November 23, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket No. 40-8943
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal)	)	

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

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TABLE OF CONTENTS

Page

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I. INTRODUCTION

1.1 This Initial Decision pertains to Crow Butte Resources' License Renewal Application ("LRA") (Exh. CBR-011) filed on November 27, 2007. The Crow Butte facility is a uranium in situ recovery ("ISR") facility subject to safety requirements found in 10 C.F.R. Part 40. The LRA consists of a combined technical and environmental report. This renewal request is the second renewal request for this license. The initial license was issued in 1989 for a 6-year time period, and a 1995 renewal application was approved in 1998 for a 10-year time period.

1.2 This Initial Decision resolves all of the admitted contentions in this proceeding: Contentions A, C, D, F, 1, 6, 9, 12, and 14.

1.3 After considering all of the evidence and arguments presented for Contentions A, C, D, 1, 6, 9, 12, and 14, we conclude that the NRC Staff's Final Environmental Assessment ("EA"),[1] as supplemented by the evidence and testimony introduced at the evidentiary hearing and by our findings of fact and conclusions of law herein, is adequate. The NRC Staff reasonably considered the potential impacts of renewing Crow Butte's license for an additional 10-year period. The NRC Staff has taken the requisite "hard look" at the potential

[1] The EA is Exh. NRC-010.

impacts of license renewal. The environmental record satisfies the requirements of the National Environmental Policy Act ("NEPA") and 10 C.F.R. Part 51. Contentions A, C, D, 1, 6, 9, 12, and 14 are resolved in favor of the NRC Staff and Crow Butte.

1.4 After considering all of the evidence and arguments presented for Contention F, we conclude that Crow Butte has provided sufficient information on the site's geologic and hydrogeologic setting to satisfy the requirements of 10 C.F.R. Part 40. No issues of material significance have been identified in this proceeding. Contention F is resolved in favor of Crow Butte.

II. PROCEDURAL HISTORY

2.1 A notice of opportunity to request a hearing was published in the *Federal Register* with a deadline for filing petitions of July 28, 2008.[2] Three timely petitions to intervene were filed by: (1) the Oglala Sioux Tribe ("OST");[3] (2) Beatrice Long Visitor Holy Dance, Joe American Horse, Sr., Debra White Plume, Loretta Afraid of Bear Cook, Thomas K. Cook, Dayton O. Hyde, Bruce McIntosh, Afraid of Bear/Cook Tiwahe, American Horse Tiospaye, Owe Aku/Bring Back the Way, and Western Nebraska Resources Council ("Consolidated Intervenors" or "CI");[4] and (3) the Oglala Delegation of the Great Sioux Nation Treaty Council ("Treaty Council").[5] OST submitted five proposed contentions; the Consolidated Intervenors

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[2] *See* "Notice of Opportunity for Hearing, Crow Butte Resources, Inc., Crawford, NE, In Situ Leach Recovery Facility, and Order Imposing Procedures for Access to Sensitive Unclassified Non-Safeguards Information (SUNSI) for Contention Preparation," 73 Fed. Reg. 30426 (May 28, 2008).

[3] "Request for Hearing and/or Petition to Intervene," dated July 28, 2008.

[4] "Consolidated Request for Hearing and Petition for Leave to Intervene," dated July 28, 2008 ("Consolidated Petition").

[5] "Request for Hearing and Petition for Leave to Intervene," dated July 28, 2008.

submitted twenty-three proposed contentions; and the Treaty Council submitted six proposed contentions.

2.2 The Licensing Board issued its decision on standing and contentions on November 21, 2008. The Board found that OST had standing and admitted all five proposed contentions (Environmental Contentions A through E). The Board granted standing to Consolidated Intervenors and admitted four contentions (or parts of contentions) (Environmental Contention E, Technical Contention F, and Miscellaneous Contentions G and K). The Board denied the petition of the Treaty Council. On December 10, 2008, the Board admitted a late-filed contention filed by Consolidated Intervenors.

2.3 In CLI-09-09, dated May 18, 2009, the Commission reversed the Board's decision admitting the OST's Contentions EC-B (cultural resources) and EC-E (waste removal) and Consolidated Petitioners' Contentions EC-E (economic value of environmental benefits), MC-K (foreign ownership), and SC-A (Arsenic). The Commission also granted a motion for summary disposition on MC-G (concealment of foreign ownership). The Commission affirmed admission of the four remaining contentions (Contentions A, C, D, and F).

2.4 In December 2012, the NRC Staff issued its Safety Evaluation Report ("SER") on the license renewal application. The SER documented the safety aspects of the NRC Staff's review of the LRA, as amended, and included an assessment of Crow Butte's compliance with applicable 10 C.F.R. Part 40 requirements, including Appendix A. The NRC Staff subsequently revised and reissued the SER in August 2014 to revise several license conditions and the discussion of them in the SER (Exh. NRC-009).

2.5 The SER concludes that the LRA complies with the standards and requirements of the Atomic Energy Act and the Commission's regulations. Based on its review,

as documented in this SER, the NRC Staff found that Crow Butte is qualified by reason of training and experience to use source material for the purpose it requested; and that Crow Butte's proposed equipment and procedures for use at its Crow Butte facility are adequate to protect public health and minimize danger to life or property. In accordance with 10 C.F.R. § 40.32(d), the NRC Staff found that license renewal will not be inimical to the common defense and security or to the health and safety of the public. The intervenors did not file any new or amended contentions based on either version of the SER.

2.6 The NRC Staff completed its environmental review and issued the final EA on October 27, 2014. The NRC Staff concluded that the impacts from the proposed action would be small for all environmental resource areas. In addition, the NRC Staff concluded that there would be no disproportionately high and adverse impacts to minority and low-income populations during the license renewal period. Based on its review of the proposed action relative to the requirements set in 10 C.F.R. Part 51, the NRC Staff determined that license renewal will not significantly affect the quality of the human environment. Based on that assessment, the NRC concluded that preparation of an Environmental Impact Statement ("EIS") was not necessary and issued a Finding of No Significant Impact ("FONSI"). The NRC subsequently issued the renewed license on November 5, 2014 (Exh. NRC-012)

2.7 In their filings, dated January 5, 2015, CI and OST proposed 14 new "joint" contentions, and OST proposed one additional contention, purportedly based on the EA/FONSI. In LBP-15-11, dated March 16, 2015, the Board admitted several new contentions, including Contention 1 (cultural resources), Contentions 6 and 9 relating to restoration, Contention 12, and Contention 14. The Board also incorporated parts of other contentions into the previously admitted contentions.

2.8 Following preparation and submittal of written direct and rebuttal testimony by the parties' witnesses, the Board held an evidentiary hearing on contested in Crawford, Nebraska, from August 24-28, 2015. Subsequent to that evidentiary hearing, the parties filed supplemental direct and rebuttal testimony on six topics raised during the August evidentiary hearing. The Board conducted a supplementary evidentiary hearing on October 23, 2015.

III. LEGAL STANDARDS

A. National Environmental Policy Act

3.1 Contentions A, C, D, 1, 6, 9, 12, and 14 arise 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.[6]

3.2 Under NEPA, the NRC is required to take a "hard look" at the environmental impacts of a proposed action.[7] 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.[8]

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6 42 U.S.C. § 4332(2)(C).

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

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

3.3 Agencies are permitted to use "bounding analyses" to ensure that the range of impacts and alternatives are taken into account in an EIS.[9] NEPA also does not require a fully developed plan to mitigate all environmental harm before an agency can act.[10] Instead, NEPA requires only that mitigation be discussed in sufficient detail to ensure that environmental consequences have been fully evaluated.[11]

3.4 Finally, NEPA also gives agencies broad discretion to keep their inquiries within appropriate and manageable boundaries.[12] NEPA does not demand that every impact be precisely evaluated, nor does it require perfection of detail.[13] As the Commission explained, NEPA "does not call for certainty or precision, but an estimate of anticipated (not unduly speculative) impacts."[14] When faced with uncertainty, NEPA only requires "reasonable forecasting."[15] 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."[16]

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9 *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.

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

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

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

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

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

15 *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

3.5 For this reason, licensing boards do not sit to "flyspeck" the EA or to add details or nuances.[17] If the EA on its face "comes to grips with all important considerations" nothing more need be done.[18]

B. Atomic Energy Act

3.6 Technical contentions raise issues regarding compliance with the Atomic Energy Act ("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.

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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).

16 *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 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").

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

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

3.7 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 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.[19]

C. National Historic Preservation Act

3.8 A portion of Contention 1 involves consultation under Section 106 of the National Historic Preservation Act ("NHPA"). Under Section 106, an agency must consider the effects that granting a license will have on any property that is listed in, or eligible to be listed in, the National Register of Historic Places.

3.9 To help implement this mandate, the NHPA established the Advisory Council on Historic Preservation ("ACHP"). The ACHP is charged with enforcing Section 106 and issuing implementing regulations.[20]

3.10 Under the ACHP's implementing regulations, an agency must make a "reasonable and good faith effort" to identify properties eligible for inclusion on the NRHP. A "reasonable and good faith effort" at identifying properties may involve approaches such as background research, sample field investigations, or field surveys.[21] The agency need not,

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19 *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).

20 The NHPA's implementing regulations are at 36 C.F.R. Part 800.

21 36 C.F.R. § 800.4(b)(1).

however, identify every historic property within a project's area of potential effects. Nor does the agency need to conduct on-the-ground surveys of this entire area. In addition, the agency does not need to conduct investigations outside the area of potential effects. Once the agency has identified properties potentially eligible for the NRHP, it assesses whether there will be adverse effects to these properties and attempts to resolve any adverse effects.[22]

3.11 Agencies must ensure that a tribe has "a reasonable opportunity to identify its concerns about historic properties, advise on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, articulate its views on the undertaking's effects on such properties, and participate in the resolution of adverse effects."[23]

3.12 The NHPA also requires that federal agencies "consult with any Indian tribe . . . that attaches religious and cultural significance" to the sites.[24] Consultation must provide the tribe "a reasonable opportunity to identify its concerns about historic properties, advise on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, articulate its views on the undertaking's effects on such properties, and participate in the resolution of adverse effects."[25] The NHPA further requires that consultation with Indian tribes "recognize the government-to-government relationship between the Federal Government and Indian tribes."[26]

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22 36 C.F.R. §§ 800.4, 800.5.

23 36 C.F.R. § 800.2(c)(2)(ii)(A).

24 16 U.S.C. § 470a(d)(6)(B).

25 36 C.F.R. § 800.2(c)(2)(ii)(A).

26 36 C.F.R. § 800.2(c)(2)(ii)(C).

3.13 An agency may choose to coordinate its NHPA review with any NEPA review the agency is conducting. However, an agency may also decide to issue separate NEPA and NHPA documents. Under guidance published jointly by the ACHP and the Council on Environmental Quality ("CEQ"), this approach is permissible as long as the agency finalizes its NHPA review before issuing its Record of Decision for the proposed action.

D. Burden of Proof

3.14 An applicant generally has the burden of proof in a licensing proceeding.[27] However, in cases involving NEPA contentions, the burden belongs to the NRC Staff because it has the ultimate responsibility for complying with NEPA.[28] Nevertheless, because the Staff, as a practical matter, relies heavily upon the applicant's LRA 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."[29]

3.15 The showing necessary to meet the burden of proof is the "preponderance of the evidence" standard.[30] NRC administrative proceedings have generally relied upon the preponderance standard in reaching the ultimate conclusions after a hearing to resolve the

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27 10 C.F.R. § 2.325.

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

29 *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).

30 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."

issue.[31] 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, NEPA, and the NHPA.

E. Record of Decision

3.16 Adjudicatory findings on NEPA issues, including those in this decision, become part of the environmental "record of decision" and effectively supplement the EA.[32] Accordingly, to the extent that the EA does not address an issue or does not adequately address a topic, the information presented in the hearing can be relied upon to satisfy the NRC's NEPA obligation.[33]

3.17 In NRC licensing proceedings, the ultimate NEPA judgments regarding a facility can be made on the basis of the entire record before a presiding officer, such that the EA "can be deemed to be amended pro tanto."[34] Therefore, the Board may consider the full record before it, including the testimony and exhibits at the hearing, to conclude that "the aggregate is

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31 *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. 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).

32 *Louisiana Energy Servs., L.P.* (Nat'l Enrichment Facility), CLI-06-15, 63 NRC 687, 707 n. 91 (2006).

33 *Louisiana Energy Servs., L.P.* (Nat'l Enrichment Facility), LBP-06-08, 63 NRC 241, 285-286 (2006); *see also Hydro Resources, Inc.* (P.O. Box 15910, Rio Rancho, NM 87174), CLI-01-04, 53 NRC 31, 53 (2001) ("[I]n an adjudicatory hearing, to the extent that any environmental findings by the Presiding Officer (or the Commission) differ from those in the FEIS, the FEIS is deemed modified by the decision.").

34 *Louisiana Energy Servs., L.P.* (Nat'l Enrichment Facility), LBP-05-13, 61 NRC 385, 404 (2005).

sufficient to satisfy the agency's obligation under NEPA" to take a "hard look" at the environmental consequences of issuing the renewed license.[35]

IV. FINDINGS OF FACT

A. Contention A

1. Background

4.1 Contention A asserts that "[t]here is no evidence based science for [the NRC Staff's] conclusion that ISL mining has 'no non radiological health impacts,' or that non radiological impacts for possible excursions or spills are 'small.'" OST claims, based on a 1989 letter to the NRC and a statement by Dr. Hannan LaGarry, that the mined aquifer used by Crow Butte "likely" communicates with aquifers that supply water to the Pine Ridge Indian Reservation and that mining fluid could migrate into the aquifer that supplies drinking water. In effect, the contention challenges Crow Butte's conclusion that there is adequate confinement of the uranium-bearing aquifer, the Basal Chadron Sandstone.

4.2 In addition, OST argues that there is no scientific basis for excluding uranium from the monitor well testing and that bi-weekly testing of monitoring wells is insufficient to identify potential contamination.

2. Communication Among Aquifers

4.3 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. The intervenors witnesses, in contrast, argue that there may be a hydraulic

[35] *LES*, LBP-06-08, 63 NRC at 286.

connection between the mined aquifer and the Brule aquifer through fractures, faults, or other preferential flow paths.

4.4 As an initial matter, there is no dispute among the parties regarding the adequacy of the lower confining unit, the Pierre Shale. Dr. LaGarry, the intervenors witness, agreed with Crow Butte and the NRC Staff that the integrity of the Pierre Shale has not been contested in this proceeding and is therefore not a contested issue. Tr. at 1028. Testimony at the hearing therefore centered around the adequacy of the upper confining unit at the site, which separates the mined aquifer from the next overlying aquifer (*i.e.*, the upper portion of the Brule Formation).

a. Borehole Logs

4.5 Crow Butte witnesses testified regarding the results of more than 10,000 borehole logs at the site. Tr. at 1049. Upper confinement consists of the middle and upper Chadron Formation and Orella Member of the lower Brule Formation. The middle and upper Chadron Formation is generally composed of impermeable clay grading upward into several hundred feet of siltstones and claystones of the Brule Formation. Exh. CBR-001 at 14.

4.6 According to Crow Butte witnesses, the middle and upper Chadron Formation represents a distinct and rapid facies change from the underlying Basal Chadron Sandstone (the mined unit). The lowest portions of the middle Chadron Formation are predominantly red or green clay, which grade upward to generally light green-gray bentonitic claystone. The middle and upper Chadron Formation claystones are laterally continuous and distinctive claystone marker beds that have been observed in all borings at the Crow Butte site. Exh. CBR-001 at 14.

4.7 Table 2.6-2 of the LRA (Exh. CBR-011) shows that the upper confining unit (upper Chadron Formation) contains significant percentages of montmorillonite clay and other clays and/or calcite. Particle size distribution analyses of samples collected within these confining units indicate mostly silt and clay-sized fractions, which are consistent with observations from pervasive geophysical logging that noted very thick sequences of predominantly fine-grained materials. These two observations indicate that the upper confinement is significantly less permeable than the ore zone and, given its substantial thickness, is essentially impermeable, absent preferential flow paths (*e.g.*, fractures). Exh. CBR-001 at 15.

4.8 We find that borehole data confirms that the middle and upper Chadron Formation and the Orella Member of the lower Brule Formation are laterally extensive. We further find that the upper confining units consist of particles of a type that are expected to act as a confining layer, so long as they are not penetrated by faults, fractures, or other preferential flow paths.

b. Consolidation Testing

4.9 Another line of evidence centers around consolidation testing of cores taken from the upper confining unit. The vertical hydraulic conductivity of the overlying confining layer, as determined from the laboratory tests of core samples, was about 7.8 x 10^{-7} ft/day (2.8 x 10^{-10} cm/sec). Exh. CBR-001 at 15. The laboratory testing was performed using ASTM standard consolidation testing. Tr. at 1293. Confining layers with vertical hydraulic conductivities this low are sometimes called aquicludes (rather than aquitards).[36]

[36] The term "aquiclude" is used to describe strata that are very nearly impermeable and capable of transmitting only minor amounts of fluid either vertically or horizontally. Typical values for vertical and horizontal hydraulic conductivity of aquicludes are in the range of 10^{-7} to 10^{-10} cm/sec. Exh. CBR-001 at 15. As a point of reference, materials

4.10 We find that vertical hydraulic conductivity is sufficiently low to establish the adequacy of the upper confining layer, so long as it is laterally continuous and not penetrated by faults, fractures, or other preferential flow paths.

c. Aquifer Pump Tests

4.11 Crow Butte and the NRC Staff relied, at least in part, on the results of the four aquifer pumping tests performed at the site to show the absence of faults, fractures, or other hydraulic connections between the mined aquifer and the Brule aquifer.[37] Aquifer pump 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. The four pump tests were discussed at length during the evidentiary hearing.

4.12 We note initially that the license renewal application is not the time to revisit past assessments of aquifer pumping tests that were not challenged in prior proceedings. Absent new information, those assessments may not be challenged in a license renewal proceeding where Crow Butte is not proposing any new or different activities than those previously authorized under the license. License renewal simply is not an opportunity to challenge the adequacy of evaluations and assessments that took place, in some cases, more than

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with conductivity less than 10^{-6} cm/sec are commonly used as liners in landfills and hazardous waste repositories to protect groundwater from contamination. *Id*.

37 Dr. Kreamer complained that information regarding the aquifer pumping tests performed at the North Trend Expansion Area was "not available for review." Tr. at 1262. This concern is misplaced. First, the tests to which he refers involved a different site (the North Trend site) and not the area being considering this proceeding. Second, information on the North Trend Expansion Area pump test results was presented in this proceeding and discussed during the hearing. *See, e.g.*, Exh. CBR-013; Tr. at 1257-63.

30 years ago.[38] Nevertheless, the Board solicited testimony on these topics to ensure that NRC Staff took a hard look at the potential environmental impacts. We conclude that they did.

4.13 The Nebraska Department of Environmental Quality ("NDEQ") authorized Crow Butte to operate in Underground Injection Control ("URIC") Permit Number NE 0122611 (Exh. CBR-017) at the current license area. The permit required aquifer pumping tests to demonstrate the integrity of the confining layer above the mining zone prior to mine development. Crow Butte performed four groundwater pumping tests between 1982 and 2002 in order to comply with the requirements of the URIC permit.[39]

4.14 Crow Butte and the NRC Staff relied on the aquifer test report results as part of the basis for demonstrating adequate confinement. As discussed and confirmed by the Crow Butte and NRC Staff witnesses, all four pump tests conclude that that there is no hydraulic connection between the Brule and the Basal Chadron Sandstone.

