March 12, 1999

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE PRESIDING OFFICER

In the Matter of	)	
	)	Docket No. 40-8968-ML
HYDRO RESOURCES, INC.	)	
2929 Coors Road, Suite 101	)	(Leach Mining and Milling License)
Albuquerque, New Mexico 87120	)	

NRC STAFF'S RESPONSE TO INTERVENORS' AMENDED PRESENTATION ON GROUNDWATER ISSUES

INTRODUCTION

By submittal dated January 18, 1999, Intervenors Eastern Navajo Diné Against Uranium Mining (ENDAUM), Southwest Research and Information Center (SRIC), Grace Sam, and Marilyn Morris, jointly filed an amended written presentation on groundwater protection issues,[1] pursuant to 10 C.F.R. § 2.1233. In accordance with the Presiding Officer's Memorandum and Order (Scheduling and Partial Grant of Motion for Bifurcation), dated September 22, 1998 (unpublished) (September 22 Order), and the subsequent Joint Notice of Modification of Schedule for Written Presentations dated November 5, 1998, as amended, the Intervenors' Groundwater Brief is part of

[1] On January 13, 1999, ENDAUM, SRIC, Grace Sam, and Marilyn Morris (hereinafter referred to collectively as the Intervenors) moved for leave to amend their January 11, 1999 presentation of groundwater issues, and the Presiding Officer granted the motion. The amended brief regarding groundwater protection issues, received on January 19, 1999, will be referred to as Intervenors' Groundwater Brief.

a series of written presentations being filed on issues involving the proposed in situ leach (ISL) uranium mining by licensee Hydro Resources, Inc. (HRI).

Pursuant to the September 22 Order (as later modified by the Presiding Officer), HRI filed its response to Intervenors' Groundwater Brief on February 19, 1999.[2] The Staff has reviewed HRI's February 19 response, and agrees with the technical information contained therein and attached thereto. *See* Affidavit of William Ford, dated March 12, 1999, attached hereto as Staff Exhibit 1 (Ford Affidavit), at ¶ 6. The Staff hereby submits its response the Intervenors' Groundwater Brief.

As discussed below, the Intervenors' arguments on groundwater issues lack technical and legal merit. The Intervenors' requests that action be taken against HRI's 10 C.F.R. Part 40 license (*see* Intervenors' Groundwater Brief, at 69) should accordingly be denied.

BACKGROUND

Proposed operations at HRI's Church Rock Section 8 site, located about five miles north of the town of Church Rock,[3] and the consequences of ISL mining on Section 8, delineate the scope of issues relevant to this phase of the proceeding. *See* September 22 Order, at 3.[4] Earlier, the

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[2] In responding to the Intervenors' Groundwater Brief, and the supporting testimony of Dr. Richard Abitz (Exhibit 1, hereinafter "Abitz Testimony," with Attachments A-O), Dr. William Staub (Exhibit 2, hereinafter "Staub Testimony," with Attachments A-Y), and Mr. Michael Wallace (Exhibit 3, hereinafter "Wallace Testimony," with Attachments A-P), HRI filed a number of rebuttal affidavits proffering extensive opinion testimony.

[3] One of the expert witnesses proffered by the Intervenors, sociologist Dr. Robert Bullard, provides a more specific estimate of 6.5 miles as the distance separating Section 8 from the town of Church Rock. *See* ENDAUM and SRIC's February 19, 1999 brief on environmental justice issues, Exhibit 1, at 16-17.

[4] The Commission's January 29, 1999 Order reinforced this limited scope by directing the Presiding Officer to "complete his series of merits decisions on all matters related to the Church

Presiding Officer ruled that concerns regarding existing radiological contamination in and around HRI's Church Rock site are not germane to this proceeding. *See* LBP-98-9, 47 NRC 261, 283 (1998). Contrary to this limited scope, much of the Intervenors' Groundwater Brief, and the supporting testimony, either concerns proposed ISL operations at HRI's Unit 1 or Crownpoint sites,[5] or existing radiological contamination in and around HRI's Church Rock site. *See* Abitz Testimony, at 13. The discussion below, and the Ford Affidavit, address only those issues relevant to HRI's Church Rock site.

DISCUSSION

A. Intervenors Fail To Show Harm To Drinking Water

Similar to a general description made by Dr. Staub (*see* Staub Testimony, at 10-11), Church Rock Section 8 is in a remote area with no nearby municipal water supplies at risk. Drs. Staub and Abitz, and Mr. Wallace, postulate that lixiviant excursions will occur at Church Rock Section 8 and will not be detected, but they provide no explanation how harm to drinking water would thereby

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Rock Section 8 property" by June 15, 1999. CLI 99-1, 49 NRC __, slip op. at 4.

[5] *See, e.g.*, Intervenors' Groundwater Brief, at 22-23 (regarding Unit 1 sensitivity analysis); *id.*, at 29 (regarding radium levels in the Crownpoint mineralized zone); Abitz Testimony, at 47 (regarding uranium levels in Crownpoint's drinking water); Intervenors' Groundwater Brief, at 33 (regarding analysis of water levels at Unit 1 and Crownpoint); *id.*, at 39, and Wallace Testimony, at 26 (regarding the effect of drinking water wells in Crownpoint); Intervenors' Groundwater Brief, at 40 (regarding the degradation of Crownpoint's water supply); Abitz Testimony, at 15-19, and 22 (regarding water quality of Unit 1 and Crownpoint groundwater); Wallace Testimony, at 75-77, and Abitz Testimony, at 49-50 (regarding the relocation of Crownpoint drinking water wells); Staub Testimony, at 4 (endangered drinking water supplies at Crownpoint); *id.*, at 20 (regarding pilot project near Crownpoint); *id.*, at 24 (quality of Crownpoint groundwater); *id.*, at 31, and Wallace Testimony, at 47, and 60-61 (regarding analysis of Crownpoint pump test data); Staub Testimony, at 37, and Wallace Testimony, at 13 (regarding HRI's descriptions of Crownpoint geology); and Staub Testimony, at 38 (regarding monitor well spacing at Crownpoint and Unit 1).

occur. As shown below, statements supporting claims of such harm, made by counsel in the Intervenors' Groundwater Brief, are not supported by the testimony of their experts in this area.

Dr. Staub's testimony does not support the alleged presence of 'pipelines" (Intervenors' Groundwater Brief, at 19), or "bounded channels" (*id.*, at 22), or "mineralized sand channels" (*id.*, at 37), or that any such geologic features would "prevent lixiviant from diluting to any significant degree" as the postulated excursion plumes move past monitor wells. *Id.*, at 19. In this regard, Dr. Staub states only that the geometry of the uranium ore bodies present at HRI's Church Rock site[6] indicates the presence of buried streambeds (which he describes as "thin, narrow and long channels through which groundwater flow is speeded up"), and that the large number of wells HRI plans to construct "increases the chances that excursions will occur in the channels where flow is faster." Staub Testimony, at 37. Dr. Staub does not state how fast an excursion flow would be in these "channels," nor does he provide any description of where excursions from Section 8 would go. His testimony thus lends no support to Intervenors' contention that Church Rock excursions will "endanger drinking water sources at Church Rock" (Intervenors' Groundwater Brief, at 62), nor does it validate the following scenario in which:

> contaminated mining fluids [will] flow swiftly through the thin, narrow and long channels that course through the Westwater Aquifer. The lixiviant plume, measuring less than 100 feet in width, flows between perimeter monitor wells spaced 400 feet apart. The plume is drawn toward Crownpoint, pulled by the pumping of the municipal wells.

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[6] The Staff disputes the accuracy of the Church Rock ore body dimensions provided by Dr. Staub in his Table 7. *See* Staub Testimony, at 37. The dimensions are as stated in the Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico, NUREG-1508 (FEIS), at 3-21.

Id.[7]

In fact, none of the Intervenors' groundwater experts specify how fast contaminated groundwater at Section 8 would travel to either the Crownpoint municipal wells or to any wells used by the residents of Church Rock several miles to the south of Section 8. The collective expert testimony does not support the notion that there is some sort of natural "pipeline" leading from Section 8 to Crownpoint, nor does this testimony account for the fact that even if some underground connection exists, any contamination produced by the postulated excursions at Church Rock would dissipate long before the affected groundwater reached the Crownpoint area. *See* Ford Affidavit, at ¶ 10.

