UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judge Peter B. Bloch

In the Matter of	)	
	)	
HYDRO RESOURCES, INC.	)	Docket No. 40-8968-ML
(2929 Coors Road, Suite 101	)	ASLBP No. 95-706-01-ML
Albuquerque, NM 87120)	)	
	)	

INTERVENORS WRITTEN PRESENTATION IN OPPOSITION TO HYDRO RESOURCES, INC.'S APPLICATION FOR A MATERIALS LICENSE WITH RESPECT TO:

GROUNDWATER PROTECTION

January 11, 1999

VOLUME IV

EXHIBITS

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Before Administrative Judge
Peter B. Bloch, Presiding Officer

Administrative Judge
Thomas D. Murphy, Special Assistant

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WRITTEN TESTIMONY OF MICHAEL G. WALLACE

On behalf of Eastern Navajo Diné Against Uranium Mining ("ENDAUM") and Southwest Research and Information Center ("SRIC"), Michael G. Wallace submits the following testimony regarding ground water issues regarding Hydro Resources Inc.'s ("HRI's") amended application for a source materials license.

Q.1. Please state your name and qualifications

A.1. My name is Michael G. Wallace. My education and experience as a professional hydrologist are described in my vita, attached to this testimony as **Exhibit A**. I have a master's degree in hydrology from the University of Arizona and extensive knowledge and experience in the movement of contaminants in ground water systems, as a consultant

to industry and government agencies. My experience includes development of hydrogeologic conceptual models and the application of those to the valid prediction of contaminant transport through numerical modeling. For much of the past ten years, I have been a consultant to the U.S. Department of Energy working on modeling radionuclide movement through hydrogeologic formations at the proposed Waste Isolation Pilot Project (WIPP) in southeastern New Mexico. I continue to work in this capacity as a contractor within Sandia National Laboratories on an essentially full-time basis.

All of my professional experience is relevant to ground water issues associated with ISL mining. However, some experience seems particularly worthy of note, given the groundwater issues that have received much attention on this case. First, I have considerable expertise in the subject of deep well injection of chemicals and/or contaminants into faulted stratigraphic units. This was the subject of my masters thesis and of a paper presented at an international ground water modeling conference. I also assisted three industrial firms in obtaining permits from the EPA for deep well injection of hazardous wastes, through my hydrologic expertise.

Second, I have significant expertise in the evaluation of multi-dimensional hydraulic effects and patterns in the subsurface. This concerns the subject of where ground water goes, why it goes there, how much of it gets there, and how long it takes to get there. I have published numerous papers on this topic and have spent a considerable

percentage of my career (and still do) concentrating on this particular field. Notably, I recently conducted a study for Sandia National Laboratories which addressed the impacts of nearby underground mine workings on ground water flow and radionuclide transport in the Culebra aquifer, an underground stratigraphic sedimentary formation sandwiched between two aquitards. The study underwent extensive review by a large body of professionals, including Sandia National Laboratories hydrogeologists, the National Academy of Sciences, and the EPA, and the study played a role in helping to get an historic environmental license for nuclear waste disposal.

Q.2. What is the purpose of your testimony?

A.2. I have been retained by ENDAUM and SRIC as a technical expert in the field of groundwater hydrology in the matter of the licensing proceeding for the application for a source and byproducts materials license submitted by HRI for the Crownpoint Uranium Solution Mining Project ("CUP"), Crownpoint and Church Rock, McKinley County, New Mexico.

Q.3. What materials have you reviewed in preparation of your testimony?

A.3. In this capacity, I have reviewed the following documents, correspondence and professional literature:

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Staub, W.P., Hinkle, N.E,, Williams, R.E., Anastasi, F., Osiensky, J., Rogness, D. An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas. Oak Ridge National Laboratory, prepared for U.S. Nuclear Regulatory Commission NUREG/CR-3967. July 1986. ["Staub et al., 1986"]

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Geraghty and Miller, Inc. Analysis of Hydrodynamic Control, HRI, Inc., Crownpoint and Churchrock New Mexico Uranium Mines. Prepared for H , Inc., Dallas, Texas, October 7, 1993. ["Geraghty and Miller, 1993"]

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Johnson, M., Navajo Nation Department of Water Resources Management. Memorandum to Peg Rogers, Navajo Nation Department of Justice, December 29, 1994. ["Johnson, 1994"]

Dalton, M.P., Navajo Tribal Utility Authority, letter to the Chief of the High-Level Waste and Uranium Recovery Projects Branch, U.S. Nuclear Regulatory Commission, from Docket No. 40-8968, Hydro Resources, Inc. February 17, 1995. ["Dalton, 1995"]

Rogers, P., Navajo Nation Department of Justice. Comments on DEIS to Construct and Operate the Crownpoint Uranium Solution Mining Project, Docket No. 40-8968, Hydro Resources, Inc. Letter to the Chief of the High-Level Waste and Uranium Recovery Projects Branch, U.S. Nuclear Regulatory Commission. February 21, 1995. ["Rogers, 1995"]

Uranium Mining in Navajo Ground Water: The Risks Outweigh the Benefits, Southwest Research and Information Center, Albuquerque, New Mexico. February 28, 1995. ["SRIC 1995"]

Kirk, A.R., Condon, S.M. Structural Control of Sedimentation Patterns and the Distribution of Uranium Deposits in the Westwater Canyon Member of the Morrison Formation, Northwestern New Mexico A Subsurface Study. In: A Basin Analysis Case Study: The Morrison Formation Grants Uranium Region New Mexico. C.E. Turner-Peterson, E.S. Santos, N.S. Fishman, eds. American Association of Petroleum Geologists, Tulsa, Oklahoma. 1995. ["Kirk and Condon, 1995"]

Kirk, A.R., Huffman, A.C., Jr., Zech, R.S. Design and Results of the Mariano Lake-Lake Valley Drilling Project, Northwestern New Mexico. In: A Basin Analysis Case Study: The Morrison Formation Grants Uranium Region New Mexico. C.E. Turner-Peterson, E.S. Santos, N.S. Fishman, eds. American Association of Petroleum Geologists, Tulsa, Oklahoma. 1995. ["Kirk et al., 1995"]

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William Ford and Chris McKenney, U.S. Nuclear Regulatory Commission, Trip Report of 11/27 - 11/29/95 Site Tour of Proposed Hydro Resources, Inc., In-Situ Leach Facility in Crownpoint, New Mexico. Memorandum to Joseph J. Holonich U.S. Nuclear Regulatory Commission. December 14, 1995. ["Ford and McKenney, 1995"]

Pelizza, M.S., Hydro Resources, Inc. Responses to NRC Requests for Additional Information, Questions 49 through 91, Letter to Joe Holonich, U.S. Nuclear Regulatory Commission. Hearing Record ACN 9604030208 (April 1, 1996) ["Pelizza, 1996a"]