4.15 Results from Test #1 (Exh. BRD-002A) imply that the aquicludes over- and under-lying the Basal Chadron Sandstone probably yielded some small amount of water as recharge (or leakage) to the aquifer during the pump test.[40] Exh. CBR-067 at 9. However, Crow Butte witnesses testified that examination of the time-drawdown responses indicate the observed aquifer response is indicative of a fully confined aquifer (*e.g.*, time drawdown responses fit the

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[38] We also note that the Intervenors did not challenge the assessment of the aquifer pumping tests that was used in the Safety Evaluation Report (Exh. NRC-009).

[39] Crow Butte has performed additional aquifer tests within the region, but no additional tests have been conducted at the license renewal area.

[40] This conclusion was implied from the results of the "leaky confined aquifer" analysis that was performed at the NRC Staff's request. Other analyses, including the two-stage Theis aquifer curve matching method, concluded that leakage was not evident and that the deviation from the ideal confined aquifer drawdown curve in late time was due to changes in local transmissivity. Crow Butte witnesses concurred with the conclusion that leakage was not evident. Exh. CBR-074 at 13; Tr. at 2533-34.

Theis confined aquifer type curves very well, as does the two-state Theis aquifer type curve matching method). *Id*.

4.16 In any case, the amount of this recharge or leakage calculated by the authors was extremely small, equivalent to 947 gallons spread out over 50,268,240 square feet (1154 acres) over a period of nearly 51 hours, or 0.00001884 gallons/square foot. *Id*. These extremely small leakage rates are consistent with a fully confined aquifer response. *Id*.

4.17 According to the test results, the time needed for a water molecule to travel through a thickness of the aquiclude is calculated as the hydraulic resistance times the effective porosity. Authors of the aquifer test report calculate that it would take more than 12,000 years for water to move through a 15-foot thick section of the Red Clay. *Id*. The time for water to move through the entire Upper Confining Unit would be much longer.

4.18 During Test #2 (Exh. BRD-002BR), the overlying confining layer piezometer showed no response to the pumping from the Basal Chadron Sandstone during the aquifer test. Exh. CBR-067 at 9. The overlying aquifer monitor well also showed no response to the pumping from the Basal Chadron Sandstone during the aquifer test. *Id* at 9-10. The authors of the aquifer test report estimate it would take more than 2.8 million years for a molecule of water to move through the Upper Confining Unit. *Id*. at 10.

4.19 Aquifer Test #3 report (Exh. BRD-002C) concludes that there is integrity of the Upper Confining Unit above the mining zone without evidence of confining layer leakage, confirming the integrity of the confining layer between the Chadron Sandstone and the Brule Formation. *Id*.

4.20 Aquifer Test #4 report (Exh. CBR-012) concludes that there is integrity of the Upper Confining Unit above the mining zone and that the Chadron Sandstone exhibits a

hydrologic response consistent with a relatively homogeneous and isotropic aquifer within the southern portion of the permit area, without evidence of confining layer leakage. Exh. CBR-067 at 10.

4.21 In his supplemental testimony (Exh. INT-079 at 2), Dr. Kreamer states that the barometric response of Basal Chadron Sandstone wells during Aquifer Test #1 and #2 indicate vertical groundwater communication. Mr. Wireman abandoned his testimony on the significance of barometric pressure changes in water level data at the hearing. Tr. at 1320-21.

4.22 We find that the small changes in water level observed in the Brule aquifer and the Basal Chadron Sandstone aquifer in response to barometric fluctuations are expected and are consistent with the response of a fully confined aquifer (Basal Chadron Sandstone) and a shallow unconfined aquifer (Brule Aquifer). *See* Exh. CBR-074 at 10. There is no correlation or conclusion that can be drawn to suggest potential leakage between aquifers based on the observed barometric pressure fluctuations and small water level fluctuations.

4.23 In addition, if small changes in shallow water levels due to barometric pressure changes caused similar water level changes in the Basal Chadron Sandstone aquifer, as Dr. Kreamer implies, significant drawdown in shallow water levels would have been observed as a result of lowering water levels in the Basal Chadron Sandstone during aquifer testing. Drawdown in shallow Brule monitoring wells has never been observed during aquifer tests in the license renewal area. Exh. CBR-074 at 11.

4.24 Dr. Kreamer, in attempting to discredit the conclusions in Test #1 (Exh. BRD-002A), relied on early-time drawdown data to draw his conclusions regarding potential aquifer leakage. Exh. INT-079 at 3-4. However, as the NRC Staff and Crow Butte both point out (Exh. CBR-074 at 11; Exh. NRC-103 at 16-17), relying upon early time drawdown data is

inconsistent with aquifer testing guidance, which concludes that the use of late-time drawdown data is superior for analytical curve-matching purposes. Exh. CBR-074 at 11; Exh. NRC-103 at 16-17.

4.25 Early-time drawdown data are negatively influenced by a number of factors not related to the aquifer response to pumping, which greatly limits the use of early-time data for estimating aquifer behavior. As stated by Kruseman and de Ridder at page 64 (Exh. CBR-081):

> In applying the Theis curve-fitting method, and consequently all curve-fitting methods, one should, in general, give less weight to the early data because they may not closely represent the theoretical drawdown equation on which the type curve is based. Among other things, the theoretical equations are based 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 the pressure head.

4.26 Another factor that negatively influences early-time drawdown data, and not accounted for in Dr. Kreamer's analysis, is wellbore storage in both pumping and observation wells. Exh. CBR-074 at 11-12; Exh. NRC-103 at 25 (citing Exh. NRC-111). In wells of large diameter or deep wells with large water column height, the amount of water stored within the wellbore (casing and gravel pack) can be substantial. This water must be removed from the wellbore before the aquifer can respond properly to the induced drawdown. As a result of wellbore storage in both pumping and observation wells, early measured drawdown is less than what would should theoretically be observed using analytical type-curve matching techniques. This can give the false impression of aquifer leakage. Exh. CBR-074 at 12.

4.27 In the case of the production aquifer at Crow Butte, production wells are unusually deep and have an unusually large water column height, which in turn results in a

relatively large wellbore storage volume.[41] In the case of Aquifer Test #1, the volume of water in wellbore storage is greater than 500 gallons. Exh. CBR-074 at 12. At a pumping rate of 23.8 gpm, it would take more than 21 minutes to purge a single casing volume from the pumped well.[42] *Id*.

4.28 Dr. Kreamer also states the calculations used by the aquifer report authors to estimate the rate of leakage are inappropriate, but he does not provide an independent estimate for the rate of leakage, despite having the necessary information to do so. As Crow Butte witnesses testified (Exh. CBR-067 at ¶26), the rates of leakage are clearly so low as to be considered negligible and within the range expected for a fully confined aquifer. We agree.

4.29 Dr. Kreamer correctly points out that there was considerable variation in aquifer thickness across the Aquifer Test #1 area. Exh. INT-079 at 8. And, the witnesses agreed that variations in aquifer thickness can cause deviations from the theoretical type-curve used to determine aquifer parameters. Mr. Lewis testified that this is the reason why the authors of the aquifer test report also elected to use a two-stage Theis type-curve analysis. Exh. CBR-074 at 13; Tr. at 2533-34.

4.30 As directly related to Aquifer Test #1 analyses, Crow Butte witnesses testified that variation in aquifer thickness can give the false impression of leakage or recharge

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41 The wellbore volume was based on "the size of the casing, which is 4-1/2 inches, not 2 inches," and "over 500-foot head." Tr. at 2539. The conclusion that there is a relatively large wellbore storage volume applies for all four of the aquifer tests, as a high water column height in a deep well yields a relatively large storage volume.

42 An example of the effect of wellbore storage, among other factors, on early-time drawdown at observation wells is shown on Figure 2-15 of Kruseman and de Ridder (Exh. CBR-081 at 52). The deviation of the early time drawdown data on Figure 2-15 shows close resemblance to early time data used by Dr. Kreamer in his "Exhibit 3" to supposedly illustrate confining unit "leakage" in observation well COW-3 during Aquifer Test #2.

on the type-curve (*e.g.*, flattening of time-drawdown curve as a result of a local increase in thickness or transmissivity). Exh. CBR-074 at 13. The authors of the Aquifer Test #1 Report (Exh. BRD-002A) note a 30-50% variation in aquifer thickness over the test area and an observed 53% increase in aquifer transmissivity using late time data compared to early time data (see page 2.7A(13) of the Aquifer Test #1 Report). The increasing transmissivity in late time is reflected as a "flattening" of the time-drawdown curve relative to early time, giving the false impression of aquifer leakage or recharge boundary. Exh. CBR-074 at 13.

4.31 Dr. Kreamer states that "the clearest demonstration of a recharge boundary" for Aquifer Test 2 is shown in Figure 2.7-14 on page 2.7(40) on a semi-logarithmic Cooper Jacob plot of the time drawdown of the piezometric surface of COW-3 during the second pumping test. Exh. INT-079 at 7. According to Dr. Kreamer, "[t]he figure has been miss-drawn to consider only the late time data." *Id*. For the reasons discussed above and in Kruseman and de Ridder, Dr. Kreamer's use of the early-time drawdown data is inappropriate.

4.32 We find that there is no evidence of aquifer leakage or recharge boundaries in time-drawdown data or type-curve matches in the Aquifer Test #1 or Aquifer Test #2 reports.[43]

4.33 In addition, the Cooper-Jacob straight-line method is an approximation of the more rigorous Theis curve-matching method. Exh. CBR-074 at 14. It is not the preferred method for drawing conclusions concerning aquifer properties or boundary conditions. In particular, the Cooper-Jacob method is considered invalid during early time and at moderate distances from the pumping well. In Aquifer Test #2, observation wells were located 61-101 feet from the pumped well in Aquifer Test #2. *Id*. At these distances, data is presumptively valid

[43] Dr. Kreamer did not claim that Aquifer Test #3 or #4 suggested leakage or the presence of recharge boundaries.

only at times greater than about 37 minutes. *Id*. In other words, early time data less than 37 minutes should be considered discarded in the Cooper-Jacob analysis (as correctly applied by the authors of the Aquifer Test #2 report). Because Dr. Kreamer states there is "a distinct breakpoint at about 30 minutes" representing a "recharge boundary", and because he uses the early time data less than 37 minutes to "redraw" the Cooper-Jacob curve fit (Exh. INT-079 at 7), his analysis and conclusions regarding potential aquifer leakage during Aquifer Test #2 are not supported by the record in this proceeding.

4.34 We note that, as pointed out by Mr. Beins, the entire operating history of the site effectively acts as a very long duration pumping test. Tr. at 2560. Contrary to statements by Dr. Kraemer (Tr. at 1902), there is no quasi-steady state across the site, as the system's overall consumptive use changes over time and location as new mine units are brought online and others are restored. And, as discussed further below, there is no evidence of long-term drawdown in the Brule aquifer that would suggest a hydraulic connection. The fact that no observable drawdown associated with operations has been observed in the shallow aquifer monitoring wells over the history of facility provides additional support for our finding that there is adequate confinement between the production zone and the overlying shallow aquifer.

4.35 Overall, we find that the results from the four aquifer pump tests, along with long-term operation of the site, demonstrate that there is no hydraulic connection between the Brule and Basal Chadron Sandstone. The pump tests also demonstrate proper plugging and abandonment of all exploration, development, and pilot test holes drilled on the site that could act as a secondary conduit between aquifers.

4.36 Moreover, any "leakage", if it existed, would result from the downward movement of water from the shallow aquifer to the production aquifer. Upward leakage of

groundwater (and mining solution) is not possible under the observed natural and induced downward vertical hydraulic gradients in the mine area. Exh. CBR-001 at 16. We therefore find that mining fluids would not migrate upward into the shallow aquifer during Crow Butte's operations even if a hydraulic connection were found to exist.

d. Water Quality Sampling

4.37 Crow Butte and NRC Staff witnesses also discussed the results of groundwater quality sampling as a basis for confinement. According to those witnesses, the geochemical groundwater characteristics of the Brule Formation and Basal Chadron Sandstone further indicate that the two aquifers are not hydrologically connected. *See, e.g.*, Exh. CBR-001 at 16. The Intervenors' witnesses did not address this basis directly.

4.38 Radium levels in the Brule Formation groundwater samples collected within the license area have mean concentrations of 0.7 picocuries per liter (pCi/L), while the mean concentration of samples collected from the Basal Chadron Sandstone is 53 pCi/L. *Id*., citing Exh. CBR-011 at Table 2.9-5 and Exh. CBR-014 at Table 4.4-13, "Aquifer Water Quality Summary" (pg. 4.4(62)). Significant differences also exist for sodium, chloride, sulfate, conductance, and uranium.[44] If there were a hydraulic connection between the Basal Chadron Sandstone and the Brule Formation, witnesses testified that they would expect to see higher chloride, sodium and sulfate levels that are characteristic of Basal Chadron Sandstone water quality.

[44] *See* LRA at Table 2.9-5 (Exh. CBR-011) and Ferret of Nebraska, *Application and Supporting Environmental Report for State of Nebraska Underground Injection Control Program Commercial Permit*, dated November 1987 at Table 4.4-13, "Aquifer Water Quality Summary" (pg. 4.4(62)) (Exh. CBR-014).

4.39 We agree with Crow Butte and the NRC Staff that water quality differences are a strong indication of hydraulic isolation. We therefore find that water quality sampling provides additional support for the conclusion that there is adequate confinement.

e. Water Level Sampling

4.40 Water levels were discussed at length during the evidentiary hearing. According to Crow Butte and NRC Staff witnesses, water level data also support hydrologic isolation of the Basal Chadron Sandstone with respect to the other water-bearing intervals of interest at Crow Butte. Mr. Wireman, for his part, claimed that there was insufficient information for him to draw conclusions regarding the effects of mining on the Brule aquifer water levels, though he also noted that he was "not prepared to say" that Basal Chadron was not confined. Tr. at 1142.

4.41 We note as an initial matter that there is a substantial body of water level data for the Crow Butte site, including pre-application data, pre-mining data, during mining data, and data during restoration. All of this detailed data was available to the intervenors and their witnesses.

4.42 LRA Tables 2.7-5 and 2.7-6 (Exh. CBR-011), as well as Figures 2.7-3d and 2.7-4d, show that the potentiometric surface of the Basal Chadron has historically ranged between approximately 3690-3750 above mean sea level, while the Brule generally varies between approximately 3830-3970 feet above mean sea level. The large differences in hydraulic head (generally in excess of 100 feet) provide an additional line of evidence of hydraulic confinement because, if significant hydrologic communication was present, the hydraulic heads of the two aquifers would be expected to be much closer in elevation. Exh. CBR-001 at 16; Tr. at 291.

4.43 Long-term water level data collected during operations also support confinement. Crow Butte currently maintains in excess of 200 shallow monitoring wells in the Brule formation (approximately one well every four acres). Exh. CBR-001 at 36; Exh. CBR-074 at 5. Water level data is collected every two weeks for each of these wells for the entire time that the mine unit containing the monitoring well is in operation. Exh. CBR-074 at 5. Data is collected before mining, during mining, and during restoration. As a result, there is a lengthy history of water level data for each of these wells and therefore for the entire mining area for the time that the mine has been in operation. *See, e.g.*, Exhs. CBR-063 to CBR-065 (water level data) and CBR-066 (locations of shallow monitoring well water level data).

4.44 According to the evidence presented at the hearing by Crow Butte and the NRC Staff, there is no indication that water levels in the Brule aquifer have been lowered due to mining activities in the Basal Chadron Sandstone or inadequate confinement. There has been no sustained downward trend in water levels or correlation to mine activities within the underlying Basal Chadron Sandstone that would suggest mining is having an effect on Brule water levels.

4.45 The Intervenors' witness, Dr. Kreamer, at the hearing complained that "no data" was presented for the pre-1999 period during the evidentiary hearing. Exh. INT-079 at 10. As Crow Butte explained, the site did not begin operations until 1991, so there is no data for the period from 1983 until then. Exh. CBR-074 at 6.

4.46 Crow Butte provided two exhibits during the hearing (Exhs. CBR-063 and CBR-064) that show long-term water level trends (1999-present) for two shallow (Brule) monitoring wells, SM7-17 and SM7-22.[45] Data is collected every two weeks. Neither exhibit

[45] Crow Butte filed revised versions of the exhibits (Exhs. CBR-063R and CBR-064R) with this supplemental testimony. The revised exhibits fill in the short data gap that existed in the prior version of each exhibit.

shows a long-term decline in water levels that would suggest an impact from Crow Butte's mining operations. Instead, the relatively narrow band of water levels (+/- several feet) suggest changes due to seasonal and annual weather patterns in the area, not Crow Butte's operations.

4.47 And, in Exh. CBR-065, Crow Butte presented data for ten monitoring wells from across the length of the site. The data in Exh. CBR-065 for SM1-2 and SM4-9 starts in 1994. Crow Butte explained that the hydrographs for SM1-2 start in 1994 as that is the limit of Crow Butte's electronic data, and earlier dates require retrieval of archived reports and then data entry into electronic format (>300 individual water level measurements would need to be individually retrieved and tabulated just for SM1-2). Data for other monitoring wells was provided for the entirety of the time that those well were in use. Exh. CBR-074 at 6.

4.48 With respect to Dr. Kreamer's claim that Crow Butte has selectively ignored water level changes that may have occurred during early mine operations, we note that the first mine unit, MU-1, was the smallest of the mine units. As subsequent, larger units were commissioned (with more pumping wells), there would be a change in the drawdown in the Basal Chadron Sandstone within that mine unit (*i.e.*, perturbation towards a "new" steady-state and a shift in the centroid of pumping). If there were a hydraulic connection with the Brule, you would expect to see changes in Brule water levels for shallow monitoring wells located within that new mine unit once that mine unit began operations.

4.49 However, as Exh. CBR-065 shows, there are no long-term declines in water levels in shallow monitoring wells for newly-commissioned mine units that would suggest an impact on Brule water levels as a result of Crow Butte's mining operations in the Basal Chadron Sandstone.

4.50 Mr. Wireman also repeatedly claims that there has been a 40-foot decline in Brule water levels from 1982 based, at least in part, on the elevation at Well #11 in Figure 2.7-3a. Tr. at 1798. As Crow Butte witnesses explained at the evidentiary hearing (Tr. at 1983-1895), the Well #11 data in Figure 2.7-3a contains a transcription error. *See* Exh. BRD-008A. Based on the information in Table 2.7-5 of the LRA (Exh. CBR-011 at 2-194), water levels for Well #11 throughout 1982 were in the low 3830s, not the 3880s. Tr. at 1893-94.

4.51 We agree with Crow Butte that the data on Well #11 in the contour map reflects a typographical error — based primarily on contemporaneous data collected and presented in Table 2.7-5 of the LRA (Exh. CBR-011 at 2-194). The data does not suggest a 40-foot decline in Brule water levels.

