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July 28, 2008 (11:59pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543 July 28, 2008

United States Nuclear Regulatory Commission Official Hearing Exhibit
In the Matter of: CROW BUTTE RESOURCES, INC. (License Renewal for the In Situ Leach Facility, Crawford, Nebraska)
ASLBP #: 08-867-02-OLA-BD01
Docket #: 04008943
Exhibit #: INT-001-00-BD01
Admitted:
Rejected:
Other:
Identified: 8/18/2015
Withdrawn:
Stricken: 8/18/2015

CONSOLIDATED REQUEST FOR HEARING AND PETITION FOR LEAVE TO INTERVENE

Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Sir or Madam:

Pursuant to 10 CFR Section 2.309, each of the following requestor/petitioner states that he, she or it has an affected interest in this matter and desires to participate as a party and files this request for hearing and petition for leave to intervene and a specification of the contentions which should be litigated.

A hearing should be granted and the undersigned should be entitled to participate in it if he, she or it has shown standing and has proposed at least one admissible contention that meets the requirements of Section 2.309(f).

This request/petition is timely filed on July 28, 2008 based on the FRN published at 73 Fed. Reg. 30426 (May 27, 2008) (the "FRN"). Capitalized terms that are not defined herein have the meanings assigned to them in the License Renewal Application ("LRA") which contains a combined Technical Report and Environmental Report filed by Applicant Crow Butte Resources, Inc. d/b/a Cameco Resources ("Applicant") on

Template Secy-037

DS-03

November 27, 2007. The LRA was found acceptable by NRC Staff letter dated March 28, 2008.

Each requestor/petitioner notes that Section 2239(a)(1)(A) of the Atomic Energy Act, as amended, provides that in any proceeding for the amending of any license, the Commission shall grant a hearing upon the request of any person whose interest may be affected by the proceeding, and shall admit any such person as a party to such proceeding.

Background:

Certain of the requestor/petitioners, namely Debra White Plume, Owe Aku, and Western Nebraska Resources Council ("WNRC"), are requestor/petitioners in a concurrent proceeding on CBR's proposed "North Trend Expansion," ASLBP No. 07-859-03-MLA-BD01 (the "Expansion Proceeding.") The North Trend Expansion is the subject matter of the Expansion Proceeding and the related proposed amendments to CBR's License which are described in the North Trend Expansion Application are referred to in the LRA as the "Satellite Facility." See, e.g., LRA Section 7.12.4.2.

The Board in the Expansion Proceeding issued a decision on April 29, 2008 (corrected May 29, 2008), LBP-08-06, finding that the foregoing three requestor/petitioners had standing and at least three admissible contentions, reframed by the Board as Contention A, Contention B and Contention C. Id. at 128. The Board also heard additional oral argument in the Expansion Proceeding on July 23, 2008 on the issues of whether Contention E (concerning foreign ownership of CBR) should be

admitted and also whether the procedures of Subpart G should apply to the Expansion Proceeding.

Requestor/Petitioners:[1]

Each Requestor/Petitioner is located within the 80 Km radius of the Licensed Area and is in the pathway of contaminants from the ISL uranium mining operations of Applicant CBR described in the LRA. These pathways are further described in the geologic and stratiagraphic opinion letter of Dr. Hannan LaGarry, and the opinion letter of Paul Robinson, experts in support of Requestor/Petitioners. In summary, CBR's operations are mining uranium in mineralized fractures and faults which cause inter-connection between the aquifer being mined and other aquifers being used for drinking and other purposes in and around Crawford and Chadron, Nebraska, Hot Springs, South Dakota and Pine Ridge Indian Reservation. More detailed information concerning the Petitioners is set forth below in "Discussion of Requestor/Petitioners."

A. **Individuals**

Beatrice Long Visitor Holy Dance(I)(T)
Joe American Horse, Sr.(I)(T)
Debra White Plume(I)(T)
Loretta Afraid of Bear Cook(I)(T)
Thomas Kanatakeniate Cook(I)
Dayton O. Hyde
Bruce McIntosh

B. **Organizations**

[1] Indigenous (Native American) Petitioners are denoted by an "(I)", and beneficiaries of the Ft. Laramie Treaty of 1851 and the Ft. Laramie Treaty of 1868 are denoted by a "(T)."

Afraid of Bear/Cook Tiwahe, by Thomas Kanatakeniate Cook(I)(T)

American Horse Tiospaye, by Joe American Horse, Sr.(I)(T)

Owe Aku, Bring Back the Way, by Debra White Plume(I)(T)

Western Nebraska Resources Council, by Bruce McIntosh, Vice-Chairman

C. Experts, Supporting Documents and References

The following documents, articles and information are hereby incorporated by reference as if set forth at length herein:

1. Expert Opinions.

(a) Opinion of Geologist Richard Abitz of Geochemical Consulting Services, LLC by letter dated July 28, 2008 ("Abitz Opinion"), which is incorporated herein by this reference as if fully set forth at length herein.

(b) Opinion of Dr. Hannan LaGarry, July 2008 ("LaGarry Opinion"), which is incorporated herein by this reference as if fully set forth at length herein.

(c) Opinion of JR Engineering, LLC by letter dated July 28, 2008 ("JR Engineering Opinion"), which is incorporated herein by this reference as if fully set forth at length herein.

(d) Opinion of Paul Robinson by letter dated July 28, 2008, together with all attachments thereto ("Robinson Opinion"), which are incorporated herein by this reference as if fully set forth at length herein.

2. Source Documents

Baseline Hydrogeochemical Investigation in a Part of Northwest Nebraska, A Report Prepared for the Nebraska Department of Environmental Control, by The Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, 68588, 402-472-3471, Roy Spaulding, Principal Investigator (June 1, 1982).

Environmental Assessment, Monitoring and Remediation of Uranium Mining: An Independent Reflection on the Role of Community and Advocacy Groups, Mudd, GM (2008) In "Low environmental impact uranium mining and remediation: 25 years of multinational experience through UMREG", IAEA Monograph, p 10 (Accepted for Publication, release due late 2008).

List of CBR Violations, Spills and Leaks, prepared by Shane Robinson on behalf of Western Nebraska Resources Council, as of July 28, 2008

Nebraska Department of Environmental Equality v. Crow Butte Resources, Inc., Complaint and Consent Decree, District Court of Lancaster County, NE (May 23, 2008)

3. Incorporation of Publicly Filed Documents by Reference to ADAMS

- Consolidated Response to the NRC & Applicant ML081760301
  - re Contention E & Subpart G
- Attachments & the May 23 Brief on Contention E/Subpart G ML081570141
  - 1984 Elliot Analysis
  - 1988 Dec. State Briefing Notes
  - 1989 GJEL Steen Ltr
  - 1989 McGuire Ltr
  - 1989 NE Atty Gen Ltr to Dec.
  - 1989 NE Atty Gen Press Release
  - 1989 Petersen Ltr
  - 1989-Aug-11 Ltr to NE Atty Gen
  - 1989-July-22 Ltr to NE Atty Gen
  - 1990 McGuire Ltr
  - 1990 –Jan-29 NE Atty Gen Ltr to Dec.
  - 1991 WNRC Interrogatories
  - 1993-June-06 DOE Order 5634.3 06141993 re Foreign Control
  - 1996-Oct-14, Cameco history
  - 1998-apr-17, camceo
  - 2008-Mar, Cameco 2007 Annual Info Form
  - Cameco Prospectus
- Answer to Staff's Notice of Appeal & Opp. To Interlocutory Review ML081490597
- Answer to Applicant's ML081490596
  - Notice of Appeal & Opp. To Interlocutory Review
- April 29th, Memo and Order ML081200636
- Reply in support of Motion to File a brief amicus curiae ML080800086
  - Center for Water Advocacy, RtE, and Robert Lippman
- Response to NRC Brief regarding treaties, etc. ML080720327
- Response to Applicant's Brief regarding treaties, etc. ML080720326
- Affidavit of Winona LaDuke ML080700706
- Affidavit of Rita Long Visitor Holy Dance ML080660092
- Notice of Appearance and Leave to File Brief Amicus Curiae ML080590472
  - Center for Water Advocacy, RtE, and Robert Lippman
- Affidavit of Beatrice Long Visitor Holy Dance ML080660093
- OST's Brief of Amicus Curiae ML080660206
- Memo of Law regarding Indigenous Rights, Treaties and Indian Law ML080640548
- Affidavit of Mona Ann Polacca ML080660091
- Affidavit of Flordemayo ML080660094
- Affidavit of Harvey Whitewoman ML080660097

- Combined Reply to NRC & Applicant's Responses to Exhibits A & B ML080570595
- Supplemental Affidavits of Dr. Francis E. Anders and Beth Ranger ML080370544
- Supplemental Affidavit of Janet Mize ML080370540
- Affidavits of David Alan House, Sandy Sauser, & Lester "Bo" J. Davis ML080240299
- Corrected Reference Petition (w/ copy of original) ML080220348
- Reply to NRC Response to Petition of Owe Aku & Debra White Plume ML080070051
- Reply to Applicant's Response ML080080290
- Affidavits in Support of Slim Buttes Agri. Dev. Corp. & WRNC ML080080289
    - By Joseph R. American Horse, Sr., Thomas K. Cook, Francis E. Anders, Bruce McIntosh, Janet Mize, and Beth Ranger
- Reply to CBR Response to Petitioner Owe Aku & Debra White Plume ML080070050
- Reply to NRC Staff Response, ML080080390
    - Submitted by T. K. Cook, SBADC & WRNC
- Intervenor Exhibit B, Tech. Review of Aquifer Exemption Petition ML081090240

Torrell, L., et. al., The Market Value of Water in the Ogallala Aquifer, 66 Land Economics 2d 163 (1990) ADAMS ML080080390.

Revised Lithostratiagraphy of Late Paleogene and Neogene Strata of the High Plains Aquifer in Western Nebraska, USA, LaGarry & LaGarry (Geological Society of America 2007), Exhibit D to Amicus Curiae Brief of Center for Water Advocacy (CWA), Rock the Earth and Mr. Robert Lippman ("CWA/RtE Amicus"), ADAMS ML080590472.

Human-Induced Changes in the Hydrology of the Western United States, Barnett, Pierce, Hidalgo et al., Sciencexpress 10.1126/science.1152538, January 31, 2008, www.sciencexpress.org, Exhibit C to CWA/RtE Amicus, ADAMS ML080590472.

Uranium ISL Ground-Water Data from Written Testimony of William P. Staub, Ph.D (January 9, 1999), Exhibit A to CWA/Rte Amicus, ADAMS ML080590472.

4. Publicly Available References

Dr. Mararu Emoto & David A. Thayne, The Messages in Water (Beyond Words Publishing 2004).

Climactic and Hydrologic Trends in the Western U.S.: A Review of Recent Peer-Reviewed Research, Udall, WWA and Bates (Intermountain West Climate Summary, January 2007).

Climate Change 2007: Synthesis Report, An Assessment of the Intergovernmental Panel on Climate Change, adopted section by section at IPCC Plenary XXVII (Valencia, Spain, 12-17 November 2007), represents the formally agreed statement of the IPCC

concerning key findings and uncertainties contained in the Working Group contributions to the Fourth Assessment Report.

Climate Change, Water Quality and the Future: Lessons from the Western Water Assessment, Western Coalition of Arid States, February 23, 2006, wwa.colorado.edu.

Ionizing Radiation from Nuclear Power and Weapons and its Impacts on Animals, Diane D'Arrigo, Radioactive Waste Project Director, Nuclear Information and Resource Service, June 2004.

Fort Laramie Treaty of 1851

Fort Laramie Treaty of 1868

UN Declaration on the Rights of the World's Indigenous Peoples ("Declaration"), Article 32 (General Assembly Resolution A/61/L.67 of 7 September 2007.

International Covenant on Civil and Political Rights (ICCPR), adopted by General Assembly Resolution 2200A (XXI), December 16, 1966, entered into force March 23, 1976 in accordance with Article 49 thereof; ratified by US Senate, 102nd Cong. 2nd Sess., Exec. Rept. 102-23 (March 24, 1992); http://www2.ohchr.org/english/law/ccpr.htm.

American Indian Religious Freedom Act (AIRFA), 42 U.S.C. 1996.

Religious Freedom Restoration Act (RFRA), 42 USC Section 2000bb, *et seq.*; 42 USC Section 2000bb-1.[2]

Native American Graves Protection and Repatriation Act (NAGPRA), 25 USC Sections 3001-3013.

"Government-to-Government Relations with Native American Tribal Governments", 59 Fed. Reg. 22951, 1994 WL 16189198 (April 24, 1994)

Executive Order No. 13175, Consultation and Coordination With Indian Tribal Governments, 65 FR 67249, 2000 WL 1675460 (Pres.Exec.Order Nov 06, 2000)

M.C. Woods, Indian Land and the Promise of Native Sovereignty: The Trust Doctrine Revisited, Utah L. Rev. 1471 (1994.

[2] As this matter is before a federal administrative court, concerning a federal licensing process, it is not relevant that RFRA was found to be unconstitutional as applied to state and local governments because it was an unlawful assertion of federal authority under Section 5 of the 14th Amendment of the Constitution. See City of Boerne v. Flores, 521 U.S. 507 (1997), however Congress has attempted to close the gap with the adoption of the Religious Land Use and Institutionalized Persons Act of 2000 ("RLUIPA"). 42 U.S.C. § 2000cc et seq.

James R. Walker, Lakota Belief and Ritual, University of Nebraska Press, R. DeMallie and E. Jahner, Ed. (1991)

Intervention Requested

Intervention is requested in addition to a request for a hearing. If the petition for leave to intervene as a matter of right is denied, then this request includes a request to be allowed discretionary intervention under Section 2.309(d).

Request for Subpart G Hearing Procedures

Pursuant to Section 2.310(d), each Requestor/Petitioner further requests that Subpart G Hearing Procedures be applied under Section 2.700 et seq. because these contentions necessitate resolution of issues of material fact relating to the occurrence of past events, i.e., whether CBR disputes any of the Relevant Facts and/or Positions stated herein.

Description of Each Requestor/Petitioner[3]

A. Individuals

Beatrice Long Visitor Holy Dance(I)(T): Slim Buttes, Pine Ridge Indian Reservation. Beatrice Long Visitor Holy Dance is a great grandmother, matriarch, Lakota spiritual leader and one of the International Council of Thirteen Indigenous Grandmothers (www.grandmotherscouncil.org). She is an enrolled member of the Oglala Lakota Nation. She lives near the White River which flows through her family land. She requires pristine water for her ceremonies, including the *inipi*, or "sweat lodge". She uses water to make traditional medicines. She uses water on her family gardens and she eats

[3] The address and phone number of each requestor/petitioner is set forth on his or her Affidavit, filed with this Petition, and incorporated herein by this reference as if fully set forth at length herein.

food from those gardens. She believes water, *mni*, is very sacred and deserves the highest respect and care.

Joe American Horse, Sr.(I)(T): Oglala, Pine Ridge Indian Reservation. Joe American Horse, Sr., is the grandson of Chief American Horse, who was a headman, military leader and signatory to the Fort Laramie Treaty of 1868. Joe American Horse is a former two-term President of the Oglala Sioux Tribe, currently serves as an Associate Justice of the Oglala Sioux Tribe Supreme Court and is commonly known as Chief Joe American Horse. Joe American Horse, Sr. has participated in sacred ceremonies throughout his life including the *Hanblechia* (Vision Quest), which he has performed at Crow Butte several times starting about 12 years ago. Joe American Horse, Sr., also participates for at least 20 continuous years in the *inipi*, or "sweat lodge" ceremony at Slim Buttes, Pine Ridge Indian Reservation. Slim Buttes is located along the White River and the wells at Slim Buttes draw water from the Arikaree aquifer.

Debra White Plume(I)(T): Manderson, Pine Ridge Indian Reservation. Debra White Plume is a great grandmother who has raised her family on her Tiospaye (extended family) land along the banks of Wounded Knee Creek. She is an enrolled member of the Oglala Sioux Tribe and descended from Chief Red Cloud on her father's side and Northern Cheyenne on her mother's side. She feels responsible as a mother, grandmother and great grandmother of generations to make a good home and environment and to preserve and hand down the Lakota way of life for her generations. Debra White Plume and her family drink water from a private well in the Arikaree aquifer, raise buffalo and horses and depend on groundwater from their land to be pristine

so it can be used for medicine, sustenance and traditional ceremonies. Debra White Plume was found to have standing and admissible contentions in the Expansion Proceeding. See, LBP-08-06.

Loretta Afraid of Bear Cook(I)(T): Slim Buttes, Pine Ridge Indian Reservation and Chadron, Nebraska. Loretta Afraid of Bear Cook is a "Lakota Culture Bearer," and is a daughter of Beatrice Long Visitor Holy Dance and is an enrolled member of the Oglala Sioux Tribe. Loretta Afraid of Bear Cook was born and raised at Slim Buttes, played and bathed in the White River as a child, and with her children when she became a mother. After living at Slim Buttes for about a year, Loretta's daughter Sakakohe developed a chronic skin irritation that was diagnosed in 1983 as being an allergic reaction to unknown contaminants in the groundwater and river water. Shortly after that, the Afraid of Bear Cook family moved away from their family land to Chadron, Nebraska and soon after Sakakohe's skin condition abated. To this day, Sakakohe remains sensitive, bruises and welts easily and remains on medications to deal with her environmental illness.

Thomas Kanatakeniate Cook(I): Slim Buttes, Pine Ridge Indian Reservation and Chadron, Nebraska. Thomas Kanatakeniate Cook is an enrolled member of the St. Regis Mohawak Traibe, Akwesasne, New York. He has been on Pine Ridge Reservation for 35 years and married to Loretta Afraid of Bear Cook for 32 years. Mr. Cook own real estate both at Slim Buttes and at Chadron. Mr. Cook is employed as a field coordinator for Running Strong for American Indian Youth, serves as president of the Chadron Native American Center and has been a duly appointed member of the Nebraska Commission on Indian Affairs since 1999. During the 8 years that Mr. Cook

and his family lived at Slim Buttes, they used a 30 foot groundwater well in the Arikaree and used the water from the White River on a daily basis. Mr. Cook and his family also ate fish from the White River and irrigated their family garden with water from the White River and the well and ate food from the gardens. Since 1980, the White River has run completely dry in only two years – 2007 and 2008. Mr. Cook has participated and led sacred Lakota ceremonies including the *inipi* twice a week throughout the year since 2004. Before that, for more than 20 years before his death, my father-in-law Ernest Afraid of Bear, Sr. led the *inipi* at Slim Buttes on a weekly basis. Mr. Cook also works with Slim Buttes Agricultural Development Corp. and Running Strong for American Indian Youth for 23 years to stimulate self-sufficiency through developing family and community vegetable gardens. This year that work resulted in 244 family gardens across Pine Ridge Indian Reservation and, in addition, Running Strong has drilled almost 400 water wells at Pine Ridge for use to irrigate family gardens. Such water wells draw water from the Arikaree. This work would be undermined to the extent that there is any contamination of the water supply, surface waters, or land that would make the wells toxic and the gardens unproductive or that would make the food from the gardens unhealthy.

Dayton O. Hyde: Hot Springs, South Dakota. Dayton O. Hyde is a cowboy author, World War II combat veteran and founder of the Black Hills Wild Horse Sanctuary which is home to America's largest wild horse herd with over 500 wild horses including American Spanish Mustangs, Sulphur and Kiger Mustangs, herds from State Governments, Bureau of Land Management, and the US Forest Service. Dayton O. Hyde's personal website is: www.daytonohyde.com and the Black Hills Wild Horse

Sanctuary website is www.wildmustangs.com. As someone who has personally served the US national interest, and staked his life on securing the common defense and security of the American people, Dayton Hyde is concerned that atomic energy and uranium not be controlled by foreign persons who have no loyalty to the United States or its people. He does not believe that foreign persons can be trusted to act in the best interests of the United States and its people or to comply with United States laws and regulations or to protect the water and environment of the communities that are near the Mine. As a steward of the wild horses, Dayton is concerned that bioaccumulation of radionuclides in the food chain may harm the animals in the area including the wild horses at the Sanctuary.

Bruce McIntosh: Chadron, Nebraska. My Grandfather owned and operated the finest Mercantile in the region, in Crawford, during the 1890's. My great, great Aunt was married to the first mayor of Crawford. Having this long family history and deep roots in the area has provided a keen sense for the surrounding environment. I worked with the University of Nebraska conducting paleontological fieldwork within the badlands of Fort Robinson, NE and I have been a guest lecturer at American University in D.C. almost annually, for the science curriculum. I am on the NE USDA WHIP Subcommittee & USDA EQIP Subcommittees. Currently, I am coordinating research on aspen within NE. It is during the sample collecting of data for DNA analysis that I have observed the hydrologic loss of surface flow within the lower reaches of Pine Ridge streams.

B. Organizations

Afraid of Bear/Cook Tiwahe, by Thomas Kanatakeniate Cook(I)(T):

The Afraid of Bear/Cook family, or *Tiwahe*, constitutes the organization of the married couple Thomas Kanatakeniate Cook and Loretta Afraid of Bear Cook, Loretta's mother, Beatrice Long Visitor Holy Dance, and their children, including Sakakohe Afraid of Bear Cook who suffers from an environmental illness related to contamination of the water at Slim Buttes. The *Tiwahe*, or family, has been forced to live away from their family lands which impairs their ability to live traditionally as a family on their family land. The *Tiwahe* has also suffered harm from environmental pollution of the groundwater from the Arikaree, surface waters and the White River. Mr. Cook also asserts all indigenous and treaty rights held by the members of his *Tiwahe*.

American Horse Tiospaye, by Joe American Horse, Sr.(I)(T): The American Horse *Tiospaye*, (extended family), constitutes the organization of the related families, or *Tiwahe*, to Joe American Horse, Sr. and his brothers. The *Tiospaye* has been forced to suffer contamination of groundwater and surface water in and around Pine Ridge Indian Reservatin. Joe American Horse, Sr., asserts all indigenous and treaty rights held by the members of his Tiospaye.

Owe Aku, Bring Back the Way, by Debra White Plume(I)(T): Owe Aku is a nongovernmental organization dedicated to the preservation of the Lakota Way of Life, including our territories and environment. Debra White Plume is a Director of Owe Aku. Owe Aku was found to have standing and admissible contentions in the Expansion Proceeding. See, LBP-08-06. Owe Aku works to preserve 1951 and 1868 Ft. Laramie Treaty Territory and our environment as part of Creation and are concerned with the Cameco uranium mining and milling activities and planned activities for the area near Crawford Nebraska that is only 30 miles for our nearest border. Owe Aku endorses the

Declaration on the Rights of Indigenous Peoples passed by the United Nations and actually participated in the drafting at Geneva Switzerland. Our people were not consulted on the Canadian company infiltration to our treaty territory to extract minerals and metals and impacts on our people and our water source. This is a violation of the Declaration. This is a violation of our Human Rights. Owe Aku endorses the Sioux Nation Treaty Council Position Statement being forever opposed to uranium mining and Crow Butte Resources mining in our treaty territory. Owe Aku is concerned with the health and future health of our people. Our people have high cancer and diabetes which we believe may be impacted by high rads and arsenic in our water.

Western Nebraska Resources Council, by Bruce McIntosh, Vice-Chairman: Western Nebraska Resources Council ("WNRC"), is a Nebraska nonprofit which was formed in 1983 to protect the natural resources of Western Nebraska with a focus on groundwater contamination from uranium mining. WNRC was found to have standing and admissible contentions in the Expansion Proceeding. See, LBP-08-06. WNRC member Dr. Francis Anders lives very close to the Mine operations and has experienced direct impacts on his water, including the changing of the color of his water in relation to the schedule of drilling by the Mine nearby.

Relevant Facts and Positions:

The Indigenous and Oglala Petitioners contend that pursuant to federal Indian law, including the trust responsibility and the Winters Doctrine, the 1851 and 1868 Ft. Laramie Treaties, the UN Declaration of Indigenous Rights, the IPCCR, Executive Orders, the NEPA, the NHPA, the AEA, and the AIRFA, RFRA, NAGPRA, they have

standing and admissible contentions regarding the potential impact of the renewal proposed by Applicant. Petitioners further respectfully submit that pursuant to federal Indian law, the 1851 and 1868 Ft. Laramie Treaties, Executive Orders, the UN Declaration of Indigenous Rights, the NEPA, the NHPA, the AEA, the AIRFA, RFRA, NAGPRA, Applicant has failed to take reasonable steps to ensure meaningful consultation with the Lakota elders, or the Oglala Sioux Tribe.

The expert opinions, criticisms, comments and recommendations set forth in the Abitz Opinion, the LaGarry Opinion, the JR Engineering Opinion and the Robinson Opinion are hereby incorporated herein by this reference.

Petitioner requests an Oral Hearing, Discovery and Expert Testimony concerning the following relevant facts and positions, which include the facts, opinions, criticisms, and positions expressed in the Abitz Opinion, the LaGarry Opinion, the JR Engineering Opinion, and the Robinson Opinion, each of which is incorporated herein by reference (collectively, the "Relevant Facts"):

(1) LRA is incomplete, missing page 3-22 and omits all data on such missing page, is lacking reference to recent research, fails to correlate monitoring results with known mining activities, and fails to comply with Section 40.9 which requires full and complete disclosure of all material facts.

(2) CBR is owned by Cameco, Inc., a Canadian corporation which purports to be the largest Uranium producer in the World with operations in Canada, the US and Kazakhstan. See www.cameco.com. Cameco acquired just under 1/3 control of CBR in

1995/1996 in a concealed transaction, acquired 90% control of CBR in 1998 at which time it disclosed its ownership in CBR and acquired 100% control of CBR in 2000.

(2) CBR currently is using up to 9,000 gallons per minute, which equals 4.7 billion gallons per year at its current operation and wants to use up another 4,500 gallons per minute, equal to 2.4 billion gallons per year for its operations.

(3) Foreign owned CBR is using up and contaminating vital water supplies in a time of drought for its profit to the detriment of the people, wildlife and land in Crawford, NE, surrounding areas including Chadron, NE, and Pine Ridge Indian Reservation and other users of the High Plains aquifer in Colorado, Kansas, New Mexico, Oklahoma, South Dakota, Texas and Wyoming. Most of such persons are unaware of CBR's operations or Application.

(4) Foreign owned CBR has been reckless and has allowed numerous spills and violations to occur. See, List of CBR Violations, Spills Etc., attached. These spills include.

(5) It is believed there is a slow-moving radioactive plume of contaminated water moving through the related aquifers. CBR's Application states that contaminants may enter the human body through water and through ingestion of meat of livestock and/or fish or wild game exposed to the contamination. Contaminants include Radon-222, Thorium, Uranium and inorganic Arsenic.

(6) It is believed that leaks of radioactive arsenic laden fluid into the Brule aquifer from prior "Excursions" from CBR's operations have slowly mixed with the High Plains aquifer and/or the Arikaree aquifer due to connectivity between the Brule aquifer and High Plains aquifer and Arikaree aquifer which runs under Pine Ridge Indian Reservation. The High Plains aquifer is depleting at a rate in excess of its recharge rate.

(7) It is believed there is a relationship between the ninety-eight (98) closed wells on the Western side of Pine Ridge Indian Reservation and certain incidences of cancer, kidney disease, birth defects, miscarriages and infant brain seizures on the Reservation which is downwind and downstream of CBR's existing ISL mining operation. Under the doctrine of *Res Ipsa Loquitor*, the burden of proof shifts to CBR to show that its operations have no causal connection to the contamination of the Pine Ridge water wells or the diseases of the people who drank and bathed in that water.

(8) The impacts of the mining to the health and environment of people and wildlife relying on the High Plains aquifer and the Arikaree aquifer should be evaluated as part of the Application.

(9) International human rights standards indicate that Indigenous peoples' whose lands are affected by development projects have the right to "free, prior and informed consent." In the Declaration on the Rights of the World's Indigenous Peoples ("Declaration"), Article 32, ¶ 1, "Indigenous peoples have the right to determine and

develop priorities and strategies for the development or use of their lands or territories and other resources," and ¶ 2, "States shall consult and cooperate in good faith with the indigenous peoples concerned through their own representative institutions in order to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources," and ¶ 3, "States shall provide effective mechanisms for just and fair redress for any such activities, and appropriate measures shall be taken to mitigate adverse environmental, economic, social, cultural or spiritual impact." (See General Assembly Resolution A/61/L.67 of 7 September 2007.) To date, no opportunity has been provided under this applicable provision of the Declaration for members of the Oglala (Lakota) Sioux Tribe, its members or representative institutions to analyze CBR's License Renewal or its affect on lands, territories and resources. A favorable decision permitting intervention would provide this opportunity. This is also a violation of the International Covenant on Civil and Political Rights (ICCPR), Treaty Rights of Consultation and applicable Executive Orders.

(10) CBR's 2.0-2.25 mile radius is inadequate; rather the entire 80km radius should be used to evaluate the impacts of the mining to the health and environment of people and wildlife who are admittedly downwind and/or downstream of CBR's current and proposed operations.

(11) Yellowcake Uranium products from the CBR operation is exported to

processing facilities in Canada almost entirely for foreign use. After conversion and enrichment by CBR's parent company, Cameco, the nuclear fuel is used by Cameco's affiliate Bruce Power for its nuclear power plants or sold to the highest bidder free of US restrictions. This makes Crawford, Nebraska the equivalent of a "raw materials colony" of the Canadians.

(12) There is no assurance that Yellowcake Uranium products from the CBR operation will not be used for nuclear weapons of a foreign country or terrorists despite the fact that Canada is a signatory to the Non-Proliferation Treaty.

(13) Although CBR's Application discusses economic benefits in the immediate vicinity of its facilities (i.e., Crawford, NE), CBR acknowledges that residents and wildlife in at least an 80 Km radius, including Chadron, NE, Hot Springs, SD, and Pine Ridge Indian Reservation and that none of such areas receive any economic benefit from CBR's activities.

(14) There are at least 26 Nebraska towns that have illegally high levels of Uranium in their water supplies. Recently, the Nebraska Indian Affairs Commission passed a resolution calling for a public hearing on CBR's Application. See "Uranium Levels Too High in 26 Nebraska Towns" by Tracy Overstreet, The Independent.com (December 18, 2005).

(15) CBR's Application mentions a prehistoric Indian camp found in the area

proposed for the North Trend expansion. CBR is not qualified to make judgments about the significance of the Indian camp as an archaeological find or significance to the Oglala Sioux people. Oglala Sioux elders should be consulted concerning such prehistoric Indian camp. Further, the planned ground disturbances will disturb ancient archeological sites that may be covered by other federal law.

Discussion of Contentions By Category[4]

I. Environmental – primarily concerns issues relating to matters discussed or referenced in the Environmental Report for the proposed action.

Contention A: CBR's License Application does not accurately describe the environment affected by its proposed mining operations or the extent of its impact on the environment as a result of its use and potential contamination of water resources, through mixing of contaminated groundwater in the mined aquifer with water in surrounding aquifers and drainage of contaminated water into the White River.

Contention B: CBR's proposed mining operations will use and contaminate water resources, resulting in harm to public health and safety, through mixing of contaminated groundwater in the mined aquifer with water in surrounding aquifers and drainage of contaminated water into the White River.

The LRA fails to disclose results of baseline preoperational sampling:

> **2.7.1** Surface Water
> The License Area is located within the watershed of Squaw Creek and English Creek, which are small tributaries to the major regional water course, the White River. As a part of the preoperational environmental study, flow measurements and water quality samples were taken from Squaw Creek in the vicinity of the study area.

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[4] The FRN requires each requestor/petitioner in this renewal proceeding (the "Renewal Proceeding") to group his, her or its contentions into the following broad categories:

- Technical – primarily concerns issues relating to matters discussed or referenced in the Safety Evaluation Report for the proposed action.
- Environmental – primarily concerns issues relating to matters discussed or referenced in the Environmental Report for the proposed action.
- Miscellaneous – does not fall into one of the categories outlined above.
- Other – If a contention raises issues that cannot be classified as primarily falling into one of these categories, the requester/petitioner must set forth the contention and supporting bases, in full, separately for each category into which the requester/petitioner asserts the contention belongs with a separate designation for that category.

Id. at 30427.

The LRA fails to compare existing data with pre-operational levels. See, Baseline Hydrogeochemical Investigation in a Part of Northwest Nebraska, A Report Prepared for the Nebraska Department of Environmental Control ("the 1982 Baseline"). The 1982 Baseline states:

> "No samples from the Arikaree, Brule or upper Chadron units had radium levels above 0.5 pCi/l. Only in the basal Chadron did radium amounts exceed the maximum contaminant level (MCL) of 5 pCi/l....Arsenic levels exceeded the MCL of 50 ppb in only one well water....Surface water quality appeared directly related to seepage from nearby units. Highest pathfinder element levels and uranium concentrations were in streams cutting the White River Group." Id. at ii.
>
> ***
>
> "Although there is some difference in the rock descriptions, the Upper Chadron and Brule have similar geologic characteristics. In those wells which do not reach the Lower Chadron, particularly north of Crawford, it is difficult to determine a Brule-Chadron distinction. As would be expected from Figure A-3(1), most of the wells in the western and southern portions of the project area are completed in the Arikaree. Sufficient quantities can be obtained for household and stock wells in most areas so that deep drilling to the older units is not justified....
>
> The thickness and groundwater reservoir characteristics of the Quaternary rocks are highly variable. As was discussed, this hydrogeologic unit in the northeast corner of the project ara is strongly influenced by the underlying Pierre Shale. Along the major streams, the Quaternary Alluvium is hydrogeologically connected to the surface flow. In areas where near-surface fractures occur in the bedrock, hydrologic interchange between the Quaternary and older units can be rapid.
>
> It should be noted that although a large number of wells are present in the project area, reliable geologic interpretation. Any project development, however, can more closely document these geologic-hydrologic relationships. Id. at 17.
>
> ***
>
> ...In very shallow wells (a few tens of feet), significant amounts of the water utilized may be contained in the thin Quaternary sediments overlying the designated hydrogeologic unit. This situation is particularly

true for those wells noted as completed in the Pierre Shale (Kp). However, the mineralogical characteristics of the older rocks can have a significant influence on the chemistry of the related groundwater. IN some cases a low confidence level was expressed in interpreting the hydrogeologic unit. This was a direct result of the geologic complexity and the lack of test hole data within the investigated area. Sixty-eight percent of the wells tap the Arikaree Group, 16% tap the Brule, 10% tap the Chadron and 6% tap the Pierre. Id. at 18.

***

In general, wells near Crawford and within T31N, R51W produce from the Tertiary Brule and/or Tertiary Cbhadron formations.

Within T31N, R51W the principal water-bearing formation for domestic use is the Brule. Sand lenses and filled fracture channels provide low to moderate yielding strata for wells within the Brule. Many wells in the Tertiary Chadron near and east of Crawford are artesian. These wells are producing from sands of the lower Chadron.

By far the most wells within the investigated area are used for water stock. Many of the domestic wells were also used to water stock, trees and lawns. In such cases a priority was given to the well's use as a sole source of potable water for the household. IN addition several stock wells also were used for small-scale irrigation. In such cases priority was given to their use for stock. Although Crawford derives its water from the White River, public supply wells serve schools and campgrounds. Id. at 38.

***

In general the observed trends in chemical character of the streams appear to be closely associated with the formation they dissect. Upper Ash Creek, Soldier Creek and White River have chemical characteristics similar to the groundwater in the Arikaree and undoubtedly receive most of their base flow from this formation. The sampling locations for Lower Squaw, White Clay and English Creeks are in the Brule formation and the water has chemical characteristics of that formation. The sample from middle Squaw Creek has characteristics similar to the upper Squaw Creek sample and probably receives its major contribution from upgradient Arikaree seep. Sample ST-2 form Lower Ash Creek would appear to have a significant contribution from the Brule formation; however, this portion of the stream may also be receiving seepage water from the Pierre formation. The chemical characteristics of groundwater in the Pierre

formation were not well documented in this study due to the sparcity of wells sampled form this formation.

Chemical characteristics of the springs indicate that sample 649 is reciving water from the Chadron formation and Spring SP-4 probably originates in the Brule. The remaining springs have chemical characteristics similar to those of the Arikaree formation. Id. at 46.

***

The artesian flow from flowing groundwater in the deeper basal Chadron demonstrated higher average temperatures conductivities and pH values than groundwater from wells producing in younger strata.... Id. at 48.

***

Selenium levels were very low in all analyzed groundwater samples....

Arsenic levels were quite variable but showed a generalized increase in older oxidizing formation waters. This is demonstrated in a trend towards higher average As concentrations in lower Brule and upper Chadron formation waters than in either the Brule or Arikaree waters....Therefore, in slightly oxidizing environments such as those reported in the upper Chadron and lower Brule wehre there are occurrences of relatively high arsenic levels in the sediments, the groundwater could become enriched in As.

Arsenic levels exceeded the maximum contaminant level (MCL) of 50 ppb in only one well. Thus in terms of the water quality, arsenic is not of particular concern in the groundwater of the investigated area.

Molybdenum is often associated with reduced uranium ores as molybdenum sulfide. Similarly to arsenic the highest concentrations are expected in oxidized and moderately reduced waters. Molybdenum is slightly more stable than uranium in reducing groundwater and therefore molybdenum ore tends to be concentrated slightly downgradient from uranium bodies. Id. at 52 (emphasis added.)

***

Spring and stream levels of the pathfinder elements generally were low. Slightly elevated As and Mo appeared in #649 which is believed to

be a spring originating in the Chadron formation. Highest concentrations of pathfinder elements result from a relatively high component of White River Group seepage in the base flow of the creeks.

Neither molybdenum nor vanadium has maximum concentration level (MCL) values, and therefore it is not a water quality concern at ppb levels. Id. at 55.

***

Uranium U-238 and Radium-226 are the two most mobile elements in the uranium natural decay series. Their mobility in groundwater combined with their relatively long half-lives allows them to be transported considerable distances from their points of origin. This potential for transport is depending on the geochemical nature of the rocks and the rates of groundwater flow. It is essential to know the premining soluble levels of these nuclides if a future assessment of the impact of the mining activity is to occur. This is especially appropro for in situ leach mining where the uranium is remobilized by various lixiviants and restoration of the formation water is necessary. In some instances, significant increases in U-238 and Ra-226 levels above background have been reported in post restoration groundwaters (Thompson, 1980). Id. at 56.

***

Now, in 2007, there are elevated concentrations of Uranium at English Creek and Squaw Creek:

.... locations. Samples obtained in 1998 before mining operations began in this area showed similar elevated uranium concentrations. The sample locations are in a wetland area in the upper course of English Creek and downstream impoundments. The area has a large amount of organic matter and low water flows as compared with the other surface water sampling locations for the project. CBR believes that the upper courses of English Creek are an area with reducing conditions that favor deposition of radionuclides. **Due to the drought conditions in this area, the streams and wetland areas have been *dry*.** Appendix H contains a trend graph for English Creek sediment sample points since

1998 that shows the elevated uranium concentrations noted in past sediment samples along with a trend graph for Squaw Creek showing the elevated uranium concentrations upstream from the current operation.

Semiannual Radiological Effluent and Environmental Monitoring Report for First and Second Quarters 2007 for Crow Butte Resources. Inc., (at ML080710479), Section 3.3 at page 5.

Contention C: Failure of CBR to consider Climate Change. See, references above concerning Climate Change. LRA fails to analyse Climate Change in the following sections:

2.5.3

Tornadoes are rare. In the USNRC, "Draft Generic Environmental Impact Statement on Uranium Milling", (USNRC 1979) the authors calculated a mean annual frequency of 0.6 for tornadoes in intensity Category I at Rapid City. The annual probability of occurrence at this location is 4.8 x 10-4. A tornado in intensity Category I has a rotational speed of 134 meters per second (m/s) and a translational speed of 26 mis.

CBR is using old data and such data concerning the weather and tornados needs to be updated in light of known factors related to Climate Change.

Contention D: Changing the geo-chemistry of the water is equivalent to adulteration of of the water. It takes many generations for the adulterated water to recover so that it can once again be used for traditional medicines and ceremonies, and before it can be healthy again for drinking and irrigation. This causes environmental and cultural impacts, lack of environmental justice, depletion of the aquifer at a time of

drought, and economic detriments to property owners as a result of the lowering of the water table.

The Affidavits of Beatrice Long Visitor Holy Dance, Loretta Afraid of Bear Cook, Joe American Horse, Sr., Thomas Kanatakeniate Cook, and many others describe the spiritual nature of the water, *mni.* The same has been noted by western scientific observers such as Dr. Masaru Emoto, in The Messages in Water, Dr. Emoto writes:

> Understanding the fact that we are essentially water is the key to uncovering the mysteries of the universe If you reexamine the world around you from this new perspective, you will start to see things as you have never seen them before. Id. at 1.
>
> "Water is not just another substance - it is the life force of majestic nature. It made me once again realize the mysterious ability of water to cleanse and give life to all living. I can see that the soul, feelings, and vibration have an effect on the formation of ice crystals, and through this I can feel the importance of the soul and words. This information is extremely wonderful and uniquely impressive." Id. at 38.
>
> "The natural world is indeed well designed - everything is in balance. And as sound is created, there is a master listener to receive the sound: water." Id. at 43.
>
> "The ability of water to dissolve other substances creates a type of "soup of life" that supplies the oceans with the necessary nutrients that enable life. This soup became the birthplace of all living creatures of the earth....Indeed, water is the force that creates and gives life. Without water, particles wouldn't mix together or circulate. Water created chaos on the earth and it also gave birth to order - resulting in a planet overflowing with life." Id. at 55.
>
> "Water is the mother of life, while also being the energy of life. This is possible because of the unique characteristics of water." Id. at 56.
>
> "The important thing is that we recover our desire to treat water with respect. In our modern culture, we have lost our attitude of respect for water. In ancient Greece, people paid true respect to water, and many Greek myths are based on the protection of water. But then science

appeared, and rejected these myths because they were not scientific. Water lost its mystique and became just another substance that technology could clean up as necessary. We sometimes say, "Purified water is not pure." Water processed in treatment plants is not the water that forms beautiful crystals. What water requires is not purification but respect." Id. at 63.

"We don't believe what we can't see, but the ice crystals show us everything - it's no longer about whether you believe or disbelieve. Using this method, anyone can conduct their own experiment and prove it for themselves." Id. at 38.

Contention E: Cost Benefits as discussed in the LRA Fail to Include Economic Value of Environmental Benefits. A University of Adelaide study has put an economic value on the wetlands of the River Murray, highlighting the ramifications of cutting off water flows in times of drought. The study has concluded that every hectare of permanent wetland provides more than $7,000 worth of water purification each year. http://www.adelaide.edu.au/adelaidean/issues/23221/news23241.html

According to one assessment of natural ecosystems, the dollar value of wetlands worldwide was estimated to be $14.9 trillion. (Source: Costanza et al. 1997). See also Economic Benefits of Wetlands, EPA 843-F-06-004, Office of Water (May 2006), and Economic Reasons for Conserving Wild Nature, Science Vol. 297 (August 9, 2002), www.sciencemag.org.

8.1.2 Impacts of the No-Action Alternative
The no-action alternative would allow CBR to continue mining operations in the current License Area until the USNRC formally denied the renewal of the license application. As long as CBR submits a source material renewal application to the USNRC at least thirty days before the expiration date of the existing license (February 28, 2008), the license would not expire until the USNRC determined the final disposition of the renewal application and advised CBR of its decision. If the license renewal was not approved by the USNRC, restoration and reclamation activities would then become the primary activities.
If renewal of the current source material license was not approved, all activities at the

Crow Butte site that are not associated with groundwater restoration and decommissioning would be completed, resulting in the loss of a significant portion of the total employment at the site. At the completion of decommissioning activities, all employment opportunities at the mine would be terminated.
In addition to the loss of significant employment opportunities in Crawford and Dawes Counties, the premature closing of the Crow Butte Project before commercially viable resources had been recovered would adversely affect the economic base of Dawes County. As discussed in further detail in **Section 7.10** and shown in **Table 8.1-1,** the Crow Butte Project currently provides a significant economic impact to the local Dawes County economy.

** Failure to disclose number of years it would take to complete restoration and reclamation and decommissioning – I think at least 10-20 years – so these jobs are safe until at least then –

A decision to not renew **SUA-1534** for mining in the Crow Butte License Area would leave a large resource unavailable for energy production supplies. In **2006,** total domestic **U.S.** uranium production was approximately 4 million pounds U_3O_8, of which more than **700,000** pounds (or approximately **18** percent) were produced at the Crow Butte Project. During the same year, domestic **U.S.** uranium consumption was approximately **67** million pounds **Of** U_3O_8 with approximately **16** percent supplied **by** domestic producers **(EIA 2007).** The Crow Butte Project represents an important source of domestic uranium supplies that are essential in providing a continuing source of fuel to power generation facilities. The current limited supplies of fuel for nuclear power plants may negatively impact the renewed and growing interest in nuclear energy in the **U.S.** and other nations (MIT **2007).**

** NB – gives misimpression that this U is used in the US when it is in fact shipped to Canada, processed, enriched and used by Canadian power companies like Cameco's affiliate Bruce Power and/or sold on the international market free of US restrictions.

Denial of this
license renewal would also have an adverse economic impact on the individuals who have surface leases with CBR and own the mineral rights within the License Area.

** NB - Failure to disclose that due to foreign ownership and under the NE Alien Property Ownership Act, the leases are voidable and, therefore, of nominal value.

8.2 PROPOSED **ACTION**
With USNRC approval of Source Material License SUA-1534, CRB would continue to operate the Crow Butte Project ILR operation as discussed in Section 5 of this LRA. Amendments to the license may be sought as needed in order to recover the uranium resources, for which CBR holds valid claims, in the most effective manner.

** NB – failure to disclose 3 Crow and Marsland and other contemplated expansions in this LRA –

II. Technical – primarily concerns issues relating to matters discussed or referenced in the Safety Evaluation Report for the proposed action.

Contention B: CBR's proposed mining operations will use and contaminate water resources, resulting in harm to public health and safety, through mixing of contaminated groundwater in the mined aquifer with water in surrounding aquifers and drainage of contaminated water into the White River.

Contention C: Failure of CBR to consider Climate Change. See above re: Climate Change, which is incorporated herein by reference.

Contention D: Failure to follow statistical analysis protocols – see Abitz opinion.

Contention E: Failure to use best available technology such as 3D computer modeling, SCADA – see JR Engineering opinion. Failure to maintain back-up power in case of power outages.

Contention F: Failure to include recent research – see LaGarry opinion.

2.6 GEOLOGY SOILS AND SEISMOLOGY
This section describes the regional and local geology and seismology related to the current License Area and CSA. In this regard, discussion of the geology of the License Area and CSA, in particular, has been presented in previous reports (WFC 1983; Ferret Exploration of Nebraska 1987). Information contained in these reports include laboratory results and field data that describe formation characteristics (mineralogy, permeability, etc.) for the Pierre Shale, Brule Formation, Chadron Formation, and the Basal Chadron Sandstone in the CSA. These data, in addition to new information from exploratory drilling/logging activities within the License Area, are used to describe the geology and seismology in this section.

Why is CBR referring to the old data and old research when there is more recent research? Note that this criticism was raised by NDEQ in its November 8, 2007.

Contention G: Failure to analyze mine unit activities in correlation with excursions and radiological emissions. Why did radon levels spike in 2003? Table 1.7-1

says that Mine Unit 9 went into production in 2003 – perhaps the AM-1, AM-2 and AM-8 picked up on that? Section 5.8 fails to show where the Air Monitoring stations are.

III. Miscellaneous – does not fall into one of the categories outlined above.

Contention A: Reasonable consultation with Tribal Leaders regarding the prehistoric Indian camp located in the area surrounding CBR's proposed North Trend Expansion Project has not occurred as required under NEPA and the National Historic Preservation Act.

Contention B: Failure to Consult with Tribal Authorities

Contention C: Failure to Abide Trust Responsibility

Contention D: Failure to respect Winters Rights.

Contention E: Failure to respect Treaty Rights. Oglala Petitioners have asserted treaty rights concerning the Licensed Area.

2.2.2 Land and Mineral Ownership
...No Indian lands are present in the 8-km (5 mile) radius of the License Area.

The Oglala Petitioners dispute the foregoing statement.

Contention F: Failure to respect Hunting and Fishing Rights

Contention G: Failure to Disclose in violation of 40.9. There are several instances of intentional, reckless or negligent failures to disclose, including:

(1) Concealment of Foreign Ownership, as described herein.

(2) Suppression of Geologic Data – Whistleblower Letter/LaGarry, as described herein.

(3) Failure to adequately disclose the flow of the White River towards Pine Ridge Indian Reservation:

> 2.7.1.1 Location
> The License Area is located in Sections 18, 19, 20, 29, and 30 of T31N, R51W and Sections 11, 12, and 13 of T3 **IN** and R52W within the drainage basin of the White River. The White River heads in Sioux County and flows northeasterly across Dawes County into South Dakota.

LRA fails to state that the White River flows NE into South Dakota and then to **Pine Ridge Indian Reservation**. As a result, contaminants that flow into the White River or along the White River may result in contamination downstream at Pine Ridge Indian Reservation, which would violate hunting, treaty and Winters rights.

> 2.7.1.1
>
> Squaw Creek is one of the southern tributaries of the White River. This creek heads in the Pine Ridge southeast of the License Area. From the headwaters, it flows northwest over range and agricultural land to the White River. Contributions to flow come from springs in the Arikaree Formation, snowmelt, runoff, and the shallow Brule sands. The latter may receive inflow from the creek during periods of high flow. Due to the time-variable nature of these water sources, discharge rates at various points along the creek may experience wide fluctuations monthly and yearly.

Dispute: Brule sands may receive inflow from the creek during periods of high low

(also Climate Related/Climate Change discussion needed), and Brule is related to Arikaree and may contact with drinking water supplies.

> Squaw Creek enters the License Area on the southeast comer, travels through the entire length of the License Area approximately paralleling its long axis, and exits to the north. Two branches of an unnamed tributary enter along the southern boundary, join just north of the Mine Unit 1 wellfield, and exit the northern boundary before converging with Squaw Creek. Figure 2.7-1 illustrates the location of the License Area with respect to the Squaw Creek and English Creek watercourses and the locations of the commercial evaporation ponds.

Dispute: Squaw Creek flows across the Mining Units and if there are surface spills or problems, even small excursions, they could be carried into the Squaw, into the White River, and towards the Reservation.

2.7.2.2 –

> The Basal Chadron Sandstone, the aquifer which is host to the uranium mineralization, is bounded above and below by strata which form aquicludes. The term "aquiclude" is used to describe strata capable of transmitting only minor amounts of fluid either vertically or horizontally. Typical values for vertical and horizontal permeability of "aquicludes" are in the range of 1o 4 to ***10-5*** darcys (Todd 1980), which is equivalent to a hydraulic conductivity of **10-7** to **10-8** centimeters per second (cm/sec). The vertical hydraulic conductivities of the aquicludes calculated from pumping tests conducted in the CSA are on the order of 1011 cm/sec (Ferret Exploration of Nebraska 1987). Laboratory analysis of cores from wells in the CSA indicates vertical hydraulic conductivities on the order of 10-° to **10** " cm/sec (Ferret Exploration of Nebraska 1987). Local groundwater flow within the Basal Chadron is to the east, with a gradient of 0.0016 feet per feet (ft/ft) or 8.5 feet per mile (ft/mile).

Dispute: the LRA fails to discuss analysis of fracturing and faulting relative to flow and conductivity discussion.

2.7.2.2

> Water level data support hydrologic isolation of the Basal Chadron Sandstone with respect to the other water-bearing intervals of interest in the CSA. Groundwater production rates within the Brule and Upper/Middle Chadron sands are low to exceptionally low.
> The geochemical groundwater characteristics of the Brule and Chadron

further indicate that the two zones are not naturally interconnected.

Dispute: why does LRA refer to CSA, which is very old? Also what is support for conclusion that the geochemical groundwater characteristics indicate that the two zones are not connected – and what about fractures and faults?

Dispute: LRA 2.6, 2.7 fails to disclose the different geologic characteristics of the satellite area in the North Trend area.

2.7.2.3

Purpose & Objectives of Aquifer Testing
The objectives of the aquifer pumping tests are to assess the integrity of the confining layer above the mining zone and characterize the hydrogeology of the ore-bearing aquifer in order to comply with NDEQ and USNRC permit requirements.

Dispute: LRA fails to disclose the test results? Fails to disclose against what standards are they measured to assess the integrity of the confining layer.

2.8.6.4 –

Sixteen habitat types were originally identified in the License Area as described in the 1983 report. These have remained relatively unchanged and include; wet meadow, mixed prairie-riparian, wet meadow-riparian, deep marsh-riparian, riverine, impoundment, deciduous streambank forest, shelterbelts and tree plantings, ponderosa pine, mixed grass prairie, range rehabilitation, cultivated, surface disturbance, human biotopes, cemeteries, and roads and roadside complex (Figure 2.8-2).

Dispute: Without doing ecological monitoring what is the support to say that "These have remained relatively unchanged" from 1983 to 2007 – despite Climate Change? Also a failure to discuss Climate Change.

2.9.6 –

Three trace elements were chosen for consideration in this sampling. Arsenic, selenium and vanadium are commonly associated with uranium ore deposits. This is especially true in roll-front type deposits where halos of metal sulfides and other reduced compounds occur at the "nose" or in front of the uranium mineralization. When leaching takes place during mining, varying concentrations of companion compounds will be solubilized. Thus, a surface spill of leach solution might contain small amounts of these three elements. The leach solution will also contain uranium and radium-226. The baseline uranium and radium-226 levels in the soil are found in Section 2.10. Samples from the License Area and the specific samples from Section 19 (Figure 2.9-6) were analyzed for arsenic and selenium and the samples from the proposed restricted area (Figure 2.9-7) were analyzed for vanadium.

Dispute: Failure to disclose the results of these tests? And where is comparison between the 1982 results and recent tests?

Contention H: Failure to Update in violation of Part 40, App. A; 51.45.

There are many examples of failures to update to current information in the LRA:

2.2 USES OF ADJACENT LANDS AND WATERS
The information in this section provides relevant data concerning the physical, ecological and social characteristics of the commercial study area and surrounding environs for uranium in-situ mining.

This section indicates the nature and extent of present and projected land and water use and trends in population or industrial patterns., The information in this section was initially developed over a 9-month period in 1982 as part of the Research and Development (R&D) License Application and updated in 1987 for the Commercial Application and in 1997 for the LRA. Preliminary data were obtained from several sources followed by field studies to collect on-site data to check land uses. Interviews with various state and local officials provided additional information.

Petitioners note CBR's failure to update the information to 2007.

Contention I: Failure to Include Recent Research; Use of Obsolete Data and Information in violation of AEA 182 or 184 –

Contention J: Missing Pages – incomplete – violation of 40.9 –

Contention K: Lack of Authority to Issue License to US Corporation which is 100% owned, controlled and dominated by foreign interests; voidability of mineral and real estate leases due to Nebraska Alien Ownership Act.

The LRA states that:

1.2 CROW **BUTTE PROJECT BACKGROUND**
What is now the Crow Butte Project was originally developed by Wyoming Fuel Corporation, which constructed a R&D facility in 1986. The project was subsequently acquired and operated by Ferret Exploration Company of Nebraska until May 1994, when the name was changed to Crow Butte Resources, Inc. Only the name of the company changed, not its ownership. CBR is the current owner and operator of the Crow Butte Project.

The R&D facility was located in the N1/2SE1/4 of Section 19, Township 31 North, Range 51 West, Dawes County, Nebraska. Operations at this facility were initiated in July 1986, and mining took place in two wellfields (WF-1 and WF-2). Mining in WF-2 was completed in 1987, and restoration of that wellfield has been completed. WF-1 was incorporated into Mine Unit 1 of commercial operations. CBR has successfully operated the current production area since commercial operations in 1991. Production of uranium has been maintained at design quantities throughout that period with no adverse environmental impacts.

1.3 SITE LOCATION AND DESCRIPTION
...This original License Area occupies approximately 3,300 acres, and the surface area affected over the estimated life of the project is approximately 1,100 acres. Approximately 100 percent of the minerals leased in the License Area are on private lands.

5 OPERATIONS

CBR operates a commercial-scale in-situ leach uranium mine (the Crow Butte Project) near Crawford, Nebraska. CBR maintains a headquarters in Denver, Colorado where site-licensing actions originate. All CBR operations, including the Crow Butte Project operations, are conducted in conformance with applicable laws, regulations, and requirements of the various regulatory agencies. The responsibilities described below have been designed to both ensure compliance and further implement CBR's policy 'for providing a safe working environment with costeffective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

5.1 CORPORATE **ORGANIZATION/ADMINISTRATIVE** PROCEDURES
CBR will maintain a performance-based approach to the management of the environment and employee health and safety including radiation safety. The Environmental, Health, and Safety Management System (EHSMS) Program encompasses licensing, compliance, environmental monitoring, industrial hygiene, and health physics programs under one umbrella, and it includes involvement for all employees from the individual worker to senior management. This EHSMS Program will allow CBR to operate efficiently and maintain an effective environment, health, and safety program.

Figure 5.1-1 is a partial organization chart for CBR with respect to the operation of the Crow Butte Project and associated operations. This structure represents the management levels that play a key part in the EHSMS Program. The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and groundwater monitoring programs, as well as routine and non-routine maintenance activities. These individuals may also serve a functional part of the Safety and Environmental Review Panel (SERP) described under Section 5.3.3.
Specific responsibilities of the organization are provided below.

5.1.1 Board of Directors
The CBR Board of Directors has the ultimate responsibility and authority for radiation safety and environmental compliance for CBR. The Board of Directors sets corporate policy and provides procedural guidance in these areas. The Board of Directors provides operational direction to the President of CBR.

Dispute: LRA omits to state that the Board is appointed by a sole shareholder corporation which itself is a wholly owned subsidiary of Cameco.

The Petitioners have repeatedly challenged the legitimacy of the Applicant's license on the grounds that the Applicant's status as a foreign corporation violates the explicit terms of the Atomic Energy Act of 1954, as amended (Act), and the rules and regulations promulgated by the Commission thereunder. As noted by the Board, "previous Commission decisions regarding foreign ownership or control did not appear to trun on which particular nation the applicant was associated with." LBP 08-06.. For the reasons stated below, the Atomic Energy Act of 1954, as amended (the "AEA"), and

Section 40.32(d) clearly bar the issuance of the sought license amendment. Further, a fair reading of Section 40.38 also supports a bar to the issuance of the sought license due to the admitted foreign ownership and control of the licensed uranium mining activities by Cameco Corporation, a Canadian corporation ("Cameco").

Given the importance of the Act as means of ensuring nuclear security in the post-9/11 world, it is critically important that the issue of the Applicant's foreign ownership be assessed in light of the Congressional mandate that nuclear material be regulated "in the national interest and in order to provide for the common defense and security and to protect the health and safety of the public."[5] As discussed herein, Applicant's ownership and complete domination by a Canadian corporation violates the applicable regulatory scheme and flaunts laws specifically enacted by the U.S. Congress to ensure the health, security and safety of U.S. citizens. No less important is the Applicant's consistent failure to make adequate disclosures and its flagrant disrespect for and noncompliance with NRC regulations.

Set forth below is an overview of the Applicant's relevant corporate history, which has been gleaned from the limited public record. As noted below, Applicant has been embroiled in past legal battles with Petitioner WNRC respect to the illegal foreign ownership, domination and control of Applicant in violation of Nebraska's Alien Ownership Act at Neb.Rev.Stat. 476-02. The Petitioners believe that, taken together, the Applicant's history and current actions before the Board demonstrate disturbing pattern of violations which harm the national interest and are clearly contrary to the public health and welfare of the People of the United States. This must not be allowed to continue.

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5 See U.S.C. § 2133(d).

