR005 at 3-39; Ex. CBR006 at 2-114 to 2-115; Ex. CBR009 at 87-113, 115-141, 199-206). Finally, CBR obtained information on the connectivity within the Basal Chadron Sandstone aquifer, the hydraulic properties of that aquifer, and the confinement of that aquifer from overlying aquifers from an aquifer pumping test (Ex. CBR005 at 3-45 to 3-47; Ex. CBR006 at 2-81 to 2-84); Ex. CBR009 at 72-74). CBR provided supporting data and documentation that included geophysical logs used for cross-sections (Ex. CBR013 at 1-59), geophysical logs from oil and gas exploration wells (Ex. CBR013 at 60-61); the aquifer pumping test (Ex. CBR016), and the grain-size analysis and X-ray diffraction test results (Ex. CBR031; Ex. CBR032).

The information on surface water hydrology and groundwater hydrology in the MEA application covers the applicable topic areas in Section 6.3.4 of NUREG-1748 and is consistent with the guidance in Section 2.7 of NUREG-1569. In Section 2.4.3 of the SER, the Staff found that the application presented a thorough characterization of surface water and groundwater hydrology for the MEA, and that the information provided met the applicable acceptance criteria in Section 2.7.3 of NUREG-1569 (Ex. NRC008 at 45-57). Specifically, the Staff found that (1) CBR characterized the location, size, hydrologic characteristics and uses of surface water bodies and drainages on and near the MEA site (Ex. NRC008 at 45-46); (2) CBR assessed the potential for erosion and flooding of the site by conducting hydrologic and erosion studies that identified areas prone to flooding or high erosion risk and proposed protective design measures for such areas (Ex. NRC008 at 46-47); (3) CBR's description of hydrostratigraphy is consistent with descriptions by others (Ex. NRC008 at 48); (4) CBR provided thorough descriptions of thickness, composition, and hydraulic properties of overlying aquifers, confining units, and the Basal Chadron Sandstone aquifer based on site-specific borehole geophysical logs, water level measurements in wells, and analysis of core samples (Ex. NRC008 at

48-53); and (5) CBR performed a large-scale aquifer pumping test of the Basal Chadron Sandstone aquifer that was consistent with industry practice and sufficiently defined properties of the aquifer and demonstrated adequate confinement between the overlying Brule aquifer and the Basal Chadron Sandstone aquifer (Ex. NRC008 at 53-54); CBR provided sufficient information on water use to evaluate potential risks to users of surface water and groundwater near the MEA (Ex. NRC008 at 54-57).

Q.13 Does the LaGarry Opinion or the 2010 EPA Letter provide any support for (or relevant discussion of) the Intervenor's claim that there is insufficient information in the EA and application to establish potential effects on surface and groundwater resources at the MEA?

A.13 (D. Back, T. Lancaster) No. The LaGarry Opinion does not specifically discuss the MEA application. It also predates both the Staff's draft and final EAs for Marsland. The LaGarry Opinion contains a summary of the regional stratigraphy of northwestern Nebraska, along with general assertions about potential contamination pathways and impacts (LaGarry Opinion at 2-5). However, none of Dr. LaGarry's assertions identifies or refers to a deficiency in either the application or the EA. As we have explained in A.6 and A.9, the application and EA contain thorough discussions of geologic setting, including regional and local stratigraphy and geologic structure. We address Dr. LaGarry's assertions about potential contamination pathways in A.23 to A.29 below.

The purpose of the 2010 EPA Letter, which predates both the MEA application and the Staff's draft and final EAs for Marsland, was to provide comments to the NRC on draft SEISs for ISR projects located in Wyoming (2010 EPA Letter at 1-2). The comments in the 2010 EPA Letter related to the following topics: (1) wastewater disposal alternatives and waste management impacts, (2) air pollutants and impacts of air pollutant emissions, (3) establishment of alternate concentration limits as groundwater restoration targets, and (4) climate change and greenhouse gas emissions (2010 EPA

Letter at 2-5). None of those topics is within the scope of Contention 2. Because the 2010 EPA Letter does not discuss the MEA application or any topics relevant to Contention 2, it does not support the Intervenor's claim that the MEA application and the Staff's EA contain insufficient descriptions of the affected environment (i.e., geologic setting, surface water hydrology and groundwater hydrology) to establish potential effects on surface water and groundwater quality at the MEA.

AQUIFER PARAMETERS ABSENT FROM APPLICATION

Q.14 The Intervenors assert that the MEA technical report does not include 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." Could you please explain the terms effective porosity, hydraulic porosity, hydraulic conductivity, hydraulic gradient, transmissivity and storativity?

A.14 (D. Back, T. Lancaster, E. Striz) The term "hydraulic porosity" was not originally identified by the Intervenors. Hydraulic porosity applies to turbulent flow in porous media, which is not significant in this operational setting. The term "porosity" refers to the volume of void space (expressed as a percentage) in a given volume of a rock matrix. Effective porosity is the percentage of void space within a rock matrix that is interconnected and allows fluid to flow through it. The remaining porosity consists of isolated or unconnected pores.

Hydraulic conductivity is a measure of the ability of a porous material (in this case, an aquifer) to transmit water. Transmissivity is the product of hydraulic conductivity and aquifer thickness. Transmissivity is calculated from aquifer pumping test data, and hydraulic conductivity can then be calculated from transmissivity if the aquifer thickness is known. Storativity is the volume of water released from storage per unit change in head per unit area. Storativity is also calculated from aquifer pumping test data. Specific storage is storativity divided by aquifer thickness.

Hydraulic gradient is the slope of the potentiometric surface. It is calculated as the difference in water level elevation over a unit distance. For example, the hydraulic gradient between two wells is the difference in water level elevations in the wells divided by the distance between the wells.

Q.15 Please explain the significance of the parameters defined in A.14 for ISR facilities.

A.15 (D. Back, T. Lancaster, E. Striz) Hydraulic gradients are used to determine the magnitude and direction of groundwater flow through the aquifers and aquitards. Groundwater flow occurs along the maximum hydraulic gradient as defined by the potentiometric surface. Figure 2.9-5a in the TR (Ex. CBR008 at 112) is an example of a potentiometric surface contour map for the Brule aquifer.