4.52 At the hearing, there also was discussion comparing water levels in the pre-mining period to the 2008 time period based on contour maps in the LRA Figures 2.7-3 a-d (Exh. CBR-011 at 2-172 to 2-179). Those contour maps were prepared primarily to show groundwater flow direction across the mine site. Tr. at 2439. The pre-mining contour maps also were based on a limited data set from regional private wells, some of which have limited information regarding the depth of the well and the screened interval — both factors that can affect the water level measurements. Exh. CBR-067 at 6; Tr. at 1795.

4.53 For example, deeper screened private wells can have heads that are significantly different than heads measured in shallow wells. Exh. CBR-067 at 6. For this reason, differences in water levels derived from contour maps should not be misinterpreted to represent actual or significant changes in head over time — especially when compared with contemporaneous and more precise water level measurements taken from shallow wells screened in consistent locations.

4.54 Crow Butte's and the NRC Staff's conclusion that water levels in the Brule have not been affected by mining activities is based on monitoring well water level data — detailed both in terms of the number of wells and the frequency of data collection — collected for the duration of mine activities. Crow Butte's monitoring well water level data, which is collected every two weeks and is the most reliable data, enables an "apples to apples" comparison of water levels at a particular point over time.

4.55 Dr. Kraemer claims (Tr. at 1458) that Squaw Creek Reservoir has reduced in size from 1993 to 2010, inferring that this is the result of drawdown from mining. In addition to there being no documentary evidence of this in the record of this proceeding, there is no evidence to suggest that the declining reservoir levels have any relationship to mining activities.[46] We therefore assign no weight to Dr. Kraemer's opinion on this point.

4.56 We find that the Intervenors' witnesses' reliance on contour maps comparing Brule water levels in the early 1980s to elevations in the 2000s is misplaced. The use of contour lines based on a very limited dataset to evaluate the potential influences of pumping is no substitute for the use of detailed biweekly water level data obtained during operations of each mine unit. We find that the evidence and testimony presented by Crow Butte and the NRC Staff is more comprehensive and reliable than that presented by Intervenors and allows for a more direct assessment of water levels impacts from operations.

4.57 We find that there is no indication that water levels in the Brule aquifer have been lowered due to mining activities in the Basal Chadron Sandstone or inadequate confinement. As an aquifer that recharges, in part, through the direct infiltration of precipitation

[46] And, as Crow Butte witnesses testified (Tr. at 2471-73), recharge of surface water features can be heavily influenced by perched groundwater zones, which have little correlation to fluctuations in the underlying water table surface and likely show significantly delayed responses from precipitation.

at the mine site, the Brule aquifer is subject to seasonal water levels changes, as well as changes due to drought or periods of wet weather. There is no sustained downward trend in water levels or correlation to mine activities within the underlying Basal Chadron Sandstone that would suggest mining is having an effect on Brule aquifer water levels.

3. Faults or Fractures

4.58 A large portion of the intervenors' testimony focused on the potential for there to be faults and fractures that act as a preferential pathway for mining fluid at the site. Although we concluded above that there is no hydraulic connection between the mined aquifer and the Brule aquifer at the site, we nevertheless considered the testimony on the potential for contamination of the White River or Pine Ridge drinking water supplies through faults and fractures. For the reasons below, we conclude that there is no evidence of faulting, fracturing, or other preferential flow paths at the Crow Butte site.

a. Deposit Type

4.59 The Intervenors first claim, based on the "Petersen Letter" (Exh. INT-009 at 2) that uranium mineralization in the Crow Butte area is directly and primarily controlled by near-vertical faults cutting through the area. The letter claims not only that faults exist, but also that they control mineralization and that the uranium mined by Crow Butte occurs within the faults themselves. The supposed concern is that mining could open these faults, providing a passageway for aquifer impacts from uranium laden solvents.

4.60 Crow Butte witnesses testified (Exh. CBR-045 at 9-11) that the deposit at the site is a classic roll-front deposit, as verified by detailed drilling, cutting observations, and geophysical surveys. *See, e.g.*, CBR-059 (roll-front cross section example). Crow Butte

concludes that there is no evidence to support the contention that the ore is present within inferred faults or fractures within the current licensing area.

4.61 The NRC witnessed agreed, based on a comprehensive analysis of over 2,000 uranium exploration bore holes and mineralogical analyses of the sediments. Exh. NRC-030 at 280-281.

4.62 At the hearing, Dr. LaGarry acknowledged that, within the license area itself, he had "no data and no evidence" to claim that uranium mineralization occurred in faults, rather than in roll-front deposits. Tr. at 1066.

4.63 We find that the uranium deposits at the site exist as roll-front deposits and not as mineralized fractures.

b. Transport Through Faults/Fractures

4.64 Dr. LaGarry did not allege a direct connection between the Basal Chadron Sandstone and drinking water aquifers at the reservation. Instead, he posited a series of hydraulic connections such that "water could migrate through Chamberlain Pass, through a fault, through Chamberlain Pass, through a fault, through Chamberlain Pass, through a fault, through Chamberlain Pass to the reservation." Tr. at 1220-21. However, at the supplemental hearing, Dr. LaGarry acknowledged that "lateral migration of contaminated water from the license area somehow around, or over, or through the Chadron Arch onto the reservation is extremely unlikely." Tr. at 2582.

4.65 Additionally, the parties agreed that the White River Group (including the Chamberlain Pass, Chadron, and Brule formations) has been entirely removed by erosion between the current license area and the Pine Ridge Reservation, as evidenced by the mapping of extensive Pierre Shale bedrock outcrops between the two locations. Tr. at 1220 (Dr. LaGarry),

2577 (Mr. Spurlin) and 2578 (Dr. LaGarry). This is compelling evidence that the now-withdrawn suggestion by Dr. LaGarry of a tortuous groundwater pathway through a repetitive series of disjointed, but interconnected occurrences of Chamberlain Pass Formation and inferred faults is implausible.

4.66 Dr. LaGarry now states only that he is primarily concerned with contamination of White River alluvium that could be flushed along the river to the reservation. Tr. at 2583. Nevertheless, we address the potential for a connection via faults and fractures for completeness.

4.67 Dr. Striz testified that the Basal Chadron Sandstone does not subcrop into the White River alluvium downgradient of Crow Butte. Tr. at 1226. Dr. LaGarry did not disagree. Tr. at 1076-77.

4.68 We find that there is no direct hydraulic connection between the alluvium and the mined aquifer. The only plausible pathway (absent a leak or a spill) would be through a fault, fracture, or other preferential flow that connected the mined aquifer with the White River alluvium. There is no evidence of such a pathway.

4.69 As we found above, the aquifer pump tests do not indicate any faulting or fracturing that affects the confinement of the Basal Chadron Sandstone or that would affect in-situ mining (*see* Exh. CBR-011 at Section 2.7).

4.70 Crow Butte also testified that it has plugged all exploration and development holes to prevent co-mingling of Brule and Chadron aquifers and to isolate the mineralized zone. Ex. CBR-001 at 35. Crow Butte testified that all of the boreholes at the site were developed pursuant to NDEQ requirements and also abandoned as required by NDEQ. Tr. at 1236. Crow Butte testified that practice was carried out during initial licensing (*i.e.*, in 1982-

83) and subsequently. Tr. at 1237-38. This was confirmed by the aquifer pump tests. Tr. at 1238. No evidence was presented to the contrary. We therefore find that exploration and development holes do not provide a preferential pathway for communication between the Basal Chadron and the Brule aquifers.

4.71 Crow Butte recognizes the potential for small faults and fractures to occur in the sediments overlying the mined aquifer (*i.e.*, the Brule formation). Exh. CBR-001 at 56. Hypothetically speaking, the presence of a fault or joint does not necessarily mean there is a hydraulic connection created. Faults and joints may be barriers to groundwater flow, or neutral (*i.e.*, do not significantly affect groundwater flow), depending on the degree of offset and character of the material that fills the fault/joint.

4.72 As we found above, no boundary conditions were encountered during aquifer testing that would indicate the existence of faulting or fractures that transmit fluids at the Crow Butte site. Exh. CBR-001 at 18.

4.73 Crow Butte witnesses acknowledge that there may be limited areas of secondary permeability within isolated areas of the Brule Formation. However, they state that these features typically only develop in materials having a significant silt and sand percentage (*e.g.*, siltstones and sandstones), not the claystones that are common in the upper and lower confining units, which have very low permeability and higher plasticity. Exh. CBR-001 at 21.

4.74 Moreover, the sediments overlying the mined aquifer have not undergone complete lithification (the process by which sediments are converted into rock), as observed in cores and drill cuttings during drilling investigations. Exh. CBR-001 at 21. Some sediments also tend to swell rapidly (*i.e.*, higher expansivity) when exposed to water, as evidenced by bridging of borings due to swelling clays. *Id.* Therefore, any minor faults or fractures that did

appear would likely close up quickly (*i.e.*, be essentially self-sealing) as a result of lithostatic pressure (*i.e.*, overburden pressure) from the weight of overlying materials. *Id*.; *see also* Tr. at 1134-35 (Mr. Beins discussing field observations of swelling); Tr. at 1103 (LaGarry acknowledging swelling of clays).

4.75 In addition, the vertical hydraulic gradient in the permit area is strongly downward. Contrary to claims by Mr. Wireman (Exh. INT-083 at 2), this is a positive attribute — not a negative one — because it eliminates the potential for groundwater to flow upward from the production aquifer and into the shallow aquifer during mining and restoration. *See* Exh. CBR-001 at 18 (explaining that, in part due the strongly downward vertical hydraulic gradient in the permit area, mining development at the site is very unlikely to impact the shallow aquifer). There is therefore no potential for groundwater to flow upward from the production aquifer and into the shallow aquifer within the current license area during mining and restoration, even if there were a preferential flow path.

4.76 Dr. LaGarry in his opinions submitted in this proceeding observed that that Chadron Creek went dry in 2007 and infers that this is the result of a preferential flow pathway into underlying aquifers through secondary porosity (fracture porosity). Exh. INT-013 at 3. Dr. LaGarry extrapolates the inference to assert that similar flow pathways may be present between the Basal Chadron Sandstone and overlying aquifers and the White River. *Id*.

4.77 We find that extending Dr. LaGarry's application of his observations at Chadron Creek to the Crow Butte site is not supported by the evidence. Chadron Creek is more than 15 miles from the Crow Butte site. And, the studies cited by Dr. LaGarry — Exhs. CBR-023 and CBR-022 — are conference abstracts that do not provide evidence of a connection between the portion of the Basal Chadron Sandstone mined by Crow Butte and the White River.

On the face of the abstracts, the authors acknowledge that additional research is needed to understand the interaction between groundwater, joints, and faults, as well as the potential influence of evapotranspiration and alluvial infiltration within Chadron Creek. *See, e.g.*, Exhs. CBR-023 and CBR-022.

4.78 We find that, while groundwater flow along faults and joints is a possibility, the research and observations cited by Dr. LaGarry and Mr. Wireman lack a nexus to the Crow Butte site.

c. Lineaments

4.79 Dr. LaGarry cited the existence of regional lineaments to support his claim that faults or fractures are present at the Crow Butte site. Exh. INT-043 at 2-4. But, statistical analyses performed by Balmat (Exh. INT-056) indicate only that mapped faults and lineaments identified by remote sensing techniques are closer than random points. Field observations of 25 lineament locations failed to identify a single fault, and, as reported by Balmat and Leite (2008) (*see* abstract on page 32 of Exh. CBR-023), only one lineament in follow-up studies has been confirmed as a fault.

4.80 Crow Butte and the NRC Staff testified that, while faults and joints may exist at a regional level, there is no evidence of the existence of faults or fractures at the site that affect confinement or transmit mining fluids. *See, e.g.*, Exh. CBR-001 at 28-29.

4.81 Crow Butte witnesses did not discount the possibility that some lineaments within the Balmat study area represent faults, fractures, or joints, but they testified that Dr. LaGarry's contention that all or most lineaments identified by remote sensing in the area of question represent faults identifiable on the ground is not supported by the evidence. Moreover,

as even Dr. LaGarry notes (Exh. INT-043 at 2-3), lineaments identified from aerial sources cannot be confirmed as being faults or joints without field confirmation.

4.82 At Crow Butte, site-specific investigations have not revealed the presence of faults or joints. Exh. CBR-045 at 15.

4.83 We note that Dr. LaGarry's opinions are based largely on field observations from across the region. Much of his opinion concerning faulting and fractures stems from observing outcrop data that is above the water table and that has been exposed to chemical and mechanical weathering. Tr. at 1103, 2568, 2574-75, and 2580. Fracture and joint observations in weathered outcrops generally are not representative of secondary porosity (and associated hydraulic apertures) in the subsurface. Further, Dr. LaGarry does not provide subsurface information to support his opinion. And, as Mr. Wireman noted during the hearing (Tr. at 1097), aquifer pump testing is a "far superior" method of evaluating hydraulic conditions of the formations underlying the site than reviewing outcrop data. We discount the relevance of outcrop data as a result.

4.84 Crow Butte also testified that, if there were any significant changes in hydrogeological conditions (*e.g.*, newly formed fractures or faults), Crow Butte would detect the change in well-field operations, water levels, and environmental monitoring data. Exh. CBR-001 at 56. No such conditions have been observed by Crow Butte during operations. *Id*. We find the absence of any observed impacts to provide additional support for the absence of faults or fractures affecting confinement at the site.

d. White River Structural Feature

4.85 There was one feature located approximately two miles from the Crow Butte site discussed at the hearing — the White River Structural Feature. Crow Butte

investigated the potential for the White River Structural Feature to be a contaminant pathway as part of the license renewal review. Crow Butte concluded that the feature, which at depth offsets the Pierre Shale, is manifested at shallower depths as a northeast trending, subsurface fold within the formations of interest near the license areas. Exh. CBR-001 at 23.

4.86 Crow Butte witnesses testified that the White River Structural Feature is not acting as a discharge location for groundwater in the Basal Chadron Sandstone, as evidenced by contoured groundwater levels and artesian conditions, which indicate a consistent flow direction and consistently confined aquifer conditions across the structure. Exh. CBR-001 at 23; ARCADIS, *Petition for Aquifer Exemption – North Trend Expansion Area* at Figure 22 (Exh. CBR-013). Witnesses stated that the increased gradient in the vicinity of the structure is likely the result of reduced transmissivity due to structural thinning of the Basal Chadron Sandstone along the fold limb. Exh. CBR-001 at 23.

4.87 Crow Butte witnesses also pointed to 3D modeling of the structural feature. The 3D modeling conducted by Crow Butte across the White River fold structure utilized the elevations of the top and bottom contacts for the production zone based on the geophysical signatures at more than 70 borehole locations that are spatially distributed within the footprint of the fold structure. Exh. CBR-001 at 24. The 3D analysis permits a sophisticated evaluation of the spatial distribution and lateral correlation of marker horizons between borehole locations. Based on the 3D modeling and the very tight clustering of borehole locations across the fold structure at the North Trend Expansion Area, the witnesses conclude that a linear offset feature (*i.e.*, a fault) is not present within the White River Structural Feature at stratigraphic horizons above the Pierre Shale. Exh. CBR-045 at 9.

4.88 The NRC Staff agreed, noting in its EA (Exh. NRC-010 at 27, 38-39) that the White River Structural Feature does not include an offset of the geologic contact between the Pierre Shale and the Chadron Formation, nor members of the Chadron or Brule formations. The NRC concluded that the feature does not affect hydraulic confinement of the Basal Chadron Sandstone aquifer. *Id*.; *see also* Exh. NRC-001 at 36-39

4.89 Crow Butte's witnesses also testified that, even assuming hypothetically that a fault across the Chadron Formation were present at this location, the observed consistent northwest dip of the production zone unit within the fold structure would require that little to no fault offset be present based on the distribution of marker horizons. Exh. CBR-045 at 9.

4.90 At the evidentiary hearing (Tr. at 1172-73), Mr. Wireman withdrew the portion of his testimony (Exh. INT-070 at 1) that asserted that Crow Butte should conduct drilling near the feature. Mr. Wireman acknowledged that Crow Butte had in fact conducted a drilling campaign to assess the White River Structural Feature. Dr. LaGarry had no testimony specifically related to the interpretation of the drilling campaign or interpretations of the White River Structural Feature advanced by Crow Butte and the NRC Staff. Tr. at 1173-74, 1184. The totality of the intervenors' testimony on the White River Structure Feature therefore suggests only that some unspecified "more" must be done. This is not enough to prevail in this proceeding, particularly in light of the detailed investigations performed by Crow Butte.

4.91 Crow Butte witnesses noted that groundwater levels in the Chadron Formation wells at the North Trend site also are different than water levels in wells in the Brule Formation. Exh. CBR-001 at 26. If there were a conduit or hydraulic connection, similar hydraulic head levels would be observed in all wells. The fact that there is a significant

difference in head further supports the conclusion that the White River Structural Feature does not convey water between the Chadron Formation and the Brule Formation.

4.92 An additional line of evidence supporting the low likelihood of groundwater impacts reaching the White River Structural Feature pertains to the observed hydraulic gradients in the Basal Chadron Sandstone within the license area. Exh. CBR-001 at 25. Historic water level measurements from 1982-1983 and from 2008-2009 for wells within the license area, indicate groundwater flow in the northernmost portion of the area is directed toward the southeast, away from the White River Structural Feature. *Id*. Groundwater flow across the central and southern portion of the license area is directed to the northeast, parallel with the White River Structural Feature. Based on hydraulic gradients observed during the period of record, Crow Butte witnesses testified that groundwater within the mining zone exiting the license area would not encounter the White River Structural Feature under natural flow conditions in the near vicinity of the license area.

4.93 We note here that the NRC Staff, as described in its EA and SER, conducted some modeling to investigate the potential for the White River Structural Feature to transmit fluids. During the course of the hearing, the NRC Staff informed the Board and the parties that, due to the modeler leaving the agency, it is unable to support the results of modeling exercise. Exh. NRC-095 at 20-21. As a result, we give the discussion of modeling the EA and SER no weight in evaluating the White River Structural Feature.

4.94 Instead, we rely on the detailed site investigation of the White River Structural Feature and 3D modeling evidence presented by Crow Butte, in conjunction with the other lines of evidence discussed above, the distance to the White River Structural Feature from the Crow Butte site, and the absence of any affirmative evidence presented by the Intervenors to

suggest that the White River Structural Feature in fact conveys mining fluids from the Basal Chadron Sandstone to the Brule aquifer or the White River alluvium. Our decision today therefore effectively amends the EA and SER by eliminating reliance on the NRC Staff modeling of the White River Structural Feature.

4.95 We find that Dr. LaGarry's opinions regarding the existence of faults or fractures at the Crow Butte site are based on reconnaissance level information from the region. There is no site-specific evidence in the record to support the existence of faults or fractures at the Crow Butte site. We also find that, even if small faults or joints do in fact exist, they are neutral and do not affect groundwater flow at the site. This finding includes the White River Structural Feature.

4.96 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 correlated borehole logs (lithologic and geophysical), laboratory tests of confining zone cores, water quality data, water level data, aquifer pump tests, and operating experience. 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 Crow Butte site. The significant age of the fold structure (>34 million years) also provides compelling evidence that any secondary porosity developed during folding has since been sealed (*i.e.*, does not transmit water) by natural subsurface processes (*e.g.*, mineralization or compaction) in the lengthy intervening period of geologic time.

4. Uranium as Testing Parameter

4.97 Mr. Wireman argued that Crow Butte should include uranium as part of its regular sampling program of monitoring wells at the site, claiming that the existence of uranium would be a better, or at least additional, indicator of mining fluid than the parameters currently considered. Exh. INT-070 at 2; Tr. at 1603-04.