The upshot of all of this is that Cameco was able to acquire de facto ownership of a uranium mine and NRC source materials license when such acquisition could not have been accomplished by Cameco's direct purchase of the Applicant's common stock under applicable law, at the very least without a substantial Negation Plan. Had Cameco sought to acquire the Applicant through the outright purchase of all of the Applicant's equity, it would have faced extensive security from the NRC, not to mention the public outcry that certainly would have followed. To allow the Applicant and Cameco do indirectly what they would certainly have been prohibited from doing indirectly would be a travesty and would require an Act of Congress because there would be no authority under the AEA. We note with interest the public and Congressional outcry several years ago that followed the proposed acquisition of several U.S. ports by a Dubai-based company. One can only imagine the outcry that would be triggered by a foreign company gaining access to America's uranium reserves. Ultimately, that acquisition by a foreign company was blocked on the grounds that it was inimical to national security. A much stronger case can be made with respect to mining, processing, transporting, marketing and exporting something as sensitive as uranium which is an obvious pre-cursor to weapons grade uranium.

Finally, due to the unclean hands of Applicant and its control persons and intentional disregard for applicable disclosure requirements, the proposed loopholes by Applicant (collectively, the "Cameco Loophole"), to the effect that a foreign person may secretly acquire ownership and control of a NRC licensed uranium mine in a staged corporate stock acquisition without public notice, hearings or disclosures as to foreign affiliations, must be permanently closed. While we are thankful that Cameco is a real

corporation run by recognized business professionals, Petitioners share the Board's concerns that "previous Commission decisions regarding foreign ownership or control did not appear to turn on which particular nation the applicant was associated with. Memorandum at 122. In addition, such prior Commission decisions must be evaluated in the context of the post-9/11 World in which we live.

In this case, we have the luxury of addressing these issues before a tragic incident occurs that is traceable to this Cameco Loophole. As a matter of pure legal analysis, however, there is absolutely no distinction between the ability to use the Cameco Loophole by legitimate Canadian business people and the same ability to use the Cameco Loophole by enemies of the United States to perpetrate horrible wrongdoing. Under the Cameco Loophole, such enemies would have legal grounds to acquire US based uranium and nuclear assets through a complex of subsidiary companies that conceal the true beneficial owners and control persons until it is too late. These technical legal grounds could enable the creation and use of weapons of mass destruction by enemies of the United States because Americans, including state and federal regulators, would be unwittingly assisting such enemies due to the secrecy of the foreign control. Then the Cameco Loophole and its proponents would be responsible for the death or injury to innocent Americans – how can that be in the national interest? How can that not be inimical to the common defense and security or to the health and safety of the public?

Even if such dire events never come to pass, and Petitioners sincerely hope and pray that they do not, it is clearly inimical to the common defense and security or to the health and safety of the public for foreign persons to be in control of US uranium mines

because it encourages the operation of the mining operation itself in reckless disregard for the probability of ground water contamination to the surrounding aquifers and communities. As described below, this is precisely what has happened in the case of the Crow Butte mine.

The NRC itself lacks authority under the AEA to grant a license or amendment where, as here, there is no benefit to the US national interest, common defense or security and there are clear detriments to the health and safety of the public. Mere technical compliance with NRC disclosure regulations does not in and of itself satisfy the purposes stated in the Atomic Energy Act, as amended. The United States Supreme Court has stated that a regulation "is not a reasonable statutory interpretation unless it harmonizes with the statute's 'origin and purpose.'" US v Vogel Fertilizer Co., 455 US 16, 26 (1982). Accordingly, it is incumbent upon the NRC to evaluate the US national interest or common defense and security, or lack thereof, as well as the protection of public health and safety, or failure thereof. Furthermore, the NRC is required to deny a license amendment that would not serve the US national interest or common defense and security or would fail to protect public health and safety. Since the purposes of the AEA would not be served by honoring the Cameco Loophole or granting any license or amendment to a foreign owned, controlled and dominated applicant, this Contention E must be admitted and determined upon a proper record.

Contention L: Calculation of Surety Bond Fails to Consider Reasonably Foreseeable Costs of Restoration and Decommissioning. The bond calculation fails to consider post-restoration, post-decommissioning monitoring, or related ecological

monitoring. Cameco's subsidiary, Power Resources, Inc. was just required to increase its bond substantially by WY DEQ based on a similar theory.

1.11 SURETY ARRANGEMENTS

CBR maintains a USNRC-approved financial surety arrangement consistent with 10 CFR 40, Appendix A, Criterion 9 to cover the estimated costs of reclamation activities. Crow Butte maintains an Irrevocable Standby Letter of Credit issued by the Royal Bank of Canada in favor of the State of Nebraska in the present amount of $22,980,913. The surety amount will be revised annually in accordance with the requirements of SUA-1534.

In this case, Congress has unambiguously expressed its intent that atomic energy and source material be regulated in the US national interest to assure the common defense and security and to protect the health and safety of the public. The AEA expressly provides that "the Congress of the United States hereby makes the following findings concerning the development, use and control of atomic energy:....[t]he development, utilization, and control of atomic energy for military and for all other purposes are vital to the common defense and security, [t]he processing and utilization of source material must be regulated in the national interest and in order to provide for the common defense and security and to protect the health and safety of the public, and [s]ource and special nuclear material, production facilities, and utilization facilities are affected with the public interest, and regulation by the United States of the production and utilization of atomic energy and of the facilities used in connection therewith is necessary in the national interest to assure the common defense and security and to protect the health and safety of the public. AEA Section 2012(a), (c)(d)(e); 42 USC §2012.

Significantly, the national interest and common defense aspects include protecting the health and safety of the public, including the environment and water resources. "The Atomic Energy Act was passed years before broader environmental concerns prompted enactment of the Environmental Protection Policy Act. Yet many of those same concerns permeated provisions of the first-mentioned legislation and the regulations promulgated in accordance with its mandate. To say that these must be regarded independently of the constantly increasing consciousness of environmental risks reflected in proceedings with reference to NEPA, would make for neither practicality nor sense. Nor can AEA requirements be viewed separate and apart from NEPA considerations. Especially in

view of NEPA, it also is unreasonable to suppose that risks are automatically acceptable, and may be imposed upon the public by virtue of AEA, merely because operation of a facility will conform to the Commission's basic health and safety standards. The weighing of risks against benefits in view of the circumstances of particular projects is required by NEPA in view of AEA. The two statutes and the regulations promulgated under each must be viewed in *para material.* Citizens for Safe Power, Inc. v. NRC, 524 F.2d 1291, 1299 (DC Cir. 1975).

AEA Sections 62 and 69 are the most directly applicable as they expressly govern source material. This matter may be resolved without a new interpretation of AEA Section 103(d). Additional guidance from AEA Section 103(d) is allowable due to the operation of Section 2012(f) quoted above that **"source...material... facilities are affected with the public interest, and regulation by the United States of the production and utilization of atomic energy and of the facilities used in connection therewith is necessary in the national interest to assure the common defense and security and to protect the health and safety of the public**. 42 USC §2012 (e) (emphasis added). Under Vogel, infra, any NRC Regulations must be interpreted consistently with these Congressionally expressed purposes in order to be effective under Chevron.

AEA Section 61 provides that the Commission may make certain determinations concerning source material provided that before making such determination, the Commission must "find that the determination that such material is source material is in the interest of the common defense and security. 42 USC 2091. AEA Section 62 provides that "no person may transfer or receive in interstate commerce, transfer, deliver,

receive possession of or title to, or import into or export from the United States any source material after removal from its place of deposit in nature. 42 USC 2092. AEA Section 69 provides that **"[t]he Commission shall not license any person to transfer or deliver, receive possession of or title to, or import into or export from the United States any source material if, in the opinion of the Commission, the issuance of a license to such person for such purpose would be inimical to the common defense and security or the health and safety of the public.** 42 USC 2099 (emphasis added). As a result, AEA Section 69 contains the dispositive rule.

For additional guidance, we may look to AEA Section 103(d), which states "[n]o license [for a utilization facility] may be issued to an alien or any corporation or other entity if the Commission knows or has reason to believe it is owned, controlled, or dominated by an alien, a foreign corporation, or a foreign government. In any event, no license may be issued to any person within the United States if, in the opinion of the Commission, the issuance of a license to such person would be inimical to the common defense and security or to the health and safety of the public. 42 USC 2133(d). Similarly, AEA Section 126, concerning export licensing, provides that no export license may be issued for source material until the Commission has been notified by the Secretary of State that it is the judgment of the executive branch that the proposed export or exemption will not be inimical to the common defense and security, belongs would not be inimical to the common defense and security because it lacks significance for nuclear explosive purposes. 42 USC 2155.

In order to obtain a source materials license from the NRC, an applicant must file a license application under AEA Section 182. 42 USC 2232. Each application shall be in

writing and "shall specifically state such information as the Commission, by rule or regulation, may determine to be necessary to decide such of the technical and financial qualifications of the applicant, the character of the applicant, **the citizenship of the applicant**, or any other qualifications of the applicant as the Commission may deem appropriate for the license. Id. (emphasis added.) Further, licenses issued under the AEA are not transferable, directly or indirectly, through transfer of control or otherwise unless full disclosure is made to the NRC and the NRC "after securing full information" finds that the transfer is in accordance with the provisions of the AEA. 42 USC 2234. In order to find that the transfer is in accordance with the AEA, the NRC would have to make a determination under AEA Section 69 that the transfer is not inimical to the common defense and security or the health and safety of the public. 42 USC 2099. Since AEA Section 182 requires the citizenship of the license applicant to be disclosed and evaluated in connection with making a determination under AEA Section 69 as to whether granting the request would be inimical to the common defense and security or the health and safety of the public, it is clear that the determination of foreign ownership, control and domination is a statutory requirement that transcends all of the applicable NRC regulations concerning the issuance and transfers of various kinds of licenses.

Petitioners note that Section 50.92 provides that in determining whether an amendment to a license will be issued to the applicant, the Commission will be guided by the considerations which govern the issuance of initial licenses, to the extent applicable and appropriate and that the Commission will be particularly sensitive to a license amendment request that involves irreversible consequences, such as the irreversible use of water in Applicant's ISL mine. 10 CFR50.92.

The NRC Regulations are for the most part consistent with the Congressional intent discussed above. Significantly, under Regulations Section 40.2, the regulations in Part 40 apply to all persons in the United States. 10 CFR § 40.2. In this case, if the Applicant's position were to be accepted, how would the control persons of the parent company of Applicant be made subject to NRC Regulations if Section 40.2 makes them applicable only to persons in the United States? If Applicant corporate shares are secretly acquired, at what point in the process does NRC have an opportunity to secure full information and obtain sufficient assurances in a "Negation Plan" (through contracts, corporate structuring or otherwise) to neutralize the risks associated with foreign ownership, control and domination of an NRC licensee.

As discussed above, AEA Section 189 requires a written license application which states the citizenship of the applicant, all information required by NRC regulations and regulators. NRC Regulation Section 40.9 provides that all information provided to the Commission by Applicant shall be complete and accurate in "all material respects" which can be read to mean that the Applicant has disclosed all information that a reasonably prudent regulator would consider important in making a licensing decision.[6]

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[6] Rules for establishing materiality under federal law are well-established by the Supreme Court under the securities laws, see TSC Industries, Inc. v. Northway, Inc., 426 U.S. 438 (1976), concluding in the proxy-solicitation context that "[a]n omitted fact is material if there is a substantial likelihood that a reasonable shareholder would consider it important in deciding how to vote." Id., at 449. Acknowledging that certain information concerning corporate developments could well be of "dubious significance," id., at 448, 96, the Court was careful not to set too low a standard of materiality; it was concerned that a minimal standard might bring an overabundance of information within its reach, and lead management "simply to bury the shareholders in an avalanche of trivial information-a result that is hardly conducive to informed decisionmaking." Id., at 448-449. It further explained that to fulfill the materiality requirement "there must be a substantial likelihood that the disclosure of the omitted fact would have been viewed by the reasonable investor as having significantly altered the 'total mix' of information made available." *Id.*, at 449.

10 CFR 40.9(a). Further, Section 40.9(b) requires Applicant to notify the Commission if Applicant has identified information having a significant implication for public health and safety or common defense and security. Accordingly, the Cameco Loophole must be rejected because it would conflict with the disclosure requirements of Section 40.9. Petitioners note that there is a private cause of action for violations of the AEA, including violations of the disclosure requirements therein. Drake v. Detroit Edison, 443 F.Supp. 833, 837 (WD Mich. 1978).[7] Petitioners further assert that the same type of due diligence obligations apply to professionals in preparing and filing NRC applications as are applicable to professionals preparing and filing SEC documents. See, e.g., Escott v. BarChris Const. Corp., 283 F.Supp. 643 (S.D.N.Y. 1968) (finding lawyer among others did not have benefit of due diligence defense when he had knowledge that information in forms submitted to SEC, which were themselves treated as revisions to previously filed documents, contained false information. The court held that in the case of company counsel, Birnbaum, he could not claim a due diligence defense because he should have known better as lawyer for the company involved.)

We now expressly adopt the TSC Industries standard of materiality for the § 10(b) and Rule 10b-5 context. Basic Inc. v. Levinson, 485 US 224, 231-232 (1988).

[7] The court stated, "[i]t is necessary to consider one more extremely important point: does a private cause of action exist under the Atomic Energy Act? For the reasons discussed below, I conclude that a private cause of action does exist. Id. In its discussion based on Cort v. Ash, 422 U.S. 66 (1975),, the Court referred to other areas where the Supreme Court has implied private causes of action including the Securities Act of 1933 and the Securities Exchange Act of 1934. Id. at 838 (J. I. Case Co. v. Borak, 377 U.S. 426 (1964) re: 1933 Act and Superintendent of Ins. v. Bankers Life & Casualty Co., 404 U.S. 6 (1971) re: 1934 Act.) In short, plaintiffs are members of the public, for the protection of whom the Atomic Energy Act expressly provides. There is no indication that private suits will be detrimental to the purpose of the Act; to the contrary, those purposes will be furthered by permitting the class in which the statute creates a federal right to seek judicial relief for alleged unlawful conduct. Such actions will not intrude upon administrative licensing procedures, nor will they tend to abrogate the NRC's statutory authority. When, as here, administrative remedies are insufficient to adequately protect the public, and the legislation in question mandates such protection, it is the duty of the courts to make judicial relief available "where necessary to achieve that result."(J. I. Case Co. v. Borak, infra, 377 U.S. at 432.) Id. at 840.

Once the Commission has received full disclosure in an application, it may approve the sought after source materials license in accordance with Section 40.32 if: (a) The application is for a purpose authorized by the Act; (b) The applicant is qualified by reason of training and experience to use the source material for the purpose requested in such manner as to protect health and minimize danger to life or property; (c) The applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property; and

(d) **The issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.** 10 CFR 40.32 (emphasis added.)

F. Foreign Ownership of US Uranium Mines Is Inimical to US Common Defense and Security and to Public Health and Safety.

Due to Applicant's intentional failures to disclose material information concerning its foreign ownership, control and domination, Applicant has "unclean hands" in this proceeding and may not receive the benefits of any presumptions or assumptions. Rather, Applicant must be held to the highest standards for the protection of the US national interest, common defense and security and health and safety of the public.

One example of the impact of foreign ownership, control and domination on the operation of an ISL uranium mine is that foreign owners and control persons who are not US persons have no loyalty to prevent the reckless, negligent or intentional contamination of the environment by the ISL mining. For example, a foreign controlled uranium mining company would be more inclined to suppress relevant geologic data that shows probabilities of structural control and mineralization (and related groundwater

flows and contamination risks) in favor of profit taking in what is often known as "cut and run" mining operations. As a result, lack of foreign ownership, control and domination is required in order to properly preserve the health and safety of the public as required by the AEA and NRC Regulations. In the absence of any Negation Plan, Applicant's license amendment for the benefit of foreign Cameco must be denied.[8]

The Court of Appeals recognized the problems associated with allowing non-US persons to control nuclear materials, "the internal evidence of the Act is that Congress was thinking of keeping such materials in private hands secure against loss or diversion; and of denying such materials and classified information to persons whose loyalties were not to the United States. In the case of the latter standard of 'the public health and safety,' the Congressional preoccupation was with industrial accidents and the dangers they presented to employees and the neighboring public...In short, Congress certainly can be taken to have expected that an applicant for a license should bear the burden of proving the security of his proposed facility as against his own treachery, negligence, or incapacity. Siegel v. Atomic Energy Commission, 400 F.2d 778, 784 (DC Cir. 1968).

Another example of how it may be inimical to the common defense and security of the United States to grant a foreign company a license to mine and export yellowcake uranium, is that takes the yellowcake uranium outside of US legal restrictions. Cameco is aware of this and makes the statement on pages 12-13 of its 2007 Annual Information

[8] Had Applicant made full disclosures of the foreign ownership and control issues, the NRC would have been able to evaluate such issue and make license conditions if possible that might allow for licensing in accordance with the AEA under NRC Regulation Section 40.41, which contemplates special requirements or conditions that it deems necessary to promote the common defense and security, protect health or minimize danger to life or property, protect restricted data, and require reporting and recordkeeping to effect the purposes of the AEA. A Negation Plan could be properly delineated and adopted under such Regulation 40.41. 10 CFR 40.41.

Form dated Marcy 28, 2008, attached hereto, that: [t]he US restrictions have no effect on the sale of Russian uranium to other countries. About 70% of the world uranium requirements arise from utilities in countries unaffected by the US restrictions. **In 2007, approximately 48% of Cameco's sales volume was to countries unaffected by the US restrictions.** (Emphasis added.) This shows that while Canada is subject to the Non-Proliferation Treaty, there are other aspects of US legal control over source and nuclear materials that can be avoided by foreign owners of US uranium mines such as Cameco.

A cursory comparison of Applicant's disclosures concerning its ownership in with the applicable standard for disclosures of material facts under Section 40.9, requires a conclusion that there are gross omissions to disclose material facts that are necessary to make the Application itself, in light of the circumstances, not misleading. For example, the LRA states that the project was developed by Wyoming Fuel Corporation. "The project was subsequently acquired and operated by Ferret Exploration Company of Nebraska until May 1994, when the name was changed to Crow Butte Resources, Inc. (CBR). This change was only a name change and not an ownership change. CBR is the owner and operator of the Crow Butte Project." There are no additional disclosures concerning ownership.

In fact, a brief review of Cameco's website reveals a much different story of foreign ownership, control and domination of the Crow Butte uranium mine, and concealment thereof from regulators, since the inception of the project. In fact, the project was developed by a 50/50 joint venture of Wyoming Fuel Co. and Ferret Exploration Company of Nebraska, Inc. ("FEN"), which later changed its name to

Crow Butte Resources, Inc., and recently to "Cameco Resources, Inc." ("Applicant"). At various relevant times, Applicant has concealed its true foreign ownership in order to avoid legal problems associated with the Nebraska Alien Ownership Act, Neb.Rev.Stat. 76-400 to 76-415 prohibits corporations organized under the laws of any state or country outside Nebraska from acquiring title to, or taking or holding, any land or real estate.[9] In addition, alien corporations holding or owning real estate in Nebraska were prohibited from (i) electing aliens as members to its board of directors in sufficient number to constitute a majority, or (ii) issuing to or otherwise allowing aliens to own a majority of its capital stock.[10]

In 1989, Petitioner WNRC investigated and made public disclosures concerning Applicant's illegal foreign ownership in violation of Neb.Rev.Stat. Section 76-402 due to its uranium mineral leases in Dawes County, Nebraska. As in this case, almost 20 years later, WNRC was then asserting that Applicant made false statements at public hearings concerning faulting or fracturing that may be occurring in the rock formation that contains the uranium bearing ore. As a direct result of WNRC's investigation, the Nebraska Attorney General investigated and ruled that Applicant was in violation of the alien ownership prohibition. See Press Release dated September 18, 1989, attached

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9 See Neb.Rev.St §76-402 "Aliens and corporations not incorporated under the laws of the State of Nebraska are prohibited from acquiring title to or taking or holding any land, or real estate, or any leasehold interests extending for a period for more than five years or any other greater interest less than fee in any land, or real estate, in this state by decent, devise, purchase or otherwise, except as provided in Sections 76-403 to 66-405."

10 See Neb.Rev.St §76-406 "No corporation organized under the laws of this state and no corporation organized under the laws of any other state or country, doing business in this state, which was organized to hold or is holding real estate, except as provided in Section 76-404 and 76-412 to 76-414, shall elect aliens as members of the board of directors or board of trustees in number sufficient to constitute a majority of such board, nor elect aliens as executive officers or manager not have a majority of its capital stock owned by aliens."

hereto.

While declining to criminally prosecute Applicant due to a lack of expertise or statutory authority to conduct a geologic investigation, the NE Attorney General: (1) caused the Dawes County Attorney to commence forfeiture proceedings where the mineral leases were located pursuant to Neb.Rev.Stat. Section 76-408; (2) caused the NE Secretary of State to commence an action to forfeit Applicant's corporate charter and dissolve Applicant and its subsidiary; and (3) caused the Nebraska Department of Environmental Control ("NDEC") to cease any processing of Applicant's permits related to the then-proposed ISL mine in Crawford, NE. [11] WNRC later commenced litigation against the Nebraska Secretary of State to cause it to follow through with the forfeiture and dissolution of Applicant. See State of Nebraska, ex rel. WNRC v. Beermann, (No. 451-098) (District Court of Lancaster County, Nebraska 1989). At some point after the commencement of such litigation, Applicant and its shareholders changed the share ownership structure to satisfy the expressed concerns of the NE Attorney General. See November 7, 1989 Letter from Applicant's Counsel Mark D. McGuire to NE Attorney General Robert M. Spire, attached hereto. According to Mr. McGuire's November 7, 1989 Letter, the following was Applicant's share ownership, as of a February 1987 recapitalization, and as reported to NRC on June 2, 1989[12], FEN's corporate shares were owned as follows:

Shareholder	Percentage

[11] See September 19, 1989 Letter from NE Attorney General Robert M. Spire to NDEC, attached hereto.

[12] June 2, 1989 Letter from Applicant's President Thor Gjellsteen to Edward F. Hawkins, NRC Denver, attached hereto.

[Imperial Metals Group ("IMC") Undisclosed Parent]	
Ferret Exploration Company, Inc. ("FEC")	28.304%
First Holding Company	8.196%
Geomex Minerals, Inc.	28.500%
Uranerz USA, Inc.	25.000%
Korea Electric Power Corp. ("KEPCO")	10.000%
TOTAL:	100.000%

Applicant's June 2, 1989 Letter to NRC further states:

"The first three are Delaware corporations, Uranerz, USA is a Colorado corporation and Korea Electric Power is a South Korean corporation....Those five companies are also all of the Participants which, along with FEN, have financial interests in the Crow Butte Project under the Production Venture and Operating Agreement dated February 25, 1987, as amended, to which the companies are parties.....The Agreement provides a management structure similar to that of a typical US corporation, which is also typical for mining projects in the US. There is a Management Committee whose role is similar to a corporate board of directors....The present members of the Management Committee for the commercial production venture are as follows:

Participant	Primary	Alternate
Ferret (DDR/CDN/Korea) (DDR)	Ralph Barnard (US)	Dr. Peter Geib
First Holding (DDR/CDN) (DDR)	Gene Webb (US)	Dr. Peter Geib
Geomex (DDR)	Dr. Hugh Morris	Pierre Lebel
Uranerz (DDR) (DDR)	Karl-Ernst Kegel	Hikmet Akin
Kepco (Korea) (Korea)	S.M. Chang (Korea)	E.W. Kim

"....FEN performs these activities through its management, which continues to include myself as president, Steve Collings as vice president and all of the other employees you are familiar with from the past...."

"FEN believes that the commercial production Venture structure makes it clear that FEN has and will continue to control all activities and materials and the Crow Butte Project which are subject to licensing requirements under the Atomic Energy Act of 1954. Therefore, FEN is the proper

applicant and licensee for the project."

Significantly, Applicant's letter omits to state that the three Delaware corporations and the Colorado corporation are themselves owned and controlled by foreign interests. Applicant's letter also omits to state that one of the Alternates to the Management Committee, Peter Geib (W. German Citizen), was the controlling party of the "ultimate parent" at the top of Applicant's complex corporate structure.[13] Also omitted was that Applicant was essentially a joint venture of Imperial Metals Group ("IMC"), Uranerz and KEPCO. It would be impossible to conclude that these disclosures pass muster under NRC Regulations Section 40.9.

In Mr. McGuire's November 7, 1989 Letter and the attached Memorandum dated November 3, 1989, Applicant's then-corporate assistant secretary refers to a February 1987 recapitalization and the share ownership at certain times. Significantly, the November 3, 1989 Memorandum states with respect to the recapitalization that occurred two years earlier:

> [t]he shareholders realized at the time of this recapitalization that a further change in share ownership might be necessary in the future in order to bring the project more in line with the way U.S. mining operations are held when there are multiple participants. Such a change has now been agreed to in principle by the shareholders, and the necessary documents are being circulated for review and final approval. When the change is finalized, the share ownership of FEN will be as follows:
>
> | | |
> |---|---|
> | Ferret Exploration Company, DE Corp | 96 % |
> | Geomex Minerals, Inc., DE Corp | 1 % |

[13] See July 22, 1989 and August 11, 1989 Letters from WNRC Counsel to NE Assistant Attorney General Steven J. Moeller, attached hereto.

First Holding Company, CO Corp[14]	1 %
Uranerz USA, Inc., CO Corp	1 %
Korea Electric Power Corp., Republic of Korea Corporation	1 %
TOTAL:	100 Shares

Although the change was required because of the threatened dissolution of FEN after the NE Attorney General ruled that FEN was illegally owned in violation of Neb.Rev.Stat. 76-402, Memorandum dated November 3, 1989 makes it seem like this was contemplated at the time of the February 1987 recapitalization. This is yet again evidence of the Applicant's sophistry when communicating its ownership information to regulators. And it makes no sense. Why would Uranerz USA give up 24% of Applicant and why would the Korea Electric Power Corp. give up 9% of its interest for the benefit of the IMC companies getting 33% more? Such would not be the indicated in an arms-length transaction by rational economic actors. Rather, it seems, that this was a temporary ploy to assuage the concerns of the NE Attorney General but which lacked real economic substance. Applicant and the same foreign beneficial owners, IMC, Uranerz and KEPCO, continued to hold their equity in the Crow Butte mine despite the prohibition on alien ownership in Neb.Rev.Stat. 76-402.

On March 16, 1994, by letter from Stephen P. Collings, President of FEN, the NRC was notified that:

[14] First Holding holds 100% of Ferret Exploration Company; see Page 2, Paragraph 3(c) of Letter dated January 4, 1990 from Mark D. McGuire to NE Attorney General Robert M. Spire.

As a result of transactions between FEN's shareholders, FEN's corporate shares are now held as follows:

Shareholder	Shares
Uranerz U.S.A., Inc., a Colorado corporation	79
Geomex Minerals, Inc., a Delaware corporation	16
Kepco Resources America, LTD, a Colorado corporation	5
Total shares issued and outstanding	100

Perhaps, since four years had elapsed since the NE Attorney General's office had threatened to terminate Applicant's charter, it felt safe to allow the creeping acquisition of its shares by foreign interests. Since the Alien Ownership restrictions of Neb.Rev.Stat. 76-402 had not changed, as of 1994 and is still on the books, FEN's shares were once again illegally held by foreign controlled, US-chartered corporations. One must ask whether this is part of a concerted effort to avoid NRC regulations on foreign ownership by all the shareholders of FEN and related officers, directors, affiliates and attorneys. One must also ask how Mr. Collings can make disclosures like this without violating NRC Regulation 40.9.

In 1994, a 49% interest in the Crow Butte mine was shifted from the IMC group to Uranerz, paving the way for Cameco's purchase of Geomex. 1994 was also the year that recently retired NRC Commissioner and new Winston & Strawn (now retired) Partner James R. Curtiss joined Cameco's Board of Directors for the last 14 years of continuous board service. This would have given Cameco the expertise to navigate the gray areas and loopholes in the AEA and NRC Regulations and help them articulate the "Cameco Loophole."

Geomex was acquired by Cameco in 1995 or 1996[15] and Uranerz was aquired by Cameco in 1998. As discussed below, Geomex and Uranerz were Canadian-based subsidiaries of West German backed companies. See Cameco Press Release dated April 17, 1998, attached hereto (Uranerz Exploration and Mining Limited (UEM) and Uranerz USA, Inc., being purchased from parent company, Uranerzbergbau GmbH (UEB) which is jointly owned by Preussag AG and Rheinbraun AG (itself wholly owned by RWE AG, Germany's largest electrical utility, "[w]ith the acquisition of UUS's 57.69% interest in the Crow Butte in-situ leach (ISL) production centre in Nebraska, Cameco's ownership increases to 90%. As a result of this purchase, Cameco also adds about 23 million pounds U308 to its US reserve and resource base.").

Once again in 1998, since Cameco had acquired a 90% controlling interest in Applicant, it reported it to the NRC[16]. See NRC Appeal Brief at 27. However, it is not clear whether in its report to the NRC concerning the purchase of Uranerz, whether the NRC was informed that KEPCO's ownership would be restored to its original 10% interest. Somehow, between the time of Steve Colling's 1994 report to the NRC that Uranerz had 79%, Geomex had 16% and KEPCO had 5%, the shares were shifted around again in 1995 so that when Cameco bought Geomex it acquired just shy of a 1/3 interest (32.304%) of the Crow Butte mine. At that level, it appears that the transaction was specifically structured to avoid the appearance of the characteristics of control and that

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[15] See October 14, 1996 Cameco Press Release concerning acquisition of Power Resources, Inc., "Cameco presently owns about 32% of the Crow Butte ISL mine in Nebraska through its wholly owned subsidiary Geomex Minerals, Inc.", at p. 2., attached hereto

[16] (Accession No. 9805260014) re: purchase of Uranerz USA, Inc. report to Staff, June 5, 1998; the NRC Staff consented to the proposed change and determined that no license amendment was necessary. (Accession No. 9806120319).

the other shareholders cooperated in the intra-shareholder transfers, possibly without any consideration, to shift an additional 16.304% to Geomex and an additional 5% to KEPCO in 1995. These kinds of deceitful practices are contrary to Section 40.9, undermine the purposes of the AEA for the safe utilization of atomic energy and are grounds for denial of the sought after amendment and revocation of the Applicant's license under AEA Section 186[17] and NRC Regulations 40.71(b).

Petitioners note that Cameco explains the staged acquisition of the Crow Butte mine in its Prospectus dated June 21, 1999, attached hereto, at page 7:

> *Crow Butte*
> Crow Butte is an in-situ leach uranium operation near Crawford, Nebraska which has been in production since 1991. **Cameco holds a 90% interest in Crow Butte through two wholly-owned subsidiaries, UUS Inc. (57.691%) and Geomex Minerals, Inc. ("Geomex") (32.309%). The remaining 10% share is owned by KEPCO Resources America, Ltd., a subsidiary of Korea Electric Power Company.** In 1998, Cameco's share of Crow Butte production was 655,000 pounds U3O8. At December 31, 1998 Cameco's share of reserves and resources was 10.2 million pounds and 25.0 million pounds, respectively. (emphasis added.)

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[17] Sec. 186. Revocation.

a. Any license may be revoked for any material false statement in the application or any statement of fact required under section 182, or because of conditions revealed by such application or statement of fact or any report, record, or inspection or other means which would warrant the Commission to refuse to grant a license on an original application, or for failure to construct or operate a facility in accordance with the terms of the construction permit or license or the technical specifications in the application, or for violation of, or failure to observe any of the terms and provisions of this Act or of any regulation of the Commission.

b. The Commission shall follow the provisions of section 9(b) of the Administrative Procedure Act in revoking any license.

c. Upon revocation of the license, the Commission may immediately retake possession of all special nuclear material held by the licensee. In cases found by the Commission to be of extreme importance to the national defense and security or to the health and safety of the public, the Commission may recapture any special nuclear material held by the licensee or may enter upon and operate the facility prior to any of the procedures provided under the Administrative Procedures Act. Just compensation shall be paid for the use of the facility. 42 USC 2236.

Upon information and belief, in 2000, Cameco purchased the remaining 10% of the Crow Butte mine from KEPCO.

IV. Other – If a contention raises issues that cannot be classified as primarily falling into one of these categories, the requester/petitioner must set forth the contention and supporting bases, in full, separately for each category into which the requester/petitioner asserts the contention belongs with a separate designation for that category.

Request for Subpart G Procedures

, Petitioners have properly requested that the Board apply Subpart G hearing procedures to this proceeding, pursuant to 10 CFR Section 2.310(d) because these contentions necessitate resolution of issues of material fact relating to the occurrence of past events, i.e., whether CBR disputes any of the Relevant Facts. Memorandum at 126; Reference Petition at 2, 5. Specifically, Petitioners have requested discovery and expert testimony. Reference Petition at 5. Discovery should include depositions, documents requests, interrogatories and any other discovery allowed under the Federal Rules of Evidence.

As noted at the oral argument, Entergy Nuclear Vermont Yankee et al. (Vermont Yankee Nuclear Power Station), LBP-06-20, 64 NRC 131, 201 (2006), stands for the proposition that the word "may" in 10 CFR Section 2.310(a) indicates that the Board has discretion in determining whether to hgold hearings under Subpart L or Subpart G.

Where, as here, the Applicant has intentionally concealed material information from all of its Applications going back 20 years concerning the foreign ownership of

Applicant, in clear violation of 10 CFR Section 40.9, the Board should exercise such discretion and grant Petitioners' request for Subpart G hearing procedures.

The nature of the technical issues of geologic formations, intermixing of aquifers as well as the cultural issues, on the one hand, and the failure of the Applicant to be forthcoming and make appropriate disclosures even when required under the regulations, call for Subpart G in order to have a proper and accurate record.

The various characterizations and concealment of the identity and ownership and persons having control over this licensed uranium mine is astonishing. It gives rise to a presumption that every material statement of this Applicant must be tested as to its veracity. Material witnesses need to be examined to determine whether an ongoing fraud has been perpetrated on the People of the State of Nebraska due to intentional and long-term violations of the Alien Ownership Act at Neb.Rev.Stat. 76-402 and the restrictions on foreign ownership, control and domination under the AEA.

1. True Beneficial Ownership and Nature of Crow Butte Mine Was Intentionally Concealed From Regulators

From the beginning, the Crow Butte mine was a foreign owned and controlled joint venture between W. Germany and S. Korea – both of whom at that time shared (and Korea still shares) divided borders with communist nations viewed as enemies of the US. The corporate structure is complicated and difficult to understand and gives rise to a need for Subpart G discovery simply to ascertain what has transpired.

Based on publicly available information, it appears that in the late 1970s, when the citizens of West Germany were allowed to write off over 200% of income against

taxes for funds invested in overseas mineral exploration, a number of West German mineral drilling partnerships, mostly in uranium, known as the "Sedimex Partnerships" founded E&B Canada Resources Ltd. ("E&B"), a private Canadian company to manage their investments. In May of 1983, E&B acquired a Canadian holding corporation known as Imperial Metals Corporation ("IMC"). The Sedimex Partnerships own approximately 36.5% of the IMC stock through 14 Colorado limited partnerships known as the "Sedex Partnerships" and including two entities known as "Sedex Securities Sixth Partnership and Sedex Securities Seventh Partnership. The Sedex Partnerships have as limited partners 14 other limited partnerships which are wholly-owned and managed by IMC. IMC is fifty percent (50%) owned by the West German investors through the Sedimex and Sedex Partnerships which are themselves managed and controlled by Novis Investitions GmbH which is controlled by **Dr. K. Peter Geib, Citizen of West Germany.**[18]

In May 1978, it was the West German investors who organized FEN to acquire, develop and operate mining projects in the United States, Canada and elsewhere as general partner of Geomex Development Sixth Partnership and Geomex Development Seventh Partnership. In 1978, First Exploration Company, Inc. ("FEC") entered into a 50/50 joint venture with Wyoming Fuel Company for the exploration and development of the Crow Butte Uranium Project. In January 1986, FEC and affiliates acquired Wyoming Fuel Company's 50% joint venture interest. Accordingly, in reality Applicant gives the impression that it is a US company it has always been an instrument of foreign interests.

In 1987, First Holding Company was organized to hold the stock of FEC and

[18] We note that Mr. Geib appears to control Geomex but is an "Alternate" for FEN and First Holding which indicates control attributes.

affiliates. FEC is wholly owned by First Holding Company which is held by shareholders including **William E. Grafham (CDN; Caymans Resident) (15.77%), W. Gene Webb (US) (5.26%), K. Peter Geib (DDR) (4.16%), Sedex Securities Sixth Partnership (12.99%) (DDR), Sedex Securities Seventh Partnership (24.93%) (DDR), Sedex Securities Ninth Partnership (2.67%) (DDR), E&B Mines (CDN)(1.27%), Geomex Minerals, Inc. (DDR) (1.11%) and FEC (2.00%).**

In May 1987, First Holding Company sold an interest in the Crow Butte Project to Uranerz USA, Inc., a wholly owned subsidiary of a West German mineral development corporation. In August of 1987, First Holding Company sold a 10% interest in the Crow Butte Project to the Korea Electric Power Company ("KEPCO"). This is the restructuring referred to in the Memorandum dated November 3, 1989, which is attached to Mark D. McGuire's Letter dated November 7, 1989. In late 1989, due to the NE Attorney General ruling discussed above to the effect that FEN was in violation of the Alien Ownership Act at Neb.Rev.Stat. Section 76-402, FEN resdistributed its stock as described above. As discussed above, these transactions indicate a willingness to enter into sham stock transfers and equity shifts, without consideration, simply to give the appearance of regulatory compliance.

In connection with this matter, and particularly in light of the fact that these sham equity transfers in 1989 caused prejudice to Petitioner WNRC's rights and its Nebraskan members' rights to compliance with the rulings of the NE Attorney General and with the Alien Ownership Law of Neb.Rev.Stat. 76-402, Petitioners under Subpart G procedures reasonably request complete discovery including answers to interrogatories similar to the ones propounded in WNRC's 1989 case in Lancaster County Court, attached hereto.

Further discovery should include the deposition of Mark D. McGuire as to non-attorney-client privileged communications as well as any communications exempted therefrom by the crime/fraud exception should it be found that there was a conscious arrangement to shift equity in sham transactions to evade regulatory requirements. The deposition of Applicant's President Steve Collings should also be taken concerning this matter. Depositions should be accompanied by appropriate deliveries of relevant documents.

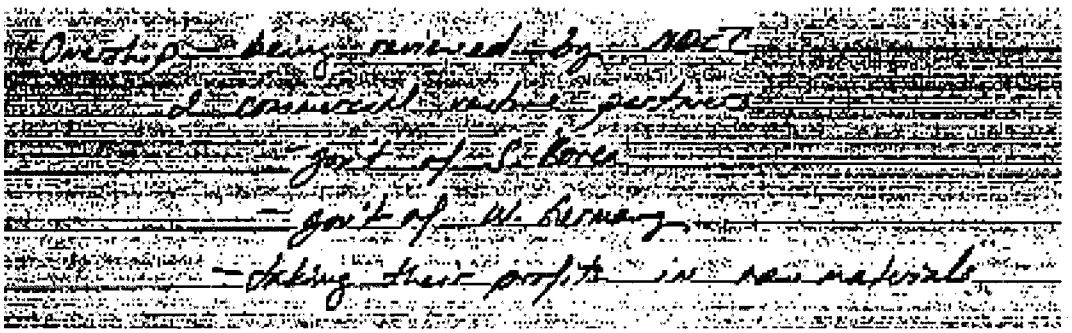
In addition, Petitioners would like discovery concerning a meeting that took place on April 5, 1988, "State Briefing of RA & Staff" that involved the NDEC and Applicant's personnel. The copy of the notes that we have, attached hereto, states:

p.2 –

"Ownership – being reviewed by NDEC
- **2 commercial venture partners**
- **"Gov't of S. Korea"**
- **"Gov't of W. Germany"**
- **"taking their profits in raw materials"**

...

"Region VI – Stephanie Johnson 219-665-7160"



This indicates that the Crow Butte project was and has always been a joint venture between the foreign interests of the Government of South Korea and the Government of West Germany. Further, we note that in 1988, before the fall of the Berlin Wall, the

United States was still engaged in the Cold War and dealing with the emergence of fundamentalist and terrorist extremists. During that time, in and close to the de-militarized zones that separate North Korea and South Korea, and East Germany from West Germany, the communist backed intelligence services were actively working through counterparts in their respective "sister" countries in the West. It is well known that the East German Stasi had one of the most effective and active intelligence services in the World. In fact, given the circumstances, it is not unlikely that some relative of an employee in the South Korean Electric Company (or the West German Electric Company) would be contacted and offered large sums of money by someone who is an operative for the communist sister country who might actually be related to that employee by blood or marriage. That being the case, where the parties intend to accept profit shares in the form of "raw materials," i.e., yellowcake uranium, one must ask whether any Crawford, Nebraska yellowcake might be sitting in an underground tunnel in North Korea this very moment.

If NRC regulators at appropriate levels had been made aware of this joint venture of foreign interests they would certainly have denied such attributes of foreign control, ownership and domination as being inimical to the common defense and security of the United States. While it is theoretically possible to imagine an effective Negation Plan for such a venture, the entire matter would be subject to severe scrutiny at various levels of the US Government and its intelligence services as well as by the public and concerned citizen groups such as WNRC. Anyone who was aware of the applicable NRC regulations would have had to turn a blind eye or intentionally conceal the true ownership of the Crow Butte mine in order to secure an NRC license on behalf of his foreign

bosses.[19] How could that not be inimical to the common defense and security of the United States?

2. Applicant CBR Has Suppressed Geologic Data and Designed Monitoring to Avoid Detection of Suspected Groundwater Contamination For the Purpose of Concealing Knowledge of the Same Faults and Fractures Alleged by Petitioners to Exist

In connection with this matter, and particularly in light of the fact that these fractures and faults have been known to exist since at least 1984, Petitioners under Subpart G procedures reasonably request complete discovery including the deposition of Applicant's President Steve Collings and the authors of the following 1984 Expert Hydrogeologist's Opinion, attached hereto (emphasis added):

> **Letter dated June 21, 1984 from Hoskins Western Sunderegger, Inc., Lincoln Nebraska to Upper Niobrara – White Natural Resources District, Chadron, NE**
>
> Re: EPA Aquifer Exemption Hearing for Uranium Mining Permit Application for Wyoming Fuel Company
>
> Page 2 -
>
> "....3. **Wyoming Fuel has not shown that the lower Chadron is a separate unit of the Regional aquifer which includes the Chadron and the Brule. If the lower Chadron is hydraulically connected with the Brule, any injection would "endanger drinking water sources"**....
>
> "We have prepared an alternate geologic interpretation (Figures 1 and 2 of this letter) based on the Wyoming Fuel data submitted in the exemption petition. The alternate interpretation is a physical model which includes faults to explain changes between bore holes. Faults are known to occur in the region in connection with springs. Thus the fault fractures play an important role in the flow system by providing upward movement along faults. The best example of this is the large spring (1,000 GPM) at Fort

[19] Such a person would also be in violation of 10 CFR Section 40.10 regarding deliberate misconduct.

Robinson State Park located about 6 miles west of Boring numbered PT-7. Numerous smaller springs occur in the area northwest to northeast of Boring numbered PT-7. It is possible that the disruption of groundwater flow by faulting caused the uranium ore to be deposited in the first place."

/s/ David W. Thomssen, Certified Professional Geologist
/s/ Roy W. Elliot, Hydrogeolist

In addition, Petitioners were recently made aware of the following Whistleblower Letter (attached hereto) which describes the intentionally suppression by Mr. Collings on behalf of FEN and by representatives of Uranerz, to conceal unfavorable geologic data:

Excerpt from John Petersen Letter dated April 4, 1989 to Gary Konwinski, NRC, Uranium Recovery Field Office, Denver –

"I am writing to you to express my concern regarding the **probability of ground water contamination in the course of on-going and anticipated in situ uranium mining operations in Dawes County**, Nebraska. These operations are directed by Ferret Exploration Company of Nebraska with joint venture support from Uranerz USA, Inc...."

"I am personally acquainted with the circumstances which are described herein through my former affiliation with Uranerz....During my employment by Uranerz I had the opportunity to examine the exploration data of the Crow Butte area in the course of my normal duties, and in fact, my opinion concerning the interpretation of the Crow Butte data was specifically sought by Uranerz management within the last year....I believe certain aspects of the geology of the Crow Butte uranium deposits have been deliberately overlooked or suppressed so that mining could proceed and profits be gained regardless of the effect upon local ground water quality...."

"...The amount of information that is now available in the general Crow Butte area is great enough to minimize the uncertainty of geologic interpretation to the point that certain probabilities (not possibilities) may be stated."

"It is my understanding that geologists of the Nebraska State agencies involved in permitting believed that structural control of the Crow Butte mineralization was likely, but were ultimately dissuaded from that belief by

Ferret personnel. In fact, it is my understanding that mining was only allowed to proceed because structural control was finally ruled out. I have no way of knowing exactly what information was used to arrive at that evaluation, but I can state that as a matter of my professional **opinion I find it to be highly probable that most, if not all, uranium mineralization in the Crow Butte area is directly and primarily controlled by near-vertical faults cutting through the area."**
***

"**Mr. Stephen P. Collings of Ferret and Mr. Karl Kegel, President of Uranerz USA, Inc. were made aware of the liklihood [sic] of structural control by means of technical memoranda written in July 1988** by another geologist in the Uranerz organization. This person would have reasons to fear retribution if he made is own views known to regulatory agencies. Since I am separated from Uranerz however, I am free to act. **Mr. Kegal and Mr. Collings along with Mr. H. Akin, who is the Uranerz Vice President in charge of mining operations, and who has immediate supervisory responsibility on behalf of Uranerz have apparently agreed to surpress [sic] general knowledge of the structural interpretation so that mining and exploration may proceed unimpeded."**

"...It is true that hardly an area exists that is not somehow affected by faulting....In contrast, the Crow Butte area faults not only exist, but they control mineralization. The significance is obvious. **Near-vertical, secondary porosity that is provided by such faults make for natural and effective zones for ground water movement and also for the movement of uranium-laden solvents injected into the ore zone in the course of mining. Under these circumstances, the contamination of suprajacent, and to some extent, subjacent, aquifers becomes possible, if not likely."**

"It is my understanding that Ferret, with the approval of Uranerz top management, has refused to undertake specifically designed drilling to investigate the significance of the structural control of mineralization. Clearly, Ferret and Uranerz will choose to ignore the existence of faults and their significance in relation to ground water quality unless they are forced to address the issue either by enforcement of regulation, or perhaps, if that is not forthcoming, by public pressure."

"I believe that the Nebraska Department of Environmental Control and the Nuclear Regulatory Commission should require specific investigations to evaluate the significance of faulting in relation to ground water quality and that mining should be suspended until it can be shown that uranium mining has not and will not cause ground water contamination."

The Whistleblower Letter contains conclusions very similar to the assertions by the Petitioners in connection with the admitted Contentions in this very case – through no coincidence. Accordingly, Petitioners under Subpart G procedures reasonably request complete discovery including the deposition of Applicant's President Steve Collings, Mr. H. Akin, Mr. Karl Kegel, Uranerz, the July 1988 Geologist Memorandum referred to in the Whistleblower Letter and the testimony of the author thereof, John Petersen, if he is alive and can be found after almost 20 years.

Petitioners also seek discovery of Applicant's geologic data, drilling logs, water quality records, monitoring well records, well logs, data concerning the localized geology especially through the White River alluvium, data concerning flow rate, flow directions and porosity and related information that may be relevant to the admitted Contentions.

3. Applicant Has Misrepresented the Nature of Consultations Regarding Mineral and Water Resources in Conflict With Testimony of Material Witnesses.

During oral argument Applicant's counsel made certain representations concerning the nature and extent of consultations and what might have occurred or been said. Specifically, the discussion with Mr. Harvey Whitewoman concerning water quality, and with regard to the pre-historic Indian Camp and artifacts was described by Counsel for Applicant. See, HT at 321 ("Harvey White Woman called and spoke to the Crow Butte. That's a statement of fact, that's in the nature of a consultation..."); HT at 323 ("Those requirements are that you consult with tribes, tribal governments in the potentially affected area, send out letters, follow up to make sure they respond."); HT at

326 ("in this particular set of circumstances it doesn't because no one from the tribes responded to the letter and identified potential cultural or archeological resources in the area of the project. They didn't respond to the consultation. So that they didn't avail themselves of the opportunity to make a determination. That's all there is."); HT at 327 ("It's a consultation which is here is what we are going to do, do you have anything to say back. And if there is nothing back then that is the end of the process, there's-nothing more for the applicant to do there. They've responded.")

According to Mr. Whitewoman, no concerns of any kind were addressed. Affidavit of Harvey Whitewoman at Paragraphs 3-6. As attested to by the attached Affidavit of Harvey Whitewoman attached to Petitioners Memorandum of Law re: Indigenous Issues dated February 22, 2008, at the time, Mr. Whitewoman was employed as assistant to Mr. Johnson Holy Rock, who was the Fifth Member of the OST Council. The Office of the Fifth Member is a member of the Executive Committee of the Tribal Council and does not have any authority to bind the Tribe. Such authority rests with the Tribal Council and to some extent the Tribal President. Under the Oglala Sioux Tribe Constitution and Bylaws. Upon receipt of Applicant's notice to the Tribe that it planned to expand to a new site just south of the Pine Ridge Indian Reservation, Mr. Holy Rock sent a letter to Applicant to inquire about possible impacts on the Tribe's water resources. Receiving no response, Mr. Whitewoman as administrative assistant to the Fifth Member called to follow-up on the letter and spoke with a company representative, who explained the *in situ* mining process. Applicant's representative did not provide information to either Mr. Whitewoman, Mr. Holy Rock, or the OST on the potential impacts of the proposed new mine site on the Tribe's water resources. Affidavit of Harvey Whitewoman

at Paragraphs 8-9.

Unfortunately, since the filing of his Affidavit, Mr. Whitewoman has succumbed to terminal cancer and will not be available to give testimony. Accordingly, Petitioners under Subpart G procedures reasonably request complete discovery including the deposition of whomever spoke with Mr. Whitewoman, whomever wrote the letters referred to in the Application and by Applicant's Counsel in the oral argument and referred to above, as well as the opportunity to submit testimony of Johnson Holy Rock and others with relevant information concerning the cultural resources. For example, there is general knowledge at Pine Ridge Indian Reservation that there was a plague on a large number of families who were camped out at or near Crow Butte. As a result, it is suspected that there may be Indian graves in addition to the other cultural resources in the area.

During the May 8, 2008 scheduling tele-conference, Mr. Steve Cohen, NRC Project Manager stated that he was restricted by something from revealing the location of the Indian Camp and artifacts except to a very large general area of about 160 acres. When Judge Oliver asked more precisely where it was, Mr. Cohen refused to answer saying he was restricted. It was stated that the Oglala Sioux Tribe Historic Preservation Officer could contact the Nebraska SHPO and get the information. This result makes no sense. We are in a legal proceeding governed by the Federal Rules of Evidence and further governed by the penalties of perjury, enforcement of contempt orders and our obligations as attorneys and officers of the court. There are mechanisms to protect the confidentiality of information including the presentation *in camera* with attorneys and not lay petitioner clients so that the information may be evaluated. It is also possible to

include lay petitioner clients based on a written undertaking or court order to preserve the confidentiality of the information. All these are sufficient to protect the interests – against theft or wrongdoing associated with the cultural artifacts – especially where, as here, the interests of the Indigenous Petitioners are the same as the interests being protected by the statute. Accordingly, Petitioners seek further discovery of the information withheld by Mr. Steve Cohen during the May 8, 2004 tele-conference subject to such protections as the Board may deem necessary or appropriate to protect the confidentiality and serve the purposes of the underlying statute.

CONCLUSION

For the reasons stated above, the foregoing legal principles and facts, especially in light of the reckless disregard by Applicant of the applicable laws and regulations concerning disclosure of foreign ownership and geologic information and the intentional concealment of such information from regulators, clearly support of the standing of Petitioners and the admissibility of the Contentions stated in the Petition and the implementation of Subpart G discovery procedures including depositions, interrogatories and document requests under supervision of the Board as described above.

Respectfully submitted,

Shane Robinson
Attorney for Above-Referenced Requestor/Petitioners
c/o David Frankel
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Geochemical Consulting Services, LLC

Solubility, Speciation, and Reaction Path Modeling
Groundwater and Soil Geochemistry
Environmental Assessment
Risk Assessment

July 28, 2008

David Frankel
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Mr. Frankel:

I have reviewed documents associated with the Renewal of the Source Material License (No. SUA-1534) for Crow Butte, Nebraska and have found the applicant has not provided sufficient data to demonstrate proper development of (1) baseline water quality in the aquifer exemption zone and (2) excursion limits at monitoring wells.

Baseline Water Quality in the Aquifer Exemption Zone

Figure 2.9-2 illustrates the proposed aquifer exemption zone around the ore bodies, and there is no statistical justification for the location of the baseline wells to validate that the results in Table 2.9-4 represent the water quality in the exempt zone. Note that the baseline wells in Figure 2.9-2 are clustered and not spread out over the entire exempt zone, and this violates statistical protocol. Within the aquifer exemption zone (i.e., the zone within the monitoring well ring), a systematic grid must be laid out to determine the location of the baseline water-quality wells. The density of nodes within the grid will be determined by the size of the area and the data quality objectives. Data quality objectives (EPA 2000a & 2000b) state the statistical confidence one wishes to have in the estimate of the mean (normal or log normal distribution) or median (no defined distribution) for the water-quality parameters. If a high level of confidence is required for an estimate of the mean or median, more baseline wells will be required.

For example, if we wish to establish a 95 percent confidence interval on the mean for a normal or log normal set of data, with an estimated standard deviation of 20 and using a half width of 10 for the confidence interval, an exempt aquifer area measuring 1200 by 1200 feet would require a minimum of 9 baseline wells (PNNL, 2007). The location of the wells on the grid nodes is illustrated on Figure 1. The half width of the confidence level is a key consideration in determining the number of wells; as the half width decreases, the number of wells increases. The selected level of confidence and estimated standard deviation also affect the number of wells. A lower level of confidence and lower estimate of the standard deviation would result in fewer baseline wells.

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Alternatively, we may elect to locate wells on the grid using a random number generator. In general, less wells are required if they are located randomly, and this is shown on Figure 1 as two random locations per quadrant. Free modeling software, developed by the Pacific Northwest National Laboratory for the Department of Energy (PNNL 2007), allows a large number of scenarios to be evaluated to determine the optimum data quality objectives and sampling approach for the stakeholders.

The well logs provided indicate the Chadron is approximately 50 to 80 feet thick through most of the mining area (Figures 2.6-4 through 2,6-11). The sampling interval for the baseline wells is 20 feet (Table 2.9-3), which does not represent the entire thickness of the aquifer. Figure 2 shows that a water sample obtained from Well 1, screened only in the ore zone, returns a biased sample that does not represent the water quality of the column of water at the given location. Well 2 (Figure 2) indicates the correct method for sampling the water, which requires that the entire thickness of the aquifer be screened to obtain a representative sample.

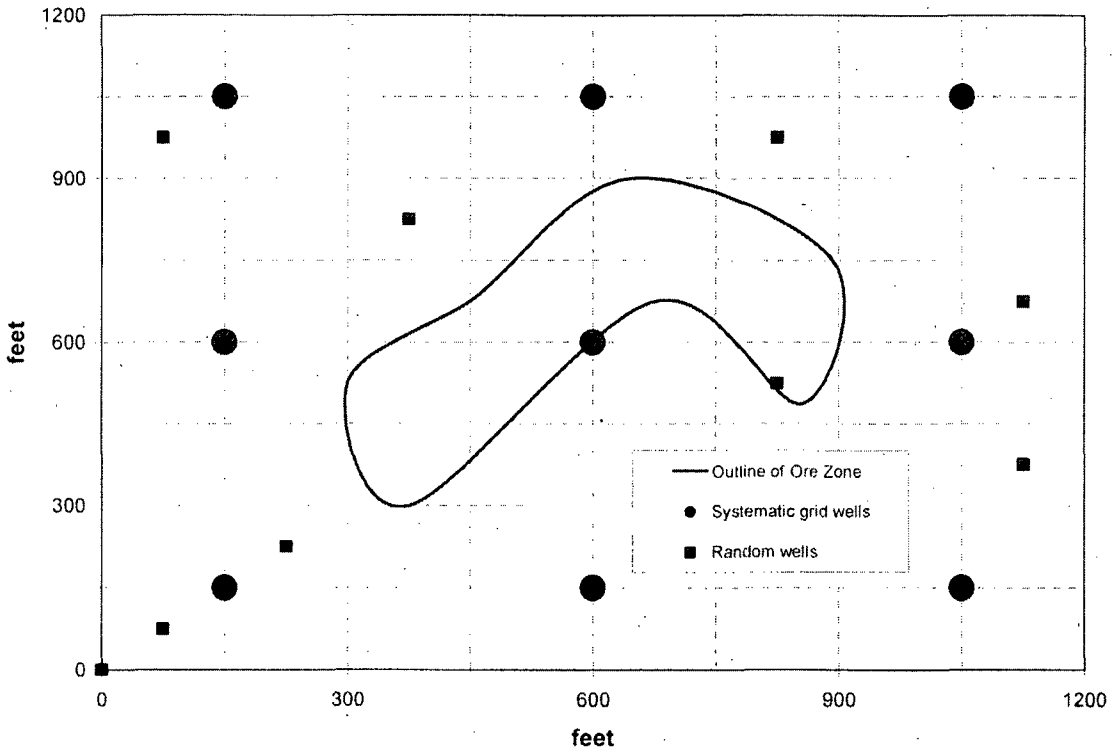

Figure 1. Chart of aquifer exempt zone (i.e., zone surrounded by monitoring wells) and locations for baseline wells established with valid statistical methods.

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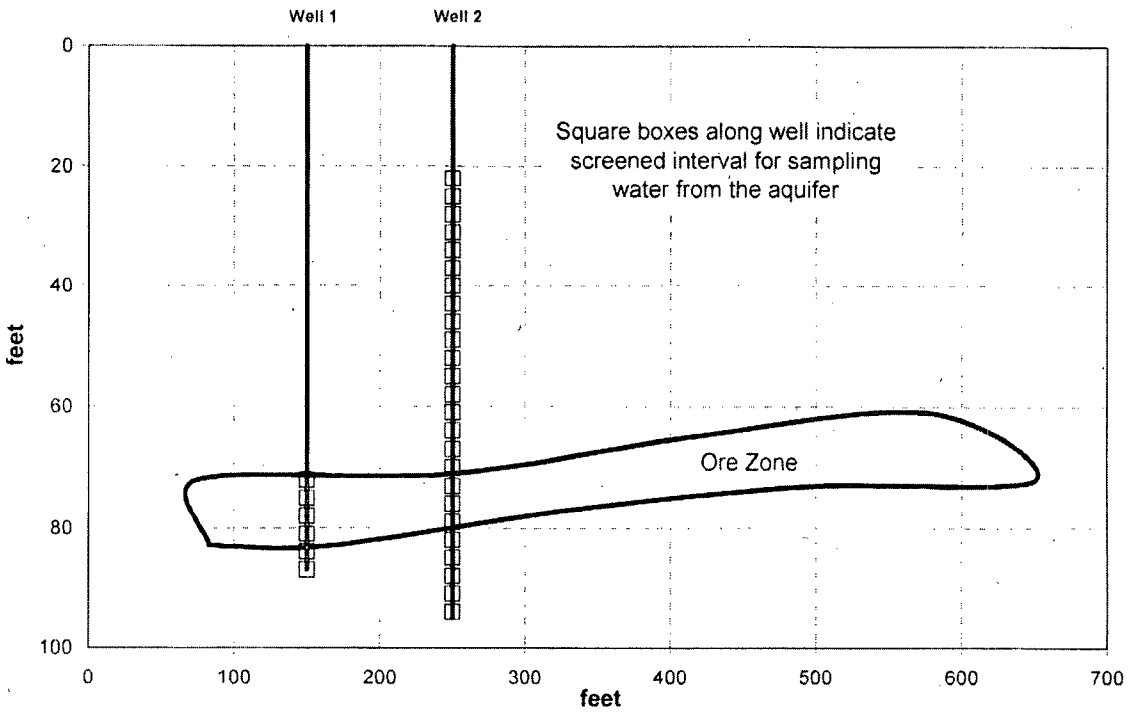

Figure 2. Cross section of an aquifer (20 to 90 feet) showing improper (Well 1) and proper (Well 2) sampling intervals to obtain a representative sample.