As to drinking water sources south of Section 8, such as Well No. 16T-513, Dr. Staub's testimony actually rebuts the Intervenors' contentions that harm thereto is threatened. *See* Intervenors' Groundwater Brief, at 9, 57, and 64.[8] Dr. Staub correctly explains that the groundwater

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[7] This fanciful scenario, set forth in the context of the Intervenors' argument that HRI's license violates the Safe Drinking Water Act, 42 U.S.C. §§ 300f *et seq.* (SDWA), does not support their SDWA contentions. *See* Intervenors' Groundwater Brief, at 60-65. The Intervenors make no showing that Congress, in enacting the SDWA, thereby intended to prohibit ISL mining in isolated areas many miles away from any town. Moreover, the Intervenors acknowledge that the U.S. Environmental Protection Agency (EPA) issued an aquifer exemption to HRI for its Church Rock Section 8, further weakening their SDWA argument. *See* Intervenors' Groundwater Brief, at 14. Furthermore, the pipeline hypothesis supporting the SDWA argument lacks a technical basis. *See* Ford Affidavit, at ¶¶ 8-15.

[8] These contentions rely on Intervenors' Groundwater Brief Exhibits 4 and 5. Well No. 16T-513 (referenced in Intervenors' Groundwater Brief, at 9) is designated as well number 8 in Table B3.15 (part of Exhibit 4), and as shown on Figure B3-8 (also part of Exhibit 4), well number 8 is located about 1.5 miles southeast of Section 8. Since any contaminated groundwater caused by ISL mining at Section 8 would flow north, away from Well No. 16T-513 (*see* Staub Testimony, at 32), the groundwater supply this well would draw from would not be affected by any lixiviant excursions. *See also* Ford Affidavit, at ¶ 7.

flows north-northeast from Section 8. *See* Staub Testimony, at 32.[9] Accordingly, any lixiviant excursions at Section 8 would pose no threat to Well No. 16T-513. *See* Ford Affidavit, at ¶ 7.

The Intervenors' contention that excursions "could travel far beyond the monitor wells, [and] contaminate the good quality Westwater groundwater" (Intervenors' Groundwater Brief, at 46, *citing* Abitz Testimony, at 39), is similarly unsupported. Dr. Abitz states there that excursions would flow past the monitoring wells and be drawn "into high-quality groundwater down-gradient of the Church Rock mine site." *Id.*, at 39 (emphasis added). Thus, reading the Abitz and Staub Testimony together, even assuming that their undetected excursion hypothesis is valid, only groundwater to the north-northeast of Section 8 would be threatened by HRI's mining there. The Intervenors fail to identify any threatened drinking water sources to the north-northeast of Section 8.

Perhaps to address this problem, the Intervenors reference the need to protect future water supplies, vaguely stating that "communities in the Church Rock/Crownpoint area need to be able to plan for the future, when population growth in the area may result in a greater demand for water." Intervenors' Groundwater Brief, at 42 (footnote omitted). As to the area in the vicinity of HRI's Church Rock site, there are no communities, and a reliance on population growth there is thus quite speculative.

Dr. Staub, for one, is not claiming that ISL operations at Section 8 would pose any threat to drinking water at the town of Church Rock. *See* Staub Testimony, at 4; *see also id.,* at 24-25 (he

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[9] As Dr. Staub acknowledges there, the Staff earlier made the same finding. *See* NUREG-1508, Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico (February 29, 1997) (FEIS), Figure 3.11, at 3-37.

does not designate the town of Church Rock as a surrounding community). Nor does Dr. Staub claim that ground water at HRI's Church Rock site is now used as a domestic drinking water source. *See id.*, at 38 n. 16. Moreover, Dr. Staub offers no testimony regarding how fast excursion contamination would travel away from Section 8. Similarly, Mr. Wallace fails to say how quickly his postulated lixiviant excursion would foul the groundwater at Section 8. *See* Wallace Testimony, at 25. His reliance there on the presence of "narrow sand channels" which would "rapidly transport flows" is unrealistic, as demonstrated in Mr. Ford's February 1998 affidavit, at ¶¶s 13, and 21-22. The Intervenors wrongly accuse Mr. Ford of not accounting for the presence of such channels (*see* Intervenors' Groundwater Brief, at 39), and in doing so ignore the above-cited portions of Mr. Ford's rebuttal affidavit. Moreover, Mr. Wallace's vague statement that drinking water would be contaminated in just a "few years" does not say where the postulated contamination would enter the hypothetical sand channels. Wallace Testimony, at 38. Mr. Wallace cites various HRI License Conditions which he apparently believes are not sufficiently protective of the public health and environment. *See* Wallace Testimony, at 55-56, and 78-79. As he admits (*id.*, at 60), the conditions he cites are all prefaced with the phrase "prior to lixiviant injection." Since lixiviant cannot be injected until the condition is fulfilled, Mr. Wallace has the burden of showing how harm will nonetheless result. This he fails to do in his 79 pages of testimony.

Dr. Abitz is similarly vague on the question of harm. He states that "surrounding groundwater" would be degraded by the postulated excursions, but like Mr. Wallace does not specify the speed with which any contamination from excursions would "pose a threat to the groundwater at Church Rock." Abitz Testimony, at 9, and 31. He states that HRI's operation "poses a grave

threat to the health, well being and environment" of Church Rock residents and surrounding areas (*id.*, at 47-48), yet fails to acknowledge that there are no "residents" at HRI's Church Rock Section 8 site, which is more than five miles north of the town of Church Rock.

As discussed above, the Intervenors' expert testimony contains no specifics as to how long it would take for contaminated groundwater to travel from Church Rock Section 8 to either Crownpoint or to the town of Church Rock. Accordingly, the Intervenors have failed to show any realistic threat to drinking water posed by ISL mining at Section 8.

B. Geology Literature Does Not Support Intervenors' Channel Theory

Dr. Staub and Mr. Wallace each attach as Exhibit N to their respective testimonies a two-page excerpt from a 1969 paper by Hilpert (also referenced in the Intervenors' Groundwater Brief, at 24), containing two Figures. Far from supporting the channel theory, the text of Hilpert's paper (not included in either Exhibit N) contradicts the theory. *See* ¶ 14 of the Ford Affidavit, and Attachment B referenced therein.

C. Pump Test Critique Too Vague To Be Meaningful

As summarized at pages 32-33 of Intervenors' Groundwater Brief, Mr. Wallace is critical of the pump tests which HRI has performed to date. What is unclear from the presentation is how much further pump testing would have to be done before Mr. Wallace would be satisfied, or why future pump tests required by HRI License Condition 10.23 will not be adequately protective in preventing excursions. In attempting to rebut ¶ 32 of Mr. Ford's February 1998 affidavit, which discussed HRI License Condition 10.23, Mr. Wallace discusses only one of the three points made there by Mr. Ford, ignoring the relevant part of HRI License Condition 10.23 (determining whether overlying

aquitards are adequate confining layers), one of the factors lessening the chance that vertical excursions would occur. *See* Wallace Testimony, at 54. Similarly misleading is his repeated attempts to show that Mr. Ford disavowed all HRI pump test results. *See* Wallace Testimony, at 56-57, 60, 60-61, and nn. 15, 16, and 18. Mr. Ford's February 1998 affidavit, at 21 n.10, could not have been much clearer in stating that only tests at Crownpoint were being referenced. The part of Mr. Ford's note omitted by Mr. Wallace cites to FEIS p. 3-29, which is part of the discussion in FEIS § 3.3.1.2 titled "Crownpoint" beginning at p. 3-22.

Mr. Wallace also fails to explain why his analysis of pump test data taken by HRI at Unit 1 and Crownpoint is applicable to HRI's Church Rock site. He states only that he has "no doubt" his analyses are so applicable. Wallace Testimony, at 60.

Accordingly, the Presiding Officer should reject the Intervenors' pump test critique.

D. Reliance On Abitz Exhibit M

This Exhibit is a May, 1997 letter which the Navajo Tribal Utility Authority (NTUA) sent to the NRC regarding the re-location of Crownpoint water wells as a prerequisite to HRI being authorized to conduct ISL mining at Crownpoint. As such, it deals with issues which are obviously outside the scope of this phase of the proceeding. *See* September 22 Order, at 3. Nonetheless, the Intervenors' groundwater arguments reference this NTUA letter in several places.[10] The Staff requests the Presiding Officer to reject all arguments based on Exhibit M.

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[10] *See, e.g.*, Intervenors' Groundwater Brief, at 25, and 41-42; Abitz Testimony, at 36 and n.7; and Wallace Testimony, at 64 n. 19.

E. Underlying Strata At HRI's Church Rock Site

The Intervenors contend that HRI in its license application misled the Staff regarding the thickness of a rock strata (known as the Recapture Shale) at its Church Rock site (*see* Intervenors' Groundwater Brief, at 23-26, 41-42, n. 14, and 56; and Wallace Testimony, at 62-65), and that the Staff's assessment of risks regarding vertical excursions, and the assumptions relied on, "are full of significant errors." Intervenors' Groundwater Brief, at 43. On the contrary, in preparing the FEIS, and in assessing the suitability of ISL mining at Church Rock, the Staff performed an independent review of the available literature describing the relevant site geology. *See* FEIS § 3.2.4, at pages 3-18 to 3-21. The Intervenors offer no new information which calls into question the adequacy of the Staff's assessment, and fail to show that local geologic conditions at HRI's Church Rock site make the occurrence of horizontal or vertical excursions there more likely. *See* Ford Affidavit, at ¶ 28. Moreover, in making their conclusory charge regarding "significant errors," the Intervenors fail to address ¶¶ 32, and 36-38, of Mr. Ford's February 1998 affidavit.