4.98 According to Crow Butte witnesses, the parameters and constituents chosen for indicators of lixiviant migration and for which limits are set are chloride, conductivity, and total alkalinity. Exh. CBR-001 at 37. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). *Id*., citing Exh. CBR-011 at 5-123. Chloride is also a highly mobile constituent in the groundwater and increased concentrations will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. *Id*. Total alkalinity concentrations also should be affected during an excursion, as bicarbonate is the major constituent added to the lixiviant during mining. *Id*.

4.99 Crow Butte and the NRC Staff witnesses both agree that uranium is not a good excursion indicator because, although it is mobilized during mining, it may be retarded by reducing conditions in the aquifer — that is, the rate of uranium transport in the aquifer could be slowed by adsorption and precipitation, which would render it a poor leading indicator of an excursion. Exh. CBR-001 at 38-39. Mr. Lewis calculated that, under the conditions encountered at Crow Butte, the total distance uranium could be expected to travel would be 0.5 to 15% of the distance traveled by a conservative parameter such as chloride. WorleyParsons, "Response to NDEQ Excursion Monitoring Issues," dated August 26, 2010, at 3 (Exh. CBR-020).

4.100 The NRC Staff witnesses noted that it does not require monitoring of uranium at other ISR facilities, nor is uranium suggested as an excursion parameter in NUREG-1569. Tr. at 1604-05.

4.101 For the reasons articulated by Crow Butte and the NRC Staff, we find that uranium is not as effective a tool for providing a timely alert regarding a lixiviant excursion from an ISR facility as the other parameters used by Crow Butte.

4.102 Although not discussed at length during the evidentiary hearing, the parties addressed the frequency of testing in their written presentations. According to Mr. Lewis, the horizontal flow rates at the edges of the mining area are relatively slow. Based on groundwater modeling of the site, the movement of fluids at the edges of the operating wellfields typically ranges from 5-15 feet per month. *See* WorleyParsons Report at 3 (concluding that, based on a conservative maximum groundwater velocity, indicator parameters would move less than 14 feet beyond the monitor well ring once detected) (Exh. CBR-020). This means that there is more than ample time with biweekly testing to detect a potential excursion and take corrective action prior to there being any movement of mining fluids beyond the permit area.

4.103 In fact, prior to detecting an "excursion," Crow Butte witnesses noted that they commonly see an increase in indicator parameter concentration in monitor ring wells. Exh. CBR-001 at 39. This serves as early warning. Crow Butte is then able to take preemptive corrective actions to further reduce the rate of groundwater movement and reverse the flow direction back toward the wellfield. In addition, once a potential excursion is identified, the sampling frequency is increased to weekly. The sampling may also be augmented to include uranium. Tr. at 1638.

4.104 Overall, we find that there is no evidence that Crow Butte's choice of parameters or frequency of testing is inadequate to detect any excursions.

B. Contention C

1. Background

4.105 Contention C asserts that "[the NRC Staff's] characterization that the impact of surface waters from an accident is 'minimal since there are no nearby surface water features,' does not accurately address the potential for environmental harm to the White River." OST claims that, because the White River runs through the Pine Ridge Reservation, there is the potential for contamination of the White River from surface spills and subsurface migration. They argue that Crow Butte ignores the White River as a potential surface water that is affected in the event of an accident and claim that the White River alluvium should be evaluated for contamination.

2. Waterbodies

4.106 Two waterbodies are present within the Crow Butte mine site: English Creek and Squaw Creek. Both creeks drain to the White River north of the site. Although the Intervenors also claim that Sawlog Creek could be impacted by Crow Butte's operations (Tr. at 1031), the creek is not present within the mined area of the site and is not discussed further. Neither is West Ash Creek. Tr. at 1824.

4.107 Crow Butte performed preoperational water quality sampling and conducts quarterly sampling of Squaw and English Creeks both upstream (background) and downstream of the mine site. Exh. CBR-001 at 45-46. This data does not indicate impacts from Crow Butte's operations on water quality in either water body. Crow Butte also takes quarterly water quality samples of impoundments located within the permit boundary, as well as annual sediment

samples. *Id*. These data also do not indicate impacts from Crow Butte's operations. All of these data are provided in semi-annual effluent monitoring reports that are submitted to the NRC. *See, e.g.*, Section 3.3 and Appendix H of 2013 *Semiannual Radiological Effluent and Environmental Monitoring Report for the Crow Butte Uranium Project* (ADAMS Accession No. ML14071A019) (Exh. CBR-018).

4.108 Crow Butte does not conduct water quality sampling in the White River, which is located some distance from the mine site. NDEQ, however, does conduct sampling of the White River. No data was presented by the Intervenors' witnesses (or other witnesses) to demonstrate that there have been impacts to the White River associated with Crow Butte's operations. Exh. CBR-001 at 46.

3. Leaks and Spills

a. Underground Leaks and Spills

4.109 Spills can take two forms within an in situ recovery 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.

4.110 Crow Butte witnesses testified that Crow Butte has plugged all exploration and development holes to prevent co-mingling of Brule and Chadron aquifers and to isolate the mineralized zone. Exh. CBR-001 at 35. In addition, prior to placing a well in service, a well mechanical integrity test ("MIT") is performed. Wells are re-tested every five years. *Id*. at 35-

36. This requirement ensures that all wells are constructed properly and are capable of maintaining pressure without leakage.

4.111 We find that Crow Butte's methods for developing, testing, and abandoning boreholes is appropriate and minimizes the risk of underground leaks.

4.112 Crow Butte's operations also present the possibility of movement of mining fluids beyond the operating wellfield — either horizontally within the Basal Chadron or vertically into the Brule aquifer. Crow Butte maintains an extensive water sampling program to identify potential impacts to water resources in the area. The groundwater monitoring program is designed to establish baseline water quality prior to mining at each mine site; detect excursions of lixiviant either horizontally or vertically outside of the production zone; and determine when the production zone aquifer has been adequately restored following mining. *Id*. at 34.

4.113 The monitoring program includes sampling of monitoring wells and private wells within and surrounding the license area to establish pre-mining baseline water quality. *Id*. Water quality sampling continues throughout the operational phase of mining for detection of excursions. *Id*. Water quality sampling also will be conducted during restoration, including stabilization monitoring at the end of restoration activities, to determine when baseline or otherwise acceptable water quality has been achieved. The monitoring requirements (parameters, monitoring well spacing, location of shallow monitoring wells) are established by the Class III permit issued by the State of Nebraska. *Id*. at 35, citing Class III URIC Permit No. NE0122611 (Exh. CBR-017).

4.114 The function of the encircling monitor well ring is to detect any mining solutions that may migrate away from the production area due to fluid pressure imbalance. *Id*. The monitoring well ring is located well inside the permit area. According to Crow Butte's

Class III URIC permit, production zone monitor wells shall be spaced no greater than 300 feet from a mine unit and no greater than 400 feet between the wells and located so as to detect excursions. NE Permit NE0122611 at 16 (Exh. CBR-017). Shallow monitor wells are completed in the first continuous and water-bearing sandstone unit overlying the production zone. The shallow monitor wells are equally distributed throughout the mine unit, with one well for every four acres included in the mine unit. Sampling of these wells is done on a biweekly basis. *Id*.

4.115 During operation, the primary purpose of the wellfield monitoring program is to detect and correct conditions that could lead to an excursion of lixiviant or detect such an excursion, should one occur. The techniques employed include monitoring of production and injection rates and volumes, wellhead pressure, water levels, and water quality.

4.116 The use of an injection well and production well pattern creates a "spot" in which local flow is toward production wells and therefore relatively little flow across the mined area or toward the monitoring well ring. Exh. CBR-001 at 41. In addition, a "bleed" system results in less leach solution being injected than the total volume of fluids (leach solution and native groundwater) being extracted. Exh. CBR-001 at 36. A bleed of 0.5-1.5 percent is typically maintained during production. *Id*. at 36-37. Maintenance of the bleed causes an inflow of groundwater into the production area and prevents loss of leach solution.

4.117 There remains nonetheless the possibility of mining fluids migrating beyond the mine area. As discussed above, the parameters and constituents chosen for indicators of lixiviant migration and for which upper control limits ("UCLs") are set are chloride, conductivity, and total alkalinity. Upper control limits are set at 20 percent above the maximum baseline concentration for the excursion indicator. Exh. CBR-001 at 37. For excursion

indicators with a baseline average below 50 mg/L, the UCL may be determined by adding 5 standard deviations or 15 mg/L to the baseline average for the indicator. *See* NE Permit NE0122611 at 9 (Exh. CBR-017).

4.118 During routine sampling, if two of the three UCL values are exceeded in a monitor well, or if one UCL value is exceeded by 20 percent, the well is resampled within 48 hours and analyzed for the excursion indicators. Exh. CBR-001 at 39. If the second sample does not exceed the UCLs, a third sample is taken within 48 hours. If neither the second nor third sample results exceeded the UCLs, the first sample is considered in error. If the second or third sample verifies an exceedance, the well in question is placed on excursion status. Upon verification of the excursion, the NRC Project Manager is notified by telephone within 48 hours and notified in writing within 30 days. Exh. CBR-001 at 40.

4.119 If an excursion is verified, Crow Butte is required to take correction actions, including completing a preliminary investigation is completed to determine the probable cause, adjusting production and/or injection rates in the vicinity of the monitor well to increase the net over-recovery (*i.e.*, forming a hydraulic gradient toward the production zone), pumping individual wells to enhance recovery of mining solutions, and suspending injection into the well field area adjacent to the monitor well. *Id*. In addition to the above corrective actions, sampling frequency of the monitor well on excursion status is increased to weekly. *Id*. An excursion is considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion for three consecutive 1-week samples. *Id*.

4.120 According to Crow Butte witnesses, there have been several confirmed horizontal "excursions" in the Basal Chadron Sandstone. Exh. CBR-001 at 40. However, these excursions were detected and recovered through overproduction in the immediate vicinity of the

excursion. *Id*. at 40-41. Moreover, according to Crow Butte (Exh. CBR-020 at 3), under the conditions encountered at Crow Butte, the total distance uranium could be expected to travel would be 0.5 to 15 percent of the distance traveled by a conservative parameter such as chloride or less than 40 feet beyond the active mining area. Exh. CBR-001 at 38. This distance is well within the monitoring well ring.

4.121 In all but one case, the reported vertical "excursions" were due to natural seasonal fluctuations in Brule groundwater quality and very stringent UCLs (typically the result of abnormal spring rains). *Id*. at 41. The one exception involved a spill (not an excursion) that was corrected and remediated. *Id*. Crow Butte has never had a vertical excursion of mining solution. *Id*. The Intervenors did not allege otherwise.

4.122 Crow Butte also conducts quarterly radiological sampling of all private wells within 1 km of the mine unit. *Id*. at 41. These wells were sampled prior to the start of operations. These wells are screened for the most part in the Brule, though one well is screened in the Basal Chadron. The one well that is screened in the Basal Chadron is along the hydraulic gradient between the mine site and the White River. The data do not show any indication that mining fluid has migrated beyond the mine site. *Id*.

4.123 We find that the total effect of the close proximity of the monitor wells, the low flow rate from the well patterns, and overproduction of leach fluids (production bleed) makes the likelihood of an undetected excursion extremely remote.

b. Surface Leaks and Spills

4.124 The most common form of surface release from in-situ mining operations occurs from breaks, leaks, or separations within the piping that transfers mining fluids between the process plant and the wellfield. Exh. CBR-001 at 44. These are generally small releases due

to engineering controls that detect pressure changes in the piping systems and alert the plant operators through system alarms. *Id*.

4.125 In general, piping from the plant to and within the wellfield is constructed of PVC, high-density polyethylene pipe with butt-welded joints or equivalent. *Id*. All pipelines are pressure tested at operating pressures prior to operation. *Id*.

4.126 Crow Butte also has taken affirmative steps to protect surface water quality in the event of a wellfield accident. Crow Butte installs protective berms and dams around Squaw Creek and English Creek to minimize the potential for a spill of mining, process, or restoration solutions from impacting the creeks. *Id*. at 45. These berms and dams are routinely maintained and inspected to ensure their integrity and protect the surface water in the permit area. Crow Butte has installed instrumentation to detect wet berms, wet valve stations, and wet wellhouses. *Id*.

4.127 The Nebraska permit for in-situ recovery — Permit Number NE0122611 (Exh. CBR-017) — further requires corrective action for any lixiviant movement that may impact waters of the State, including surface waters.

4.128 Underground pipelines are protected from a major cause of potential failure: vehicles driving over the lines causing breaks. *Id*. at 44. The only exposed pipes are at the process plant, the wellheads, at temporary transfer lines and in the control house in the wellfield. Trunkline flows and wellhead pressures are monitored each shift for process control. *Id*.

4.129 One section of underground piping that passes beneath Squaw Creek is double contained, with leak detection, for additional protection. *Id*.; Tr. at 1534-36. Spill response is specifically addressed in the Crow Butte emergency manual. Exh. CBR-001 at 44.

4.130 Process buildings are constructed with secondary containment, and a regular program of inspections and preventive maintenance is in place. Exh. CBR-001 at 47; Exh. CBR-011 at 7-11.

4.131 Crow Butte has never had a spill that was reportable under 10 C.F.R. Part 20. Exh. CBR-001 at 45; Tr. at 1556.

4.132 All spills are analyzed for root causes and contributing factors. Exh. CBR-001 at 45. Periodically, the Crow Butte Safety and Environmental Review Panel ("SERP") meets to analyze recent spill events and to determine whether engineering or administrative improvements are indicated to reduce the frequency and magnitude of spills. *Id*.

4.133 Overall, we 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 features at the Crow Butte 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 features is minimal.

4. Distance to Pine Ridge Reservation

4.134 There is no evidence to suggest that any mining fluids have migrated beyond the license area. Even if it had, however, it is unlikely to have any impacts on water supplies on the Pine Ridge Reservation.

4.135 The parties agree that the closest boundary of the Pine Ridge Reservation is at least 30 miles from the northeast boundary of the license area. Tr. at 1032-33.

4.136 Mr. Lewis, for Crow Butte, stated his professional opinion that it is not plausible that a release of uranium from Crow Butte's operations to the White River alluvium could be detected on the Pine Ridge Reservation within 25 years of the release given the distance

to the reservation, the effects of dilution and chemical attenuation, and the properties of the uranium. Tr. at 1822. Mr. Lewis cited the distance involved, natural rates of flow in the groundwater system, the length of time the mine has been in operation, and the fact that the aquifer would be fully restored before any chemical transport away from the mine would take place. Tr. at 1823. He also testified that the processes of dispersion, attenuation, and chemical dilution render it inconceivable that contamination from Crow Butte could be detected at the reservation. This does not even consider the additional distance that the plume would have to travel on the reservation in order to reach water supply wells.

4.137 Mr. Spurlin stated that he was aware of no contaminant plume in history that had migrated the distance from Crow Butte to the Pine Ridge Reservation. Exh. CBR-001 at 55.

4.138 More importantly, though the Intervenors posited that the White River alluvium *could be* a potential contaminant pathway, the Intervenors' witnesses pointed to no data to suggest that uranium or other contaminants from Crow Butte's mine site are in fact present in the White River alluvium.

4.139 We find that it is highly improbable, bordering on the physically impossible, for contamination from Crow Butte mining operations to have reached water supply wells on the Pine Ridge Reservation in the period of time since operations began.

4.140 Overall, we find that the NRC Staff has considered reasonably foreseeable impacts of Crow Butte's operations on surface waters, including Squaw Creek, English Creek, and the White River, from an accident. Crow Butte has taken active steps to minimize the potential for leaks and spills (underground or surface), and has a comprehensive monitoring program in place to detect any such leaks or spills should they occur. The NRC Staff has

considered the potential for contamination of the White River from surface spills and subsurface migration, as well as the potential impacts on downstream users.

C. Contention D

1. Background

4.141 Contention D asserts that "[the NRC Staff] incorrectly states there is no communication among the aquifers, when in fact, the Basal Chadron aquifer, where mining occurs, and the aquifer, which provides drinking water to the Pine Ridge Indian Reservation, communicate with each other, resulting in the possibility of contamination of the potable water. Based on this potential communication between the aquifers, the EA's environmental justice analysis, including analysis of cumulative effects, should be expanded to consider potential impacts on the aquifer which provides drinking water to the Pine Ridge Indian Reservation."

4.142 Based on statements by Dr. LaGarry, OST claims that aquifers in this area are interconnected, and, as a result, there is potential pathway for contamination of the Pine Ridge water supply via faults and fractures. OST also asserts that Crow Butte failed to adequately consider the White River Structural Feature, which may affect the control of fluid migration outside the mining area.

4.143 The contention also includes a piece related to the potential for contamination to cause environmental justice impacts outside the immediate vicinity of the site.

2. Geologic Setting

4.144 As both Crow Butte and NRC Staff witnesses stated in the hearings and, as shown by Exhs. NRC-023 and INT-059, the particular sandstone unit of the Chamberlain Pass Formation mined in the license renewal area (*i.e.*, the Basal Chadron Sandstone) is not present a few miles east of the mine site. Exh. CBR-045 at 34; Exh. NRC-076 at 65; Tr. at 1224.

4.145 In fact, the entire White River sequence, including the Chamberlain Pass, has been completely eroded away from those areas shown on Exh. NRC-097 (extending from a few miles east of the current license area northeastward to several miles north of the border of South Dakota) where the Pierre Shale or older strata (*e.g.*, Niobrara Formation) are exposed at the ground surface. Tr. at 1220 (Dr. LaGarry), 2577 (Mr. Spurlin) and 2578 (Dr. LaGarry).

4.146 While deposits representing the Chamberlain Pass, Chadron, and Brule Formations may be present beneath the Pine Ridge Reservation, we do not need to resolve this question for this proceeding. It is sufficient to conclude the specific depositional packages of interest (*i.e.*, the basal sandstone unit of the Chamberlain Pass mined in the license renewal area) is not continuous to the reservation, nor is there any hydrologic connectivity between these formations on the reservation and the license renewal area.

4.147 In addition, all parties agree that the Arikaree aquifer does not exist at Crow Butte site. The Arikaree Group is only present in the far south end of site as an elevated outcrop, where it is upgradient of site operations and is unsaturated. Tr. at 1156-57; Exh. NRC-076 at 46.

4.148 Dr. Striz for the NRC Staff testified (Tr. at 1224) that there is "no pathway in the southern portion of the license area for water to get in the Arikaree and to be transported 30 miles all the way up to the Pine Ridge Reservation" because the Basal Chadron Sandstone pinches out and then "you have all the siltstones and mudstones for 27 miles that a particle of water would have to pass through." Ms. White Face did not refute the NRC Staff's testimony on this point. Tr. at 1518. And, Dr. LaGarry concurred with the NRC Staff's assessment that it is very unlikely that there is a direct lateral route from the license area to the reservation. Tr. at 2622.

4.149 Dr. LaGarry also acknowledged at the oral hearing that there is no direct connection via the Chamberlain Pass Formation (Tr. at 1220). Instead, he posited (*id*.) that the faults could allow "transmissivity of fluids connecting these little isolated pod[s] to Chamberlain Pass Formation, then water could migrate through Chamberlain Pass, through a fault, through Chamberlain Pass, through a fault, through Chamberlain Pass, through a fault, through Chamberlain Pass to the reservation."