Hydraulic conductivity is used, in conjunction with other parameters, to determine groundwater flow volume and velocity. For example, the product of hydraulic gradient and hydraulic conductivity is used to determine the volume of flow per unit area. Transmissivity (the product of hydraulic conductivity and aquifer thickness) and hydraulic gradient are important for the selection of ISR wellfield patterns, injection and extraction flow rates, and bleed rates needed to maintain inward hydraulic gradients. With respect to excursions, hydraulic conductivity and hydraulic gradient are relevant to maintaining an inward hydraulic gradient during operations to prevent excursions. In addition, vertical hydraulic conductivities and vertical hydraulic gradients, in conjunction with other lines of evidence, are also used to demonstrate the degree of confinement between the production zone aquifer and overlying and underlying aquifers.

Effective porosity, along with hydraulic conductivity and hydraulic gradient, can be used to calculate groundwater velocity in a simple flow setting (e.g., ambient groundwater flow). Effective porosity is also used in groundwater flow and transport modeling, which may be used to demonstrate excursion prevention and control. However, groundwater flow and transport modeling is not required in the Staff's safety review of ISRs, including the review of excursion prevention and control. The Staff's review focuses on procedures for preventing, detecting, and controlling excursions. During ISR operations and groundwater restoration, the required inward hydraulic gradient and excursion monitoring procedures (i.e., well density, sampling and testing) provide the primary assurance for control and prevention of excursions. An applicant can demonstrate its ability to comply with such requirements without providing effective porosity.

Q.16 Could you please address the Intervenor's claim that CBR failed to describe these parameters in the MEA technical report?

A.16 (D. Back, T. Lancaster) The MEA TR contains potentiometric contour maps showing the hydraulic gradients of the overlying Arikaree and Brule aquifers and the Basal Chadron Sandstone (Ex. 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, (Ex. 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 (Ex. CBR006 at 2-84 to 2-85). For the Pierre Shale, the hydraulic conductivity values are based on reported values in the literature (Ex. CBR006 at 2-85). 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 (Ex. CBR006 at 2-81 to 2-84; Ex. CBR009 at 72-74).

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 (Ex. CBR006 at 3-26). In our experience, 0.20 is a reasonable value for this type of application based on the description of the Basal Chadron Sandstone.

ADEQUACY OF MEA HYDROLOGIC CONCEPTUAL MODEL

Q.17 What is the "conceptual model of site hydrology" for an ISR facility?

A.17 (D. Back, T. Lancaster, E. Striz) A complete conceptual model of hydrology for an ISR facility consists of both the surface water hydrology and groundwater hydrology conceptual models.

A surface water hydrology conceptual model describes the presence, characteristics, and behavior of regional and local surface water features. For surface water, the conceptual model includes watersheds and drainages; surface water feature types (e.g., streams, impoundments), size, and morphology (e.g., stream cross-sections); drainage peak flow rates at storm recurrence intervals; the potential for flooding (based on Federal Emergency Management Administration (FEMA) 100-year flood hazard maps); the typical seasonal ranges for water levels of surface water features; seasonal surface water quality; and information on past, current, and anticipated surface water use.

A groundwater hydrology (or hydrogeology) conceptual model describes the presence and behavior of regional and local groundwater aquifers within the geologic setting. For groundwater, the conceptual model includes the hydrostratigraphy (depth and thickness of aquifers and aquitards); hydraulic properties of the aquifers/aquitards; aquifer potentiometric surfaces and hydraulic gradients; aquifer groundwater flow directions and magnitudes; preferential flow pathways; aquifer recharge/discharge areas; aquifer water quality; and information on past, current and anticipated groundwater use.

The above descriptions of conceptual models for surface water hydrology and groundwater hydrology are consistent with the guidance in Sections 2.7.1 to 2.7.3 of NUREG-1569 (Ex. NRC010 at 2-20 to 2-26).

Q.18 Please identify the sections of the Staff review documents that describe the conceptual model of site hydrology for the MEA.

A.18 (D. Back, T. Lancaster) Section 3.3.1 of the EA describes the Niobrara River basin, characteristics of the Niobrara River, and local surface water features at the MEA (Ex. NRC006 at 3-18). As stated in that section, there are no perennial surface water features within the MEA license area, and the Niobrara River is approximately 0.42 miles from the southernmost mine unit (Ex. NRC006 at 3-18). Section 3.11.3 provides information on local surface water characteristics (Ex. NRC006 at 3-72).

Section 3.3.2.2 through 3.3.2.5 are the primary sections in the EA that describe the groundwater hydrology conceptual model for the MEA (Ex. NRC006 at 3-30 to 3-34). As discussed in A.12 above, these sections describe the hydrostratigraphy at the site and groundwater flow characteristics in the vicinity of the MEA, characteristics of the proposed production zone aquifer (Basal Chadron Sandstone), local groundwater quality, and the bases for vertical confinement of the production zone aquifer. Section 3.3.3.2 presents information on the uses, locations, depths, and screened intervals of private water supply wells near the MEA (Ex. NRC006 at 3-35 to 3-36). In addition, Section 3.2.2.2 discusses the lack of preferential flow pathways due to faults (Ex. NRC006 at 3-11 to 3-14), and Section 5 of the EA states that all exploratory boreholes at the MEA have been plugged and abandoned (Ex. NRC006 at 5-2). Finally, Section 3.11.2 of the EA provides information on groundwater quality based on testing in private wells and CBR monitoring (Ex. NRC006 at 3-70 to 3-71). The sections of the EA described above cover all of the aspects of a complete conceptual model for the MEA (i.e., for both surface water and groundwater) described in A.17 above.

In the SER, the hydrologic conceptual model (for both surface water and groundwater) is primarily discussed in Section 2.4.3, which contains the Staff's analysis of hydrology at the MEA (Ex. NRC008 at 45-57). In addition, Sections 2.3.3.2 and 2.3.3.3 of the SER discuss geologic information related to the groundwater hydrology conceptual model, such as stratigraphic units, the existence of reported faults and plugging of exploratory boreholes (Ex. NRC008 at 29-37).

Q.19 The Intervenors assert that CBR "failed to develop an acceptable conceptual model of site hydrology adequately supported by site characterization data." In the Staff's view, is the conceptual model for the MEA adequately supported by site characterization data?