Accordingly, the Staff requests the Presiding Officer to find that this Intervenor contention has no technical merit.

F. Use of Uranium as an Excursion Parameter

The Intervenors contend that the Staff should have required the use of uranium as an excursion parameter in HRI's License. *See* Intervenors' Groundwater Brief, at 44-45. In doing so, the Intervenors fail to address ¶¶ 30 and 31 of Mr. Ford's February 1998 affidavit. Thus, as previously explained, this contention has no merit, and should be rejected.

G. Groundwater Restoration Can Be Adequately Accomplished

The Intervenors express concerns regarding the presence of old mine workings on Section 17, and related groundwater restoration concerns regarding the order in which Sections 8 and 17 will be mined. *See* Intervenors' Groundwater Brief, at 56-59. The former concerns have already been evaluated. *See* ¶¶ 36-38 of Mr. Ford's February 1998 affidavit, which the Intervenors do not address. Regarding the latter groundwater restoration concerns, ¶¶ 18-21 of the Ford Affidavit detail why Section 8 may be mined first without compromising later restoration efforts. These concerns thus do not support the relief the Intervenors seek.

H. FEIS Adequately Described Groundwater Impacts

The Intervenors recite their familiar litany of cases regarding agency obligations concerning the preparation of environmental impact statements. *See* Intervenors' Groundwater Brief, at 65-68. Therein, the Intervenors cite *Louisiana Energy Services* (Claiborne Enrichment Center), LBP-96-25, 44 NRC 331 (1996), a decision which has been largely discredited by the Commission. See *Louisiana Energy Services* (Claiborne Enrichment Center), CLI 98-3, 47 NRC 77, 83 n.1, 99, 102, and 110 (1998),[11] reversing in part and remanding LBP-96-25. Amid the legal citations are only two examples of issues (regarding HRI's use of production "bleed," and the presence of Recapture Shale) which the Intervenors contend were erroneously evaluated in the FEIS. Both of these issues lack technical merit. *See* Ford Affidavit, at ¶¶ 17, and 28.

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[11] The Intervenors are aware of this Commission decision, as they cite it in their February 19, 1999 cumulative impacts brief, at n.27 therein, but ignore it here.

CONCLUSION

For the reasons set forth above, and as discussed in the Ford Affidavit attached hereto as Staff Exhibit 1, the Staff has determined that the Intervenors' groundwater contentions lack legal and technical merit. Accordingly, the Presiding Officer should deny the relief sought by the Intervenors regarding the groundwater issues they have raised.

Respectfully submitted,

John T. Hull
Counsel for NRC Staff

Dated at Rockville, Maryland
this 12th day of March 1999

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE PRESIDING OFFICER

In the Matter of	)	
	)	Docket No. 40-8968-ML
HYDRO RESOURCES, INC.	)	
2929 Coors Road, Suite 101	)	(Leach Mining and Milling License)
Albuquerque, New Mexico 87120	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF'S RESPONSE TO INTERVENORS' AMENDED PRESENTATION ON GROUNDWATER ISSUES" in the above-captioned proceeding have been served on the following by U.S. Mail, first class, or, as indicated by a single asterisk through deposit in the Nuclear Regulatory Commission's internal mail system, or, as indicated by double asterisks, via e-mail and express mail, this 12th day of March 1999:

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John T. Hull
Counsel for NRC Staff

Staff Exhibit 1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE PRESIDING OFFICER

In the Matter of	)	
	)	
HYDRO RESOURCES, INC.	)	Docket No. 40-8968-ML
2929 Coors Road, Suite 101	)	
Albuquerque, New Mexico 87120	)	

AFFIDAVIT OF WILLIAM H. FORD

I, William H. Ford, being duly sworn, declare as follows:

1. I am competent to make this affidavit, and the factual statements herein are true and correct to the best of my knowledge, information, and belief. The opinions expressed herein are based on my best professional judgment. This declaration will serve to present my understanding of the health, safety and environmental effects of in situ leach (ISL) uranium mining at the Crownpoint Uranium Project of Hydro Resources Inc. (HRI). I will evaluate some of the comments and conclusions reached by Dr. Richard J. Abitz, Dr. William P. Staub, and Michael G. Wallace, as expressed in their affidavits attached as Exhibits 1, 2, and 3 to "Intervenors Amended Written Presentation in Opposition to Hydro Resources, Inc.'s Application for a Materials License with Respect To: Groundwater Protection," dated January 18, 1999 ("Groundwater Brief"). I also reviewed the Groundwater Brief and Exhibits 4-10 thereto in preparing my affidavit. In addition to these documents, I was previously familiar with and reviewed:

A. Deutsch, W. J., et al., 1983, *Aquifer Restoration at In-Situ Leach Uranium Mines: Evidence for Natural Restoration Processes*, NUREG/CR-3136.

B. Deutsch, W. J., et al., 1985, *Method of Minimizing Ground-Water Contamination From In Situ Leach Uranium Mining*, prepared for the Nuclear Regulatory Commission by Pacific Northwest Laboratory, NUREG/CR-3709.

C. HRI 1989a, May 8 *Supplementary Environmental Report.*

D. HRI 1992a, January 6 *Environmental Assessment, HRI, Inc., Unit 1 Allotted Lease Program, Eastern Navajo District, New Mexico, Hydro Resources, Inc.*

E. HRI 1992b, July 31 *Crownpoint Project In-Situ Mining Technical Report, Hydro Resources, Inc.*

F. HRI 1992d, October 9 Unit 1 U.I.C. Application and Technical Report.

G. HRI 1993a, March 16 *Church Rock Project Revised Environmental Report.*

H. HRI 1993b, March 16 *Section 9 Pilot Summary Report.*

I. HRI 1995a, October 9 *Unit 1 U.I.C. Application and Technical Report: Analysis of South Trend Development Area Pumping Test, August 16–18, 1982.*

J. HRI 1995b, January 6 *Environmental Assessment Allotted Lease Program Unit 1: Analysis of South Trend Development Area Pumping Test, August 16–18, 1982.*

K. HRI 1996a, April 1 and 5 *Request for Additional Information Questions 49-91, Water Resources Protection and Cost/Benefit Analysis, Safety Analysis Review and Environmental Review for Hydro Resources, Inc.*

L. HRI 1996b, August 15 *Response to Request for Further Clarification and Additional Information of Responses; Safety Analysis Review and Environmental Review for the Hydro Resources, Inc., Uranium Solution Mining License Application, Crownpoint, New Mexico.*

M. HRI 1996d, June 18 *Unit 1 Water Quality Information* (included as an attachment in HRI's summary of the June 19 and 20, 1996, public meetings held at U.S. Nuclear Regulatory Commission Headquarters).

N. HRI 1996h, September 27 *Response to Additional Comments Dated September 16, 1996, on the License Application for an In-Situ Mining Facility at Crownpoint, New Mexico, Q3/57, Q3/95 and Q3/96.*

O. HRI 1996n, November 18 transmittal from Craig Bartels (HRI) to William Ford (NRC) regarding comments on groundwater velocity calculations.

P. HRI's August 15, 1997 *Crownpoint Uranium Project Consolidated Operations Plan*, rev. 2.0.

Q. HRI 1997b, August 18 *HRI Response to NRC Q99: Sensitivity Analysis of Modeled Unit Site Ground-Water Flow.*

R. Mobil Alternative Energy Inc. 1986, January 22 *Restoration Progress Report, Crownpoint Section 9 Pilot In Situ Leach Plant* (submitted by J. Cullen, Mobil Alternative Energy Inc., to F. Miera, New Mexico Environmental Improvement Division).

S. Mobil Mining and Minerals Company 1986, November 14, *Mobil Pilot In Situ Leach Restoration Results* (submitted by J. Cullen, Mobil Mining and Minerals Company, to G. Konwinski, NRC).

T. NRC 1981, *Groundwater Monitoring at Uranium In Situ Solution Mines*, Staff Technical Position Paper No. WM-8102.

U. NRC 1983, *Aquifer Restoration at In-Situ Leach Uranium Mines: Evidence For Natural Restoration Processes*, NUREG-/CR-3136.

V. NRC 1988, February 4 *Environmental Assessment in Consideration of the Release of Source Material License SUA-1479 for Mobil Oil Corporation, Crownpoint Section 9 In Situ Test Project* (prepared by NRC Uranium Recovery Field Office, Denver, Colorado).