The number of sampling events used to establish the aquifer water quality in Table 2.9-4 and the analytical results for each sampling event are not provided to evaluate the results in the table. A minimum of 4 sampling rounds should be collected, and EPA recommends 8 rounds with sampling occurring no more frequently than once monthly.

After collecting a round of data, a proper statistical analysis must be performed to obtain a valid estimate of the mean or median for the water-quality parameter. The first statistical test that must be performed is to evaluate whether the data follow a normal or log normal distribution, and this can be done with the Shapiro-Wilk test or a probability plot (EPA 1992). If the data fail to follow a normal or log normal distribution, non-parametric methods must be used to estimate the median and confidence intervals. The importance of establishing the data distribution is summarized in Table 1.

Assume nine samples were taken from the nine locations on Figure 1 and analyzed for radium-226. A valid statistical sampling of the exempt aquifer zone collects more

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samples from outside the ore zone than within the ore zone, as the greater area within the monitoring well ring is outside the ore zone. Reported results, mean and median values, and probability scores from the Shapiro-Wilk test are given in Table 1. Note the significant difference between the mean (exceeds EPA drinking water standard) and median (below EPA drinking water standard) values, and this is a fairly good indication that the data do not follow a normal or log normal distribution.

A probability plot of the data (Figure 3) and the results of the Shapiro-Wilk test confirm this. The normal-quantile values must fall on a straight line or the Shapiro-Wilk probability values must exceed 0.05 (at the 95 percent confidence level) for a normal or log normal distribution to be declared, which is clearly not the case. Therefore, the median, and not the mean, must be used to represent the central tendency of the data. Note that inappropriate use of the mean results in a high bias on the estimate of the baseline value for radium-226, which improperly elevates restoration clean-up levels and lowers the costs associated with the number of pore volumes needed to exchange to meet the clean-up levels.

Table 1. Radium-226 values and statistical results.

Radium-226 (pCi/L)	Mean (pCi/L)	Median (pCi/L)	Shapiro-Wilk test
0.8			Probability result
0.9	12	2.3	
1.1			Normal
1.7			$P < 0.01$
2.3			
2.8			Log normal
3.1			$P = 0.02$
5.2			
87			

The arguments presented above for Section 2.9-3 of the License Renewal Application also hold for the baseline and restoration values presented for the mining units (Tables 2,7-6 through 2.7-15 and Tables 6.1-2 through 6.1-11). That is, all data and methods used to construct baseline and restoration values must be included in the application to allow an independent evaluation of the summary tables and valid statistical protocols must be used to locate the wells and evaluate the analytical results. Baseline and restoration values presented in the application are improperly biased to high results, and this allows restoration to be achieved with less cost and time at the expense of greater contamination in the aquifer.

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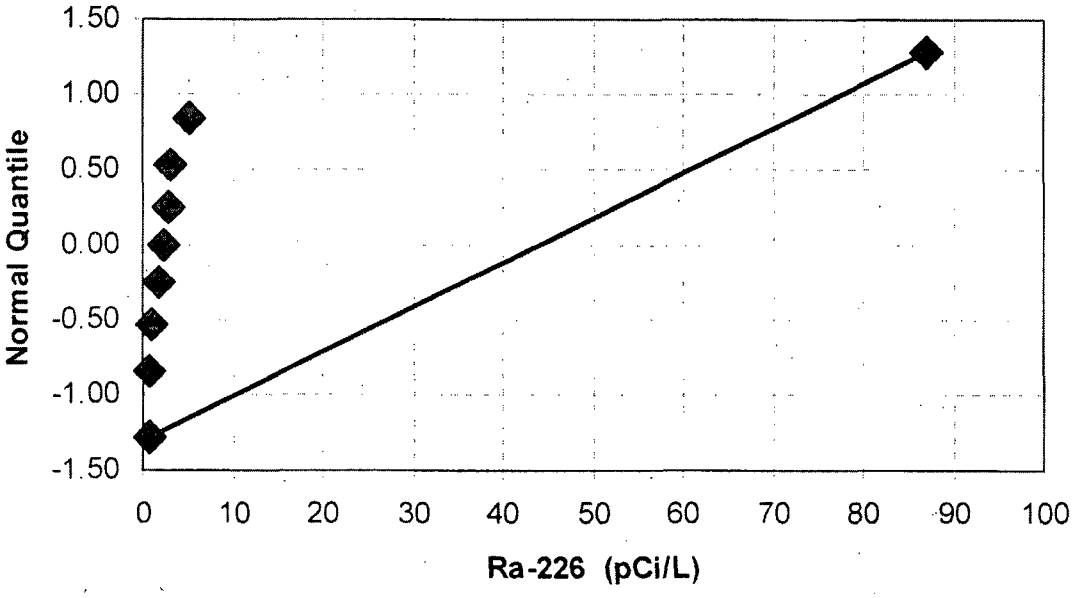

Figure 3. Probability plot indicating that all data do not lie near or on a straight line, which rules out a normal or log normal distribution.

Excursion Limits at Monitoring Wells

Section 5.8.8.2 briefly touches on baseline water quality for the monitoring wells, and upper control limits for indicating an excursion. Baseline water quality is determined on three samples collected 14 days apart, and this is inconsistent with the best practice and guidance discussed above. Chloride, conductivity and alkalinity are noted as the parameters used to monitor lixiviant migration. As uranium is mobilized and transported by the high oxygen and alkalinity in the lixiviant, there is no valid scientific reason to exclude it from the list of excursion monitoring parameters. Upper control limits are set at 20 percent above the maximum baseline value for parameters that exceed 50 mg/L, and for parameters below 50 mg/L 5 standard deviations or 15 mg/L is added to the average value for the indicator. There is no discussion of a valid statistical approach to justify the method for calculating upper control limits.

Ground-water quality data from the monitoring wells must be evaluated to determine if a normal or log normal distribution is present (see discussion above). If the data fail to

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follow a normal or log normal distribution, the mean and standard deviation cannot be used and non-parametric methods must be employed to develop the upper control limit for the excursion parameters.

Uranium is a key indicator of lixiviant excursion because its concentration in baseline wells is generally two or three orders of magnitude lower than the lixiviant and it is highly mobile as a carbonate complex in the lixiviant. Comparing Table 2.7-15 with Table 3.1-3 shows that the lixiviant/baseline concentration ratio is 27 for chloride, 11 for conductivity, 13 for alkalinity and 1300 for uranium (the higher the lixiviant/baseline ratio, the greater the probability that an excursion will be detected at a monitoring well). As the uranium ratio is approximately 100 times greater than the other parameters, it will perform about 100 times better in the detection of an excursion. Therefore, there is no rationale basis to exclude the best excursion indicator from the list of excursion parameters.

EPA (1992) discusses the proper statistical calculation of tolerance limits (a.k.a. upper control limits) using parametric (normal or log normal) and non-parametric techniques. In general, 3 or 4 samples are not sufficient to establish a normal or log normal distribution, and EPA recommends that a non-parametric tolerance limit be set at the maximum observed value (not the maximum value plus 20 percent). As more data are collected at the monitoring well, the distribution of the data is rechecked and if a normal or lognormal distribution is indicated, a tolerance limit can be calculated using the equations provided by EPA (1992). There is no basis or justification for calculating an upper control limit by adding 15 mg/L to the average value. Additionally, using 5 standard deviations added to the average applies only if the data follow a normal or log normal distribution and a Shewhart control chart is constructed.

EPA (1992) addresses the use of 4.5 standard deviations added to the mean via the construction of a Shewhart-cumulative sum control chart. The use of this approach is recommended provided that the data follow a normal or log normal distribution. Assuming a sufficient number of samples have been collected at a monitoring well to demonstrate that the measured values follow a normal distribution, two statistical parameters are calculated to evaluate contaminate migration at the well. First, the standardized mean is calculated from the mean and standard deviation (EPA 1992) and compared to the Shewhart control limit (SCL; set at 4.5 standard deviations above the mean) to evaluate a rapid increase in concentration at the monitor well. Second, the cumulative sum (CUSUM; set at 5 standard deviations above the mean) of the standardized means is calculated for each sampling period (EPA 1992) to determine if it has crossed the 'decision internal value' (h). If h is exceeded, it can indicate a rapid or

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slow rise in concentration at the monitoring well. A gradual increase is indicated when the CUSUM exceeds h and the standardized mean does not exceed the SCL.

Figure 4 illustrates the importance of using the SCL and CUSUM for monitoring lixiviant excursion. The SCL (Z) and CUSUM (C) are plotted for an excursion parameter, a gradual increase in contamination exceeds the CUSUM limit in February of 2002, while the SCL limit is not exceeded until January of 2003. The SCL limit is similar to the CBR's use of 5 standard deviations above the mean for any one sampling event, although EPA recommends 4.5 standard deviations for any one sampling event. Using only the SCL limit allows contamination to migrate beyond the monitoring well for nearly a year before an excursion is declared. Therefore, if the CUSUM is not used with the SCL limit a gradual increase in contamination will not be detected and migration of diluted lixiviant will pass the montoring well without corrective action.

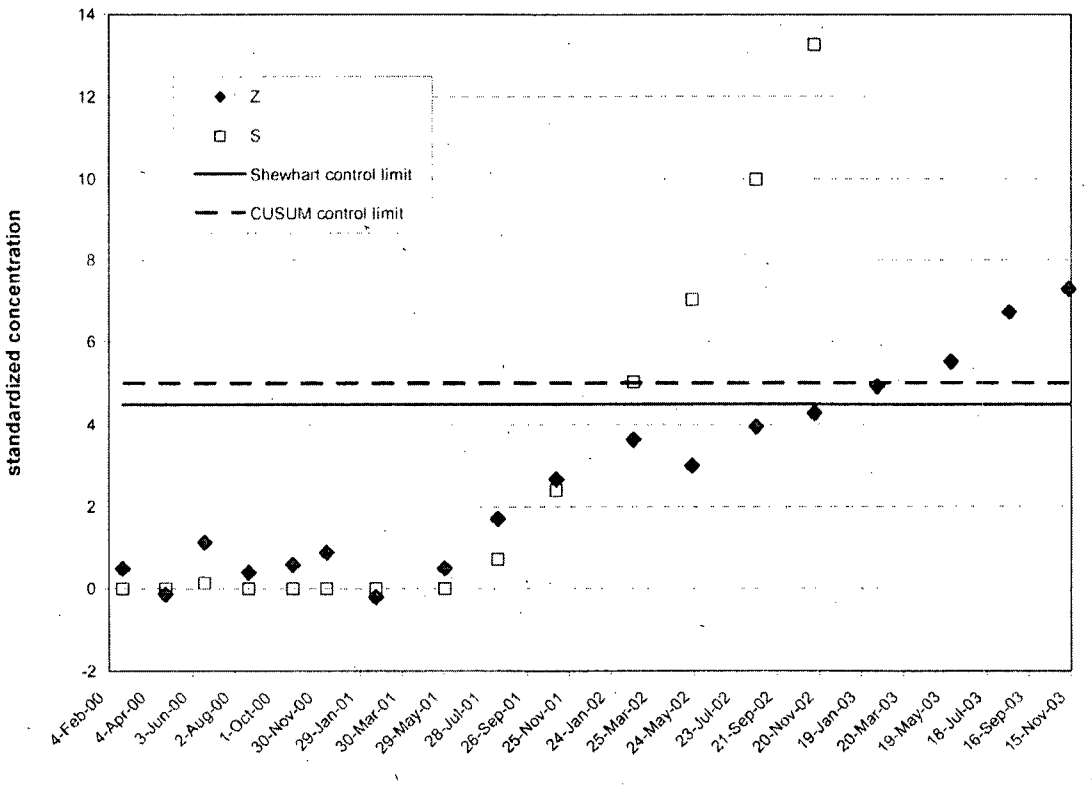

Figure 4. Proper use of a control chart to determine lixiviant excursions.

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Although there was insufficient time to develop a detailed analysis of all the concerns and omissions in the application, I note 46 additional issues that warrant a more detailed evaluation.

1) Section 1.8.1 notes that the only radioactive airborne effluent is radon-222 gas. This is not correct in the strict sense, as the radioactive daughters of radon-222 (Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210) form in the radon-22 gas cloud emitted from the facility. The radioactive daughters fallout as the plume drifts downwind, and particulate monitoring downwind should be performed to determine the fallout dose.

2) Section 1.11 notes that a yearly review is done to ensure that proper funds have been set aside for restoration. A key factor in calculating the amount of financial surety is the number of pore volumes of groundwater that must be processed to restore the aquifer to per-mining levels. As pre-mining levels are often biased improperly to high values, the number of pore volumes needed to restore the aquifer is underestimated and insufficient surety is posted.

3) There are no data to support the water quality results in Table 2.2-9. All data must be provided to allow an independent reviewer to derive values presented in the table. Use of the mean implies that the proper statistical test was performed to demonstrate that the data follow a normal or log normal distribution. There is no discussion of the use of statistical distribution tests.

4) Table 2.5-13 summarizes particulate data for the Black Hills and Rapid City, and is used to conclude that there is no problem with particulate matter less than 10 micorns (PM_{10}). This is unacceptable. Site specific data must be collected to demonstrate that the CBR site does not emit PM_{10} that exceeds 150 ug/m^3 (24-hour average) or 50 150 ug/m^3 (annual average).

5) Section 2.6.1.5 notes that the Chadron Sandstone formed as part of a vigorous braided stream system in the early Oligocene. Braided stream systems form a complex assemblage of sediments that consist of channel sands and gravels isolated by sand, silt and clay bank deposits. The primary flow for groundwater is through the channel sands and gravels, and the width of these channels are generally much narrower than the 400-foot spacing of wells in the monitoring ring. Therefore, it is possible that a paleochannel could exist between two monitoring wells and allow pregnant lixiviant to flow past the montoring wells without being detected. There is no discussion on this type of aquifer heterogeneity in Section 2.7.2.3.

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6) Figures 2.6-4 through 2.6-11 show the thickness of the Chadron to be 40 to 80-feet thick through most of the mine area. Therefore, it is inappropriate to use a screened interval of 20 feet to sample the groundwater from the ore zone (Table 2.9-3). The entire thickness of the aquifer must be sampled to obtain a representative sample.

7) Tables 2.7-6 through 2.7-16 are not supported by the analytical results used to derive the reported values. See comment 4.

8) Section 2.9 notes that a preoperational monitoring was conducted for nonradiological parameters. This is unacceptable. Uranium and radium must also be considered because exploration holes placed in the ore zone disturb the ore and create a path for oxygen. The disturbance of the ore will expose new uranium mineral surfaces to the groundwater, which will release additional uranium, radium and their progeny. Addition of oxygen to the disturbed region will increase the dissolution of uranium ore minerals.

9) No justification is provided for the location of water-quality wells within the monitoring ring on Figure 2.9-2. Valid statistical methods must be used to locate the systematic or random samples on a grid than covers the entire area enclosed by the monitoring wells.

10) There are no data to support the water quality results in Table 2.9-4. See comment 4. Additionally, if preoperational monitoring was only for nonradiological parameters (see comment 9), when where the samples collected for uranium and radium results that appear in the table?

11) Section 2.9.4 is on surface water quality, but there are no data in the report stream water quality. Surface and buried pipelines that fail catastrophically or slowly leak pregnant lixiviant could contaminate surface water. Pipelines transferring pregnant lixiviant from the well fields to the processing facility are monitored for sudden drop in pressure, which indicates a massive failure and spill. However, small leaks in the buried pipelines, along joints and valves, would not be indicated on the monitor. Therefore, large volumes of pregnant lixiviant could be released to the environment from small leaks over the period of years. Surface waters should be monitored and sampled on a quarterly basis.

12) The end of Section 2.9.4 notes that suspended sediment samples have not been collected since 1982 and there is no plan to collect further samples. This is unacceptable, for reasons noted in comment 11.

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13) Soil results in Tables 2.9-10 and 2.9-11 have no results for molybdenum. Molybdenum is known to be concentrated by certain plants and cause problems when livestock ingest the plants containing Mo.

14) On page 3-21 the assumption is made that the aquifer is homogenous and isotropic. This is a poor assumption for fluvial deposits, as there is considerable lateral variability in the grain size (gravel, sand, silt, clay) and preferred flow paths will follow paleochannels.

15) Page 3-32 notes that a risk assessment was performed for the chemical storage facility. There are no assumptions or exposure scenarios discussed to determine if the conclusions are valid.

16) Section 3.3 discusses instrumentation used to monitor the flow out of and into the well fields. There is no detail provided on the pressure drop needed to denote a leak in the piping system transporting pregnant lixiviant. Is a leak of one liter a minute detectable? If so, what pressure drop is associated with such a leak and what is the sensitivity of the system to detect such a drop? If this cannot be detected, there is a potential for a significant amount of contamination to be released over the lifetime of the well field. A one liter per minute leak would result in 1440 liters per day released to the environment.

17) The pond inspection program discussed on page 4-5 does not address air monitoring around the ponds. Radon, mist, and particulate may be mobilized by the wind from the pond and dried margins. Why is air monitoring omitted? What data support such a decision?

18) Page 4-6 notes that if a pond liner leaks, the pond contents will be transferred to another pond. This creates a potential exposure scenario where the contaminated sediments dry out and become airborne by the wind. Air monitoring for particulate and radon is needed around the ponds.

19) Page 4-7 notes that flow-monitoring alarms are activated for a significant piping failure. This implies that a slow leak will not be detected. As noted in comment 16, a slow leak can result in significant contamination of the environment.

20) Page 4-8 (Piping) notes that large leaks would be detected quickly. Again, a small leak could go undetected for years because the piping is buried. This is unacceptable.

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21) Page 4-9 notes that the most common surface release is from piping. How is the spill cleaned up? What is done with the contaminated soil?

22) Section 4.2.2.4 (Hazardous Waste) does not mention the arsenic and selenium released from the ore zone. What is the quantity generated and where does it end up in the waste streams?

23) Page 5-15 mentions pond sprays from the enhanced evaporation system. This system has the potential to release mist to the surroundings. See comment 17.

24) Section 5.8 discusses radiation safety controls and monitoring. There is no discussion of air monitoring for radon and daughters downwind of the exhaust vents. What data support such an omission, given hundreds of curies of radon are emitted from this facility.

25) Page 5-28 notes subsurface releases are from ponds and excursions. There can also be subsurface releases from slow leaking pipelines when the leak is too slow to set off the alarm.

26) Section 5.8.7.2 discusses radon monitoring, and notes that 7 locations are monitored. There is no map to show the location of these monitors relative to facilities and downwind direction.

27) Page 5-78 discusses results for air particulate, and notes uranium results are shown on Figs 5.8-18 through 5.8-24. Why are there no displayed results for Ra-226 and Pb-210?

28) Page 5-87 notes that uranium was elevated in the sediment from English Creek. Sediments downstream from the mine areas should be monitored in the future to determine if concentrations increase in the future.

29) The discussion on monitoring well baseline water quality (p. 5-107) indicates the wells are only used to establish excursion limits, which reveals the inadequate approach to establishing baseline in the exempt zone of the aquifer. Monitor wells will reflect the baseline water quality in most of the exempt zone, and should be used to establish baseline in the exempt zone.

30) The discussion on upper control limits and excursion monitoring (p. 5-107) does not cite statistically valid methods for establishing the upper control limits. The use of the noted improper method can result in a large volume of contaminated

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groundwater to pass by the monitor wells, as the proposed method only accounts for a rapid increase in contamination, and not a slow increase that is more representative of a migrating plume.

31) The absence of uranium as an indicator of excursion is not justified (p. 5-107). Uranium is highly mobile in the lixiviant and is an excellent indicator of excursions.

32) Section 6.1.3.1 notes that one baseline well per 4 acres is used to establish water quality prior to mining. Are the wells randomly located within each 4 acre zone. If not, why not?

33) Section 6.1.3.2 states that if the baseline concentration exceeds the NDEQ MCL, then the baseline average plus two standard deviations is used to set the restoration goal. What is the justification for this approach? Using the mean and standard deviation is inappropriate unless it can be demonstrated that the data follow a normal or log normal distribution.

34) Analytical data to support the results in Tables 6.1-2 through 6.1-11 are not available to verify that proper statistical methods were used to derive the restoration results.

35) Section 6.1.4 states that Mine Unit 1 was successfully restored to primary or secondary standards. Bicarbonate, sulfate, manganese, selenium, vanadium, uranium and radium were not restored to their primary standard, and there is no summary of secondary standards in Table 6.1-2. What secondary standards apply and why?

36) Section 6.2.3.4 notes that on site burial is possible. If the disposal ponds are to be used as burial sites, will the liners in the system be redesigned to account for permanent disposal? What limits will be placed on the materials that can go into the disposal cell? Will a risk analysis be performed to justify the construction of a disposal cell?

37) Section 6.4.1 gives clean-up criteria for radium and uranium in soil. Why are there no clean-up levels listed for radon decay products (e.g., lead-210), arsenic, molybdenum and selenium?

38) Section 7.6 and 7.12.1.1 discuss air quality impacts. There is no discussion of potential air impacts from contaminated particulate during decommission

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activities. The disturbance of contaminated soil during site remediation could suspend contaminants and transport them considerable distances. What type of air monitoring will be performed to ensure that contamination is not spread by air borne dust?

39) Section 7.12.5 discusses air exposure and notes radon and its decay products are the only concern. This is incorrect. Particulate from contaminated soil and mist from the evaporation ponds are also air exposure concerns. Why is there no discussion of these sources?

40) The MILDOS-Area code was used to model the radon dose to receptors. Why are there no input and output files provided to evaluate the model? Tables 7.12-3 through 7.12-7 provide some of the model information. Absent is the wind rose for the area, average wind speeds at 10 and 60 meters, rainfall events and duration, and topographic effects that influence the model results. Also, there is no summary table to compare model results with actual measurements from radon monitors.

41) There is insufficient data provided for the accident scenarios discussed in Section 7.14.5 to properly evaluate the meaning of the stated results.

42) The discussion of economic impacts under Section 8.1.2 notes that failure to renew the license will be detrimental to the economy in the area. However, there is no discussion of the long-term effects of mining. In reality, mining will end and the economy will suffer at some point, and there is little chance for recreation or other industry in an area contaminated by ISL operations. Therefore, the discussion in this section is merely innuendo to intimidate the reader.

43) Section 8.3.1.2 discusses the effectiveness of groundwater restoration as a reason to continue mining. Based on comment 35, one can hardly say the restoration was an overall success. Only by using undefined secondary standards can CBR claim to have restored the groundwater.

44) Section 9.3 notes the groundwater impact is temporary, as restoration returns the groundwater to pre-mining levels. This is simply not true. Restoration to pre-mining levels was not achieved in Mine Unit 1 (comment 35). Secondary standards are not pre-mining levels.

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45) Section 9.3 also notes radiological impacts will be small because all radioactive wastes will be transported off site. This is a false statement, as comment 36 notes that on site disposal is a possible option.

46) Section 9.4 states there is considerable value offered by CBR to the U.S. energy needs. This implies all the mined uranium is bought and used by the U.S. What assurance is given by CBR that all their mined uranium that is sold on the spot market ends up in the U.S.? Can any ISL operation tell the buyer of their product that the product has to stay in the U.S.?

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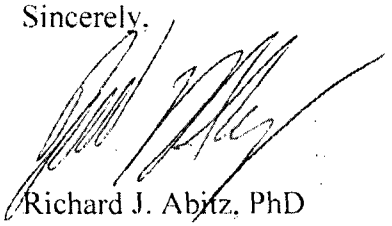
Sincerely,



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EXPERT OPINION REGARDING ISL MINING IN DAWES COUNTY, NEBRASKA

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INTRODUCTION

In 2007, Chadron Creek, a stream that supplies water to the city of Chadron, Nebraska, went dry for the first time in the citys' history. Subsequent study of the creek's water flow rates by Chadron State College students suggested that normal amounts of water are flowing from the springs, but the water is disappearing into deeper alluvium or into fractures in the rock (Balmat & others 2008, Butterfield & others 2008). Following these observations, a Chadron State College graduate student began studying the widespread faults and lineaments of northwestern Nebraska using data collected by high-flying aircraft, satellites, and the space shuttle (Balmat & Leite 2008). These data, along with contributions from scientists from the Nebraska Geological Survey, the United States Geological Survey, the University of Nebraska School of Natural Resources, and the Upper Niobrara-White Natural Resource District, were presented in May 2008, at "Our Water, Our Future: a Town Hall Meeting." The consensus opinion of the presenters was that water shortages and declining water quality are real and worsening problems in northwestern Nebraska.

In January 2008 I was contacted by the Western Nebraska Resource Council for information about the geology and hydrology of northwestern Nebraska, and how uranium contamination might spread from an ISL mine site into surrounding areas. I was shown documentation reporting spills of mine waste water, and asked if there was any way that this waste could have made it's way northward 30 miles (see below). The uranium mine is situated along the same aquifers and fault zones as Chadron Creek. If faults and joints are draining the flow of Chadron Creek, they could also be allowing mine waste waters to migrate through faulted and jointed confining layers. A review of the scientific literature showed that faults and joints are well-known in some areas, but especially along the Pine Ridge near Chadron and Crawford (Swinehart & others 1985), and along the southern border of the Pine Ridge Reservation near the towns of Whiteclay, Nebraska, and Pine Ridge, South Dakota (Fielding & others 2007). Faults are also common in the vicinity of Taodstool Park on northeastern Sioux County and northwestern Dawes County (LaGarry & LaGarry 1997).

I am offering this expert opinion regarding ISL uranium mining near Crawford because I am concerned that unmapped and unmonitored faults may be transmitting lixiviant and waste water through confining layers and into the White River, the alluvium within the White River Valley, and into the secondary porosity of the Brule Formation. I am not against uranium mining in fact or principle. Since arriving in Chadron three years ago, my spouse (also a geologist) and I have sought employment at Crow Butte Resources. Crow Butte employs many of Chadron State College's recent graduates, This issue isn't even about the uranium. It's about protecting the region's water supply, and the future inhabitability of northwestern Nebraska and southwestern South Dakota. In this document, I will briefly explain the basis for my concerns, and propose a series of studies that should clarify whether or not Crow Butte Resources is contaminating the region's water, and if so, how much.

PROFESSIONAL BACKGROUND

I have 20 years experience studying the rocks and fossils of northwestern Nebraska. From 1988-1991 I collected fossils from northern Sioux County for my dissertation work. From 1991-1996 I led field parties from the University of Nebraska State Museum while mapping the fossils and geology of the Oglala National Grassland in Sioux and Dawes Counties. From 1996-2006 I led a team of geologists from the Nebraska Geological Survey that mapped in detail the

surficial geology of most of northwestern Nebraska (a total of 80 1:24,000 quadrangles). This mapping included the entire Pine Ridge area and the area between Crawford, Nebraska and Pine Ridge, South Dakota. These maps, including digital versions (ArcInfo) and supporting field notes, are available from the University of Nebraska-Lincoln School of Natural Resources (contact James B. Swinehart). As a direct consequence of this mapping, I have published peer-reviewed articles on the Chadron Formation (Terry & LaGarry 1998), the Brule Formation (LaGarry 1998), the mapping of surficial deposits (Wysocki & others 2000, 2005), and local faults (Fielding & others 2007). Based on this mapping, we also intend to revise and reclassify the remaining rocks and surficial sediments of northwestern Nebraska.

STRATIGRAPHY OF WATER-BEARING ROCKS IN NORTHWESTERN NEBRASKA

The rocks of northwestern Nebraska range from Cretaceous to Pleistocene in age, and consist entirely of sedimentary rocks. These rocks vary in thickness and geographic extent, and are described as follows (see LaGarry & LaGarry 1997, Terry 1998).

Pierre Shale (aquiclude 1) - underlies all other units, generally 1000'-2000' thick. Contributes small amounts of sulfer and arsenic to overlying surface aquifers (e.g. modern White River alluvium) and water in streams and impoundments. Joints and faults within this unit contain minerals deposited by water movement in the geological past,

Chamberlain Pass Formation (aquifer 1) - formerly 'basal Chadron sandstone,' base of White River Group, overlies Pierre Shale, underlies Chadron Formation and modern river alluvium. Channel sandstones within this unit are a local aquifer and are mined for uranium. Water from this unit is typically used for residential and livestock supplies. Unit was deposited in an ancient paleovalley oriented generally from Crawford in the N-NW and Bayard to the S-SE. Joints and faults within this unit contain minerals deposited by water movement in the geological past,

Chadron Formation (aquitard 1) - middle of White River Group, overlies Chamberlain Pass Formation, underlies Brule Formation and modern river alluvium. Generally impermeable, except where fractured. Many faults and joints contain minerals deposited by water movement in the geologic past.

Brule Formation (aquitard 2) - top of White River Group, overlies Chadron Formation, underlies Arikaree and Ogallala groups (High Plains Aquifer) and modern river alluvium. Generally impermeable, except where fractured. Where fractured, has enough water to be included with overlying High Plains Aquifer. Used locally for residential and low-intensity agricultural supplies. Secondary porosity in Brule can transmit water up to 1500' day. Many faults and joints contain minerals deposited by water movement in the geologic past.

Arikaree Group (aquifer 3, lower part) - base of High Plains Aquifer, overlies Brule Formation of the White River Group, underlies Ogallala Group and modern river alluvium. Consists of moderately porous and permeable sandstones and silty sandstones. Coarser sandstone beds deposited along preexisting fault traces. Unit highly faulted and jointed along Pine Ridge Escarpment. Water supplies springs that feed local creeks, and is used for high-capacity irrigation wells.

Ogallala Group (aquifer 3, upper part) - upper part of High Plains Aquifer, overlies Arikaree Group, underlies modern rever alluvium and sand dunes. Consists of highly porous and permeable sandstones and conglomerates, Coarser sandstone beds deposited along preexisting fault traces. Unit highly faulted and jointed along Pine Ridge Escarpment. Water is used for high-capacity irrigation wells.

Modern river alluvium (aquifer 4) - overlies all bedrock units at one place or another. Consists of layers of silt and sand and lens-shaped ribbons of coarse gravel. Unit also overlies major fault zones. Unit is used as aquifer, and supplies water to residences, livestock, and in the case of the

White River, supplies water to the cities of Crawford, Nebraska and Pine Ridge, South Dakota, among others. Crow Butte Resources surface operations all occur on this unit.

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, and overestimates the thickness and areal extent of many units by 40-60%. Many units' distributions are heavily influenced by the contours of the ancient landscapes onto which they were deposited. For example, when considered to be the 'basal Chadron sandstone,' the Chamberlain Pass Formation was assumed to have a distribution equal to that of the overling Chadron Formation. However, the Chamberlain Pass Formation is 1-1.5 million years (Ma) older than the Chadron Formation, and has a distribution determined by the ancient topography weathered into the Pierre Shale prior to deposition of the Chamberlain Pass Formation.

SECONDARY POROSITY IN NORTHWESTERN NEBRASKA

Secondary porosity, in the form of intersecting faults and joints, is common in northwestern Nebraska, especially along the Pine Ridge Escarpment (see Swinehart & others 1985). These faults and joints are generally oriented NW-SE and SW-NE, and are most likely a result of the uplift of the Black Hills of southwestern South Dakota. The Black Hills have been tectonically active since the late Eocene (Evans & Terry 1994), and continued to fault, fracture, and fold the rocks of northwestern Nebraska and southwestern South Dakota into the middle Miocene (Fielding & others 2007). These faults and fractures transect all major bedrock units listed above. These faults could potentially connect the uranium-bearing Chamberlain Pass Formation to modern river alluvium, and connect the uranium-bearing Chamberlain Pass Formation to the overlying secondary porosity of the Brule Formation.

In addition to allowing contaminated water to move vertically, it can also transmit water horizontally. Many of the faults in northwestern Nebraska persist for tens of miles (Diffendal 1994, Fielding & others 2007). Also, many of the ancient river deposits of the Arikaree and Ogallala Groups, along with the alluvium deposited by modern rivers, follow the faults zones because fractured rock erodes more easily. Swinehart & others (1985) and Diffendal (1994) reported faults that could transmit contaminants from Crawford to Chadron, and from Crawford to Pine Ridge, South Dakota. In its license amendment for the North trend expansion, Crow Butte Resources reports a fault along the White River that could transport contaminants from the ISL mine to the White River, and from the river directly to Pine Ridge, South Dakota.

CONTAMINANT PATHWAYS

There are two principal pathways through which contaminated water could migrate away from Crow Butte Resources well fields and into adjacent areas: 1) along the White River alluvium (modern river alluvium); and 2) along faults. The White River alluvium can receive contaminants from three sources: a) from surface spills at the Crow Butte mine site; b) from waters transmitted through the Chamberlain Pass Formation where it is exposed at the land surface; and c) through faults. Contaminants within the White River can be transmitted into the areas where the alluvium intersects faults downstream from Crawford. Once into the White River alluvium, every rain event will push the contaminants a little bit downstream. In the case of the White River, downstream is to the N-NE and directly onto the Pine Ridge Reservation. Residential users, agricultural users, wildlife, and the City of Crawford all receive water supplies from the White River alluvium.

The second pathway is through faults. These faults can receive contaminants from three sources: a) from surface spills into the White River alluvium; b) from waters transmitted through the Chamberlain Pass Formation; and c) from underground excursions, which can of either lixiviant or uranium-laden water. Once into the faults, contaminants could migrate along the groundwater gradiant (which is generally eastwards) northeastward towards the Pine Ridge Reservation or southeastward toward Chadron and the majority of the remaining High Plains Aquifer. Uranium could also be drawn upwards into parts of the High Plains Aquifer by high-

capacity irrigation wells, some of which are known to be within major fault zones (northernmost Sheridan County, Nebraska).

In May of 2008, I was asked to evaluate the importance of a "whistleblower letter" from Mr. John Peterson, a mining geologist, to Mr. Gary Konwinski of the Nuclear Regulatory Commission. This letter is dated 4 April 1989, and expresses Mr. Petersons concern that information pertaining to faults was being suppressed so that that Crow Butte Resources (CBR) could mine in an unsafe area. Mr. Peterson's main contention is that the uranium mined by CBR occurs within the faults themselves, and is not a roll-front deposit as CBR maintains. This would be the worst possible situation. If there are minerals within faults, they are there because flowing water brought them there and deposited them there. If there are minerals along the faults and CBR is mining them, then they (CBR) are progressively "uncorking" the flow pathways along these faults. If this is the true situation, the risk of spilling contaminants into these faults increases with additional mining, and contamination by chemically altered waters is a virtual certainty. Also, mining the Chamberlain Pass Formation could cause these faults to move again. This could create new, unforeseen pathways for contaminants spread through.

THE PROBLEM OF ARTESIAN WATER

Artesian flow occurs along the Pine Ridge of Nebraska when there is a hydrologic connection, through faults or highly permeable strata, between the Chamberlain PassFormation and the High Plains Aquifer. The weight of water in the topographically higher High Plains Aquifer exerts pressure downward into the Chamberlain Pass Formation, which can be released as artesian water flow where the topographically lower Chamberlain Pass Formation is exposed at the surface, or where it is punctured by drilling. Artesian flow was predicted by NDEQ in their evaluation of CBR's petition for an aquifer exemption, and was observed by a local landowner as CBR did test drilling for the North Trend Expansion. Artesian flow could transmit the most mineral-laden of waters onto the land surface (and into White River alluvium) and discharge large amounts of contaminants into aquifers or faults in a very short time.

CONCLUDING REMARKS

Based on the arguments presented above, it is my expert opinion that ISL mining in the Crawford, Nebraska area should not be allowed to continue until the potential contaminant pathways of the White River alluvium and the SW-NE and NW-SE trending fault zones are examined and monitored. To this end, I suggest:

1. establishing a GIS database for the mapping of existing geologic units and features (e.g., faults). This would allow computer modeling of the region geology, hydrology, and structure, and would present the most complete picture of the data for final evaluation. Data acquired during the following investigations would be incorporated to the database.

2. map the White River alluvium in order to characterize its potential as a conduit for radioactive contaminants.

3. sample water from the White River at regular intervals (e.g., 2 miles) between Crawford and Pine Ridge to locate a plume of contaminated water or sediments, if present.

4. if contaminants are detected, convert sample wells to monitoring wells.

5. map the network of faults present in northwestern Nebraska and southwestern South Dakota.

6. pump test the faults to determine their permeability and the rate of water flow along them.

7. if water flow is detected along the faults, the convert selected sampling wells into monitoring wells.

8. color the water used in all underground stages of production. This will allow future leaks to be detected even if they manifest far from the mined area.

If these steps were taken, and the threat of uranium contamination were to be disproven, then Crow Butte Resources can proceed to mine uranium, but with renewed confidence, public trust, and regulatory credibility. If these steps were taken, and the threat of uranium contamination were to be confirmed, then it may be possible to mitigate the situation such that water supplies are protected and preserved as much as possible following the early detection of contaminants.

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July 28, 2008

David Cory Frankel
ARM Aligning for Responsible Mining
P.O. Box 3014
Pine Ridge, South Dakota 57770

Re: Summary of Recommendations and Opinions on CBR

Dear Mr. Frankel:

We have conducted a limited review of the 2007 License Renewal Application for Crow Butte Resources (CBR). Overall, we found it to be a professionally written document, with a large amount of useful information.

It is our understanding that there has been some offsite contamination as a result of mining operations at the CBR site, and that there is a likelihood of further contamination of the alluvium along the White River from these mining operations. It certainly should be the goal of all concerned parties that any further migration of contaminants off site be stopped as soon as possible. This requires an understanding of the mining operations, the local geology, and how the contaminants got released. It should also be the goal to understand the nature and extent of the contaminated area, so that informed decisions can be made about any mitigation.

To that end, we make the following recommendations:

Better Monitoring and Response to Excursions

Monitor wells at the CBR site appear to be only screened in the ore-bearing part of the Chadron formation. There should be additional monitor wells that are completed in all of the water bearing formations above the Pierre Shale. In order to prevent cross contamination of aquifers, and to establish which aquifer is indicating an excursion, any one monitor well should be sealed and screened in only one aquifer. For any one location, this would require a set of wells independently monitoring the Chadron, Brule, and alluvium.

We understand that there are over 5000 wells at the CBR site. We also have been informed that anytime a lixiviant excursion is detected in the monitoring system, a person has to physically go to the well field and make some adjustment, based on that person's judgment of the situation. The complex nature of this well system suggests that this method is likely to be error prone.

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There is an Allen-Bradley PLC-5 based control system in place. However, we have no information about the level of system detail this provides. The system should have a Supervisory Control and Data Acquisition (SCADA) system that provides all water level, well pump and pipe flow telemetry data to one location, linked to a real-time well and pipe flow-modeling system. This would provide the well field operator with the best information to determine what may have caused the excursion. It could also alert the operator to a problem before it becomes an excursion.

Offsite Baseline Water Quality Sampling

The only way to quantify any contamination is to have a baseline for comparison. Historic water quality information from sources such as the USGS should be explored. Existing offsite wells in the vicinity of CBR and wells along the White River alluvium should be sampled for pertinent water quality parameters to establish this baseline. In areas with no existing wells, monitor wells should be installed. In addition, surface water quality sampling sites should be established along the White River and its tributaries.

Characterization of Contamination Pathways/Offsite Aquifer Parameters

As part of any site characterization, aquifer parameters such as transmissivity and saturated thickness should be established. Potentiometric surfaces should be mapped. This will likely require test holes, monitor wells, and pumping tests. Surface and borehole geophysical techniques and hydrophysics should be considered to characterize the system in sufficient detail.

Surface geophysical techniques can help define the geometry on the depositional environments of the White River alluvium and underlying units. Borehole geophysics can provide information about boundaries and preferential pathways. Hydrophysical examinations of the subsurface can characterize things like fracture flow to quantify secondary hydraulic conductivity. Many new techniques have emerged in recent years. For example, scanning colloidal boroscope flow meters can track naturally-occurring colloidal-sized particles in groundwater, provide very accurate measurements of speed and direction of natural flows through boreholes, aiding in identification of preferential pathways.

Depending on other investigation results, a numerical groundwater flow and contaminant transport model such as MODFLOW/MT3DMS may be needed to quantify the extent of the contamination. This type of modeling effort would require extensive field data for calibration and verification.

White River Contamination

In reference to statements from Dr. Hannan LaGarry, we agree with his assessment that an examination of the extent of contamination of the White River alluvium is warranted. Many of his suggestions can be augmented by the geophysical and hydrophysical techniques previously mentioned. We agree that the subsurface should be fully characterized in as much detail as

possible, using a Geographic Information System (GIS). Subsurface mapping in three dimensions will substantially contribute to an overall understanding of this system.

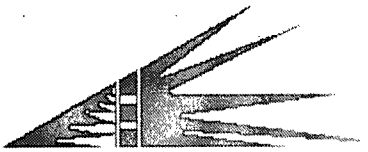
As mentioned previously, a re-examination of select boreholes could employ newer techniques to understand the overall geologic setting as well as contaminant fate and transport. Areas of concern for data gaps could be refined through the use of these newer techniques.

We understand the concerns of down-gradient water users, such as the Towns of Crawford, Chadron and Pine Ridge. The extent of contamination is unknown at this stage. Any plan for sampling and characterization should be flexible until the full extent of the problem is better understood. Any monitor wells installed should be constructed so as to be considered permanent, so that extended monitoring may be conducted indefinitely.

Respectfully,

Paul G. Ivancie, PG

W. Austin Creswell, PE



Southwest Research and Information Center
PO Box 4524 Albuquerque, NM 87196 www.sric.org

July 28, 2008

David Frankel
Attorney for Western Nebraska Resource Council (WNRC)
POBox 3014
Pine Ridge, SD 57770

Dear David:

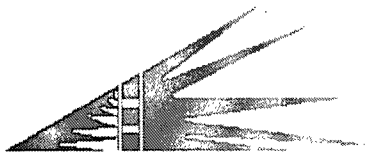
Enclosed please find a copy of Comments and Recommendations Regarding the "Application for 2007License Renewal USNRC Source Materials License SUA-1534 Crow Butte License Area."

This report provides an initial review of the Crow Butte Application for License Renewal.

Sincerely,

<signed>
Paul Robinson
Research Director

Enclosure with attachments



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Comments and Recommendations Regarding the "Application for 2007 License Renewal USNRC Source Materials License SUA-1534 Crow Butte License Area"

Compiled:
July 28, 2008

Prepared by:
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This report compiles comments and recommendations development following review of the Application for 2007 License Renewal USNRC Source Materials License SUA-1534 Crow Butte License Area, (hereinafter "License Renewal Application" or "ALR") License Renewal Application for the Crow Butte in situ uranium mine in northwestern Nebraska.

The review identified portions of the ALR which fail to identify the analytic methods and data used to support information presented, fail to provide current or independently verified information and omit information regarding operations at the mine during the license period.

Technical criteria used in the conduct of this evaluation included, "GUIDANCE FOR REVIEWING HISTORICAL ASPECTS OF SITE PERFORMANCE FOR LICENSE RENEWALS AND AMENDMENTS," are provided at Appendix A of NRC 2003, GUIDANCE FOR REVIEWING

HISTORICAL ASPECTS OF SITE PERFORMANCE FOR LICENSE RENEWALS AND AMENDMENTS" (NUREG-1569, Attachment A to this report).

I. Failure to identify methods, data and supporting information

Much of the data provided by CBR in the ALR is not supported identified analytic methods, demonstrations that methods used are appropriate for the data set being considered, or that the data was collected and analyzed using appropriate standard methods.

A. ALR Section 2.7.3 Discusses Surface Water and Groundwater Quality including water quality restoration standards for mining areas at the CBR sites. CBR appears to state that only two wells were involved in the establishment of baseline water quality conditions in 1996-1997. At p. 2-167, the ALR states, "Monitoring was conducted to establish baseline groundwater quality conditions in the License Area. The program was conducted in 1996 and 1997, and includes samples from a Basal Chadron well (Well 81) and Brule well (Well 78) in the License Area."

No information is provided on the sampling programs at those two wells or the water quality data from those two wells. The ALR appears to indicate that data from those two wells appears to have been the sole source of data used in the development of "Baseline and Restoration Values for Mine Units – 1- 10 on ALR p. 2-166 – 2-176, tables 2.7-6 – 2.7-16."

The ALR fails to provide information on the information collected from the two baseline wells identified on p. 2-167, including: 1) where they are located relative to the various mine units and 2) how water quality in the mine units and water quality in the areas between the mine units and the monitoring wells varies.

The ALR fails to demonstrate that the data base from the two baseline wells identified at p. 2-167 is sufficiently detailed or well developed to determine whether: 1) a sufficient number of samples were collected, 2) the statistical distribution of sampling sites and data are accurately characterized and 3) the statistical analysis of sample data support the restoration values listed.

B. The ALR relies on a USEPA guidance documents for groundwater monitoring that is out of date and no longer current in use:

> U.S. Environmental Protection Agency. 1974. Manual of Methods for Chemical Analysis of Water and Wastes, USEPA-62516-74-003a, 1974 (EPA, 1974).
>
> U.S. Environmental Protection Agency. 1977. Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities, USEPA-530/SW-61 1, August, 1977. (EPA 1997)

More recent and appropriate EPA guidance documents for groundwater analyses used in standard setting include:

> U.S. Environmental Protection Agency (EPA), 1992. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance, Washington, DC. (EPA 1992)
>
> U.S. Environmental Protection Agency (EPA), 2000a. Guidance for the Data Quality Objective Process – QA/G-4, EPA/600/R-96/055, Washington, DC. (EPA 2000a)
>
> U.S. Environmental Protection Agency (EPA), 2000b. Guidance for the Data Quality Assessment – Practical Methods for Data Analysis - QA/G-9, EPA/600/R-96/084, Washington, DC. (EPA 2000b)

CBR should be required to demonstrate, prior to license renewal, that the restoration guidelines found in the ALR meet the requirements of the identified EPA guidance documents including whether CBR has: 1) properly collected the number of samples required for specific statistical analyses conducted in the ALR; 2) collected data that are "normally" or "log-normally distributed" and used statistical methods for standard setting that appropriate for the distribution of data collected , and 3) whether samples were collected for the full period of time provided for in the USEPA Guidance documents.

If the CBR data is found to not meet EPA guidance criteria with respect to the number samples, distribution and/or frequency of samples, then a supplemental effort should be required to establish baseline and restoration data that meet USEPA guidance document criteria before additional uranium extraction is permitted.

Where restoration criteria are found to have been inappropriately or erroneously set as defined by the current USEPA guidance documents, additional groundwater restoration efforts should be conducted to complete restoration to appropriate set standards as defined by methods in the USEPA guidance documents.

C. The ALR at p. 5-109 – 5-117 provides Tables 5.8-12 – 5.8-15 which identify uranium and radium results from private well and surface water monitoring activities from 1991- January 2007. CBR provides no information regarding the collection and analysis of these data such as: 1) how wells were purged or pumped before sampling to insure that "water from the aquifer" - rather than water from that has been sitting in a piping system - is collected, 2) how water samples were collected, controlled and analyzed, 3) how many samples were collected and by whom, and 4) whether spilt samples or blank samples were analyzed for to insure proper quality control and quality assurance for sampling programs described.

The ALR should be revised and supplemented to include data about the collection, handling and analysis of water quality samples including a demonstration that quality assurance and quality control measures are in place and used for all CBR sampling and analysis programs.

D. ALR Section 6 addresses Groundwater Quality Restoration, Surface Reclamation and Facility Decommissioning. Tables are provided at p. 6 –8 – 6 – 18. The restoration standard setting methodology described at P. 6-6 – 6-7 does not address the statistical validity of the restoration goals at the site in the context of the EPA groundwater restoration methodologies cited above. Restoration goals should be reconsidered by reviewing the adequacy of the data base supporting the current standard listed in Section 6

to meet the statistical tests for restoration standards and groundwater monitoring in EPA 1992, EPA 2000a and EPA 2000b. If the use of the baseline as established cannot be supported by independent analysis using EPA criteria, a revised set of appropriate derived restoration goals should be established for the CBR mine fields.

II. Failure to provide current or independently verified information

A. The ALR provides regional water level information in Tables 2.7-3 – 2.7-4 which show "Brule and Basal Chadron Water Levels" with data from the 1982-3 period only. No information on water level variability in these important regional aquifers is provided for the period of time since start-up of CBR ISL or during current 10-year current license period. The data is out of date and of poor quality, as noted in the ALR, "Because these data presented in Figure 2.7-2 and Figure 2.7-3 are over 10 years old and limited in extent, no potentiometric contours are presented. Further, because the regional flow in the Brule and Basal Chadron differ depending on location (e.g., south versus north of the White River), a regional potentiometric map with data from the [CBR site] is not presented."

To address the failure of the ALR to provide regional water level data on local aquifers including potentimetric surface – water level information; updated, current water level information should be compiled and incorporated in to the ALR. Current, accurate information is data fundamental to mapping local water resource conditions and aquifer flow characteristics including but not limited to the potentiometric surface including season change in the potentiometric surface.

Data in the ALR should be supplemented to include recent, including contemporary, water level data from all wells available from the 1982-3 samples and wells installed since that time, compilation of data for water level for wells in the affected area between 1983 and 2008 to identify variation from the 1982-3 data and mapping of the potentiometric – water level patterns – and other characteristics of the aquifers in the affected area.

This supplementary regional water level information should then be analyzed in the context of the regional stratigraphic profiles shown in Figures 2.6-3 – 2.6-11, to demonstrate the location of the potentiometric surface in the context of existing geologic stratigraphy and structure, including the White River Fault identified on p. 2-11 and 2-11.

B. ALR Section 2.7.2.3 discusses a series of aquifer pump tests. The ALRA provides only a narrative descriptions of the pump tests conducted by CBR and does not provide the data compiled during the pump tests which is essential for an independent review of the analysis and conclusions provided by CBR.

Figure 2.7 –8 for examples, identifies the area of influence of the pump tests but not the location of the observation wells from which data is collected during properly conducted aquifer pump tests. The discussion in the ALR fails to identify well construction or completion methods for pumping or observation wells including whether the screened area – the portion of the well casing that allows water flow into the well – was constructed across the complete cross-section of the aquifers being examined or not.

At p. 2-106 the ALR states, "The vertical thickness of the Chadron Sandstone within the Area of Review averages about 60 feet. An isopach of the Chadron Sandstone in the Area of Review indicates a range in thickness of 0 feet on the northeast to nearly 100 feet on the west." Figure 2.6 – 12 shows large area of the Chadron Sandstone greater than 80 feet thick. P. 2-165 includes the conclusion that the aquifer thickness is 33 – 45 feet from the pump test data at p. 2-165.

Failure to identify the specific observation wells, their logged characteristics and completion methods prevents independent evaluation of the pump tests described in the ALR. As the Chadron Sandstone appears to have a high degree of variation in its thickness - 0-100 feet at p. 2-106 concluding that the aquifer averages 33- 45 feet thick at p. 2-165 fails to accurately characterize the wide variation in aquifer thickness demonstrated in well log data presented other sections of the ALR.

C. The ALR fails to incorporate a current understanding of the geologic structure and stratigraphy of the CBR site and surrounding areas. As the ALR uses the same geological structure and stratigraphic information as the CBR North Trend Expansion Area License Amendment Application and supporting documents. Therefore, the critique of CBR's geologic information provided by the November 2007 "Technical Review of Aquifer Exemption Petition for North Trend Expansion" compiled by Nebraska Department of Environmental Quality also applied to the geologic information in the ALR. The NDEQ Technical Review showing that CBR has failed to provide geologic information in its licensing documents which is up to date with the geologic literature related to structure – including fault and fracture patterns, stratigraphy – including the names for and delineation of geologic units, and geohydrology – including primary and secondary permeability in aquifers of concern for Northwestern Nebraska applies directly to the content of the ALR.

The CBR ALR and other licensing document should be revised to reflect current literature on geologic and hydrologic conditions in the White River Fault area a occupied by the CBR mine.

III. Omission of information regarding operations

A. At p. 3-16, the ALR states that the injection of solutions for mining will be at the rate of 9,000 gallons per minutes and that the volume of liquid waste generated from that injection rate would be 47,304,000 gallons per year. CBR fails to provide information from past operations at the site and neither demonstrates or indicates what operating injection rate as and liquid waste volume during the license period actual were.

At. p. 3-16, the ALR states, "CBR adequately handles the liquid waste through the combination of deep disposal well injection and evaporation ponds."

No information is provided in the ALR to demonstrate whether a 9,000 gpm injection rate was ever attained or was maintained during the 10 year license period. No operational information from CBR experience is provided as to: 1) the actual volume of liquid water was actually generated during the 10 year license period, 2) the portion of that liquid waste that was sent to the evaporation ponds relative to the

volume of liquid waste sent to the deep disposal well and 3) what the concentrations of constituents of concern were in the liquid waste generated.

These omission should be eliminated by addition of supplemental information to the ALR before its approval.

B. At p. 4-3, the ALR provides a narrative regarding liquid and solid wastes including, and, at p. 4-6, the ALR provides a discussion of "Potential Pollution Event involving Liquid Wastes." CBR fails to provide any historical record of site operations – as provided for in NUREG 1569 APP. A – for any incidents regarding liquid or solid wastes. Such records would include such as: 1) inspection reports or records documenting how and when releases were discovered, 2) notices of violations and 3) associated responses for any activity involving liquid or solid wastes.

NRC records show that CBR incidents include, at least, 3 leaks of liquid waste from evaporation ponds detected in 1997, 2004 and 2006. Historical records appropriate for incorporation in to a renewal application per NUREG-1569 App. A would include records of those and other releases of liquid or solid waste, records of responses to those incidents and inspections record resulting for CBR or regulator investigations of releases.

C. At p. 5-88 – Section 5.8.8, the ALR discusses Groundwater/Surface Water Monitoring Programs including, at "Upper Control Limit and Excursion Monitoring" at p. 5-107 and "Excursion Verification and Monitoring" at p. 5-108. CBR fails to include any historical records of site operations regarding excursions including inspection reports, notices of violation and associated responses for those incidents and inspection records resulting from CBR or regulator investigations of those releases.

NRC records show at least 20 instances where CBR monitoring wells were placed on excursion status from 1998 – 2006 including two instances in 2008. The ALR fails to identify these incidents, describe CBR or regulator responses to those incidents or identify and lessons learned to minimize or eliminate future instances of excursion.

D. At p. 1-23, Section 1.9, the ALR provides an overview of the range of groundwater restoration activities proposed by CBR, activities discussed in Section 6. At p. 1-25, Section 1.11, the ALR identifies existing reclamation surety for the CBR facility as in the amount of. $22,980,913. This amount is derived from an evaluation based on groundwater restoration activities described in Section 6.

The ALR discussion of groundwater restoration methods fails to consider or evaluate any historical operational experience at the site related to groundwater restoration in any detail though more than a dozen excursions have been detected. The Crow Butte experience, from both mine fields that have undergone restoration efforts and the history of excursions at the sites should be incorporated into the discussion of restoration methods and activities, including pore volumes calculations, to verify that "real world" field restoration processes reflect the scope of proposed activities and projected reclamation surety level accurately. CBR should be required to reassess its restoration methodology and costs based on the real world experience from data generated during mine field restoration and excursion management including total reclamation surety needs.

E. At Section 8, the ALR addresses alternatives the proposed action. The ALR fails to demonstrate that any uranium from CBR or any other CAMECO mine reaches US uranium consumers. As the ALR does not demonstrate that any CBR uranium is processed or used in the US, rather than CAMECO-owned uranium processing facilities in Canada, the alternatives identified do not demonstrate an accurate assessment of uranium market conditions or the actual use of CBR uranium in fact during its operating life to date. CBR should be required to demonstrate were the uranium produced at the site is used and develop alternative variants based on actual use of uranium from the site rather than conceptual alternatives as discussed in the ALR.

The global uranium market is awash in uranium supplies from existing producers as well as secondary sources. Increased availability of secondary uranium is a major alternative to primary uranium in enrichment tailings-owning countries such as the US. Development of realistic alternative sources of uranium such as upblended enrichment tailings is already conducted in Russia at levels well above the

production rate at CBR. The evaluation of alternative sources of uranium should reflect real world market conditions and the market role of producers such as the licensee in this case, CAMECO. Alternatives should not be developed solely to bolster opportunistic production considerations of well diversified multinational uranium producers such as Cameco. Attachment B – "Need or Greed?: Uranium Prices and Demand" provides an overview of uranium supply and demand conditions in 2005 and 2006 including the availability of more than 50 years of uranium supplies in existing deposits, not including secondary sources, as reported by the World Nuclear Association a nuclear industry trade group, www.world-nuclear.org.

F. The ALR identifies Environmental Justice matters at Section 2.3.3 at p. 2-44 and Section 7.11 at p. 7-31. These discussion fail to identify and address the strong historical and cultural connections of the Lakota Nation to the Crow Butte area. The ALR fails to identify cultural resources in the Crow Butte area, consultation with tribal leaders with authority to address cultural resources, or the history of Lakota cultural activities in the area. The ALR fails to identify community development initiative to insure that Native Americans, the minority ethnic group with the largest population in the region, receive any of the potential economic benefit ascribed to the CBR operations in the ALR. The ALR relegated Environmental Justice to a bean counting exercise and fails to full and completely address environmental justice issues associated with activities described in the ALR.

F. The ALR fails to identify the potential health consequences of uranium, radium, radon, radon decay products, and other radionuclides and heavy metals found in the ore zone and liquid and solid waste from the CBR operations. The ALR should be revised and expanded to identify the potential health consequences of exposures to uranium, radium, radon, radon decay products and other radionuclides and heavy metals associated with the Crow Butte area uranium ores. Attachment C – "Uranium Fact Sheets on the Web" includes citations to the Agency for Toxic Substance and Disease Registry (ATSDR) Toxicology Fact Sheets on Radon, Radium, Uranium, Arsenic, Cadmium and Lead. Other Toxicology Fact Sheets are readily available.

Conclusion

This brief analysis of the Application for License Renewal for the Crow Butte In Situ Uranium Mine demonstrates that the application fails to use current research and analytic methods, fails to provide historical information about operations at the site including data from restoration and excursion experience on site, and omits key information about social and economic aspects of the uranium development activity proposed.

Because the ALR so fails to provide current and updated data on geologic and water resources in the affected area and fails to recount the CBR operational experience, and other major limitations, the license renewal should not be provided and revised ALR required.