A.19 (D. Back, T. Lancaster) Yes. The MEA application contained extensive site characterization data that support the conceptual model of site hydrology. The data provided are consistent with the guidance in NUREG-1569 Sections 2.6 and 2.7 (Ex. NRC010 at 2-16 to 2-19, 2-20 to 2-26). In addition, the methods CBR used to collect and analyze these data are appropriate and widely used in developing hydrologic conceptual models, and followed standard methods and industry practices.

First, CBR stated that over 1600 boreholes have been drilled within the MEA license area (Ex. CBR006 at 3-7), and over 2100 boreholes have been drilled within the MEA area of review[1] (Ex. CBR005 at 3-6) to provide site-specific characterization of the MEA geologic setting. To support its conclusions about local stratigraphy, including the thickness and continuity of stratigraphic units at the MEA, CBR created cross-sections

[1] As noted on page 3-3 of the EA (Ex. NRC006), the area of review is the proposed MEA license area plus a 2.25 mile buffer around the license area.

that cover the entire MEA site (Ex. CBR008 at 48-62 (Figures 2.6-2 and 2.6-3a to 2.6-3n)). These cross-sections were created based on geophysical logs and observations of drill cuttings from 57 boreholes that cover the entire MEA site (Ex. CBR005 at 3-6; Ex. CBR006 at 2-42 to 2-49, Ex. CBR008 at 48 (Figure 2.6-2); Ex. CBR013 at 1-59)). CBR supplemented this information with geophysical logs from oil and gas exploration wells drilled by others in the vicinity of the MEA (Ex. CBR005 at 3-16 to 3-17; Ex. CBR006 at 2-52 to 2-53).

In addition to cross-sections, CBR created isopach maps and structure contour maps based on borehole data (Ex. CBR008 at 72-80 (Figures 2.6-6 to 2.6-14)). CBR also provided regional cross-sections, also based on geophysical logs, to evaluate the existence of reported faults (Ex. CBR006 at 2-58 to 2-59; Ex. CBR008 at 87-90 (Figures 2.6-21 to 2.6-24)), and provided well plugging records showing that wells were properly plugged and abandoned. (Ex. CBR005 at 3-48; Ex. CBR006 at 2-7, 2-10; Ex. CBR028; Ex. CBR014)

CBR provided information on chemical and physical properties of the confining units and the mineralized zone at the MEA based on drill cuttings and analysis of representative core samples taken from seven locations at the MEA site (Ex. CBR005 at 3-6 and 3-301 (Figure 3.3-5); Ex. CBR008 at 70 (Figure 2.6-4); Ex. CBR006 at 2-42). Core samples were taken from the Arikaree, Brule, Upper and Middle Chadron, Basal Chadron and Pierre Shale formations (Ex. CBR005 at 3-127 (Table 3.3-3); Ex. CBR009 at 64 (Table 2.6-3)). CBR performed grain-size analysis using ASTM D4464 to obtain information on particle size distribution, and used X-ray diffraction to obtain information on mineralogical composition (Ex. CBR005 at 3-6 to 3-16, 3-48; Ex. CBR006 at 2-43 to 2-52, 2-84; Ex. CBR031; Ex. CBR032). CBR also used the results of grain-size analysis to estimate hydraulic conductivity using the Kozeny-Carman equation, a well-established and widely used method, and conducted falling-head permeameter testing (ASTM

D5084) on undisturbed samples to measure hydraulic conductivity (Ex. CBR005 at 3-43; Ex. CBR006 at 2-79 to 2-81, 2-84 to 2-87; Ex. CBR015).

As discussed in Section 3.4.3.2 of the ER (2.7.2.2 of the TR), CBR conducted a regional aquifer pumping test to assess the hydraulic isolation of the production zone aquifer (Basal Chadron Sandstone) and to calculate hydraulic conductivity, transmissivity, and storativity within that aquifer (Ex. CBR005 at 3-45 to 3-47; Ex. CBR006 at 2-81 to 2-84). The pumping test was conducted according to a plan approved by the Nebraska Department of Environmental Quality (NDEQ) and used accepted industry testing and analysis procedures (Ex. CBR005 at 3-45; Ex. CBR006 at 2-82). CBR also used measurements of static water levels in monitoring wells in the Arikaree, Brule and Basal Chadron Sandstone aquifers to determine the groundwater flow regime from horizontal and vertical hydraulic gradients, and presented that information in potentiometric surface contour maps for each aquifer (Ex. CBR005 at 6-155 to 6-163; Ex. CBR006 at 2-115 to 2-119; Ex. CBR008 at PDF 105-116 (Figures 2.9-4a-d, 2.9-5a-d, 2.9-6a-d)).

CBR provided water quality data for the Niobrara River based on its own testing as well as testing by the NDEQ (Ex. NRC006 at 3-72; Ex. CBR006 at 2-119 to 2-123). CBR also provided groundwater quality data, based on tests of active private water supply wells within two kilometers of the MEA license boundary and CBR monitoring wells in the Arikaree, Brule and Basal Chadron Sandstone aquifers, to define groundwater geochemistry (Ex. NRC006 at 3-70 to 3-71; Ex. CBR006 at 2-113 to 2-119; Ex. CBR009 at 87-113, 115-141, 199-206 (Tables 2.9-4, 2.9-5, 2.9-7, 2.9-9 to 2.9-11, 2.9-42, 2.9-43)).

Finally, although no perennial surface water drainages were identified within MEA, CBR conducted a flooding and erosion study on MEA ephemeral drainages to determine their flooding and erosion potential and identify protective design features for areas at risk for flooding or erosion (Ex. CBR005 at 1-28 to 1-32; Ex. CBR006 at 2-78 to 2-79, 3-15 to 3-20; Ex. CBR019; Ex. CBR020).

Q.20 The Intervenors claim that the conceptual model of site hydrology "must demonstrate with scientific confidence that the area hydrogeology, including horizontal and vertical hydraulic conductivity, will result in the confinement of extraction fluids" (OST Petition at 18). Please explain what "confinement" means, and how an applicant's demonstration of confinement informs the Staff's environmental and safety reviews of an ISR facility.