W. NRC 1997, *Draft Standard Review Plan for In Situ Leach Uranium Extraction License Applications*, NUREG-1569.

X. NRC 1997, December 4 *Safety Evaluation Report, Hydro Resources, Incorporated License Application For Crownpoint Uranium Solution Mining Project McKinley County, New Mexico, Docket No. 40-8968.*

Y. NRC 1998, January 5 Source Material License SUA-1508, For In Situ Leach Uranium Mining Project at Crownpoint, New Mexico (HRI License).

Z. Prickett, T. A., 1983, *Analysis of South Trend Development Area Pumping Test, August 16-18, 1982, Crownpoint McKinley County, New Mexico.*

AA. Reed, S. 1993, October 7 *Analysis of Hydrodynamic Control, HRI, Inc., Crownpoint and Church Rock New Mexico Uranium Mines* (Geraghty & Miller, Inc.).

BB. Staub, W. P., et al., 1986, *An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas*, NUREG/CR-3967, ORNL/TM-9956 (prepared for the Nuclear Regulatory Commission by Oak Ridge National Laboratory).

CC. Turner-Peterson, C.E., et al, 1988, A Basin Analysis Case Study: The Morrison Formation Grants Uranium Region, New Mexico, Energy Minerals Division of the American Association of Petroleum Geologists.

DD. U.S. Bureau of Mines, *Environmental Assessment of In Situ Mining*, Open-File Report 101–80, December, 1979.

EE. Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico, NUREG-1508 (FEIS).

FF. Wyoming Department of Environmental Quality Land Quality Division Guide Line No. 4, In-situ Mining, August 1994.

Professional Qualifications Regarding ISL Mining

2. I am an employee of the United States Nuclear Regulatory Commission (NRC), in the Office of Nuclear Material Safety and Safeguards. In my 14 years with the NRC, I have worked on groundwater concerns at uranium mill sites throughout the western United States. In addition, from 1985 to 1986, I worked on a project with NRC Research to study past excursions at ISL mines. This work eventually resulted in a publication by Staub, *et al.,* which I refer to later in my affidavit. For the past three years, I have been doing groundwater and geology reviews, writing regulatory guidance, and doing inspections of conventional uranium mill tailings sites and ISL sites for the Uranium Recovery Branch at the NRC. As part of my duties, I have worked on the HRI license application since approximately June of 1995. I have reviewed HRI submittals in the areas of groundwater, geology, and soils. On November 27 through November 29, 1995, Christopher McKenney

and I participated in a site tour of HRI's proposed ISL mining facilities near Crownpoint, New Mexico, including HRI's Church Rock site. I am an author of the FEIS.

3. Prior to coming to NRC, I was employed for 5 years (From 1975 to 1980) by Wyoming Mineral Corporation, a subsidiary of Westinghouse Electric Corporation. Wyoming Mineral Corporation built and operated ISL mines in Texas, Wyoming, and Colorado. I was responsible for conducting groundwater studies for environmental and well field design purposes for two mine sites in Texas, one site in Wyoming, and two sites in Colorado. During this time, I conducted and participated in new mine development projects, the operation of well fields, and well field restoration. I actively conducted pump tests, aquifer rupture (injection) tests, studies of aquifer water quality, studies of groundwater excursion identification and correction (both vertical and horizontal), and participated in well field restoration demonstration projects. Additionally, for two years while employed by Atlantic Richfield Coal Company, I participated in groundwater studies of a successful coal gasification project in Wyoming, which used wells to mine coal by converting it to natural gas. My role on this project was to study and monitor the hydrologic impacts associated with this operation.

4. My resume, attached to my February, 1998 affidavit previously filed in this proceeding, accurately describes my general background, training, and other qualifications to express the opinions stated herein.

General Opinion

5. In my professional opinion, ISL mining at Section 8 of HRI's Church Rock site, as regulated by the HRI License, will not irreparably damage the local groundwater

quality, and will not threaten the public health, safety, or environment. Further discussion supporting this opinion is provided below.

Agreement With HRI Brief and Affidavits

6. Over a period of several days I carefully evaluated HRI's "Response to Intervenors' Brief in Opposition to Hydro Resources, Inc.'s Application for a Materials License with Respect to Groundwater Issues," dated February 19, 1999; the affidavits of Craig S. Bartels, Frank Lee Lichnovsky, Steve Reed, Dan W. McCarn, Mark S. Pelizza, Maryann Wasiolek and Michael Spinks (joint affidavit), and Dr. Schlomo Orr, attached thereto; the letter of HRI counsel David Lashway to the Presiding Officer dated February 26/March 1, 1999; and the revised exhibits attached thereto. I agree with the statements, opinions, and conclusions expressed in the above-referenced materials. My following statements are meant to supplement HRI's comments, as they either address points not covered by HRI, or express opinions in addition to those contained in the above-referenced materials.

Uranium Extraction at Section 8 Will Not Impact Local Water Supply

7. ISL mining at Section 8 will not threaten local water supplies, because such mining and related activities will be adequately controlled and monitored under HRI's License, and because the groundwater there will be restored at the end of ISL mining

operations. In addition, as stated on page 3-31 of the FEIS, with the exception of a water well located in the Dakota Sandstone aquifer (one half mile south of Section 8), there are no other wells within 1.6 km (1 mile) of HRI's Church Rock site. Thus, within one mile of Section 8, there are no water wells withdrawing water from the Westwater Canyon Aquifer. In the Groundwater Brief, at 9, the intervenors identify water well 16T-513 as being completed in the Westwater Canyon Aquifer. However, as shown in Exhibit 5 of their brief, this well is located 1.5 miles southeast of Section 8, meaning that it is located up-gradient from HRI's Church Rock site. Over a short distance, an excursion from a well field can move in any direction, since well field injection pressures can overcome the regional gradient. However, as distance from the well field increases (*i.e.*, beyond the ring of monitor wells), ISL injection pressures rapidly dissipate until the regional groundwater gradient dominates. Since water well 16T-513 is located so far away from Section 8, and is up-gradient from Section 8, it cannot be impacted by solution mining activities at Section 8, contrary to the intervenors' claim.

Uranium Extraction Will Not Impact Town of Crownpoint Water Supply

8. I read pages 62-63 of the Groundwater Brief as claiming that a groundwater excursion from the Church Rock site will cause a violation of the drinking water standards at NTUA Well No. 1 in the town of Crownpoint. The intervenors posit a scenario whereby (1) HRI fails to maintain an adequate bleed rate; (2) an excursion goes undetected; (3) the excursion contains high levels of toxic substances such as radium-226 and arsenic; (4) the

excursion flows swiftly through thin, narrow, and long channels; and (5) the excursion mobilizes more uranium, radium, arsenic and molybdenum as it flows toward the town of Crownpoint wells.

9. This hypothetical is fanciful. The intervenors present no calculations to support it, and the premise of their scenario is wrong. The major cause of excursions are improperly balanced well fields, not the bleed rate. As I explained in my February 1998 affidavit filed in this proceeding, at ¶¶ 13, and 21-22,[1] the Westwater Canyon Aquifer is not a collection of thin, narrow, and long channels through which the groundwater is flowing rapidly. *See* ¶¶ 11-15, *infra.* Therefore, groundwater at Section 8 cannot move rapidly toward the Crownpoint drinking water wells, which are more than 20 miles away from HRI's Church Rock site. Moreover, any Section 8 excursion would be detected very close to the well field. Additionally, as discussed in ¶ 10, *infra*, the lixiviant to be used by HRI cannot mobilize and transport uranium very far from any well field. Indeed, the opposite would occur. Rock-water interactions would remove mobilized chemical constituents from the groundwater. Therefore, an excursion at the Church Rock site would not impact groundwater quality at the town of Crownpoint.

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[1] Neither the Groundwater Brief, nor any of the intervenor supporting affidavits, address my previous rebuttal testimony on this point.

Any Excursions Would Be Chemically Retarded

10. On page 39 of his January 11, 1999, affidavit, Dr. Abitz claims that uranium excursions will not be retarded by reducing zones in the aquifer. This is simply not true. The lixiviant has a limited ability to oxidize the rock, otherwise there would not be any need to re-fortify the lixiviant prior to re-injection. Therefore, the ability of the lixiviant to mobilize uranium usually does not extend beyond the well field. Research conducted by Pacific Northwest Laboratory (PNL) for the NRC showed that after solution mining, the reducing capacity of sediments outside the well field (and even for leached ore zones within the well field) remains very high. PNL concluded that the ability of the lixiviant to mobilize uranium quickly expends itself within the well field, and that when the dissolved uranium encounters reducing conditions in the rock, the uranium is removed from solution. *See* Deutsch, W.J., *et. al.*, 1985, Methods of Minimizing Ground Contamination From In Situ Leach Uranium Mining, NUREG/CR-3709, at page 81, a copy of which is attached hereto as Attachment A.