Attachment A – NUREG 1569 Appendix A

Standard Review Plan for In Situ Leach Uranium Extraction License Applications NUREG 1569 – 2003

Appendix A

GUIDANCE FOR REVIEWING HISTORICAL ASPECTS OF SITE PERFORMANCE FOR LICENSE RENEWALS AND AMENDMENTS

For license renewals and amendments, the historical record of site operations, including air and ground-water quality monitoring, provides valuable information for evaluating the licensing actions. Following are specific areas where a compliance history or record of site operations and changes should be provided for review:

- For license renewals, U.S. Nuclear Regulatory Commission (NRC) inspection reports and license performance reports

- Amendments and changes to operating practices or procedures

- License violations identified during NRC or Agreement State site inspections

- Excursions, incident investigations or root cause analyses, and resultant cleanup histories or status

- Exceedences of any regulatory standard or license condition pertaining to radiation exposure, contamination, or release limits

- Exceedences of any non-radiation contaminant exposure or release limits

- Updates and changes to any site characterization information important to the evaluation of exposure pathways and doses including site location and layout; uses of adjacent lands and waters; population distributions; meteorology; the geologic or hydrologic setting; ecology; background radiological or non-radiological characteristics; and other environmental features

- Environmental effects of site operations including data on radiological and non-radiological effects, accidents, and the economic and social effects of operations

- Updates and changes to factors that may cause reconsideration of alternatives to the proposed action

- For license renewals, updates and changes to the economic costs and benefits for the facility since the last application

- For license renewals, the results and effectiveness of any mitigation proposed and implemented in the original license

Attachment B
http://www.sric.org/voices/2006/v7n3/Need_Greed.html

Need or Greed?
Uranium Prices and Demand

In "Voices from the Earth" V7 n3, Fall 2006

By
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The sevenfold increase in uranium prices during the past four years has resulted in a tidal wave of uranium ore exploration and development activity around the world. But based on a close review of existing and projected world uranium supplies, there's really no need for any new mining sites. The fact is, there's more than enough yellowcake (uranium oxide) in existing deposits and secondary sources to meet projected demand for nuclear fuel for more than 50 years.

The rise in the uranium spot market price (for buyers without long-term contracts) reflects that investors and private industry are focused more on profiting from an imaginary "shortage" than filling a fuel gap to address increased uranium demand to feed new nuclear power stations being advocated by reactor manufacturers. All of which begs the question: is the sudden interest in new uranium mining a matter of real need or plain old-fashioned greed?
That opportunist profiteering may be at the root of the current uranium boom is suggested by the entrance into the market of a new wave of uranium companies — many of which are "junior mining companies" joining the uranium market. The "old wave" of the world's major uranium producers had already identified uranium ore resources at existing deposits that are sufficient to meet the more than 50 years of current or projected uranium demand. Junior mining companies often have limited financial resources, and instead plan to make money on a commodity that is relatively inexpensive to find and produce in comparison to current prices. Many junior companies have never actually mined anything, and are instead buying up existing claims, leases and other forms of "uranium properties" in the hope of attracting capital to develop them at some time in the future. Often, junior companies want to attract more substantial "senior" mining companies and banks to invest in the deposits that the juniors may identify, but lack the financial resources or corporate track record to fund them.

The current boom is resulting in renewed uranium exploration and development activities in communities that have suffered from the legacy of uranium mining in the 20th century and prospecting near communities that have never faced the juggernaut of uranium mining or other industrial development activity. Many of the communities facing renewed interest in long-dormant mining districts are in low-income rural areas and indigenous communities that have little long-term benefit to show from past uranium mining. The legacy of the first 50 years of uranium mining in those communities can provide a warning to areas where new mines, and rosy projections of economic benefit from the new mining activity, are being touted.

How do we know there's enough uranium for the next 50 years?

In 2003, the World Nuclear Association ("WNA") asserted that the known recoverable uranium resources already identified provide a 50-year supply for conventional nuclear reactors at a projected long-term demand of about 70,000 tonnes per year, countering perceptions that uranium for any future nuclear reactors might be in short supply. Recognizing the enormity of the known recoverable uranium resource, WNA asserted:

"The world's present measured resources of uranium in the lower cost category (3.5 million tonnes) and used only in conventional reactors, are enough to last for some 50 years. This represents a higher level of assured resources than is normal for most minerals."

By 2005, WNA's global total of known recoverable uranium resources had increased by 34% to 4.7 million tonnes. The 1.2 million tonnes of additional uranium in unmined deposits identified in just the last three years is roughly equal to the total amount of uranium consumed by the nuclear weapons and reactor industry from its inception in the 1940s through 2005. Estimates of world uranium resources are a long-time interest of the WNA (www.world-nuclear.org), formerly called the Uranium Institute, and a prominent source of uranium supply and demand information for industry and government for decades. The on-line proceedings of WNA's annual symposia are a readily available source of detailed nuclear fuel market information and a major source for this article.

Table 1 identifies the countries with the largest known recoverable uranium resources and the amount of increase in those resources between 2003-2005. The commonly used term for uranium in unmined mineral deposits that can be exploited at market prices is "known recoverable uranium resources," which are identified as the amount of uranium that can be extracted at a specified cost. The standard cost category for known recoverable uranium resources has been set at $80 per kilogram (/kg), or $36/ per pound, for several decades.

TABLE 1
INCREASES IN KNOWN RECOVERABLE URANIUM RESOURCES*
2003 – 2005
$80/pound ($176/kilogram) cost category • 1 tonne = 1 metric ton = 2,200 pounds

COUNTRY	TONNES U 2003	WORLD PERCENT 2003	TONNES U 2005	PERCENT INCREASE 2003-2005	WORLD PERCENT 2005
Australia	989,000	28%	1,143,000	16%	24%
Kazakhstan	622,000	18%	816,000	31%	17%
Canada	439,000	12%	444,000	1%	9%
South Africa	298,000	8%	341,000	16%	7%
Namibia	213,000	6%	282,000	33%	6%
Brazil	143,000	4%	279,000	97%	6%
Russian Federation	158,000	4%	172,000	9%	4%
USA	102,000	3%	342,000	235%	7%
Uzbekistan	93,000	3%	116,000	20%	2%
All Other Countries	480,000	14%	808,000	68%	18%
World total	3,537,000		4,743,000	34%	

Sources: World Nuclear Association 2005 Symposium, International Atomic Energy Agency

NB: Throughout this article, the terms "uranium resources," "uranium oxide," and "yellowcake" refer to natural uranium that has been concentrated after extraction from its host rocks, which are called "uranium ore." Concentrated uranium (U3O8) must be converted, enriched, and fabricated before being used as fuel in nuclear power plants.

While large increases in recoverable resources are reported for many countries, the largest total increase and largest percentage increase is for the United States (U.S.). Much of this increase can be attributed to reconsideration of U.S. deposits — some through paper exploration involving review and republication of decades-old resource estimates — that were previously identified as recoverable at the cost of $50/pound in the 1970s. "Uranium reserves" are a category of available uranium determined based on future operating and capital expenditures incurred in the recovery of uranium and reflect greater certainty regarding the availability uranium from a mineral deposit than uranium "resources." In 1979, U.S. "reserves" of uranium at the $50/pound cost of recovery were 979,000 tonnes — almost three times the total of U.S. recoverable uranium "resources" for 2005 — of which New Mexico uranium reserves were 511,500 tonnes, or 52% of the total. New Mexico would be listed as having the third largest uranium resource tonnage in 2005 if the 1979 New Mexico "reserves" figure was used as New Mexico "resources."

How are uranium resources and uranium demand estimated?
WNA reports that annual uranium consumption in 2005 was approximately 70,000 tonnes. Even at the most optimistic of growth projections, future uranium consumption would top off at 125,000 tonnes by 2025; consumption of uranium as nuclear reactor fuel would be even less under more moderate growth predictions. These uranium demand figures are dwarfed by the known recoverable uranium resource in 2005: 4.7 million tonnes, which represents more than 67 years of world requirements at the 2005 rate of 70,000 tonnes. Using the 2025 medium growth scenario of 100,000 tonnes, this total would provide more than 47 years of world requirements. World uranium demand projections are updated frequently by WNA and other sources to reflect changing market conditions.

Is uranium from unmined deposits the only source for potential future use?
Though the amount of identified unmined uranium is enough for 50 years of current and projected use, "recycled or secondary uranium" derived from previously mined and processed uranium (processed for use in nuclear fuel or weapons) has been a significant and growing source of uranium for reactor use in recent years. Secondary sources include:

- Commercial inventories — uranium supplies owned by reactor operators;
- Government inventories — uranium supplies owned by governments;
- Nuclear weapon/military inventories — uranium supplies in the form of "highly enriched uranium" used in nuclear weapons manufacturing and owned by governments;
- Reprocessed uranium and MOX fuel — uranium supplies in used nuclear reactor fuel;
- Re-enriched depleted uranium — uranium supplies in residuals from uranium enrichment processing — called "uranium enrichment tailings," or "depleted uranium."

Uranium from secondary sources such as commercial inventories, weapons-grade uranium stockpiles and, in Russia, uranium enrichment tailings, has been used for nuclear reactor fuel for the past decade. In 2005, secondary sources provided more than 45% of the roughly 70,000 tonnes used worldwide. WNA uranium supply and demand projections estimate that secondary sources will provide 35% of the uranium to be consumed in 2010.

How does the availability of secondary sources of uranium affect uranium prices and future demand?
Secondary uranium sources affect the uranium market in a range of complex ways. In brief, government-held secondary uranium resources entered the reactor-fuel uranium market in a major way during the period when uranium prices were less than $10/pound. The market entry resulted from policy changes by the U.S. and Russian governments that strictly limited the volume and prices of those supplies that have been allowed to enter the market. The prices for the secondary uranium are much higher than the cost of uranium from mines. During the past five years, the price of the uranium at existing mines and unmined deposits or "primary" uranium has risen to approach the secondary uranium prices.

However, mining uranium is very inexpensive compared with the current spot market price. The historic "finding cost" — the cost of finding and identifying mineable uranium ore deposits — is estimated at about $0.60/pound ($1.50/kgU). Estimates of the cost of recovery of uranium oxide by milling or in situ recovery have been in the $15 - $25/pound ($33 - $55/kg) range for more than 20 years. In five years, the uranium market has turned on its head; ore that cost twice the market price to recover in 2000 when the price was $7/pound now costs less than half the September 11, 2006 market price of $52.00.

While the price of uranium has risen, in part, because of secondary supplies, the long-term availability of uranium from secondary sources is yet to be determined. Although the amount of uranium available from secondary sources is very large, the lack of long-term agreements to use the secondary uranium sources leaves the projections of secondary uranium consumption beyond 2010 very uncertain. As plans, and eventually contracts, emerge for use of secondary sources of uranium for reactor fuel, demand for newly mined primary uranium may decrease.

How much uranium is available from secondary supplies?
Substantial amounts of uranium are available in each of the categories of secondary uranium supply. Commercial inventories of uranium — the supplies of uranium owned by reactor operators — were

estimated at 110,000 tonnes of uranium in 2005, equal to about 1.5 years of global uranium demand in 2005. Commercial uranium inventories represent holdings for future use and are not predicted to be maintained near current levels for the next several decades by WNA analysts.

Government inventories of uranium are considered by WNA to be composed primarily of non-military government-owned supplies of "highly enriched uranium" (HEU), a form of uranium usable for nuclear weapons production, held largely by the government of the Russian Federation. As noted in Voices in 2004 (Vol. 5, No. 4), the U.S. and Russia, as well as other nations that have nuclear weapons, continue to retain extensive HEU stockpiles. World HEU stocks at the end of 2003 are reported as 1,900 tonnes, of which non-military resources total 175 tonnes and military resources total 1,725 tonnes. Of the total military uranium, 300 tonnes of HEU in Russia are "declared excess," and available for blending down to reactor grade.

Assuming that one tonne of HEU contains the U-235 content of 360 tonnes of yellowcake (which is refined, but unenriched uranium oxide), then 300 tonnes of HEU contain the U-235 content of 108,000 tonnes of yellowcake. The "recycling" of the Russian "excess" HEU is the projected source of 10,000 to 12,000 tonnes of future uranium supply through the year 2013, though future agreements to reuse HEU may be developed sooner.
Russian civilian HEU — HEU transferred from military to non-military government ownership — was estimated at 175 tonnes, or equivalent to 63,000 tonnes of uranium oxide. This resource is projected to contribute about 9,000 tonnes of uranium to global uranium supplies until existing HEU blending and marketing agreements involving the U.S. and Russia expire in 2013.

The 1,725 tonnes of military HEU, held primarily by the governments of U.S. and Russia, is equivalent to more than 600,000 tonnes of yellowcake. Though the global inventory of HEU is under a sales embargo until 2009, the U.S. has initiated plans to market that uranium when the moratorium expires. The first sale of the U.S. civilian uranium inventory is to Bonneville Power Administration, a federally-owned power provider, in an amount equivalent to 2,500 tonnes of yellowcake to be provided during the 2009-2017 period.

The uranium content of enrichment tailings has been estimated to be equivalent to roughly 770,000 tonnes of uranium oxide. Of that amount, U.S. enrichment tailings contain the equivalent of roughly 450,000 tonnes of uranium and Russian enrichment tailings contain roughly 300,000 tonnes of uranium. In recent years, Russian has made 3,000 tonnes of uranium from enrichment tailings available on the world market. The U.S. has yet to make any uranium from enrichment tailings available for use as reactor fuel.

Uranium market analysts estimate that only about 20%, or 130,000 tonnes of uranium oxide equivalent in uranium enrichment tailings, is likely to be marketed during the next 25 years. Of that amount, some 60,000 tonnes of uranium are projected to come from Russian enrichment tailings and 70,000 tonnes from uranium from U.S. enrichment tailings. Since current U.S. policy is not to use recycled enrichment tailings for reactor fuel, stockpiles of uranium enrichment tailings have been growing at the U.S. uranium enrichment sites at Portsmouth, Ohio; Paducah, Kentucky; and Oak Ridge, Tennessee.

The uncertainty about future availability of large amounts of uranium from secondary sources is a focus of considerable speculation within the nuclear industry and is reflected in presentations from WNA symposia. Analysts recognize that government policies play a key role in determining if and when major amounts of secondary sources — particularly highly enriched uranium and uranium enrichment tailings — will enter the uranium market. This uncertainty involves many issues that governments must address, from nuclear weapons production and nuclear non-proliferation policy to the need of states to assure domestic uranium supplies when the U.S. might free up uranium enrichment tailings to supplement primary uranium sources. Certainly, if uranium from non-proliferation-driven "blending down" of highly enriched uranium and reuse of the uranium content of enrichment tailings enters the uranium reactor fuel market during the next several decades, the need for primary uranium, ore from yet to be mined deposits, will be significantly reduced, and the market price would likely drop considerably.

Who is involved in the new uranium boom?
In 2000, about 30 companies were actively involved in uranium exploration. About half were uranium producers, including government-owned companies, and the other half were junior companies. By 2005, the number of firms involved in uranium exploration had increased 500% to approximately 175 companies, and almost all the new entrants are juniors.

Uranium exploration expenditures have also risen steeply. World uranium exploration spending grew from $55 million (U.S.) in 2000 to approximately $185 million (U.S.) in 2005, an increase of more than 333%. During the 2000-2005 period, exploration work by juniors grew from $15 million, about 27% of world uranium exploration spending, to $100 million, or about 54% of world uranium exploration spending.

While the number of uranium exploration companies has exploded in the past five years, the number of uranium producing companies has remained relatively static. In 2004, the leading uranium producer in the world controlled about 20% of world uranium production capacity and 28% of "Western World" capacity. The top three companies controlled more than 50% of world production and more than 70% of Western production capacity. The top five companies controlled 70% of world capacity and 89% of Western capacity.

In 2005 the top uranium producing companies, both "Western World" and "non-Western World" were:

- **Cameco** — a company that is part-owned by the government of the Province of Saskatchewan, Canada, with production primary from its home Province; 20% of world production
- **Rio Tinto** — a private company with production in Australia and Nambia; 13% of world production
- **Areva** (formerly known as Cogema) — a company part-owned by the government of France with production in Saskatchewan and Niger; 12% of world production
- **KazAtomProm** — A government-owned company in Kazakhstan that produces uranium in its home country; 10% of world production
- **BHP Billiton** — a private company with production in Australia; 9% of world production
- **TVEL** — a company owned by the government of the Russian Federation with production in Russia; 8% of world production
- **Navoi** — a company owned by the government of Uzbekistan that produces uranium in its home country; 6% of world production

That list demonstrates the growing significance of uranium production from the Former Soviet Union — the Russian Federation, Kazakhstan and Uzbekistan — and the lack of significant major U.S.-based uranium companies or production.

The 235% increase in known recoverable uranium resources in the U.S., the largest for any country during the 2003-2005 period, may be an indication that the U.S. will return to the list of major uranium-producing regions. Recent uranium exploration and development activity in the U.S. has included both major uranium producers and juniors. Cameco is the only leading world uranium producer operating in the U.S. with in situ leach (ISL) uranium properties in Wyoming and Nebraska.

Only four conventional uranium mills remain in the U.S., as more than 50 have been dismantled since the late-1960s. Cotter Corporation's Canon City, Colo., mill has been in operation the longest, beginning in 1958, but operating only intermittently since 1979. International Uranium Corp., which has kept its White Mesa uranium mill at Blanding, Utah, operating in the past decade by recovering uranium from "alternate feed sources" — usually wastes from remediation projects with high uranium content — has announced plans to operate uranium mines in southeastern Utah. In July 2006, SXR Uranium One (SUO) announced its acquisition of the other two uranium mills in the U.S., the Sweetwater mill in Wyoming (formerly owned and operated by hardrock mining giant Rio Tinto) and the Shootaring Canyon mill in Utah. Both of these facilities have been inactive for many years. Uranium is also being produced from at least three ISL mines operating in Nebraska, Texas and Wyoming. Unlike conventional mills, which crush and grind rocks to extract and concentrate uranium, ISL plants "recover" uranium from groundwater that has been oxidized by injection of chemicals that liberate uranium from the host rocks underground.

Junior companies with no past history of uranium production lead the uranium exploration boom in the U.S. Ur-Energy is actively re-exploring formerly investigated uranium properties in Wyoming. Energy Metals, which recently acquired fellow junior Quincy Energy, Inc., has exploration activities in Wyoming, Arizona, Colorado and New Mexico. Laramide Resources, a Canadian firm, announced the acquisition of Homestake Mining Co.'s properties in the Grants, N.M., area, and is planning exploration on the flanks of Mt. Taylor in the Grants Minerals Belt, the most productive uranium district in the U.S. Mesa Uranium is developing deposits in the Lisbon Valley of southeastern Utah. Strathmore Minerals Corp. (SMC), another Vancouver-based company, has acquired properties in predominantly Navajo areas of New Mexico. Hydro Resources, Inc. (HRI), the wholly owned subsidiary of Uranium Resources, Inc. (URI), a Texas-based uranium company, continues to pursue permits for its Church Rock and Crownpoint holdings. Numerous other junior companies — for example, Glen Hawk Minerals, Golden Patriot, Mill Bay Ventures, Mangum Uranium, Powertech Uranium — have been big splashes in the trade and investor press in the past year with their announcements of acquisitions of existing uranium deposits in the Western U.S. Each of these firms touts the prospects of making serious money in the "hot" uranium market.

Few, if any, of these junior uranium companies have articulated policies reflecting the internationally recognized guidelines for socially responsible mineral development and informed prior consent for mineral exploration and development reflected in the Equator Principles adopted by a growing set of international firms. The principles are reflected in the International Finance Corporation emerging Environmental and Social Development Guidelines (www.ifc.org/enviro) and other institutional policies of the World Bank Group.

The new uranium boom is driven by a rising price of uranium that is considerably higher than the cost of discovery and extraction of known unmined uranium resources. Thus, greedy companies are eagerly pursuing potentially large profits from development of previously explored and cheap to mine uranium deposits. The victims of the boom could again be communities around the world — and including many native communities in the Western U.S. and Canada — that have the legacy of busted uranium economies, health impacts from human exposures, and land and water contamination from past uranium exploration and production.

- Paul Robinson

Attachment C

Uranium Fact Sheets on the Web
May 24, 2008

Compiled by
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I. Uranium Fact Sheet
http://www.ieer.org/fctsheet/uranium.html
Institute for Energy and Environmental Research – "Uranium: Its Uses and Hazards"

II. Laguna Pueblo Uranium Curriculum
http://www.miningwatch.ca/index.php?/Uranium/Laguna_curriculum
Uranium Mining and its Impact on Laguna Pueblo: A Study Guide for an Interdisciplinary Unit, July 21, 1998

III. Uranium Overviews from Wise Uranium Project
http://www.wise-uranium.org/uwai.html
Uranium Mining and Milling Wastes: An Introduction, by Peter Diehl
Contents
- URANIUM MINES
  - WASTE ROCK
  - HEAP LEACHING
  - IN SITU LEACHING
  - MILLING OF THE ORE
- URANIUM MILL TAILINGS DEPOSITS
  - Characteristics of uranium mill tailings
  - Potential hazards from uranium mill tailings
  - Concepts for tailings disposal
  - Standards for uranium mill tailings management
  - Reclamation of uranium mill tailings deposits
- DISPOSAL OF OTHER MATERIALS

http://www.wise-uranium.org/stk.html?src=stkd01e
WISE Uranium Project - Slide Talk: Uranium Mining and Milling
- Uranium mining and milling basics
- Environmental impacts
- Health hazards for miners and residents
- Uranium mill tailings hazards and reclamation
- Tailings dam stability

www.wise-uranium.org includes pages for uranium sites around the world among other material.

IV. Environmental Protection Agency Uranium Fact Sheet
http://www.epa.gov/radiation/radionuclides/uranium.htm
URANIUM
The Basics
- Who discovered uranium?
- Where does uranium come from?
- What are the properties of uranium?
- What is uranium used for?

Exposure to Uranium
- How does uranium get into the environment?

- How does uranium change in the environment?
- How are people exposed to uranium?
- How does uranium get into the body?
- What does uranium do once it gets into the body?

Health Effects of Uranium
- How can uranium affect people's health?
- Is there a medical test to determine exposure to uranium?

Protecting People From Uranium
- How do I know if I'm near uranium?
- What can I do to protect myself and my family from uranium?
- What is EPA doing about uranium?

V. Uranium Mining documents from USEPA Technology Enhanced Naturally Occurring Radioactive Materials
Uranium Mining Wastes page - http://www.epa.gov/rpdweb00/tenorm/uranium.html

Includes TENORM from Uranium Mining Reports
In 2008, EPA updated and re-released a two-volume technical report on uranium mining TENORM wastes, *Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining,* Volumes 1 and 2:

Volume 1; Mining and Reclamation Background provides background information on the occurrence, mining, and reclamation of uranium mines - http://www.epa.gov/rpdweb00/tenorm/pubs.html#402-r-08-005

Volume 2: *Investigation of Potential Health, Geographic, and Environmental Issues of Abandoned Uranium Mines* provides a general scoping evaluation of potential radiogenic cancer and environmental risks posed by abandoned uranium mines - http://www.epa.gov/rpdweb00/tenorm/pubs.html#402-r-08-005ii

VI. Uranium and Radium Human Health Fact Sheets – 2 pages
http://www.ead.anl.gov/pub/doc/Uranium.pdf and
http://www.ead.anl.gov/pub/doc/Radium.pdf
Uranium Human Health Fact Sheet? Radium Human Health Fact Sheet - Argonne National Laboratories

Contents
- What is it?
- Where does it come from?
- How is it used?
- What's in the Environment?
- What Happens to It in the Body?
- What Are the Primary Health Effects?
- What Is the Risk?

VII. Agency for Toxic Substances and Disease Registry (ATDR) – as 2 page fact sheets as well as detailed Public Health Statement and voluminous Toxicological Profile for a wide range of metals and radionulides.

Two page ToxFAQs fact sheets related to potential hazards at uranium mines and mills include:

http://www.atsdr.cdc.gov/tfacts145.html - http://www.atsdr.cdc.gov/tfacts145.pdf - Radon

http://www.atsdr.cdc.gov/tfacts150.html - http://www.atsdr.cdc.gov/tfacts150.pdf - Uranium

http://www.atsdr.cdc.gov/tfacts144.html - http://www.atsdr.cdc.gov/tfacts144.pdf - Radium

http://www.atsdr.cdc.gov/tfacts5.html – http://www.atsdr.cdc.gov/tfacts5.pdf - Cadmium

http://www.atsdr.cdc.gov/tfacts13.html - http://www.atsdr.cdc.gov/tfacts13.pdf – Lead

http://www.atsdr.cdc.gov/tfacts2.html - http://www.atsdr.cdc.gov/tfacts2.pdf – Arsenic

TOXFAQs all use a similar outline, such as:

- What is radon?
- What happens to radon when it enters the environment?
- How might I be exposed to radon?
- How can radon affect my health?
- How likely is radon to cause cancer?
- Is there a medical test to show whether I've been exposed to radon?
- Has the federal government made recommendations to protect human health?
- Glossary, References, and Contact Information

ATSDR Public Health Statements and toxicological profiles for Radon are at:

http://www.atsdr.cdc.gov/toxprofiles/tp145.html#bookmark05 - ATSDR Full Toxicological Profile on Radon

VIII. Selected Uranium Related-materials on the Southwest Research and Information Center Web Site: Additional materials available related to renewable energy, nuclear safety, mining and waste management and community development.

http://www.sric.org

Uranium Overview:
http://www.sric.org/uranium/upresentation/4-1.html –

Uranium Health and Environmental Research in Diné Communities

- Brief History of Uranium Development in Diné communities
- Basics of Radiation Health Issues
  - Sources
  - Pathways of Exposure
  - Review of Uranium Health Studies
    - workers, general population, livestock, environment
- Case Study — Outdoor Radon in Church Rock
- Implications for Navajo Communities
- Educational Programs
- Resources for Information

http://www.sric.org/uranium/1979-SRIC-URANIUM%20MINING%20AND%20MILLING%20PRIMER.pdf

Southwest Research and Information Center – Uranium Mining and Milling: A Primer

Uranium developments in Southwest US – AZ and NM; Mt. Taylor Traditional Cultural Property Petition, Uranium and the 1872 Mining Law
http://www.sric.org/1872/index.html

Navajo Nation Legislation
http://www.sric.org/uranium/DNRPA.pdf

Dine Natural Resources Protection Act of 2005

From the SRIC Newsletter Voices From The Earth:
http://www.sric.org/voices/2006/v7n4/index.html

CONTINUING TARGETS: New Mexico and Navajo & Hopi lands

http://www.sric.org/voices/2006/v7n3/index.html

New Uranium Boom Threatens Communities

http://www.sric.org/voices/2006/v7n3/NewUBoom.html
The New U Boom: Speculation or Serious Development?

http://www.sric.org/voices/2006/v7n3/Need_Greed.html
Need or Greed? Uranium Prices and Demand

http://www.sric.org/voices/2004/v5n4/uspotprice.html
Uranium Price Rise...Still No Need for New Mines

http://www.sric.org/voices/2004/v5n3/index.html
Uranium...the problems continue

http://www.sric.org/voices/2004/v5n3/UMTRCA.html
Reclaiming the Land: History of Uranium Mill Tailings Clean-up – full report listed below

Environmental Justice Principles
http://www.sric.org/voices/2003/v4n1/principles.html

http://www.sric.org/U_Mill_Tailing_Remediation_05182004.pdf
Uranium Mill Tailings Remediation Performed by the US DOE: An Overview
Table of Contents – ***brief introductory "fact sheet-like" sections in bold italics***

- Acknowledgements
- ***Summary***
- ***Introduction***
- ***UMTRAP and Uranium Mill Tailings Information Sources on the Internet***
- ***Characteristics of Uranium Mill Tailings and the Hazardous Materials They Contain***
- ***UMTRAP Uranium Mill Tailings Sites Before and After Remediation***
- DOE's UMTRAP Project is a Unique and Significant Example of a Complete Radioactive Waste Management Program
- Uranium Mill Tailings Radiation Control Act (UMTRCA) and Associated Implementing Regulations
- Summary of UMTRAP Performance After 25 Years of Effort
- Ground Water Remediation and UMTRAP
- Cost of UMTRAP Uranium Mill Tailings Remediation
- Projected Cost of Long-Term Surveillance and Maintenance at UMTRAP Sites
- DOE Policy Developments Related to Uranium Mill Tailings Since 2000
- Reference
- Appendix A – Tables and Figures
- Appendix B – Photographs of UMTRAP Sites
- Appendix C – Summary of NRC Criteria Adopted to Implement the Uranium Mill Tailings Radiation Control Act

IX. Radiation Exposure Compensation Act/Uranium Worker Compensation Program

http://www.bu.edu/formerworker/RECP_Factsheet.pdf
Radiation Exposure Compensation Program

http://www.recalaw.com/index.htm
In 1990, the Radiation Exposure Compensation Act (RECA) was signed into law by President George Bush. The law established one time payments of $100,000.00 to uranium miners who suffered a compensable disease. On July 10, 2000, President Clinton signed the RECAA amendments that expanded the program to include uranium millers and ore transporters. Energy Employees Occupational Illness Compensation Program Act (EEOICPA) of 2000 also included an additional $50,000.00 and medical benefits for uranium workers approved under RECA.

If you or a deceased relative of yours worked in the uranium industry between 1942 and 1971, you may be eligible for benefits under the Radiation Exposure Compensation

http://www.recalaw.com/faq.htm
Radiation Exposure Compensation Act: Frequently Asked Questions

X. Uranium Market

http://www.infomine.com/commodities/uranium.asp
Uranium Market Home page - INFOMINE

http://www.goldletterint.com/egr/egr_uranium.pdf
Uraniumletter International – "Uranium Price Remains on the Move," July, 2006 – 20 pp.

XI.News Reports

http://www.latimes.com/news/nationworld/nation/la-na-navajo-series,0,4515615.special
"Blighted Homeland" – Four-part series on uranium problems in Navajo Country

Southwest Research and Information Center News Links Focussed on Uranium
http://www.sric.org/news/index.html

See Community-Oriented Uranium Information Sites

XII. Nuclear Regulatory Commission (NRC) – Uranium Licensing Overviews
http://adamswebsearch2.nrc.gov/idmws/ViewDocByAccession.asp?AccessionNumber=ML070460009
Includes:
- 02/08/07 NRC Licensing Process Presentation by Stephen Cohen.
- 2/08/07 NEPA Process Presentation by J. Park.
- 02/08/07 Underground Injection Control Program Presentation by M. Ginsberg, EPA.

Materials from NRC-National Mining Association April- May 2008 meeting
http://www.uraniumwatch.org/nrc_nma_workshop.2008.htm

Updates and NRC posting anticipated by June 1, 2008

XIII. Community-Oriented Uranium Information Sites

WISE Uranium Project
www.wise-uranium.org

Uraniumwatch
www.uraniumwatch.org

Miningwatch Canada
www.miningwatch.ca

Western Mining Action Network
www.wman-info.org

Indigenous Environmental Network
www.ienearth.org

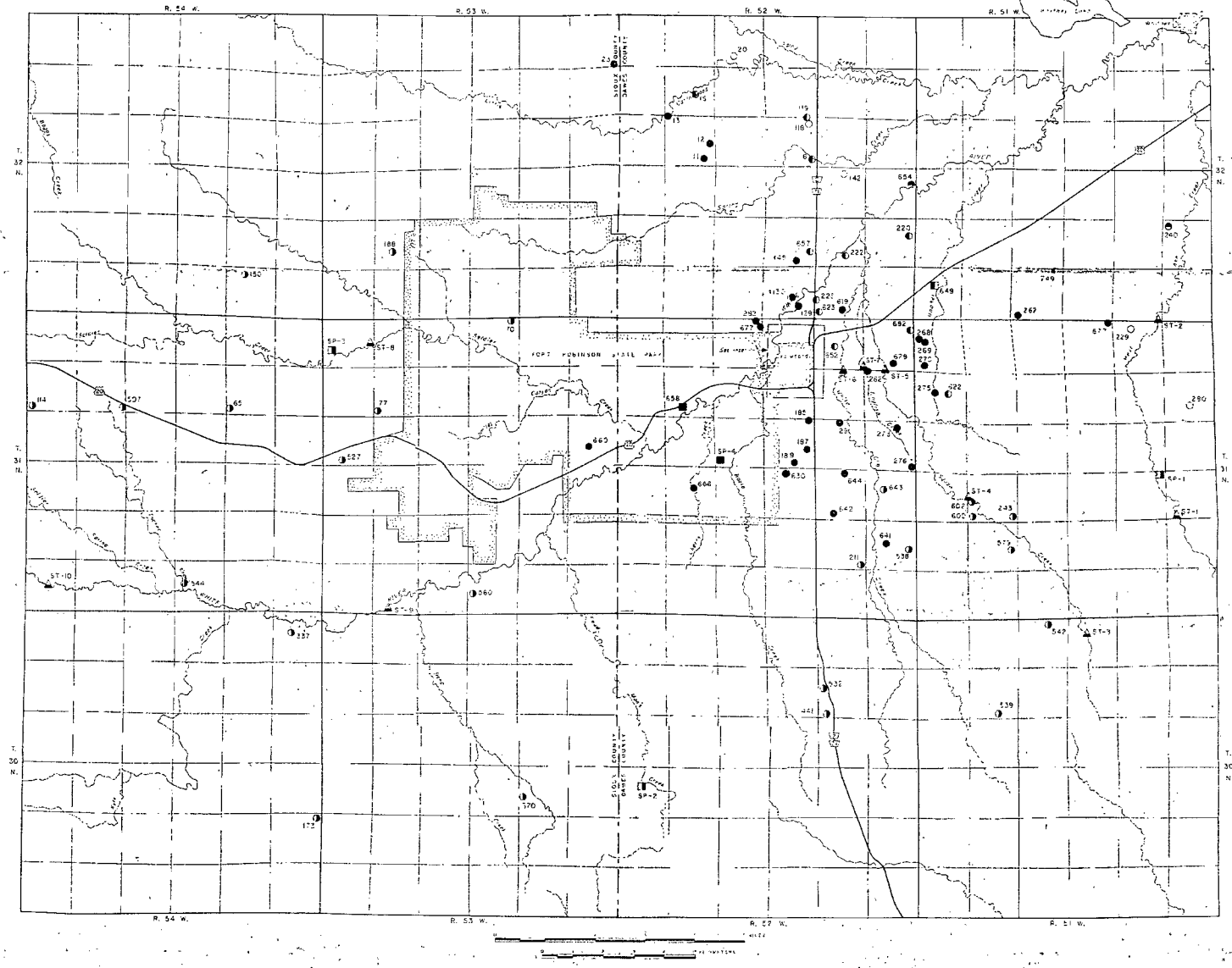
XIV. Uranium Policy Statements and Resolutions

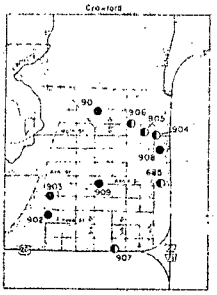
All Indian Pueblo Council and Navajo Nation Resolutions
http://www.uraniumwatch.org/envjustice.htm

XV. Atomic Posters
http://www.orau.org/ptp/collection/Atomicposters/atomicmovieposters.htm
Movie Posters

http://www.printsandprintmaking.gov.au/Catalogues/Works/tabid/57/frmView/Record/itemID/56672/Default.aspx
Anti-Uranium Poster, 1978 (Spanish)

FOLDOUT B-3(2)





SAMPLE SOURCE

ST-3
STREAM

SP-9 Arikaree
SP-4 Brule
649 Chadron

SPRINGS

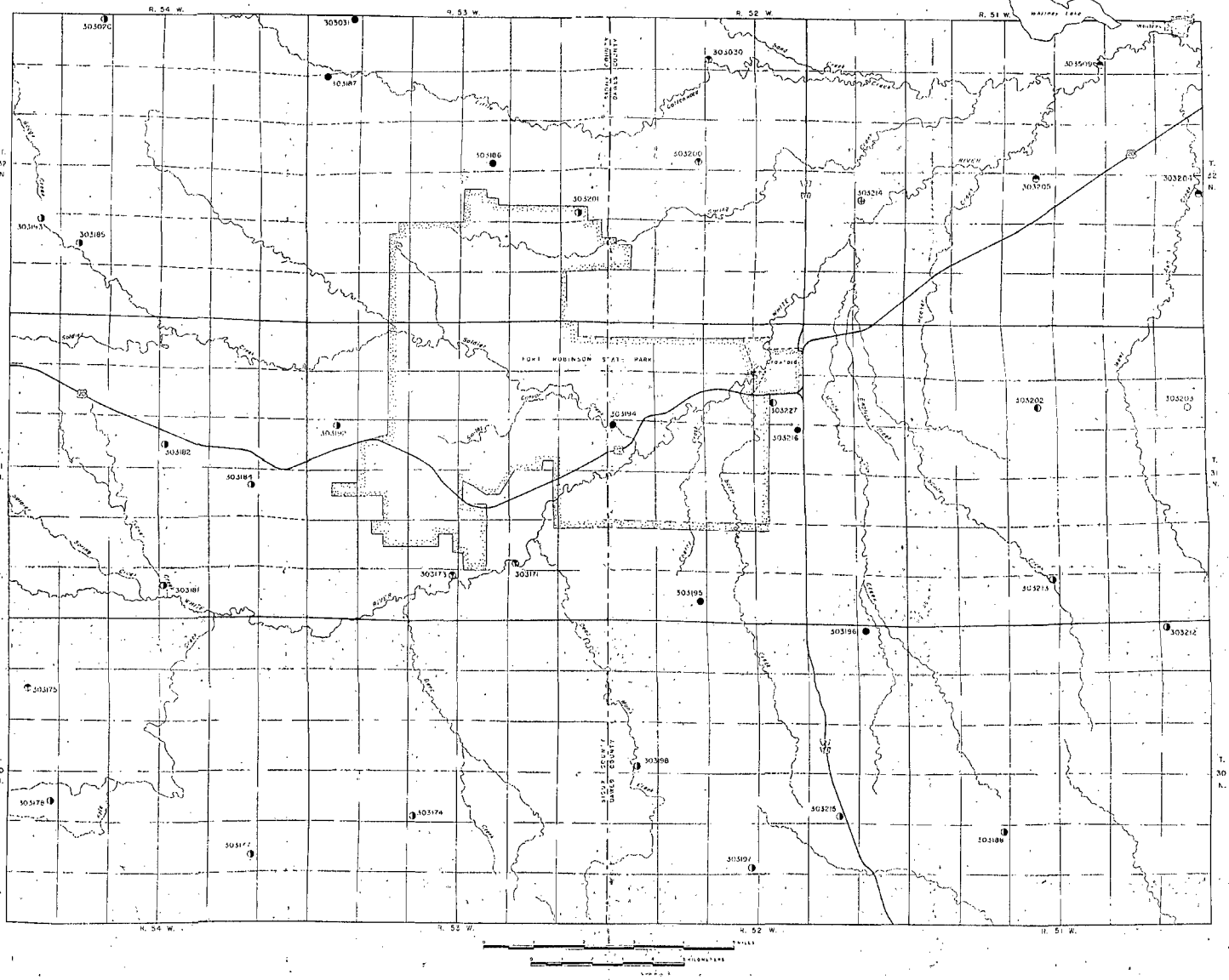
240 Alluvium
370 Arikaree
866 Brule
652 Chadron
280 Brule - Chadron
654 Pierre

WELLS

Figure beside symbol is sample-site number

SITES SAMPLED IN PROJECT AREA

FOLDOUT A-2



COMPLETION HORIZON

303177 Arikaree
303175 Arikaree–Alluvium
303195 Brule
303202 Basal-Chadron
303203 Brule-Chadron
303204 Pierre
303214 Pierre-Chadron

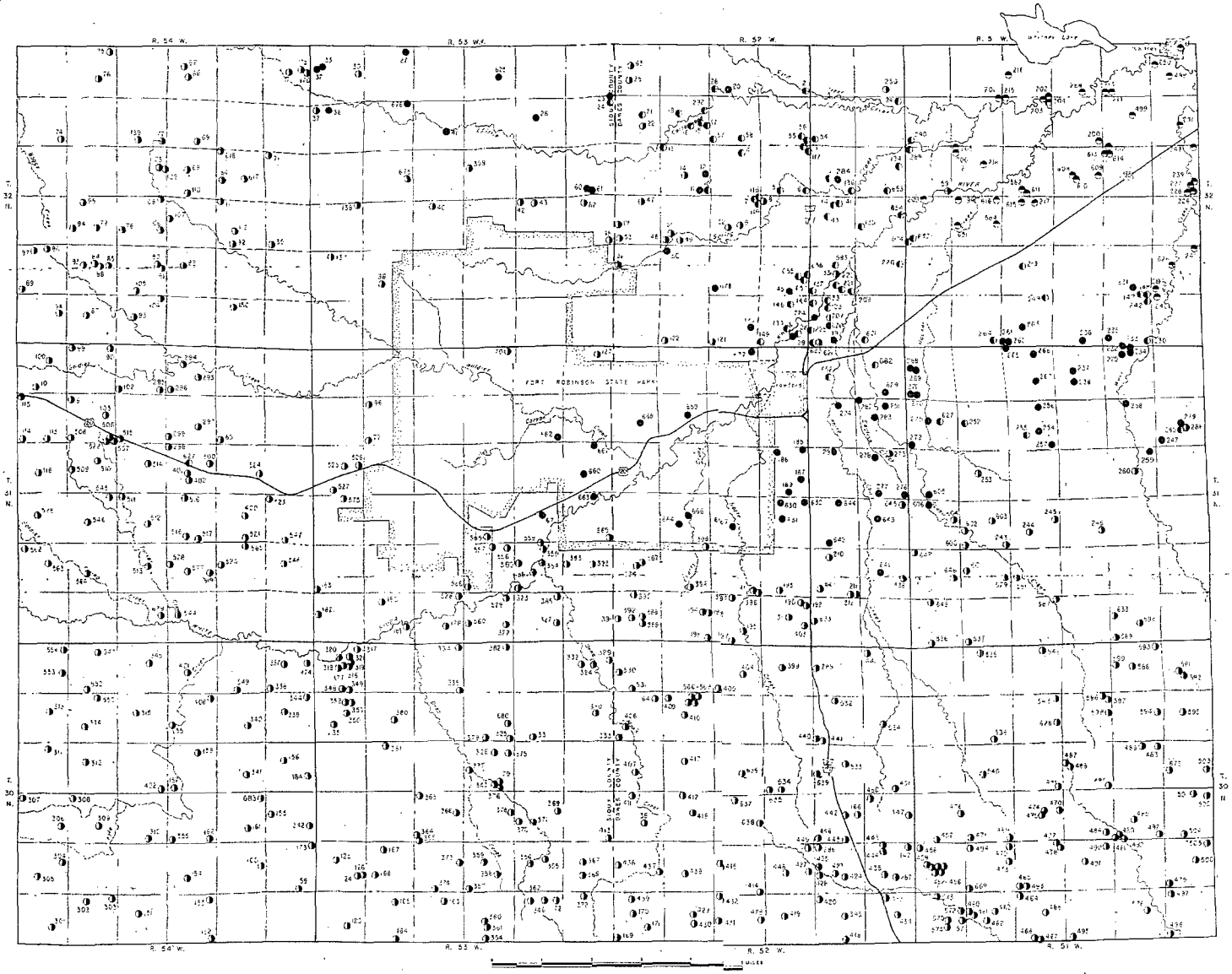
WELLS

Figure beside symbol is NURE sample collecting site identification number

GROUNDWATER SAMPLE SITES FROM NURE PROGRAM

(Arendt et al, 1980)

FOLDOUT B-1

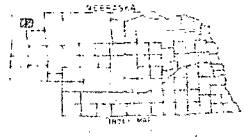


COMPLETION HORIZON

Arikaree Brule Chadron Pierre

WELLS

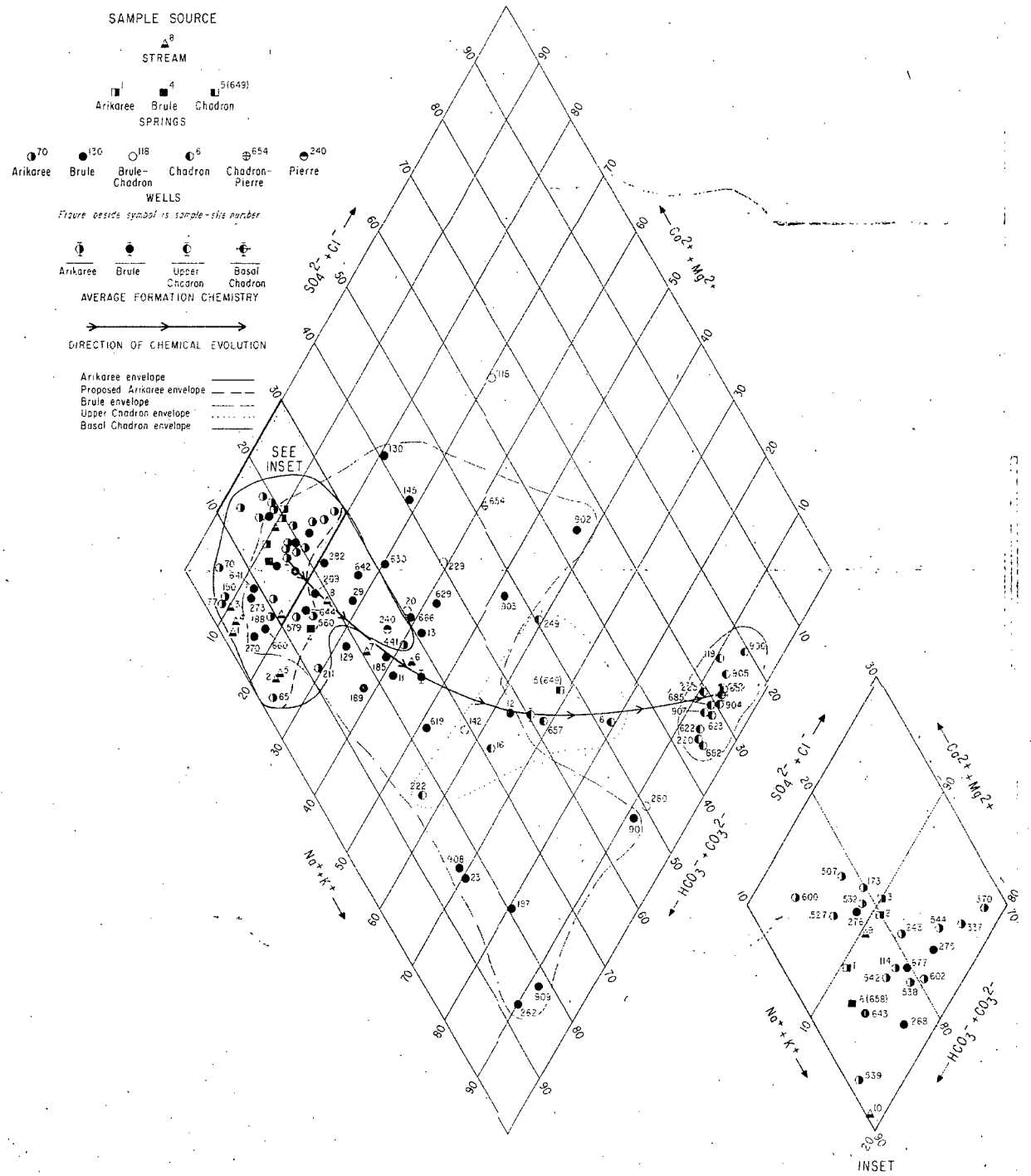
Figure beside symbol is site number



INDEX MAP

WELLS INVENTORIED IN PROJECT AREA

FOLDOUT B-3(1)



PIPER DIAGRAM

Baseline hydrogeochemical Investigation in a part of Northwest Nebraska

A Report Prepared for the
Nebraska Department of Environmental Control

by

The Conservation and Survey Division
Institute of Agriculture and Natural Resources
University of Nebraska-Lincoln, 68588
402/472-3471

Principal Investigator
Roy Spalding

June 1, 1982

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ABSTRACT

Summaries of available background hydrological, geological, and water quality data indicate that there has been a sparcity of hydrologic and geologic data collected within the designated area. Past water quality data was primarily restricted to those of the National Uranium Resource Evaluation (NURE) project. Data from this project, although helpful from the standpoint of major ion and uranium distribution does not have reliable trace metal analyses or uranium and radium isotopic results. This uranium data from the NURE project indicated anomalously high uranium concentrations from both sediments and groundwaters of the White River formation.

During the fall fo 1981 a comprehensive inventory of wells and springs identified and described 721 existing wells and 8 significant springs.

Detailed water quality analysis was performed on 81 selected wells, 6 springs and 10 surface water samples within the project boundaries.

Lowest conductivities were associated with wells of the Arikaree unit ($\bar{x}$=332 umohs/ cm^2) and highest conductivities were in artesian wells completed in the basal Chadron ($\bar{x}$= 1824 umohs/cm^2). The distribution of major ions described an evolutionary trend from a Ca-HCO_3 type groundwater in the Arikaree unit to a Na-SO_4-Cl type groundwater from the basal Chadron. This evolutionary trend towards a progressively older, more mineralized and oxygen depleted groundwater with age, allows unit identification of the groundwater source. The end members; the Arikaree and basal Chadron are most easily identified while water presumed to originate from the Brule and upper Chadron sands have considerable overlap.

Uranium and radium concentrations ranged from 0.02 - 98.0 ug/l and <0.1 - 181 pCi/l, respectively. Highest uranium levels were associated with oxidizing groundwaters in Brule and upper

Chadron units while highest Radium levels probably are indicative of adjacent uranium ore bodies. No samples from the Arikaree, Brule or upper Chadron units had radium levels above 0.5 pCi/l. Only in the basal Chadron did radium amounts exceed the maximum contaminant level (MCL) of 5 pCi/l.

The pathfinder elements As, V, and Mo showed some positive association with uranium in the oxidizing well waters of the White River Group . Arsenic levels exceeded the MCL of 50 ppb in only one well water.

Nitrate levels in all well waters were low indicating minimum surface contamination.

Surface water quality appeared directly related to seepage from nearby units. Highest pathfinder element levels and uranium concentrations were in streams cutting the White River Group.

Well-numbering system

Each well referred to in this report is identified by a number indicating its location in the U.S. Bureau of Land Management's survey of Nebraska. The figure preceding N (for "north") indicates the township, the figure preceding W (for"west") indicates the range, and the figure preceding the lowercase letters indicates the section. The lowercase letters denote location within the section. As shown in figure 1, the first of these letters indicates the quarter section, the second the quarter-quarter section, and the third, if given, the quarter-qu rter-quarter section. Thus, in this system of numbering, a test hole or well in the SE1/4 SE1/4 SE1/4 section 17, Township of 30 North, Range 47 West, is identified by the number 30N-47W-17ddd.

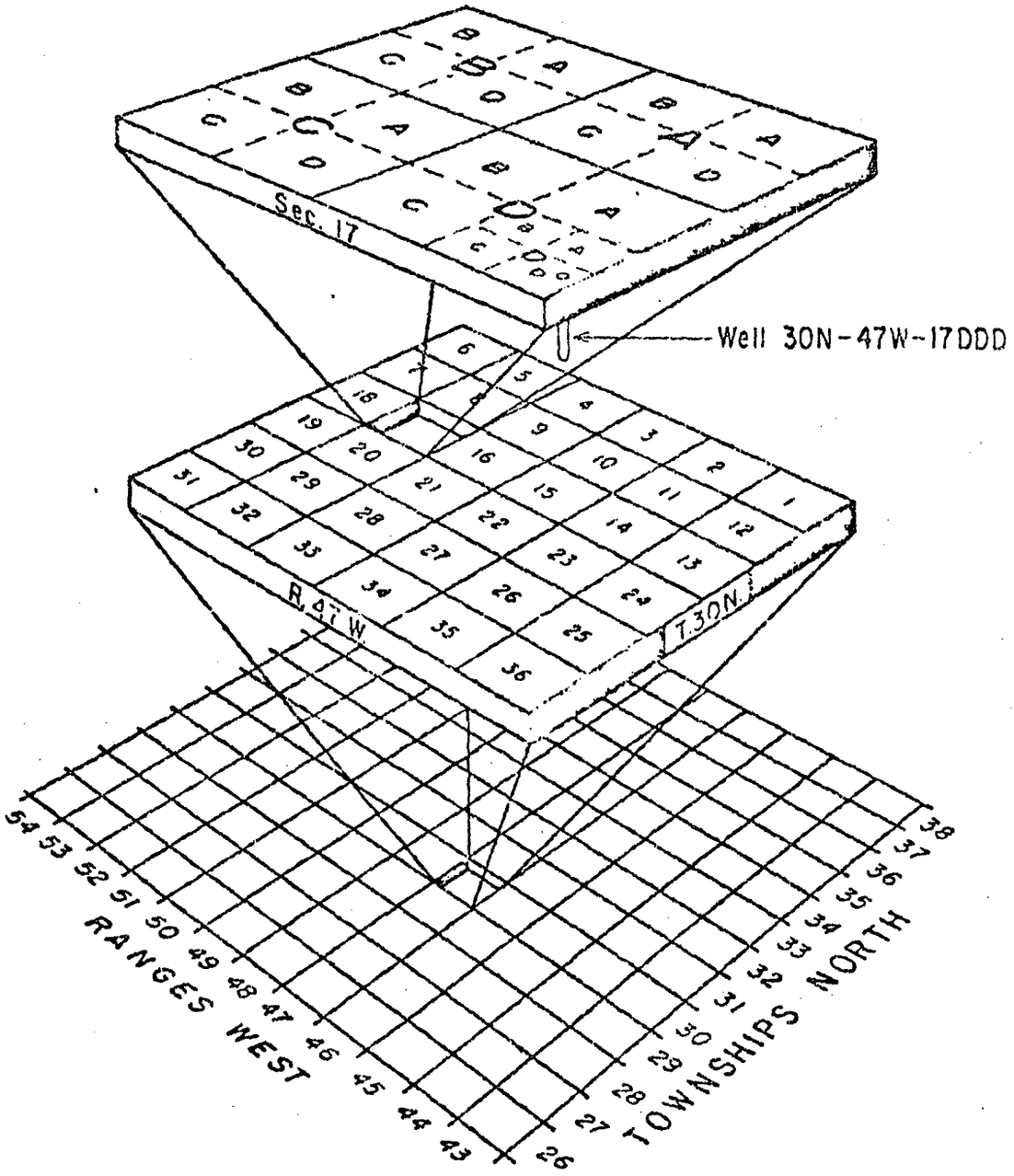

Fig. 1 System used for identifying wells according to location

ACKNOWLEDGMENTS

Dr. Arthur Struempler of Chadron State College was most cooperative in assisting us in this investigation. Dr. Struempler, with the help of his son Michael, did the project water sample collection and provided analyses for all but the radioactive constituents.

The efforts of several members of the Conservation and Survey staff are also greatly appreciated. They include Dr. Marvin P. Carlson, Mr. A. Douglas Druliner, Dr. Charles Lindau, Ms. Cynthia Norris, Mr. Frank Smith, Ms. Mary Spalding, Mr. James Swinehart, and Mr. Lowell Whiteside.

INTRODUCTION

The primary purpose of this project was to provide a water quality baseline for an area of northwest Nebraska. A twelve township project area was defined along the White River drainage basin in Sioux and Dawes counties (Figure A-3(1)). Of principal concern was the current groundwater chemistry and the hydrogeological relationships. Fieldwork and analysis was a coordinated effort of the Division, the Department of Environmental Control and Chadron State College.

Additional tasks of this project included summaries of background hydrologic, geologic and water quality investigations and an inventory of the location of all wells within the project area.

Historical USGS Surface water, Suspended sediment and seepage records

Tasks A-1 and A-4

Water quality samples from station 0644500 located near Whitney Nebraska on the White River were collected from August 1969 through September 1971 by the U.S. Geological Survey (USDI, 1969a, 1970, 1971). The data demonstrated a general trend of high dissolved solids at periods of low flow and low dissolved solids at periods of high flow. This trend is primarily associated with the concentration effects of evaporation during low flow stages. Throughout this period contaminants such as nitrates and pesticides remained at low levels. Uranium and radium analyses are not available in these reports.

No seepage or sediment studies are reported for the investigated area; however point seepage measurements and sediment characteristics from the Slim Butte , South Dakota station on the White River were recorded during the mid sixties (USDI, 1971a). Suspended sediment analyses indicated that a major percentage of sediment load was from clay-sized particles. According to Mike Ellis (personal communication), the clays were predominantly bentonitic and presumed to be from dissociated volcanic ash beds in Nebraska. Such clays would tend to release dissolved uranium to the river waters.

Several stream-gaging stations have been maintained by the U.S. Geological Survey within the project area. Station 444000 on the White River at Crawford has data for 1931-'43 and 1947 to present (USDI, 1950, USDI, 1960, USDI, 1970, USDI, 1971-81). Discharge extremes in cubic feet per second are a maximum of 1580 and a minimum of 2.7. Mean discharge is 20.2 cf/s.

National Uranium Resource Evaluation (NURE) Results

Task A-2

Both stream sediment and groundwater samples were collected in the northern half of the Panhandle (Alliance 1:250,000 sheet) during 1979. Sediment sampling for the NURE program was performed by Biospheric Consultants International. Groundwater sampling utilized student help from Chadron State College and the University of Nebraska.

Stream Sediment Data

Approximately 10% of the 523 stream sediment samples collected in the Alliance sheet were located within the boundaries of the current project. Total uranium concentrations ranged from 2.5 to 4.5 ppm (Arendt et al.,1980). Thus background uranium concentrations are slightly higher than the average crustal abundance which is 2.7 ppm (Taylor, 1964).

Within the project area, high background levels of hot acid soluble uranium occurred in sediments from the White River Group and Pierre Shale. Adams and Weaver (1958) reported that most marine shales such as the Pierre contain higher than average uranium levels and approach those of primary igneous rock (mainly granite). According to Piller and Adams (1962) ash beds with anomalous uranium concentrations commonly occur in marine Cretaceous shales in the western U.S. Similar ash beds frequently are noted in drilling through the White River Group and generally are considered by Arendt et al.(1980) to be the most probable source of elevated uranium and arsenic (an associated element) levels in these Oligocene sediments.

Groundwater Data

Thirty-six of the 514 groundwater samples collected from existing wells within the Alliance sheet are located in the project area (Foldout A-2). Split samples were collected at each site during May - June 1979. One sample was analyzed for nitrate at the Department of Environmental Control in Lincoln and the remaining sample was shipped to Union Carbide Corp. in Oak Ridge, Tenn. for major ion and trace metal analyses. Temperature, pH, alkalinity, hydrogen sulfide and conductivity were determined in the field. The data (Table A-2a) are grouped according to producing horizon. In some cases there is a low degree of confidence in the assigned producing horizon since the investigated area is geologically complex and lacking in sufficient control points.

Except for uranium, sulfate, chloride, arsenic and selenium, the remaining 27 elements (Table A-2a) were analyzed by plasma source emission spectrometry. Uranium concentrations were determined by either fluorometry or isotope dilution mass spectrometry. Arsenic and selenium were determined by hydride generation atomic absorption and chloride and sulfate were determined spectrophotometrically. Details of sampling, analyses and statistical procedures are presented in Arendt et al. (1979).

The results of the Alliance report indicated that the Oligocene formations (Chadron and Brule) of the White River group provide the most favorable geologic unit for potential uranium mineralization. This conclusion was based upon the occurrence of uranium levels adjusted for total dissolved solids by the formula 1000(uranium/specific conductance).