A.20 (D. Back, T. Lancaster, E. Striz) Confining layers are geologic units with low hydraulic conductivity that are stratigraphically adjacent to (above or below) an aquifer. Therefore, the term "confinement" is generally understood to refer to the ability of a confining layer to restrict or prevent migration of water in a <u>vertical</u> direction (upward or downward). The term "hydraulic isolation" is sometimes used as a synonym for confinement. The concept of confinement is illustrated in Figure 3-5 of Section 3.3.2.1 of the EA, which shows upper and lower confining layers adjacent to a confined aquifer (Ex. NRC006 at 3-24). For an ISR facility, any permeable pathways in the confining layers above or below the production zone (e.g., faults, improperly abandoned boreholes or wells, or zones of higher permeability in confining layers) could affect the degree of confinement and the ability to contain vertical migration of production fluids.

An applicant's demonstration of confinement is a key aspect of the Staff's environmental and safety reviews for ISR facilities. In the environmental review, the demonstration of confinement informs the Staff's evaluation of potential impacts to surface water and groundwater resources. In the safety review, an applicant's demonstration of confinement informs the Staff's assessment of the applicant's ability to ensure that possession and use of source and byproduct material will be confined to the locations authorized in the license, as required by 10 C.F.R. § 40.41(c). Generally speaking, an applicant must provide sufficient information in the groundwater hydrology conceptual model to demonstrate confinement of the production zone aquifer.

Q.21 Please describe the bases for concluding that there is adequate confinement at the MEA.

A.21 (D. Back, T. Lancaster) In Section 3.3.2.5 of the EA, the Staff discusses several bases for its conclusion that CBR has demonstrated adequate vertical confinement of the Basal Chadron Sandstone aquifer at the MEA site (Ex. NRC006 at 3-32 to 3-34). Based on our environmental and safety reviews of the information in the MEA application and additional information cited in the EA and SER, hydraulic isolation between the Basal Chadron Sandstone aquifer and the overlying aquifers (Brule and Arikaree) is established by multiple lines of evidence based on measurable and reproducible data from the MEA site.

These lines of evidence include the following: (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. We discuss each of these in turn below.

(1) Hydrologic Characteristics of Confining Units

As discussed in Section 3.3.2.5 of the EA and Section 2.4.3.2.2 of the SER, the overlying and underlying confining units at the MEA are continuous layers over 300 feet thick with extremely low vertical hydraulic conductivities—on the order of what is used for a clay landfill liner (Ex. NRC006 at 3-32 to 3-34; Ex. NRC008 at 50-53). As described in Section 3.2.2.1 of the EA, the Upper and Middle Chadron Formations (the upper confining unit at the MEA) are primarily composed of silty clays, range in thickness from about 360 to 450 feet within the MEA (Ex. NRC006 at 3-9), and have reported hydraulic conductivities on the order of 10^{-5} cm/sec (based on estimates from grain-size distributions) to 10^{-7} cm/sec (based on falling-head permeameter tests) (Ex. NRC006 at 3-33). We also note that, although not designated as an upper confining unit, the lower Brule Formation consists almost entirely of silts and clays (Ex. NRC006 at 3-25) and thus may serve as an additional confining layer.

The lower confining unit for the Basal Chadron Sandstone aquifer is the Pierre Shale, a marine shale that is over 750 feet thick in the vicinity of the MEA (Ex. NRC006 at 3-11). The Pierre Shale is continuous over the entire MEA license area and has reported hydraulic conductivities on the order of 10^{-10} cm/sec (Ex. NRC006 at 3-11). CBR's particle size distribution results show that the Pierre Shale is predominantly clay size particles (Ex. CBR005 at 3-16; Ex. CBR006 at 2-85). CBR's X-ray diffraction test results indicate that both the overlying and underlying confining units (the Upper and Middle Chadron Formations and the Pierre Shale) contain significant percentages of clays, including swelling clays such as smectite (Ex. NRC006 at 3-9 to 3-10; Ex. CBR005 at 3-48; Ex. CBR006 at 2-84 to 2-85).

(2) Aquifer Pumping Test

As explained in Section 3.3.2.3 of the EA and Section 2.4.3.3 of the SER, CBR conducted a regional aquifer pumping test at the MEA in 2011 (Ex. NRC006 at 3-31). One of the purposes of the test was to demonstrate sufficient confinement between the Basal Chadron Sandstone aquifer (production zone) and the overlying Brule aquifer (Ex. NRC006 at 3-13 to 3-14). The aquifer pumping test was conducted in the central portion of the MEA, and it involved pumping a well screened within the Basal Chadron Sandstone aquifer and observing the responses in water levels in nine wells in the Basal Chadron Sandstone aquifer and three wells screened in the Brule aquifer (Ex. CBR005 at 3-345 (Figure 3.4-7); Ex. CBR008 at 97 (Figure 2.7-7); Ex. CBR009 at 72-74

(Tables 2.7-2 to 2.7-4)). The pumping test was designed to significantly stress the Basal Chadron Sandstone aquifer with a pumping rate of 27.08 gallons per minute applied over 103 hours (Ex. NRC006 at 3-31). During the test there was no discernible drawdown observed in the overlying Brule aquifer wells, indicating that there is adequate confinement between the Basal Chadron Sandstone aquifer and the Brule aquifer (Ex. NRC006 at 3-33).

(3) Potentiometric Surface of Basal Chadron Sandstone aquifer

As stated in Section 3.3.2.5 of the EA, the potentiometric surface of the Basal Chadron Sandstone aquifer shows that the water level rises hundreds of feet above its top (Ex. NRC006 at 3-34). This is illustrated in TR Figure 2.6-12 (showing the top of the Basal Chadron Sandstone ranging from approximately 3210 to 3290 feet above sea level) and Figures 2.9-6a through 2.9-6d (showing the potentiometric surface of the Basal Chadron Sandstone at roughly 3700 feet above sea level) (Ex. CBR008 at 78, 113-116). This situation (a potentiometric surface significantly higher than the top elevation of the aquifer) can only occur in a confined aquifer with overlying strata that are effective confining units.