Pelizza, M.S., Hydro Resources, Inc. Crownpoint Project Water Quality Information. Letter to Mike Layton, U.S. Nuclear Regulatory Commission. June 18, 1996. ["Pelizza, 1996b"]

Crownpoint Uranium Project Consolidated Operations Plan, Revision 0, Hydro Resources,Inc., Albuquerque, New Mexico. September 1996. ["COP Revision 0.0"]

Review Comments to Hydro Resources, Inc. Responses to NRC Additional Information Request (RAI), Navajo Nation Environmental Protection Agency, Window Rock, Arizona. November 1996. ["NNEPA, 1996"]

Holonich, J.F., U.S. Nuclear Regulatory Commission. Proposed Requirements and Recommendations for the Crownpoint, New Mexico Uranium Solution Mining Project. Letter to Richard F. Clement, Jr., Hydro Resources, Inc. December 20, 1996. ["Holonich, 1996"]

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Crownpoint Uranium Project Consolidated Operations Plan, Revision 2.0. Hydro Resources, Inc., Albuquerque, New Mexico. August 15, 1997. ["COP Revision 2.0"]

Intervenors ENDAUM and SRIC's Second Amended Request for Hearing, Petition to Intervene, and Statement of Concerns, New Mexico Environmental Law Center, Santa Fe, New Mexico, and Diane Curran, Harmon, Curran & Spielberg, Washington, D.C. August 15, 1997. ["ENDAUM-SRIC's Second Amended Request"].

HRI, Inc. Response to NRC RAI #99, Sensitivity Analysis of Modeled Unit 1 Site Ground-Water Flow. Letter from C.S. Bartels, HRI, to W.H. Ford, U.S. Nuclear Regulatory Commission. Hearing Record ACN 970108219 (August 18, 1997). ["Unit I Sensitivity Analysis, 1997"]

Farrell, D.J., U.S. Environmental Protection Agency, Region IX. Letter to Joseph J. Holonich, U.S. Nuclear Regulatory Commission, transmitting comments on Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project. September 23, 1997. ["USEPA, 1997"]

Draft Standard Review Plan for In Situ Leach Uranium Extraction License Applications. Division of Waste Mangement, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC, October 1997. ["Draft Standard Review Plan"]

Errata sheets to FEIS. U.S. Nuclear Regulatory Commission. November, 1997. ["FEIS Errata Sheets"]

Safety Evaluation Report, Hydro Resources, Inc. License Application for Crownpoint Uranium Solution Mining Project, McKinley County, New Mexico, U.S. Nuclear Regulatory Commission, Washington, D.C. December 5, 1997. ["SER"]

Numerous "Requests for Additional Information" (RAIs) from NRC to and HRI's responses to those RAIs. 1996-1997. ["Response to NRC-RAI #X"]

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Hydro Resources, Inc., Albuquerque, New Mexico, Docket No. 40-8968. Jan 5, 1998. ["NRC License SUA-1508"]

Memorandum from Joseph J. Holonich NRC Staff, to Peter B. Bloch, Atomic Safety and Licensing Board, concerning "Supplement to February 27, 1998, Notification of New Iormation Potentially Relevant and Material to the Proceeding in the Matter of Hydro Resources, Inc. (ASLBP Number 95-706-01-ML): March 19, 1998, Teleconference with Professor Neuman (April 20, 1998) ("Holonich Memorandum II"); and Memorandum from Joseph J. Holonich, NRC Staff, to B. Paul Cotter, Atomic Safety and Licensing Board, concerning "New Information Potentially Relevant and Material to the Proceeding in the Matter of Hydro Resources, Inc. (ASLBP No. 95-706-01-ML", and attaching overheads from a January 29, 1998, presentation to the NRC Staff by Professor Shlomo P. Neuman, University of Arizona, titled, "Hydrogeologic Conceptualization for Environmental Safety Assessment: Case Studies and Steps Toward a Strategy" February 27, 1998) (hereinafter, "Holonich Memorandum I, Neuman Presentation").

Affidavit of William H. Ford, attached to the U.S. Nuclear Regulatory Commission Staff's Response to Motion for Stay, Request for Prior Hearing, and Request for Temporary Stay, along with some of the cited documents (February 20, 1998) ["Ford Affidavit"]

Affidavits of Mr. Richard F. Clement, Jr., and Mr. Craig S. Bartels, attached to HRI's Response to Petitioners' Motion for Stay ("HRI's Response") (January 26, 1998) along with some of cited documents ["Clement Affidavit" and "Bartels Affidavit"].

Responses of counsel for the NRC Staff (Letter from Mitzi A. Young to Johanna Matanich (November 13, 1998)), and of HRI (Letter from Mark Pelizzá to Bob Carlson (October 16, 1998) and Letter from Frederick S. Phillips to Johanna Matanich (December 29, 1998)) to an earlier request by counsel for ENDAUM and SRIC for certain geologic information, including structural cross-sections and structure contour maps.

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Anderson, O.J., and S.G. Lucas, 1996, *The Base Of The Morrison Formation (Upper Jurassic) Of Northwestern New Mexico And Adjacent Areas*, from; The Continental Jurassic, Michael Morales, ed., Museum of Northern Arizona Bulletin 60.

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Developments in Uranium Resources, Production and Demand - Vienna, 10-13 June, 1997

Peterson, R.J., 1980, *Geology of Pre-Dakota Uranium Geochemical Cell, sec. 13, T. 16N., R. 17W., Church Rock Area, McKinley County*, New Mexico Bureau of Mines and Mineral Resources, Memoir 38, 1980

Freeze, A., and J. Cherry, 1979, GROUNDWATER, Prentice Hall publishers, Englewood Cliffs, NJ

Affidavit of Mr. Mark S. Pelizza, attached to HRI's Response to Scheduling Conference Briefs of all Petitioners ("HRI's Response b") (September 9, 1998) ["Pelizza Affidavit"].

Transcript of Proceedings (Volume 1), In the Matter of the Application of HRI,Inc., to Change Place or Purpose of Use and Points of Diversion of Underground Waters, before the New Mexico State Engineer (March 24, 1998)

Hydro Resources, Inc., Albuquerque, New Mexico, March 1993 Church Rock Revised Environmental Report ["Church Rock Revised Environmental Report"]

Q.4. What is your evaluation of HRI's geologic and hydrogeologic characterization of the mining zones and their surroundings?