TABLE 6-2a. ANALYTICAL DATA FROM INVESTIGATED AREA COLLECTED FOR THIS PROGRAM (ARCHEY ET AL. 1980)
WELLS PRODUCING FROM ARKANSAS AND YOUNGER STRATA

ID NO.	LEGAL LOCATION	WELL TYPE	WELL DEPTH(FT.)	PRODUCING HORIZON	TEMP. °C	pH	S.C. eq/l	H_2S	COND. micromhos/cm²	Ca^{2+}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	NO_3^{-}	PO_4^{3-}	SiO_2
										← mg/l →									
303020	32N-54W-S05AA	H,S	95	Ta	12	7.7	7.5	ND	360	38	8.3	4.9	4.8	248	18	<10	3.6	<.12	60
303030	32N-52W-S04CC	H,S	23	Ta/Qal	12	7.5	5.7	ND	790	69	16	113	30	368	156	<10	8.9	<.12	67
303171	31N-53W-S26CC	H	89	Ta/Qal	12	8.2	5.6	ND	350	16	0.4	86	16	172	54	<10	4.0	<.12	6.3
303173	31N-53W-S33AA	H	79	Ta/Qal	14	7.7	8.3	ND	220	45	5.7	7.7	7.5	175	5	<10	3.5	<.12	74
303174	30N-53W-S21CC	H,S	335	Ta	15	7.8	8.1	ND	220	40	7.5	8.4	2.2	164	<5	<10	8.4	<.12	76
303175	30N-54W-S07BD	H	30	Ta/Qal	13	7.9	9.2	ND	230	41	7.7	9.5	4.6	160	<5	<10	7.5	<.12	74
303177	30N-54W-S26DA	S	266	Ta	13	7.9	7.6	ND	230	42	5.2	9.5	6.9	147	<5	<10	7.5	<.12	69
303178	30N-54W-S19DA	S	374	Ta	14	7.5	9.8	ND	420	42	5.2	9.5	6.9	166	<5	<10	7.1	<.12	65
303181	31N-54W-S34BC	H	30	Ta	14	7.7	8.3	ND	350	41	7.3	8.7	7.2	170	<5	<10	5.8	<.12	71
303182	31N-54W-S15CB	H,S	404	Ta	14	7.7	9.5	ND	340	36	9.5	10	8.5	162	<5	<10	5.8	<.12	70
303184	31N-54W-S23AD	H,S	443	Ta	13	7.8	9.0	ND	470	46	8.1	3.4	4.7	150	<5	<10	22	<.12	61
303185	32N-54W-S29CA	H,S	282	Ta	14	7.2	8.9	ND	470	45	6.4	5.2	6.3	168	<5	<10	5.3	<.12	62
303188	30N-51W-S29AA	S	207	Ta	12	7.5	9.3	ND	390	43	7.9	7.8	5.2	290	<5	<10	3.1	<.12	64
303192	31N-53W-S18AB	S	443	Ta	14	8.0	10.4	ND	340	46	7.7	4.7	5.3	196	<5	<10	4.4	<.12	58
303193	32N-54W-S30AB	S	295	Ta	14	8.0	9.5	ND	330	37	8.7	6.9	6.9	183	<5	<10	3.1	<.12	65
303197	30N-52W-S22DD	H,S	312	Ta	14	7.2	9.5	ND	410	39	8.7	6.9	2.0	192	<5	<10	3.1	<.12	77
303198	30N-52W-S12BC	H	30	Ta	11	7.3	9.2	ND	430	45	8.8	11	2.2	188	<5	<10	4.8	<.12	70
303200	32N-52W-S17DD	H	26	Ta/Qal	11	6.9	5.5	ND	770	91	11	80	19	356	42	200	8.4	0.40	72
303201	32N-53W-S24CD	H	88	Ta	12	7.1	7.2	ND	409	51	4.3	26	9.3	236	5	<10	3.5	<.12	66
303212	30N-51W-S01BB	H	177	Ta	12	7.6	10.5	ND	530	92	5.7	8.4	3.6	223	20	<10	93	<.12	54
303213	31N-51W-S33AA	H	39	Ta	12	7.2	5.9	ND	510	80	9.9	9.7	6.2	344	14	<10	8.9	<.12	53
303215	30N-52W-S23DC	H,S	344	Ta	14	7.3	10.3	ND	430	36	5.3	13	2.2	188	14	<10	3.3	<.12	78

H= house; S=stock

TABLE 6-2a (CONTINUED)

WELLS PRODUCING FROM THE BOULE FORMATION

ID NO.	LEGAL LOCATION	WELL TYPE	WELL DEPTH(ft.)	PRODUCING HORIZON	TEMP. °C	pH	D.O. mg/l	H_2S	COND. umhos/cm	Ca^{2+}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	NO_3^{-}	PO_4^{3-}	SiO_2
										← mg/l →									
303031	32N-53W-S06AA	H,S	161	Tb	14	7.9	13.1	ND	380	41	4.7	33	7.2	190	14	<10	28	<.12	65
303186	32N-53W-S15DC	S	158	Tb	14	7.3	8.3	ND	390	40	5.2	9.7	9.2	180	<5	<10	2.7	<.12	71
303187	32N-53W-S07BA	NONE	33	Tb	12	7.3	2.9	ND	440	62	8.5	8.3	7.2	217	<5	<10	31	<.12	52
303194	31N-52W-S18BB	S	148	Tb	15	8.3	5.1	ND	520	7.5	0.7	108	11	230	40	<10	3.1	<.12	82
303195	31N-52W-S32DA	H,S	197	Tb	14	6.7	9.3	ND	490	28	3.0	5.5	7.6	186	5	<10	2.7	0.20	70
303196	30N-52W-S01BB	H,S	194	Tb	12	6.9	8.6	ND	680	69	4.6	54	18	334	10	<10	20	<.12	68
303218	31N-52W-S15AA	H	98	Tb	14	7.2	9.9	ND	580	49	5.4	49	17	336	39	11	14	<.12	64

Table A-2a (Continued)

WELLS PRODUCING FROM THE UPPER CHADRON, LOWER BRULE AND PIERRE FORMATIONS

ID NO.	LEGAL LOCATION	WELL TYPE	WELL DEPTH(ft.)	PRODUCING HORIZON	TEMP. °C	pH	B.G. mg/l	H_2S	COND. $\mu mhos/cm^2$	Ca^{2+}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	NO_3^{-}	PO_4^{3-}	SiO_2
										(mg/l)										
303203	31N-51W-S12DB	H,S	541	Tp/Tc	14	8.0	9.1	MD	1040	11	0.7	174	8.9	20	336	137	86	0.9	<.12	72
303204	32N-51W-S24AD	H,S	49	Kp	16	7.1	5.1	MD	1040	63	14	103	14		468	132	15	<.08	<.12	50
303205	32N-51W-S21AB	H,S	59	Kp	14	7.4	9.5	MD	2380	69	9.5	285	20		392	792	78	58	<.12	59
303214	32N-52W-S24CB	H	49	Tc/Kp	13	6.9	8.9	MD	590	46	2.4	50	23		300	40	20	13	<.12	69
303509	32N-51W-S03DC	H,S	52	Kp	13	7.4	2.9	MD	1980	76	17.8	306	24		716	900	24	1.3	0.28	38

WELLS PRODUCING FROM THE BASAL CHADRON SANDS

ID NO.	LEGAL LOCATION	WELL TYPE	WELL DEPTH(ft.)	PRODUCING HORIZON	TEMP. °C	pH	B.G. mg/l	H_2S	COND. $\mu mhos/cm^2$	Ca^{2+}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	NO_3^{-}	PO_4^{3-}	SiO_2
										(mg/l)										
303202	31N-51W-S09DB	H,S	440	Tc	14	8.4	4.7	MD	430	3	0.2	107	8.9	1.2	186	20	<10	3.1	<.12	72
303227	31N-52W-S10CA	H,S	423	Tc	17	8.0	1.2	MD	1990	17	4.1	262	12		326	457	165	<.08	<.12	9

Table A- 2a (Continued)

WELLS PRODUCING FROM THE ABIKARRE AND YOUNGEN STRATA

ID NUMBER	TRACE METALS																			
	ug/l																			
	Ag	Al	As	B	Ba	Ce	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Se	Sr	V	Zn	Zr	U
303020	<2	<10	3.7	16	101	<30	<2	<4	<2	24	10	<2	7	11	0.6	313	<4	61	<2	5.2
303039	<2	<10	7.0	158	13.	<30	<2	<4	<2	12	66	<2	<4	6	0.6	1273	10	77	<2	40.2
303171	3	<10	10.4	116	23	32	3	5	<2	17	25	<2	10	<4	0.3	194	10	153	5	20.8
303173	<2	<10	2.6	23	87	<30	<2	<4	<2	15	12	<2	<4	4	0.3	373	7	480	2	7.1
303174	<2	<10	3.7	23	32	<30	<2	<4	<2	18	13	<2	<4	<4	0.4	386	7	10	<2	5.5
303175	<2	14	2.5	26	91	<30	<2	<4	<2	16	15	<2	<4	5	0.3	303	12	30	<2	5.8
303177	<2	<10	3.7	26	51	<30	<2	<4	<2	17	18	<2	5	<4	0.3	303	<4	43	<2	3.4
303178	<2	<10	3.8	26	51	<30	<2	<4	<2	17	18	<2	5	<4	0.4	303	<4	43	<2	5.6
303181	3	<10	2.7	24	128	<30	2	<4	<2	16	12	<2	<4	<4	0.4	243	18	56	<2	7.9
303182	<2	<10	2.4	24	66	<30	<2	<4	<2	17	14	<2	<4	<4	0.2	224	11	95	<2	7.1
303184	<2	<10	1.3	20	53	<30	<2	<4	<2	17	10	<2	<4	<4	0.2	269	<4	42	<2	4.0
303185	<2	80	1.9	24	80	<30	<2	<4	<2	16	11	<2	<4	<4	0.4	247	<4	107	<2	3.9
303188	<2	<10	3.7	31	42	<30	<2	<4	<2	17	14	8	4	<4	0.3	351	6	1187	2	6.9
303192	3	<10	1.1	24	49	<30	5	4	<2	15	12	2	<4	5	0.3	174	21	109	3	4.6
303193	2	<10	2.8	27	73	<30	<2	<4	<2	17	11	2	<4	<4	0.4	206	8	121	<2	3.7
303197	<2	<10	4.7	21	19	<30	<2	<4	<2	17	19	<2	<4	6	0.4	396	<4	108	<2	9.6
303198	2	<10	3.4	26	38	<30	<2	<4	<2	19	17	<2	12	<4	0.3	436	<4	100	3	7.0
303200	3	<10	19	96	129	<30	<2	<4	<2	<10	61	<2	21	8	0.8	1371	13	60	2	35.8
303201	3	<10	5.4	49	93	32	<2	5	<2	<10	35	2	7	8	0.3	473	60	150	4	12.2
303212	2	46	1.3	29	177	<30	<2	<4	<2	<10	12	2	<4	<4	<0.2	588	<4	52	3	2.7
303213	<2	31	1.3	29	321	<30	<2	<4	<2	<10	19	8	<4	<4	<0.2	529	<4	1108	<2	5.0
303215	<2	20	4.5	36	28	<30	<2	<4	<2	<10	16	3	<4	<4	<0.2	407	9	134	<2	7.2

All analyses for : Be<1 ug/l; Sc <1 ug/l; Ti <2 ug/l; and Y< 2 ug/l

Table A - 2a (continued)
WELLS PRODUCING FROM THE BELLE FOURCHE

ID NUMBER	TRACE METALS																			
	Ag	Al	As	B	Ba	Be	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Se	Sr	V	Zn	Zr	U
	ug/l																			
303031	<2	<10	2.1	21	126	<30	<2	<4	<2	<10	18	6	<4	<4	0.3	385	<4	214	<2	11.3
303186	<2	<10	1.8	20	51	<30	<2	<4	<2	13	10	<2	5	<4	0.3	364	<4	359	<2	8.1
303187	<2	<10	0.6	28	29	<30	<2	<4	16	14	14	7	9	6	0.3	437	<4	138	<2	6.9
303194	5	<10	64	157	14	42	2	5	<2	48	29	<2	9	<4	0.4	106	21	60	6	8.4
303195	5	<10	4.2	30	61	36	<2	<4	<2	17	10	33	11	13	0.3	132	<4	66	6	9.0
303196	<2	<10	3.5	79	213	<30	<2	<4	<2	12	50	13	<4	<4	0.4	1254	<4	36	<2	21.7
303216	<2	28	8.0	109	113	<30	<2	<4	<2	<10	37	<2	<4	4	<0.2	890	10	102	<2	19.1

All analyses for : Be<1 ug/l; Sc <1 ug/l; Tl <2 ug/l; and Y< 2 ug/l

Table A- 2z (continued)

WELLS PRODUCING FROM THE UPPER CHADRON, LOWER BRULE AND PIERRE FORMATIONS

ID NUMBER	TRACE METALS																			
	Ag	Al	As	B	Ba	Ce	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Se	Sr	V	Zn	Zr	U
	ug/l																			
303203	<2	<10	6.7	647	25	<30	<2	<4	<2	31	50	<2	28	4	0.4	238	<4	28	<2	5.8
303204	<2	<10	7.6	163	103	<30	<2	<4	<2	<10	87	82	12	<4	0.3	937	<4	23	<2	23.6
303205	2	<10	18.4	444	21	<30	2	<4	<2	<10	153	<2	9	4	0.4	1781	5	18	2	85.9
303214	<2	<10	7.7	12	88	<30	<2	<4	<2	<10	52	<2	<4	<4	0.5	784	<4	48	<2	18.6
303509	<2	<10	13.6	336	73	<30	<2	<4	<2	<10	258	<2	9	<4	0.5	1239	48	34	<2	18.0

WELLS COMPLETED IN THE BASAL CHADRON SANDS

ID NUMBER	TRACE METALS																			
	Ag	Al	As	B	Ba	Ce	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Se	Sr	V	Zn	Zr	U
	ug/l																			
303202	<2	<10	38	151	6	<30	<2	<4	<2	<10	31	2	<4	<4	0.8	47	13	10	<2	5.9
303227	4	<10	<5	1216	8	38	9	<4	<2	<10	100	19	16	<4	0.2	348	11	14	4	2.8

All analyses for : Be <1 ug/l; Sc <1 ug/l; Ti <2 ug/l; and Y < 2 ug/l

EXPLANATION OF ABBREVIATIONS: Ta:Arikaree ;Qal:Alluvium ;Tb:Brule ;Kp:Pierre ; Tc:Chadron ;D.O. :Dissolved Oxygen ;Cond.: Conductivity ;H: Household ; S: Stock ; ND: no data .

TABLE 8 - 2b

GENERALIZED PHYSICAL AND CHEMICAL CHARACTERISTICS OF ANALYZED WATERS

TEMPERATURE (°C)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	11-13	12-13	13-16	14-17
MEAN	13	13.57	14	15.5
Std.DEVIATION	1.13	1.04	1.09	1.5

WELL DEPTH (Ft.)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	23-443	33-197	49-541	423-640
MEAN	200.5	141.3	150	531.5
Std.DEVIATION	148.7	53.7	195.5	108.5

pH

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	6.9-8.2	6.7-8.3	6.9-8.0	8.0-8.4
MEAN	7.54	7.37	7.36	8.20
Std.DEVIATION	0.35	0.51	0.37	0.2

B.O. (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	5.5-10.4	2.9-13.1	2.9-9.1	1.2-4.7
MEAN	8.22	8.2	7.1	2.95
Std.DEVIATION	1.67	3.07	2.63	1.75

COND. (mMHOS/CM.)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	220-790	380-680	590-1930	430-1990
MEAN	409.6	481.4	1406	1219
Std.DEVIATION	146.1	93.1	665.2	780

Ca^{2+} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	16-92	7.5-62	11-76	3-17
MEAN	46.2	42.3	53	10
Std.DEVIATION	18	19.2	23.2	7

Mg^{2+} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	0.4-11	0.7-8.5	0.7-17.8	0.2-4.1
MEAN	7.43	4.59	8.88	2
Std.DEVIATION	2.88	2.20	6.56	1.95

Na^{+} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	3.4-113	8.3-108	50-306	107-262
MEAN	20.28	38.2	183.6	184.5
Std.DEVIATION	29.7	33.82	99.7	77.5

K^{+} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	2-30	7.2-17	8.9-24	6.8-12
MEAN	7.52	10.74	17.88	9.40
Std.DEVIATION	6.42	3.86	5.72	2.60

CO_3^{-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE			20	1.8
MEAN			20	1.8
Std.DEVIATION			0	0

HCO_3^{-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	147-366	180-336	300-710	186-326
MEAN	208.82	239	441.2	254
Std.DEVIATION	66.85	62.89	145.87	70

SO_4^{2-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<5-156	<5-40	40-900	20-457
MEAN	<17.68	<16.86	400.2	238.5
Std.DEVIATION	>32.88	>14.65	367.2	218.5

NO_3^{-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	3.1-93	2.7-31	<.08-58	<.08-3.1
MEAN	10.20	14.50	<15.06	<1.59
Std.DEVIATION	18.91	11.3	>22.17	>1.51

PO_4^{3-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<.12-.46	<.12-.2	<.12-.28	<.12
MEAN	<.13	<.13	<.15	<.12
Std.DEVIATION	>.06	>.03	>.06	0

Cl^{-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<10-200	<10- 11	15- 56	<10-165
MEAN	<18.64	<0.14	40.6	<87.50
Std.DEVIATION	>39.59	>0.35	34.75	>77.50

Table A-2b (continued)

SiO_2 (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	6.3-78	52-82	38-72	9-72
MEAN	44.01	67.43	57.6	40.5
Std.DEVIATION	14.34	8.35	12.50	31.9

Ag (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<2-3	<2-5	<2-2	<2-4
MEAN	<2.23	<2.86	<2	<3
Std.DEVIATION	>0.42	>1.34	>0	>0

Al (ug/l)

	Ta	Tb	Ta/Tc/Kp	Tc
RANGE	<10- 89	<10-28	<10	<10
MEAN	<16.41	<12.57	?<10	<10
Std.DEVIATION	>16.31	>6.30	>0	>0

As (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1.3-1.9	0.6-64	6.7-18.4	<5-38
MEAN	4.22	12.03	10.80	<21.50
Std.DEVIATION	3.83	21.33	4.52	>16.50

B (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	16-158	20-157	12-647	151-1216
MEAN	39.73	63.43	320.40	683.5
Std.DEVIATION	35.13	49.47	220.03	532.5

Ba (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	13-128	14-213	21-103	6-8
MEAN	78.41	86.71	62.00	7
Std.DEVIATION	66.27	64.07	33.25	1

Be (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<30-32	<30-42	<30	<30-38
MEAN	<30.18	<32.57	<30	<34
Std.DEVIATION	>0.37	>4.37	>0	>4

Co (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<2-5	<2-2	<2-2	<2-9
MEAN	<2.18	<2	<2	<5
Std.DEVIATION	>0.65	>0	>0	>3

Cr (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<4-5	<4-5	<4	<4
MEAN	<4.09	<4.14	<4	<4
Std.DEVIATION	>0.29	>0.35	>0	>0

Cu (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<2	<2-16	<2	<2
MEAN	<2	<4	<2	<2
Std.DEVIATION	>0	>4.9	>0	>0

Fe (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<10-24	<10-46	<10-31	<10
MEAN	<15.32	<17.71	<14.20	<10
Std.DEVIATION	>3.52	>12.57	>8.40	>0

Li (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	11- 66	10-50	50-258	31-100
MEAN	20.00	24.0	120	65.5
Std.DEVIATION	14.84	14.13	78.42	34.3

Mn (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<2-8	<2-33	<2-82	2-10
MEAN	<2.59	<9.29	<18.0	6
Std.DEVIATION	>1.73	>10.36	>32.0	4

Mo (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<4-21	<4-11	<4-28	<4-16
MEAN	<5.77	<5.57	<12.60	<10
Std.DEVIATION	>3.93	>2.77	>8.21	>6

Ni (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<4-11	<4-13	<4-4	<4
MEAN	<4.95	<5.29	<4	<4
Std.DEVIATION	>1.80	>3.15	>0	>0

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
317	30N 53W 06 AA	125	HOUSEHOLD
318	30N 53W 06 AC	60	HOUSEHOLD
319	30N 53W 06 AC	30	HOUSEHOLD
320	30N 53W 06 AC	30	HOUSEHOLD
321	30N 53W 06 AC	30	HOUSEHOLD
322	31N 53W 34 DA	72	HOUSEHOLD,STOCK
323	31N 53W 26 CC	90	HOUSEHOLD,STOCK
324	30N 53W 01 AC	60	STOCK
325	30N 53W 10 DD	390	STOCK
326	30N 53W 15 AB	380	STOCK
327	31N 53W 35 DA	80	HOUSEHOLD,STOCK
328	31N 53W 33 AA	60	HOUSEHOLD
329	30N 53W 01 AD	60	HOUSEHOLD,STOCK
330	30N 53W 12 AC	30	STOCK
331	30N 53W 11 CD	380	STOCK
332	30N 53W 01 BD	60	STOCK
333	30N 52W 07 CC	50	HOUSEHOLD
334	30N 53W 04 AA	104	HOUSEHOLD,STOCK
335	30N 53W 04 DD	128	STOCK
336	32N 52W 26 DB	40	HOUSEHOLD,STOCK
337	30N 54W 01 BD	30	HOUSEHOLD,STOCK
338	30N 54W 01 CC	60	STOCK
339	30N 54W 12 BD	60	STOCK
340	30N 54W 11 DB	220	STOCK
341	30N 54W 14 DB	220	STOCK
342	30N 54W 24 DA	160	STOCK
343	30N 53W 15 DC	64	STOCK
344	30N 54W 12 AA	60	STOCK
345	30N 54W 04 AC	230	NOT REPORTED
346	30N 53W 35 AB	200	STOCK
347	30N 54W 05 AB	180	STOCK
348	30N 53W 06 DC	40	HOUSEHOLD,STOCK
349	30N 53W 06 DC	70	STOCK,HOUSEHOLD
350	30N 53W 07 AC	40	STOCK
351	30N 53W 07 CA	50	HOUSEHOLD
352	30N 53W 07 AB	40	HOUSEHOLD
353	30N 53W 07 AB	40	HOUSEHOLD
354	30N 53W 34 CD	252	STOCK
355	30N 53W 26 AC	180	STOCK
356	30N 53W 26 BD	210	HOUSEHOLD,STOCK
357	30N 53W 27 CC	310	STOCK
358	30N 53W 27 DB	270	STOCK
359	30N 53W 27 BD	290	STOCK
360	30N 53W 34 CA	252	HOUSEHOLD,STOCK
361	30N 53W 34 CA	300	STOCK,IRRIGATION

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
362	30N 53W 35 BA	270	STOCK
363	30N 53W 21 BB	250	STOCK
364	30N 53W 21 CC	252	NOT REPORTED
365	30N 53W 21 CC	300	HOUSEHOLD, STOCK
366	30N 53W 21 AD	270	STOCK
367	30N 53W 25 BD	300	NOT REPORTED
368	30N 53W 25 CA	240	HOUSEHOLD, STOCK
369	30N 53W 23 AD	140	STOCK
370	30N 53W 23 CB	300	STOCK
371	30N 53W 23 CA	90	STOCK
372	30N 53W 36 BA	250	STOCK
373	30N 53W 28 AD	260	HOUSEHOLD, STOCK
374	30N 53W 28 CD	270	STOCK
375	30N 53W 15 AA	300	STOCK
376	30N 53W 15 DC	18	HOUSEHOLD, STOCK
377	30N 53W 15 CB	64	STOCK
378	30N 53W 22 AD	62	STOCK
379	30N 53W 10 CD	400	STOCK
380	30N 53W 08 DB	440	STOCK
381	30N 53W 17 BA	400	STOCK
382	30N 53W 03 AA	110	STOCK
383	31N 53W 25 BC	100	HOUSEHOLD
384	31N 53W 26 AC	80	STOCK
385	31N 53W 35 AA	90	STOCK
386	31N 52W 30 AC	80	HOUSEHOLD, STOCK
387	31N 52W 30 AC	N.R.	NOT REPORTED
388	31N 52W 31 DB	300	HOUSEHOLD, STOCK
389	31N 52W 31 DB	166	HOUSEHOLD, STOCK
390	31N 52W 31 BA	100	STOCK
391	31N 52W 31 CB	160	STOCK
392	31N 52W 31 BC	160	STOCK
393	31N 53W 25 AC	90	STOCK
394	31N 52W 29 DB	65	HOUSEHOLD, STOCK
395	30N 52W 35 AC	190	HOUSEHOLD, STOCK
396	31N 52W 28 DD	100	STOCK
397	31N 52W 33 BA	120	STOCK
398	31N 52W 29 AA	120	HOUSEHOLD, STOCK
399	30N 52W 03 BD	60	STOCK
400	31N 54W 23 AC	250	STOCK
401	31B 54W 15 CA	408	HOUSEHOLD, STOCK
402	31N 54W 15 CA	400	HOUSEHOLD, STOCK
403	31N 52W 34 DA	180	HOUSEHOLD
404	30N 52W 04 DB	N.R.	STOCK
405	30N 52W 04 CC	40	STOCK
406	30N 52W 07 CA	50	STOCK
407	30N 52W 18 CA	70	HOUSEHOLD, IRRIGATION

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
408	30N 54W 10 AA	260	STOCK
409	30N 52W 08 BB	60	HOUSEHOLD
410	30N 52W 08 BD	60	HOUSEHOLD
411	30N 52W 19 BA	N.R.	HOUSEHOLD
412	30N 52W 20 BA	250	HOUSEHOLD,STOCK
413	30N 53W 24 DD	N.R.	STOCK
414	30N 52W 28 DD	320	HOUSEHOLD,STOCK
415	30N 52W 28 DC	350	STOCK
416	30N 52W 20 AC	310	STOCK
417	30N 52W 17 BD	310	STOCK
418	30N 52W 35 DC	190	STOCK
419	30N 52W 34 BD	100	STOCK
420	30N 52W 35 BB	180	HOUSEHOLD
421	30N 54W 03 CA	200	STOCK
422	30N 54W 16 DD	400	STOCK
423	30N 52W 26 CA	40	HOUSEHOLD,STOCK
424	30N 52W 26 DB	360	ABANDONED
425	30N 52W 26 BC	260	STOCK
426	30N 52W 26 CB	360	STOCK
427	30N 52W 27 DA	350	STOCK
428	30N 52W 33 AD	320	HOUSEHOLD,STOCK
429	30N 52W 32 AC	300	STOCK
430	30N 52W 32 DB	300	HOUSEHOLD,STOCK
431	30N 52W 33 CB	250	STOCK
432	30N 52W 33 BB	280	STOCK
433	30N 52W 36 BA	150	HOUSEHOLD,STOCK
434	30N 52W 36 AC	180	STOCK
435	30N 52W 25 CA	160	HOUSEHOLD,STOCK
436	30N 52W 30 BC	200	INDUSTRIAL
437	30N 52W 30 DA	300	STOCK
438	30N 52W 29 CA	200	STOCK
439	30N 52W 31 BA	300	STOCK
440	30N 52W 11 CC	400	HOUSEHOLD,STOCK
441	30N 52W 11 CC	430	HOUSEHOLD
442	30N 52W 23 AC	285	HOUSEHOLD,STOCK
443	30N 52W 25 BA	180	HOUSEHOLD
444	30N 52W 25 BA	180	STOCK
445	30N 52W 23 DC	200	HOUSEHOLD,STOCK
446	30N 52W 23 CC	400	STOCK
447	30N 52W 24 AD	265	HOUSEHOLD
448	30N 52W 27 CA	190	STOCK
449	30N 52W 27 AA	180	STOCK
450	30N 52W 24 BB	265	STOCK
451	30N 52W 13 DC	150	HOUSEHOLD
452	30N 51W 30 BD	200	HOUSEHOLD
453	30N 51W 30 BD	185	HOUSEHOLD,STOCK

Note:
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WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
455	30N 51W 30 BD	235	HOUSEHOLD
456	30N 51W 30 BD	200	STOCK
457	30N 51W 19 CD	278	HOUSEHOLD,STOCK
458	30N 51W 30 BB	260	STOCK
459	31N 51W 30 BD	240	PUBLIC SUPPLY
460	30N 51W 32 BC	125	HOUSEHOLD,IRRIGATION
461	30N 51W 32 BC	35	HOUSEHOLD,STOCK
462	30N 51W 32 CA	60	STOCK
463	30N 51W 32 AC	270	STOCK
464	30N 51W 33 BB	100	NOT REPORTED
465	30N 51W 28 CC	260	NOT REPORTED
466	30N 51W 33 CD	150	STOCK
467	30N 51W 33 CD	150	STOCK
468	30N 51W 33 AC	200	STOCK
469	30N 51W 20 DD	165	HOUSEHOLD,STOCK
470	30N 51W 21 AD	232	STOCK
471	30N 51W 20 CC	150	STOCK
472	30N 51W 29 AA	130	HOUSEHOLD,STOCK
473	30N 51W 29 AD	184	STOCK
474	30N 51W 21 AC	220	HOUSEHOLD,STOCK
475	30N 51W 21 AC	260	HOUSEHOLD,STOCK
476	30N 51W 19 AD	340	STOCK
477	30N 51W 28 AA	300	STOCK
478	30N 51W 28 AA	280	STOCK
479	30N 51W 25 CC	100	STOCK
480	30N 51W 23 CC	150	STOCK, HOUSEHOLD
481	30N 51W 23 CC	100	HOUSEHOLD,STOCK
482	30N 51W 23 CA	100	HOUSEHOLD,STOCK
483	30N 51W 14 AA	310	HOUSEHOLDS,TOCK
484	30N 51W 22 DD	65	STOCK
485	30N 51W 23 CA	180	STOCK
486	30N 51W 15 DD	200	STOCK
487	30N 51W 15 BC	310	STOCK
488	30N 51W 15 BC	310	STOCK
489	30N 51W 14 AB	300	STOCK
490	30N 51W 27 AA	80	STOCK
491	30N 51W 27 BD	50	STOCK
492	30N 51W 23 DD	200	STOCK
493	30N 51W 28 CC	50	STOCK
494	30N 51W 29 BB	200	STOCK
495	30N 51W 34 CC	225	STOCK
496	30N 51W 36 CC	100	STOCK
497	30N 51W 36 BB	100	STOCK
500	30N 51W 25 AC	150	STOCK
501	30N 51W 24 AB	150	STOCK
502	30N 51W 24 AA	120	STOCK

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
502	30N 51W 24 AA	120	STOCK
503	30N 51W 13 DA	250	STOCK
504	30N 51W 24 CD	265	STOCK
505	30N 51W 25 AA	250	STOCK
506	31N 54W 08 DD	350	STOCK
507	31N 54W 08 DD	350	STOCK, HOUSEHOLD
508	31N 54W 08 CC	300	STOCK
509	31N 54W 17 CB	300	STOCK
510	31N 54W 17 AC	300	STOCK
511	31N 54W 21 BB	400	STOCK
512	31N 54W 21 DB	400	STOCK
513	31N 54W 28 AC	100	STOCK
514	31N 54W 16 AC	400	STOCK
515	31N 54W 09 CC	400	STOCK
516	31N 54W 22 BA	400	STOCK
517	31N 54W 22 DC	350	STOCK
518	31N 54W 22 CD	400	STOCK
519	31N 54W 27 DA	250	STOCK
520	31N 54W 26 BC	350	STOCK
521	31N 54W 23 DC	350	STOCK
522	31N 54W 08 DD	400	STOCK,HOUSEHOLD
523	31N 54W 24 BB	360	HOUSEHOLD,STOCK
524	31N 54W 14 DA	360	STOCK
525	31N 53W 18 AC	360	STOCK
526	31N 53W 18 AD	360	STOCK
527	31N 53W 18 CD	515	NOT REPORTED
528	31N 54W 19 BD	300	STOCK
529	31N 53W 34 AA	125	HOUSEHOLD
530	30N 52W 06 CB	50	HOUSEHOLD,STOCK
531	30N 52W 06 CD	50	STOCK
532	30N 52W 11 BA	140	HOUSEHOLD
533	30N 52W 14 AC	320	STOCK
534	30N 52W 12 CA	40	HOUSEHOLD,STOCK
535	30N 51W 05 BA	110	HOUSEHOLD,STOCK
536	31N 51W 31 CD	80	STOCK
537	31N 51W 32 CC	180	STOCK
538	31N 52W 25 DA	60	HOUSEHOLD,STOCK
539	30N 51W 08 DC	280	HOUSEHOLD,STOCK
540	30N 51W 17 CA	275	STOCK
541	30N 51W 16 DD	250	STOCK
542	30N 51W 04 AB	250	HOUSEHOLD,STOCK
543	30N 51W 09 AA	250	STOCK
544	31N 54W 34 BC	35	HOUSEHOLD
545	31N 54W 20 AA	100	STOCK
546	31N 54W 20 CA	400	STOCK
547	31N 54W 24 CD	280	STOCK

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
548	31N 54W 25 BC	250	STOCK
549	30N 54W 02 CD	140	STOCK
550	30N 54W 08 AB	300	STOCK
551	30N 54W 10 CB	80	HOUSEHOLD,STOCK
552	30N 54W 05 CD	40	STOCK
553	30N 54W 06 DA	360	STOCK
554	30N 54W 06 AA	300	STOCK
555	30N 54W 22 CC	N.R.	STOCK
556	31N 53W 27 AA	60	HOUSEHOLD,STOCK
557	31N 53W 27 AB	60	STOCK
558	31N 53W 26 AB	60	HOUSEHOLD
559	31N 53W 26 AB	60	NOT REPORTED
560	31N 53W 34 CB	70	STOCK
561	31N 53W 26 CA	60	STOCK
562	31N 54W 30 BB	200	STOCK
563	31N 54W 30 AC	150	STOCK
564	31N 54W 29 CA	120	NOT REPORTED
565	31N 54W 26 AB	250	STOCK
566	30N 52W 08 AB	100	HOUSEHOLD,STOCK
567	30N 52W 08 AB	100	STOCK
568	30N 52W 08 AB	100	HOUSEHOLD
569	30N 52W 08 AB	100	IRRIGATION
570	30N 51W 31 DB	160	HOUSEHOLD,IRRIGATION
571	30N 51W 31 DA	160	IRRIGATION
572	30N 51W 31 AD	100	STOCK
573	30N 51W 31 BA	160	STOCK
574	30N 51W 31 DB	100	STOCK
575	31N 53W 19 AB	220	STOCK
576	30N 51W 35 AC	200	STOCK
577	31N 54W 27 CA	350	STOCK
578	31N 54W 27 BC	320	STOCK
579	31N 51W 29 DA	60	HOUSEHOLD,IRRIGATION
580	31N 53W 26 BC	60	IRRIGATION
581	31N 51W 28 CB	50	PUBLIC SUPPLY
585	31N 53W 22 CD	100	HOUSEHOLD,IRRIGATION
586	31N 53W 27 CC	125	WILDLIFE
587	31N 51W 33 AA	27	HOUSEHOLD
588	30N 51W 02 BD	213	HOUSEHOLD,STOCK
589	31N 51W 35 CC	220	STOCK
590	30N 51W 02 AA	210	STOCK
591	30N 51W 01 CA	200	STOCK
592	31N 51W 35 DB	300	HOUSEHOLD,STOCK
593	30N 51W 01 CA	300	NOT REPORTED
594	30N 51W 11 AD	300	STOCK
595	30N 51W 12 BD	300	STOCK
596	30N 51W 10 AA	300	HOUSEHOLD,STOCK

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
597	30N 51W 10 AA	300	STOCK
598	30N 51W 10 AD	300	STOCK
599	30N 51W 02 BC	300	STOCK
600	31N 51W 20 CC	70	HOUSEHOLD,STOCK
601	31N 51W 29 BC	79	STOCK
602	31N 51W 20 CB	60	HOUSEHOLD,STOCK
603	31N 51W 20 AC	90	STOCK
604	31N 51W 19 AD	N.R.	STOCK
617	32N 54W 14 DB	396	STOCK
618	32N 54W 14 BB	409	STOCK
624	32N 52W 35 CC	70	STOCK
628	30N 51W 09 DA	N.R.	STOCK
633	31N 51W 35 BC	140	HOUSEHOLD,STOCK
634	30N 52W 15 CC	320	STOCK
635	30N 52W 15 CC	330	HOUSEHOLD,STOCK
636	30N 52W 16 DB	300	STOCK
637	30N 52W 21 BA	300	STOCK
638	30N 52W 21 DA	400	STOCK
639	30N 52W 14 CB	280	HOUSEHOLD,STOCK
640	30N 52W 01 BB	85	HOUSEHOLD,STOCK
645	31N 52W 24 AA	80	STOCK
646	31N 51W 30 DA	175	STOCK
647	31N 51W 30 BB	100	STOCK
648	31N 51W 31 BA	120	STOCK
665	31N 53W 24 DD	150	STOCK
669	30N 51W 29 CC	180	STOCK
672	30N 51W 13 CB	280	HOUSEHOLD,STOCK
675	32N 53W 17 DA	130	HOUSEHOLD,STOCK
679	31N 54W 33 AD	200	STOCK
680	30N 53W 10 DA	300	STOCK
683	30N 54W 23 AA	N.R.	NOT REPORTED

THE FOLLOWING WELLS ARE IDENTIFIED AS CHADRON

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
001	32N 52W 15 AA	30	HOUSEHOLD,STOCK
002	32N 52W 03 DD	N.R.	HOUSEHOLD,STOCK
003	32N 52W 14 CA	35	STOCK
004	32N 52W 16 AD	40	STOCK
005	32N 52W 15 CD	15	STOCK
006	32N 52W 15 DD	35	HOUSEHOLD,STOCK
007	32N 52W 21 AA	N.R.	NOT REPT.
010	32N 52W 17 DD	40	HOUSEHOLD,STOCK
015	32N 52W 08 DA	30	HOUSEHOLD
016	32N 52W 08 DB	30	HOUSEHOLD
017	32N 52W 08 DA	30	STOCK
018	32N 52W 08 BD	30	HOUSEHOLD,STOCK
021	32N 52W 07 AC	150	STOCK
024	32N 52W 12 AA	45	STOCK
028	32N 52W 04 CC	30	HOUSEHOLD,STOCK
054	32N 52W 11 CC	35	STOCK
055	32N 52W 10 DA	65	HOUSEHOLD,STOCK
056	32N 52W 10 DD	40	HOUSEHOLD,STOCK
057	32N 52W 09 CC	50	HOUSEHOLD,STOCK
058	32N 52W 09 DC	40-45	HOUSEHOLD,STOCK
117	32N 52W 15 AA	100	STOCK
118	32N 52W 27 AA	100	HOUSEHOLD,STOCK
119	32N 52W 27 AA	250	STOCK
120	32N 52W 34 DD	60	HOUSEHOLD,IRRIGATION
132	32N 52W 26 CC	35	STOCK
133	32N 52W 35 BA	65	HOUSEHOLD
134	32N 52W 13 AD	50	STOCK
135	32N 52W 24 CB	N.R.	HOUSEHOLD,STOCK
136	32N 52W 14 DD	40	HOUSEHOLD,STOCK
141	32N 52W 23 AB	35	HOUSEHOLD,STOCK
142	32N 52W 23 AB	35	HOUSEHOLD,STOCK
143	32N 52W 23 BD	35	STOCK
144	32N 52W 35 BB	55	STOCK
146	32N 52W 34 AB	50	STOCK
147	32N 51W 35 AA	30	STOCK
148	32N 51W 35 AA	30	STOCK
149	32N 52W 34 CC	N.R.	STOCK
208	32N 52W 26 DD	52	HOUSEHOLD,STOCK
219	32N 51W 23 BD	35	STOCK
220	32N 52W 25 AD	100	HOUSEHOLD,STOCK
221	32N 52W 26 DC	160	NONE
222	32N 52W 26 DC	30	HOUSEHOLD,STOCK
223	32N 52W 35 BD	35	HOUSEHOLD,STOCK
225	32N 52W 35 CB	480	STOCK,IRRIGATION
230	32N 51W 35 DD	35	STOCK

WELL ID	LEGAL LOCATION	DEPTH (FT.)	USES
242	32N 51W 35 AA	35	STOCK
249	32N 51W 33 AA	50	HOUSEHOLD,STOCK
252	31N 51W 08 BC	400	HOUSEHOLD,STOCK
255	31N 51W 09 CA	675	STOCK
264	32N 51W 32 DD	60	STOCK
280	31N 51W 12 DB	520	HOUSEHOLD
289	32N 51W 18 BB	60	HOUSEHOLD,STOCK
290	32N 51W 07 CC	N.R.	EMPTY HOUSE
292	32N 52W 08 AD	40	HOUSEHOLD
501	618 MAIN, CRAWFORD	198	IRRIGATION, (ARTESI/
503	TEXACO STATION,CRAWFORD	N.R.	IRRIGATION, (ARTESI/
583	32N 52W 26 AC	50	STOCK
621	32N 52W 36 CC	125	HOUSEHOLD,STOCK
622	31N 51W 07 AC	300	STOCK, (ARTESIAN)
623	32N 52W 35 CC	280	STOCK, (ARTESIAN)
627	31N 54W 15 BD	610	IRRIGATION
652	31N 52W 02 CA	280	HOUSEHOLD,STOCK
653	32N 52W 13 DC	60	STOCK
655	32N 52W 27 DA	670	IRRIGATION
656	32N 52W 27 DA	110	IRRIGATION
657	32N 52W 27 DA	110	IRRIGATION
673	32N 51W 19 CC	90	HOUSEHOLD,STOCK
674	32N 51W 19 CC	75	STOCK
682	31N 52W 01 BD	600	IRRIGATION(ARTESIAN)
685	CERAMIC SHOP, CRAWFORD	380	IRRIGATION(ARTESIAN)
902	7 COATES, CRAWFORD	N.R.	IRRIGATION
904	701 MAIN, CRAWFORD	280	IRRIGATION (ARTESIAN
905	618 MAIN, CRAWFORD	198	IRRIGATION
906	520 PINE, CRAWFORD	285	IRRIGATION
907	SOUTHGATE, CRAWFORD	N.R.	IRRIGATION
911	119 LINN, CRAWFORD	160	HOUSEHOLD

THE FOLLOWING ARE IDENTIFIED AS PIERRE FORMATION

WELL ID.	LEGAL LOCATION	DEPTH (FT.)	USES
199	32N 51W 20 BB	20	NOT REPT.
200	32N 51W 10 DD	75	STOCK
201	32N 51W 08 AA	N.R.	STOCK
202	32N 51W 09 AA	36	NOT REPT.
203	32N 51W 09 AA	N.R.	STOCK
204	32N 51W 09 AA	47	STOCK
205	32N 51W 17 BB	40	HOUSEHOLD
206	32N 51W 17 BB	50-60	STOCK
209	32N 51W 19 BA	18	HOUSEHOLD,STOCK
213	32N 51W 02 CC	30	STOCK
214	32N 51W 02 CC	30	NOT REPT.
215	32N 51W 09 BB	35	NOT REPT.
216	32N 51W 04 CB	35	NOT REPT.
217	32N 51W 21 AB	60	HOUSEHOLD,STOCK
218	32N 51W 17 AC	60	STOCK
226	32N 51W 13 DD	31	HOUSEHOLD
227	32N 51W 13 DD	31	HOUSEHOLD
228	32N 51W 13 DD	31	HOUSEHOLD,STOCK
239	32N 51W 13 DD	40	NOT REPT.
240	32N 51W 25 BB	44	HOUSEHOLD,STOCK
241	32N 51W 25 AA	28	STOCK
248	32N 51W 13 AA	25	STOCK
284	32N 51W 14 CA	40-50	STOCK
288	32N 51W 03 DC	28	HOUSEHOLD,STOCK
291	32N 51W 12 DB	50	HOUSEHOLD
498	32N 51W 01 CA	26	NOT REPT.
499	32N 51W 11 AC	39	NOT REPT.
582	32N 51W 16 CD	45	STOCK
584	32N 51W 20 DA	27	NOT REPT.
607	32N 51W 01 AB	50	IRRIGATION
608	32N 51W 15 CA	100	HOUSEHOLD,STOCK
609	32N 51W 15 DA	N.R.	STOCK
610	32N 51W 15 CA	100	STOCK
611	32N 51W 16 CD	60	STOCK
612	32N 51W 14 BB	35	NOT REPT.
613	32N 51W 14 BB	35	NOT REPT.
614	32N 51W 14 BB	35	STOCK
615	32N 51W 21 BA	60	NOT REPT.
616	32N 51W 20 AA	41	NOT REPT.
626	32N 51W 25 BD	50	STOCK
650	32N 51W 01 BC	50	HOUSEHOLD
651	32N 51W 20 CB	60	HOUSEHOLD,STOCK
654	32N 52W 24 AD	40	HOUSEHOLD,STOCK
684	32N 51W 25 CC	N.R.	NOT REPT.

THE FOLLOWING ARE LISTED AS IN THE BRULE FORMATION

WELL ID	LEGAL LOCATION	DEPTH (FT.)	USES
011	32N 52W 17 DD	20	HOUSEHOLD (SPRING)
012	32N 52W 17 DA	50	HOUSEHOLD, STOCK
013	32N 52W 17 BB	150	HOUSEHOLD, STOCK
020	32N 52W 04 CD	28	HOUSEHOLD, STOCK
023	32N 53W 12 AA	45	HOUSEHOLD
026	32N 53W 11 BD	200	IRRIGATION
027	32N 53W 05 AA	100	HOUSEHOLD, STOCK
029	31N 52W 14 BA	40-50	STOCK
032	32N 53W 06 BC	280	HOUSEHOLD, STOCK
033	32N 53W 06 BC	220	HOUSEHOLD, STOCK
036	32N 53W 07 BA	N.R.	NOT REPORTED
041	32N 53W 09 DB	40	STOCK
050	32N 52W 29 BB	160	STOCK
060	32N 53W 13 CD	140	HOUSEHOLD, STOCK
061	32N 53W 13 CD	140	STOCK, IRRIGATION
120	32N 52W 33 DA	80	HOUSEHOLD
129	32N 52W 34 DD	60	HOUSEHOLD, IRRIGATION
130	32N 52W 34 DC	45	HOUSE, STOCK, IRRIGATION
145	32N 52W 27 DC	50	HOUSEHOLD, STOCK
185	31N 52W 15 AA	100	HOUSEHOLD, STOCK
186	31N 52W 15 BA	100	STOCK
187	31N 52W 15 DA	70	STOCK
189	31N 52W 15 DC	60	HOUSEHOLD
224	32N 52W 35 BC	84	HOUSEHOLD
229	31N 51W 02 BA	80	HOUSEHOLD, STOCK
231	32N 51W 26 DC	35	STOCK
232	31N 51W 02 BA	75	STOCK
233	31N 51W 02 BA	75	HOUSEHOLD
234	31N 51W 02 BA	75	STOCK
235	32N 51W 35 CC	75	STOCK
236	32N 51W 34 DC	75	STOCK
237	31N 51W 03 BD	N.R.	NOT REPORTED
238	31N 51W 03 CA	75	STOCK
247	31N 51W 12 CC	400+	NOT REPORTED
251	31N 52W 12 AB	70	STOCK
254	31N 51W 09 DB	115	HOUSEHOLD
256	31N 51W 09 AD	40	STOCK, IRRIGATION
257	31N 51W 09 DD	400	HOUSEHOLD
258	31N 51W 11 BA	90	HOUSEHOLD, STOCK
259	31N 51W 14 AA	65	HOUSEHOLD, STOCK
261	32N 51W 33 CC	50	HOUSEHOLD
262	32N 51W 33 CC	80	STOCK
263	32N 51W 33 CA	60	STOCK
265	31N 51W 04 BB	50	STOCK
266	31N 51W 04 AB	80	STOCK
267	31N 51W 04 DB	310	STOCK
268	31N 51W 06 BC	45	HOUSEHOLD, STOCK
269	31N 51W 06 BC	18	HOUSEHOLD, STOCK
270	31N 51W 06 CC	40	NOT REPORTED
271	31N 51W 06 CC	N.R.	NOT REPORTED
272	31N 51W 07 CC	N.R.	STOCK
273	31N 52W 13 AB	N.R.	HOUSEHOLD

WELL ID	LEGAL LOCATION	DEPTH (FT.)	USES
274	31N 52W 11 AB	N.R.	NOT REPORTED
275	31N 51W 07 BD	25	STOCK
276	31N 52W 13 DD	25	HOUSEHOLD , STOCK
277	31N 52W 13 CD	35	STOCK
278	31N 52W 13 BA	38	STOCK
279	31N 51W 12 DB	110	IRRIGATION
282	31N 52W 12 BB	40	HOUSEHOLD,STOCK
283	31N 52W 12 DD	N.R.	NOT REPORTED
605	31N 51W 18 CD	32	HOUSEHOLD,STOCK
606	31N 51W 19 BA	40	STOCK
619	32N 52W 35 DC	125	HOUSEHOLD,STOCK
620	32N 52W 35 CA	120	STOCK
625	32N 53W 03 DB	660	NOT REPORTED
629	31N 52W 01 DC	55	HOUSEHOLD,STOCK
630	31N 52W 22 BA	80	HOUSEHOLD,STOCK
631	31N 52W 22 BD	80	STOCK
632	31N 52W 22 AA	N.R.	NOT REPORTED
641	31N 52W 25 BD	95	HOUSEHOLD,STOCK
642	31N 52W 23 CD	60	STOCK
643	31N 52W 24 BD	< 100	HOUSEHOLD
644	31N 52W 23 AB	< 100	STOCK
659	31N 52W 08 AC	380	STOCK
660	31N 53W 13 CA	150	STOCK
661	31N 53W 13 AB	N.R.	STOCK
662	31N 53W 11 DD	150	STOCK
663	31N 53W 24 AB	70	NOT REPORTED
664	31N 52W 20 CA	150	STOCK
666	31N 52W 20 AC	150	STOCK
667	31N 52W 21 CA	150	STOCK
668	31N 52W 07 DB	300	STOCK
671	31N 53W 23 AD	40	HOUSEHOLD,STOCK
676	32N 53W 08 AA	45	STOCK
677	31N 51W 04 AA	60	HOUSEHOLD,STOCK
678	32N 52W 28 CC	N.R.	NOT REPORTED
901	311 OAK, CRAWFORD	45	IRRIGATION
902	7 COATES, CRAWFORD	55	IRRIGATION
903	14 PADDOCK, CRAWFORD	100	IRRIGATION
908	723 ELM,CRAWFORD	40	IRRIGATION
909	311 ANNIN,CRAWFORD	60	IRRIGATION
	406 LINN,CRAWFORD	50	IRRIGATION
	315 OAK,CRAWFORD	45	IRRIGATION
	235 MAIN,CRAWFORD	50	NOT REPORTED
	602 E.MAIN,CRAWFORD	80	IRRIGATION
	136 LINN,CRAWFORD	50	IRRIGATION
	1109 6TH,CRAWFORD	60	IRRIGATION
	216 PADDOCK,CRAWFORD	50	IRRIGATION
	233 PADDOCK,CRAWFORD	50	IRRIGATION
	1100 1ST,CRAWFORD	45	IRRIGATION
	419 ANNIN,CRAWFORD	60	HOUSEHOLD,IRRIGATI
	111 ANNIN,CRAWFORD	N.R.	HOUSEHOLD,IRRIGATI
	113 LINN,CRAWFORD	N.R.	IRRIGATION
	302 LINN,CRAWFORD	50	HOUSEHOLD,IRRIGATI

LEGAL LOCATION	DEPTH (FT.)	USES
302 LINN,CRAWFORD	80	IRRIGATION
119 PINE,CRAWFORD	54	IRRIGATION
10239.HOSPITAL DRIVE,CRAWFORD	N.R.	HOUSEHOLD, IRRIGATI
409 MAIN,CRAWFORD	28	IRRIGATION
1115 HALF PARK,CRAWFORD	N.R.	IRRIGATION
623 ELM,CRAWFORD	30	IRRIGATION
314 PADDOCK,CRAWFORD	50	HOUSEHOLD, IRRIGATI
115 OAKS,CRAWFORD	36	IRRIGATION
821 1ST,CRAWFORD	27	IRRIGATION
141 LINN,CRAWFORD	70	IRRIGATION
702 4TH,CRAWFORD	50	IRRIGATION
915 5TH,CRAWFORD	57	IRRIGATION
502 ANNIN,CRAWFORD	60	IRRIGATION

northeastern portion of the investigated area (T32N, R51W) the wells are completed in either the Tertiary Chadron or the Cretaceous Pierre formations. In general, wells near Crawford and within T31N, R51W produce from the Tertiary Brule and/or the Tertiary Chadron formations.

Within the proposed mining area in the northeastern sections of T31N, R51W the principal water-bearing formation for domestic use is the Brule. Sand lenses and filled fracture channels provide low to moderate yielding strata for wells within the Brule. Many wells in the Tertiary Chadron near and east of Crawford are artesian. These wells are producing from sands of the lower Chadron.

By far most wells within the investigated area are used for watering stock (Table B-1b)

TABLE B-1b. SUMMARY OF WELL USE WITHIN INVESTIGATED AREA

		PRIMARY WELL USE							
UNIT	TOTAL	STOCK	DOMESTIC	IRRIG.	WILDLIFE	NOT REPT.	ABANDONED	INDUSTRIAL	PUBLIC SUPPLY
ARIKAREE	484	308	142	3	2	23	3	1	2
BRULE	112	37	37	26	-	12	-	-	-
CHADRON	76	24	35	11	-	2	2	-	-
PIERRE	43	16	12	1	-	14	-	-	-
TOTALS	715	388	226	41	2	51	5	1	2
% OF TOTAL		54	32	6	<1	7	<1	<1	<1

Many of the domestic wells also were used to water stock, trees and lawns. In such cases a priority was given to the well's use as a sole source of potable water for the household. In addition several stock wells also were used for small-scale irrigation. In such cases priority was given to their use for stock. Although Crawford derives its water from the White River, public supply wells serve schools and campgrounds.

SPRINGS

Seven active springs were inventoried within the investigated area (Table B-1c). These springs represent the larger and better known springs in the investigated area.

Table B-1c. Spring Inventory

Spring ID	Legal Location	Uses	Probable producing Unit
	SAMPLED		
SP-1	31N 51W 23 AA	Not Rept.	Ta
SP-2	30N 52W 19 BD	Not Rept.	Ta
SP-3	31N 53W 06 CA	Not Rept.	Ta
SP-4	31N 52W 16 CC	Not Rept.	Tb
SP-5 (649)	32N 51W 31 BD	Household	Tc
SP-6 (658)	31N 52W 08 CD	Public Supply	Tb
	NOT SAMPLED		
SP-7 (681)	31N 51W 11 DD	Household	Tc or Kp
SP-8 (140)	32N 52W 13 CA	Not Rept.	Tc

Several smaller seasonal springs and seeps along rivers and creeks probably do occur but to our knowledge these were not active during late summer and fall 1981 when the inventory took place.

SELECTED SITES FOR STREAM SAMPLING

TASK B-2

Ten samples were collected from streams dissecting the area. The stream samples were collected by wading into the middle of the main flow and sampling halfway between the surface and bottom of the stream.

The distribution of the sampling sites is shown on Foldout B-3(2). The legal locations are listed in Table B-2. Sites were selected on the rationale that at least one sample would be taken from each of the major streams in the area and more than one taken from selected streams flowing through the proposed mining area. On this basis samples ST-8, ST-9 and ST-10 are from streams cutting into the Arikaree Formation in the western part of the study area. Samples ST-1 and ST-2 are from Ash Creek which flow on the Cretaceous Pierre Shale in the eastern part of the study area. The remaining streams sampled cut into the Brule formation and are in part within the proposed uranium mining area. They include Squaw, White Clay and English creeks. Since Squaw Creek is centrally located within the proposed mining area, upper (ST-3), middle (ST-4) and lower (ST-5) samples were collected.

TABLE B-2. STREAM SAMPLING SITES

Sample Site No.	LEGAL LOCATION	
ST-1	31N 51W 24 CC	STREAM #1 (UPPER ASH)
ST-2	31N 51W 02 AA	STREAM #2 (LOWER ASH)
ST-3	30N 51W 03 BB	STREAM #3 (UPPER SQUAW CREEK)
ST-4	31N 51W 20 BC	STREAM #4 (MIDDLE SQUAW CREEK)
ST-5	31N 52W 12 BA	STREAM #5 (LOWER SQUAW CREEK)
ST-6	31N 52W 11 AB	STREAM #6 (WHITE CLAY CREEK)
ST-7	31N 52W 12 BB	STREAM #7 (ENGLISH CREEK)
ST-8	31N 53W 06 DA	STREAM #8 (SO. FORK SOLDIER CREEK)
ST-9	31N 53W 32 CD	STREAM #9 (MIDDLE WHITE RIVER)
ST-10	31N 54W 31 CA	STREAM #10 (WHITE RIVER NEAR ANDREWS NEBRASKA)

BASELINE DETERMINATION OF MAJOR IONS

TASK B - 3(1)

Introduction

Major ions include the cations calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}) and potassium (K^{+}) and the anions bicarbonate (HCO_3^{-}), sulfate (SO_4^{2-}) and chloride (Cl^{-}). The hydrogeologic units are characterized by different groundwater chemistries and can be classified by the distribution of these ions.

Methods

Except for bicarbonate all analyses were done on samples that had been filtered through 0.45 um filters. The samples for cation analysis were acidified after filtration.

Calcium, magnesium, sodium and potassium were measured by standard atomic absorption methods (APHA, 1975).

Sulfate was analyzed by turbidimetric titration (APHA, 1975).

Bicarbonate was measured at the collection site (APHA,1975).

Chloride was measured by titration with mercuric nitrate (APHA, 1975).

Results and Discussion

The results of the major ion analyses (Appendix A, Table 1) are represented graphically in a diamond-shaped field [Foldout B-3(1)] known as a Piper diagram (Piper,1944). Piper diagrams provide a basis for comparing water types as they relate to geologic formations. In this case the total concentration (expressed in percentage on a milliequivalent basis) of 8 major ions are plotted. On a milliequivalent basis the total cations minus the total anions should be near zero to maintain an electrochemically neutral solution. The major ion balances (Appendix A,Table 1) indicate that this prerequisite has been met and that the quality of the major ion data is good.

The Piper diagram [Foldout B-3(1)] shows two distinctly

different hydrochemical facies. These tend to cluster at the extreme left and the extreme right sides of the diamond field. These clusters represent the $Ca^{2+} - HCO_3^-$ type groundwater of the Arikaree unit and the $Na^+ - SO_4^{2-}$, Cl^- type groundwater of the basal Chadron unit. These two groundwater types represent the end members in the evolution of groundwater chemistry within the investigated area. This represents a normal sequence in major ion evolution and requires hundreds of thousands of years.

In the cation sequence, soluble calcium exchanges with sodium on clays and a "natural softening" of the water takes place. Also as gypsum is dissolved a high degree of supersaturation causes calcium and magnesium to precipitate out as calcite and dolomite. This results in an eventual lowering of the HCO_3^- concentration and an increase in the SO_4^{2-} concentration. The final step in the evolutionary sequence produces $Na^+ - Cl^-$ type groundwater. This step is being approached in the groundwater of the basal Chadron formation. The Cl^- increases probably result from the upward migration of Cl^- from the Cretaceous Pierre shale.

The evolution is exemplified best by the progression of the ratios of $Ca^{2+} + Mg^{2+} / Na^+ + K^+$ and $HCO_3^- / SO_4^{2-} + Cl^-$ in Table B-3(1). An arrow drawn through plotted points of the average formation concentrations [Foldout B-3(1)] indicates a gradual evolution to the $Na^+ - SO_4^{2-}$, Cl^- groundwater of the basal Chadron.

It appears that most large excursions of ions from the basal Chadron to the Brule formation caused by mining activities could easily be identified. The one exception might be in the Crawford area where Brule wells 901 and 909 have cation ratios similar to those of the basal Chadron. The Brule envelope [Foldout B-3(1)] does overlap wells in both the Arikaree and the upper Chadron formations. Thus chemically distinguishing Brule groundwater from that in the other formations (excluding the basal Chadron) is most difficult.