(4) Differences in potentiometric surface

As stated in Section 3.3.2.5 of the EA, a comparison of the potentiometric surfaces of the Brule and Basal Chadron Sandstone aquifers provides another indication that the two aquifers are not hydraulically connected (Ex. NRC006 at 3-34). The most recent potentiometric surface maps for the Brule aquifer and the Basal Chadron Sandstone aquifer are provided in Figures 2.9-5d and 2.9-6d of the TR (Ex. CBR008 at 112, 116). These figures show that the potentiometric surfaces in the Brule aquifer (which range from 4050 feet above sea level to over 4230 feet above sea level) are several hundred feet higher than the potentiometric surfaces in wells screened in the Basal Chadron Sandstone aquifer (roughly 3700 feet above sea level). Therefore, a strong downward gradient exists at the MEA site, and any groundwater movement through the confining units would be downward from the Brule aquifer to the Basal Chadron Sandstone aquifer, rather than upward from the production zone to overlying aquifers.

(5) Differences in water quality

As discussed in Section 3.3.2.5 of the EA and Section 2.7.2.3 of the TR, CBR identified geochemical differences as support for the conclusion that the Brule and Basal Chadron Sandstone aquifers are not hydraulically connected (Ex. NRC006 at 3-32 to 3-34; Ex. CBR005 at 3-47 to 3-50; Ex. CBR006 at 2-86 to 2-87). The water quality data in ER Tables 6.1-4, 6.1-9, and 6.1-10 (TR Tables 2.9-8 through 2.9-11) show distinct differences in geochemistry (total dissolved solids and major anions and cations, such as calcium, sodium, sulfate and bicarbonate) between the Brule and Basal Chadron Sandstone aquifers that indicate hydraulic isolation (Ex. CBR005 at 6-49, 6-55, 6-59; Ex. CBR009 at 115-141).

(6) Groundwater age differences

As discussed in Section 3.3.2.1 of the EA, based on isotopic age dating performed at the existing Crow Butte facility, the Brule aquifer (250,000 to 300,000 years old) and Basal Chadron Sandstone aquifer (300,000 to 500,000 years old) have large groundwater age differences (Ex. NRC006 at 3-28). If the Basal Chadron Sandstone aquifer was not hydraulically isolated from the Brule aquifer, the relative groundwater age would be much more similar.

Q.22 Does the 2010 EPA Letter provide any support for the assertion that the hydrologic conceptual model for the MEA does not demonstrate that confinement can be achieved?

A.22 (D. Back, T. Lancaster) No. Our response in A.13 above explains that the 2010 EPA letter predates the MEA application and the Staff's final and draft EAs, and, more importantly, explains that the concerns raised in the 2010 EPA letter are unrelated to the issues within the scope of Contention 2. With respect to this question specifically, the 2010 EPA letter does not address confinement of production zone aquifers. Therefore, it provides no support for the Intervenor's assertion.

Q.23 On page 4 of his opinion, Dr. LaGarry identifies "lack of containment" due to faults as a potential contamination pathway. Did the Staff consider whether faults could affect confinement or lead to potential impacts on surface water and groundwater quality at the MEA?

A.23 (D. Back, T. Lancaster). Yes. Section 3.2.2.2 of the EA provides a thorough discussion of the existence of reported faults near the MEA and their potential impacts on confinement and surface water and groundwater quality (Ex. NRC006 at 3-11 to 3-14). Section 2.3.3.2.2 of the SER provides a similar discussion and conclusions related to safe operation of the MEA (Ex. NRC008 at 33-36).

As discussed in Section 3.2.2.2 of the EA, the literature reports two postulated faults near the MEA: the Pine Ridge fault, which is reportedly located along the northern edge of the Pine Ridge Escarpment, approximately 5 miles north of the northern MEA boundary; and the Niobrara River fault, which is reported to run along the southern margin of the MEA (Ex. NRC006 at 3-11). The EA describes the Staff's extensive independent review of available literature on these faults (including cross-sections provided in the literature), CBR's site-specific and regional cross-sections, and CBR's site-specific and regional structure contour maps (Ex. NRC006 at 3-11 to 3-14). Based on our review of this information, we concluded that there is no evidence of vertical offsets indicative of faults within the MEA (Ex. NRC006 at 3-14).

In addition, Section 3.2.2.2 of the EA discusses several reasons why, even if these faults exist, they would not lead to significant adverse environmental impacts to surface water or groundwater. As stated in the EA, the reported Pine Ridge fault is five miles from the northern boundary of the MEA (Ex. NRC006 at 3-11). Therefore, it would take at least 500 years for contaminants to reach the Pine Ridge fault, and sorption and dilution occurring over that timeframe would lead to attenuation of contaminants (Ex. NRC006 at 3-14). Furthermore, as stated in the EA, the MEA will be operated under an inward hydraulic gradient (as required by License Condition 10.1.6), which would prevent flow toward the reported Pine Ridge fault during ISR operations (Ex. NRC006 at 3-14; Ex. NRC009 at PDF 11). For the reported Niobrara River fault, the EA explains that ambient groundwater flow in the production zone aquifer is away from the reported Niobrara River fault, and the inward hydraulic gradient would maintain that flow direction (Ex. NRC006 at 3-14). Also, the strong downward gradient from the Brule to the Basal Chadron Sandstone aquifer would prevent upward migration of ISR production fluids through any preferential pathways such as faults (Ex. NRC006 at 3-14).

Based on the review discussed above, the Staff determined that there are no preferential pathways due to faulting. As required by License Condition 11.3.4, CBR will conduct aquifer pumping tests for each wellfield as part of the wellfield packages that must be submitted to the NRC for review and verification prior to beginning operations in a wellfield (Ex. NRC008 at 139-140, 142-143; Ex. NRC009 at PDF 21). As an added conservatism, License Condition 11.3.4 requires CBR to submit its plans for conducting aquifer pumping tests in the southern mine units (D-F) to the NRC for review and verification, to ensure that they are designed to identify potential fault-related flow effects (Ex. NRC008 at 139-140).

Q.24 On page 3 of the LaGarry Opinion, Dr. LaGarry presents a figure (Figure 1) depicting a geologic cross-section of "far western Nebraska," and on page 4 of his opinion, Dr. LaGarry cites papers by Diffendal (1994) and Swinehart et al. (1985). Are you familiar with Figure 1 and the papers Dr. LaGarry references?