A.4. HRI's assumptions about the hydrogeologic characteristics of the Westwater Canyon Member are profoundly inaccurate. In fact, excursions of lixiviant from the WCM are more likely than HRI has estimated because the WCM is a heterogeneous formation. Furthermore, for the same reason, those excursions may travel much faster than HRI has estimated, and they could well go undetected in light of HRI's proposed monitor well configuration. In addition, claims of vertical confinement are generally unsubstantiated, and in some cases belied by HRI's own data. In the following paragraphs I detail the major deficiencies under this topic heading.

fluvial geomorphology, sand channels, heterogeneity, anisotropy

It is my view that NRC's and HRI's conceptual model of the hydrology of the Westwater is seriously flawed, and that the Westwater is in fact a series of thin, stacked and criss-crossing sand channels bounded by less permeable siltstones and shales. The likely existence of thin sand channels in the formation has wide-reaching implications for lixiviant control, the efficacy of the monitoring well networks to detect excursions, the velocity of groundwater carrying mining solutions, and, in the case of the Unit 1 and Crownpoint sites, protection of the Crownpoint municipal water system located down gradient from the mining sites.

HRI inaccurately describes the Westwater Canyon Member ("WCM") as a "massive" sandstone. See Geraghty and Miller at 2-3, Hearing Record ACN 9312160178 (October, 1993). To geologists and hydrogeologists, the word "massive" refers to rock formations that have the same geologic composition throughout, such as sandstones derived from ancient sand dunes (called "eolian" rock). The WCM, however, is a "fluvial" sedimentary formation derived from ancient streambeds. See Turner-Peterson, 1986. Figure 9. HRI and its consultants also make inaccurate assumptions about the hydrology of the WCM. For instance, they assume that the formation is of uniform thickness and infinite width across the proposed mining areas (Unit I Sensitivity Analysis at 3-4), and use aquifer models to predict groundwater flows in the mining zones that are appropriate only for aquifers that are homogeneous, isotropic and of vast areal extent (Pelizza, 1996a, Response to NRC-RAI #77;

Geraghty and Miller, 1993, at 2-3). In hydrology, the term homogeneous refers to rocks that vary little in their geologic composition, and the term isotropic means that the rocks are identical or similar in all directions such that groundwater can flow with equal ease in virtually any direction. The hydrogeology of the Westwater Canyon Member is exactly opposite of these characteristics. In fact, HRI's view of the WCM as "massive" has no basis in the professional, peer-reviewed literature with which I familiar. On the contrary, according to one typical paper from the literature:

> . . .The Westwater Canyon Member was deposited by composite systems of moderate- to high-energy braided streams. This braided character of the streams is recognized . . . by the tabular to lenticular geometry and stacking of sandstone beds.

Kirk and Condon, 1995, at 111. Moreover, Wentworth (1980) illustrates quite clearly how the WCM varies geologically throughout its entire thickness. These investigators published an electric well log from an exploration hole drilled in the Crownpoint area,[1] showing five different sand layers ranging from 20 feet to 75 feet in thickness, separated by four mudstone or shale layers measuring 10 to 20 feet in thickness (Wentworth et al., at 140). To show this "layer cake" pattern, I have copied and slightly enlarged the Wentworth well log, labeling the thickness of each of the Westwater layers. **<u>See</u> Exhibit**

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[1] The borehole from which the electric well log was derived was located in Section 29, Township 17 North, Range 12 West. FEIS at 2-28. Figure 1 is provided as a general illustration of the geological variation in the Westwater through the Unit I and Crownpoint sites; the actual layering at any particular location certainly would not be identical.

B attached hereto. This picture of the WCM as a series of ancient, buried streambeds, stacked one on top of another and separated, to one degree or another, by mudstones, siltstones, and shales, has remained remarkably consistent in the geologic literature over the past 20 years, evolving only in refinement and detail. (See, e.g. , Galloway, 1980, at 59-59; Johnson, 1994, at 2-3; Kirk et al., 1995, at 236; and Turner-Peterson and Fishman, 1995, at 362-363.)

Geologists and hydrogeologists call rock formations with the characteristics of those like that of the WCM "heterogeneous," meaning that they vary greatly in geologic composition and in hydrologic properties in both localized occurrences, and over entire regions, such as in the San Juan Basin of northwestern New Mexico where HRI is planning to operate the Crownpoint Uranium Project. In the case of the WCM, this characterization makes sense because the formation was deposited, some 140-150 million years ago, by the overland flow of streams and rivers, each succession of which was buried on top of the last. That depositional history is why the Westwater today contains dozens of criss-crossing (i.e., "braided") sand channels, each having their own unique hydrogeologic properties.

This mischaracterization of the Westwater is especially peculiar for at least three reasons:

(a)the extensive professional literature that consistently describes the Westwater as a series of stacked and braided stream deposits;

(b) the evidence from the literature that individual "ore pods" in the Crownpoint area range "from a few feet to 200 ft (60 m) wide and from a few inches to 20 ft (6 in) thick";

(c) HRI's own graphic depiction of the LB Sand as a snake-like channel measuring approximately 80 feet to 140 feet in width in Section 24 of the Crownpoint mine site. **<u>See</u> Exhibit C.**

(d) Figure 8 from a paper by McCarn (1997), depicting stacked roll fronts at the Crownpoint site, which obviously correspond to sand channel morphology. **<u>See</u> Exhibit D.**

In the Church Rock area, the orientation of these sand channels is generally from south to north. In the Crownpoint area, the orientation of the sand channels in the Westwater is generally west-to-east (Galloway, 1980, at 60). Regionally, the groundwater moves from southwest to northeast across the channels (Stone et al., Sheet 7, Figures 72 and 74), and on a localized basis, south to north across the Unit 1 site (Unit 1 Sensitivity Analysis, Figure 5). Water can move much faster along the sand channels than across the channels, where it encounters materials of a finer grain that bound the sands. This condition is known to hydrogeologists as "anisotropy," it is typical of heterogeneous rock formations. HRI's own calculations showed that the WCM in the Unit 1 area has anisotropic conditions in which groundwater can move through the sand channels, east to west, twice as fast as it can flow across the channels from south to north, all other things being equal. (Unit 1 Sensitivity Analysis at 10).

In summary, the Westwater is not a homogeneous isotropic uniform aquifer of constant thickness and infinite areal extent. Rather it is a heterogeneous, anisotropic, non-uniform formation comprised of buried sand channels and the finer grained material that surrounds them. The ore bodies reside within sand channels, and reflect that condition in several maps of the very orebodies that HRI proposes to mine. Later sections of my testimony will detail how this mischaracterization by HRI has profoundly influenced their analyses in support of their application, such that those analyses are critically flawed.

Recapture Shale is not a shale in this region

HRI's application incorrectly identifies a confining unit below the Westwater at all sites. This unit is the Recapture Shale. It is purportedly about 200 ft. thick at each area (this is not true at the ore zone in section 8, as will be discussed later). According to HRI, this unit is extremely impermeable and of course, thick, such that it should not be necessary to monitor the Cow Springs aquifer that underlies it (for example, see Pelizza 1996a, response NRC-RAI #63, page 1). Although NRC has required that the Cow Springs at least be tested for hydraulic connections (to their credit), they have missed the point that the Recapture Shale may be an aquifer itself. In any event, the Recapture Shale is definitely not a confining shale at any of the four sites. To develop this point, I will first explain what exactly a shale is, and second, I will clarify some characteristics of the practice of geologic nomenclature.