Table B- 3(1)

Baseline concentrations of major ions

in analyzed waters

Ca^{2+} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	48-73	30-78	40-88	8-101	15-114	13-25
MEAN	61	56	51	58	68	19
Std. DEVIATION	9	13	16	23	30	5

Mg^{2+} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	4-11	4-10	1-13	1-15	1-14	2-6
MEAN	6.8	7.2	6.2	5.8	7.8	3.1
Std. DEVIATION	2.4	2.0	2.5	2.7	3.8	1.4

Na^{+} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	7-127	9-37	3-35	7-210	21-270	310-540
MEAN	31	18	11	53	117	399
Std. DEVIATION	43	10	7	48	69	66

K^{+} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1-13	2-13	1-8	4-46	6-25	5-14
MEAN	5.3	5.9	3.4	10.1	14.8	11.5
Std. DEVIATION	3.7	3.3	1.5	8.2	5.2	2.3

Cation Ratios

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
Ca/Mg	8.9	7.8	8.3	9.9	8.8	6.3
Na/K	5.8	3.1	3.1	5.3	7.8	34.7
(Ca+Mg)/(Na+K)	1.9	2.6	4.0	0.98	0.61	0.05

Table B- 3(1) (continued)

HCO_3^- (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	190-250	180-310	120-270	160-420	175-460	280-370
MEAN	217	221	179	271	331	323
Std. DEVIATION	26	36	45	69	89	29

SO_4^{2-} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1-98	1-20	1-17	5-260	20-320	175-600
MEAN	21	6.5	4.8	39	118	382
Std. DEVIATION	35	6.9	4.6	50	84	123

Cl^- (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	10-60	2-26	3-30	3-113	15-110	110-240
MEAN	26	12	16	29	56	183
Std. DEVIATION	17	10	8	25	27	36

Anion Ratios

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
$HCO_3/(SO_4+Cl)$	4.6	12.0	8.5	4.0	1.9	0.57

MAJOR ION BALANCE

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	.09-7.3	-3.2- +7.8	-5.3 - +5.5	-8.-+6.9	-9 -+5.9	-5 - +6.9
MEAN	+3.08	+1.68	+0.77	+2.00	-0.08	+0.94
Std. DEVIATION	2.3	4.1	4.1	3.8	4.6	3.4

This process, however, may be enhanced by looking at other parameters. As an example, Arikaree wells 441 and 211 force the downward movement of the Arikaree envelope in Foldout B-3(1). These wells contained the highest uranium levels and lowest uranium activity ratios in the formation water (Appendix A, Table 1). This significant chemical difference signifies that these wells may indeed be Brule. This change would further confine the Arikaree envelope [dashed line in Foldout B-3(1)] and eliminate a significant amount of the Brule-Arikaree overlap.

In general the observed trends in chemical character [Foldout B - 3(1)] of the streams appear to be closely associated with the formation they dissect. Upper Ash Creek (ST-1), Soldier Creek (ST-8) and White River (ST-9, ST-10) have chemical characteristics similar to the groundwater in the Arikaree and undoubtedly receive most of their baseflow from this formation. The sampling locations for Lower Squaw (ST-5), White Clay (ST-6) and English (ST-7) Creeks are in the Brule formation and the water has chemical characteristics of that formation. The sample from middle Squaw Creek (ST-4) has characteristics similar to the upper Squaw Creek sample (ST-3) and probably receives its major contribution from upgradient Arikaree seep. Sample ST-2 from Lower Ash Creek would appear to have a significant contribution from the Brule formation; however, this portion of the stream may also be receiving seepage water from the Pierre formation. The chemical characteristics of groundwater in the Pierre formation were not well documented in this study due to the sparcity of wells sampled from this formation.

Chemical characteristics of the springs indicate that sample 649 is receiving water from the Chadron formation and Spring SP-4 probably originates in the Brule. The remaining springs have chemical characteristics similar to those of the Arikaree formation.

BASELINE DETERMINATIONS OF PHYSICAL CHARACTERISTICS OF ANALYZED WATERS TASK B-3 (2)

Introduction

Well depth, temperature, conductivity, pH, Eh, and H_2S are reported for 83 groundwater samples collected from the investigated area (Appendix A). The data are grouped according to the suspected producing horizon (Appendix A). Differences and similarities in the physical characteristics of the water from each producing horizon will be emphasized in this section.

In addition to the aforementioned groundwater samples, 16 surface water samples - 6 from active springs and 10 from rivers and creeks - were collected and analyzed. The physical data are tabulated in Appendix A.

The location of the sampling sites is shown in Foldout B-3(2).

Methods

Well depth was determined during discussions with the property owner and the local well drillers. In the majority of cases the reported well depths appear to be relatively accurate.

Temperatures were recorded with a mercury thermometer ($\pm$ 0.2°C) immersed in a bucket of the water. For wells water was discharged into the bucket until the temperature stabilized.

Conductivity was determined with a temperature compensated conductivity probe contained in a Hach Direct Reading Environmental Laboratory (DREL/4).

Both pH and Eh were measured at the time of sampling with an Orion 408 A/F meter. Measurements of pH were made using a combination electrode [Orion pH (91-05)] and the double buffer technique. The estimated error is 0.05 pH units. Eh measurements were determined in a flow-through electrode system. At least 15

minutes were allowed to pass before equilibrium was assumed and the Eh potential recorded. Eh potentials are based upon the saturated calomel reference electrode standard and were measured with an Orion model 96-78 redox electrode and have not been corrected.

Any odor resembling H_2S was confirmed using the lead acetate paper method (0 - 5 ppm) contained in the Hach DREL/4.

Results and Discussion

The artesian flow from flowing groundwater in the deeper basal Chadron demonstrated higher average temperatures, conductivities and pH values than groundwater from wells producing in younger strata [Table B-3(2)] . The temperature increase appears related primarily to the geothermal gradient where there is an increase of 0.56° C for every 55-foot increase in depth.

The high conductivity in the groundwater from the basal Chadron relates directly to a high dissolved solids content and indicates that the groundwater is old. An increased residence time within a formation generally promotes a more highly mineralized groundwater such as that which characterizes the basal Chadron. The average dissolved solids of ~ 1200 mg/l (~0.65 X conductivity) is considerably greater than the 500 mg/l level normally advocated by the U.S. Public Health Service for public supply systems. In contrast the low dissolved solids of ~ 215 mg/l in water from the Arikaree and younger strata indicate that these waters have had a relatively short residence in the formation. In regard to dissolved solids the proposition holds that poorer quality water results from a longer residence time in the formation.

The generalized increase in pH with the increase in age of the formation is anticipated in the normal evolution of mineralized groundwaters from the western Great Plains. The increased pH is believed to be associated with a depletion of hydrogen ions during

TABLE B- 3(2).

Baseline determinations of physical characteristics of analyzed waters

WELL DEPTH (Ft.)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE			30-527	18-150	30-520	100-600
MEAN			230.3	68.0	91.8	313
Std. DEVIATION			157.9	35.5	131.9	128.3

TEMPERATURE ^{o} C

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	12-26	12-24	12-18	10-19	12-18	15-23
MEAN	15.7	19.6	14.4	14.2	14.5	16.5
Std. DEVIATION	4.9	3.1	1.4	1.7	1.7	2.1

CONDUCTIVITY (uMHOS/CM)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	310-730	275-500	240-540	315-1210	485-1350	1460-2450
MEAN	443	386	332	610	893	1824
Std. DEVIATION	138	78	83	223	[illegible]	272

pH

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	6.9-7.8	6.9-8.6	6.9-8.2	7.0-8.4	6.9-7.8	6.9-8.4
MEAN	7.4	8.0	7.5	7.6	7.4	7.9
Std. DEVIATION	.3	.6	.4	.4	.3	.5

Eh *

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	80-700	70-700	-350-+700	-95-+250	-30-+290	-380-+70
MEAN	217	227	197	132	117	-245
Std. DEVIATION	217	172	200	83	75	124

H_2S (ppm)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	ND	ND	ND	ND	ND	0.1-5
MEAN	ND	ND	ND	ND	ND	1.5
Std. DEVIATION	ND	ND	ND	ND	ND	1.9

ND = Not detected

* All Eh values are based on Calomel reference and are not corrected.

carbonate dissolution.

Eh values and H_2S levels are indicators of the oxidizing conditions of the groundwater. In general the oxidizing nature of the formation waters demonstrated a trend towards lower oxidizing capacity with apparent increased residence time in the formation [Table B-3(2)]. The relatively high Eh values in the Arikaree and younger formation waters suggest that recharge occurs rapidly through fractures . Negative average Eh values in the basal Chadron formation indicate that this water is reducing relative to the H^+/H_2 couple. Negative redox potentials result from consumption of oxygen by bacterial oxidation of organic matter.

The observed H_2S levels in the groundwater of the basal Chadron formation indicate the presence of anaerobic sulfate reducers. These bacteria convert organic matter and sufate to hydrogen sulfide and bicarbonate. Although not usually harmful at low levels, the presence of the rotten egg odor of H_2S makes the basal Chadron waters less palatable.

BASELINE MEASUREMENTS OF TRACE METALS

TASK B-3 (3)-NONRADIOACTIVE

Introduction

The samples were analyzed for the trace metals arsenic (As), selenium (Se), vanadium (V), and molybdenum (Mo) because they are considered pathfinder elements for potential uranium ore bodies (Wanty et al., 1981) and in western states V and Mo are byproducts of uranium mining. Elevated levels of vanadium in run-off off have occasionally resulted from uranium mining and milling operations (Hopkins et al.,1977).

Methods

Arsenic and selenium were determined by the hydride generation method using an argon-hydrogen flame and a Perkin Elmer 303 atomic absorption spectrophotometer (APHA,1975) The detection limits for both elements were 0.5 ppb.

Molybdenum was analyzed by flameless atomization using a Perkin Elmer HGA-2000 graphite furnace. The detection limit was 1 ppb.

Vanadium was detected using a spectrophotometric technique via the gallic acid method (APHA,1975). The detection limit for vanadium was 0.5 ppb.

Results and Discussion

Selenium levels were very low in all analyzed groundwater samples (Appendix A, Table 1). Only 3 samples contained Se concentrations greater than 1 ppb. All three samples were from groundwater from the Brule formation and none of them had concentrations above 2 ppb. In terms of water quality no samples approached or exceeded the current maximum contaminant level (MCL) of 10 ppb Se. These low selenium levels negate the use of selenium as an indicator of potential uranium

deposits within this investigated area.

Arsenic levels were quite variable but showed a generalized increase in older oxidizing formation waters (Table B-3(3)a). This is demonstrated in a trend towards higher average As concentrations in lower Brule and upper Chadron formation waters than in either the Brule or Arikaree waters.

Soluble arsenic levels are controlled by the oxidation potential of the groundwater. Arsenic would precipitate only in strongly reducing environments in the presence of sulfide. Extremely low As levels in the basal Chadron are associated with the strongly reducing nature of that formation. Therefore, in slightly oxidizing environments such as those reported in the upper Chadron and lower Brule where there are occurrences of relatively high arsenic levels in the sediments, the groundwater could become enriched in As. Such enrichment appears to be occurring in the vicinity of wells 006, 016, 247 and 654 and also in Brule wells 901, 902, 903, 908, 909, 262, 023 and 187. These wells also contained relatively high uranium levels and low U-234/U-238 disequilibrium ratios. The above association is suggestive of an accumulation of elements which are presently dispersing (Osmond and Cowart, 1976 and Wanty et al., 1981). Arsenic levels exceeded the maximum contaminant level (MCL) of 50 ppb in only one well (006). Thus in terms of the water quality, arsenic is not of particular concern in the groundwater of the investigated area.

Molybdenum is often associated with reduced uranium ores as molybdenum sulfide. Similarly to arsenic the highest concentrations are expected in oxidized and moderately reduced waters. Molybdenum is slightly more stable than uranium in reducing groundwater and therefore molybdenum ore tends to be concentrated slightly downgradient from uranium ore bodies.

Molybdenum levels range from 1 (minimum detectable) to 12 ppb

TABLE B - 3(3) a.

BASELINE MEASUREMENTS OF TRACE METALS

IN ANALYZED WATERS

As (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	2-12	1-9	1-11	1-26	1-81	0.5-1
MEAN	4.3	4.1	3.2	6.9	15.6	0.54
Std.DEVIATION	3.5	2.3	2.3	6.3	20.7	1.14

Se (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<1	<1	<1	<1-1.6	<1	<1
MEAN	<1	<1	<1	<1.1	<1	<1

V (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1.1-9.0	3.0-10.7	0.5-9.7	1.6-27	0.9-155	0.5-20
MEAN	3.6	4.9	4.5	6.9	17.0	6.0
STD. DEVIATION	2.8	2.3	2.3	6.3	41.8	5.1

Mo (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1-5	1-6	1-5	1-7	1-12	1-10
MEAN	2	2.6	1.8	2.9	5.4	4.8
STD. DEVIATION	1.4	1.5	1.2	2.6	2.9	2.9

(Appendix A). As predicted molybdenum demonstrated a trend similar to that of arsenic; that is, the average concentrations increased with the apparent age of the oxidizing formations. The highest molybdenum levels generally were found in wells with the highest arsenic and uranium concentrations and were in the White River Group. Thus the soluble molybdenum concentrations probably are associated with dispersing accumulations.

Molybdenum levels in the basal Chadron ranged from 1 - 10 ppb (Appendix A). The levels were elevated slightly in samples containing uranium concentrations greater than 10 ppb and are probably higher because the wells are screened near the ore accumulations.

Vanadium levels have been shown to follow trends similar to those of uranium in the vicinity of uranium ore bodies in south Texas (Langmuir and Chatham, 1980). These trends are substantiated by the occurrences of high grade ore-bearing minerals containing both elements.

In the investigated area, vanadium followed trends in the oxidizing formations similar to those discussed for the other pathfinder elements. The major difference was that the V concentration range (0.5- 155 ppb) was much greater than that of the other non-radioactive trace elements. While no samples from the Arikaree contained over 10 ppb V, 9 samples from the White River Group contained 10 ppb or more. These samples also contained more than 10 ppb U (Appendix A) and probably are related to dispersing mineral accumulations.

Vanadium levels in the basal Chadron formation ranged from 0.5 - 20 ppb with no apparent association with uranium or any of the other pathfinder elements. The reasons for the relatively high V levels in wells 622 and 652 remain unresolved.

Spring and stream levels of the pathfinder elements generally were low (Appendix A). Slightly elevated As and Mo appeared in #649 which is believed to be a spring originating in the Chadron formation. Highest concentrations of pathfinder elements result from a relatively high component of White River Group seepage in the base flow of the creeks.

Neither molybdenum nor vanadium has maximum concentration level (MCL) values, and therefore it is not a water quality concern at ppb levels.

BASELINE DETERMINATIONS OF RADIOACTIVE CONSTITUENTS

TASK B-3(3)

Introduction

Uranium (U-238, $t_{1/2}$=4.5X 10^9 yr.) and radium (Ra-226, $t_{1/2}$ = 1620 yr.) are the two most mobile elements in the uranium natural decay series. Their mobility in groundwater combined with their relatively long half-lives allows them to be transported considerable distances from their points of origin. This potential for transport is dependent on the geochemical nature of the rocks and the rates of groundwater flow. It is essential to know the premining soluble levels of these nuclides if a future assessment of the impact of the mining activity is to occur. This is especially appropro for in situ leach mining where the uranium is remobilized by various lixiviants and restoration of the formation water is necessary. In some instances significant increases in U-238 and Ra-226 levels above background have been reported in post restoration groundwaters (Thompson, 1980).

Uranium isotopic ratios (U-234/U-238) were determined because uranium activity ratios cover the total U alpha particle activity in drinking water (EPA, 1980) and because uranium activity ratios are valuable in prospecting for uranium deposits.

Methods

Uranium and uranium isotopes were measured by standard isotope dilution - alpha spectrometry techniques using electrode deposition of purified uranium on polished stainless planchettes and a 2-9 day counting time with PGT - 400 mm. surface barrier detectors interfaced with a Canberra 4096 multi-channel analyzer split 4 ways (EPA, 1980; Cowart and Osmond; 1977 and Spalding and Druliner, 1981).

Radium was determined by the radon emanation technique (EPA, 1979) using scintillator-coated lucite Lucas cells and RCA photomultiplier tubes (Reid, 1979).

Results and Discussion

Radium 226 levels ranged from less than 0.1 pCi/l to 181 pCi/l (Appendix A). Lowest average levels occurred in groundwater from the Arikaree Group [Table B-3(3)] where only 5 of 23 samples contained >0.11 pCi/l. The highest average Ra-226 levels [Table B-3(3)] occurred in the basal Chadron formation where only 1 of 12 samples contained < 0.11 pCi/l. Unlike the previously discussed trace metals, radium concentrations generally are too low in natural systems to be controlled by chemical precipitation ($RaSO_4$) and therefore Ra-226 levels are dependent on the proximity of dispersing sources and chemical exchange. For that reason and the potential of radium to form soluble chloride complexes, anomalous radium levels are useful indicators of parent uranium ore accumulations. Elevated radium levels in artesian wells in northwestern Crawford appear to signify a nearby ore accumulation. Several of these wells in the basal Chadron formation have radium levels greater than the MCL for public supply systems of 5 pCi/l. None of the wells in the other formations that were surveyed had Ra-226 levels greater than 0.5 pCi/l.

Slightly elevated radium levels (>0.2 pCi/l) in several groundwater samples from the Brule, lower Brule and upper Chadron were associated with anomalously high U concentrations. Water-bearing sand lenses have dispersed soluble uranium from sediments and over time these waters appear to have become slightly enriched in Ra-226 via radioactive decay in the U-238 decay series.

Uranium levels ranged from 0.02 - 98 ug/l and U-234/U-238 activity ratios ranged from 1.50 - 12.60. With the exception of wells 211 and 441 , all Arikaree groundwater contained less than 8 ppb uranium. Both of these wells contained anomalously low isotopic ratios and high relative U levels for the Arikaree Group. As discussed in the major ion section both samples are more similar chemically to groundwater from the Brule than the Arikaree Group .

Average uranium concentrations show a marked increase and U-234/U-238 ratios demonstrate a marked decrease in the oxidizing waters of the White River group relative to those of the Arikaree [Table B-3(3)]. This is a normal progression of events for oxidizing formation waters which have undergone continuous leaching for long periods of time. As more Uranium-234 is preferentially leached from the grain surfaces, the surface slowly becomes depleted with respect to U-234 and eventually equilibrium is reached (U-234/U-238 =1) in groundwater. If leaching continues, ratios considerably below 1 occur as is evidenced by groundwater ratios in Florida Miocene formations (Osmond et al. 1969). The effects of this leaching are especially evident in the upper Chadron formation (wells 006, 016 and 249) where uranium concentrations are greater than 50 ppb and disequilibrium ratios range from 1.49 - 1.66.

The highly variable uranium levels and isotopic ratios in the basal Chadron sands typify those of a reducing aquifer with known uranium deposits (Osmond and Cowart, 1976). In this formation, uranium levels range from 0.02 - 22.5 ppb and disequilibrium ratios range from 1.69 - 12.60. The ratios greater than 4.0 are associated with uranium levels below 1 ppb. These low levels and high ratios occur on the downgradient side of deposits. The highly reducing nature of this groundwater is thought to prohibit further solute migration of U. (Osmond and Cowart, 1976). High isotopic ratios are a direct result of alpha recoil which preferentially ejects the U-234 nuclide into solution. High uranium levels (>10 ppb) occur in close proximity to the ore body and are related to movement of the uranium within the deposit. The relatively high ratios (> 3.2) in wells 904, 905 and 906 are suggestive of conditions on the downgradient side of an ore body (Cowart and Osmond, 1977).

Presently there is not an MCL for either uranium or uranium activity because of the additional complexity of uranium being both

TABLE B - 3(3).

BASELINE MEASUREMENTS OF RADIOACTIVE CONSTITUENTS IN ANALYZED WATERS

Ra-226 (pCi/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<.1-.15	<.1-.16	<.1-.14	<.1-.40	<.1-.48	>.10-181
MEAN	<.11	<.11	<.10	<.18	<.20	34
STD. DEVIATION	>.02	>.02	>.01	>.08	>.12	58

U-238 (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	2.2-15.7	3.3-11.8	3.1-15.8	3.8-46.7	2.8-98.0	.02-22.5
MEAN	7.6	6.0	5.7	16.8	29.6	6.2
STD. DEVIATION	4.8	2.9	2.7	11.9	27.5	7.6

U-234/U-238

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1.99-2.26	1.88-2.33	1.87-2.61	1.68-2.35	1.5-2.9	1.69-12.
MEAN	2.09	2.12	2.23	1.96	1.90	5.22
STD. DEVIATION	.10	.16	.21	.19	.35	3.2

chemically and radiologically toxic (EPA,1981). A level of 3 ppb has an equivalent activity of ~ 1 pCi/l. The activity of U-238 in pCi is multiplied by the U-234/U-238 disequilibrium ratio to calculate the contribution (pCi) from U-234. The total activity (pCi/l) from uranium represents the summation of the pCi/l of both nuclides. The range in the total pCi/l for the investigated formation waters is from less than .02 to ~ 50 pCi/l. If the suggested MCL for U of 10 pCi/l (Lappenbusch, 1979) was approved, several groundwater samples from the White River Group would not comply.

The source classification of seepage water into springs and streams by uranium and radium levels and disequilibrium ratios appears in good agreement with the previously discussed major ion classification. Highest levels of U and Ra are in springs and streams associated with the White River Group. Lower disequilibrium ratios of ~ 2 were common in streams draining the Brule while higher ratios occurred in streams draining the Arikaree and Pierre units. Thus uranium and radium levels in these streams can be used to characterize base flow from the adjacent strata and provide further confirmatory evidence of the origins of this surface water.

BASELINE DETERMINATION OF NUTRIENTS

TASK B - 3 (4)

Introduction

The nutrients nitrogen (N), phosphorus (P) and silicon (Si) are important in water quality investigations. In surface water, excesses in concentration can result in eutrophication while in groundwater elevated levels of nitrate-nitrogen (NO_3-N) (> 10 mg/l) are reported to cause cyanosis in infants. Elevated nitrate (NO_3^-) levels in groundwater are also reliable indicators of contamination from anthropogenic activities.

Methods

Nitrate, phosphate and silicate were determined on filtered samples by EPA-accepted spectrophotometric techniques using Hach Company reagents.

Results and Discussion

Nitrate levels in the investigated groundwater were all less than 9.0 ppm (<2ppm NO_3-N) (Appendix A). Thus the groundwater is considered pristine (Exner and Spalding , 1979) and inputs from fertilizer, barnyard and septic tank leachates are (insignificant considerations).

In comparison to other areas in Nebraska the groundwater appears as some of the least influenced by agricultural activities. Since the primary agricultural use is as rangeland, the data indicate that stock wells within the investigated area presently are not being contaminated by leachate from manure near the wells. No wells contained NO_3-N levels that approach the present MCL of 10.0 ppm (45 ppm for NO_3^-). Thus, in terms of health, groundwater nitrate is not a problem in this area.

Phosphate levels range from the minimum detectable (0.10 mg/l) to 2.2 mg/l and generally were ~ 0.5 ppm [Table B -3(4)]. No trends were observed. Phosphate is not considered harmful in drinking water

TABLE B - 3(4)

BASELINE DETERMINATIONS OF NUTRIENT LEVELS IN ANALYZED WATERS

NO_3^- AS N (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	0.02-0.5	0.1-0.9	0.02-1.5	0.09-1.8	0.1-1.9	0.1-1.6
MEAN	.20	.20	.27	.49	.58	.63
Std.DEVIATION	.13	.24	.30	.31	.53	.61

NO_3^- (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	0.1-2	0.5-4	0.1-7.0	0.4-8	0.5-8.5	0.5-7.2
MEAN	.87	.88	1.3	2.2	2.6	2.8
STD.DEVIATION	.58	1.1	1.4	1.4	2.4	2.7

PO_4^{3-} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	0.1-1.5	0.05-0.80	0.1-1.05	0.13-1.5	0.1-2.2	0.13-1.7
MEAN	.52	.32	.45	.33	.57	.44
STD. DEVIATION	.46	.21	.28	.26	.63	.52

SiO_2 (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	53-67	38-67	22-68	31-88	35-70	0-20
MEAN	60	50	54	57	55	14
STD. DEVIATION	5	8	9	10	9	3

and does not have an MCL.

In oxidizing formations silica levels generally were at or above their saturation level with respect to silica gel, however, they were well below saturation levels in the reducing basal Chadron formation. High Na^+ levels may be instrumental in the uptake of SiO_2 in the authigenic formation of clays in the basal Chadron.

Concentrations of nitrate, phosphate and silica in streams (Appendix A) of the area were slightly lower than the average concentrations in the groundwater of the underlying rocks [Table B-3(4)]. This decrease may be partially due to algal assimilation of these nutrients.

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APPENDIX A

PHYSICAL AND CHEMICAL DATA FROM WELLS COMPLETED IN THE ARIKAREE AND YOUNGER STRATA

ID	LEGAL LOCATION	WELL TYPE	WELL DEPTH (FT)	PROD. HORZ.	TEMP °C	pH	REDOX INDICATORS Eh	H_2S	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	MAJOR ANIONS HCO_3^{-}	SO_4^{2-}	Cl^{-}	MAJOR ION BALANCE	NUTRIENTS NO_3^{-}	PO_4^{3-}	SiO_2	SI_c	SI_{sg}	As	TRACE METALS V	Mo	Se	RADIOACTIVE CONSTITUENTS Ra-226	U-238	U-234/U-238
#			(FT)	HORZ.	°C		meq/l			--mg/l--				---meq/l---				--meq/l--						--ug/l--			pCi/l	ug/l	A.R.
065	31 54 11 CC	S	420	Ta	16	7.8	+230	ND	280	52	3	10	4	220	1.0	3	- 5.3	1.3	.75	47	SS	S	2	3.4	1	<1	<0.1	3.8	2.24
070	31 53 03 AA	H,S	98	Ta	15	7.7	+110	ND	320	60	6	3	2	180	1.0	11	+ 4.8	2.5	.25	53	S	S	1	2.4	1	<1	<0.1	3.2	2.17
077	31 53 08 CC	S	420	Ta	14	8.2	N.A.	ND	250	42	8	4	4	190	1.0	3	- 3.3	0.1	.41	22	SS	U	1	0.5	2	<1	.12	6.3	2.21
114	31 54 07 CC	H,S	343	Ta	15	7.5	+185	ND	300	48	6	8	5	180	8.0	18	- 4.1	0.9	.40	53	U	S	3	6.0	2	<1	<0.1	6.0	2.61
150	32 54 35 BA	S	420	Ta	15	7.9	+140	ND	250	46	4	4	4	150	1.0	3	+ 5.6	0.6	.52	55	S	S	2	9.2	3	<1	<0.1	3.4	2.23
173	30 54 25 AA	S	350	Ta	13	6.9	+ 30	ND	280	45	13	6	2	150	1.0	21	- .41	0.7	1.05	68	U	SS	2	5.0	1	<1	<0.1	4.6	2.42
188	32 53 29 CA	S	275	Ta	15	7.9	+200	ND	250	43	1	8	5	170	2.0	3	- 4.2	0.8	.53	47	SS	S	1	3.3	2	<1	<0.1	5.3	2.59
211	31 52 26 DD	S	180	Ta	12	7.3	+100	ND	500	72	4	35	8	270	17.0	9	+ 5.5	1.0	.30	65	U	SS	5	5.6	5	<1	0.11	9.5	1.88
243	31 51 20 DD	S,H	65	Ta	13	7.1	+190	ND	540	88	7	16	4	250	13.0	28	+ 4.4	7.0	.31	51	U	S	4	1.4	1	<1	0.11	5.9	1.89
276	31 52 13 DD	H,S	25	Tb	13	7.6	+140	ND	390	64	5	7	2	190	10	17	+ 1.6	1.7	.19	45	U	S	1	3.2	1	<1	.24	3.0	2.34
337	30 54 01 BD	S,H	30	Ta/Qal	14	7.6	+310	ND	340	32	7	9	3	130	8.0	20	- 4.9	1.1	1.05	58	U	SS	4	6.9	1	<1	<0.1	6.5	2.46
370	30 53 23 CA	S	300	Ta	15	6.9	+139	ND	240	38	6	12	2	120	1.0	27	+ 3.4	0.7	.17	67	U	SS	11	7.1	2	<1	<0.1	6.0	2.53
507	31 54 08 DD	S,H	350	Ta	18	8.2	+210	ND	260	52	6	4	2	180	1.0	23	- 4.8	0.5	.64	55	SS	S	1	5.5	1	<1	<0.1	2.5	2.42
527	31 53 18 CD	I	5150F	Ta	15	7.9	+ 90	ND	390	50	8	4	3	170	1.0	19	+ .52	0.8	.41	57	SS	SS	2	5.8	1	<1	<0.1	4.0	2.21
532	30 52 11 BA	H	140	Ta	14	7.6	+250	ND	290	54	4	6	2	145	1.0	20	+ 5.7	1.0	.28	53	U	SS	2	3.4	1	<1	<0.1	4.1	2.13
538	31 52 25 DD	S,H	60	Ta	12	7.0	+ 90	ND	460	83	6	18	4	250	8.0	30	+ 3.6	1.0	.35	52	U	SS	5	3.4	1	<1	0.13	5.9	2.00
539	30 51 08 DC	S,H	280	Ta	15	7.4	+180	ND	310	40	8	11	2	150	1.0	10	+ 6.8	0.5	.23	58	SS	SS	7	9.7	4	<1	.10	7.9	2.31
542	30 51 04 AB	S,H	250	Ta	16	7.4	+150	ND	280	39	5	9	2	140	1.0	18	- 1.4	0.4	.25	58	U	SS	4	2.7	1	<1	<0.1	3.5	2.25
544	30 54 34 BC	H	35	Ta	13	7.6	+700	ND	280	38	6	7	5	140	3.0	23	- 3.6	1.0	.40	48	U	S	3	2.0	3	<1	<0.1	6.8	2.40
560	31 53 34 CB	S	70	Ta/Qal	14	7.6	+320	ND	340	40	6	16	4	150	8.0	10	+ 5.5	1.1	1.05	58	U	SS	3	3.3	1	<1	.13	7.2	2.23
579	31 51 29 DA	H,I	60	Ta	14	7.5	+700	ND	380	42	7	16	3	170	7.0	10	+ 3.3	2.0	.10	45	U	S	1	1.9	4	<1	<0.1	5.5	2.22
600	31 51 20 CC	S,H	70	Ta	14	7.4	+230	ND	430	83	11	4	1	260	9.0	19	+ 2.3	2.5	.31	55	U	SS	2	7.0	1	<1	<0.1	5.1	2.08
602	31 51 20 CB	S,H	60	Ta	14	7.5	+190	ND	390	63	8	16	4	230	11.0	26	- 1.7	1.0	.33	46	U	S	4	5.0	1	<1	0.13	3.1	2.15

All Eh values are based on Calomel reference and are not corrected

PHYSICAL AND CHEMICAL DATA FROM WELLS COMPLETED IN THE BRULE FORMATION

ID	LEGAL LOCATION	WELL TYPE	WELL DEPTH (FT)	PROD. HORZ.	TEMP °C	pH	REDOX INDICATORS Eh*	H_2S mg/l	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+}	Mg^{2+}	Na^{+}	K^{+} (--mg/l--)	MAJOR ANIONS HCO_3^{-}	SO_4^{2-}	Cl^{-} (---eq/l---)	ION BALANCE	MAJOR NUTRIENTS NO_3^{-}	PO_4^{3-}	SiO_2 (--mg/l--)	SI_c	SI_{sg}	TRACE METALS As	V	Mo	Se (-----ug/l-----)	RADIOACTIVE CONSTITUENT Ra-226 pCi/l	U-238 ug/l	U-234/U-238 A.R.
#								mg/l																					
011	32 52 17 BD	H	20	Tb	13	7.4	+130	ND	600	60	5	49	11	290	36	24	- 3.7	2.5	1.5	86	U	SS	1	4.4	1	<1	.19	19.3	2.14
012	32 52 17 DA	H,S	50	Tb	18	8.2	+110	ND	600	36	2	75	6	230	71	25	- 5.5	2.5	.35	57	SS	S	5	6.0	3	<1	.15	19.3	1.93
013	32 52 17 BB	H,S	150	Tb	15	7.8	+120	ND	650	50	6	48	7	250	59	22	- 6.8	4.5	.15	57	SS	SS	8	6.3	1	<1	.27	21.9	1.92
023	32 53 12 AA	H	45	Tb	15	8.0	+120	ND	830	32	4	100	12	290	13	24	- 8.0	8.0	.25	62	SS	SS	12	6.2	2	<1	.23	23.1	1.83
029	31 52 14 BA	S	45	Tb	14	7.8	+170	ND	450	55	5	25	8	225	25	23	- 4.8	2.5	.14	55	SS	SS	2	3.4	2	<1	.39	15.1	2.01
129	32 52 34 DD	H,I	60	Tb	16	7.4	+100	ND	698	71	5	38	7	310	19	28	- 4.3	1.5	.39	57	S	S	10	4.0	1	<1	.15	6.8	2.14
130	32 52 34 BC	H,S,I	45	Tb	14	7.4	+100	ND	520	73	6	21	6	210	47	47	- 5.4	3.0	.20	60	SS	SS	7	4.3	5	<1	<0.1	5.0	2.17
145	32 52 27 DC	H,S	50	Tb	14	7.1	+200	ND	520	60	5	27	8	190	36	50	- 5.3	2.5	.15	60	SS	SS	4	2.2	2	<1	.12	16.5	2.13
185	31 52 15 AA	H,S	100	Tb	15	7.5	+165	ND	540	57	4	42	10	290	28	12	- 4.1	1.8	.23	37	U	U	5	9.4	4	<1	.17	18.9	2.23
187	31 52 15 DA	H,I	70	Tb	15	8.3	+150	ND	450	17	1	80	13	220	26	14	+ 1.8	1.5	.23	46	S	S	8	28.0	4	<1	<0.1	11.1	1.56
189	31 52 15 DC	S	60	Tb	14	7.7	+220	ND	530	52	4	37	11	280	18	22	- 7.9	3.2	.20	62	SS	SS	5	5.0	3	<1	.18	5.4	1.78
262	32 51 33 CC	S	80	Tb	19	8.4	+240	ND	890	11	2	145	5	390	13	27	- 2.3	3.0	.34	75	SS	SS	26	27.0	2	1.6	<0.1	46.7	1.74
268	31 51 06 BC	H,S	45	Tb	16	7.5	+145	ND	550	76	4	17	4	270	25	14	- 4.0	1.5	.28	60	SS	SS	2	3.4	2	1.5	.12	13.2	1.91
269	31 51 06 BC	H,S	19	Tb	10	7.3	+ 95	ND	570	75	8	26	6	270	25	17	+ 1.9	2.5	.22	31	U	U	5	7.4	1	<1	.20	7.1	2.05
270	31 51 06 CC	NR	40	Tb	12	7.2	+160	ND	610	96	6	20	8	330	8	4	+ 5.1	2.5	.43	53	U	SS	1	8.2	3	<1	.12	7.3	1.99
273	31 52 13 AB	NR	50	Tb	14	7.6	+250	ND	420	69	9	12	4	250	12	3	+ 3.7	1.5	.20	53	SS	S	4	6.2	3	<1	.34	10.3	2.08
275	31 51 07 BD	S	25	Tb	13	7.2	+ 30	ND	400	67	7	14	5	190	10	25	+ 6.8	1.3	.46	48	U	S	3	1.8	1	<1	.13	6.9	2.12
282	31 52 12 BB	H,S	40	Tb	14	7.4	+150	ND	690	101	11	32	8	370	33	37	- 2.0	2.8	.21	53	SS	S	8	5.0	1	<1	.22	28.4	1.99
441	30 52 11 CC	H	430	Tb	16	6.9	+150	ND	275	27	3	23	4	120	6.0	21	- .04	0.5	.22	65	U	SS	3	5.4	2	<1	.14	15.8	1.87
619	32 52 35 DC	H,S	125	Tb	15	7.6	+125	ND	685	55	5	73	11	330	35	32	- 3.3	0.8	.33	60	SS	SS	8	1.7	5	<1	.16	15.7	1.80
629	31 52 01 DC	H,S	55	Tb	15	7.4	+ 95	ND	810	72	8	65	15	300	65	50	- 3.7	2.5	.58	60	U	SS	6	4.0	4	<1	<0.1	18.0	1.85
630	31 52 22 BA	H,S	80	Tb	14	7.6	+170	ND	450	55	6	27	10	210	25	38	- 4.2	2.2	.20	52	U	S	2	3.0	2	<1	.20	19.4	1.94
641	31 52 25 BD	H,S	95	Tb	14	7.5	+180	ND	500	79	8	14	3	290	11	9	+ .29	0.8	.20	65	SS	SS	3	2.2	3	<1	.15	8.3	2.06
642	31 52 23 CD	S	60	Tb	12	7.2	- 10	ND	450	68	8	31	9	240	20	35	+ 1.6	1.1	.24	50	U	S	2	3.2	1	<1	.21	17.9	2.02
643	31 52 24 BD	H	<100	Tb	13	7.4	+140	ND	450	77	8	15	4	275	11	19	- .42	1.1	.31	55	U	SS	3	5.1	1	<1	.25	4.5	2.06
644	31 52 23 AB	S	<100	Tb	14	7.7	+160	ND	450	63	6	22	6	230	11	16	+ 2.8	2.0	.23	57	SS	SS	2	1.6	3	<1	.25	14.9	2.01
660	31 53 13 CA	S	150	Tb	14	7.0	+250	ND	350	50	5	11	6	195	5	4	+ 1.5	1.0	.13	57	U	SS	2	3.8	2	<1	<0.1	10.9	1.97
666	31 52 20 AC	S	150	Tb	14	7.0	+250	ND	350	38	7	29	14	160	11	32	+ 5.0	1.1	.13	57	U	SS	3	3.2	1	<1	.13	17.0	1.94
677	31 51 04 AA	H,S	60	Tb	15	7.6	+165	ND	315	51	4	9	4	180	8	19	- 4.3	0.9	.24	67	U	SS	2	5.4	1	<1	.15	6.8	2.35
901	311 OAK,CRANFORD	I	45	Tb	17	8.0	- 45	ND	890	13	3	210	10	370	110	113	- 5.9	1.4	.35	66	U	SS	23	7.9	4	<1	.10	37.4	1.71
902	7 COATES,CRAWFORD	I	55	Tb	13	7.6	+ 70	ND	1110	82	8	135	30	270	260	94	- 4.7	0.4	.33	50	S	S	10	6.1	7	<1	.14	16.2	1.76
903	14 PADDOCK, CRAWF.	I	100	Tb	13	7.5	+170	ND	1210	97	15	125	46	420	165	95	- 1.3	2.7	.47	53	SS	S	14	18.0	2	1.5	.40	46.4	1.69
908	723 ELM,CRAWFORD	I	40	Tb	13	7.5	+170	ND	1120	39	6	115	20	420	45	15	- 2.4	4.0	1.0	70	U	SS	22	6.8	5	<1	.31	44.1	1.72
909	311 ANNIN,CRAWF.	I	60	Tb	14	8.1	- 95	ND	600	8	2	120	13	330	33	18	- 4.1	2.0	.24	71	U	SS	14	21.0	4	<1	.13	26.2	1.68

* All Eh values are based on calomel reference and are not corrected.

PHYSICAL AND CHEMICAL DATA FROM WELLS COMPLETED IN THE LOWER BRULE , UPPER CHADRON AND PIERRE

ID	LEGAL LOCATION	WELL TYPE	WELL DEPTH	PROD. HORZ.	TEMP	pH	REDOX INDICATORS* Eh	H_2S	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	MAJOR ANIONS HCO_3^{-}	SO_4^{2-}	Cl^{-}	ION BALANCE	MAJOR NUTRIENTS NO_3^{-}	PO_4^{3-}	SiO_2	Si_c	Si_{sg}	TRACE METALS As	V	Mo	Se	RADIOACTIVE CONSTITUENTS Ra-226	U-238	U-234/U-238
#			(FT)		°C		mg/l			--meq/l--				---meq/l---				--mg/l--					--ug/l--				pCi/l	ug/l	A.R.
006	32 52 15 DD	H,S	35	Tc	15	7.6	+160	ND	1350	51	7	270	25	460	320	61	- 1.2	1.8	.40	35	SS	U	81	155.0	12	<1	.28	98.0	1.49
016	32 52 08 DB	H	30	Tc	14	7.6	+ 85	ND	1140	76	9	165	18	460	120	33	+ 4.5	8.5	.45	55	SS	SS	28	4.0	7	<1	<.10	53.4	1.66
020	32 52 04 CD	H,S	28	Tc/Tb	18	7.5	+130	ND	890	74	13	61	13	370	100	15	- 5.2	1.3	.20	57	SS	S	7	7.5	4	<1	.26	31.8	1.76
118	32 52 27 AA	H,S	100	Tc/Tb	16	7.0	+290	ND	950	100	6	54	10	210	210	65	- 9.0	2.0	.32	53	SS	S	11	2.0	4	<1	.13	12.9	2.10
142	32 52 23 AB	H,S	35	Tc/Tb	14	7.7	+ 80	ND	620	43	3	68	12	250	46	27	- 1.9	2.7	.35	63	U	SS	4	2.4	1	<1	.10	14.5	1.71
222	32 52 26 DC	H,S	30	Tc	17	7.5	+200	ND	640	53	11	95	23	380	20	31	+ 4.5	1.1	.28	50	S	S	8	13.0	5	<1	<.10	13.2	1.85
229	31 51 02 BA	H,S	80	Tc/Tb	13	6.8	+ 85	ND	605	69	14	63	11	250	58	55	+ 5.0	1.1	.33	58	SS	SS	7	5.2	4	<1	.14	14.5	1.90
249	32 51 33 AA	H,S	50	Tc	13	7.0	+110	ND	1110	84	7	152	18	360	140	110	- .51	2.3	.22	49	SS	S	12	4.0	3	<1	.48	65.4	1.59
654	32 52 34 AD	H,S	40	Kb/Tc	14	7.8	+ 90	ND	1100	106	11	95	10	340	190	77	- 5.6	7.0	2.2	52	SS	S	13	10.0	7	<1	.37	29.8	1.85
657	32 52 27 DA	I	110	Tc	13	7.2	+135	ND	485	25	4	70	17	175	38	48	- .02	2.2	.30	65	U	SS	9	2.2	3	<1	.13	14.6	2.15

PHYSICAL AND CHEMICAL DATA FROM FLOWING WELLS SLOTTED IN THE BASAL CHADRON SANDS

ID	LEGAL LOCATION	WELL TYPE	WELL DEPTH	PROD. HORZ.	TEMP	pH	REDOX INDICATORS* Eh	H_2S	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	MAJOR ANIONS HCO_3^{-}	SO_4^{2-}	Cl^{-}	ION BALANCE	MAJOR NUTRIENTS NO_3^{-}	PO_4^{3-}	SiO_2	Si_c	Si_{sg}	TRACE METALS As	V	Mo	Se	RADIOACTIVE CONSTITUENTS Ra-226	U-238	U-234/U-238
#			(FT)		°C		mg/l			--meq/l--				---meq/l---				--mg/l--					--ug/l--				pCi/l	ug/l	A.R.
119	32 52 27 AA	S	250	Tc	23	7.0	-165	ND	2450	32	6	480	13	310	540	140	+ 6.9	ND	.18	14	U	U	0.5	4.2	5	<1	13.8	0.7	12.6
220	32 52 25 AD	H,S	100	Tc	16	8.2	-295	5.0	1460	15	2	335	12	360	175	240	- 2.0	7.2	.20	18	SS	U	0.5	0.5	2	<1	<.10	0.4	1.81
225	32 52 35 DB	S,I	480	Tc	17	6.9	-300	ND	2150	22	2	310	12	280	370	110	- 1.1	ND	.20	12	U	U	0.5	4.1	1	<1	.63	0.03	7.94
240	32 51 25 BB	H,S	44	Kp	12	7.2	+ 70	ND	775	114	8	81	8	400	44	50	+ 5.9	0.5	1.7	54	SS	SS	3	0.5	6	<1	.14	4.6	1.82
280	31 51 12 DB	H	520	Tc/Tb	15	7.7	- 30	ND	1050	15	1	230	12	320	125	95	+ 2.8	0.5	.10	70	U	SS	4	0.9	9	<1	.14	2.8	2.90
622	31 51 07 AC	S	300	Tc	15	8.0	-310	1.0	1680	16	2	325	10	320	180	220	+ .46	0.5	.27	16	U	U	0.5	20.0	3	<1	1.04	.02	8.32
623	32 52 35 CC	S	290	Tc	17	8.4	-340	0.1	2150	13	2	325	10	320	380	130	- 5.0	ND	.13	9	SS	U	0.5	1.9	5	<1	.14	.02	4.06
652	31 52 02 CA	H,S	280	Tc	16	7.8	-290	3.0	1690	16	2	395	11	320	410	187	- 1.7	0.5	.24	13	U	U	0.5	11.0	4	<1	5.1	1.1	1.69
682	31 52 01 BD	I	600	Tc	15	8.1	-285	5.0	1600	14	2	400	5	370	290	175	+ 3.7	3.0	.27	14	U	U	0.5	1.4	NA	<1	24	0.80	5.28
685	31 52 02 CC	I	380	Tc	16	8.1	-270	0.5	1710	22	4	440	13	370	400	187	+ 3.0	ND	.15	12	SS	U	1.0	4.3	9	<1	1.2	15.90	2.26
904	701 MAIN CRAWF.	I	280	Tc	15	8.2	-380	0.1	1620	17	4	400	12	320	325	200	+ 3.3	ND	.19	15	S	U	0.5	7.2	8	<1	43	15.70	3.41
905	618 MAIN CRAWF.	I	198	Tc	15	8.2	-320	0.1	1750	18	5	420	12	320	425	200	+ .36	ND	.24	14	S	U	0.5	6.5	1	<1	141	11.8	3.23
906	520 PINE CRAWF.	I	285	Tc	16	7.8	-265	0.1	1830	23	4	540	14	280	600	200	+ 5.3	ND	1.5	20	SS	U	0.5	4.2	10	<1	181	22.50	3.97
907	SOUTH GATE CRAW.	I	NR	Tc	17	7.7	-250	0.1	1800	25	2	420	14	300	485	202	- 2.0	ND	1.7	15	U	U	0.3	4.5	5	<1	3.0	2.92	8.10

* All Eh values are based on Calomel reference and are not corrected.

PHYSICAL AND CHEMICAL DATA FROM SPRINGS

ID	LEGAL LOCATION	TEMP	pH	REDOX INDICATORS Eh*	COND.	MAJOR CATIONS				MAJOR ANIONS				MAJOR NUTRIENTS					TRACE METALS				RADIOACTIVE CONSTITUENTS		
					uMHOS/CM.	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	ION BALANCE	NO_3^{-}	PO_4^{3-}	SiO_2	Si_c	Si_{sg}	As	Mo	V	Se	Ra-226	U-238	U-234/U-238
#		°C				--meq/l--				---meq/l---				--ug/l--					--ug/l--				pCi/l	ug/l	A.R.
SP-1	31 51 23 AA (NEAR LEVI)	12	7.5	>700	350	56	5	8	1	180	10	10	+ 1.8	0.5	.10	60	U	SS	3	2	1.7	<1	.12	5.5	2.26
SP-2	30 52 19 BD DEAD MAN'S CRK.	26	6.9	+ 85	480	73	9	10	4	230	1	31	+ 2.1	0.1	1.5	67	U	S	4	1	1.1	<1	<0.1	2.2	2.18
SP-3	31 53 06 CA SO.SOLDIER CRK.	13	7.7	+120	310	57	11	7	4	190	1	27	+ 3.0	0.7	.25	50	S	S	2	1	9.0	<1	<0.1	3.3	2.00
SP-4	31 52 16 CC FREDS 1ST FISH POND	13	7.3	+119	400	69	6	24	5	210	13	10	+ 7.3	1.0	.48	58	U	SS	3	1	5.1	<1	<0.1	12.0	1.99
649	32 51 31 BB MRS. BRITTON M,H.S	17	7.8	+125	730	48	4	127	13	250	98	60	+ 4.2	2.0	.45	62	SS	SS	12	5	1.2	<1	.10	15.7	2.00
658	31 52 08 CD FT.ROB'S.H2O SUPPLY	13	7.6	+160	390	71	6	10	5	240	2	21	+ .09	0.9	.30	53	SS	SS	2	2	3.8	<1	.15	6.8	2.12

PHYSICAL AND CHEMICAL DATA FROM STREAMS

ID	LEGAL LOCATION	TEMP	pH	REDOX INDICATORS Eh*	COND.	MAJOR CATIONS				MAJOR ANIONS				MAJOR NUTRIENTS					TRACE METALS				RADIOACTIVE CONSTITUENTS		
					uMHOS/CM.	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	ION BALANCE	NO_3^{-}	PO_4^{3-}	SiO_2	Si_c	Si_{sg}	As	Mo	V	Se	Ra-226	U-238	U-234/U-238
#		°C				--meq/l--				---meq/l---				--ug/l--					--ug/l--				pCi/l	ug/l	A.R.
ST-1	31 51 24 CC UPPER ASH	12	8.4	+230	390	60	10	12	2	240	1	3	+ 4.4	0.5	.05	53	SS	SS	3	3	3.7	<1	<0.1	4.1	2.26
ST-2	31 51 02 AA LOWER ASH	24	8.6	+240	350	40	8	17	4	200	4	3	+ .58	0.5	.05	54	SS	U	4	3	3.4	<1	.10	5.4	2.20
ST-3	30 51 03 BD UPPER SQUAW	16	8.1	+230	495	68	7	9	3	240	5	2	+ 3.9	0.5	.14	67	SS	SS	4	2	7.3	<1	<0.1	3.9	2.03
ST-4	31 51 20 BC MIDDLE SQUAW	20	8.6	>700	370	64	7	11	3	220	1	2	+ 7.8	0.5	.35	44	SS	U	2	2	3.4	<1	<0.1	3.3	1.98
ST-5	31 52 12 BA LOWER SQUAW	21	7.8	+110	500	78	5	27	10	310	11	3	+ 2.8	0.5	.47	42	SS	U	9	3	5.7	<1	.13	6.3	1.88
ST-6	31 52 11 AB WHITE CLAY CREEK	22	7.1	+295	420	30	7	32	8	180	18	25	- 5.7	4.0	.33	42	U	U	6	6	5.1	<1	.16	11.8	2.00
ST-7	31 52 12 BB ENGLISH CREEK	20	6.9	+165	460	54	10	37	13	230	20	20	+ 6.6	1.0	.35	38	U	U	7	4	3.2	<1	.13	111.4	1.97
ST-8	31 53 06 DA SO. FORK SOLDIER CR.	22	8.3	+ 90	290	51	4	18	6	200	1	26	- 3.2	0.1	.30	45	SS	U	1	1	3.0	<1	<0.1	4.2	2.33
ST-9	31 53 32 CD MIDDLE WHITE RIVER	19	8.1	+140	305	58	9	7	5	210	1	25	- 1.5	0.5	.39	53	SS	S	2	1	3.6	<1	<0.1	4.9	2.30
ST10	31 54 31 CA WEST WHITE RIVER	19	8.3	+ 70	275	46	5	12	5	180	3	10	+ .61	.75	.30	57	SS	S	3	1	10.7	<1	<0.1	4.8	2.29

* All Eh values are based on Calomel reference and are not corrected.

ENVIRONMENTAL ASSESSMENT, MONITORING AND REMEDIATION OF URANIUM MINING : AN INDEPENDENT REFLECTION ON THE ROLE OF COMMUNITY AND ADVOCACY GROUPS

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ABSTRACT

There should be no doubt that uranium mining and nuclear power remains highly controversial to a significant proportion of the community. This paper is a brief summary of some of the major aspects commonly involved in the development and operation of uranium mines. The paper is not intended to be exhaustive but rather indicative of the approach and specific issues raised by many people in the community, by environmental non-government organisations ('ENGO's) or indigenous groups. The paper briefly touches on the nuclear power debate, typical mine development processes, environmental impact assessment, environmental monitoring, mine site remediation and rehabilitation as well as briefly covering social issues, regulatory performance and sustainability reporting. The paper includes many examples from around the world with respect to former, current and proposed uranium mines, with a particular emphasis on Australia. A brief discussion of the underlying scientific issues is presented, including a major case study of water quality monitoring for the Ranger uranium project. Overall, the paper is an unique reflection on the complex interaction of community groups, ENGO's, regulators and uranium miners in the assessment, remediation and regulation of uranium mines, and should provide many valuable insights to all parties interested in these issues.

1. Introduction

There should be no doubt that uranium mining and nuclear power remains highly controversial to a significant proportion of the community – and more commonly a majority (despite optimistic assertions to the contrary). The extent of the controversy and the current status of these issues is often a result of a particular nation's assorted nuclear history. For example, in Australia debate is centred on uranium mining while in Japan debate focuses on nuclear power. It is almost unanimous that community and civic groups, especially environmental non-government organisations ('ENGO's) and indigenous groups, have an adamant opposition to nuclear power while industry groups, private companies and commonly governments have policies ranging from neutral to strongly supportive of nuclear power. The principal concerns over nuclear power still remain the same : reactor safety, high level waste management, existing nuclear weapons and proliferation, economics and viable energy alternatives. It is common that specific concerns over a proposed uranium mine can be confused with the more intractable debate over nuclear power – and this paper is clearly not the place for this debate. It is, however, critical that any developer of a proposed uranium mine understand the distinction between specific issues concerning nuclear power, nuclear weapons and uranium mining. Over the past several years, there has been a concerted effort by both sides of the nuclear debate to argue and promote their perspective, especially with respect to concerns over climate change, such as the Australian Parliament report [1], European Extern-E studies [2], MIT report [3], Storm-Smith study [4] and Australian civic society (or 'Green') report [5]. It is pivotal that all sides of the debate be acknowledged for their respective legitimacy, and sincere efforts made to understand the substance of their position. A fundamental skill is to distinguish between moral or emotive arguments and technical or scientific issues – as it is possible to mix these aspects (deliberately or unintentionally).

This is the challenging situation into which any proposed new uranium mine currently finds itself – *it is considerably more challenging to navigate than a gold or iron ore mine.*

This paper is intended to be a guide to some of the principal aspects which ENGO's challenge for any proposed uranium mine, and outlines many scientific, legal, political and social issues involved in attempting to develop a new uranium project. The paper is an open, honest and critical reflection of the challenges that a proposed uranium mine brings. Given the author's considerable experience of uranium mining in Australia, the paper will be weighted in this way, however, several examples from around the world will also be cited as appropriate. The use of Australia is also appropriate as it is often viewed as a leader in the environmental regulation of uranium mining.

2. Typical Mine Development Process

The normal routine for developing a new uranium mine starts with exploration, discovery, moving to detailed evaluation, regulatory approvals (environmental impact assessment or 'EIA', uranium exports, mining leases, etc.), construction, operation and subsequent rehabilitation. Although this is the typical pathway for any mine, for uranium the process often takes longer and requires several additional approvals not necessary for say gold or copper mining. In general, the steps involved are somewhat similar between most countries, though the jurisdictional power may reside differently between local / council, state / provincial and federal governments.

For many community groups, and especially indigenous groups, they remain fiercely opposed to nuclear power and nuclear weapons and they therefore take a legitimate position of opposing all uranium exploration and possible mine development. For example, in North America many indigenous remain firmly opposed to uranium exploration and mining, such as northern Ontario, the Northwest Territories, Labrador, Nova Scotia, New Mexico and South Dakota – there are significantly more groups opposing than supporting uranium (see [6]). In South Australia, in January 2008, community groups revealed that a uranium exploration company was allegedly not following procedures during exploration work and is currently being formally investigated for breaches of its exploration licence requirements – proving a major setback for the project's intended development. Community groups are a fundamental aspect of a strong democracy and must be given the legitimacy they deserve – or a company risks facing even more hurdles and possible impacts in their mine development schedule (eg. failure to secure environmental approvals, stringent conditions, etc.). In broader sustainability terms, the mining industry believes they need to earn and maintain a 'social licence to operate' (eg. [7]).

3. Environmental Impact Assessment ('EIA')

The most fundamental hurdle for any major new industrial, but especially for uranium mining, is the environmental impact assessment (EIA) process (see [8]). This typically involves the preparation of an environmental impact statement (EIS), or similar study, which covers the proposed operations, baseline conditions, expected impacts, mitigation and management measures. Within this broad framework, many wide ranging areas are covered, including social, heritage, environmental, legal and economic aspects of the proposal, with the emphasis on particular aspects varying slightly depending on the project and site-specific issues. In most countries an EIS is the major study upon which all other approvals and permits are based on or derived from – therefore making them of fundamental importance. A formal process of community consultation is often legally required under EIA, ranging from information sessions, submissions to public hearings. External peer review is used though it is not very common. Many community groups work very hard during the EIA stage of a proposed uranium mine, as it is their opportunity to voice their concerns and build community awareness.

Some common issues raised during this period include water management, tailings management, radiological impacts, air quality, heritage (especially indigenous heritage), mine rehabilitation, social impacts, regulatory arrangements, project economics, nuclear power and weapons and so on. The exact focus will vary from place to place and the communities involved. Good examples include :

- ***Jabiluka*** uranium project (northern Australia) – the 1997 and 1998 EIS documents saw in excess of 2,200 submissions with more than 97% being strongly opposed to the project [9];
- ***Kiggavik*** uranium project (northern Canada) – the 1990 EIS was rejected as deficient by the community and government agencies in Canada; the project remains undeveloped (see [10]).

The scientific (and historic) value of an EIA or EIS should never be under-estimated. When done comprehensively, they can allow numerous aspects and potential impacts to be addressed methodically. Conversely, when done poorly, they will fail to provide sufficient information to characterise pre-mining conditions and therefore allow an informed assessment of a mine's impact or the success of post-mine rehabilitation measures. For example, many uranium mine EIS's in Australia have recently been analysed with respect to radon releases to investigate the changes due to uranium mining, or predictions of changes [11] – without thorough baseline radon emanation and release rate studies in an EIS, it is impossible to assess whether mining has facilitated additional releases to the environment or achieved pre-mining levels following rehabilitation. The analysis also demonstrated that there is no convincing evidence that rehabilitation will achieve pre-mining conditions for radon releases, and that there is reasonable evidence to suggest an elevated radon load following mining and rehabilitation [11]. Another example is the EIA for the proposed Kayalekera uranium project in northern Malawi, Africa. A technical critique of this EIA found that baseline environmental conditions in the region were very poorly characterised (eg. due to lack of sampling, poor analytical detection limits, etc.) – thereby making it impossible to ascertain the true mine impacts should it proceed [12].

A common issue raised in community group and individual submissions on EIS studies is opposition to nuclear power and weapons. It is often claimed by a mining proponent that this is beyond the scope of their EIS, and that it would be unreasonable for them to undertake such an assessment for a single mine – it is therefore the role of government policy (eg. [13]). In the 1970s the broader debate about the nuclear industry was undertaken through a public inquiry form of EIA, the best examples being the Australian Ranger Uranium Environmental Inquiry [14] and Canadian Cluff Lake Board of Inquiry [15]. The Ranger inquiry remains heavily cited and referred to, as it is commonly perceived to be a thorough and independent inquiry (despite the Australian Government owning 50% of the Ranger uranium project at this time – a clear conflict of interest). The issue of nuclear power in EIA is of the utmost importance for many community and indigenous groups – *and remains just as critical as ever.*

It is vital that the EIA process for a proposed uranium mine present all relevant information and have extensive public consultation and dialogue. This will ***NOT*** guarantee any outcomes or approvals, however, the EIA process must be viewed seriously along with major technical and human resources.

4. Environmental Monitoring

The environmental monitoring for rehabilitated, existing and proposed uranium mines is commonly of significant interest. The exact regime for a specific uranium project will vary depending on local factors, such as climate (arid, tropical), surrounding land use (rural, national park), mine type (open cut, underground, in situ leach) and population density (towns, indigenous). The locations, frequency and reporting mechanisms are often determined during the EIA process and included as conditions of regulatory approvals. Two particular aspects are water quality and radiological impacts.

Water quality is a critical aspect of any mining or industrial project and is an extremely sensitive issue for many in the community. Any monitoring regime should be established with a view to : (i) distinguishing natural variation from possible mine-site sources; (ii) ensuring monitoring frequency is consistent with natural processes affecting water quality (eg. event-based as well as set-frequency); and (iii) ensuring sufficient monitoring locations to capture all possible impacts from a project. In this way monitoring can provide early notice of possible solutes leaving a mine site and potentially impacting on the environment and its beneficial uses (eg. recreation, water supply, environmental values). It is also critical that sampling and analytical methods are maintained at a very high standard.