A.24 (D. Back, T. Lancaster) Yes, we are familiar with both of those papers, and we discussed Swinehart's findings in our evaluation of faults in the EA and SER. We have also reviewed Figure 1 in the LaGarry Opinion, which appears to be a reproduction of cross-section A-A' in Figure 5 of Swinehart (Ex. NRC012 at PDF 3).

Q.25 On page 4 of the LaGarry Opinion, Dr. LaGarry asserts that Diffendal showed "that there are several potential faults in the Marsland area" and that Swinehart and others "show known faults both north and south of Marsland." He then asserts that these faults may allow mining fluids to travel upward and then laterally. Do Dr. LaGarry's statements change the Staff's view of the existence of faults at the MEA, or their potential effects on confinement or on environmental impacts to surface water and groundwater?

A.25 (D. Back, T. Lancaster) No. As discussed A.23 above, the Staff found no evidence within the MEA of faults that could act as permeable pathways between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer. The Staff independently evaluated the evidence of reported faults and CBR's interpretations of subsurface data in the EA and SER. In contrast, Dr. LaGarry relies on studies that rely on lineament analysis (Diffendal) and large-scale (regional level) cross-sections (Swinehart et al.).

The lineament analysis and large-scale, regional interpretations cited by Dr. LaGarry are not persuasive when compared with analysis of site-specific cross-sections created from extensive and thorough analysis of geophysical log data and drill cuttings (see A.9 and A.19 above). Diffendal's analysis of lineaments involved observations based on a 1:1,000,000 scale digital shaded relief map and a 1:250,000 scale USGS topographic map (Ex. NRC013 at PDF 1). A claim that a lineament represents a subsurface geologic fault, fracture, or joint is speculative until verification ("ground truthing") is performed with extensive hard data obtained in the field. The lineaments described in the Diffendal paper have not been verified to be anything more than linear alignments of ground surface features. As acknowledged by Diffendal, additional field work would be required to ascertain whether the lineaments are caused by structural features (Ex. NRC013 at PDF 1). More importantly, subsurface exploration is essential to determine not only the existence of faults, fractures, and joints, but also their extent and possible impacts on confinement. As we have explained, CBR has in fact obtained more relevant and persuasive information through its extensive site-specific subsurface exploration for the MEA site.

The Staff discussed the Swinehart paper in the Section 3.2.2.2 of the EA (Ex. NRC006 at 3-13). Swinehart's study area covers the entire panhandle of Nebraska, which comprises hundreds of square miles (Ex. NRC012 at PDF 1), and his cross-sections do not pass through the actual location of the MEA. Cross section A-A' in Swinehart's paper, which is the basis for Dr. LaGarry's Figure 1, is over 25 miles west of the MEA (Ex. NRC012 at PDF 3-4). As noted in Section 3.2.2.2 of the EA, cross-section B-B' in Swinehart's paper, which is closer to the MEA (but still 7.5 miles to the east), shows no evidence of faulting (Ex. NRC006 at 3-13). Swinehart's Figure 2 confirms that the fault he identifies near the Niobrara River has a limited areal extent and is considerably west of the MEA (Ex. NRC012 at PDF 2).

For the reasons discussed above, Dr. LaGarry's Figure 1 does not accurately represent the stratigraphy or presence of faults at the MEA site, and the references he cites do not provide evidence of faults at the MEA. In addition, in A.23 we explain why the Pine Ridge or Niobrara River faults, if they do exist, would not lead to significant adverse impacts. In particular, the strong downward gradient between the Brule and Basal Chadron Sandstone aquifers would prevent upward migration through pathways such as faults. Therefore, Dr. LaGarry's statements regarding faults do not change the Staff's view on the existence of the reported faults or their potential impacts.

Q.26 On Page 4 of the LaGarry Opinion, Dr. LaGarry also states that, based on his experience, "there are likely hundreds more [faults] too small to be shown" in a

diagram such as the figure he provided (Figure 1). Could you please address this claim?

A.26 (T. Lancaster, D. Back) We acknowledge that faults and joints exist in northwestern Nebraska, but as explained in A.23 above, there is no evidence of structural features at the MEA site that are capable of transmitting fluids from the Basal Chadron Sandstone aquifer through the upper confining layers to the overlying Brule aquifer. As discussed in detail in A.21 above, CBR has demonstrated vertical hydrologic confinement of the Basal Chadron Sandstone aquifer in the MEA through several lines of evidence. These include (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 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. This evidence refutes Dr. LaGarry's implication that unknown faults are affecting vertical confinement.

Q.27 On page 4 of the LaGarry Opinion, Dr. LaGarry identified spills and leaks at the MEA as a possible contamination pathway. Could you please respond to this?

A.27 (D. Back, T. Lancaster) In Sections 4.3.1.1 and 4.3.2.2 of the EA, the Staff concluded that impacts to surface water and groundwater from spills and leaks would be SMALL (Ex. NRC006 at 4-10 to 4-13, 4-22 to 4-23). Our position is based on the extensive operational controls, procedures, and monitoring that would be in place at the MEA to prevent and detect spills and leaks and to address and minimize impacts should they occur (Ex. NRC006 at 4-10 to 4-13, 4-22 to 4-23).

As discussed in Sections 4.3.1.1 and 4.3.2.2 of the EA, spills or leaks at the MEA that could impact surface waters or the surface aquifer include spills of barren lixiviant or wastewater and leaks from exposed or buried piping and well casing failures

(Ex. NRC006 at 4-12, 4-22 to 4-23). There are two potential pathways for spills and leaks to reach adjacent surface water or groundwater resources: (1) contaminants from a spill or leak could enter ephemeral drainages during a significant rain event, and (2) contaminants from a spill or leak could enter the surficial aquifer and migrate offsite through the aquifer.

As discussed in Section 3.3.1 of the EA, the only surface water features at the MEA that could carry surface water runoff are ephemeral drainages (Ex. NRC006 at 3-19). These drainages lack defined banks and streambeds and would only be expected to carry water during significant rain events via surface runoff (Ex. NRC006 at 3-19). And only in rain events sufficient to cause flow in the drainages would there be any chance of runoff reaching the Niobrara River. Therefore, it is unlikely that contaminants from a spill or leak would be transported outside of the MEA by surface water.