4.150 We conclude that Dr. LaGarry's speculation is insufficient to demonstrate the existence of a hydrologic link between the mined aquifer and drinking water supplies at the Pine Ridge Reservation. Dr. LaGarry acknowledged this during the supplemental hearing (Tr. at 2582-83), when he stated that "lateral migration of contaminated water from the license area somehow around, or over, or through the Chadron Arch onto the reservation is extremely unlikely." Dr. LaGarry also noted that "since [his] 2008 testimony, [he has] largely discounted that as not being possible." *Id*.

4.151 We also note that, even if, hypothetically, there were faults or fractures connecting the Basal Chadron Sandstone to the Brule aquifer at the Crow Butte site, the vertical hydraulic gradient in the permit area during operations is strongly downward, which precludes upward migration of mining fluids into the Brule aquifer.

4.152 Overall, we find that there is no evidence of hydrologic connectivity between the channel sandstone lithofacies of the Chamberlain Pass Formation (*i.e.*, Basal Chadron Sandstone) within the license renewal area and the Chamberlain Pass Formation at the Pine Ridge Reservation. The Basal Chadron Sandstone present within the license renewal area pinches out (*i.e.*, is not present) beyond a few miles to the east of the license area and is not

hydraulically connected to the Chamberlain Pass Formation, if it exists, on the reservation located more than 30 miles away.

3. Confinement

4.153 As we found above for Contention A, 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 the aquifer pump tests. 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 Crow Butte site. We therefore do not discuss this aspect of Contention D further.

4. Environmental Justice

4.154 A portion of Contention D alleges that potential contamination outside the immediate vicinity of the site could have environmental justice impacts. We found above that there is adequate confinement and no evidence of faults or fractures and also that Crow Butte maintains a comprehensive monitoring network to identify any migration of mining fluids beyond the permit area. In the absence of any "off-site" impacts that could contaminate the White River or drinking water supplies at Pine Ridge, there would be no environmental justice impacts from Crow Butte's operations.

4.155 The Intervenors' witness, Ms. Charmaine White Face, testified that the results of tests of domestic water from the deep wells into the Arikaree aquifer on the Pine Ridge Reservation — combined with her assessment of the direction of flow within the Arikaree aquifer, the number of excursions from the Crow Butte Resources Operation, secondary porosity,

and the physical pull from the wells — show that Crow Butte Resources is "polluting the Arikaree aquifer" with radioactive contaminants. Exh. OST-001 at 7-8.

4.156 Ms. White Face claimed that the ratios of different isotopes of uranium indicated contamination from Crow Butte's operations. Exh. OST-001. Ms. White Face, however, is comparing activity levels, not concentrations. Tr. at 1494-95. A direct comparison is inappropriate because the specific activity of U-234 is over four orders of magnitude greater than that of U-238. Exh. NRC-082 at 2. And, in any event, the ratio of various uranium isotopes varies widely in nature. Exh. NRC-072-R2 at 49; Tr. at 1677-78. Dr. LaGarry, for his part, acknowledged that there is no definitive evidence that radiological materials in wells on the reservation came from Crow Butte. Tr. at 1489. And, Ms. White Plume testified that she did not "have the evidence that everybody else has in terms of western science," and noted only that "I know what I know." Tr. at 1521.

4.157 In contrast, the NRC Staff testified (Exh. NRC-072-R2 at 46) that the Arikaree aquifer is absent in northeastern Dawes County and that the ground water flow direction in the Arikaree aquifer at its southwestern edges is primarily west and northwest, away from the Reservation.

4.158 We find that groundwater does not flow via the Arikaree aquifer from Crawford through northeastern Dawes County to the Pine Ridge Reservation as posited by Ms. White Face.

4.159 The Board also carefully considered the evidence presented regarding the presence of uranium in groundwater at the Pine Ridge Reservation. Significantly, the references provided by the Intervenors (*e.g.*, INT-072 and 074) identify the Chamberlain Pass Formation as the source of naturally-occurring uranium contamination of groundwater at the Pine Ridge

Reservation. And, Exhibit INT-074 proposes that "Cretaceous sandstones" are a likely source of groundwater contamination near the community of Red Shirt on the Pine Ridge Reservation. The publications note uranium contamination in locations so far distant from the Crow Butte site that they could not possible be from mining fluids — due to dilution effects over that distance, the slow travel times for uranium, and the differences in head between the Crow Butte site and the Pine Ridge Reservation.

4.160 This undercuts the claim, which, in any event, was not based on evidence or data, that Crow Butte's operations are the source of uranium found in groundwater at Pine Ridge. As we have stated previously, there is no evidence to suggest that any mining fluids have migrated beyond the license area, much less are the source of uranium contamination at the far-off locations in South Dakota cited by Ms. White Face during the hearing.

4.161 Dr. LaGarry also references research documenting uranium-contaminated artesian springs along the Sandoz Ranch-White clay Fault in Fall River and Shannon counties (Bhattacharyya, et al. 2008) (Exh. CBR-022) as potential evidence of a hydraulic connection between the Chamberlain Pass Formation and the surface. We find that the noted uranium concentrations likely are representative of the natural water quality of the aquifer (*i.e.*, regionally-elevated radiological levels), and not caused by mining fluids from Crow Butte's operations.[47]

4.162 Overall, we find that there is no evidence of impacts to drinking water on the Pine Ridge Reservation from Crow Butte's operations (as opposed to being naturally-occurring). Because of the absence of any impacts beyond the mining area, much less impacts

[47] As noted in the LRA and other licensing documents, groundwater in the Basal Chadron Sandstone is naturally of poor water quality because it is mineral-bearing with high levels of naturally-occurring radionuclides. *See, e.g.*, LRA at 7-14, 8-5 (Exh. CBR-011).

over 30 miles away at the Pine Ridge Reservation, we find that there was no need for the NRC Staff to include the Pine Ridge Reservation in the environmental justice analysis.

D. Contention F

1. Background

4.163 Contention F is a technical contention entitled "Failure to Include Recent Research." The contention is based on claims by Dr. LaGarry that Crow Butte (as well as the NRC and NDEQ) are relying on old data and old research when there is more recent research. In particular, Dr. LaGarry claims that the recent mapping of the geology of northwestern Nebraska has shown that the simplified, "layer cake" concept applied by pre-1990's workers is incorrect. Exh. INT-003 at 3. In addition, the intervenors claim that references in the License Renewal Application (Exh. CBR-011) were to outdated EPA guidance documents for taking groundwater samples from 1974 and 1977 and that the LRA should have cited more recent guidance from 1992 and 2000.

2. Nomenclature

4.164 There have been recent studies of the regional geology that have resulted in the proposal of a new nomenclature for some of the geologic units within the license area, including proposals by Dr. LaGarry. Dr. LaGarry repeatedly claimed that failure of the application or NRC reviews to incorporate this new information reflected a lack of "due diligence." Exh. INT-080 at 2.

4.165 In discussing site geology, Crow Butte and the NRC Staff state that they continue to use the nomenclature found in the prior license applications for consistency and to prevent confusion as to where mining is occurring (for both the public and regulators). *See, e.g.*, Exh. CBR-001 at 31. However, they both acknowledge revisions to the local stratigraphy and

provide tables correlating the nomenclature for the various units. *See, e.g.*, MEA Technical Report, Table 2.6-2, *Representative Stratigraphic Section* (Exh. CBR-015).

4.166 At the supplemental hearing, Dr. LaGarry acknowledged that he was satisfied that Crow Butte and the NRC Staff had done their "due diligence" regarding the revised nomenclature by using the terminology in its historical context. Tr. at 2570.

4.167 Overall, we find that it is appropriate for Crow Butte and the NRC Staff to continue to use historical nomenclature in documentation for consistency and ease of understanding for the public and regulators, particularly in light of the fact that they both acknowledge and correlate their descriptions among various naming conventions. Stratigraphic nomenclature aside, we find that nothing in the naming conventions for the geologic units in Nebraska or at the Crow Butte facility changes the interpretation of the physical or hydraulic features of the rock units.

3. Outdated EPA Guidance

4.168 The Intervenors witnesses also complained that Crow Butte relied on outdated EPA guidance for taking water quality samples. Exh. INT-005 at 4. We note, however, that the author of INT-005 was not a witness at the hearing.

4.169 Nevertheless, at the hearing, witnesses for the NRC Staff testified that the reference to the outdated EPA guidance was a historical artifact taken from an earlier application. Tr. at 1652. The LRA (Exh. CBR-011 at 2-275) refers to earlier versions of the EPA documents that were used at the time those original baseline measurements were taken. But, the LRA does not actually cite those documents for any particular evaluation; the guidance is mentioned only in the "Reference" section of the application.

4.170 In addition, because Crow Butte has begun operating the last wellfield at the site, there are no more "baseline" water quality samples left to be taken.

4.171 For these reasons, we find that the inclusion of outdated EPA guidance within the reference section of the LRA has no bearing on the adequacy of the LRA or the NRC Staff's evaluation of the LRA.

E. Contention 1

1. Background

4.172 Contention 1, which was merged with Contention 2, addresses "[w]hether the cultural surveys performed and incorporated into the EA formed a sufficient basis on which to renew Crow Butte's permit." The intervenors contend that the EA lacks an adequate description of either the affected environment or the impacts of the project on archaeological, historical, and traditional cultural resources. Intervenors maintain that surveys from 1982 and 1987 do not provide proper baseline information, and claim that the NRC Staff should have conducted a new survey of the license area. The Intervenors also contend that the NRC failed to engage in meaningful consultation with the Oglala Sioux Tribe.

2. Identification of Cultural Resource

4.173 According to the evidence in the proceeding, Crow Butte engaged qualified archeological contractors to conduct a cultural resource survey prior to beginning site operations. Specifically, a Class III inventory, which is the standard for locating and recording archaeological resources having exposed indications in an APE, was conducted. Exh. CBR-007 at 5.

4.174 The University of Nebraska conducted in-field identification and assessment of cultural resources in the CBR research and development area in March and April

1982. The Nebraska State Historical Society surveyed the remainder of the license area during April and May 1987. The results of the two surveys were presented in a single report. *See* Bozell and Pepperl, "A Cultural Resources Study of the Crow Butte Uranium Prospect, Dawes County, Nebraska," Main Report (September 1987) (Exh. CBR-027); *see also* Bozell and Pepperl, "A Cultural Resources Study of the Crow Butte Uranium Prospect, Dawes County, Nebraska," Appendices (September 1987) (Exh. CBR-028).

4.175 The report explains that the surveys followed standards (36 C.F.R. § 1210) for data recovery and reporting requirements and were conducted under provisions of the Secretary of Interior's Professional Qualifications and Standards and Standards for Archaeology and Historic Preservation (48 Fed. Reg. 22716 and 48 Fed. Reg. 44716-42, respectively). Exh. CBR-027 at 1; Exh. NRC-001 at 71.

4.176 The survey methodology is described in detail in Bozell and Pepperl at 18 (Exh. CBR-027). All lands within the project area were subjected to intensive (100%) pedestrian surface survey. The investigation procedure consisted of walking in a zigzag reconnaissance pattern at closely spaced intervals, normally 20-30 m. Intervals were modified as necessary to meet varying terrain and vegetation conditions. Inspection of all exposed areas, such as animal burrows, exploratory drill pads and eroded surfaces, was completed.

4.177 An intensive effort was made to examine all cutbanks exposed along creeks and adjacent intermittent tributaries for buried cultural deposits. *See* Exh. CBR-007 at 6 (summarizing discussion in CBR-027). Surface visibility varied within the study area. Much of the tract surface was covered with short bunch grass offering fair visibility. Roughly 300 acres was cultivated (winter wheat) providing good to excellent visibility. About 100 acres in the extreme southeastern corner of the survey area are sparsely covered with evergreen forest where

visibility was fair. The surface of the wooded creek bottomland was generally obscured, however creek bank exposures facilitated subsurface observations throughout this area.

4.178 All cultural sites identified during the surveys were plotted on maps. A detailed examination of the immediate area of each located cultural resource was performed to identify horizontal limits and composition of surface materials. A preliminary field inventory of observed materials and a sketch map of the immediate site vicinity were also made at this time. In addition, photographic documentation of all site locations was completed. More extensive field documentation, such as instrument mapping, test unit excavation, collection of select surface specimens, and cutbank profiling, was carried out during further investigations of potentially significant sites.

4.179 The efforts in 1982 and 1987 recorded a total of 21 prehistoric and historic period archaeological sites. Exh. CBR-027. Cultural affiliation of the recorded sites included eight with Native American components, 12 historic period locations, and a buried bone deposit of undetermined cultural association.

4.180 Two Native America sites, an isolated fragment of chipped stone flaking debris (FN-l) and a subsurface deposit of bone (bison) and charcoal (FN-2) exposed along the Squaw Creek cutbank were identified within the pilot plant unit. Site 25DH114 consists of an extensive scatter of chipped stone tools, flaking debris, bone, and trade goods. Site 25DH116 was limited to three specimens of chipped stone flaking debris. All of these sites are located within 100 meters of Squaw Creek in the northeastern portion of the section.

4.181 Five additional Native American lithic or lithic and bone scatters were identified during survey of the remainder of the study area (25DW194-25DW198). All of these resources are located northwest of the pilot unit on either upland divides or level terraces of

English or Squaw Creeks. *See* Bozell and Pepperl, Main Report, at 18-24 (Exh. CBR-027). The locations of the sites are shown in a figure (Exh. CBR-036).

4.182 Investigators from the University of Nebraska and the State Historical Society found that 15 of the newly recorded sites, including four Native American and nine historic period locales, contained limited scientifically important cultural remains or were not determined to be of significant historic value based on archival research. These 15 sites were evaluated as being "not eligible" for nomination and potential listing on the NRHP. Bozell and Pepperl, Main Report, at 71-73 (Exh. CBR-027).

4.183 Six sites, including three Native American and three historic period locales, were evaluated as being "potentially eligible" for the NRHP, requiring further field assessment for a full evaluation as being "eligible." Four of these sites (25DW114, 25DW192, 25DW194, and 25DW198) were evaluated as having potential importance for the recovery of archaeological data, and sites 25DW112 and 25DW00-25 have possible architectural values. The "potentially eligible" Native American and historic period sites were treated as "eligible," pending further actual determination of their eligibility status. Bozell and Pepperl, Main Report, at 69-77 (Exh. CBR-027).

4.184 In a letter, dated August 5, 1987, the Nebraska State Historic Preservation Officer ("SHPO") concurred with the findings and recommendations of the Bozell and Pepperl report (Exh. CBR-030).

4.185 The Intervenors' witness, Dr. Redmond, stated during the hearing that he did not contest the qualifications of Bozell and Pepperl or the conclusions of their report. Tr. at 989. There was some discussion regarding the location of certain cultural resources identified by

Bozell and Pepperl, but Mr. Teahon and Dr. Nickens confirmed that the site of those resources is located outside of the area affected by mining. Tr. at 2372-2374.

4.186 For its first license renewal, Crow Butte did not conduct additional field studies because the results of the prior surveys remained applicable. Exh. CBR-007 at 8. There were no major changes in site activities or disturbed areas since initial surveys were performed and the site was constructed.

4.187 However, as part of the 1998 initial renewal of the CBR license to continue operation, a consultant conducted a Traditional Cultural Property ("TCP") study that involved sending letters to Tribal governments, including the Oglala Sioux Tribe, and requesting any information on localities of potential traditional concern or value to Native American groups. *See* RTG Technologies, "Survey of Traditional Cultural Properties, Crow Butte Project, Dawes County, Nebraska," dated April 2, 1998 (Exh. CBR-029). No responses were received.

4.188 The Deputy SHPO stated that he considered the results of the 1987 survey still to be adequate and that Crow Butte's continued policy of avoidance to be acceptable. *See* Letter from R. Puschendorf, NSHS, to J. Holonich, NRC, dated May 4, 1998 (Exh. CBR-031).

4.189 Crow Butte did not conduct additional field studies at the site to support the most recent license renewal. Again, according to Crow Butte, there were no major changes in site activities or disturbed areas since initial surveys were performed and the site constructed that would warrant revisiting the earlier surveys.

4.190 The NRC Staff nevertheless considered potential impacts to cultural resources beyond archeological sites. The NRC Staff took tribal representatives on site tour (Tr. at 2051) and NRC contractors met with knowledgeable individuals in the area and performed a literature review (Tr. at 2077-2078, 2286-90). *See also* SCA Trip Report (Exh. NRC-051). The

review identified areas of cultural significance to OST and other tribes, such as the Crow Butte "butte" (Tr. at 2078-2080), historical uses in the area, and cultural significant plants. Exh. NRC-010 at 56-57; Tr. at 2080.

4.191 In addition, two of the Section 106 consulting Tribes, the Crow and Santee Sioux Nations, accepted an offer to visit the Crow Butte project areas during the November-December 2012 timeframe. Exh. NRC-010 at 70. Reconnaissance of the existing license area by the Crow Nation field crew determined that the project area is heavily impacted by past Euro-American settlement and farming practices, CBR project mining, and other activities over the past 25 years to the extent that little or no undisturbed areas exist. The Tribal field crews determined that additional field inspection of the existing license area for potential places of religious or cultural places beyond those previously identified was not practical. Santee Sioux Nation, Tribal Historic Preservation Office, "TCP Survey Report" (2013) (Public) (ADAMS Accession No. ML13093A123) (Exh. NRC-052).

4.192 The NRC Staff provided other consulting tribes, including OST, with an equal opportunity to participate in the development of a Statement of Work or to conduct their own site investigation. *See, e.g.*, Exh. NRC-001R at 64-65. The NRC Staff tailored its approach to address two concerns that had been raised by tribes: (1) that the tribes wanted to be in charge of their own TCP survey (*i.e.*, not the applicant or the applicant's contractor and not the NRC Staff or its contractor); and (2) that the tribes did not want a phased approach. Tr. at 2252. The NRC Staff witness, Mr. Goodman, testified that the open site approach would accommodate both of these requests. *Id*.

4.193 Crow Butte offered to pay for tribes to participate in Traditional Cultural Property surveys and both changed the method by which it would pay (to an honorarium) and the

amounts it would pay. *Id*. at 66; Tr. at 2222-23, 2229, 2232-33, 2314-15. At least two tribes in fact conducted field surveys, as noted above. Exh. NRC-052. OST, however, voluntarily elected not to submit a proposed Statement of Work or to participate in a field survey; OST witnesses could not explain why OST declined to participate.[48] Tr. at 2181-86, 2190-91.

4.194 In 2013, the Deputy SHPO again acknowledged the prior Class III field inventory and reiterated that the findings of the original Environmental Assessment in 1988 and the subsequent Environmental Assessment in 1998 addressed the SHPO's comments. The Deputy SHPO reconfirmed the findings of "no effect." Letter from R. Puschendorf, Deputy SHPO, to K. Hseuh, NRC, "Request for Concurrence for a Finding of No Historic Properties Present for the Proposed Crow Butte Resources, Inc. In-Situ Uranium Recovery License Renewal Project, Dawes County, Nebraska," dated July 15, 2013 (Exh. NRC-041).