For uranium in particular, it is commonly present at levels of fractions of a micro-gram per litre (µg/L) and sampling and chemical analysis should ensure that such levels are able to be detected and differentiated. For surface water samples for the Kayalekera project, the EIA used analytical detection limits for uranium of 2 mg/L (ie. 2,000 µg/L) [12] despite surface waters commonly having just 0.1-7 µg/L (eg. [16]) – it thus remains impossible to ascertain the true background and discern possible future impacts from the proposed mine.

A well recognised case of water quality monitoring is that undertaken for the Ranger uranium mine, and is presented here as a good example of the complexity of issues involved. The Ranger uranium mine is located in the Alligator Rivers Region of the Northern Territory, in the wet-dry monsoonal tropics of northern Australia. It is exists on indigenous (specifically Mirarr-Gundjeihmi) freehold land and is completely surrounded by the world-heritage listed Kakadu National Park – a very complex mix of issues. At present, three groups monitor surface water quality at Ranger – the Northern Territory government (through the Department of Primary Industry Fisheries and Mines, DPIFM), the operating company Energy Resources of Australia Ltd (ERA) and the Commonwealth agency the Office of the Supervising Scientist (OSS). The regulatory regime for Ranger involves a 'Minesite Technical Committee' (MTC), which also includes the Northern Land Council (NLC) as the statutory agency to represent indigenous interests. Through the MTC the three groups of monitoring data are reviewed and ongoing regulation applied. The primary policy used to establish water quality monitoring criteria is the National Water Quality Management Strategy (NWQMS) [17], released in 2000. In general, the guiding principle is to achieve and maintain natural variation in water quality and associated ecological and hydrological processes. A three-tier trigger system is based on mean plus one, two and three standard deviations called the 'Focus', 'Action' and 'Limit' triggers, with each level intended to give a statistical measure of deviation from natural background and therefore whether concentrations are possibly mine-related. A breach of the *Limit* for specific solutes such as uranium would entail a breach of regulatory conditions (though some *Limits* are 'guidelines' only, with no penalty for exceedance). The triggers are applied at a monitoring location downstream from Ranger and compared to upstream. The NWQMS also allows for the *Limit* to be determined from studies of the ecotoxicity of particular solutes (eg. uranium, copper), with this derived value used in place of the mean plus three standard deviations. The current water quality triggers and water sources for Ranger are summarised in Table 1, with graphs for SO_4 and U in Figure 1 (further details are given by [18, 19]).

The changes in water management regimes at Ranger are clearly visible in Figure 1, such as land application and later wetland treatment of minesite waters, with land application primarily being responsible for the Mg-SO_4 signature downstream in the adjacent Magela Creek. It remains contested as to whether this represents an environmental impact (see [19]). The interpretation of U monitoring data is complicated by the improvements in sampling and analytical methods over the past 25 years plus the geologic background, with no clear signature attributable to minesite water management. Public concern about impacts on water quality downstream of Ranger is a constant and controversial debate – further enhanced by the repeated occurrence of accidents, spills and leaks (see [20]). Concerns have been repeatedly raised about the adequacy of the monitoring regime to capture potential impacts on downstream water quality, since an incident often occurs rapidly while water monitoring is of a set frequency – any sampling undertaken for an incident is often after it has finished. This re-enforces the need for comprehensive monitoring designed to capture the potential for such events and is also relative to the local environment and associated hydrologic processes (eg. a monsoonal storm). An associated issue is the need to quantify the load of contaminants, requiring the sound combination of water quality and hydrologic monitoring. A final point is that the contaminant of fundamental public concern is uranium. The limit of 6 µg/L is based on ecotoxicity criteria and not natural variability. In Table 1, uranium downstream averages ~0.1 µg/L with a standard deviation of ~0.22 µg/L – giving a mean plus three standard deviations of ~0.76 µg/L or an order of magnitude lower than the limit. Average annual flow in Magela Creek is ~350 GL, giving a natural load of ~35 kg U – the limit allows some ~2,100 kg U. The limit therefore remains highly controversial as it could allow for an environmentally significant increase over natural concentrations and loads.

Radiological monitoring requires highly specialised expertise and equipment, entailing substantive human and financial resources. Radionuclides may be included in routine water testing (surface and groundwaters), but possible public exposure is more commonly related to radon and radon decay products and dust (to a minor extent). The international (ICRP) standards for public exposure are 1 mSv/year, and in theory all uranium mining projects would be required to meet this. Demonstrating this dictates the combination of climate monitoring (eg. rainfall, temperature, relative humidity, wind speed and direction) with environmental monitoring and radon and radon daughter activity and dust. Many communities expect several monitoring locations as well as a high frequency of testing and analysis. Transparent public reporting is especially critical for public radiological issues.

Table I. Typical water quality monitoring and NWQMS-derived triggers for the Magela Creek downstream of the Ranger uranium project (2004/05 wet season) (adapted from [19])

	pH -	EC µS/cm	Mg mg/L	SO_4 mg/L	Mn µg/L	U µg/L	^{226}Ra mBq/L
NWQMS – Focus	5.9-6.5 [a]	21 [b]	use EC [c]	use EC [c]	7 [d]	0.3	*not set*
NWQMS – Action	5.6-6.7 [a]	30 [b]	use EC [c]	use EC [c]	11 [d]	0.9	*not set*
NWQMS – Limit	5.0-6.9 [a]	43 [b]	use EC [c]	use EC [c]	26 [d]	6	10 diff. [e]
Retention Pond 1 [f]	6.3-7.7	25-500	2.3-28	1-100	<2-37	0.2-10	*no data*
Retention Pond 2 [f]	6.0-9.3	1,030-1,785	130-250	500-1,100	10-1,600	2,750-14,800	*no data*
Process Water [f]	3.9-6.7	8,900-40,000	2,400-10,000	6,700-61,000	710,000-4,200,000	420-3,900	*no data*
Upstream (MCUS) [g] **Average**; *Std Dev* (Min-Max)	**6.16**; *0.38* (3.37-6.98)	**13.4**; *5.1* (5-47)	**0.61**; *0.30* (0.1-2.7)	0.43; 0.67 (0.03-6.2)	**5.95**; *4.35* (<1-50)	**0.10**; *0.22* (<0.001-2.90)	**6.75**; *9.45* (0.2-46.4)
Downstream (009) [h] **Average**; *Std Dev* (Min-Max)	**6.16**; *0.37* (4.6-7.7)	**17.9**; *7.7* (5-72)	**0.95**; *0.56* (0.1-4.4)	**1.52**; *2.19* (0.1-18.6)	**8.25**; *8.52* (<1-161)	**0.15**; *0.17* (0.006-2.19)	**6.87**; *11.5* (0.001-83)

[a] A range is specified for pH to reflect natural variation in water quality processes.
[b] This is a combination of statistical analyses of MCUS and 009 data and is intended to provide a compromise between existing water quality impacts, the practicality of dilution variability with each wet season and the desire to work towards the express wishes of the Mirarr traditional owners for no change in water quality.
[c] Due to the Mg-SO_4 signature at 009, and the results emerging from research into the ecotoxicological effects of the Ca:Mg ratio, EC is used as a surrogate for Mg and SO_4.
[d] Based on flow in the middle of the wet season due to the seasonal behaviour of Mn in the Magela Creek catchment.
[e] Radium standards are primarily considered with respect to human health and radiological exposure assessments, especially through uptake of ^{226}Ra by species favoured as 'bush tucker' by indigenous people.
[f] Years are 1980 to 2004 for RP1, Sept. 2001 to Aug. 2004 for RP2, and 1989 to 2004 for process water; further details provided by [19].
[g] ERA data covers wet seasons 1991/92 to 2003/04 #; OSS data covers years 2000/01 to 2003/04 (^{226}Ra is ERA data only).
[h] ERA data covers wet seasons 1980/81 to 2003/04 #; while OSS data covers years 2000/01 to 2003/04 (^{226}Ra is ERA data only).
Uranium concentrations for the 1990/91 wet season are excluded due to unresolved issues over sampling and analytical errors; see [19].

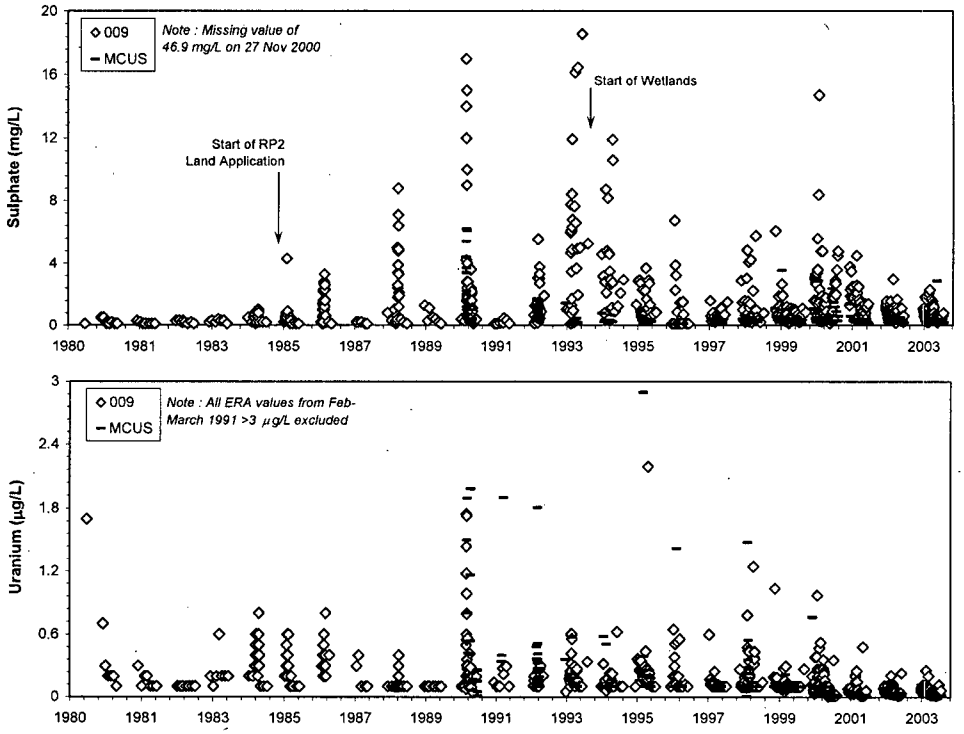


Figure 1. Sulphate and uranium in Magela Creek, Ranger uranium mine [19]

In all environmental monitoring, demonstrating transparency is critical. For most mines, this is often achieved through a statutory independent regulator such as an Environment Protection Agency (EPA). There are many places around the world, however, where the environmental regulation of uranium mining is undertaken by the Department of Mining (or equivalent) – and this is legitimately seen as a serious conflict of interest and viewed with suspicion by community and indigenous groups. A mechanism for independent verification remains critical – either by company or government policy.

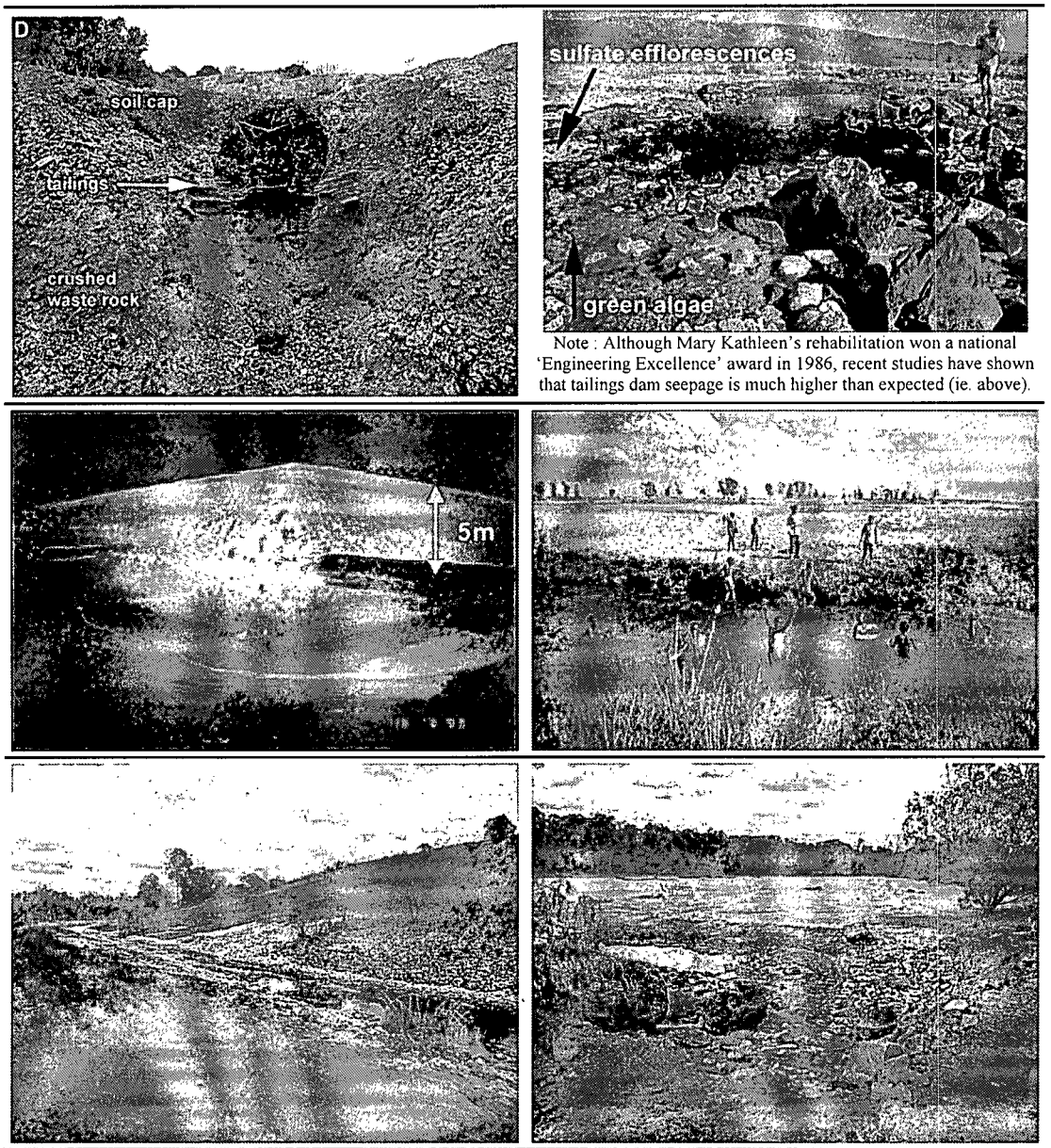
5. Remediation and Rehabilitation

The community rightly expects that all former or closed mining projects should be returned back to a stable land use and that this should ensure that no pollution leaves the site and impacts on the environment and surrounding community. This more modern approach has underpinned the regulation of uranium mining by statutory agencies since about the 1970s, and is fundamental to the longer term sustainability of mining generally (eg. [21]). Whether the uranium industry thinks specific regulations are technically sound is irrelevant – the community has high expectations regarding remediation of past and abandoned uranium mines as well as standards for operating and potential future projects. The regulatory agencies therefore reflect legitimate community standards, and the industry needs to recognise this and work towards achieving and demonstrating high environmental standards.

In brief, uranium mining can be considered to have two principal periods – the 'Cold War' phase to supply nuclear weapons programs of the early 1950s to mid-1960s, followed by the civilian phase whereby uranium was sold for nuclear electricity. The Cold War era was driven by the urgent priority for production, with other factors such as environmental management and mine rehabilitation not considered a sufficient concern. The rise of uranium production for civilian use from the late 1960s also coincided with the rise of environmental legislation and regulators, and hence this phase has been operated in an improved manner compared to Cold War era mines. Although this is a simplified history, it distinguishes the needs for each phase : Cold War era mines often require expensive and challenging remediation, while civilian phase mines were better planned and generally had funds set aside for rehabilitation (for some mines, rehabilitation was actively integrated into operations).

For many community groups, especially indigenous groups, they remain highly sceptical of claims about rehabilitation of current or future uranium mines since many of the earlier generation of Cold War mines have yet to be remediated to a high standard which has stood the test of time. Depending on a countries uranium mining history, the experience and evidence will vary. For example, Canada is still undertaking remediation works on former Cold War era uranium mines, such as the Uranium City area. In Australia major Cold War era uranium mines included Radium Hill and Rum Jungle, both still need active maintenance and vigilance despite being rehabilitated in the 1980s. At Radium Hill there remains ongoing dispersion of radioactive materials from the site leading to low-level uptake of radionuclides [22]. About $20 million of works were undertaken at Rum Jungle to reduce severe acid mine drainage (AMD) pollution to the Finniss River [23] – yet in 2007 AMD pollution was still extreme, demonstrating that the rehabilitation works have not proven adequate over time. Similarly, ongoing release of uranium, metals and radionuclides to surface water and groundwater has been documented from tailings dams in the Witwatersrand field of South Africa [24, 25], with similar examples in most countries. Some photographs are shown in Figure 2. On this evidence, many in the community therefore remain sceptical of the ability to remediate and rehabilitate former and current uranium mines (regardless of climate; see Figure 2).

The real test for remediation and rehabilitation of former and current uranium mines is the long term – that is, some decades later as climate variability and natural ecosystem processes test the engineering integrity of the works. In Australia, as is the case in some countries, the available evidence only shows ongoing problems at all former uranium mines. Community groups are excellent at documenting such sites and communicating these outcomes to the public – the mining industry should take note of this evidence and exercise realistic caution rather than optimistic hope.



Note : Although Mary Kathleen's rehabilitation won a national 'Engineering Excellence' award in 1986, recent studies have shown that tailings dam seepage is much higher than expected (ie. above).

Figure 2. Photo's of uranium mine rehabilitation : a Radium Hill tailings dam, ~2001 (top left) [22]; saline, metal and radionuclide-rich seepage from the Mary Kathleen tailings dam (~15 years after rehabilitation) (top right) [26]; Au-U tailings dam (left) and kids playing in a contaminated stream (right), Klerksdorp field, South Africa (middle) [24]; severe acid mine drainage flowing from White's waste rock dump, July 2007 (ie. dry season), ~20 years after rehabilitation (bottom) (photo's author).

A final aspect of remediation or rehabilitation is groundwater contamination. At some former uranium mine or milling sites, tailings dam seepage has severely impacted on groundwater (eg. United States, Germany) or through in situ leach mining. The vast majority of the community expects that groundwater will be remediated and returned to pre-mining quality – even at acid leach mines like Beverley in Australia (see [20, 27]). At sites such as Rum Jungle, failure to remediate heavily polluted groundwater is a major reason for the continuing salt and metal loads in the Finniss River [23]. The Ranger mine is required to rehabilitate tailings to ensure that solutes will not cause "impacts for at least 10,000 years" [20] – yet the primary pathway of groundwater remains the least researched field in more than 30 years at the site. With rising concern about the sustainability of water resources, the community expects groundwater to be remediated to ensure no liability for future generations.

6. Social Issues

The nature and extent of social impacts are a critical aspect of uranium mining projects. Although some believe that there are opportunities for positive as well as negative impacts, many communities commonly perceive the negative impacts will be substantial and easily outweigh any hoped-for benefits. Indeed, for some groups (especially indigenous groups), social issues are more important than potential environmental or economic impacts. Social issues commonly include heritage aspects and sites – such as an indigenous sacred site. For example, the Mirarr elders in the 1970s were adamant in their opposition to the Ranger uranium project primarily on concerns over social impacts (see [28]) – a fear now proven justified 20 years later (see [29]). A fundamental and difficult problem with social issues is that current regulatory regimes and approvals processes are geared towards environmental aspects – only a minor focus is generally given to social issues. It is very clear from extensive personal experience that social impacts and issues need to be given increased attention by industry and government – yet in contrast, many civic society groups and ENGO's are well advanced in working on social issues. For many communities, especially indigenous groups, the right to determine their own social future is paramount – and is considered an inalienable human right. This means the right to say no to whatever imposed development must be treated with dignity and respect.

7. Regulatory Performance, Transparency, Public Reporting and Accountability

A major area of concern for many communities and ENGO's is regulatory performance. That is, are mining companies and mine sites complying with the numerous conditions of their approvals and operating permits. In any country, legitimate concerns are raised when a particular mine is shown to be failing to comply with such conditions. In Australia, the 1982 EIS for Olympic Dam project included approvals for a particular tailings dam design and operating regime – yet when ENGO's visited the project in the early 1990s they observed that tailings were being managed differently. Subsequently, it was found that the altered tailings management regime was a principal factor leading to massive seepage from the tailings dams (see [30]). Another Australian example is the Ranger uranium mine, where despite the numerous incidents and breaches of authorisations over its history [20], it was not until the 2004 process water leak that legal convictions and penalties were finally applied by regulators. The community expects that regulators are and will maintain frank and fearless independence from the projects they are regulating, and view the lack of or weak enforcement of regulatory conditions as unacceptable. The protection of the environment, public health and heritage issues should be of the utmost priority – not economic viability or government expediency.

An emerging way to improve transparency and accountability is through sustainability reporting, based on the Global Reporting Initiative (GRI) [31]. At present, some uranium mining companies are already releasing annual sustainability reports alongside corporate/financial reports (eg. Rio Tinto and previously WMC Resources). A major component of these reports is the information and detailed data on various aspects such as economic outcomes, social aspects (eg. jobs, human rights) and environmental inputs and outputs (eg. energy, greenhouse emissions, water). Given the fiercely contested nature of the life cycle metrics of the nuclear fuel chain compared to renewable energy (eg. contrast [1] and [4]), it is pivotal that uranium companies show leadership, like their gold mining counterparts (see [32]), and be transparent and accountable by publishing all relevant sustainability information and data on a mine site-specific basis using the GRI protocol. Unfortunately, some companies do not report site-specific data in their sustainability reports (eg. Cameco, BHP Billiton), making it impossible to verify various sustainability claims. A recent analysis of the available data has shown that such reporting can be used to estimate the sustainability metrics of uranium mining and assess the effects of ore grade, showing that energy, water and greenhouse costs per tonne of uranium increase with declining ore grade [33]. In a global environment where greenhouse emissions are a major international issue, it is vital that all existing producers as well as hopeful companies prepare and publish accurate sustainability reports with all relevant site-specific data. In this way the data will gradually increase upon which various sustainability metrics of uranium mining and the nuclear fuel chain can be estimated more accurately – by all sides. Comprehensive sustainability reports are a fundamental mechanism to demonstrate transparency and accountability to a sceptical public.

An important feature of the modern age is, of course, rapid telecommunications infrastructure – especially the advent of the internet and world wide web. The internet has become a primary tool for information and research for almost all aspects of society – though the quality of the information is highly variable. All sides of the nuclear debate continue to expand the extent and quality of their online information, as well as providing space for interaction (eg. 'blogs'). One of the best examples and most critical resources on global issues in uranium mining is the 'WISE Uranium Project' (an ENGO) [34]. The website is updated daily and contains extensive news, links to scientific reports, technical issues as well as numerous online calculators for radon flux, radiation exposure and the like. The calculators are based on published scientific papers, and are very popular with industry and government professionals as well as allowing the community an independent check on certain claims.

8. Discussion: Salient Lessons and Sustainability

The issue of uranium mining and nuclear power remains as controversial today as it has been for decades – and the vast majority of community and indigenous groups and environmental non-government organisations continue to adamantly oppose all forms of nuclear energy, and this is highly unlike to change. Therefore, with respect to potential uranium mine developments, it is critical to understand the context of nuclear issues in a given region and recognise the legitimate positions taken by various groups. Any uranium mine needs to undertake a thorough environmental impact assessment which includes all relevant aspects and issues – this is a fundamental stage as it is generally used to reject or accept a project with various stringent conditions. The environmental monitoring of former, current and potential projects remains pivotal – all communities expect first-rate monitoring, including high frequency, appropriate locations and transparent analysis and reporting. Based on the review of available information for abandoned, remediated and rehabilitated uranium projects, there is ample evidence known to the community concerning ongoing pollution and impacts – leading many in the community to remain sceptical of industry and government claims. Overall, the paper is a unique and thorough reflection on the complex interaction of community groups, ENGO's, regulators and miners in the assessment, remediation and regulation of uranium mines, providing valuable insights.

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CBR Violations, Spills, and Leaks as of July 28, 2008

Prepared by Shane Robinson on behalf of Western Nebraska Resources Council

- June 19, 2008: Power outage resulting in loss of flow to the well field and exceedance of the 100 PSIG NDEQ Class III UIC permit limitation.
- June 4, 2008: Exceeding of Well Head Manifold Pressure Limitations
- May 15, 2008: CM9-5 Monitor Well Excursion
- May 30, 2008: CM9-3 Monitor Well Excursion
- April 29, 2008: Thirty day response to self identified license violation for missed five-year MIT re-tests
- January 24, 2007: 2006 Annual pond inspection report is 45 days past due and has been recorded as a self identified reporting violation
- September 26, 2006: Monitor well placed on excursion status
- May 5, 2006: Evaporation Pond 4 Liner Leak
- March 31, 2006: CBR became aware of the noncompliance of three violations listed below on July 1, 2003 and failed to provide written notification to NDEQ as required by Title 122, Chapter 21 §001.06 until May 12, 2006.
- January 18, 2006: CM8-21 Monitor Well Excursion
- October 27, 2005: 5-Year Mechanical integrity test failure at well 12340-31 leak detected
- August 4, 2005: CM9-16 Monitor Well Excursion
- July 4, 2005: Mechanical integrity test failure at well 1723-14
- June 27, 2005: SM6-12 Monitor Well Excursion
- May 2, 2005: CM5-19 Monitor Well Excursion
- June 16, 2005: SM6-28 Monitor Well Excursion
- May 14, 2004: leak detected at Pond 1
- December 23, 2003: Monitor well placed on excursion status
- July 1, 2003: Violations of Permit by releasing well development water upon the surface of the ground (**continued until March, 31, 2006**)
- July 1, 2003: Violation of Permit by using Chadron Formation well development water as drilling water (**continued until March, 31, 2006**)
- July 1, 2003: constructed injection wells and mineral production wells in a manner that had the potential to allow the movement of fluid containing contaminants into an underground source of drinking water, in violation of Title 122, Chapter 4, §001 (**continued until March, 31, 2006**)
- December 26, 2002: Monitor well placed on excursion status
- September 10, 2002: Monitor well placed on excursion status
- April 4, 2002: Monitor well placed on excursion status
- December 4, 2001: Monitor well placed on excursion status
- March 2, 2001: Monitor well placed on excursion status
- September 10, 2000: Monitor well placed on excursion status
- May 26, 2000: Monitor well placed on excursion status
- April 27, 2000: Monitor well placed on excursion status
- March 6, 2000: Monitor well placed on excursion status
- July 2, 1999: Monitor well placed on excursion status
- August 7, 1998: Spill of 10,260 gallons of injection fluid
- March 21, 1998: Monitor well placed on excursion status

IN THE DISTRICT COURT OF LANCASTER COUNTY, NEBRASKA

STATE OF NEBRASKA, ex rel., MICHAEL J. LINDER, Director NEBRASKA DEPARTMENT OF ENVIRONMENTAL QUALITY, Plaintiff, v. CROW BUTTE RESOURCES, INC., a Nebraska Corporation, Defendant.	)	Case No. _____ **COMPLAINT**

COMES NOW, Michael J. Linder, Director of the Department of Environmental Quality, who institutes this action through Jon C. Bruning, Attorney General, on behalf of the State of Nebraska, and alleges as follows:

FIRST CLAIM

1. The Nebraska Department of Environmental Quality (hereinafter NDEQ), is at all times alleged herein, the agency of the State of Nebraska charged with the duty, pursuant to Neb. Rev. Stat. §81-1504(1) (Reissue 1999), of exercising exclusive general supervision, administration, and enforcement of the Environmental Protection Act (hereinafter the Act), Neb. Rev. Stat. §81-1501 *et seq* (Reissue 1999 and Cum. Supp. 2006) and all rules, regulations, and permits created thereunder.

2. Defendant Crow Butte Resources, Inc. (hereinafter CBR), at all times alleged herein, is a Nebraska corporation which owns and operates an in-situ uranium mining facility which is located on approximately 2,840 acres in all or portions of Sections 11, 12, and 13 of Township 31 North, Range 52 West of the

6th P.M., Dawes County, Nebraska, and Sections 18, 19, 20, 29, and 30 of Township 31 North, Range 51 West of the 6th P.M., Dawes County, Nebraska.

3. Pursuant to its authority under Neb. Rev. Stat. §81-1504(11) (Cum. Supp. 2006), NDEQ issued an Underground Injection Control (hereinafter UIC) Permit to CBR, UIC Permit No. NE0122611 which required:

> All of the liquid waste streams shall be collected and retained in the lined evaporation ponds, or disposed of in a permitted deep disposal well as approved by the Department. This permit does not authorize any wastewater discharge to the land surface or surface waters of the State.

4. Violation of a permit condition or limitation is a violation of Neb. Rev. Stat. §81-1508.02(1)(b).

5. Beginning on or about July 1, 2003, and continuing daily thereafter until March 31, 2006, Defendant CBR violated its UIC Permit No. NE0122611 by releasing well development water upon the surface of the ground during CBR's well development and drilling process.

6. Pursuant to Neb. Rev. Stat. §81-1508.02, a civil penalty, not to exceed ten thousand dollars ($10,000.00), is warranted for each day of violation.

SECOND CLAIM

7. Plaintiff hereby incorporates by reference each and every allegation contained in paragraphs 1 through 6 as if fully stated herein.

8. Defendant CBR's UIC Permit No. NE0122611 further prohibited the use of Chadron Formation well development water as drilling water and required Defendants to treat well development water from the Chadron Formation as a liquid waste stream to be collected and retained in lined evaporation ponds.

9. Beginning on or about July 1, 2003, and continuing daily thereafter until on or about March 31, 2006, Defendant CBR, used Chadron Formation well development water as drilling water in violation of UIC Permit No. NE0122611.

THIRD CLAIM

10. Plaintiff hereby incorporates by reference each and every allegation contained in paragraphs 1 through 9 as if fully stated herein.

11. At all times alleged herein, Nebraska Administrative Code Title 122 "Rules and Regulations for Underground Injection and Mineral Production Wells" (hereinafter Title 122) was in full force and effect and applied to the Defendant's facility and activities.

12. Title 122, Chapter 4, §001 prohibits an owner or operator from constructing an injection well or mineral production well in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water if the presence of the contaminant may cause a violation of any primary drinking water regulation or may otherwise adversely affect the health and safety of persons.

13. Defendant CBR, on a daily basis from on or about July 1, 2003 until March 31, 2006, constructed injection wells and mineral production wells in a manner that had the potential to allow the movement of fluid containing contaminants into an underground source of drinking water, in violation of Title 122, Chapter 4, §001.

14. Neb. Rev. Stat. §81-1508.02(1)(e) (Cum. Supp. 2006) makes it

unlawful for any person to violate any rules or regulations adopted and promulgated pursuant to such Act.

FOURTH CLAIM

15. Plaintiff hereby incorporates by reference each and every allegation contained in paragraphs 1 through 14 as if fully stated herein.

21. Title 122 Chapter 21 §001.06 further requires a permittee to provide written notification to NDEQ of any noncompliance which may endanger the health and safety of persons or cause pollution of the environment within five days of the time the permittee becomes aware of the noncompliance.

23. Defendant CBR became aware of the noncompliance on or about March 31, 2006 and failed to provide written notification to NDEQ as required by Title 122 Chapter 21 §001.06 until May 12, 2006.

WHEREFORE, NDEQ prays that judgment on its Claims be entered herein in favor of NDEQ and against Defendant in the form of a civil penalty as provided under Neb. Rev. Stat. §81-1508.02, together with the costs of the action and such other relief as the Court deems just and equitable.

STATE OF NEBRASKA ex rel.
MICHAEL J. LINDER, Director
Department of Environmental
Quality, Plaintiff,

BY: JON BRUNING #20351
Attorney General

BY: _____
Katherine J. Spohn #22979
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2115 State Capitol Bldg.
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Attorneys for Plaintiff

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Complaint has been served upon the Defendant by regular United States mail, first class postage prepaid on this __ day of May, 2008 addressed to the Defendant's attorney of record as follows:

Mark D. McGuire
McGuire and Norby
605 South 14th Street, Suite 100
Lincoln, NE 68508

_____
Katherine J. Spohn
Assistant Attorney General

IN THE DISTRICT COURT OF LANCASTER COUNTY, NEBRASKA

STATE OF NEBRASKA, ex rel., MICHAEL J. LINDER, Director NEBRASKA DEPARTMENT OF ENVIRONMENTAL QUALITY,

Plaintiff,

v.

CROW BUTTE RESOURCES, INC., a Nebraska Corporation,

Defendant.

LANCASTER COUNTY
2008 MAY 23 AM 8 57
CLERK OF THE DISTRICT COURT

Case No. CI08-2248

CONSENT DECREE

Plaintiff, the Nebraska Department of Environmental Quality ("NDEQ"), proceeding on its Complaint filed herein and appearing through its counsel, Jon C. Bruning, Attorney General, and the Defendant, Crow Butte Resources, Inc., a Nebraska Corporation, appearing through its counsel, Mark D. McGuire, and each party having consented to the making and entering of this Consent Decree without trial, the Court finds that the Consent Decree should be and hereby is entered.

IT IS THEREFORE ORDERED AND DECREED as follows:

1. The court has jurisdiction of the parties and the subject matter of this action. The Complaint herein sets forth justiciable causes of action against Defendant.

2. NDEQ, in its Complaint, alleges that beginning on or about July 1, 2003, and continuing daily thereafter until March 31, 2006, Defendant Crow Butte Resources, Inc., (hereinafter CBR), violated its Underground Injection Control (hereinafter UIC) Permit No. NE0122611 by releasing well development water

upon the surface of the ground during CBR's well development and drilling process. CBR recycled its well development water as a conservation measure, rather than treating it as a waste stream and collecting and retaining such water in CBR's lined evaporation ponds, contrary to the terms of its UIC permit. Such treatment of its well development water did not result in any pollution of either the surface of the ground or any aquifer thereunder. CBR discovered this process potentially violated the literal terms of its UIC permit on or about March 31, 2006, and self-reported it to the DEQ's on-site inspector on or about April 7, 2006.

3. NDEQ further alleges that Defendant is therefore subject to a civil penalty as provided in Neb. Rev. Stat. §81-1508.02(2) (Reissue 1999).

4. The parties agree that settlement of these matters is in the public interest and entry of this Consent Decree is the most appropriate means of resolving their dispute. Defendant, without admitting any allegations of the Complaint, agrees to the form and entry of this Consent Decree for purposes of settlement only.

5. The parties agree that this Consent Decree shall be in full satisfaction of all claims alleged in the Complaint and arising out of the same transaction or occurrence asserted therein, provided that such claims were known or were reasonably ascertainable from information in the State's possession as of the date of the filing of this Consent Decree.

6. IT IS THEREFORE ORDERED that Defendant shall pay to the Clerk of the District Court of Lancaster County a civil penalty in the sum of fifty thousand dollars ($50,000) pursuant to Neb. Rev. Stat. §81-1508.02, together

with court costs in the amount of seventy-nine dollars ($79.00). Said penalty is to be handled pursuant to Article VII, Section V, of the Nebraska Constitution.

A. $25,000 (twenty-five thousand dollars) of said penalty will be imposed immediately upon the entry of this Consent Decree by the Court, and is due no later than 10 (ten) days after the entry of this Consent Decree by the Court.

B. $25,000 (twenty-five thousand dollars) of said penalty will be due and owing 180 days following the approval of this Consent Decree by the Court. In the event that said Defendant continues to maintain compliance with the following obligations and provisions, during the time period between the approval of this Consent Decree by the District Court and 180 days following that approval, the $25,000 (twenty-five thousand dollars) of civil penalties will be waived:

1. The Environmental Protection Act, Neb. Rev. Stat. §81-1501 *et seq*;
2. Title 122 of the Nebraska Administrative Code, "Rules and Regulations for Underground Injection and Mineral Production Wells;" and
3. Defendant's UIC Permit No. NE0122611 and all conditions and provisions related thereto.

C. To qualify for the $25,000 (twenty-five thousand dollars) waiver of civil penalties as stated in paragraph 6(B), Defendant shall file a showing with the

Court within 30 (thirty) days following the due date of the civil penalties establishing that it has maintained compliance as required. If the Defendant does not receive a Notice of Violation from NDEQ and is not a party to legal action initiated by the NDEQ disputing compliance with the statutes and regulatory provisions in paragraph 6(B) during the relevant time period, NDEQ shall file a Satisfaction of Judgment in the case within ten days of receipt of Defendant's showing. If Defendant receives a Notice of Violation from NDEQ, or is a party to legal action initiated by NDEQ disputing compliance with the statutes and regulatory provisions in paragraph 6(B) during the relevant time period, NDEQ shall file an objection to Defendant's showing and determination of this waiver provision will be stayed pending ongoing enforcement proceedings.

7. IT IS FURTHER ORDERED that the Defendant shall pay, as a Supplemental Environmental Project, the sum of 50,000 (fifty thousand dollars) into the Attorney General's Environmental Protection Fund to be used for environmental safety, training, public awareness, or other related uses as permitted by state law, at the sole discretion of the Nebraska Attorney General. This sum shall be paid as a lump-sum payment due no later than 10 (ten) days after the entry of this Consent Decree.

8. This Consent Decree will have no effect on any enforcement action brought by NDEQ against Defendant for future violations of any statutes or regulations.

9. The undersigned consent without further notice to the form and entry of the foregoing Consent Decree.

DATED THIS 23 day of May, 2008, in Lancaster County, Nebraska.

BY THE COURT:

District Judge
JODI L. NELSON

STATE OF NEBRASKA ex rel.
MICHAEL J. LINDER, Director
Department of Environmental
Quality, Plaintiff,

BY: JON BRUNING #20351
Attorney General

BY:
Katherine J. Spohn #22970
Assistant Attorney General
2115 State Capitol Bldg.
Lincoln, NE 68509
Tel. (402) 471-2682
katie.spohn@nebraska.gov
Attorneys for Plaintiff.

CROW BUTTE RESOURCES, INC.,
a Nebraska Corporation, Defendant

BY:
Mark D. McGuire
McGuire and Norby
605 South 14th Street, Suite 100
Lincoln, NE 68508
Tel. (402) 434-2390
Attorney for Defendant.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Consent Decree has been served upon the Defendant by ~~regular United States mail, first~~ Hand Delivery

class postage prepaid on this 23rd day of May, 2008 addressed to the Defendant's attorney of record as follows:

Mark D. McGuire
McGuire and Norby
605 South 14th Street, Suite 100
Lincoln, NE 68508

Katherine J. Spohn
Assistant Attorney General

SUZANNE M. KIRKLAND
CLERK of the DISTRICT COURT
LANCASTER COUNTY
575 South 10th Street
Lincoln, Nebraska 68508-2810
402-441-7328/Fax 402-441-6190

IN THE DISTRICT COURT OF LANCASTER COUNTY, NEBRASKA

--CERTIFICATE--

I, Simon G. Rezac, Deputy Clerk of the District Court of Lancaster County, Nebraska, do hereby certify that the foregoing is/are a full and correct copy/copies of the original instrument(s) duly filed and or record in this court. This Certificate, which bears the seal of the District Court of Lancaster County, State of Nebraska, USA, was signed on MAY 2 3 2008.

By: _____
Simon G. Rezac, Deputy Clerk

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543 July 27, 2008

AFFIDAVIT

I, Beatrice Long Visitor Holy Dance, hereby state as follows:

1. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). My address is: POB , Pine Ridge SD 57770. I have authorized attorneys David Frankel and Shane Robinson to represent me in this matter. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. My name is Beatrice Long Visitor Holy Dance and I am 81 years old. I am also known as Beatrice Weasel Bear. My daughter Loretta Afraid of Bear is married to Thomas Kanatakeniate Cook. I am an enrolled member of the Oglala Lakota Nation, Pine Ridge Reservation. I live at Slim Buttes, which is about 20 miles from the Nebraska border on BIA 41, at Pine Ridge Indian Reservation. Our family has lived at Slim Buttes for many years. My daughter Loretta and son-in-law Tom have built a farm and timber frame house on our family land at Slim Buttes. Our family land at Slim Buttes has several well pumps. My family also maintains an *inipi*, a "sweat lodge," on our family land. A tributary of the White River flows through our family land although it has run dry.

3. I am one of the International Council of Thirteen Indigenous Grandmothers (www.grandmotherscouncil.org). We represent a global alliance of prayer, education and healing for our Mother Earth, all Her inhabitants, all the children, and for the next seven generations to come. We are deeply concerned with the unprecedented destruction of our Mother Earth and the destruction of indigenous ways of life. We believe the teachings of our ancestors will light our way through an uncertain future. We look to further our vision through the realization of projects that protect our diverse cultures, lands, medicines, language and ceremonial ways of prayer and through projects that educate and nurture our children.

4. I make this affidavit to provide relevant information about the cultural and spiritual nature and value of water.

5. Water (mni) is very sacred to our people, the Lakota. We can't live without it. We are taught that we can't live without the elements of water and fire. We are taught that we pray with water before we drink it. We are taught to respect the water.

6. Lakota people use water to make our medicines. We put herbs in the water, pray with it, and use it for healings.

7. We use this water on our gardens on our family land at Slim Buttes to grow our food and we eat the food from these gardens.

8. When we come into this life, our mothers carry us in their bodies, and we are in the water. That is our first experience in this life, being in the water and so it is holy for us. We carry that relationship with the water through our lives.

9. Lakota believe that the Creator first created the rock of the earth, the rock is burning in the center of the earth, and the Creator put water on the rock so we could live on the earth.

10. Lakota people need to have good water nearby to use for our ceremonies. In the *inipi*, or sweat lodge, ceremony, water is poured on hot rocks in a sacred manner according to traditional ways. Participants in the *inipi*, or sweat lodge, ceremony we heat up rocks to recognize that rock at the center of the earth put there by Creator, then we pour the water over the hot rocks as the Creator put water on the earth. The water purifies us. We breathe in water vapor during the ceremony. During the *inipi*, we pray for the health of all people, the safety of all those in jeopardy including the soldiers abroad and for the healthy future of our children, grandchildren and their grandchildren.

11. When we bury our loved ones, we put water and food in with them. The water and food isn't for the deceased to have, it is for the deceased to bring to the Creator. It is offered to the Creator by the deceased to ask the Creator to bless our future generations, so there will be plenty of good water and food for our future generations and life for our people can continue. I am often called upon in our community to help make that sacred food for the burial, and I do this to help the people.

12. In our Sun Dance ceremony, we commit to go without water for days, it is part of how we honor it and respect the water, and we offer our suffering up to the Creator. Sometimes we pour water out in front of the dancers to help them even though they can't drink it; water is so sacred and powerful that it helps us even that way.

13. We use the water in the Native American Church ceremony too. The water is put inside the drum, and we bring it in a bucket at midnight, and in the morning so we can drink it. I was healed by the water in this ceremony. I was sick and ate the medicine in the ceremony. I threw up lots of blood. I had something wrong with my

liver. Many hours after the ceremony was over I was still sick and throwing up. My brother gave me more medicine to eat, then he prayed over a cup of water and blessed it in front of the fire. He gave me that cup of water and told me that the water is the water of life, *mni wiconi*. He told me to believe that when I drink the water that I will be healed, that I will be able to care for my children. I did like he said, I thought that way while I drank the water, and I was healed when I drank it.

14. Lakota people are taught to honor our water, to respect it, to understand that it is holy and sacred to us.

15. It takes many generations to restore the natural qualities of water that has been adulterated sufficiently for it to be used again for natural medicines and sacred ceremonies.

16. We expect the United States government to protect the water so that we have as much pristine water as we need for ourselves, our grandchildren and their grandchildren to have for drinking, praying, and healing.

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 27th, 2008 at Chadron NE.

Beatrice Long Visitor Holy Dance aka - Wizard Bear.
BEATRICE LONG VISITOR HOLY DANCE

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543 July 27, 2008

AFFIDAVIT

I, Buffalo Bruce, hereby state as follows:

1. I make this affidavit in support of Western Nebraska Resources Council ("WNRC"), which was formed in 1982 to protect the natural resources of Western Nebraska with a focus on groundwater contamination from uranium mining.

2. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). My mailing address is: 205 N Mears St., Chadron, NE 69337. WNRC has authorized attorneys David Frankel and Shane Robinson to represent WNRC in this matter. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. I have authorized WNRC to represent my interests in this proceeding. Having been a long time member of WNRC I am currently serving as Vice-Chair. My Grandfather owned and operated the finest Mercantile in the region, in Crawford, during the 1890's. My grant great aunt was married to the first mayor of Crawford.

3. My first job of substance was with the University of Nebraska conducting paleontological fieldwork within the badlands north of Fort Robinson, NE, 1962. I am a guest lecturer at American University in D.C. almost annually, for the science curriculum. I am on the NE USDA WHIP Subcommittee & USDA EQIP Subcommittees. Currently, I am coordinating research on aspen within NE. It is during the sample collecting of data for DNA analysis that I have observed the hydrologic loss of surface flow within the lower reaches of Pine Ridge streams. Recently (3 years), several of these streams, have gone dry prior to reaching the White River. Historically, even during the drought of the 30's this anomaly had not occurred, until several years after the Uranium Mine was in operation. The predicted average 'net consumption' that is written within the Renewal Application (page 7-11) is 5112gpm. If that amount is an accurate figure that means the mine consumes as much or more water in one hour than

the city of Crawford uses in a day. Whatever the true 'consumptive' use is, that amount has been degrading the already stressed watershed to localized aquatic die offs. This is a study documenting the stages of Regionwide desertification.

4. Knowledge, of humankind's relationship with the natural world has changed dramatically within the last 20 years. We can now place monetary value on degradation of native systems. (8/9/02 Journal Science mag,) www.time.com/magazine/article/0.9171.99747.00html

www.nytimes.com/2007/04/18/nyregion/18trees.html?_r=1&oref=slogan

"Humankind relies in total upon the sustenance given us from the Intact Native Wildlands, to cleanse the rivers/waters; create and store good soils and filter/alter airborne constituents. These systems are overloaded. That fact makes the tiny amount of intact native system left, extremely valuable and we should not compromise its health, unless we want humankind to be extinguished sooner."

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 28, 2008 at Chadron, Nebraska.

Buffalo Bruce

BUFFALO BRUCE

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543 July 17, 2008

AFFIDAVIT

I, Dayton O. Hyde, hereby state as follows:

1. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). I have authorized attorneys David Frankel and Shane Robinson to represent me in this matter. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. I am the founder and manager of the Black Hills Wild Horse Sanctuary located on 11,000 acres of pristine wilderness along the Cheyenne River between Hot Springs and Edgemont, South Dakota, where herds of wild American Mustangs roam and graze on prairie grasses. The Black Hills Wild Horse Sanctuary is home to America's largest wild horse herd with over 500 wild horses including American Spanish Mustangs, Sulphur and Kiger Mustangs, herds from State Governments, Bureau of Land Management, and the US Forest Service. My personal website is: www.daytonohyde.com and the Black Hills Wild Horse Sanctuary is www.wildmustangs.com.

3. My address is: PO Box 998, Hot Springs, S.D. 57747. I have lived at this address for more than 20 years.

4. Substantial resources have been invested during the past 20 years to develop and maintain the Black Hills Wild Horse Sanctuary. The health of the horses and the continued suitability of the land to be used as a wild horse sanctuary depends on the health of the ecosystem, including the flora and fauna, and on the continued availability of clean water quality from our wells and from the Cheyenne River.

5. The Wild Horse Sanctuary also serves as a cultural area where several Indigenous spiritual ceremonies such as the "sweat lodge" are performed regularly by members of the Oglala Sioux Tribe, including the American Horse and Afraid of Bear

families. The pristine nature of this land and water of this area are of great importance to the people.

6. I am a veteran of the United States Army having served in combat during World War II; assigned to General Patton's Third Army, my outfit stormed the beaches, fought through France, Belgium and Germany. We survived the Battle of the Bulge, the Ruhr Pocket and the Rhineland campaign.

7. As someone who has personally served the US national interest, and staked my life on securing the common defense and security of the American people, I am concerned that atomic energy and uranium not be controlled by foreign persons who have no loyalty to the United States or its people. I do not believe that foreign owners should be allowed to receive a license to operate the Mine because they lack the loyalty to the United States and its people that would guarantee that the Mine is operated in the best interests of the United States and its citizens, in the national interest, for the common defense and security and in the interests of public health and safety. I do not believe that foreign persons can be trusted to act in the best interests of the United States and its people or to comply with United States laws and regulations or to protect the water and environment of the communities that are near the Mine.

8. As a resident of South Dakota, I question what authority the Nebraska Department of Environmental Quality has over the regulation of my water quality. I understand that the NDEQ sets the water restoration standards for the Mine and that such standards may affect me.

9. I understand from reading "Ionizing Radiation from Nuclear Power and Weapons and its Impacts on Animals" by Diane D'Arrigo (Nuclear Information and Resource Service, June 2004), that with increased mining and uses of radioactive material in society, more radionuclides have been and continue to be released to the environment. Once released, they can circulate through the biosphere, ending up in drinking water, vegetables, grass, meat, etc. The higher an animal eats on the food chain, the higher the concentration of radionuclides. This is bioaccumulation. The process of bioaccumulating radionuclides can be especially harmful to animals at the top of the food chain because the concentrations of radionuclides are much higher. Radionuclides can concentrate in various kinds of tissue. This article also states that "animals in the vicinity of nuclear facilities and downwind from accidental radiation releases have been found to be radioactive." Id. at p. 3.

10. I understand that the Mine predicts that its operations will increase the public dose of radiation to the entire North American population (about 523 million people) by 0.0023% according to their application. Such increase, taken together with the existing exposures to radiation in my region (such as the infamous contamination due to historic open pit uranium mining in Edgemont, SD, create a major risk of bioaccumulation of radionuclides.

11. Based on the foregoing, I am concerned that bioaccumulation of radionuclides is occurring in the wild horses at the Black Hills Wild Horse Sanctuary because the Mine is located upwind and upstream of the sanctuary. I am also concerned that in 1998 (shortly after the Mine was taken over by Canadian corporation Cameco, Inc.), the Mine stopped monitoring the radiation impacts on vegetation which makes it more difficult for the public to determine if bioaccumulation of radionuclides is resulting from the Mine's operations.

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true. Executed on this 27 day of July, 2008 in Hot Springs, South Dakota.

Dayton O. Hyde

Dayton O. Hyde

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of

CROW BUTTE RESOURCES, INC.

(In Situ Leach Facility, Crawford, NE)

Docket No. 40-8943

License SUA-1543

July 27, 2008

AFFIDAVIT

I, Debra L. White Plume, hereby state as follows:

1. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). My address is: Box 71, Manderson, South Dakota 57756. I have authorized attorneys Bruce Ellison, David Frankel and Shane Robinson to represent me in this matter. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. My name is Debra L. White Plume. My husband is Alexander C. White Plume. We have raised the children John, Sam, Lance, Jess, Mashugashaun, and Rosebud and are raising Ty and Denise on our land along the banks of Wounded Knee Creek on the Pine Ridge Indian Reservation, as well as additional children in our Tiospaye (extended family). I am an enrolled member of the Oglala Sioux Tribe, descended from Chief Red Cloud on my fathers' side and the Northern Cheyenne on my mothers' side. As the mother, grandmother, and great grandmother of generations it is my responsibility to make a good home and environment and to preserve and hand down our Lakota way of life for my generations. I am compelled and required to do this as a Lakota woman.

3. Our Lakota history, culture and ways of life are handed down from generation to generation in our beautiful Lakota language, as well as the English language, since the coming of the white man. In our teachings, our Lakota worldview of Mni (water) is that water is sacred, it is our first home, it is our first medicine, it is a gift from Tunkasila (Grandfather), it is the adornment of Ina Maka (Mother Earth), and the companion of Ina Maka is Woope (the Law),

who is the daughter of Tunkasila. We are to respect Mni, honor Mni, take care of Mni. These are our teachings. Our teachings include mni on the earth as well as inside the earth, and in the sky: clouds, rain, hail, snow. Our teachings link the role of the Pte (buffalo) with Mni underground and above ground. Pte were so many they could drink a river dry, creating a natural cleansing and recharging cycle. In their millions, they would run and tremble the earth, moving water deep inside the earth. When the white man slaughtered the Pte, this natural lifeway of Creation was forever damaged. Our people suffer now but we still must honor sacred water in all its forms.

4. Our family lives the Lakota way of life out here on the land. We drink water from a private well in the Arikaree aquifer. We have buffalo and horses that we take care of. They drink from our creeks and from a water tank fed by the groundwater. We depend on our groundwater to be our medicine and keep us alive, all of us, we need our drinking water to be undisturbed and uncontaminated by mining activities. Our drinking water is from under the earth in this part of the great plains, which we believe is all connected, that there is no "wall" that separates our drinking water, protecting it from the water the corporation Cameco Resources is mixing up with uranium and its decay products. My generations will live here after me and need clean water to drink. Our drinking water well needs to give us clean water that won't make us have uncurable diseases like cancer and diabetes like so many of our tribal members have now. We breathe air that can be made to carry deadly radon from Cameco corporate mining, we have high winds and are down wind from the Crow Butte Uranium mine.

5. I expect the United States government and its' entities to protect our surface and ground water we depend on for life for us and our coming generations to drink, to heal, and to send our voice to the universe (pray), and for our buffalo and horses and all living things. We believe that the water on and in the earth and sky is all the water there will ever be and that Cameco Resources is wasting water to mine uranium as 129,600 gallons of water was being pumped into the deep disposal well at Crow Butte Operations on the day of July 24, 2008 because it was ruined by mining and milling uranium. Although the amount of water being so contaminated it has to be dumped forever deep in the ground varies each day it is still the corporation wasting water that hurts our future as a people that depend on it. They take as much radiation out of it that is profitable for their corporation but when they can't make a profit anymore they regard it as a waste product and dump it here where we have to live and get our water from, this corporate act threatens my future, my health, my water source and that of my family and generations and they want to be able to continue to waste water for many more years.

6. Every year our family travels to the area where Cameco Resources has its Crow Butte Operations uranium mine south of Crawford, Nebraska. We do ceremony there, to honor our Cheyenne ancestors who broke free of military imprisonment, and to honor Crazy Horse, who died there. Even before those sad events took place, that territory was already special to our Lakota ancestors, it was so special, they wanted that area as their primary "agency" but were instead moved to this place, the Pine Ridge Reservation as their "agency". This Canadian corporation of uranium mining and milling operations at that place impacts us Lakota families from access to the area impacting our freedom to practice our ancient way of life.

7. I am a member of Owe Aku as well.

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 28, 2008.

Signed (electronically) by
Debra White Plume
POB 71, Manderson, SD 57756
605-455-2155
lakota1@gwtc.net
July 28, 2008

/s/

Debra L. White Plume, Oglala Lakota

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543

AFFIDAVIT

I, Joe American Horse, Sr., hereby state as follows:

1. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). My address is: POB 941, Pine Ridge SD 57770. I have authorized attorneys David Frankel and Shane Robinson to represent me in this matter. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. My name is Joe American Horse. I am a grandson of Chief American Horse of the nomadic and early reservation era of Oglala history. My grandfather ***Milahanska Tashunke Icu*** *(He Took the Soldier Commander's Horse)* was a headman of the pre-reservation ***Oglalacha*** ('True Oglala') band, one of seven bands comprising the Oglala Lakota Nation. In 1865 he was elected *Shirtwearer* by the confederated Oglala bands and, as such, served as one of six military commanders in the 1865-1868 war with the United States. He was a legislator who spoke at the proceedings and signed the Fort Laramie Treaty of 1868 culminating hostilities. American Horse was a tribal historian and kept one of the thee oldest Oglala Winter Counts. His count begins in the year 1775 and was copied and transcribed by Mallory, of the Smitsonian Institution, in 1878. I am a former two-term President of the Oglala Sioux Tribe, a successor government of the Oglala Lakota Nation. This government is set up under the Indian Reorganization Act of the 1930's primarily to receive federal funding from the U.S. There is also the Black Hills Sioux Nation Treaty Council, among others, who have standing throughout are the standard-bearers of *original* Oglala national government. Historically, federal assistance and development s have been woefully inadequate through the IRA system. I currently serve as an Associate Justice of the Oglala Sioux Tribe Supreme Court, an elected position of the Tribe.

3. The Lakota (also known as the Sioux) Nation, used to be a large nation of 10,000 campfires across the states of Nebraska, Wyoming, Dakotas, Minnesota and

Missouri. These states are all Lakota names. In 1849, gold was discovered in California and people wanted to go through the Indian Country. So the Great Lakota Nation altogether signed the 1851 Fort Laramie Treaty to let the settlers and the gold miners go through. Because of this, bad things happened after 1851. And under the leadership of men like Chief Red Cloud, Oliver's great-grandfather, the Lakota Nation negotiated another treaty, the Fort Laramie Treaty of 1868. In these treaties it says what the United States owns and what the Lakotas own. Although the United States pledged its honor to govern relations by terms of the treaty, *The Treaty* has never been followed or respected by the United States. The U.S. Supreme Court remarked upon our Black Hills case in 1980, that "A more ripe and rank case of dishonorable doings will not be found in our history." After the signing of The Fort Laramie Treaty of 1868, the official headquarters for all Lakota people was the Red Cloud Agency, which became Ft. Robinson in 1874, including the environs about Crawford, Nebraska.

4. The Oglala bands have been on the Pine Ridge Indian Reservation since 1879 on land making up the southern tier of the badlands of South Dakota. The place now hosts the second-poorest county of the 3,147 counties in the USA.

5. I am in the Nebraska Sports Hall of Fame, as a long-distance runner when young. But today I am a diabetic, I have to watch what I eat, purify of toxins, don't use alcohol, tobacco, and watch where I'm going. My life depends upon a clean environment. There are many diabetics at Pine Ridge Indian Reservation and the health of the environment, especially the groundwater, has been a long-standing issue of contention on the Pine Ridge Reservation.

6. I have participated in sacred ceremonies throughout my lifetime including the ***Hanblechia*** *('Crying for a Vision,' or Vision Quest).* I have performed this ritual on many occasions including several on the top east face of Crow Butte, beginning about 12 years ago. The last time I hanblechia'd at Crow Butte was early June1996.

7. I have participated for at least twenty continuous years in the *Inipi('Sweat Lodge')* ceremony at Slim Buttes Community on the reservation. The site is located along the White Earth River, three miles north of the Nebraska State line, on the Slim Buttes road (BIA 41). It is the sweat lodge of my older cousins, the Afraid Of Bear brothers, of the same community.

8. Slim Buttes is located along the White River and wells at Slim Buttes draw water from the Arikaree aquifer.

9. In the Inipi ceremony, water is poured on very hot rocks in prescribed manner according to traditional usage. Participants actively address water as life itself, and say words of gratitude, thanksgiving, etc., to it. The intense water vapor is understood as life itself and incites focus upon it. All the elements and directions of life are addressed, and the health of all people, and particularly the safety of all those in jeopardy including the soldiers abroad, and for the healthy future of our children,

grandchildren and their grandchildren. Clean water is an essential element of this ancient ceremony of Lakota *Tiospayes (Related Families)*.

10. The Oglala Sioux Tribe, among other tribes of the Great Sioux Nation, possess superior water rights in the region, never quantified, arising from federal treaties with the Great Sioux Nation in 1851 and 1868.

11. There is a legal mechanism for formal consultations with the Tribe involving formal notice to the Tribe and the Department of Interior, Bureau of Indian Affairs ("BIA").

12. To my knowledge, no notice was provided to the Tribe or the BIA with regard to a formal consultation concerning the company. While the BIA has jurisdiction over certain areas with the Tribe, the Nebraska State Historical Preservation Officer has absolutely no authority over the Tribe or any member of the Tribe.