A shale is a rock that is very high in clay content. Because of this high clay content, the rock is relatively impervious to water flow. Hence, the common understanding that shale units serve as good aquitards (barriers to the vertical movement of water between strata). Shales are often formed in initial environments of still, deep water, where fine grade clays have an opportunity to settle. Lacustrine deposits (from ancient lake beds) are usually associated with shales, for this reason. On the other hand, fluvial environments do not always have such shale deposits, because of many factors, including the higher energy of sediment transport.

Geologic nomenclature can be very misleading. Lithologic strata often cover thousands of square miles (even millions). Every attempt is made to correlate such strata to certain time periods. However, locking a unit to a time period means that allowances must be made for the fact that the depositional environment varied over time and space to some degree for that unit. Therefore, the rock types associated with that unit vary as well. But the rock must be given some name for identifiction, although no single name is perfect. One tries to identify the name with a basic rock type that appears to be most characteristic.

Many of the strata of the San Juan Basin were named many decades ago, based on limited exposures in outcrops as far away as Utah and Colorado. The Recapture Shale is such a strata. It was named a shale, based on exposed outcrops in Utah in 1938 (see Kirk and Condon (1995), page 110), where in fact much shale was evident. That part of the

Recapture has been correlated with a lacustrine depositional environment (see COP, Revision 0.0, 1996, page 90). However, in the southern part of the San Juan Basin, including all proposed HRI sites, the Recapture has been characterized as fluvial, not lacustrine (see Kirk and Condon (1995), pages 109-110, and Hilpert (1969), pages 75-76). This is notwithstanding the claims made by HRI (Pelizza 1996a, response NRC-RAI #63, page 1), without reference to scientific evidence, that the lacustrine facies of the Recapture is roughly 200 feet thick at all proposed sites. Therefore, one must go an extra step to determine whether there is sufficient clay in the material before it can truly be characterized as a real shale.

In the case of the mining sites in question, there is no documentation that demonstrates that there are any clays in this unit[2]. In fact, there appears to be more clay in the Westwater than there is in the Recapture. Even the FEIS characterizes the Recapture as "Reddish-brown siltstone and white sandstone" (FEIS at 3-10). It would seem that, in this part of the San Juan Basin, the Recapture is far more likely to be an aquifer in its own right than a confining unit.

The NRC is obligated to see that the first underlying *aquifer* is protected.

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[2] The Geraghty & Miller report on Analysis of Hydrodynamic Control (Geraghty and Miller, 1993) claims to have reviewed "structural and lithologic cross-sections .. which indicate that the upper 160 ft. of Recapture consists predominantly of shale" (p. 7). However, as documented later in this report, HRI now states that G&M reviewed no such data. In any event, I could not find this alleged data anywhere in the application.

Groundwater STP at 9, Exhibit 1-E. An aquifer is identified by its hydraulic characteristics, not by an accident of naming conventions. To only consider units below the Recapture as valid aquifers may endanger vast quantities of potable (drinkable) water.

In summary, the Recapture shale has been incorrectly identified as a lower confining unit below the Westwater at each site, whereas in fact, the preponderance of evidence points to the likelihood that this unit may be in parts an aquifer in its own right. The license prescribes a focus on the Cow Springs Sandstone, an aquifer under the Recapture (in most places), and effectively excludes the Recapture from any monitoring requirements (see License Condition 10.32). This is a flawed condition, based on faulty reasoning and virtually no site-specific evidence.

Necessary structural data has not been provided

I have already described how rock type can influence containment issues. For example, sands are more permeable than clays. There is another class of geologic features that can have just as important an influence on containment. This is the structural class. Structural features basically concern the arrangement of the rock types in space, among other things. Faults, fractures, and scour zones, from this perspective, are all structural features.

Faults are planes along which displacement of rock has occurred. Vertical fault planes are common in the San Juan Basin. If vertical displacement is significant, then a

lower sand unit can end up in actual horizontal contact with an 'upper' sand unit. If, for example, at one of the HRI sites, a sufficiently large vertical fault existed (70 feet or so), then the Westwater would be in direct contact with the Dakota. This would create possibly overwhelming obstacles to the protection of the Dakota during ISL operations.

Fractures are broken zones of rocks with a generally planar configuration. They are often a feature of faulting. However, they can exist in the absence of faults. Imagine the 'break' of the fault without the movement of the rocks. Fractures can serve as barriers to flow or conduits for flow, depending on the circumstances. For example, if the surrounding material is high in clay, then fractures may be sealed, even during faulting (although this is not generally taken for granted by regulators). On other occasions the fractures may simply be areas where otherwise intact confining units are broken up, such that water can easily move through them. If, for example, at one of the HRI sites, a set of unsealed vertical fractures existed, then lixiviant might easily migrate up these fractures into the Dakota. Once again, this would create possibly overwhelming obstacles to the protection of the Dakota during ISL operations.

Scour zones are areas where overlying sand or gravel channels have carved into underlying, softer material, such as a shale. If a scour zone is deep enough, and the underlying zone is thin enough, then the scour zone may fully penetrate that unit, and come into contact with the second unit down. Scouring is a ubiquitous feature of the Morrison Formation environment (which includes the Westwater). The Westwater has

scoured the Recapture below it at many places. The pre-Dakota erosional surface represents scouring of much of the Brushy Basin shale (which overlies the Westwater). If for example, at one of the HRI sites, a deep enough scour zone existed, then the Dakota might come into direct contact with the Westwater. Just as reasoned before, this would create possibly overwhelming obstacles to the protection of the Dakota during ISL operations.

There are numerous tools to aid a geologist in identifying such structures. Pump tests, if properly implemented, are an excellent tool for the identification of breaches of confining units, but they do not provide the ability to easily distinguish between a fault, a fracture, a scour zone, or even a poorly sealed borehole. Structural cross-sections, fence diagrams and structure contour maps are the most reliable tools to determine whether faults exist that juxtapose geologic units. Another useful tool for geologic assessment and interpretation are the driller's logs that exist for the several hundred boreholes at the three proposed mining sites. Driller's logs (which are also called "borehole logs") contain detailed descriptions of the strata encountered at each foot in a borehole based on the written observations of the field geologist.