4.195 We find that the survey results from Bozell and Pepperl, as supplemented by the additional testing and investigations, and the additional surveys and assessments, demonstrate that the NRC Staff has taken a "hard look" at cultural resources, including both historic properties and traditional cultural properties, that could be affected by license renewal. The actions by Crow Butte, its consultants, the NRC Staff, and two tribes were adequate to identify cultural resources with the potential to be impacted by Crow Butte's operations. OST identified no deficiency with the surveys conducted previously or with Crow Butte's efforts to avoid impacts to known cultural resources during operation.

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[48] The NRC Staff is not required to delay its evaluation until every consulting tribe is satisfied with the agency's approach. Neither NEPA's "hard look" standard nor the NHPA's "reasonable and good faith effort" standard required the NRC Staff to devote virtually infinite study to cultural resources. *Entergy Nuclear Generation Co.* (Pilgrim Nuclear Power Station), CLI-10-11, 71 NRC 287, 315 (2010).

3. Protection of Cultural Resource

4.196 The six original "potentially eligible sites" were designated for avoidance during construction activities, both at the time and for the future. Only one site, 25DW192, was located entirely in an area of potential disturbance at the time. This property was and remains protected by a fenced perimeter. Exh. CBR-007 at 11.

4.197 One of the six potentially eligible archaeological sites from the 1987 evaluation, Site 25DW198, was subsequently found to be in an area of new CBR well-drilling activities. This site received additional evaluative field testing in 2003. Späth and Walth, "Crow Butte Resources Evaluative Testing of Site 25DW198, Dawes County, Nebraska" (June 2003) (Exh. CBR-032). Before the fieldwork commenced, a site testing plan was prepared and sent to the Nebraska State Historic Preservation Officer, who concurred with the approach. Letter from Greystone to SHPO, "Evaluative Testing of 25DW198," dated February 11, 2003 (Exh. CBR-033); Letter from NE SHPO to Späth, "Testing Plan for 25DW198," dated February 24, 2003 (Exh. CBR-034).

4.198 Site 25DW198 was again subjected to an intensive inventory of the previously mapped site surface and the adjacent areas, followed by excavation of four subsurface test units. Based on the findings of this field effort, a recommendation was made that the site lacked the potential to yield information important to the region's prehistory and that it was not eligible for listing on the NRHP. The NE SHPO concurred with this recommendation and the archaeological site was removed from the project list of potentially eligible archaeological sites. Letter from NE SHPO to Späth, "Site Testing," dated June 16, 2003 (Exh. CBR-035).

4.199 Crow Butte has since been able to avoid each of the remaining "potentially eligible" archaeological sites during the construction and operation phases of the project, so full

assessments of the eligibility status of these five sites were not conducted. Exh. CBR-007 at 12. Documented field visits by the NRC made to each of the five "potentially eligible" sites in August 1995, and again in 2010, 2011, and 2012, confirmed that the sites did not incur any impacts during construction and operation. Exh. NRC-056.

4.200 Crow Butte also is required by license condition (and permit condition) to stop construction activities if previously-unidentified cultural resources are discovered during ground disturbance activities. Exh. CBR-007 at 12; Exh. NRC-012 (CBR License). In any event, there are no plans for any large-scale ground disturbances at Crow Butte. No more wellfields are planned. Exh. CBR-054 at 4.

4.201 Overall, we find that, because the Crow Butte project area has been subjected to intensive cultural resources field surveys for archaeological and historical sites and because the five remaining properties evaluated as "potentially eligible" for the NRHP are being actively avoided during all phases of the overall project, there will be no effects to the known and recorded cultural resource sites from license renewal.

4. Government to Government

4.202 OST is apparently alleging that the process for complying with the NHPA for license renewal was flawed because OST did not participate in that process on a "government-to-government" basis.

4.203 OST did not, however, cite any standards to support their claim that the NRC Staff failed to consult with them on a government-to-government basis. The NRC Staff contacted and solicited comments and feedback from multiple tribal representatives, and did not fail to correspond with tribal leaders on significant issues within the scope of the NHPA. As reflected in Exh. NRC-038, the NRC Staff sent numerous letters to the president of each

consulting tribe regarding NHPA-related issues and Tribal Historic Preservation Officers ("THPOs"). The NRC Staff referred to these meetings and discussions repeatedly as "government to government" meetings. Exh. NRC-001R at 65-66.

4.204 Communication with the THPO is, by itself, sufficient to establish that there is a government-to-government communication. The ACHP's regulations (36 C.F.R. § 800.16(w)) define the THPO as "the tribal official appointed by the tribe's chief governing authority or designated by a tribal ordinance or preservation program who has assumed the responsibilities of the SHPO for purposes of section 106 compliance on tribal lands in accordance with section 101(d)(2) of the act." As OST witnesses acknowledge (Tr. at 2134-35), the OST THPO's office has taken on the responsibilities for Section 106. The OST's THPO office is therefore the tribal official designated as responsible for engaging in consultation under Section 106. By working through the THPO, the NRC Staff was engaging in government-to-government between designated representatives of the U.S. Government and the OST.[49]

4.205 Other actions by the NRC confirm the government-to-government nature of the discussions. The Staff held an NHPA consultation meeting specifically for tribal leaders. Exhs. INT-052 and INT-053. The NRC Staff also took steps to ensure that appropriate NRC officials attended these meetings. Tr. at 2127-30. We find that these additional steps further confirm the existence of a government-to-government communication.

4.206 OST failed to cite any law, court decision, or guidance document stating that the NRC Staff was required to take any particular action in order to fulfill the federal government's trust responsibility when consulting on license renewal. In fact, the NRC Staff had

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[49] *See also* 36 C.F.R. § 800.2(c)(2)(ii)(C) (stating that "[t]he agency official shall consult with representatives designated or identified by the tribal government").

no specific responsibilities when reviewing the Crow Butte application, other than to comply with applicable law.[50]

4.207 OST objected to the participation of a Cameco Resources consultant in the survey process (Tr. at 2101-02), but point to no law, regulation, or guidance document that prohibits participation by the applicant. In fact, ACHP regulations expressly permit agencies to use consultants and applicants to assist federal agencies in their consultation activities.[51]

4.208 In addition, the OST witnesses claim that no draft EA was circulated for comment. Exhs. INT-031 and INT-032. But, the evidence is clear that OST in fact had an opportunity to respond to a draft of the EA's discussion of impacts to cultural resources, as well as the Section 106 consultation documents. As the NRC Staff explains in the EA (Exh. NRC-010 at 87), the NRC posted a draft of its Section 106 documentation for the project on the NRC's public website on September 30, 2013, and requested public comment. E-mails were sent notifying the consulting parties, including the Oglala Sioux Tribe, of the website. And, a

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50 *See Gros Ventre Tribe v. United States*, 469 F.3d 801 (9th Cir. 2006) ("We recognize that there is a 'distinctive obligation of trust incumbent upon the Government in its dealings with [Indian tribes].' That alone, however, does not impose a duty on the government to take action beyond complying with generally applicable statutes and regulations."). *See also Shoshone-Bannock Tribes v. Reno*, 56 F.3d 1476, 1482 (D.C. Cir. 1995) ("[A]n Indian tribe cannot force the government to take a specific action unless a treaty, statute or agreement imposes, expressly or by implication, that duty."); *Morongo Band of Mission Indians v. FAA*, 161 F.3d 569, 574 (9th Cir. 1998) (holding that "unless there is a specific duty that has been placed on the government with respect to Indians, [the government's general trust obligation] is discharged by [the government's] compliance with general regulations and statutes not specifically aimed at protecting Indian tribes.").

51 36 C.F.R. § 800.2(a)(3) states:

> [the] agency official may use the services of applicants, consultants, or designees to prepare information, analyses and recommendations under this part. The agency official remains legally responsible for all required findings and determinations. If a document or study is prepared by a non-Federal party, the agency official is responsible for ensuring that its content meets applicable standards and guidelines.

specific notice of the availability of this information was provided to the parties in this proceeding. The website and comment solicitation included the NRC Staff's documentation of its Section 106 review findings that formed the basis for NHPA compliance and the cultural resource evaluation in the EA. OST chose not to respond.

4.209 Overall, we find that NRC Staff consulted extensively, and in good faith, with federally recognized tribes, including OST, throughout the Section 106 process. The NRC Staff made a reasonable and good faith effort over several years to obtain information on religious and cultural resources that are significant to OST. NRC Staff consultants performed literature reviews and sought out information about traditional cultural properties during site visits. The NRC Staff held multiple meetings, sent multiple letters, and made multiple phone calls in an effort to obtain information on cultural resources. A number of tribes provided such information, and the NRC Staff incorporated this information into both its NEPA and NHPA reviews. OST did not.

4.210 We further find that the NRC Staff provided the tribe "a reasonable opportunity to identify its concerns about historic properties, advise on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, articulate its views on the undertaking's effects on such properties, and participate in the resolution of adverse effects."[52]

4.211 And, we find that NRC Staff satisfied the NHPA requirement that the consultation with Indian tribes "recognize the government-to-government relationship between the Federal Government and Indian tribes."[53] The NRC Staff ensured that the responsible NRC

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52 36 C.F.R. § 800.2(c)(2)(ii)(A).

53 36 C.F.R. § 800.2(c)(2)(ii)(C).

official with authority under the NHPA, or his delegate, was present at face-to-face meetings with the tribes. Tr. at 2128-30. The NRC sent letters regarding the project and participation by the tribes to both THPOs and tribal government officials. *See, e.g.*, Tr. at 2149; Exh. NRC-038. The NRC Staff treated each tribe as a separate governmental entity by communicating directly with each tribe, rather than through the U.S. Department of Interior. And, the NRC Staff endeavored to be responsive to concerns raised by tribes during the consultation process. Together, these efforts are more than ample to establish that these interactions were taking place at a government-to-government level. Indeed, it is not clear what else would be necessary to establish a government-to-government meeting.

4.212 One final note. There is a significant distinction between the Dewey-Burdock initial licensing proceeding and this license renewal proceeding. Dewey-Burdock is a new facility, and construction and operation will therefore entail some new ground disturbance. In contrast, Crow Butte is an existing facility that has been in operation for decades. Crow Butte has successfully avoided impacts to sites of potential or known significance during that time. Dewey Burdock also involved a Programmatic Agreement, which is not used at Crow Butte. Tr. at 2173-74. And, as noted previously, Crow Butte has no plans to construct additional wellfields or engage in substantial ground disturbing activities in the main permit area. Finally, unlike for Dewey-Burdock, OST never submitted (directly or on its behalf by others) a proposed Statement of Work for conducting TCP surveys at the license renewal site. Tr. at 2181-83; 2190.

F. Contention 6

1. Background

4.213 Contention 6 is entitled "[t]he EA violates NEPA in concluding that the short-term impacts from consumptive ground water use during aquifer restoration are

MODERATE." The Licensing Board admitted Contention 6 based on references to EA Sections 4.6.2.2.1 and 4.6.2.3 (Exh. NRC-010). The former section addresses consumptive water use during operations, and the latter section of the EA addresses ground water quantity impacts from consumptive use during restoration.

4.214 The EA indicates, based on past experience, that restoration of a mine unit will need at least eleven pore volumes and that Crow Butte may need to extract "more than eleven restoration pore volumes for all mine units."[54] The EA described this short term impact from consumptive ground water use as a MODERATE impact.

4.215 The contention asserts that the experience at Crow Butte indicates that the restoration consumptive use is greater than expected by the NRC Staff in the EA, and therefore the impact is greater than MODERATE. The contention also challenges the NRC Staff conclusion that water levels would eventually recover after aquifer restoration, resulting in an overall SMALL impact from consumptive water use.

2. Consumptive Use

4.216 The Crow Butte facility is licensed to process 9,000 gallons per minute (gpm), but the actual operating flow is much less — closer to 5,000 gpm on average. Exh. CBR-008 at 17; Tr. at 1460.

4.217 Part of the operating flow is used as "bleed" to maintain an inward gradient in the wellfields in order to contain process fluids and protect surrounding groundwater. Exh. CBR-008 at 17. The consumptive use from the bleed has been about 0.5 percent to 1.5

[54] A pore volume is defined as the volume of water contained in the pore space of the aquifer affected by mining and required to be restored. The pore volume is calculated by multiplying the area of the ore zone aquifer by the aquifer thickness and the porosity. The number of pore volumes needed for ground water treatment may consist of reverse osmosis, ion exchange, and sulfide reductant addition.

percent (generally, closer to 0.5%). At a processing rate of 5,000 gpm this results in a consumptive use around 25 gpm (or 50 gpm at 1% bleed). Tr. at 1460. This small consumptive use from bleed will remain essentially the same in the renewal period, eventually declining as mining is completed in the currently operating units. Tr. at 2497.

4.218 Restoration consists of four possible activities: groundwater transfer; groundwater sweep, groundwater treatment (IX + RO); and wellfield recirculation. The most consumptive groundwater use has been and will be in the treatment processes. Exh. CBR-008 at 22.

4.219 Given current Reverse Osmosis ("RO") capacity of 1150 gpm (Tr. at 1730) and assuming an 80/20 efficiency rate, Crow Butte generates approximately 230 gpm of brine. Tr. at 1460. This is the consumptive use of restoration.

4.220 Total consumptive use therefore is approximately 255 gpm at present, and could increase to approximately 300 gpm during restoration of the largest mine units. Tr. at 2498.

4.221 The NDEQ URIC permit limits the number of wellfields in restoration at any one time (Exh. CBR-017). This permit condition imposes an effective limit on potential cumulative impacts on ground water quality and quantity during restoration.

4.222 Crow Butte currently disposes of permeate and brine by injection of the wastes into the three waste disposal ponds and then into two NDEQ-permitted non-hazardous on-site deep disposal wells or directly into the deep disposal wells. Exh. CBR-008 at 14. The waste disposal ponds comply with the design, installation, and operation criteria specified in NRC Regulatory Guide 3.11. *Id.* In 2011, Crow Butte began operating a second deep disposal well to help accommodate the disposal of additional waste water generated by the RO and IX

flow. *Id*. Evaporation pond consumptive use is approximately 25 gpm (averaged on an annual basis). Tr. at 1393. The two deep disposal wells handle approximately 200 to 250 gallons a minute. Tr. at 1394.

3. Restoration Status

4.223 Crow Butte completed ground water restoration and received NRC approval for Mine Unit 1 in 2003. Mine Units 2-6 are currently in restoration. Crow Butte began restoration of Mine Unit 2 in 1996 and Mine Unit 3 in 1999. Initial groundwater restoration of these units was relatively inefficient, resulting in an excessive number of pore volumes being treated to achieve the restoration results needed. Exh. CBR-008 at 18.

4.224 Crow Butte then retained a contractor to develop a site groundwater flow model to optimize restoration well locations, injection and extraction rates, and the overall sequence of treatment activities for each mine unit (Exh. CBR-041). The groundwater flow model was calibrated to pre-mining conditions using water level data collected prior to the mining activities in January 1983 and subsequently has been validated through observation of the site-wide aquifer response during production and restoration. Exh. CBR-008 at 20.

4.225 Use of this model led to significant improvements in restoration efficiency for Mine Units 2, 3, 4, and 5 to date. *Id*. at 19. The model greatly improved restoration efficiency by strategically focusing on water that needs to be treated and minimizing water that is treated multiple times. The plan is adjusted given certain practical limitations on treatment rates, disposal capacity, and existing well injection and extraction rates. The model is also re-calibrated periodically to reflect current mine conditions.

4. Pore Volumes

4.226 Consumptive use is linked to the number of pore volumes used in the treatment phase of restoration. Crow Butte's Pore Volume Restoration Analysis (Exh. CBR-038) discusses the pore volume modeling for Mine Units 2 and 3. After implementation of the Model Based Restoration Plan ("MBRP"), restoration of Mine Units 2 and 3 was achieved after 2.25 and 1.71 pore volumes of groundwater treatment, respectively. Exh. CBR-008 at 21. The report also addresses pore volume restoration requirements for other mine units. Crow Butte concluded that the theoretical number of pore volumes of groundwater treatment needed to restore a mine unit ranges from 1.54 to 3.00 pore volumes. *Id*.

4.227 Using historical affected pore volume ("APV") calculations that reflect restoration inefficiencies, deviations from model assumptions, and uncertainty, rather than the theoretical APV calculated by Crow Butte's model, Crow Butte calculated the total amount of full-scale groundwater treatment needed for complete restoration to be approximately 3.63 to 5.96 pore volumes. *Id*.

4.228 Crow Butte currently expect to complete restoration of Mine Unit 4 in a total of about 12 pore volumes and Mine Unit 5 in 11 pore volumes. Exh. CBR-008 at 22. These numbers are in line with the EA assumptions.

4.229 The Intervenors pointed out that Mine Unit 1 was a small mine unit, yet consumed a significantly larger number of pore volumes. Crow Butte explained that Mine Unit 1 was surrounded by production wellfields, which complicated the restoration process for that unit. Exh. CBR-008 at 21. In addition, since embarking on restoration for Mine Unit 1, Crow Butte has greatly improved restoration planning (*i.e.*, through use of the MBRP) and has invested in restoration infrastructure, including doubling the capacity of the reverse osmosis circuit and

adding an additional wellfield circuit (to separate the commercial and restoration circuits). *Id*. at 21-22.

4.230 In EA Section 4.6.2.3, the NRC Staff concluded that, "based on the restoration analogues in the most recently approved license application and representations by [Crow Butte]," restoration of a mine unit will need at least eleven pore volumes to achieve compliance with the ground water protection standards in 10 C.F.R. Part 40, Appendix A, Criterion 5B(5). Exh. NRC-010 at 83.

4.231 Based on the improvements in restoration efficiency and upgrades to restoration infrastructure, we find that the NRC Staff evaluation of the consumptive use from restoration is reasonable. No evidence was presented to call into question Crow Butte's estimate for restoring Mine Units 6-11 in 3.6 to 6.0 pore volumes of full-scale groundwater treatment. If anything, evidence from Crow Butte suggests that NRC Staff's EA is conservative in its assumptions and conclusions with respect to pore volume estimates for future restorations in light of recent improvements in restoration efficiency.

5. Drawdown

4.232 The evidentiary hearing included significant discussion regarding the drawdown in the Basal Chadron aquifer from consumptive use.

4.233 Exhibit CBR-062 shows the available head at a number of points throughout the various mine units at the license renewal area. The available head ranges from 435 feet to 147 feet (based on August 2015 data).

4.234 The NRC Staff explained that its projections of drawdown matched actual drawdown at a number of points surrounding the site. Exh. NRC-087; Tr. at 2561.

4.235 In its supplemental testimony (Exh. NRC-095 at 7-8), the NRC Staff states that consumptive use rates would have to increase to approximately 495 gallons per minute to decrease the potentiometric surface of the mined aquifer an additional 147 feet and concludes that this rate is not realistic. Although the potentiometric surface of the Basal Chadron Aquifer has been lowered, the Basal Chadron aquifer would remain saturated at all locations throughout mining operations. Exh. CBR-008 at 23.

4.236 Crow Butte agreed that the 495 gpm is not realistic given site conditions, licensed flow rates, and disposal capacity. Exh. CBR-074 at 8. Licensed flow rates for operations are insufficient to lower the water level to that point. According to Crow Butte, there is more than ample available head to accommodate the remaining wellfield production and restoration activities. Exh. CBR-067 at 7.