Intervenors' Narrow Sand Channel Theory Is Not Valid

11. On pages 36 and 37 of his January 11, 1999, affidavit, Dr. Staub claims that the uranium deposit geometry is indicative of ancient, buried streambeds - thin, narrow and long channels through which groundwater flow is speeded up. This is simply not true. The uranium deposits are long because they have formed in a sandstone aquifer of large lateral

extent, and they are thin because they are a geochemical deposit that formed when reducing conditions at a redox interface were encountered in the rock.[2] *See also* in this regard the February, 1999, affidavits of Mr. Lichnovsky, at pages 11 to 16; and Mr. Bartels', at pages 13 to 16. Furthermore, the shape of the deposit has nothing to do with the speed of groundwater movement. In fact, it is not uncommon for some uranium roll front deposits to form where there is a decrease in velocity, such as where groundwater encounters shale-sandstone contacts. The shale is less permeable than other rock types, and thus reduces the velocity of the groundwater. In these areas, the shale provides the reducing conditions necessary to form the uranium deposit.

12. In fact, if uranium deposits did form within thin, narrow, and long channels, the deposits would be no longer than the width of the channel. This is because the deposit would form in the channel, when groundwater in the channel encountered reducing conditions. This would cause a deposit to form across the width of the channel, at right angles to the direction of groundwater flow. The result would be a uranium deposit with it's longest dimension at a right angle to groundwater flow, and parallel to the channel width. Thus, if I agreed with Mr. Wallace's claim that the underground, uranium-bearing sand channels at HRI's Church Rock site are less than 400 feet wide,[3] I would also have to agree that the uranium deposits at Church Rock could be no more than 400 feet long. This is in direct contrast to what is

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[2] A redox interface is a term describing where the geochemical environment changes from oxidizing to reducing or vice versa. The location of such interfaces is not dependent on the lithology or shape of the aquifer.

[3] *See* Mr. Wallace's affidavit, January 11, 1999, page 25, criticizing the required 400-foot spacing of HRI's lateral monitor wells as being inadequate to detect horizontal excursions.

observed. At HRI's Church Rock site, the best evidence shows that the uranium ore body is in fact 5,300 feet long. *See* page 3-21 of the FEIS.[4] This dimension is consistent with the relevant geologic literature of the area showing that the Westwater Canyon aquifer is a regional aquifer of large areal extent, with groundwater encountering a redox interface that extends over a large area of northwest New Mexico. *See* ¶¶ 13-15, *infra*.

13. Exhibit B of Dr. Abitz's January 11, 1999, affidavit, contains a sandstone thickness Figure of the Westwater Canyon Fan System. Dr. Abitz references this Figure on page 10 of his affidavit, to support his statement on page 28 therein that the Westwater Canyon Aquifer is complexly interfingered , heterogeneous, and of fluvial (stream) origin. It is true that the referenced Figure shows that the subject aquifer is a fluvial deposit, but the Figure also shows that in the Church Rock and Crownpoint areas, the Westwater Canyon Aquifer is 200 to 400 feet thick, and that it is at least 100 feet thick over the northwest corner of the state. Thus, the Figure does not support the intervenors' theory that the Westwater Canyon Aquifer is a series of narrow, isolated, aquifers, as it instead depicts a thick regional aquifer of large areal extent.[5]

14. Mr. Wallace's January 11,1999, affidavit, at 63, references his Exhibit N, a two-page excerpt from Geological Survey Professional Paper 603, by Lowell S. Hilpert (Uranium

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[4] Dr Staub's affidavit, at 37, states that the ore body at the Church Rock site is 33,100 feet long.

[5] *See also* in this regard the February, 1999, affidavits of Mr. Lichnovsky, at pages 6 to 16; Mr. Bartels, at pages 10 to 38; Dr. Orr, at ¶ 5; and the entire joint affidavit of Ms. Wasilek and Mr. Spinks, rebutting the intervenors' theory that the Westwater Canyon Aquifer is a series of narrow, isolated, aquifers.

Resources of Northwestern New Mexico, 1969).[6] However, in simply relying on two Figures contained in this paper (showing the Cow Springs Aquifer's relationship relative to the Westwater Canyon Aquifer near the Church Rock site, and it's relationship relative to the Recapture Shale), Mr. Wallace fails to include Hilpert's textual description of the Westwater Canyon Aquifer, which states in relevant part as follows:

> Between Gallup and the Continental Divide the Westwater Canyon Member ranges in thickness from 175 to 275 feet and probably averages about 225 feet. In most places it contains one or more mudstone units that range from mere partings in the sandstone to units as much as 20 feet thick. These units have rather limited lateral continuity and only some of the thicker ones may extend as much as a mile or more before grading out into sandstone or being cut out at the base of overlying sandstone units.

See excerpt from Hilpert, page 76, a copy of which is attached hereto as Attachment B. Thus, Hilpert's paper does not support the intervenors' concept that the Westwater Canyon is a series of narrow, isolated, aquifers. Instead, Hilpert's description shows that the Westwater Canyon aquifer is a thick regional aquifer, that contains within it relatively thin mudstone beds of limited areal extent.

15. Exhibits C and D (Figure 7) of Dr. Abitz's affidavit show the regional redox interface in the Church Rock and Crownpoint area for the Westwater Canyon Aquifer. They show that oxidizing waters moved northward from oxidizing into reducing conditions in a broad arch that stretches from Church Rock, through Crownpoint, and beyond. It is along the arch that uranium roll front deposits formed. Again, this does not support a number of individual sand channels as claimed by Mr. Wallace, but instead supports the interpretation

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[6] *See also* Dr. Staub's testimony, at 28, referencing the same excerpt from the Hilpert paper, which is also attached as Exhibit N to Dr. Staub's testimony.

of the Westwater Canyon aquifer as a regional aquifer of large areal extent, with groundwater flowing northward and encountering a redox interface that extends over a large area of northwest New Mexico.

Groundwater At ISL Facility in Wyoming Has Been Restored

16. On page 21 of his January 11, 1999, affidavit, Dr. Staub states that Wyoming Department of Environmental Quality officials he interviewed asserted that no commercial well field at any uranium ISL facility has been successfully restored.[7] This information is incorrect. At the Bison Basin ISL mine site in Wyoming, restoration of groundwater was approved by the State of Wyoming and the NRC. *See* letter from Ramon E. Hall, Director, Uranium Recovery Field Office, NRC, dated February 20, 1990, a copy of which is attached hereto as Attachment C.

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[7] This is consistent with page 4-37 of the FEIS, where it is stated that "the NRC has approved the restoration of several test patterns used to explore the feasibility of ISL mining or demonstrate the feasibility of production-scale restoration. However, NRC has not yet approved the successful restoration of a production-scale well field at any of its licensed sites." I learned after the FEIS was published that groundwater was successfully restored by the State of Wyoming at the Bison Basin ISL mine site. This site was a production scale operation that was restored by the State of Wyoming when the company that owned the mine went bankrupt.

Re-injection of Production Bleed

17. On pages 34 and 35 of his January 11, 1999, affidavit, Dr. Staub expresses the concern that HRI's plan to re-inject its treated production bleed outside the well field would jeopardize lixiviant control, and that depending on where it is injected it could interfere with the functions of nearby monitoring wells. To the contrary, the effect of re-injection of this bleed outside the well field would be to drive water towards the well field, making excursions less likely to occur.[8] Since the re-injected bleed should be clean water, it is difficult to see how water chemistry sampling would be unable to detect an excursion that reached the monitor well (as opposed to water from the production bleed injection well).[9]

Mining Section 8 Before Section 17 Would Not Impede Restoration

18. On pages 34 and 35 of his January 11, 1999, affidavit, Dr. Staub expresses the opinion that to prevent contamination of restored well fields, mining should progress from up-gradient to down-gradient well fields. However, during mining and groundwater restoration activities, injection and pumping have a much larger effect on the direction and rate of groundwater flow in and around the well fields than does the regional direction of

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[8] This effect is sometimes taken advantage of by placing ISL clean-water injection wells in a line, thereby producing a clean-water barrier between a well field undergoing restoration and a well field undergoing uranium extraction activities.

[9] *See also* in this regard pages 49 to 54 of the February, 1999, affidavit of Mr. Bartels; and the February, 1999, affidavit of Dr. Orr, at ¶ 8.

groundwater flow. Accordingly, the regional groundwater flow does not have a big influence on restoration of well fields, or on the direction that excursions would flow out from the well field. I thus do not agree with Dr. Staub's opinion.