13. To an indigenous person such as myself, a member of the Oglala Sioux Tribe and of the Great Sioux Nation, the nature of water has cultural and spiritual significance and value that is much greater than its use and value as a vital natural resource. In Lakota language, we honor "***mni***" which means the "water" itself, as well as "***mni wiconi***" which means "water of life," and "***mni wakan***" which means "sacred water" or "holy water."

14. This means that we honor the "***mni***" as water for drinking, bathing, domestic, farming and other benign uses and it has a value to us for such purposes. Under the "***Winters Doctrine***" we are entitled to as much of this "***mni***" as is necessary for us to live on the Pine Ridge Indian Reservation our right is a federal water right that is superior to any state law water rights, including the water rights of the company, if any.

15. This means that we also honor the "***mni wiconi***" which is the water of life that we drink as a medicine during sacred prayer ceremonies like the "***inipi***" (sweat lodge ceremony). This also means that there is a life and spirit in the water which we, as indigenous people, recognize and commune with and pray with and we know its healing power.

16. This means that we also honor the "***mni wakan***" which is the sacred water used to conduct sacred prayer ceremonies like the "***inipi***" ceremony. This means that the sacredness of the spirit of the water is recognized by us as indigenous people.

17. There may be Indian graves or other Indian artifacts at the site near the Mine that are of historic and/or cultural significance.

18. We expect the United States government and all its agencies to protect the water so that we have as much pristine water as we need for ourselves, our grandchildren and their grandchildren to have for drinking, praying, and healing.

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 27, 2008, at Slim Buttes, Pine Ridge, Ind. Reservation

Joe American Horse Sr.
JOE AMERICAN HORSE, SR.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543

AFFIDAVIT

I, Lester "Bo" J. Davis, hereby state as follows:

1. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). I make this affidavit in support of Owe Aku (Bring Back the Way), which was formed in 1998 to preserve and revitalize the Lakota way of life. I have authorized attorney Bruce Ellison through Owe Aku to represent my interests in this proceeding. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. My address is: P.O. Box # 1802 Pine Ridge SD 57770
I have lived here my entire life (38 years) located less than 100 yards from the White river.

3. I have fished and bathed in the White River throughout my entire life, and hunted animals that drink and live along the White River. I am concerned that the fish and animals that I eat may be affected by any pollution in the White River from this mine.

4. I use the water from our well at this address for drinking, bathing, cooking, and irrigation. I also live in the wind path that comes from the proposed North Trend Expansion Area.

5. For meany years, I have participated in the *inipi* ceremony (also known as the "sweat lodge"), at Slim Buttes, which is about 20 miles from the Nebraska border on BIA 41, at Pine Ridge Indian Reservation.

6. Slim Buttes is located along the White River and wells at Slim Buttes draw water from the Arikaree aquifer.

7. In the *inipi*, or sweat lodge, ceremony, water is poured on hot rocks in a sacred manner according to traditional ways. Participants in the *inipi*, or sweat lodge, ceremony breathe in water vapor during the ceremony. I regularly breathe in such water vapor. During the *inipi*, we pray for the health of all people, the safety of all those in jeopardy including the soldiers abroad and for the healthy future of our children, grandchildren and their grandchildren.

8. The Oglala Sioux Tribe, among other tribes of the Great Sioux Nation, possess superior water rights in the region, never quantified, arising from federal treaties with the Great Sioux Nation in 1851 and 1868.

9. To an indigenous person such as myself, a member of the Oglala Sioux Tribe and of the Great Sioux Nation, the nature of water has cultural and spiritual significance and value that is much greater than its use and value as a vital natural resource. In Lakota language, we honor "***mni***" which means the "water" itself, as well as "***mni wiconi***" which means "water of life," and "***mni wakan***" which means "sacred water" or "holy water."

10. This means that we honor the "***mni***" as water for drinking, bathing, domestic, farming and other benign uses and it has a value to us for such purposes. Under the "***Winters Doctrine***" we are entitled to as much of this "***mni***" as is necessary for us to live on the Pine Ridge Indian Reservation our right is a federal water right that is superior to any state law water rights, including the water rights of the company, if any.

11. This means that we also honor the "***mni wiconi***" which is the water of life that we drink as a medicine during sacred prayer ceremonies like the "***inipi***" (sweat lodge ceremony). This also means that there is a life and spirit in the water which we, as indigenous people, recognize and commune with and pray with and we know its healing power.

12. This means that we also honor the "***mni wakan***" which is the sacred water used to conduct sacred prayer ceremonies like the "***inipi***" ceremony. This means that the sacredness of the spirit of the water is recognized by us as indigenous people.

13. There may be Indian graves or other Indian artifacts at the site near the Mine that are of historic and/or cultural significance.

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 27th, 2008, at Slim Buttes, SD, Pine Ridge Indian Reservation.

[redacted]

LESTER "BO" J. DAVIS

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543 July 28, 2008

AFFIDAVIT

I, Loretta Afraid of Bear Cook, hereby state as follows:

1. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). My address is: 1705 S. Maple Street, Chadron, NE, 69337. I have authorized attorneys David Frankel and Shane Robinson to represent me in this matter. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. My name is Loretta Afraid of Bear Cook, my mother is Beatrice Long Visitor Holy Dance also known as Beatrice Weasel Bear. My husband is Thomas Kanatakeniate Cook and my daughter is Sakakohe Cook. My mother, myself and my daughter are enrolled members of the Oglala Sioux Tribe.

3. The Oglala bands have been on the Pine Ridge Indian Reservation since 1879 on land making up the southern tier of the badlands of South Dakota. The place now hosts the second-poorest county of the 3,147 counties in the USA.

3. My family used to live at Slim Buttes, which is about three (3) miles from the Nebraska border on the Slim Buttes/Chadron Road (BIA 41), at Pine Ridge Indian Reservation. I was born and raised on our family land at Slim Buttes. My daughter Sakakohe was born in New York and we moved back to our family land at Slim Buttes in 1980 when she was about 1-1/2 years old. Our family land at Slim Buttes has several well pumps and we were drinking and bathing with water from our wells. The White River flows through our family land although it has run dry. My family, including my children, used to swim and play in the White River before it went dry.

4. After we were living at Slim Buttes for about a year, I noticed skin problems with Sakakohe who was otherwise a healthy baby. In April 1981 I brought Sakakohe to a healing ceremony to address the skin problems. During the following months, I monitored the situation and brought her to see a doctor as her condition

worsened. She would break out with red blotches and her eyes would puff up after we would bathe her or after she was playing in the White River. In 1983, when Sakakohe was 4 years old, on a doctor's visit, the doctor said that Sakakohe was suffering from an allergic reaction to different unknown things and put her on Benadryl for more than a year. After some time, the doctor said that the water was not good for Sakakohe and we should move her away from our family land to a place with different water. We moved to Chadron shortly after that.

5. After we moved to Chadron, the condition changed and Sakakohe stopped having puffiness and skin irritations but remains sensitive to this day in that she bruises and welts easily and her skin puffs up when lightly scratched. Sakakohe remains on skin medications to deal with her condition, which we view as an environmental illness.

6. Lakota people are taught to honor our water, to respect it, to understand that it is holy and sacred to us. We are taught that to be connected to our land and our water connects us to the Creator. When we are forced away from our family land and our water, we lose some of our connection to our Creator and it makes it difficult for us to practice our traditional ceremonies according to traditional ways.

7. I have participated for at least twenty continuous years in the *Inipi ('Sweat Lodge')* ceremony at Slim Buttes Community on the reservation. The site is located along the White Earth River, three miles north of the Nebraska State line, on the Slim Buttes road (BIA 41). It is the sweat lodge of my older cousins, the Afraid Of Bear brothers, of the same community.

8. Slim Buttes is located along the White River and wells at Slim Buttes draw water from the Arikaree aquifer.

9. In the Inipi ceremony, water is poured on very hot rocks in prescribed manner according to traditional usage. Participants actively address water as life itself, and say words of gratitude, thanksgiving, etc., to it. The intense water vapor is understood as life itself and incites focus upon it. All the elements and directions of life are addressed, and the health of all people, and particularly the safety of all those in jeopardy including the soldiers abroad, and for the healthy future of our children, grandchildren and their grandchildren. Clean water is an essential element of this ancient ceremony of Lakota *Tiospayes (Related Families).*

10. The Oglala Sioux Tribe, among other tribes of the Great Sioux Nation, possess superior water rights in the region, never quantified, arising from federal treaties with the Great Sioux Nation in 1851 and 1868.

11. There is a legal mechanism for formal consultations with the Tribe involving formal notice to the Tribe and the Department of Interior, Bureau of Indian Affairs ("BIA").

12. To my knowledge, no notice was provided to the Tribe or the BIA with

regard to a formal consultation concerning the company. While the BIA has jurisdiction over certain areas with the Tribe, the Nebraska State Historical Preservation Officer has absolutely no authority over the Tribe or any member of the Tribe.

13. To an indigenous person such as myself, a member of the Oglala Sioux Tribe and of the Great Sioux Nation, the nature of water has cultural and spiritual significance and value that is much greater than its use and value as a vital natural resource. In Lakota language, we honor "***mnī***" which means the "water" itself, as well as "***mni wiconī***" which means "water of life," and "***mni wakan***" which means "sacred water" or "holy water."

14. This means that we honor the "***mnī***" as water for drinking, bathing, domestic, farming and other benign uses and it has a value to us for such purposes. Under the "***Winters Doctrine***" we are entitled to as much of this "***mnī***" as is necessary for us to live on the Pine Ridge Indian Reservation our right is a federal water right that is superior to any state law water rights, including the water rights of the company, if any.

15. This means that we also honor the "***mni wiconī***" which is the water of life that we drink as a medicine during sacred prayer ceremonies like the "***inipi***" (sweat lodge ceremony). This also means that there is a life and spirit in the water which we, as indigenous people, recognize and commune with and pray with and we know its healing power.

16. This means that we also honor the "***mni wakan***" which is the sacred water used to conduct sacred prayer ceremonies like the "***inipī***" ceremony. This means that the sacredness of the spirit of the water is recognized by us as indigenous people.

17. There may be Indian graves or other Indian artifacts at the site near the Mine that are of historic and/or cultural significance.

18. We expect the United States government and all its agencies to protect the water so that we have as much pristine water as we need for ourselves, our grandchildren and their grandchildren to have for drinking, praying, and healing.

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 28, 2008 at Chadron, Nebraska.

Loretta Afraid Of Bear Cook

LORETTA AFRAID OF BEAR COOK

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of

CROW BUTTE RESOURCES, INC.

(In Situ Leach Facility, Crawford, NE)

Docket No. 40-8943

License SUA-1543

July 28, 2008

AFFIDAVIT

I, Debra L. White Plume, Director of Owe Aku, Bring Back the Way, hereby state as follows:

1. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). My address is: Box 325, Manderson, South Dakota 57756. I have authorized attorneys Bruce Ellison, David Frankel and Shane Robinson to represent me in this matter. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. My name is Debra L. White Plume. I am the Director of the nongovernmental organization Owe Aku, Bring Back the Way.

3. I do reiterate everything in my affidavit as an individual tribal member.

4. Owe Aku is an organization dedicated to the preservation of the Lakota Way of Life, including our territories and environment. We work to preserve 1951 and 1868 Ft. Laramie Treaty Territory and our environment as part of Creation and are concerned with the Cameco uranium mining and milling activities and planned activities for the area near Crawford Nebraska that is only 30 miles for our nearest border.

5. We serve our people and our way of life, which includes our future generations. Cameco corporation is doing business that impacts our ground water, has many leaks and spills in Crawford and everywhere they mine and has to pay fines for license violations. We believe their reputation as a polluter causes doubt they can operate safely and may endanger our people and

our water, air and land. Owe Aku has not found any research where Cameco has ever operated safely all the time, they have always leaked and spilled everywhere they mine, nor have we found research where Cameco has completed a uranium mine clean up at any of their business locations anywhere in the world so they cannot prove they know how to do this and have done it before, thus we are not convinced they have a good track record and thus deserve our respect and confidence they will not cause pollution for our environment and people. Owe Aku is concerned with the ground and surface water in this area and Cameco plans to mine and mill uranium in this area which we depend on for drinking water and where our people will live for many generations. Once radioactive contaminants are released into our environment by Cameco our people will forever be endangered so Owe Aku is forever opposed to uranium mining and milling in our environment and supports the Oglala Sioux Tribe in its legislation to declare our territory a nuclear free zone and to prosecute to fullest extent any individual or entity releasing contaminants into our environment.

6. Owe Aku endorses the Declaration on the Rights of Indigenous Peoples passed by the United Nations and actually participated in the drafting at Geneva Switzerland. Our people were not consulted on the Canadian company infiltration to our treaty territory to extract minerals and metals and impacts on our people and our water source. This is a violation of the Declaration. This is a violation of our Human Rights. Owe Aku endorses the Sioux Nation Treaty Council Position Statement being forever opposed to uranium mining and Crow Butte Resources mining in our treaty territory.

7. Owe Aku is concerned with the health and future health of our people. Our people have high cancer and diabetes which we believe may be impacted by high rads and arsenic in our water, we ask ourselves, did the rads and arsenic come from Cameco mining activities? Cameco should prove that their mining and milling activities HAS NOT impacted our health and our drinking water if they want to present an assurance that they are a safe corporation doing business here for the next 10 to 20 years. We only have so many Oglala people, if we all die from their mining and milling activities, this is a definition of genocide.

8. Owe Aku is concerned not only with the pollution impacts of Cameco mining and milling but also with Cameco's planned waste of water in this drought striken plains area for the next 10 to 20 years, which has a finite amount of water to depend on. Millions of gallons of Cameco waste water will be stored underground forever, they say it is not too radioactive, that they will take as much of the radiation out of it as they can, but that it will still be so contaminated that it must be removed from human contact FOREVER so they will dump it in the ground, under the aquifer. We could not find in their application prove that it will stay there forever. Cameco had to double their bond in Wyoming as a condition of a settlement of license violations, their bond in Nebraska is too low to cover the cost of cleanup if they walk away and leave us with the mess, this is not a sign of good faith that they are a good business who cares about the environment and the human beings. If they walk away or their bond is not high enough, Owe Aku will be impacted forever by the contamination they leave behind and by the water they wasted to do their mining activities.

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 28, 2008.

Signed (electronically) by
Debra White Plume
Director
POB 325, Manderson, SD 57756
605-455-2155
lakota1@gwtc.net
July 28, 2008

/s/

Owe Aku

By: Debra L. White Plume, Director of Owe Aku

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543 July 27, 2008

AFFIDAVIT

I, Thomas Kanatakeniate Cook, hereby state as follows:

1. I make this affidavit in connection with a Petition to Intervene in the renewal application of Crow Butte Resources, Inc. d/b/a Cameco Resources, a/k/a The Crow Butte Project concerning *in situ leach* uranium mine near Crawford, Nebraska (the "Mine"). My mailing address is: 1705 S. Maple Street, Chadron, NE, 69337. I have authorized attorneys David Frankel and Shane Robinson to represent me in this matter. I am fully familiar with the facts stated in this affidavit, and where opinions are expressed, I am competent to state such opinions based on my training, knowledge, experience and expertise. If sworn as a witness, I am competent to testify to the contents of this affidavit.

2. I am an enrolled member of the St. Regis Mohawk Tribe, Akwesasne, New York. I have been on Pine Ridge Reservation for 35 years and married for 32. My wife and I own real estate and homes both on Pine Ridge and in Chadron. Both houses are maintained and occupied. I am in my 15th year of employment as field coordinator for Running Strong for American Indian Youth (www.indianyouth.org), a national non-profit long active on Pine Ridge Indian Reservation. Currently, I serve as president of the Chadron Native American Center providing programs and services to 1,500 Native Americans in the Nebraska Panhandle. As a duly appointed member of the Nebraska Commission on Indian Affairs since 1999, I communicate to the governor the concerns of my constituency, comprised of the poorest of the poor in Nebraska. I am an inactive member of the Oglala Sioux Tribe Bar.

2. My wife of 32 years, Loretta Afraid Of Bear Cook, is the eldest of nine children of Beatrice Weasel Bear, nee Long Visitor Holy Dance, and all are enrolled members of the Oglala Sioux Tribe. Loretta is a landowner within the Long Visitor Holy Dance Allotment (#1144) containing 640 acres. Situated twenty miles north of Chadron, three miles into the reservation (BIA Rte 41), the allotment is traversed by the White River. My mother-in-law and my wife were raised on the family allotment drinking and using the White River water on a daily basis. During the eight years my wife, our three children and I lived at the place, we used a 30'groundwater well and the river on a daily basis.

3. Our youngest daughter was born in New York and we moved back to family land at said allotment in 1980 when Sakakohe was 1-1/2 years old. From that date until 1985, we used a 30' groundwater well and river water for all our needs, including swimming, garden irrigation, and eating fish from the river. Since 1980, the White River has run completely dry in only two years – 2007 and 2008 (at present).

4. After we were living at Slim Buttes for about a year, my wife noticed skin problems with Sakakohe who was otherwise a healthy baby. In April 1981, my wife brought Sakakohe to a healing ceremony to address the skin problems. During the following months, we monitored the situation and brought her to see a doctor as her condition worsened. She would break out with red blotches and her eyes would puff up after we would bathe her or after she was playing in the White River. In 1983, when Sakakohe was 4 years old, on a doctor's visit, the doctor said that Sakakohe was suffering from an allergic reaction to different unknown things and put her on Benadryl for more than a year. After some time, the doctor said that the water was not good for Sakakohe and we should move her away from our family land to a place with different water. We moved to Chadron shortly after that. For more than 20 years, I have been commuting almost daily between our house in Chadron and our family land in Slim Buttes so that we can maintain two homes and our strong connection to the land and traditions attending it.

5. After we moved to Chadron, our daughter's condition changed and Sakakohe stopped having puffiness and skin irritations but remains sensitive to this day in that she bruises and welts easily and her skin puffs up when lightly scratched. Sakakohe remains on skin medications to deal with her condition which we view as an environmental illness.

6. Indigenous people are taught by their elders to honor, respect, and address water, and understand that it is holy, sacred, and essentially life itself. It is called the 'first medicine' for any desired cure. We are led to believe that connectedness to our land and water is connection to the Creator. When we are forced away from our family land and our water, we lose a route of direct connection to the Creator making it difficult for us to practice our time-honored Lakota ceremonies and usages as we were taught.

7. I have participated in and led sacred Lakota ceremonies including the *Inipi* ceremony (the "sweat lodge") for 35 years. In conjunction with Lakota elders, I presently conduct *Inipi* twice a week throughout the year at Allotment #114. I have been conducting this ceremony twice per week since the death of my father-in-law Ernest Afraid Of Bear, Sr., in 2004. For more than 20 years before his death, my father-in-law led this particular *Inipi* consistently on a weekly basis.

8. Allotment #1144 in Slim Buttes community of Pine Ridge Reservation is traversed by the White River and our two water wells there draw water from the Arikaree aquifer. We used well water at our *Inipi* until the water pipeline reached Allotment #1144 in the mid-1990's.

9. In the *Inipi*, or sweat lodge, ceremony, water is poured on heated rocks in a prescribed manner according to traditional usage. Participants actively address water as life itself, through song, accompanying drum, ancient words and declensions. The intense water vapor is understood as life itself, inciting focus on the prayers being made. During the *Inipi*, participants pray for the health of all people, the safety of all those in jeopardy including the soldiers abroad, and for the healthy future of our children, grandchildren and their grandchildren. The ceremony is culturally perceived as beneficial to one's overall heath.

10. The Oglala Sioux Tribe, among other tribes of the Great Sioux Nation, possess superior water rights in the region, never quantified, arising from federal treaties with the Great Sioux Nation in 1851 and 1868.

11. There is a legal mechanism for formal consultations with the Tribe involving formal notice to the Tribe and the Department of Interior, Bureau of Indian Affairs ("BIA"). To my knowledge, no notice was provided to the Tribe or the BIA with regard to a formal consultation concerning the company. While the BIA has jurisdiction over certain areas with the Tribe, the Nebraska State Historical Preservation Officer has absolutely no authority over the Tribe or any member of the Tribe.

12. To an indigenous person such as myself, the nature of water has cultural and spiritual significance and value that is much greater than its use and value as a vital natural resource. In Lakota language, we honor "***Mnī***" which means the "water" itself, as well as "***Mni wiconī***" which means "water life," and "***Mni wakan***" which means "sacred water" or "holy water."

13. We honor the "***Mnī***" as water for drinking, bathing, domestic, farming and other benign uses, and it has a value to us for such purposes. Under the "***Winters Doctrine***" we are entitled to as much of this "***Mnī***" as is necessary for us to live on the Pine Ridge Indian Reservation our right is a federal water right that is superior to any state law water rights, including the water rights of the company, if any.

14. We also honor the "***Mni wiconī***" which is the water of life that we drink as a medicine during sacred prayer ceremonies like the "***Inipi***" (sweat lodge ceremony). This also means that there is a life and spirit in the water which we, as indigenous people, recognize and commune with, and pray with.

15. This means that we also honor the "***mni wakan***" which is the sacred water used to conduct sacred prayer ceremonies like the "***inipī***" ceremony. This means that the sacredness of the spirit of the water is recognized by us as indigenous people.

16. We expect the United States government to protect the water so that we have as much pristine water as we need for ourselves, our grandchildren and their grandchildren to have for drinking, praying, and healing.

17. I have worked with Slim Buttes Agricultural Development Corporation

and Running Strong for American Indian Youth for 23 years to stimulate self-sufficiency though developing family and community vegetable gardens. This year we plowed 244 family gardens across Pine Ridge Indian Reservation. Additionally, Running Strong drills water wells for families and has made close to 400 such wells across the reservation. Groundwater well development for families, along with gardening made possible by it, depends on the continued availability of pristine water to be healthy for the people. This work is undermined to the extent that there is any contamination of the water supply, surface waters or land that would make the wells toxic and the gardens unproductive or that would make the food from the gardens unhealthy.

This Affidavit is submitted in accordance with 10 C.F.R. Section 2.304(d) and 28 U.S.C. Section 1746. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 28, 2008 at Chadron, Nebraska.

Thomas Kanatakeniate Cook

THOMAS KANATAKENIATE COOK

Is Water Property?

by Sandra B. Zellmer and Jessica Harder

Sandra B. Zellmer

Sandra Zellmer is Professor and Hevelone Research Chair at the University of Nebraska College of Law and Co-director of the UNL Water Resources Research Initiative. She recently completed a casebook, *Natural Resources Law*, published by Thomson/West in 2006. Zellmer received her LL.M. in environmental law from the George Washington University National Law Center, her J.D. from the University of South Dakota School of Law, and B.S. from Morningside College. Prior to teaching, she was a trial attorney in the Environment and Natural Resources Division of the U.S. Department of Justice, litigating public lands and wildlife issues for various federal agencies.

Jessica Harder

Jessica Harder is the Water Outreach Associate with the University of Nebraska Rural Initiative and UNL Water Center. She graduated from the University of Nebraska College of Law with a J.D. and a Certificate in Natural Resources and Environmental Law.

Introduction

One of the most controversial issues in natural resources law is whether interests in water are property. In the western United States, water is typically viewed by appropriators as a form of private property, while in the East it is not. In either case, the law is surprisingly unsettled, notwithstanding the important consequences that follow, particularly under constitutional takings jurisprudence.

Treating water as property has significant implications for investment, conservation and environmental protection as well. Establishing secure property rights can foster stewardship and wise investment of labor and capital. By the same token, the absence of property ownership can result in a "tragedy of the commons," where a common resource is plundered as each selfish, yet economically rational, actor takes steps to promote self-interest with little regard for externalities that deplete the resource. On the other hand, public ownership of water is deeply embedded in western legal traditions, in recognition that water is essential to all life and must be safeguarded to prevent depletion and ensure satisfaction of a broad range of public needs.

This brief essay considers whether interests in surface water are property. Just over a year ago, in *Spear T. Ranch v. Knaub*,[2] the Nebraska Supreme Court held "no," but provided scant analysis in support of its conclusion. We assess both the nature of property and the nature of water, and then turn to the implications of treating water as property (or not) in Nebraska. These topics are the subject of a longer article in progress, which looks at water rights nationwide.

I. What is Property and Why Do We Care?

Property law helps create and safeguard stable relationships between persons and things, allowing property owners to extract the greatest value from that relationship and to protect it against competing claims.[3] Characterizing a thing as property has significant legal ramifications. First, it is essential for establishing a Fifth Amendment takings claim against the United States or an expropriation claim under international investment treaties.[4] Characterization as property has many other important legal consequences. Take remedies, for example. Property rules are often enforced through injunctions, in contrast with tort or contract liabilities, which typically lead to monetary relief. Classification as property may also be determinative of issues involving mortgaging, the creation of present and future interests, and special treatment under federal or state tax laws (like conservation easements, amortization, or like-kind exchanges).

In spite of its importance, the concept of property is frustratingly ambiguous. According to the Restatement (First) of the Law of Property, the term describes "legal relations between persons with respect to a thing."[5] But of course, not all economic relationships give rise to property rights, and herein lies the rub, as they say. According to the Supreme Court, "only those economic advantages are 'rights' which have the law in back of them."[6] In *Klamath Irrigation District v. U.S.*, the federal claims court framed its struggle to define water rights as follows:

> What is property? The derivation of the word is simple enough, arising from the Latin *proprietas* or "ownership," in turn stemming from *proprius*, meaning "own" or "proper." But, this etymology reveals little. Philosophers such as Aristotle . . . and Locke each, in turn, have debated the meaning of this term, as later did legal luminaries such as Blackstone, Madison and Holmes . . .[7]

Among the scholars and jurists cited by the court, surely Sir William Blackstone is the most familiar to property law aficionados. The American view of private property in land has been indelibly shaped by Blackstone, who described it as "that sole and despotic dominion . . . over the external things of the world, in total exclusion of the right of any other."[8] Ironically, it is highly unlikely that landowners enjoyed unfettered rights to real property when this phrase was penned, and Blackstone himself expressed some misgivings about the notion of exclusive dominion. Regardless, the concept is still influential today and has taken on near-mythical proportions among property rights proponents.

No doubt, exclusivity is a key feature of a property right; some have argued that it is in fact *the* key feature of property.[9] One way to break down the concept of property is to consider whether an interest in a thing enjoys the standard incidents of property ownership: the right to use (or not), the right to convey, and especially the right to exclude. Interests in water, as described below, are neither exclusive nor freely conveyable. Although such interests include usage, it is forbidden to *not* use water for speculative, aesthetic, or any other purpose. Yet, this begs the question—if exclusivity or one of the other incidents is lacking or severely diminished, are we dealing with something other than property?

Here is where the "bundle of sticks" metaphor may be useful. Though this conceptual tool has garnered its share of criticism, it has been employed by countless law professors to illustrate the nature of interests in property to first year students, and has become part of the "intellectual zeitgeist" of American property law.[10] The bundle represents the sum total of rights one can have with respect to a parcel of land. The sticks in the bundle can be disaggregated without defeating the characterization of the parcel as property. A reversion, a life estate, a remainder, and a fee simple determinable each represent but one stick in the bundle of legally protected property interests. Likewise, a right to exclude, to use, and to convey are each but one stick in the bundle. Collectively, the various estates or, in the second example, the various incidents, add up to the whole bundle: the fee simple absolute.

What does the metaphor tell us about things other than land, specifically, water? For one thing, it illustrates that perhaps public rights in navigation, fisheries, recreation or water quality can comprise one of the sticks in the bundle without completely eviscerating the notion that a private interest to use the water is indeed property. But if we remove the exclusivity stick, which represents the very essence of property ownership, does the entire bundle fall apart, leaving us with a few scattered twigs, but not property? Conversely, are there still enough of the incidents or attributes of property left to justify treating the interest in water as property? In effect, this exercise brings us back to square one, but at the same time it prompts us to take a closer look at water and the various interests that are asserted in water.

II. Water is a Unique Public Trust Resource

There are at least two possible ways to unbundle the notion of property in water. The first is to consider whether water is a thing that is ever subject to ownership as a form of property. In other words, do water and relationships to water possess the essential characteristics of property: exclusivity, use, and transferability? Although this approach fosters stability in the rule of law, it is quite inflexible.[11] As first year law students learn, there are very few absolutes in the law. Yet, the Nebraska Supreme Court appears to have taken this path in the *Spear T* cases, described in Part III below.

An alternative path is to review the caselaw that has addressed the issue in various contexts and draw conclusions from those cases about the fundamental nature of water. Courts employ this method frequently, although they do not always articulate it as such. In *International News Service v. Associated Press*,[12] for example, the Supreme Court characterized the news as "quasi-property" for purposes of a dispute between newspapers, but refused to recognize property rights against the general public. This contextual approach allows decision-makers to treat a thing or relationship as property in one circumstance but not necessarily others, and in doing so it promotes flexible, equitable results.

Both alternatives require a close look at the elemental nature of water. Water is a unique resource. It is essential to all life. Its physical properties are unlike any other thing. There is no capacity for exclusive possession or use of water in a stream, a lake or even an irrigation ditch. It is constantly moving along the surface, seeping into the ground, evaporating into the air, and being taken up by plants, fish and other aquatic species. Quantities are never entirely certain; drought, precipitation, and even the practices of other users create ever-changing circumstances.

According to Professor Joseph Sax, who has written frequently on the nature of property rights, the uniqueness of water as a legal concern is universally acknowledged:

> The roots of private property have never been deep enough to vest in water users a compensable right to diminish lakes and rivers or to destroy the marine life within them. Water is not like a pocket watch or a piece of furniture, which an owner may destroy with impunity. The rights of use in water, however long standing, should never be confused with more personal, more fully owned, property.[13]

In systems built on English common law, surface water is viewed as a type of "public trust" resource, where the sovereign retains rights and responsibilities to protect the resource for the public. The public trust doctrine traces its pedigree to Roman law. Because water is an essential resource upon which all life depends, navigable waterways, tidal areas, shorelines and stream beds cannot be held exclusively in private hands, but are impressed with the *jus publicum*, the public right. Although the doctrine was adopted in the United States through the incorporation of English common law, there is "an astonishingly universal regard for communal values in water worldwide."[14] A review of Asian, African, Islamic and Native American laws reveals rivulets of the public trust doctrine flowing from all reaches of the basins of the world.[15]

The public trust doctrine has enjoyed modern staying power in caselaw at both the federal and state level. In the eastern United States, it undergirds the law of "reasonable use," where riparian land owners have usufructuary rights to water that flows through or past their land, but may not deplete the flow in a way that harms other riparians or interferes with public access. In the West, the doctrine is embodied in provisions that give authority to the state to administer appropriative systems and ensure beneficial use of water resources. The public trust, however, has rarely acted a significant curb on private appropriators' rights to water. In a marked deviation from this trend, the Supreme Court of California imposed it in *National Audubon Society v. Superior Court* (the Mono Lake case):

> The state as sovereign retains continuing supervisory control over its navigable waters and the lands beneath those waters. This principle, fundamental to the concept of the public trust, applies to rights in flowing waters as well as to rights in tidelands and lakeshores; it prevents any party from acquiring a vested right to appropriate water in a manner harmful to the interests protected by the public trust.[16]

The Mono Lake decision is frequently cited by courts all across the nation, but it has had relatively little on-the-ground impact on the exploitation of water resources outside of California and a handful of other jurisdictions. Even so, the public trust doctrine is expressed in western legislation and caselaw through constraints on the use and conveyance of water, both of which are heavily regulated.

III. The Nature of Water Rights in Nebraska

Over-appropriation has become an almost insurmountable problem throughout Nebraska and in many watersheds of the West. This is hardly surprising. Prior appropriation arose during the late 1800s as a way to maximize use and promote settlement and economic development, and in fact it did just that, with little regard for the long-term sustainability of the resource or the communities—ecological and human—that rely on it.[17]

The prior appropriation regime, often described as "first in time, first in right," is an expedient means of determining who gets water, how much she gets and when. The Nebraska Supreme Court has described this system of distributing water according to appropriators' respective priorities as "undoubtedly enacted in furtherance of a wise public policy to afford an economical and speedy remedy to those whose rights are wrongfully disregarded by others, as well as to prevent waste, and to avoid unseemly controversies that may occur where many persons are entitled to share in a limited supply of public water for the purposes of irrigation."[18]

In the West, private interests in water use are typically ensconced in state constitutions. The Colorado constitution, for example, provides that "the right to divert the unappropriated waters of any natural stream to beneficial uses shall never be

denied."[19] Yet another provision specifies that water is "the property of the state, and the same is dedicated to the use of the people of the state, *subject to appropriation* . . ."[20] Courts have held that these provisions create compensable property rights to use water.[21]

Nebraska's constitution is similar, with an important distinction. It first provides that the use of water is dedicated to the people of the state, and goes on to proclaim: "The right to divert unappropriated waters of every natural stream for beneficial use shall never be denied *except when such denial is demanded by the public interest.*"[22] This language has been construed by the Nebraska Supreme Court as allowing the legislature to define the "public interest."[23] Accordingly, statutes allow only beneficial use, require permits, forbid waste, and prohibit non-use through forfeiture provisions.[24] The legislature has also restricted transfers between domestic, industrial, and agricultural preference categories, and imposed strict requirements on transfers within each category to prevent harm to other appropriators.[25] More recently, the state has taken strides toward sustainable, integrated management of surface and groundwater resources through the enactment and implementation of LB 962 and other measures,[26] some of which might not have been possible if private interests in water were viewed as inviolate property rights.

In its 2005 opinion in *Spear T. Ranch v. Knaub*, the Nebraska Supreme Court summed up these provisions to conclude that "[a] right to appropriate surface water . . . *is not an ownership of property.*"[27] As unequivocal as this sounds, the court tempered its statement in the next line: "Instead, the water is viewed as a public want and the appropriation is a right to use the water."[28] One might view this as a distinction without a difference, because rights to water have always been recognized as usufructuary—a right to use but not outright ownership in the corpus of the water *in situ*.[29] Given the usufructuary nature of water rights, appropriators' expectations of exclusive enjoyment are far less than those of landowners.[30]

The distinction between ownership of water and a mere right to use water, however, made a tremendous difference to the Spear T plaintiff, a surface water appropriator harmed by groundwater pumping. The court rejected Spear T's attempt to protect its "property" under a theory of conversion (an act of dominion wrongfully asserted over another's property), and left Spear T to tort remedies.[31] Likewise, Spear T's claim against the Department of Natural Resources for a taking of property under the Nebraska Constitution was dismissed.[32]

Curiously, the court cited only groundwater-related precedent in holding that Spear T had no property interest in its surface water.[33] In Nebraska, groundwater is not subject to private ownership; rather, it is owned by the state for the benefit of the public.[34] Indeed, "Nebraska law has never considered ground water to be a market item freely transferable for value among private parties."[35]

Previous surface water cases had concluded just the opposite: that appropriators who complied with statutory requirements did in fact possess vested property rights.[36] In 1952, *City of Scottsbluff v. Winters Creek Canal Co.* invalidated an ordinance that deemed open canals to be public nuisances and required owners to fill them or construct water pipes.[37] The court found that the ordinance was an arbitrary exercise of the police power, and opined in dicta that it would result in "confiscation of the company's property without due process or payment of just compensation."[38]

The issue was addressed directly in *Enterprise Irrigation Dist. v. Willis*.[39] There, the court held that the 1895 Irrigation Act, which limited appropriations to three acre-feet per acre, was not intended to apply retroactively. It conceded that the state may control the distribution of water to ensure beneficial use and guard against waste by virtue of its police power, but concluded that the statutory limitation could not be applied to an appropriation that vested prior to enactment. "That an appropriator of public water, who has complied with existing statutory requirements, obtains a vested property right has been announced by this court on many occasions."[40] The court continued that the state's police power had never been expanded so far as to allow the legislature "to destroy vested rights in private property when such rights are being exercised and such property is being employed in the useful and in nowise harmful production of wealth" unless use of the property is "shown to be inimical to public health or morals or to the general welfare."[41]

Perhaps *Spear T* evidences an evolution in the law to reflect modern social values, or perhaps the opinion is simply a more reasoned application of the long-standing notion that water is a "public want." Whether an emerging trend in the law is a deviation or merely a reflection of background principles of property law is an issue often raised in regulatory takings cases. State law takings jurisprudence typically follows Supreme Court precedent under the U.S. Constitution, where a governmental regulation that goes "too far" in impacting private property will be considered a compensable taking.[42] Once a property right is found to have been affected, courts employ a fact-based balancing approach that considers the effects of the regulation on reasonable investment-backed expectations and the character of government action.[43] In rare cases where a regulatory action causes a physical invasion of the property or denies all economically beneficial use, however, the balancing test is not applied; rather, a per se taking will be found.[44] That is, compensation must be paid unless the interest in question was already limited by a background principle of law that inheres in the claimant's title.[45]

Although background principles are generally found in state property law, when it comes to water, principles of federal law can also impose an inherent limitation on the claimant's interest. In *U.S. v. Rands*, the Supreme Court concluded that landowners adjacent to the Columbia River had no property rights as against the United States in any interests subject to the navigational servitude, including the flow of the water in the river, access to the water, and other values attributable to proximity to water: "these rights and values are not assertable against the superior rights of the United States, [and] are not property within the meaning of the Fifth Amendment . . ."[46]

Conversely, in *Tulare Lake v. U.S.*, the federal claims court awarded irrigators some $20 million when the Bureau of Reclamation curtailed contract allowances to provide flow for endangered species.[47] The court concluded that the plaintiffs had vested property rights by virtue of their contracts and California water law. Although there was "no dispute that [the supplier's] permits, and in turn plaintiffs' contract rights, are subject to the doctrines of reasonable use and public trust and to the tenets of state nuisance law," the court concluded that only the state Water Resources Control Board could modify the permit terms to reflect changing needs.[48] Because the Board had not done so during the period in question, the court declined: the laws "require a complex balancing of interests . . . and an exercise of discretion for which this court is not suited and with which it is not charged."[49]

The same court reached the opposite conclusion a few years later in a case arising in Oregon, *Klamath Irrigation District v. U.S.*[50] There, summary judgment was granted to the United States on the grounds that any interest the irrigators had in Reclamation water was contractual and not property. The court explicitly criticized the *Tulare* opinion for failing to assess the underlying nature of the interest in question to discern whether the plaintiffs in fact possessed property rights: "Tulare appears to be wrong on some counts, incomplete in others and, distinguishable, at all events."[51]

> Reluctant to delve into the nuances of the reasonable use and public trust doctrines, [in *Tulare*,] the Court of Federal Claims seized on [the Board's previous decision to grant the permit] . . . as the conclusive definition of the water rights . . . In essence, the court decided that an appropriator is legally entitled to engage in (and has property rights to) any conduct that is authorized by its water rights permit or license. This interpretation oversimplifies—and therefore misapprehends—the nature of California water rights.[52]

Notably, the public trust doctrine is an inherent limitation on interests in water, the exercise of which is not a taking.[53] In California, at least, the public trust doctrine forms a fundamental component of the water rights system. One distinction between California and Nebraska water law, however, is that the California code has been construed as providing the Board with continuing jurisdiction over water permits.[54] Although the Nebraska Department of Natural Resources has no parallel authority, it must remain vigilant against forfeiture or waste and scrutinize new appropriations and transfers to ensure that the public interest is satisfied.

Conclusion

What of the Nebraska Supreme Court's bold stance that "[a] right to appropriate surface water . . . is not an ownership of property?" It appears legally defensible, at least as between an appropriator and the state, on either of two grounds: (1) interests in water are not property at all when asserted against the state, acting to protect the public trust, or (2) interests in water are only quasi-property, restricted by inherent public trust requirements and the innate physical limitations of water. Arguably, the second rationale also justifies the dismissal of Spear T's property-based claims against groundwater pumpers, although this result seems less convincing. The court's sweeping conclusion is most difficult to justify as applied to disputes between individual surface water appropriators. An appropriator's right to use surface water *vis a vis* other appropriators is the very essence of the prior appropriation system, and the strongest stick in the appropriator's bundle of rights. In order for appropriators to execute water transfers, engage in water banking, conserve instream flows, or engage in the myriad of conventional beneficial uses, a clear characterization of what (if any) incidents of property inhere in a water right must be delineated in law and interpreted consistently by the courts. Moreover, adequate remedies for real world disputes between users must be available to water rights holders in order for the prior appropriation system to function and to evolve in a fashion that promotes both stability and the full range of values associated with water.

Endnotes

1 The views presented here are solely those of the authors.

2 269 Neb. 177, 185, 691 N.W.2d 116, 127 (2005).

3 Abraham Bell and Gideon Parchomovsky, A Theory of Property, 90 Cornell L. Rev. 531, 580-581 (2005).

4 U.S. Const. Amd. V; North American Free Trade Agreement, U.S.-Can.-Mex., Dec. 17, 1992, 32 I.L.M. 612 (entered into force Jan. 1, 1994).

5 Restatement (First) of Property (1936). *See Wood v Security Mut. Life Ins. Co.*, 112 Neb 66, 198 NW 573 (1924) (for purposes of construing a lease, "property" includes every interest that one may have in anything that is the subject of ownership); *U.S. v. General Motors Corp.*, 323 U.S. 373 (1945) (for purposes of the Fifth Amendment, "property" denotes the group of rights inhering in the relation to a thing, as the right to possess, use, and dispose of it).

6 *United States v. Willow River Power Co.*, 324 U.S. 499, 502 (1945).

7 *Klamath Irrigation Dist. v. U.S.*, 67 Fed. Cl. 504, 515 (2005), *cert. denied*, 69 Fed.Cl. 160 (2005).

[8] 2 William Blackstone, Commentaries (Edward Christian ed., A Strahan 1823) (1800).

[9] *See* J.E. Penner, The "Bundle of Rights" Picture of Property, 43 UCLA L. Rev. 711, 717, 742-743, 766 (1996); *Dolan v City of Tigard*, 512 US 374, 384 (1994).

[10] Penner, *supra* note 9, at 715. *See* Myrl L. Duncan, Reconceiving the Bundle of Sticks: Land as a Community-Based Resource, 32 Entl. L. 773, 774 (2002).

[11] Penner, *supra* note 9, at 723.

[12] 248 U.S. 215 (1918).

[13] Joseph L. Sax, The Limits of Private Rights in Public Waters, 19 Envtl. L. 473, 482 (1989). *See* Joseph L. Sax, Understanding Transfers: Community Rights and the Privatization of Water, 1 West N.W. 13 (1994); Joseph L. Sax, The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention, 68 Mich. L. Rev. 471 (1970).

[14] Erin Ryan, Public Trust and Distrust: The Theoretical Implications of the Public Trust Doctrine for Natural Resource Management, 31 Envtl. L. 477, 478 (2001).

[15] Charles F. Wilkinson, The Headwaters of the Public Trust: Some Thoughts on the Source and Scope of the Traditional Doctrine, 19 Envtl. L. 425, 431 (1989).

[16] *National Audubon Society v. Superior Court*, 658 P.2d 709, 727 (1983) (emphasis added).

[17] Janet C. Neuman, Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use, 28 Envtl. L 919, 967 (1998).

[18] *Enterprise Irrigation Dist. v. Willis*, 135 Neb. 827, 830, 284 N.W. 326, 329 (1939). *See Farmers' Canal Co. v. Frank*, 72 Neb. 136, 100 N.W. 286, 294 (1904).

[19] Colo. Const. Art. XVI, § 6.

[20] Colo. Const. Art. XVI, § 5 (emphasis added).

[21] *Public Service Co. of Colorado v. F.E.R.C.*, 754 F.2d 1555 (10th Cir. 1985), *cert. denied*, 474 U.S. 1081 (1986); *Ackerman v. City of Walsenburg*, 171 Colo. 304, 467 P.2d 267, 270 (1970); *Farmers Irr. Co. v. Game & Fish Comm.*, 149 Colo. 318, 369 P.2d 557 (1962). But *see Central Colorado Water Conservancy Dist. v. Simpson*, 877 P.2d 335, 347 (Colo. 1994) (regulations that "somewhat . . . decrease" the amount of water available for use will not entitle an appropriator to compensation because there is no title to water flowing in the river).

[22] Neb. Const. Art. XV, §§ 5-6 (emphasis added).

[23] *See In re* Applications A-16642 236 Neb. 671, 463 N.W.2d 591, 604-605 (1990); *In re* Applications A-16027 et al. 242 Neb. 315, 495 N.W.2d 23, 31-34 (1993); Central Platte Natural Resources District v. City of Fremont 250 Neb 252, 549 N.W.2d 112,116-118 (1996).

[24] Neb. Rev. Stat. §§ 46.229 – 46.229.04, 46.231, 46.233.01.

[25] Neb. Rev. Stat. §§ 46-289, 46-294.

[26] Laws 2004, LB 962, operative date July 16, 2004 (codified in various sections of chapter 46, inter alia, of the Nebraska Code).

[27] 269 Neb. 177, 186, 691 N.W.2d 116, 127 (2005) (emphasis added).

[28] *Id.*

[29] Richard S. Harnsberger, Josephine R. Potuto and Norman W. Thorson, Interstate Transfers of Water: State Options after Sporhase, 70 Neb. L. Rev. 754, 787 n.139 (1991).

[30] A. Dan Tarlock, Law of Water Rights and Resources § 3:10 (2006 update), citing *inter alia* Eric Pearson, Constitutional Restraints on Water Diversions in Nebraska: The Little Blue Controversy, 16 Creighton L. Rev. 695, 707 (1983); *In re* Applications A-16027 et al., 495 N.W.2d 23 (Neb. 1993), modified, 499 N.W.2d 548 (1993).

[31] 269 Neb. at 185-186, 691 N.W.2d at 127. For commentary, see LeRoy W. Sievers, Nebraska Water Law Facing Dramatic Changes in our State: The Spear T Ranch Case, *Neb. Law.*, June 2005, at 14; Donald Blankenau et al., *Spear T Ranch v. Knaub:* The Reincarnation of Riparianism in Nebraska Water Law, 38 Creighton L. Rev. 1203 (2005); J. David Aiken, Hydrologically-Connected Ground Water, Section 858, and the Spear T Ranch Decision, 84 Neb. L. Rev. 962 (2006).

[32] *Spear T. Ranch v. Nebraska Dept. of Natural Resources*, 270 Neb. 130, 139, 699 N.W.2d 379, 386 (2005).

[33] *Spear T Ranch*, 269 Neb. at 185-186, 691 N.W.2d at 127, citing Richard S. Harnsberger & Norman W. Thorson, Nebraska Water Law & Administration § 5.27 at 266-67 (1984); State *ex rel.* Douglas v. Sporhase, 208 Neb. 703, 305 N.W.2d 614 (1981), reversed on other grounds, 458 U.S. 941 (1982).

[34] Neb. Rev. Stat. § 46-702.

[35] Sporhase, 208 Neb. at 705, 305 N.W.2d at 616; *Bamford v. Upper Republican NRD*, 245 Neb. 299, 512 N.W.2d 642 (1992); *In re* Application U-2, 226 Neb. 594, 605, 413 N.W.2d 290, 298 (1987); *Prather v. Eisenmann*, 200 Neb. 1, 7, 261 N.W.2d 766, 770 (1978). But see *Sorensen v. Lower Niobrara Natural Resources Dist.*, 221 Neb. 180, 376 N.W.2d 539 (1985) (superseded by statute).

[36] Joseph A. Kishiyama, Note, The Prophecy of Poor Dick: The Nebraska Supreme Court Recognizes a Surface Water Appropriator's Claim Against a Hydrologically Connected Ground Water User in *Spear T Ranch, Inc. v. Knaub*, 85 Neb. L. Rev. 284, 285 (2006).

[37] 155 Neb. 723, 728-730, 53 N.W.2d 543, 547-548 (1952).

[38] 155 Neb. at 728-730, 53 N.W.2d at 547-548.

[39] 135 Neb. 827, 830, 284 N.W. 326, 329 (1939).

[40] *Id.*

[41] *Id.* at 331, citing *Herminghaus v. Southern Cal. Edison Co.*, 200 Cal. 81, 252 P. 607, 622, *cert. dismissed*, 275 U.S. 486 (1927).

[42] *Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393, 413 (1922).

[43] *Penn Central Transp. Co. v. New York City*, 438 U.S. 104, 123-24 (1978).

[44] *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1992).

[45] *Id.* at 1029.

[46] 389 U.S. 121, 126 (1967).

[47] 49 Fed. Cl. 313 (2001).

[48] *Id.* at 324.

[49] *Id.* at 323-24.

[50] 67 Fed.Cl. 504, *cert. denied*, 69 Fed. Cl. 160 (2005).

[51] *Id.* at 538.

[52] Brian E. Gray, The Property Right in Water, 9 Hastings W.-Nw. J. Envtl. L. & Pol'y 1, 9 (2002), citing 49 Fed. Cl. at 324. For a contrary view, see Douglas L. Grant, ESA Reductions in Reclamation Water Contract Deliveries: A Fifth Amendment Taking of Property?, 36 Envtl. L. 1331 (2006).

[53] *See* Melinda Harm Benson, The Tulare Case: Water Rights, The Endangered Species Act, and the Fifth Amendment, 32 Envtl. L. 551, 571 (2002).

[54] Audubon Society, 658 P.2d at 730-731, citing Water Code § 2501.

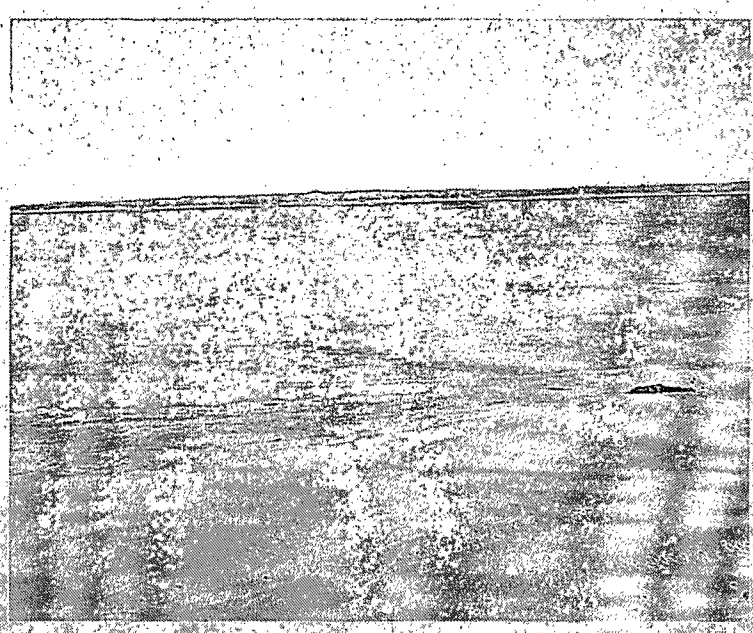
Adaptive Management Sees Resilience, Uncertainty as Allies

Third Annual Conference Looks at Innovation in Water Management

By Charles Flowerday, Editor/Communications Coordinator UNL School of Natural Resources

Sometimes a policy is a legally binding agreement. Sometimes, in an approach to natural resources policy called "adaptive management," it is a hypothesis, an experimental dynamic that helps people plan amid uncertainty.

Dealing effectively with environmental change and the resilience of policy systems is at the center of adaptive management. It was the focus of the University of Nebraska-Lincoln's third annual Water Law, Policy and Science Conference, May 4-5, 2006 at the Lied Lodge, Nebraska City.



Sponsored by UNL, UNL's Institute of Agriculture and Natural Resources, Water Center, School of Natural Resources, colleges of Law and Journalism, Water Resources Research Initiative and Department of Geosciences, "Adaptive Management for Resilient Water Resources" featured international, national and regional experts discussing a range of topics related to better managing water systems and natural resources.

Adaptive management (AM) has emerged in the last 20 years as a prominent mans of dealing with complex resource issues involving non-linear systems and multiple tradeoffs. It focuses on uncertainty and resilience in social and ecological systems and tries to turn these factors into advantages, or at least work with, not against them.

Keynoter Lance Gunderson, professor of environmental studies at Emory University, Atlanta, GA, noted, "Humans for thousands of years have intervened in ecosystems. As we intervene, they change in ways we are essentially unable to predict. Our attempts to stabilize these systems (actually) lead to dramatic changes in ecology."

Gunderson listed AM's key characteristics: filling the knowledge-to-action gap, often with action; highlighting uncertainties versus ignoring or planning them away; learning while doing versus learning before doing; integrative science, including social science, versus piecemeal science; policy as hypothesis; management actions as weak experimental treatments; and safe-to-fail versus fail-safe approaches.

The last three strategies in particular distinguish AM from more linear, problem-solving management. Its practitioners expect the policy process to be flexible enough to experiment with incremental changes, and then adjust when the results of those experiments become evident, Gunderson said.

He also contrasted passive AM with a more active variety. Passive AM wants to successively update and evaluate policy; its actions relate to the system's present state and historical constraints; it tries to resolve uncertainties; and it can fail due to conservatism in face of uncertainty.

Active AM involves deliberate experimentation; trade-offs between objectives and learning; and; and a design that can control actions and separate factors.

Gunderson noted that AM has been tried with the Columbia River; the Great Barrier Reef of Australia; the Colorado River and the U.S. waterfowl harvest. He also noted that it helped inform a change in management of the Florida Everglades but has suffered there from paralysis by analysis. More than 10 years of study and dialogue have not resulted in new management trials.

Karina Schoengold, assistant professor of environmental economics, UNL Department of Agricultural Economics and School of Natural Resources, said, "Adaptive management recognizes that there are multiple management options in natural resources, and that there are tradeoffs in choosing a particular strategy."

One of the promising aspects of AM, she added, has to do with the importance of input from all stakeholders, including local people; this input helps define an environmental management choice between multiple alternatives. Another is the analysis of marginal changes such as the difference between two different flow rates below a reservoir.

Schoengold listed three kinds of environmental decisions that have different economic implications: easily reversible, such as an increase in dam releases; reversible but very costly, such as building a new, large dam—or decommissioning one and restoring river habitat; and irreversible, such as depletion of groundwater and extinction of species. AM is most useful with

the first type, and the latter two should be approached with caution. Combining economics with AM can provide guidance about when to make such decisions, she said.

A panel responded to the morning's presentations. Mike Drain, Central Nebraska Public Power and Irrigation District, said AM, in its broadest sense, applies to anything that includes feedback, from workplace projects, to dress and hairstyles. He voiced some reservations: "I am suspicious that in some instances the focus on adaptive management is an effort, or a hope, of finding a technical solution when perhaps a technical solution doesn't always exist."

It may not help resolve problems among different sets of values, he explained.

Mike Jess, associate director of the UNL Water Center and former director of Nebraska's Department of Water Resources, said AM involves principles the private sector adopted long ago: if something doesn't sell, pull it.

"I think people, generally, want to accommodate one another. After all, that's what adaptive management is—attempting to find some sort of middle ground for all of us," he added.

One of the hard lessons of AM for the public sector may be that governments have to give up some level of equity or control. Speaking from his experience in state government, Jess said it can be difficult for elected officials to share water management. The Missouri River is a classic example, involving 10 states and many sovereign American Indian tribes. Another challenge relates to compacts that cement agreements on water allocations: how to get the law to adapt to social or ecological changes?

Steven Light of Adaptive Strategies, a consulting firm in St. Paul, MN said, "Adaptive management is the most profound change in water or natural resource history in the last 100 years. It's going to take another 20 years to roll out. I want to see somebody step up to the plate, a university that's willing to take on adaptive management resilience, and lead the country, and (even) lead internationally in this area." He challenged UNL to be that university.

Among other comments, he noted that AM is about collective learning; it requires an ecological, not engineering, design; and it treats action a way of knowing. He added that we need to move from seeing water as an enemy or victim to seeing it as an ally.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD PANEL

In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543 July 28, 2008

NOTICE OF APPEARANCE

COMES NOW, the undersigned and pursuant to 10 CFR Section 2.314(b) enters his appearance in this matter.

1. Identification: Shane C. Robinson

2814 E. Olive St.
Seattle, WA 98122
Tel: 206-465-4740
Fax: 831-603-8634
Email: shanecrobinson@gmail.com

2. Client Information:

(a) Western Nebraska Resources Council
Attn: Bruce McIntosh, Vice-Chairman
POB 612, Chadron, NE 69337
Tel: 308-432-3458
Email: buffalobruce@panhandle.net

3. Professional Affiliation:

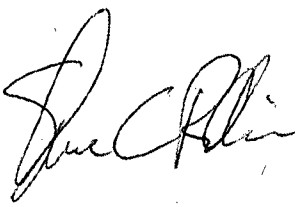
I have been admitted by the Washington State Supreme Court to practice in all Washington courts since June, 2008. My Washington State Bar ID Number is 40251.

4. Authorization:

I am authorized by each of my clients, Beatrice Long Visitor Holy Dance; Joe American Horse, Sr.; Debra White Plume, Loretta Afraid of Bear Cook; Thomas Kanatakeniate Cook; Dayton O. Hyde, and Bruce McIntosh as individuals; and Afraid of Bear/Cook Tiwahe, by Thomas Kanatakeniate Cook; American Horse Tiospaye, by Joe American Horse, Sr.; Owe Aku, Bring Back the Way, by Debra White Plume; and Western Nebraska Resources Council, by Bruce McIntosh, Vice-Chairmen as organizations to take all actions necessary, reasonable and appropriate in my representation in this matter.

Respectfully submitted,

WESTERN NEBRASKA RESOURCES COUNCIL



BY: _____

Shane C. Robinson
Attorney for WNRC
2814 E. Olive St., Seattle, WA 98122
Tel: 206-465-4740

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
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In the Matter of CROW BUTTE RESOURCES, INC. (In Situ Leach Facility, Crawford, NE)	Docket No. 40-8943 License SUA-1543 July 28, 2008

NOTICE OF APPEARANCE

COMES NOW, the undersigned and pursuant to 10 CFR Section 2.314(b) enters his appearance in this matter.

1. Identification: David Frankel

POB 3014
Pine Ridge, SD 57770
Tel: 206-427-4747
Fax: 415-707-2109
Email: davidcoryfrankel@gmail.com

2. Client Information:

The following requestor/petitioner clients have the addresses set forth in their respective Affidavits filed in this matter:

Individuals

Beatrice Long Visitor Holy Dance
Joe American Horse, Sr.;
Debra White Plume
Loretta Afraid of Bear Cook
Thomas Kanatakeniate Cook
Dayton O. Hyde
Bruce McIntosh

Organizations

Afraid of Bear/Cook Tiwahe, by Thomas Kanatakeniate Cook
American Horse Tiospaye, by Joe American Horse, Sr.
Owe Aku, Bring Back the Way, by Debra White Plume

Western Nebraska Resources Council, by Bruce McIntosh, Vice-Chairman

3. Professional Affiliations:

I have been admitted by the California State Supreme Court to practice in all California courts since 1990. My California State Bar ID Number is 148712. I am admitted to practice as a member of the bar of the Oglala Sioux Nation Supreme Court.

I am also admitted to practice by the United States District Court for the Northern District of California and the Eighth and Ninth Judicial Circuit Courts of Appeal of the United States.

4. Authorization:

I am authorized by each of my clients, Beatrice Long Visitor Holy Dance; Joe American Horse, Sr.; Debra White Plume, Loretta Afraid of Bear Cook; Thomas Kanatakeniate Cook; Dayton O. Hyde, and Bruce McIntosh as individuals; and Afraid of Bear/Cook Tiwahe, by Thomas Kanatakeniate Cook; American Horse Tiospaye, by Joe American Horse, Sr.; Owe Aku, Bring Back the Way, by Debra White Plume; and Western Nebraska Resources Council, by Bruce McIntosh, Vice-Chairman as organizations, to take all actions necessary, reasonable and appropriate in my representation in this matter.

Respectfully submitted,

BY: _____

David C. Frankel
Attorney for Each of the Foregoing Petitioners
POB 3014, Pine Ridge, SD 57770
Tel: 308-430-8160