As stated before, a juxtaposition of two different geologic units could allow water (or lixiviant) to easily travel from one unit to another. I prepared two figures in order to demonstrate the difference between a structural cross-section, which is represented in **Figure 1**, and a stratigraphic cross-section, which is represented in **Figure 2**, both of

which are attached hereto in **Exhibit E.** A structural cross-section recreates the actual elevations and thickness of each unit, measured from a common reference elevation (sea level, in most cases). This type of cross-section honors the true elevations of each geologic unit, thereby making it possible to determine if faulting causes one unit layer to be juxtaposed against another. A stratigraphic cross-section, on the other hand, cannot be used to determine whether or not one geologic unit is juxtaposed with another. This is due to the fact that to create a stratigraphic cross-section, geologic units are shifted up or down by the analyst in order to make a single layer have a perfectly horizontal top. Stratigraphic cross-sections aid in re-creating aspects of the original depositional environment of the buried geologic units of concern. They do not, however, provide information on the displacements caused by faulting.

The license material repeatedly represents that structural data was analyzed to determine whether significant faults existed at any of the sites, and that no such faults were discovered.[3] These analyses were even cited to counter evidence from the regional literature that such faults did pass through one or more of the sites. However, based on

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[3] For example, see FEIS at 3-15, 3-21, 4-42, 4-55, COP revision 0.0 1996, p. 90, and Pelizza 1996a, response NRC-RAI #85). Also, the Geraghty and Miller report on Analysis of Hydrodynamic Control (Geraghty and Miller, 1993) at pages 3 and 7 clearly state that the analysts reviewed structural cross-sections. HRI recently wrote that its consultants erred in referring to these cross-sections "as 'structural' when in fact those were stratigraphic cross-sections." Letter from Frederick Phillips to Johanna Matanich at 2 (December 29, 1998), a copy of which is attached hereto as **Exhibit F.**

recent acknowledgments by HRI (see, for example, Frederick Phillips letter, December 29, 1998, at 2), this was a gross and profound misrepresentation. In truth, no structural cross-sections, (and no structure contour maps, drillers logs, or fence diagrams for that matter) are contained in the application.

HRI has extensive geologic data from more than 320 boreholes in the Unit 1-Crownpoint area and more than 600 boreholes in Sections 8 and 17 at the Church Rock site. (See Ford Affidavit, ¶10, at 9, and Clement Affidavit, ¶12 at 2). Many of these boreholes were drilled for the purpose of delineating the uranium mineralization of the different strata (Clement Affidavit, ¶2, at 2-3). Such geologic data can be, and routinely are, used to construct fence diagrams, structural cross-sections and structure contour maps. They can also be used to verify accuracy. It is standard industry practice to prepare such diagrams. Even HRI claims to have prepared fence diagrams (COP revision 0.0, p. 90) and to have performed detailed structual analyses (Pelizza 1996a, response NRC-RAI #85) in support of this license. Yet

HRI aggressively persists in preventing review of this material[4,5].

In summary, the license clearly violated the rule against misrepresentations in 10 C.F.R. Section 40.9(a) which states "Information provided to the Commission by an applicant for a license . . . shall be complete and accurate in all material respects." In this particular case, among others, the misrepresentations HRI has made about its hydrogeologic characterization, consist not of technicalities, but of crucial information that is critical to the issue of lixiviant containment and health and safety.

Neuman critique

An internationally recognized hydrologist and part-time consultant to the NRC, Dr. Shlomo P. Neuman, used the Crownpoint Uranium Project as one of three "case studies" to illustrate "the complexity of hydrogeologic conceptualization, its numerous pitfalls and potential to constitute a major source of uncertainty in assessing the expected safety

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[4] On December 28, HRI offered to provide geophysical logs and the location of surface elevations for eight wells at Church Rock (Frederick Phillips letter December 29, 1998 at 2-3) . "The logs identified above and the surface elevations described below give Intervenors what they need to generate structural cross sections." This is much too little information. This information only allows the preparation of a small cross-section that penetrates an insignificant fraction of the site area. In any event, the main issue is that ALL of the data should have been provided in the application.

[5]A structure contour map may have been prepared at least for Unit 1 since the United States Environmental Protection Agency requested such a map in their review of Unit 1. However, this map has not been provided to us, if it in fact exists.

performance" of a particular site. Holonich Memorandum 1, Neuman Presentation at 1 attached hereto as **Exhibit G.** In a presentation to the NRC Staff on January 29, 1998, Professor Neuman, a hydrologist at the University of Arizona, wrote that HRI's modeling of the Westwater Aquifer as "hydraulically uniform, isotropic and perfectly confined" failed to consider that drawdown effects of pump tests often are obscured in a "multiaquifer" setting, as in the case of the CUP. Id., Attachment at 16. Professor Neuman concluded that the "hydrogeologic conceptual framework behind the FEIS [for the CUP] is flawed (neither realistic nor conservative) and therefore indefensible." I have reviewed Dr. Neuman's findings and concur in his conclusion that the conceptual framework is flawed and indefensible.

I was not present for Professor Neuman's January 29 presentation but examined closely a NRC Staff memorandum to which was attached copies of the overheads from his presentation. I also was not present at a March 19 teleconference between the NRC Staff and Dr. Neuman. (It is my understanding that a request by counsel for ENDAUM and SRIC to be present on that call was denied by the NRC Staff.) In a memorandum summarizing Dr. Neuman's views during that call, the NRC Staff stated that Dr. Neuman:

> "did not indicate it was his opinion that the Staff's conclusions were wrong regarding the potential for vertical excursions to occur at the [Crownpoint] site. Furthermore, he did not specifically identify anything in NUREG-1508 that he believed would disqualify the site from ISL mining. Instead, he was concerned the staff had assumed the aquifers beneath the proposed sites are not hydraulically connected, and that NUREG-1508 does not contain a compelling argument showing the geologic materials of the Brushy Basin Shale will adequately prevent vertical excursions."

Holonich Memorandum II at 2, attached hereto as **Exhibit H**. There is no evidence in Holonich's second memorandum whether Dr. Neuman acknowledges and accepts the Staff's description.

Q.5. What is your evaluation of HRI's claims (and supporting models) that the proposed activities will not be harmful to ground water and/or underground sources of drinking water?

A.5. I have given this issue considerable attention from many different perspectives. For clarity, I have divided this topic into two major sections. First, I address HRI's application materials in respect to horizontal containment, and then in respect to horizontal containment. Naturally, other areas of my testimony also consider these issues. However, this section deals with basic issues that lend themselves most ideally to this category. The materials in HRI's application do not support any claims of confinement.

Horizontal confinement

There are numerous issues and problems associated with the question of adequate horizontal confinement of lixiviant. The following discussion treats the topics of excursion monitoring, the purported bleed rate, ground water modeling, the nature of the lixiviant, and projected travel times of lixiviant or other contaminants out of the mine

zone and into the accessible environment.