4.237 As importantly, Crow Butte explained that there are no new mine units to be commissioned at the current license area and pumping rates are presently at or near their projected maximum. Exh. CBR-074 at 8. As production ends in the current mine units and restoration is completed, pumping rates will decline. *Id*. This provides further support for the NRC Staff's conclusion that a consumptive use rate of 495 gpm is not reasonably foreseeable.

4.238 The Intervenors did not specifically challenge the estimates of future drawdown from consumptive use, but Mr. Wireman did state that the differences in available head across the site could be a "concern." Exh. INT-081 at 4. His concern is unfounded. As a result of the natural orientation of surface topography and the underlying geologic surfaces of the Pierre Shale and Basal Chadron Sandstone, there is less available drawdown on the northern portion of the current licensed area. From the south to the north end of the mine, the surface topography declines by 543 feet. Exh. CBR-074 at 8-9. Over the same length, the Pierre Shale

surface rises from south to north an additional 104 feet. *Id*. at 9. The potentiometric surface within the Basal Chadron Sandstone along the same length exhibits only minimal northward decrease in elevation of 8 feet. *Id*. As a result of the orientation of these surfaces, available drawdown decreases northward in the northern portion of the current license area.

4.239 There was no evidence presented to suggest that drawdown within the mine site was adversely impacting others that draw water from the Basal Chadron or nearby water bodies.

6. Recovery

4.240 In addition to the drawdown from consumptive use, the assessment of impacts in the EA also considered whether aquifer levels would recover following cessation of operations. The NRC Staff in the EA concludes aquifer levels will eventually be restored naturally. Exh. NRC-010 at 83. Crow Butte agrees. Exh. CBR-008 at 22-23.

4.241 According to NRC Staff and Crow Butte witnesses, the Basal Chadron aquifer is a highly pressurized confined aquifer. Confined aquifers recover quickly compared to unconfined aquifers because they do not require re-saturation of the aquifer. The mining and restoration process does not de-water the aquifer pore space or de-saturate the aquifer skeleton; it merely depressurizes the system temporarily. *Id*. After uranium production and aquifer restoration are completed and ground water withdrawals are terminated, the ground water levels in the aquifer will recover relatively quickly with time. *Id*.; *see also* Exh. NRC-059. The elastic expansion of the aquifer skeleton (re-pressurization) is a rapid process.

4.242 Recovery rates of confined aquifers, such as the Basal Chadron aquifer, are generally far more rapid than those observed in shallow water-table aquifers. Exh. CBR-008 at 23. Mr. Lewis for Crow Butte testified (Tr. at 1322-1323) that characteristic of the confined

aquifer is rapid decline and recovery, generally mirroring one another. Mr. Lewis described "relatively rapidly" as 90% recovery "on the order of weeks." *Id*. And, the NRC Staff (Exh. NRC-001 at 92-93) calculated that the water levels will recover within ten feet of pre-operational values within five years after all extraction and injection have stopped. *See also* Tr. at 1324-1325; Exh. NRC-059 (figures showing predicted recovery following cessation of operations). The Intervenors' witnesses did not provide estimates of the recovery time.

4.243 In evaluating impacts in the EA, the NRC Staff witnesses testified that they considered water quality, water quantity, and potential impacts to surface water sources. Tr. at 1862-63. Mr. Back testified that, so long as the Basal Chadron remains saturated, Crow Butte's operations will not destabilize the resource. Tr. at 1694. As a result, the impact would be no greater than MODERATE, according to the NRC Staff witnesses. We agree with the NRC Staff that this is a reasonable criterion to apply in evaluating the impacts of consumptive use in a confined aquifer system.

4.244 Overall, we conclude that Crow Butte's mining activities will not cause drawdown in the Basal Chadron Sandstone aquifer below the top of the Basal Chadron Sandstone formation. Mining activities therefore will not destabilize the resource. The Basal Chadron aquifer is confined and will remain fully saturated. As a result, the aquifer should recover quickly once mining operations end. Consumptive use is well below levels that would have irreversible impact on resource.

4.245 Therefore, we find the NRC Staff's conclusion that that the short-term impact from consumptive use in restoration may be MODERATE to be reasonable. We also find the NRC Staff's conclusion that water levels would eventually recover after aquifer restoration, resulting in an overall SMALL impact from consumptive water use, to be reasonable.

G. Contention 9

1. Background

4.246 Contention 9 is entitled "the EA violates 10 C.F.R. §§ 51.10, 51.70 and 51.71, and NEPA and implementing regulations by failing to include the required discussion of ground water restoration mitigation measures." The Board admitted Contention 9 to the extent it alleges that the EA's discussion of ground water restoration mitigation measures is inadequate.

4.247 The Intervenors focus on a previously completed restoration that resulted in "uranium contaminant levels 18 times greater than baseline" and Crow Butte's experience that significant improvement could not be achieved by additional restoration efforts (*i.e.,* additional pore volumes). The contention asserts the need for more explanation and analysis related to restoration of water quality in the aquifer, the relationship to consumptive water use, and monitoring activities.

2. Restoration Standards

4.248 The goal of the restoration program is to return ground water contaminants on a mine unit average to the target concentrations on a parameter-by-parameter basis. Exh. CBR-008 at 9-10.

4.249 Under 10 C.F.R. Part 40, Appendix A, Criterion 5B(5), after termination of production activities the concentration of each hazardous constituent must be restored to not exceed (a) the background concentration, (b) the maximum values in the Criterion 5C Table, if the constituent is listed in the table and the background level is lower than the value in the table, or (c) an alternate concentration limit ("ACL") proposed by the licensee and established in accordance with Criterion 5B(6) of Part 40, Appendix A. The NRC established a license

condition to assure that baseline water quality is assessed in accordance with Criterion 5B(5). *See* LC 6.1.4 in the Final SER (Exh. NRC-009).

4.250 In the SER the NRC Staff recognized Crow Butte's commitment in the LRA to meeting the regulations in 10 C.F.R. Part 40, Appendix A, Criterion 5B(5) and concluded that the commitment is consistent with the regulations. Exh. NRC-009 at 55. For clarity, the NRC Staff imposed a license condition specifying that hazardous constituents shall be restored to the standards required by Appendix A. *Id*.; *see also* Exh. NRC-012 (Crow Butte license).

4.251 To be approved for an ACL, Crow Butte must demonstrate that for a constituent of concern it has made a reasonable effort to return the constituent to pre-operational baseline levels or to the Appendix A, Table 5C value (if applicable). Exh. CBR-008 at 11. This request for approval would be by a future license amendment application. No ACLs are at issue in this proceeding.

4.252 We find that the standards to be applied during restoration are consistent with NRC regulations.

3. Restoration Process

4.253 Restoration of an affected aquifer commences following cessation of ISR operations for a particular mine unit. The groundwater restoration process is described in Section 6.1.4.2 of the LRA (Exh. CBR-011). The current ground water restoration plan for the CBR facility mine units may consist of four activities: (1) ground water transfer; (2) ground water sweep; (3) ground water treatment; and (4) well field circulation.

4.254 Ground water transfer is the process of transferring ground water from the underground aquifer (typically from a mine unit commencing operations) to the mine unit

undergoing restoration. Exh. CBR-008 at 12-13. Higher TDS water from the mine unit in restoration will be injected into the mine unit commencing operation. This will lower the TDS in the restoration mine unit by displacing water affected by mining with baseline quality water. The recovered water may be passed though ion exchange ("IX") columns and filtration. This transfer approach reduces the amount of affected water ultimately sent to the wastewater disposal system.

4.255 During ground water sweep, water is extracted from all or portion of the former production zone with the injection system shutdown. *Id*. at 13. This causes an influx of baseline quality water to "sweep" across an affected portion of the aquifer. This can be applied to the entire mine unit or, as for the units currently undergoing restoration, only to the edges of the mine unit. *Id*.; *see also* Tr. at 1731-32. The extracted water must be sent to the wastewater disposal system during this activity.

4.256 In the treatment phase (full-scale restoration), ground water is pumped to treatment equipment and then re-injected into the well field. Exh. CBR-008 at 13. Full-scale treatment involves IX plus RO to lower the ion concentrations of the ground water in the extraction area. The IX columns exchange the majority of the contained soluble uranium for chloride and sulfate. The RO unit is used to reduce the total dissolved solids of the ground water, reduce the quantity of ground water that must be removed from the aquifer to meet restoration limits, concentrate dissolved contaminates to reduce the volume of brine and facilitate waste disposal, and enhance the exchange of ions due to differences in ion concentration. The RO unit produces clean water (permeate) and brine. *Id*.

4.257 A reductant may also be added at any time to the fluids circulated during restoration to lower the oxidation potential of the production zone and thereby render uranium

less mobile. *Id*. at 13-14; *see also* Tr. at 1882. A sulfide or sulfite compound also will be added to the injection stream in concentrations sufficient to reduce the mobilized species.

4.258 There also is a stabilization stage, which consists of monitoring the wells following successful completion of the restoration phase (return of concentrations to acceptable levels). The monitoring is intended to ensure that there is no increase in concentrations. The sampling frequency is one sample per month for a period of six months for NDEQ and one sample per quarter for the NRC. Exh. CBR-008 at 26-27; Exh. NRC-009 at Section 6.1.4(3). Restoration will be considered complete if six monthly samples and four consecutive quarterly samples show that the restoration values are maintained and that there are no significant increasing trends in any of the constituents of concern. Exh. CBR-011 at Section 6.1.5. After the stabilization period, Crow Butte will make a request to regulatory agencies to decommission the mine unit and terminate licenses as appropriate. Following regulatory approvals, wellfield reclamation, plugging, and abandonment will be completed as described in the LRA. Exh. CBR-008 at 15.

4.259 Dr. Kraemer claims that Crow Butte's proposed restoration strategy is the "short-term sequestration (stabilization) of contaminants by the addition of reductants" and claims that the effects are temporary. Exh. INT-046 at 4. He provides no evidence, however, to support his claim. As noted above, Crow Butte must conduct restoration stability monitoring specifically to confirm that hazardous constituents do not increase in concentration above the Criterion 5B(5) restoration standards subsequent to restoration.

4.260 And, as discussed in the SER (Exh. NRC-009), Section 6.1.4(3), the NRC Staff actually *increased* the stability monitoring requirements during the license renewal period. The NRC Staff imposed a license condition that requires quarterly monitoring of all constituents

of concern at the specified ore zone aquifer wells until stability for all constituents of concern (*i.e.*, no statistically significant increasing trend) is established over at least four consecutive quarters.

4.261 We find that Crow Butte has in place a process for conducting restoration activities, including adequate stabilization monitoring, to meet the restoration standards.

4. Mitigation of Leaks and Spills During Restoration

4.262 A network of buried pipelines is used during ISR operation and restoration for transporting fluids between the pump house and the satellite or processing facility. Although the liquids carried in these pipes during restoration are less hazardous than during the operation phase, the failure of pipeline fittings or valves, or failures of well mechanical integrity, could result in leaks or spills of these fluids, which could impact ground water quality. Similarly, the waste storage ponds continue to operate during restoration, and any leaks would impact shallow ground water.

4.263 To mitigate the impacts of leaks or spills, Crow Butte maintains continuous real-time monitoring and control systems to detect and mitigate potential spills and leaks that would impact groundwater. Exh. CBR-011 at Section 3.3. The monitoring and mitigation activities for ground water aquifers during operations are also described in EA Section 4.6.2.2 (Exh. NRC-010). These measures will continue during the restoration phase.

4.264 Crow Butte also maintains an extensive water sampling program to identify potential impacts to water resources in the area. The groundwater monitoring program is described in Section 5.8.8.2 of the LRA (Exh. CBR-011) and Section 5.7.9.3.1 of the SER (Exh. NRC-009). Operational monitoring for all mine units includes sampling of monitoring wells and private wells within and surrounding the license area to establish pre-mining baseline

water quality and to identify excursions into the ore zone aquifer outside of the wellfield and into the overlying water bearing strata.

4.265 If limits are exceeded in a monitor well in 2 of three values or if one value is exceeded by 20 percent, the well is resampled within 48 hours and analyzed for excursion indicators. Exh. CBR-008 at 26. If an exceedance verified, the well in question is to be placed in excursion status and the NRC is to be notified. Corrective actions are initiated as described in the LRA (Exh. CBR-011 at 5-124). Sampling frequency of the monitor well in question is also increased.

4.266 Overall, we find that the NRC Staff's evaluation of groundwater restoration impacts (and mitigation of those impacts) is reasonable. Crow Butte developed a calibrated groundwater flow model that will be applied to restoration activities going forward. The effectiveness of the model has been demonstrated for Mine Units 2 and 3. Application of the model will minimize the number of pore volumes necessary for restoration, as well as related impacts on consumptive use.

4.267 With respect to groundwater quality, we find that Crow Butte must restore groundwater quality to levels that satisfy the conditions set in its NRC license. Those restoration standards are linked to baseline conditions/background, the maximum values for groundwater protection in Part 40, Appendix A, Table 5C, or alternate concentration limits (ACLs) established by the NRC.[55] Restoration to those standards — levels that are either consistent with

[55] ACLs will, as previously discussed, require an additional regulatory approval only that will be granted only after Crow Butte demonstrates, among other requirements, that the limits are "as low as reasonably achievable" and that the constituent "will not pose a substantial present or future hazard to human health or the environment." Part 40, Appendix A, Criterion 5B(6).

baseline conditions or, by definition, protective of human health and the environment — will result in SMALL environmental impacts.

4.268 We further find that Crow Butte has considered, and implemented, measures to prevent or mitigate leaks and spills associated with its operations, including during restoration.

H. Contention 12

1. Background

4.269 Contention 12 is entitled "[t]he EA omits a discussion of the impact of tornadoes on the license renewal area, and inadequately discusses the potential impacts from land application of ISL mining wastewater." Contention 12 therefore involves two distinct issues: tornados and land application. While the LRA and the Safety Evaluation Report both address the risks associated with tornados, the EA itself does not explicitly discuss them. The intervenors also argue that the NRC Staff failed to account for potential impacts from land application of wastewater, including selenium.

2. Tornados

4.270 While the Intervenors claim that the EA improperly omitted discussion of tornadoes, they did not present any affirmative evidence, facts, or expert opinion to suggest that tornados pose a significant risk of an environmental impact at the site, nor do they rebut any of Crow Butte's statements about tornados in the LRA or the NRC Staff's discussion of tornados in the SER.

4.271 Because the Intervenors did not present any testimony on tornadoes in their direct, rebuttal, or supplemental testimony, they have waived this issue in this proceeding. *See Long Island Lighting Co.* (Shoreham Nuclear Power Station, Unit 1), LBP-82-115, 16 NRC

1923, 1935, 1936 (1982) (An intervenor's intentional waiver of the right to present witnesses amounts to an effective abandonment of their contention).

4.272 Regardless, the NRC Staff explained that the annual probability of a tornado at the site, though perhaps higher than that discussed in the SER, is still low enough that additional protections are not warranted. Tr. at 2003-04. In addition, the site maintains appropriate emergency response plans and procedures in case of a natural disaster, such as a tornado. Exh. CBR-010 at 4. These Emergency Response Plans, which address the need to contain potential or uncontrolled releases and take other corrective actions as necessary and appropriate, would be used to avoid or mitigate impacts from a tornado or other natural hazards (*e.g.*, wildfire). *Id*.

3. Land Application

4.273 The Intervenors' witness, Ms. Linsey McLean, testified that Crow Butte's use of land application as a method of wastewater disposal will have significant environmental impacts. However, as all parties agree, Crow Butte does not use land application as a wastewater disposal method, has not constructed the necessary facilities for land application disposal of wastewater, and has no plans or intentions to start land application of wastewater in the future.

a. Current Status

4.274 The current permit does allow for disposal of wastewater by land application. The NRC approved the current land application provisions for Crow Butte in a 1993 license amendment. NRC Memorandum from J. Grimm, "Land Application of Restoration Waste Water – Ferret's Crow Butte ISL Facility," dated November 16, 1993 ("1993 Amendment Memo") at 1 (Exh. CBR-042).

4.275 If Crow Butte were to decide in the future to use land application, it would need to construct additional treatment infrastructure. Exh. CBR-010 at 5. Prior to discharge, the wastewater would be processed to remove uranium and radium, treated to adjust pH, and then passed through reverse osmosis equipment to remove metals and other contaminants, including selenium. *Id*. citing Exh. CBR-042. The limits for these substances are based on NRC, EPA, and State of Nebraska standards.

4.276 The maximum limit for selenium is 0.05 mg/L, however, the reverse osmosis equipment is able to reduce selenium concentrations to <0.001 mg/L. Exh. CBR-042 at 4. Water quality is tested prior to any discharge to ensure compliance with the water quality standards. *Id.* at 5-6. The areas subject to land application are also subject to periodic soil, ground-water, and surface-water testing to monitor potential impacts. *Id.* at 5. The discharge rate for treated water is set at a specific rate which prevents soil saturation beyond two feet in depth (limiting ground-water impact), while also avoiding surface runoff. *Id*.

4.277 For these reasons, when the NRC Staff previously evaluated the environmental impacts of land application at Crow Butte, it concluded that land application would not have an environmental impact. Exh. CBR-044 at 33. The 2014 SER (Exh. NRC-009 at 59) and EA (Exh. NRC-009 at 85-86), relying on the 1998 EA, similarly determined that land application would not have an environmental impact.

4.278 The NRC Staff's conclusion was based, at least in part, on Crow Butte's National Pollutant Discharge Elimination System ("NPDES") permit from the Nebraska Department of Environmental Quality ("NDEQ") that authorizes Crow Butte to conduct land application of wastewater. Among other things, the permit provides that "[d]ischarges shall not be permitted to enter waters of the State under any circumstance and without exception."

NPDES Permit, dated October 3, 2011, at 3 (Exh. CBR-043). Land application under the NPDES permit is also limited to times after certain weather conditions have occurred. The permit also sets a number of other site prohibitions. And, the NPDES permit contains monitoring and recording requirements, and sets specific water quality limits on chemical oxygen demand, total suspended solids, zinc, radium-226, uranium, and pH. *Id.* at 4. Limits for other parameters are set by Nebraska regulations, including a limit for selenium of 0.05 mg/L.[56]

b. Bioaccumulation

4.279 Intervenors raised the issue of whether land application would result in increases in selenium concentrations due to bioaccumulation, which they posited could in turn cause toxicity in wildlife. In support of this point, Intervenors cite a 2000 U.S. Fish and Wildlife Service study and a 2007 letter from FWS to NRC commenting on NRC's then-proposed Generic Environmental Impact Statement for Uranium Mining Facilities.[57] However, review of the FWS Report and FWS Letter shows that the concerns raised in the report and letter are not applicable to Crow Butte.

4.280 Crow Butte is not currently engaging in land application of wastewater and has no plans to do so. Exh. CBR-010 at 5. Thus, the findings in the FWS Report and FWS Letter are hypothetical and speculative as applied to Crow Butte.

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[56] Nebraska Administrative Code Title 118, chapter 4(002). To the extent that the levels for chemical oxygen demand, total suspended solids, zinc, radium-226, uranium, and pH in the NDEQ permit differ from those provided for in Title 118, this serves to conform the levels in the permit with those provided for in EPA regulations related to in-situ leach uranium mining. 40 C.F.R. § 440.32(a).