With respect to both potential pathways, as discussed in Sections 4.3.1.1 and 4.3.2.2 of the EA, CBR will employ design features, monitoring, and procedures to prevent, detect and correct any spills or leaks that might occur (Ex. NRC006 at 4-10 to 4-13, 4-21 to 4-22). CBR will implement design measures to limit sediment delivery to the Niobrara River during significant rain events (Ex. NRC006 at 4-7 to 4-8, 4-11), and will use concrete curbing, berms and other design features to control runoff, contain spills, and facilitate clean up (Ex. NRC006 at 4-12). CBR will also be subject to a Storm Water Pollution and Prevention Plan under its NPDES permit that will contain requirements for measures to contain runoff and address spill prevention and control (Ex. NRC006 at 4-8, 4-11).

In addition, CBR will maintain continuous real-time monitoring and control of flow rates and trunk line pressures, and CBR has alarms, sensors, and other instrumentation in place to monitor the status of the injection system and alert operators to leaks or spills

(Ex. NRC006 at 4-12). To reduce the likelihood of pipe breaks or ruptures, piping will be placed underground below the frost line, and all pipelines will be pressure tested at operating pressures prior to use (Ex. NRC006 at 4-12). Also, as required by License Condition 10.1.12, flow rates and pressures at the MEA will be monitored daily, and injection pressures at well heads will be limited (Ex. NRC009 at PDF 12). CBR will perform wellfield inspections to ensure proper operations and detect leaks (Ex. NRC008 at 69). Finally, CBR will implement extensive controls and procedures for investigating and responding to spills and leaks, including a Spill Prevention Control and Countermeasure (SPCC) plan (Ex. CBR005 at 4-8; Ex. NRC006 at 4-9). CBR has appropriately addressed spills that have occurred at the existing Crow Butte license area and has mitigated their impacts satisfactorily (Ex. NRC006 at 4-12).

Finally, as discussed in Section 4.3.2.2 of the EA, to minimize potential spills from well failures, CBR will be required under License Condition 10.1.4 to conduct mechanical integrity testing (MIT) of wells initially and every five years (Ex. NRC006 at 4-23; Ex. NRC009 at 10-11). In addition, any time a leak is suspected, a well will be tested for mechanical integrity. MIT ensures that all wells are constructed properly and are capable of maintaining pressure without leakage (Ex. NRC006 at 4-23). If a leak is detected during MIT, the well would be repaired and a new mechanical integrity test is performed. If the well could not be repaired or fails MIT after repair, it would be plugged and abandoned (Ex. NRC006 at 4-23). Well integrity is also subject to oversight under CBR's NDEQ Class III injection well permit (Ex. NRC006 at 4-23).

In summary, spills and leaks are not likely to cause significant environmental impacts at the MEA. This conclusion is based on surface water characteristics of the MEA site (i.e., only ephemeral drainages); design features such as curbs and berms; instrumentation and monitoring, preoperational testing, wellfield inspection program, and

MIT for wells; procedures for addressing spills and leaks; and operating experience indicating the ability to mitigate spills satisfactorily.

Q.28 On page 4 of the LaGarry Opinion, Dr. LaGarry claims that excursions from the MEA production zone into the Arikaree Group are a possible contamination pathway. Could you please respond?

A.28 (D. Back, T. Lancaster) The pathway Dr. LaGarry describes is a vertical excursion from the Basal Chadron Sandstone aquifer into the overlying Arikaree aquifer. Such events are unlikely for several reasons. First, as we explained in A.21, there are multiple bases for concluding that there is adequate vertical confinement at the MEA site. In particular, the strong downward gradient at the MEA would prevent upward migration of contaminants from the production zone to the overlying Brule and Arikaree aquifers (Ex. NRC006 at 3-34). The thick (360 to 450 feet), continuous confining layer between the Basal Chadron Sandstone aquifer and the Brule aquifer, which is composed of clays, mudstones and siltstones with very low hydraulic conductivity, would also prevent vertical excursions (Ex. NRC006 at 3-32 to 3-33). In addition, CBR has plugged and abandoned all exploratory drill holes at the MEA (Ex. NRC006 at 5-2, Ex. NRC008 at 36-37), and all wells installed at the MEA will be subject to MIT as discussed in A.27 above.

Finally, as explained in Section 2.3.1.2 of the EA, CBR will install excursion monitoring wells in the shallowest aquifer (the Arikaree) at a density of one well per four acres (Ex. NRC006 at 2-6). As required by License Condition 11.1.5, these wells would be sampled at intervals of no more than 14 days for indicators to detect vertical excursions, and if an excursion is detected, corrective actions would be implemented and the sampling frequency would be increased (Ex. NRC006 at 6-2; Ex. NRC009 at PDF 17).

As stated above, the strong downward gradient between the overlying aquifer and the Basal Chadron Sandstone aquifer at the MEA makes it extremely unlikely that a vertical excursions could occur (Ex. NRC006 at 3-34). However, in the unlikely event such an excursion did occur, CBR would address it using appropriate corrective actions, as required in License Condition 11.1.5 (Ex. NRC009 at PDF 17).

Q.29 On page 5 of the LaGarry Opinion, Dr. LaGarry asserts that lateral migration within underground aquifers at the MEA is a potential pathway for contamination. Could you please respond?

A.29 (D. Back, T. Lancaster) In Section 4.3.2.2 of the EA, the Staff discusses the potential impacts of horizontal excursions (i.e., lateral migration of ISR production fluids within the Basal Chadron Sandstone aquifer) and concludes that impacts would be SMALL (Ex. NRC006 at 4-21 to 4-22). Although such horizontal excursions are possible, their occurrence, and any impacts from them, are unlikely for several reasons. First, as explained in Section 2.3.2 of the EA, License Condition 10.1.6 requires CBR to conduct ISR operations in the MEA wellfields under an inward hydraulic gradient (Ex. NRC006 at 2-8, 4-16; Ex. NRC009 at PDF 11). The purpose of the inward gradient is to contain movement of process fluids (i.e., to prevent horizontal excursions) (Ex. NRC006 at 2-7). CBR must maintain the inward gradient throughout operations and restoration.