<u>improper monitoring configurations</u>

I concur with Dr. Abitz's and Dr. Staub's testimony that HRI's perimeter monitoring well network is not adequately designed to detect excursions moving laterally through sand channels narrower than 400 feet. Given the heterogeneous, anisotropic hydrogeologic environment, in conjunction with the simple, arbitrary constant 400 ft. spacings of the monitor wells, lixiviant is likely to escape the mining zones at the Church Rock, Unit 1 and Crownpoint sites without warning, contaminate the high quality groundwater at each site (used in fact for drinking water in Crownpoint) and endanger the public health.

Mr. Ford asserts that the recommendation in the Groundwater Monitoring STP that a higher density of monitor wells be placed downgradient from the mining zone "appears to have been based on the faulty assumption that excursions will occur with a greater frequency on the down-gradient side than in the up-gradient direction." Ford Affidavit, ¶15. Mr. Ford's claim that the Groundwater Monitoring STP's apparent assumption is faulty is based on his belief that "since the difference in head is so great between an injection well and pre-mining water levels, an excursion should be able to overwhelm the local ground water gradient in any direction." <u>Id</u>.

The presence of narrow sand channels, that can rapidly transmit flows past 400-foot-spaced monitoring wells, alone calls for a higher density of down-gradient

monitoring wells. Mr. Ford also ignores the fact that the municipal wells would be pumping during the operation of the Unit 1 site. (License Condition 10.27 only requires relocation of municipal wells for the Crownpoint mine to operate). The influence of these municipal wells would be greater than normal ambient gradients. Furthermore, groundwater can be shown to flow from the Crownpoint wellfield into NTUA-1, and any horizontal excursions not detected by the perimeter monitoring wells would become known only after they had reached the closest municipal water supply well. Moreover, replacement municipal wells could also influence flow at both the Crownpoint and Unit 1 sites, depending on the location of the replacement wells. Therefore, a greater density of monitor wells down-gradient is needed.

Mr. Ford claims that License Condition 10.23 requires that wells would have to be redrilled if they are not monitoring the same sand units into which lixiviant is being injected and from which uranium is being produced. Ford Affidavit, ¶16. Mr. Ford's conclusion rests on an erroneous statement of the requirements of License Condition 10.23. That condition does <u>not</u> require that monitoring wells be placed in "the same sands as the production zone" (<u>id.</u>), but rather that the monitoring wells be "completed in the Westwater Canyon Aquifer." License Condition 10.23. The Westwater Canyon Aquifer, in its entirety, is much thicker (250 feet to 350 feet) than any of its individual sand channels or ore zones within those sands. Thus, the license condition does not mitigate the problem.

the bleed rate is not what it was purported to be

HRI asserts that it will contain all contaminated mining solutions within the boundaries of each wellfield during operations by maintaining a "bleed" rate of 1 percent, or about 40 gpm (FEIS at 2-7; COP Revision 2.0, Figure 3. 1-1 and Section 6.5.1). In other words, HRI plans to pump more fluid out of the Westwater Canyon Member (approximately 4,000) gpm) than is pumped into it (approximately 3,960 gpm). This "process bleed" (COP Revision 2.0 at 69) must account for the water that is moving naturally through the formation, as well as the water that is being introduced artificially. Large volumes of groundwater enter and leave the undisturbed ore zone every day, due to the combined effects of regional flow and, in the case of two of the sites, the pumping of nearby municipal wells. As long as the aquifer is in a chemically reduced state, the through-flowing water remains essentially uncontaminated because the contaminants indigenous in the rocks remain bound to individual grains of sand, silt and clay. However, once the lixiviant (sodium bicarbonate and dissolved oxygen) is introduced into the groundwater, this through-flowing water will mix with the injected lixiviant and immediately begin mobilizing a variety of contaminants, including radium, uranium, arsenic, molybdenum, and total dissolved solids (TDS). For two of the sites, these contaminants will move toward Crownpoint's municipal water supply wells in the direction of groundwater flow (from west to east) unless the through-flowing water is checked (Geraghty and Miller, 1993, at Figures 3 and 4). Under HRI's

conceptualization of the Westwater Canyon Member, the only way to begin to arrest groundwater through-flow is to pump enough fluid from the aquifer so that water flows inward from all directions toward the mining production wells. The amount required to create and maintain this cone-shaped fluid sink in the mining zones depends upon the size and shape of the mine-related wellfields and the natural flow rates through them.

HRI has stated that to implement this bleed, it will pump out 1% more water from the mine zones than it returns. They have stated that this will, in all cases, create a 'cone of depression'[6] around the mine zone, such that outside waters will not drift through the mine zone and pick up and transport away harmful solutes. Yet, as is well known, this bleed rate is only applied as an average over the entire zone being mined. Many wells are injecting, others are producing, so the effect is an overall one, and is set at the bare minimum that they can justify. Recently, HRI clarified what it actually is doing with the 39 gpm that is reinjected into the aquifer. In Hydro Resources Inc.'s Response to Intervenors' November 9, 1998 Briefs in Opposition to Application for a Materials License with Respect to Liquid Waste Disposal Issues (page 45) (December 9, 1998), HRI stated that the excess production bleed will be "reinjected ouside the monitor well ring."

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[6] This is inacurrate, or misleading. A sink is what is required, not necessarily a mere cone of depression. People commonly confuse the two, but it in fact is possible, even common to have a cone of depression without creating a sink.

Proof of the efficacy of HRI's bleed effect was attempted in the GM modeling studies, which made explicit simulations to demonstrate that a 1% bleed would function as intended for all mine zones. Yet the models all fail to account for the fact that the 1% bleed is actually re-injected into the very same zones, albeit on their 'edges' near the monitoring wells. Every G&M model covers more than enough area to encompass the reinjection activity that HRI has acknowledged. Failure to put this critical feature into the models is sufficient in its own right to invalidate all model results and conclusions.

As an expert with nearly two decades of experience in hydraulic analysis, and numerous publications in this particular specialty, I can explain what the results would show if they had put the reinjection activity in. Since the bleed is only an overall effect, averaged out over a large area, it is rendered useless if the fluid removed is reinjected in the same general area. Through the Principle of Superposition (see Freeze and Cherry, figure 8.15e at page 330, attached hereto as **Exhibit I**), the aquifer 'mound' generated by the reinjection will be added to the sink generated by the overall bleed, possibly canceling out the sink in many areas. In some areas the effect may be neutral, but in all areas, the sink will be diminished. In certain areas, the sink may be eliminated entirely, or even reversed. There is no way to quantitatively evaluate such an activity without knowing exactly where the reinjection is to occur. Even then, modeling or other formal analysis is essential.