19. Mr. Wallace raises a similar concern on page 67 of his January 11, 1999, affidavit. Mr. Wallace argues that restored groundwater in Section 8 will be contaminated by well fields in Section 17, because Section 8 is down-gradient from Section 17. He states that excursions in Section 17 would flow down-gradient to Section 8. This assumes that such excursions will in fact occur, and go unchecked, and implies that excursions from Section 17 will only move down-gradient. Excursions in Section 17 would not be allowed to occur unchecked in the down-gradient direction, or in any other direction. Monitor wells between the well fields in Section 17 and Section 8 would monitor for excursions, so that clean water is not contaminated beyond the mine area. I thus disagree with Mr. Wallace on this point.

20. On pages 66 to 74 of his January 11, 1999, affidavit, Mr. Wallace postulates groundwater dewatering impacts caused by restoration activities in Section 17, which he states could compromise the water quality in restored well fields of Section 8. Based on this scenario, Mr. Wallace concludes that to restore the groundwater in Section 17, the underground mine workings there would have to be dewatered. Mr. Wallace further claims that dewatering would reintroduce oxygen into the groundwater in Section 8, thereby re-mobilizing residual pockets of ore and heavy metals, thus undermining groundwater restoration efforts.

21. Mr. Wallace does not present any calculations or modeling to support these conclusions; rather, he presents a very convoluted argument for dewatering, that appears to be based on an assumption of turbulent flow within the mine tunnels during groundwater

restoration activities. In my opinion, Mr. Wallace's argument in this regard is not valid. When the underground mine in Section 17 was in operation, the aquifer was continuously dewatered below the level of the mine workings for many years. If parts of the ore zone in Section 8 had been dewatered by the mine, they would have already been exposed to oxygen much longer than any one-time dewatering of the mine tunnels as posited by Mr. Wallace. It is unclear why pumping in and near the mine tunnels should cause turbulent flow (*see also* in this regard the February, 1999, affidavit of Mr. Bartels, at page 56). It is common practice to place pumps in lakes, reservoirs, tanks, and pools, without causing turbulent flow in such bodies of water. Nor does it make sense that to achieve restoration, the mine tunnels would have to be dewatered. The standard restoration method used at ISL facilities is to re-circulate clean water through the well field (just as water in swimming pools, tanks, and reservoirs is kept clean by circulating the water through a filter), which is the technique best suited to clean up the groundwater. This standard restoration method is applicable to any open voids associated with the mine workings in Section 17.

<u>400-Foot Lateral (Ore Zone) Monitor Well Spacing Adequate</u>

22. On page 38 of his January 11, 1999, affidavit, Dr. Staub states that "at the Church Rock site, a spacing interval of up to 300 feet would be appropriate" for lateral monitor wells. HRI License Condition 10.17 only requires that lateral monitor wells be spaced 400 feet apart. In support of his 300-foot recommendation, Dr. Staub states that the COGEMA Christian

Ranch facility places its monitor wells at a 300-foot spacing on the down-gradient side of the well field. While this is true, up-gradient and side monitor wells there are placed 500 feet apart.[10] Accordingly, on average, lateral monitor wells at the COGEMA Christian Ranch facility are spaced 400 feet apart, consistent with what is to be required at HRI's ISL facility.

23. Moreover, the 400-foot requirement in HRI's license is consistent with the spacing of lateral monitor wells at all other ISL facilities licensed by the NRC. At the COGEMA Irigaray (Wyoming) site, monitor wells are spaced 400 to 600 feet apart [11]; at the Crow Butte site (Nebraska), monitor wells are spaced 400 feet apart[12]; at the Smith Ranch site (Wyoming), monitor wells are spaced 500 feet apart[13]; and at the Power Resources Inc. Highland site (Wyoming), down-gradient wells are spaced 400 feet apart, up-gradient wells 800 feet apart, and side wells from 400 to 600 feet apart.[14] These same issues of groundwater gradient and the 400-foot spacing of lateral monitor wells were addressed in my February, 1998, affidavit, at ¶ 15. My opinion remains that 400 feet is an appropriate spacing for lateral monitor wells at the Church Rock site.

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[10] This information comes from a March 3, 1999, telephone conversation I had with Donna Wichers, of Cogema.

[11] This information comes from a March 3, 1999, telephone conversation I had with Donna Wichers, of Cogema.

[12] This information comes from a March 1, 1999, telephone conversation I had with Mike Griffin, at the Crow Butte Site.

[13] This information comes from a March 1, 1999, telephone conversation the Staff had with Paul Goranson, at the Smith Ranch Site.

[14] This information comes from a March 1, 1999, telephone conversation the Staff had with William Kearney, at the Highland Site.

Lateral Monitor Wells Adequately Screen the Ore Zone

24. On page 26 of his January 11, 1999, affidavit, Mr. Wallace claims that HRI License Condition 10.23 will not require monitor wells to monitor the same sands as the production zone, because it requires that the wells be completed in the Westwater Canyon aquifer. However, since the ISL production zones are contained within the Westwater Canyon aquifer, lateral monitor wells open to the Westwater Canyon aquifer will monitor all the production zones, and provide complete vertical coverage within the Westwater Canyon Aquifer to detect horizontal excursions.[15] I thus disagree with Mr. Wallace's contention.

Use of Trend Wells to Monitor Lateral Excursions Not Required

25. On page 38 of his January 11, 1999, affidavit, Dr. Staub recommends that trend wells be placed between the well field and the monitor wells, to provide early warning for excursions. However, as stated in ¶ 14 of my February 20, 1998, affidavit, the use of two tiers of groundwater monitor wells has never been required by the NRC. To determine if any state programs have requirements in this area, I did some research. I found that the Wyoming program describes what a trend well is, but states that "water-quality analyses of samples collected from trend wells will not result in regulatory corrective action."[16] I do not believe

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[15] *See also* in this regard the February, 1999, affidavit of Mr. Lichnovsky, at page 16; reaching the same conclusion.

[16] Wyoming Department of Environmental Quality, Land Quality Division, (continued...)

that HRI should be required to drill trend wells because trend wells are not required by NRC regulation (meaning that findings from such wells cannot be used to require a licensee to take a corrective action), and because in my opinion is there are no unique site conditions at Section 8 that would require monitor wells to be placed closer to the well field than the 400 foot distance specified in HRI's License.

Setting Upper Control Limit Concentrations

26. On pages 37 to 39 of his January 11, 1999, affidavit, Dr. Abitz expresses his disagreement with License Condition 10.22 B, which requires that upper control limits be based on the "mean of the upper control limit parameter concentration, and adding 5 standard deviations". Dr. Abitz is thus also in disagreement with the Staff's Draft Standard Review Plan (DSRP), which states that in areas of good water quality (a total dissolved solids of less than 500 mg/l), it is acceptable to set the upper control limit concentration at a value of 5 standard deviations above the mean of the measured concentrations. This method of setting an upper control limit concentration for areas of good water quality is based on past regulatory experience, which attempts to set a concentration high enough that false positives (false alarms due to natural fluctuation in water chemistry) are not a frequent problem, but not so high that significant groundwater quality degradation occurs by the time an excursion is identified. This

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[16](...continued)
Guideline No. 4, In-situ Mining, dated August 1994 (Wyoming Guide), at page 39 (a copy of which is attached hereto as Attachment D).

approach is supported by the Wyoming Guide (Attachment D), at page 39, which states in relevant part as follows:

> A method that uses the baseline mean plus 5 standard deviations is the recommended method for calculating UCLs. Use of this proposed method should result in adequate excursion control, yet minimize the possibility of incorrectly placing wells in excursion status. (Emphasis added).[17]

Accordingly, I do not believe Dr. Abitz's concern to be a valid one.

Lixiviant Chemistry

27. On page 37 of his January 11, 1999, affidavit, Mr. Wallace claims that the FEIS misrepresented lixiviant as a benign material. This is not true. The FEIS did not characterize the lixiviant as benign. Lixiviant chemistry is fully described in the FEIS text, at Section 2.1.1.2 (pages 2-5 and 2-6), and in Tables 2.1 (page 2-6), 4.13 (page 4-38), and 4.14 (page 4-46) of the FEIS.

Cow Springs and Westwater Canyon Aquifers At Church Rock

28. On pages 62 to 65 of his January 11, 1999, affidavit, Mr. Wallace claims that at the Church Rock site, the Cow Springs and the Westwater Canyon Aquifers are in direct contact, and are thus the same aquifer, contrary to the allegedly erroneous information in the FEIS. The difference of opinion among publications on this point (as cited by Mr. Wallace), was identified and explained in the FEIS, at page 3-18, which states in relevant part:

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[17] *See also* in this regard the February, 1999, affidavit of Mr. Pelizza, at pages 45 to 48.