Second, as discussed in Section 4.3.2.2 of the EA, each wellfield will be surrounded by a ring of monitoring wells in the Basal Chadron Sandstone aquifer (Ex. NRC006 at 4-21). As required by License Condition 11.1.5, CBR will be required to monitor these wells through biweekly testing, and, if an excursion is detected and confirmed, CBR would be required to take corrective actions (e.g., adjusting wellfield extraction and injection rates to draw fluids back into the wellfield) and conduct more frequent (weekly) sampling (Ex. NRC009 at PDF 17).

As part of its review of the MEA application, the Staff reviewed the excursion monitoring history at the existing Crow Butte license area (Ex. NRC006 at 4-22; Ex. NRC008 at 71). Although CBR has identified several confirmed horizontal excursions within the Basal Chadron Sandstone aquifer at the existing Crow Butte license area, those excursions were controlled and corrected through corrective actions without impacts on surrounding surface water or groundwater (Ex. NRC006 at 4-22; Ex. NRC008 at 71).

Finally, the vertical confinement and the downward gradient between the overlying aquifers and the Basal Chadron Sandstone aquifer in the vicinity of the MEA would prevent fluids from moving up to any of the locations Dr. LaGarry identifies. As discussed in Section 3.3.2.5 of the EA, and in A.21 above, there are multiple lines of evidence demonstrating vertical confinement at the MEA, including the presence of a thick, continuous upper confining unit and the difference in potentiometric surfaces between the Basal Chadron Sandstone aquifer and the overlying aquifers (Ex. NRC006 at 3-34). In particular, the difference in potentiometric surfaces creates a strong downward gradient that will prevent upward migration of ISR production fluids from the Basal Chadron Sandstone aquifer (Ex. NRC006 at 3-34). As discussed in A.28 above, the strong downward gradient at the MEA will also prevent vertical excursions.

<u>UNSUBSTANTIATED ASSUMPTIONS ABOUT ISOLATION OF AQUIFERS</u>

Q.30 The Intervenors assert that the application and EA contained "unsubstantiated assumptions as to the isolation of the aquifers in the ore-bearing zones," citing pages 2-4 of the LaGarry Opinion as support (OST Petition at 18). How do you respond to this assertion?

A.30 (D. Back, T. Lancaster) As discussed in A.13 above, the LaGarry Opinion makes general statements that are not specific to the EA or to the MEA application, and therefore does not identify any “unsubstantiated assumptions” about isolation of aquifers in ore-bearing zones in those documents. In contrast, our testimony demonstrates that the statements related to isolation (i.e., vertical confinement) of the production zone aquifer in both the EA and application are substantiated by extensive, reliable supporting information and data. In particular:

(1) As discussed in A.9 and A.12 above, the EA and application describe the stratigraphy and hydrostratigraphy and identify the ore bearing aquifer and overlying and underlying confining layers. These descriptions are based on a review of relevant literature as well as cross-sections, isopach maps and structure contour maps constructed from site specific geophysical logs and drill cutting observations.

(2) As discussed in A.9, A.10, and A.17 above, the EA and application describe the properties of the upper and lower confining layers, including thickness, composition, continuity and areal extent. These descriptions are based on site-specific data from geophysical logs, as well as analysis of core samples for particle size distribution, hydraulic conductivity, and mineralogical properties using established methods.

(3) As discussed in A.12 above, the EA and application describe important hydraulic properties of the Basal Chadron Sandstone and the overlying Brule and Arikaree aquifers, including potentiometric surfaces and hydraulic gradients. These properties are based on potentiometric surface measurements from wells screened in the respective aquifers. The EA and application also describe hydraulic conductivity, transmissivity, and storativity for the Basal Chadron Sandstone aquifer determined from a regional aquifer pumping test.

(4) As discussed in A.21 above, the EA and application describe the multiple lines of evidence that form the basis for the conclusion that there is vertical confinement of the Basal Chadron Sandstone. These include (a) the physical properties of the confining units, including their thickness, continuity, areal extent, and low hydraulic

conductivity based on the site-specific data described in example 1 above; (b) lack of observed drawdown in overlying aquifer wells during the aquifer pumping test; (c) difference between potentiometric surface and top elevation of Basal Chadron Sandstone aquifer; (d) strong downward gradient between the Brule/Arikaree and Basal Chadron Sandstone aquifers, as shown by a significant difference (hundreds of feet) in potentiometric surfaces; (e) differences in groundwater geochemistry between the Brule and Basal Chadron Sandstone aquifers, based on water quality analyses of samples from wells; (f) differences in groundwater ages.

(5) As discussed in A.23, A.25, and A.26 above, the EA and application describe and evaluate reported faults in the vicinity of the MEA. The discussion in the EA is based on the Staff's independent evaluation of the literature review and regional and site specific cross-sections presented in the MEA application. The Staff concluded there is no evidence of vertical offsets indicative of faults at the MEA. The EA also explains why faults would not affect hydraulic isolation even if they are present.

(6) As discussed in A.28 above, the EA and application describe the evidence for adequate confinement at the MEA, particularly the strong downward gradient and thick, low-permeability upper confining layer, that make vertical excursions extremely unlikely. The EA and application also discuss the operating conditions (e.g., requirements for MIT of wells and monitoring) that will minimize the occurrence of vertical excursions.

CONCLUSION

Q.31 Does this conclude your testimony?

A.31 (D. Back, T. Lancaster, E. Striz, J. Trefethen) Yes.

August 10, 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. 13-926-01-MLA-BD01
(Marsland Expansion Project)	)	

AFFIDAVIT OF DAVID BACK

I, David Back, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC002 (Statement of Professional Qualifications of David Back) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)
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Executed in Falls Church, VA
this 10th day of August, 2018

August 10, 2018

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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(Marsland Expansion Project)	)	

AFFIDAVIT OF THOMAS LANCASTER

I, Thomas Lancaster, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC003 (Statement of Professional Qualifications of Thomas Lancaster) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

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August 10, 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. 13-926-01-MLA-BD01
(Marsland Expansion Project)	)	

AFFIDAVIT OF ELISE STRIZ

I, Elise Striz, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC004 (Statement of Professional Qualifications of Elise Striz) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

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August 10, 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. 13-926-01-MLA-BD01
(Marsland Expansion Project)	)	

AFFIDAVIT OF JEAN TREFETHEN

I, Jean Trefethen, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC005 (Statement of Professional Qualifications of Jean Trefethen) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

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