[57] OST Ex. O, Pedro Ramirez, Jr. & Brad Rogers, *Selenium in a Wyoming Grassland Community Receiving Wastewater from an In Situ Uranium Mine* (2000) (Exh. INT-019) ("FWS Report"); OST Ex. N, Letter from USFWS to NRC (Sept. 5, 2007) (Exh. INT-018) ("FWS Letter").

4.281 Even assuming Crow Butte were to begin land application of wastewater per its NRC license and NDEQ permit, the situation described in the FWS Report and FWS Letter are not comparable to the potential land application at Crow Butte. First, in the FWS Report, the mining wastewater which was subject to land application had a selenium content of 1000-2000 µg/L (1-2 mg/L), and these concentrations were allowed under the site's relevant permit from the Wyoming Department of Environmental Quality. FWS Report at 1. At Crow Butte, the maximum level of selenium allowed in wastewater for land application is 0.5 mg/L, which is two to four times lower than that at the FWS Report site.

4.282 Further, due to the required processing and treatment of wastewater before land application, the expected level of selenium in discharged wastewater at Crow Butte would be <0.001 mg/L, which is 1000 to 2000 times lower than levels at the FWS Report site. Exh. CBR-010 at 10.

4.283 Ms. McLean's testimony (Exh. INT-048) addresses the consequences of selenium contamination, but nowhere provides a site-specific assessment of the potential for such contamination at Crow Butte — particularly given the currently-available infrastructure and the existing NPDES permit.

4.284 We find that her generalized assertions provide no information that calls into question the conclusions of the LRA, SER, or EA regarding land application of wastewater and its potential impacts.

c. Evaporation Ponds

4.285 Ms. McLean's testimony focuses in large part on evaporations ponds, which were not part of the admitted contention. Nevertheless, to ensure a comprehensive record, we address her concerns with the evaporation ponds.

4.286 The evaporation ponds at Crow Butte are not designed as leach ponds. They are described by the EPA as *Non-Conventional Impoundments*, which includes evaporation holding ponds. Exh. CBR-054 at 3. The design requirements for the ponds are derived from the Resource Conservation and Recovery Act ("RCRA") requirements for impoundments. The design of the ponds was submitted to the NRC for approval prior to construction and were designed with the liner and leak detection system prescribed at 40 C.F.R. § 192.32(a).

4.287 Crow Butte is required to maintain a minimum "freeboard" to accommodate rain events. Exh. CBR-054 at 3. Crow Butte is also required to keep the sediments in the pond covered by liquid. *Id*.

4.288 During decommissioning the remaining liquids in the ponds will be processed through the Pond Water Treatment circuit, which is currently in place, to remove uranium. Exh. CBR-054 at 3. The remaining water will be disposed of in the deep disposal well. The remaining sludge will be de-watered and sent to an 11(e).2 disposal facility or to an alternate feed mill. The liners will be removed and sent to an 11(e).2 disposal facility. The soil beneath the ponds will be surveyed and tested for contamination and, if necessary, disposed of accordingly. The ponds will be filled in and the top soil that has been stockpiled will be placed on top and seeded back to native grasses.

4.289 Ms. McLean's characterization of the pond liner as similar to plastic in soda bottles is incorrect. The liner system is constructed of a double geomembrane liner over the entire pond interior with geonet between the two synthetic liners. Exh. CBR-054 at 4. A leak detection system was also incorporated within the liner during installation. The liners were installed over a compacted base. A clay liner was not used. *Id*. Moreover, the HDPE plastic

that is used is designed specifically for use in evaporation ponds, not for use in the food and bottled water industry. Exh. CBR-054 at 4.

4.290 The seams in the pond liner are fusion welded and are re-welded if discovered to have failed. *Id*. In December 2013, an evaluation of the liners was performed by a third party. The liners were found to be in satisfactory condition for continued operation. *Id*.

4.291 Since Crow Butte currently does not use land application, does not have the facilities to do so, and does not have plans to begin land application, there is no current or reasonably foreseeable environmental impact. And, even if Crow Butte were to begin land application of wastewater as provided for in its NRC license and NDEQ permit (and there is no indication this will actually happen), the environmental impact would be minimal. We find that the NRC license and NDEQ permit together impose stringent limits on the use of land application. Any land application wastewater is subject to water quality limits derived from NRC, EPA, and State of Nebraska rules. And, in practice, the pre-discharge processing and treatment results in water quality that is well below those limits.

4.292 Water must be tested before discharge to ensure compliance with water quality limits, and the land application area is also subject to periodic post-discharge monitoring and testing to ensure that long-term environmental impacts, if any, are small. The rate and manner by which water may be discharged is also designed to prevent both ground-water impacts and surface runoff. Areas of the site where land application of treated water has been used are included in decommissioning surveys to ensure soil concentration limits are not exceeded.

4.293 For these reasons, we find the NRC Staff's determination that the impacts, if any, to soil or wildlife from land application of treated wastewater would be SMALL to be reasonable.

I. Contention 14

4.294 Contention 14 asserts that "[t]he EA violates NEPA in its failure to provide an analysis of the impacts on the project from earthquakes; especially as it concerns secondary porosity and adequate confinement."[58] The only bases for the contention is the claim that the EA omitted two earthquakes near Chadron in 2011 (the LRA was submitted in 2007) and Dr. LaGarry's claim that even small earthquakes can alter the secondary porosity of an aquifer and modify groundwater flow patterns (affecting confinement). The Licensing Board also raised an issue regarding the EA's focus on seismology in Nebraska, rather than other nearby states.

4.295 The Crow Butte permit area in northwest Nebraska is within the Stable Interior of the United States. Exh. CBR-001 at 27. The project area, along with most of Nebraska, is in seismic risk Zone 1 on the National Seismic Hazard Maps. Most of the central United States is within seismic risk Zone 1 and only minor damage is expected from earthquakes that occur within this area. *Id*., *see also* Marsland Environmental Report at Section 3.3.1.4 (Exh. CBR-021).

4.296 In general, seismic hazard maps estimate that the LRA and City of Crawford area are at the low end of the USGS's hazard ranking system for earthquake risks. Exh. CBR-001 at 27-28. For example, the modeled peak acceleration due to seismic shaking in the City of Crawford area is very low: 6-8%g for the majority of the immediate area and 8-10%g in a much smaller area, meaning that the maximum shaking due to any given earthquake in the

[58] In many ways, this contention overlaps with Contention D, which alleges the potential for contamination via faults and fractures (secondary porosity).

region during a 50-year period would be equivalent to only 10 percent or less of the force of gravity at Earth's surface. *Id*. at 28.

4.297 Although the License Area is within an area of low seismic risk, occasional earthquakes have been reported and were documented in the LRA and in subsequent documents. *See, e.g.*, Exh. CBR-021. According to witnesses, references made to Modified Mercalli intensities of earthquakes in the region in the LRA (*see* LRA Table 2.6-3) may not be representative of earthquake intensity at the license area because intensities are typically reported for sites near the earthquake epicenter. The reported intensities, which range from II (weak) to VII (very strong), should be considered maximum intensities, which generally decrease with distance. In any event, the LRA notes that all but two of these earthquakes range from not felt (Intensity I) to light (Intensity IV).

4.298 With respect to the geographic scope of the earthquakes cataloged in the LRA and EA, we recognize that subsequent documents have expanded upon the seismology discussion — *see, e.g.*, Marsland ER, Section 3.3.1.4 (Exh. CBR-021) — to evaluate earthquakes across a wider geographic range, recent earthquakes, and updated USGS seismic hazard data. According to Crow Butte and NRC Staff witnesses (see, e.g., Exh. NRC-001 at 108; Tr. at 1656-1657), inclusion of additional data does not change overall interpretations of seismicity or seismic risks within the general Crow Butte mining area.

4.299 Although the region is tectonically active (as evidenced by the continued Black Hills Uplift), there is no evidence of significant regional seismic activity that would be likely to generate a new fault, fracture, or contaminant pathway at the license area. Exh. CBR-001 at 30. In the unlikely event that such a fault or fracture capable of generating a contaminant pathway were to occur in a location that affected confinement of the mined aquifer, it would

likely have an observable impact on wellfield operations and would trigger corrective or remedial actions. *Id*.

4.300 Crow Butte has not observed operational impacts from prior earthquakes within the region. *Id*. at 29. For example, Crow Butte did not observe any effects at the site from the two earthquakes in 2011 that were noted by the Intervenors.

4.301 Overall, we conclude that the discussion of seismology in the LRA, EA, and SER, as supplemented by the testimony at the evidentiary hearing, provides a reasonable basis for concluding that impacts from earthquakes will be SMALL.

V. CONCLUSIONS OF LAW

A. Contention A

5.1 We conclude that the available data and evidence demonstrate that the non-radiological (as well as the radiological) impacts of Crow Butte's operations are SMALL. Crow Butte has established through multiple lines of evidence — borehole logs, laboratory tests, water quality, water levels, aquifer pump tests, and operational experience — that the Basal Chadron Sandstone aquifer, where mining occurs, is isolated from overlying aquifers. In addition, Crow Butte conducts its operations to maintain hydraulic control over mining fluids and maintains an extensive environmental monitoring network to confirm control over mining fluids.

5.2 In short, mining fluid from Crow Butte's operations will not migrate beyond the license area or contaminate the aquifers that supply drinking water to the Pine Ridge Reservation. As importantly, Crow Butte's operations have not contaminated the drinking water at the Pine Ridge Reservation, nor has it contaminated any drinking water between the site and the Pine Ridge Reservation.

5.3 In addition, Crow Butte has established that parameters other than uranium provide better indications of potential excursions and also that biweekly monitoring is adequate to detect potential excursions.

5.4 For these reasons, we conclude that NRC Staff and Crow Butte have shown, by the preponderance of the evidence, that the NRC's EA, as supplemented by the testimony and evidence in this proceeding, reflects the requisite "hard look" at the non-radiological impacts of Crow Butte's operations. Contention A is resolved in favor of Crow Butte and the NRC Staff.

B. Contention C

5.5 We conclude that Crow Butte has taken active steps to minimize the potential for surface and subsurface leaks or spills that have the potential to cause environmental harm to the White River, including use of berms or dikes to protect these waterbodies and other operational constraints. Regular monitoring of Squaw and English Creeks shows that Crow Butte's operations are not adversely impacting surface waters in the mine area. If leaks and spills were to occur, Crow Butte is required to take immediate corrective actions, including restoration of the environment.

5.6 Moreover, Crow Butte maintains an extensive environmental monitoring network that will detect migration of mining fluids beyond the license area, including testing of water quality in private wells outside the mining area. Regular monitoring of at the monitoring well ring and in nearby, but offsite private wells, confirms that Crow Butte's operations are not adversely impacting subsurface waters outside the mine area.

5.7 We find that there is no data to indicate impacts from Crow Butte's operations to the White River, the White River alluvium, or the Brule aquifer outside the mine site.

5.8 For these reasons, we conclude that Crow Butte and the NRC Staff have shown, by the preponderance of the evidence, that the NRC Staff's EA, as supplemented by the testimony and evidence in this proceeding, adequately characterizes the risk of harm to surface waters, including from surface spills and subsurface migration. The EA reflects the requisite "hard look" at the potential impacts of Crow Butte's operations on nearby surface water features. Contention C is resolved in favor of Crow Butte and the NRC Staff.

C. Contention D

5.9 We conclude, based on multiple lines of evidence, that the Basal Chadron Sandstone aquifer, where mining occurs, is hydrologically isolated from overlying aquifers and that Crow Butte conducts its operations to maintain hydraulic control over mining fluids and maintains an extensive environmental monitoring network to confirm control over mining fluids.

5.10 We conclude that there is no evidence of faults or fractures that could transmit mining fluid into aquifers that provide drinking water to the Pine Ridge Reservation.

5.11 Because of the absence of any impacts beyond the mining area, much less impacts over 30 miles away at the Pine Ridge Reservation,[59] there was no need for the NRC Staff to include the Pine Ridge Reservation in the environmental justice analysis.

5.12 For these reasons, we conclude that Crow Butte and the NRC Staff have shown, by the preponderance of the evidence, that the NRC Staff's EA, as supplemented by the testimony and evidence in this proceeding, adequately characterizes the risk of communication

[59] (MS) To the best of my knowledge, I am aware of no contaminant plume in history that has migrated that distance.

among aquifers. The EA reflects the requisite "hard look" at the potential impacts of Crow Butte's operations on nearby aquifers. Contention D is resolved in favor of Crow Butte and the NRC Staff.

D. Contention F

5.13 We conclude that, while there have been recent studies of the regional geology that have resulted in the proposal of a new nomenclature for some of the geologic units within the license area, including proposals by Dr. LaGarry, these studies do not indicate that any portion of the application was inadequate.

5.14 In discussing regional geology, Crow Butte, the NRC Staff, and NDEQ continue to use the nomenclature found in the prior license applications for consistency and to facilitate public review and comparison. Stratigraphic nomenclature aside, nothing in the naming conventions for the geologic units in Nebraska or at the Crow Butte facility changes the interpretation of the physical or hydrologic features of the geologic units presented by Crow Butte.

5.15 We therefore conclude that the NRC Staff in its SER, as supplemented by the testimony and evidence in this proceeding, has by the preponderance of the evidence demonstrated that Crow Butte's application satisfies NRC requirements. Contention F is resolved in Crow Butte's favor.

E. Contention 1

5.16 Because the Crow Butte project area has been subjected to intensive cultural resources field surveys for archaeological and historical sites and because the five remaining properties evaluated as "potentially eligible" for the NRHP are being actively avoided

during all phases of the overall project, there will be no effects to the known and recorded cultural resource sites from license renewal.

5.17 In addition, the license conditions mandating that Crow Butte stop work upon discovery of new cultural resources ensure that newly-discovered cultural resources will be treated appropriately.

5.18 We conclude that the NRC Staff made a reasonable and good faith effort to identify and evaluate properties eligible for inclusion on the National Register of Historic Places. The Staff invited all interested tribes, including OST, to participate in the identification efforts. The NRC Staff also provided all interested tribes a reasonable opportunity to identify historic properties, advise on the identification and evaluation of such properties, and comment on the draft evaluation. OST voluntarily elected not to participate in the consultation process by providing comments on the draft EA, by submitting a proposed Statement of Work for a TCP survey, or by conducting a TCP survey. OST's inability or unwillingness to participate in consultation activities must be taken into account when determining whether the NRC has met the NHPA's "reasonable and good faith" standard. It would be a strange outcome indeed if a party could simply refuse to participate in a process but then succeed in litigation based on their lack of participation.

5.19 We further conclude that the NRC Staff engaged with the tribes, including OST, on a government-to-government basis through the consultation process. The NRC Staff invited the tribes to participate on a government-to-government basis, treated them as separate and independent governmental entities (*i.e.*, did not communicate with them through the Department of Interior), corresponded directly with both tribal leaders and THPOs (the tribe's

designated representatives for Section 106 matters), and ensured that NRC officials with appropriate decision-making authority were present during meetings with tribes.

5.20 Based on the above, we conclude that the NRC Staff's EA, as augmented by the testimony and evidence in this proceeding, reasonably considers the impacts to known and recorded cultural resources, including traditional cultural properties.

5.21 We further conclude that the NRC Staff has, by the preponderance of the evidence, demonstrated that overall impacts to historic and cultural resources from the relicensing of the Crow Butte facility would be SMALL and that the NRC Staff satisfied the consultation requirements of the NHPA.

5.22 For these reasons, the EA reflects the requisite "hard look" at impact to cultural resources and the NRC Staff has complied with the NHPA. Contention 1 is resolved in favor of Crow Butte and the NRC Staff.

F. Contention 6

5.23 We conclude that the NRC Staff and Crow Butte have considered the environmental impacts of consumptive water use during restoration in both the short term and the long term. We find the NRC Staff's conclusions that short term impact from consumptive ground water use is MODERATE and the long-term impact is SMALL to be reasonable. Short term consumption will not destabilize the resources and water levels will recover relatively quickly once operations cease. Based on current and future practices, these characterizations are bounding.

5.24 For these reasons, we conclude that the NRC Staff and Crow Butte have shown by the preponderance of the evidence that the NRC Staff's EA, as supplemented by the testimony and evidence in this proceeding, adequately characterizes the impacts of consumptive

use during restoration. The EA reflects the requisite "hard look" at the impacts of consumptive use. Contention 6 is resolved in favor of Crow Butte and the NRC Staff.

G. Contention 9

5.25 We conclude that the NRC Staff and Crow Butte have considered the environmental impacts of restoration. The EA, as supplemented by the testimony in this proceeding, adequately describes the restoration standards, the restoration process, and reasonable measures to mitigate the impacts of consumptive water use and to control and to mitigate impacts on groundwater water quality (*e.g.,* monitoring, treatment, and standards).

5.26 For these reasons, we conclude that the NRC Staff and Crow Butte have shown by the preponderance of the evidence that the NRC Staff's EA, as supplemented by the testimony and evidence in this proceeding, adequately characterizes the potential impacts of restoration. The EA reflects the requisite "hard look" at the impacts of the restoration process. Contention 9 is resolved in favor of Crow Butte and the NRC Staff.

H. Contention 12

5.27 The Intervenors did not present any affirmative evidence, facts, or expert opinion to suggest that tornados pose a significant risk of an environmental impact at the site, nor do they rebut any of Crow Butte's statements about tornados in the LRA or the NRC Staff's discussion of tornados in the SER. Having failed to do so, they have waived this issue in this proceeding. *Shoreham*, 16 NRC at 1936.

5.28 Regardless, we conclude that the NRC Staff's SER and EA, as supplemented by the record in this proceeding, demonstrate by the preponderance of the evidence that the risk of a tornado impact is low and that there are adequate emergency response

plans and procedures in place in case of a natural hazards phenomenon, such as a tornado, that would mitigate the impact if a tornado did occur at the site.

5.29 We further conclude that land application of wastewater is not reasonably foreseeable and therefore need not be discussed in the EA because Crow Butte does not currently practice land application, does not have the appropriate facilities to do so, and has no plans to start doing so.

5.30 Nevertheless, we agree with Crow Butte and the NRC Staff that agency has considered the potential environmental impact of land application should it occur in the future, as allowed under its NRC license and NDEQ permit. We conclude that the NRC Staff reasonably determined that the impacts, if any, to soil or wildlife from land application of treated wastewater would be SMALL.

5.31 We find that, by the preponderance of the evidence, the NRC Staff's EA, as supplemented by the record in this proceeding, reflects the requisite hard look at the impacts of land application.

5.32 For these reasons, Contention 12 is resolved in favor of Crow Butte and the NRC Staff.

I. Contention 14

5.33 We find that the NRC Staff and Crow Butte have adequately considered the potential impacts of earthquakes at the site, including the potential for significant changes in hydrogeological conditions (*e.g.*, newly formed fractures or faults).

5.34 For these reasons, we find by the preponderance of the evidence that the NRC Staff's EA adequately characterizes the risk of earthquakes and reflects the requisite "hard

look" at the potential impacts of earthquakes on Crow Butte's operations. For these reasons, Contention 14 is resolved in favor of Crow Butte and the NRC Staff.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket No. 40-8943
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal)	)	

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 this 23rd day of November 2015 via electronic mail to Consolidated Intervenors' counsel at davidcoryfrankel@gmail.com, Arm.legal@gmail.com, and harmonicengineering@gmail.com, and 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 other than Consolidated Intervenors.

/s/ signed electronically by
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