> Figure 3.7 contains a stratigraphic column of the Church Rock site. HRI indicates that the Recapture Member is at least 45 m (150 feet) thick in the mine area and overlies the Cow Springs Sandstone. This generally agrees with regional isopach data of Morrison strata (Saucier, 1967), indicating that the Recapture is 60 m (200 feet) thick in this area. Hilpert (1969) provides cross-sections through the old Church Rock mine, based on Phillips Petroleum Company drilling logs, which indicate that a tongue of Cow Springs Sandstone closely underlies the Westwater Canyon. This sandstone, however, coincides with a sandstone interpreted by HRI in the lowermost part of the Westwater and appears to be underlain by Recapture Member Shale. In Section 13, west of HRI's Church Rock site, Peterson (1980) indicates that the Recapture Member does not occur and that the Westwater Canyon Member lies directly on the Cow Springs Sandstone.

On pages 20 to 23 of his February, 1999, affidavit, Mr. Lichnovsky explains how more recent publications and site specific data support the interpretation that the lowermost sand in the ore bearing aquifer at the Church Rock site is the Westwater Canyon aquifer, and is not part of the Cow Springs aquifer. I have evaluated this point, and agree with Mr. Lichnovsky's interpretation.

29. Mr. Wallace claims that the NRC was not justified in accepting HRI's contention that the AA sand is part of the Westwater Canyon Aquifer, and that because the Cow Springs aquifer is a part of the Westwater Canyon aquifer, he concludes that the Cow Springs Aquifer cannot be protected from mining activities. Unfortunately, Mr. Wallace ignores the positive benefits of agreeing with HRI's interpretation. If the Cow Springs aquifer is in fact part of the Westwater Canyon aquifer, it will be monitored in greater detail by the lateral monitor wells. This, in effect, would achieve the request of the intervenors that the Cow Springs aquifer be monitored. Moreover, such monitoring would be in more detail than that provided by a smaller number of wells drilled down the center of the well field, such as would be the case if the intervenors' contention was accepted.

Ore Body Has Been Described In Adequate Detail

30. On page 29 his January 11, 1999, affidavit, Dr. Abitz claims that HRI has not described the ore body in the detail suggested by the Draft Standard Review Plan. This is not correct. While the Staff needs enough detail to describe environmental impacts, this can be adequately done without forcing an applicant to divulge proprietary data. In this case, the Staff needed to know: (1) what aquifers HRI would conduct ISL mining in, and what aquifers would thus need to be protected; (2) the lateral location, such as site boundaries, wherein HRI would drill its well fields; and (3) the general ore body depths, to confirm that injection pressures in HRI's well fields would not rupture the aquifer, and that the wells would be designed appropriately for the depth. HRI provided all of this information.

Analysis of Upper Control Limits

31. On page 42 of his January 11, 1999, affidavit, Dr. Abitz claims that two weeks to a month will have elapsed before laboratory results are received to declare an excursion. To the contrary, the Staff's inspection experience regarding ISL facilities has been that laboratory analysis of upper control limit parameters is done on-site, and that upper control limit parameters are usually properly analyzed and evaluated by the licensee within a few days after sampling.

Calculation of Groundwater Restoration Goal

32. On page 21 of his January 11, 1999, affidavit, Dr. Abitz uses his Table 1 figures to criticize the Staff for not correctly calculating a restoration standard (or baseline) in Table 3.13 of the FEIS. However, the water quality tables in the FEIS were not intended to establish baseline or restoration standards. These Tables were intended to generally characterize the water quality for a particular aquifer and proposed ISL site. It should be noted that in paragraph 1 of page 3-35 of the FEIS, the water quality of the Westwater Canyon Aquifer at the Church Rock site is rated as being good. Establishing restoration goals is required by HRI License Condition 10.21, but these cannot be established until the well fields are drilled.

33. On page 23 of his January 11, 1999, affidavit, Dr. Abitz claims that HRI does not use a correct methodology for calculating the groundwater restoration goal, and that HRI's methodology is not in agreement with the DSRP. His claim is based on a comparison between Table 3.13 of the FEIS, and his calculated values. As just explained above, Table 3.13 does not establish a groundwater restoration goal. HRI's' Consolidated Operations Plan is the appropriate reference for this concern, and it properly conforms to the guidelines stated in the DSRP. I thus disagree with Dr. Abitz's claim on this point.

34. The statements expressed above are true and correct to the best of my knowledge, information and belief.

William H. Ford

William H. Ford

Sworn and subscribed to before me
this 12th day of March, 1999

Melinda L. McDonald

Notary Public
My commission expires: 12/1/2001

W.H. FORD

NUREG/CR-3709
PNL-5319
RU

Methods of Minimizing Ground-Water Contamination From In Situ Leach Uranium Mining

Final Report

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Ford Attachment A

the ore zone. This will help immobilize redox-sensitive elements, as was shown for uranium, and produce a stable environment in which the redox-sensitive elements will remain immobile.

The use of sodium sulfide shows promise towards accelerating the process of aquifer restoration by reestablishing reducing conditions in the leached zone. However, in an aquifer restoration effort, enough sulfide may have to be injected into a leached ore body to consume all of the available oxidizing species. Once this is accomplished and reducing conditions are established, dissolved uranium concentrations should be greatly reduced. At this time, further research is needed to identify the important reactions controlling uranium precipitation and sulfide oxidation. In addition, associated reactions caused by sulfide addition that may have adverse effects on aquifer permeabilities need to be defined to more fully assess the use of sulfide as an aid to aquifer restoration.

SUMMARY OF EXPERIMENTAL RESULTS

During the past 3 years, batch and column experiments have been conducted to study the mobility of contaminants produced during in situ leach mining of uranium ore deposits and evaluate aquifer restoration methods following mining. Ground water, lixiviant, and sediment samples from mine operations in Texas and Wyoming were used to simulate field conditions in the laboratory. Both natural restoration and induced restoration techniques were evaluated.

Natural restoration is the process by which contaminants are removed from the leaching solution as a result of chemical interactions between the solution and the aquifer sediments. As the residual leaching solution in the aquifer moves out of the leach field in response to the natural hydrologic gradient it will contact fresh sediment that could help reestablish the aquifer conditions and ground-water chemistry that existed before mining. The experiments showed that the reducing capacity of these sediments remains very high, even for the leached ore, and that the redox-sensitive element, uranium, will be removed from solution by water/sediment interactions. The dissolved concentration of the nonredox-sensitive elements, chloride and sulfate, might also reach contaminant levels during mining and they do not appear to be affected by natural restoration. The concentration of major cations typically found in ground water (calcium, magnesium, sodium, and potassium) may also be affected by mining activities. Their concentration in solution appears to be affected by ion exchange processes between the solution and the sediment, which indicates that they will increase or decrease depending on the local equilibrium established between the ions in solution and on the sediment exchange sites. This process could theoretically increase the concentration of one contaminant while lowering that of another if a lixiviant with a high concentration of cations interacts with the aquifer sediments.

One of the commonly used methods for removing residual lixiviant in the leach field is to pump the wells after leaching has been completed to draw in fresh ground water to dilute and replace the lixiviant. This ground-water sweeping method of restoration was found to be very effective for nonreactive contaminant species and for the major cations normally found in ground water.

Uranium Resources of Northwestern New Mexico

By LOWELL S. HILPERT

GEOLOGICAL SURVEY PROFESSIONAL PAPER 603

Prepared on behalf of the U.S. Atomic Energy Commission

A description of the stratigraphic and structural relations of the various types of uranium deposits in one of the world's great uranium-producing regions

Ford Attachment B

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1969

identity immediately south of Gallup. From the northwest end of the Zuni uplift for 10–15 miles eastward, identification of the Recapture-Westwater Canyon contact is rather arbitrary or difficult in many places because of the grading and intertonguing relations with the Cow Springs.

The Recapture Member in the district is a sequence of interbedded siltstone, mudstone, and sandstone units that generally range in thickness from a foot or so to several tens of feet. The units generally consist of reddish-brown and grayish-red beds that alternate with light-gray and greenish-gray beds. Most sandstone beds are less than 15 feet thick and tend to be flat-bedded and have small-scale crossbeds, except where they intertongue with the Cow Springs. In such places the bedding locally shows sweeping cross laminations as well as some channel scours. This bedding indicates a mixture of eolian and fluvial processes. Coalified plant debris is present in the Recapture, but mostly in local and widely scattered localities.

The Recapture probably is about 500 feet thick at Twin Buttes Wash about 25 miles northwest of Gallup (Allen and Balk, 1954, p. 155–156; L. C. Craig, oral commun., 1965). Eastward it thins markedly within a few miles and, along and near the outcrop between Gallup and the east side of the district, is 150–300 feet thick but averages about 175 feet. Most of the district is in the conglomeratic facies (Craig and others, 1955, fig. 22). Dip directions of the cross laminae indicate a northeast component and a southwest source (L. C. Craig, written commun., 1961).