To summarize, HRI plans to reinject most of the 1% production bleed, in relatively

close proximity to the mining zone, in the same aquifer, thereby defeating the purpose of the bleed (to contain lixiviant and prevent excursions). Furthermore, they have failed to provide any information, modeling, or arguments, which clarifies this plan, or which even begins to substantiate that the imposed aquifer 'sink' around the mine zone will be unaffected. Common hydrologic sense would dictate that the fluid must be transported to another place completely outside of the zone of influence. Surface application or deep well injection (far below the Westwater) come to mind as the common ISL practices for disposal of bleed waters. I conclude that HRI has not demonstrated containment of lixiviant for any site, if only for this reason.

ground water modeling is flawed, even if the bleed were disposed of at the land surface

Long before I learned that HRI plans to actually reinject the bleed in close proximity to the mine zones, I conducted a review of their aquifer modeling and found numerous, critical misrepresentations of the results, as well as other serious deficiencies. Notwithstanding HRI's failure to consider bleed reinjection in their models, the simulations are seriously misleading, and critically flawed. Since I first reported these misrepresentations, both NRC and HRI have had numerous opportunities to rebut my criticism of the ground water modeling, but they have not done so.

Using data from HRI's pump tests, "Theis non-equilibrium equations" and a computer modeling program called AQUASIM (Geraghty and Miller, 1993, at 4), HRI's hydrologic consulting company, generated a series of hydraulic gradient and

potentiometric surface maps for the Crownpoint and Church Rock mine sites. These computer-generated maps depicted groundwater flow lines and fluid contour lines defined by elevations above sea level for different seasons of the year and for different phases of production (id.). A bleed rate of 1 percent was used to model groundwater flow at the end of production for each wellfield; a bleed rate of 12 percent was used to model groundwater flow at the end of restoration for each wellfield (id.).

The model used was analytic, which dictated assumptions that the aquifer was homogeneous, isotropic, and of infinite lateral extent. Initially it can be said that, due to the well-established fact that the Westwater is heterogeneous, this model is not suitable for evaluating lixiviant containment. Heterogeneity can play the most important role of all in dictating final flow patterns. Furthermore, the model does not simulate actual contaminant transport. Instead, the analyst is meant to infer actual lixiviant transport based on groundwater path curves. However, this ignores important chemical transport phenomena such as dispersion, in which chemical species may actually disperse across so-called groundwater divides or pathlines. Notwithstanding those deficiencies, I reviewed the model, if only to evaluate the flow regime that they purported to simulate.

In examining the flow modeling diagrams in the Geraghty and Miller report and the assumption and input parameters for the AQUASIM model (Pelizza, 1996a, Response to NRC-RAI #77), I determined that crucial model results were misrepresented. I must stress that the problems I observed in the diagrams of the modeling results are not minor. On the

contrary, they are substantial because they contradict HRI's assertion that mining fluids will be adequately controlled during production and restoration.

To illustrate my concerns, I will focus on inaccuracies and mistakes I encountered in Figures 9 through 11 of the Geraghty and Miller report (Geraghty and Miller, 1993), attached hereto as **Exhibit J**. However, I encountered these problems for all sites that were modeled.

These figures are important because they show the shape of the groundwater flow system at the end of restoration and end of production for Crownpoint Wellfield 4 (Geraghty and Miller, 1993, Figures 9, 10 and I 1, respectively). Each of these diagrams purports to present three distinct modeling results: (1) "groundwater pathlines," which are supposed to indicate the direction(s) of groundwater flow; (2) elevation contour lines that define the potentiometric surface and are called "head contours" or "hydraulic head contours"; and (3) thick black lines indicating the location of the "groundwater divide." The groundwater divide is a line of points in the potentiometric surface akin to a mountain ridge at which groundwater flows either toward the mining zones in one direction or toward NTUA-1 in the other direction.

Professional hydrologists adhere to strict rules about how pathlines and head contours are drawn and interpreted and how the location(s) of groundwater divides are determined. Ground water flows from regions of high hydraulic head to low hydraulic head, much as surface water flows "downhill" from high elevations on the land surface to lower elevations.

In fact, a simplified description of overland flow of water over mountains and through valleys provides a good illustration for understanding pathlines and head contours.

When rain falls on the land surface, it flows downhill from a point of high elevation to a point of low elevation. If this rain were shown on a topographic map, the water would cross consecutively lower and lower elevation contour lines, each at a right angle. Naturally, the water would never spontaneously flow uphill, crossing higher and higher elevation contour lines. The direction of this overland flow, perpendicular (i.e., at a right angle) to surface contour lines is the same for the direction of groundwater flow: the pathlines cross groundwater "surface" elevations at progressively lower and lower elevations.

Mountain ridges are surface water flow divides. In other words, water will not spontaneously flow uphill and then downhill over the other side of a ridge. A surface water divide can also be described as a river at the base of a valley. Water flowing down a slope eventually meets the river and then joins it, flowing downstream; water does not flow downhill, cross a river, and then flow up the opposite slope. In both of these examples, these flow divides are also pathlines, and, since pathlines cannot cross each other, they are also divides.

The surface water example illustrates the rules applied by professional hydrologists to model groundwater pathlines and divides:

(a) A pathline must always cross a head contour at a right angle; and

(b) A pathline must always cross successively lower values of head contours,

and accordingly, a pathline cannot cross the same head contour line twice; and

(c) Because of the lack of physical divide features in the flow domain, all ground water divides depicted must be pathlines as well and *must* follow the same rules above as for pathlines.

In examining the diagrams in the Geraghty and Miller report, I noticed that not all pathlines crossed head contours at right angles. For example, in Figure 10, the lower center pathline that forms a U shape crosses seven head contours, from left to right. Clearly, the sixth contour it crosses, just below its arrowhead, is not crossed at a 90 degree angle, thereby violating Rule #1. Had the pathline been drawn correctly, it would have indicated a significantly different trajectory. Many of these pathlines or others, if drawn correctly, would show fluid leaving the mine zone and escaping into the general aquifer. I can only conclude, as a professional in this field, that the pathlines were drawn in a manner that could mislead a reviewer into believing that containment of lixiviant is demonstrated, where in fact, it is not.

Another example is seen in Figure 9, where five pathlines are shown, all generally converging upon a central location. The arrow of the long pathline located at the lower center of the diagram is about to cross the same head contour (the 6439 value) twice. This, of course, violates Rule #2. Even of more concern is the next pathline to the right that roughly parallels the so-called groundwater divide line. Clearly, at its arrowhead, it

has just crossed the 6434 head contour line and is about to cross it again. In fact, it seems bound for a course upstream, as there are no sinks evident. Once it crossed that 6434 line, it should have turned right, and traveled across that so-called divide and directly toward the NTUA-1 water supply well. This divide is the most flagrant violation of the rules of all. Without a doubt it is shown crossing the 6434 contour line twice. Since ground water divide lines are identical to pathlines, this is analogous in the surface water example to water flowing down a valley and then spontaneously flowing up the other side. In fact, looking along the length of the divide, it is clear that nearly all of the head contours it crosses are crossed twice.