Between Gallup and the Continental Divide the Westwater Canyon Member ranges in thickness from [illegible] to 275 feet and probably averages about 225 feet. In most places it contains one or more mudstone units that range from mere partings in the sandstone to units as much as 20 feet thick. These units have rather limited lateral continuity and only some of the thicker ones may extend as much as a mile or more before grading out into sandstone or being cut out at the base of overlying sandstone units (fig. 11). Few data are available on local sedimentary trends within the sandstone units. Sharp (1955, p. 8) commented that studies on crossbedding indicate that the sedimentary trend in the Church Rock area ranges from east-northeast in the west half to southeast in the east half, but he did not indicate the extent of the studies or the units concerned. The available data indicate that the Westwater Canyon in the district is rather uniform in thickness and lithologic character along outcrop and extends from outcrop for at least several miles.

The Brushy Basin Member in the district generally ranges in thickness from 40 to 125 feet and averages about 75 feet. The range in thickness of the member is caused mostly by its intertonguing and grading at the base with the Westwater Canyon but partly by its beveling southwestward under the pre-Dakota erosion surface. The Brushy Basin consists of varicolored claystone and mudstone interbedded with some sandstone. The principal sandstone beds, which are lithologically similar to those of the Westwater Canyon, range in thickness from about a foot to as much as 60 feet, but probably average less than 25 feet. Thinner sandstone beds are present, but are generally fine grained and calcareous and grade laterally and upward into mudstone and claystone.

Two sandstone beds in the Brushy Basin contain the principal deposits, the Black Jack 2 in the eastern part of the district and the Foutz 3 in the Church Rock area in the western part of the district. Hoskins (1963, p. 49) described the host sandstone of the Black Jack 2 as ranging in thickness from 60 feet at the northwest end of the deposit to 18 feet at the south end and as pinching out from 2 to 3 miles east of the mine. He noted the sandstone is tan to dark brown except along the northeast edge of the deposit where it is brick red. He also stated that the ore follows an ancient stream pattern, which implies that the sedimentary lineation is southeastward because of the elongation of the deposit in that direction (Hoskins, 1963, p. 49, and figs. 2 and 3). He did not indicate the western extent of the host sandstone.

The host sandstone of the Foutz 3 deposit is in the approximate center of the Brushy Basin Member. Away from the deposit the lateral extent and general stratigraphy of the unit are largely taken from Sharp (1955), who referred to it as the "upper ore sand" of the Westwater Canyon Member. From measured sections along the outcrop he extended it eastward through the southern part of T. 16, N., R. 16 W., and northward from the southernmost exposures by at least 2 miles (Sharp, 1955, figs. 3–5). More northern segments of this unit, or its stratigraphic equivalents, may be the principal sandstone unit shown in the Brushy Basin in figure 11. Throughout this general area the unit ranges in thickness from 0 to 45 feet and averages about 25 feet. Where it is light brown or gray it composes an eastward-trending zone about 1 mile wide and more than 6 miles long (Sharp, 1955, fig. 2). The eastward elongation of this zone may conform with the general dip direction of the crossbeds (Sharp, 1955, p. 8).

Konigsmark (1955, p. 8 and fig. 1) showed several sandstone units at the top of the Brushy Basin at the

UNITED STATES

NUCLEAR REGULATORY COMMISSION

REGION IV

URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

FEB 20 1990

URFO:GRK
Docket No. 40-8926

MEMORANDUM FOR: David Meyer, Branch Chief
Rules and Procedures Branch
Federal Register and Notices Section
Office of the Secretary

FROM: Ramon E. Hall
Director

SUBJECT: PUBLICATION OF A FINAL FINDING OF NO SIGNIFICANT IMPACT

In accordance with 10 CFR 51.35, attached is a final finding of no significant impact regarding termination of Source Material License SUA-1492 (Docket No. 40-8926) for publication in the Federal Register as soon as possible.

Please contact Gary R. Konwinski of my staff on FTS 776-2805 when the date of publication is known and if there are any questions concerning this request. Please also, upon publication, send a copy of the Federal Register notice to our office.

Ramon E. Hall
Director

Attachment:

Final Finding of No Significant Impact

Ford Attachment C

9003010059 1p.

U. S. NUCLEAR REGULATORY COMMISSION

DOCKET NO. 40-8926

STATE OF WYOMING

FINAL FINDING OF NO SIGNIFICANT IMPACT REGARDING TERMINATION OF SOURCE MATERIAL LICENSE SUA-1492, STATE OF WYOMING, BISON BASIN IN-SITU LEACH PROJECT, LOCATED IN THE RED DESERT OF WYOMING

AGENCY: U.S. Nuclear Regulatory Commission

ACTION: Notice of Final Finding of No Significant Impact

1. Proposed Action

The proposed administrative action is to terminate Source and Byproduct Material License SUA-1492. This action would authorize the release, for unrestricted use, of the Bison Basin site.

2. Reasons for Final Finding of No Significant Impact

Restoration and decontamination inspections conducted by the NRC's Uranium Recovery Field Office indicate that licensing commitments have been fulfilled. Furthermore, gamma surveys and soil radium analysis verify that appropriate regulatory limits have been achieved. Similarly, all other monitored environs have radiological levels that are within previously observed background concentrations.

The following statements support the final finding of no significant impact, and summarize the conclusions resulting from restoration and decontamination inspections.

A. The ground-water monitoring program utilized at the site has supplied sufficient data to verify that either background concentrations or class of use standards exist for radionuclides, heavy metals, and other monitored constituents.

B. Decommissioning and decontamination inspections indicate that the site has been decontaminated to appropriate regulatory limits. Furthermore, all byproduct materials have been disposed of at a neighboring tailings disposal cell.

C. All decontamination and decommissioning requirements specified by Source Material License SUA-1492 have been fulfilled by the State of Wyoming and its contractors.

In accordance with 10 CFR 51.33(a), the Director of the Uranium Recovery Field Office, made the determination to issue a final finding of no significant impact. This finding, together with the environmental documentation setting

forth the basis for the findings, is available for public inspection and copying at the Commission's Uranium Recovery Field Office at 730 Simms Street, Golden, Colorado, and at the Commission's Public Document Room at 2120 L Street, N.W., Washington, D.C. Concurrent with publication of this finding, the staff will terminate Source and Byproduct Material License SUA-1492 authorizing release of the area for unrestricted use.

Dated at Denver, Colorado, this 16th day of February, 1990.

FOR THE NUCLEAR REGULATORY COMMISSION

Ramon E. Hall
Director
Uranium Recovery Field Office

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
LAND QUALITY DIVISION
GUIDELINE NO. 4

In-situ MINING

This document is a guideline only. Its contents are not to be interpreted by applicants, operators, or LQD staff as mandatory. Its preparation is the result of numerous requests from applicants and operators for guidance in preparation of a comprehensive application or amendment. If an operator wishes to pursue other alternatives, they are encouraged to discuss these alternatives with the LQD staff.

This guideline is intended to be comprehensive and all headings may not apply to all operators. A table of contents is provided to direct the applicant to the appropriate topic for individual permitting needs.

Ford Attachment D

RP/2-80, SI/4-89, RD/2-90
SH/1-88, RD/8-89
Rules Update/8-94

(1) the UCL for any parameter should not be exceeded in the baseline data base after it has been screened for outliers, and (2) the UCL for any parameter should be capable of detecting an excursion event within one or two sample collections (based on a 2-week sampling interval). These criteria are based on minimizing the probability of committing a Type I and Type II error. In general, the preferred method is one that results in the highest UCL value while still being capable of detecting an excursion event.

A method that uses the baseline mean plus 5 standard deviations is the recommended method for calculating UCLs. Use of this proposed method should result in adequate excursion control, yet minimize the possibility of incorrectly placing wells in excursion status.

For situations where chloride values are very low and show little variation during baseline data collection, the LQD is willing to consider allowing the upper control limit for chloride to be set at the average baseline value plus 15 mg/L if that value is greater than the average baseline value plus five standard deviations. This option will only be considered for chloride.

G. Trend Wells

The use of trend wells has enabled in-situ operators to detect an excursive groundwater plume prior to the plume reaching excursion monitoring wells. Parameter value changes in a trend well can signal a water balance problem in the active well field that may not be otherwise evident to the operator. These wells are typically located between the injection/production wells and the monitor wells in the active well field. Water-quality analyses of samples collected from trend wells will not result in regulatory corrective action. Their use is as a preventive measure to allow greater operational control of wellfield fluids and to decrease the possibility of having to halt production to restore a much more extensive plume of mine fluids had an excursion been detected at the excursion-monitoring wells.