In my extensive experience as a groundwater modeler, I have never seen a computer program make such blatant mistakes. I can only assume that these incorrect divide lines were drawn on the diagram by hand, along with the pathlines, and the fact they were done by hand was not indicated on the diagram or in the text of the Geraghty and Miller report. A reviewer who was unaware that the divide lines were hand drawn and who did not suspect that the lines were misdrawn would likely be misled by the figures that the divide lines would separate the mine zone from the water supply wells. Unfortunately, every one of those divide lines is false.

To illustrate the correct direction of water flow on Figure 9, 1 have drawn, by hand, my best estimate of the correct flow pathlines and groundwater divide lines; this revised Figure 9 is attached hereto as **Exhibit K**. My version of the diagram shows groundwater

divide lines that terminate at a single location: the NTUA-1 water supply well.[7] Of equal importance are the groundwater pathlines that emerge from the mine area and flow directly into NTUA-1 well. These flow paths are dictated by the contour lines generated by the computer model used by HRI's consultant and by application of the strict rules for drawing ground water divides stated above. The difference between my divide lines and the faulty ones submitted by HR1 is that I have followed the rules, and I have made clear that the divides are hand drawn.

That groundwater can be shown to flow from the Crownpoint wellfield directly into NTUA-1, <u>using HRI's own data and diagrams</u>, is even more disturbing for two other reasons. First, the pathline I have drawn would occur at the end of restoration, when the bleed rate is at its peak. And second, no intervening monitor wells that might intercept some contaminated fluids moving toward NTUA-1 are planned. In fact, according to HRI's most recent wellfield diagram for the Crownpoint mine site, the wellfields there would be developed from east to west across the south one-half of Section 24 (COP Revision 2.0, Figure 1.4-3). Thus, any horizontal excursions not detected by the perimeter monitoring wells would become known only after they had reached the closest municipal water supply

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[7]I took advantage of the well-known fact that flow lines are also divide lines. These were merely flow lines, of course, but flow does not cross them, so they also represent divides. I chose these two lines because they represent the bounds within which mine fluids near NTUA-1 do not pass. They clearly show the fiction of the divide lines as drawn by G&M.

well.[8]

Further, a groundwater divide line depicted on a drawdown diagram for an initial wellfield located in the northeastern quarter of Section 17 is inaccurately drawn (Geraghty and Miller, 1993, Figure 22); thus, I question the overall accuracy and reliability of previous aquifer testing done at the Church Rock site. As a result of these problems, I believe that excursions will occur, thereby creating a potential long- term harm to the local environment

misrepresentation of nature of lixiviant

One final point concerns the notion of lixiviant as a 'benign' material, as characterized by HRI in their September 9, 1998 affidavit (Pelizza Affidavit, ¶ 8 at 6). Wherever lixiviant goes, it mobilizes numerous hazardous constituents, which then move freely through the ground water. Pelizza's euphemistic characterization that "the leach solution is not significantly different from native ground water present in the ore body" is absurd. If that were so, then what is the need for injection of the expensive lixiviant in the first place? More absurdly, if that were so, then the ore body would not be there in

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[8] In 1996, HRI changed the boundaries of the Crownpoint mine site to consolidate all wellfields within the southern one-half of Section 24, Township 17 North, Range 13 West (Crownpoint Revised Technical Report, 1996, Figure 1.1-2), Geraghty and Miller, in 1993, had modeled groundwater flow from wellfields located in the southwest quarter of Section 19,Township 17 North, Range 13 West -- a location approximately one-quarter mile closer to NTUA-1. The relocation of the wellfield westward should not, however, change the conclusions, as the same groundwater divide flows exist for the mining zones as well.

the first place, having become mobilized and transported out of that region long ago.

ground water travel times misrepresented as conservative

Water travel times from the mine sites are likely to be much faster than HRI has estimated. In fact, contaminants may travel through the sand channels in the WCM to drinking water extraction points, such as the Crownpoint municipal wells, in a just few years. Thus, the project endangers human health. The following discussion draws from the earlier section on the hydrogeologic nature of the Westwater. In that section, it was clarified that the ore bodies reside in long, narrow buried sand channels. This sand channel environment is a ubiquitous characteristic of the Westwater.

These sand channels are defined by the rocks, generally siltstones or clays, that surround them above, below and on each side. Siltstones and shales are much more impermeable (i.e., impervious) to water flow than are the sands. In that respect, sand channels behave somewhat like buried pipelines. The sand channel is the interior of the pipe, through which water flows. The siltstones and shales are the walls of the pipe, through which water does not flow (or does not flow nearly so fast). Unlike the walls of a pipe, however, the siltstones and shales are irregular, and often quite wide and thick. That means that there is a significant portion of the geologic system through which water flows very slowly, or for all practical purposes, not at all.

Although the sand channels most certainly are interconnected in some places, they are separate channels where they are not connected, they contain separate mineralized zones, and

fluids travel faster through those channels because they are separated, or bounded, by less permeable strata on all sides. My assumption that the channels are separated, and therefore bounded, was based on HRI's own pump test data and consistent with the published literature. Accordingly, my analogy of the sand channels acting as pipes that transmit water at a faster rate is appropriate.

Using the pipeline analogy, water will flow more slowly through a wide-diameter pipe than it will through a narrow-diameter pipe under influence of a constant pumping rate at the end of the pipe. Differences in flow rates can be dramatic, depending on the dimensions (i.e., geometry) of the pipe. For example, the velocity of water flowing at 100 gallons per minute (gpm) through an 8-foot diameter pipeline is approximately 3 <u>inches</u> per minute, ignoring friction losses. When that same volume of water is forced through a 1 inch diameter pipe, the velocity increases to an astounding 612 <u>feet</u> per minute.

This same concept applies to a well pumping water from buried sand channels: the narrower the channel in it's lateral dimension (or the thinner in the vertical dimension, or both), the faster the groundwater will move within it and toward the well. As I will soon demonstrate, how fast the groundwater will move (i.e., its velocity) can vary over several orders of magnitude, depending on the assumptions one uses when modeling aquifer flows.

To model the time for groundwater to travel from the Unit I and Crownpoint mine sites to the Crownpoint town wells under the influence of the pumping of those wells, HRI made two critical assumptions: First, that the Westwater is one sand channel 200 feet thick

in the vertical dimension, and second, that it is infinitely wide (Unit 1 Sensitivity Analysis at 3-4). HRI chose an aquifer thickness value of 200 feet (id.), which is at the low end of the range of thickness known for the WCM (i.e., 236 feet to 350 feet thick [FEIS at 3-12 to 3-15]), and only moderately conservative in light of the fact that the Crownpoint wells pump from the entire thickness of the Westwater (FEIS at 3-22). But such an average thickness is considerably greater than the thickness of the individual layers shown in the Wentworth well log. Under HRI's model, groundwater flows toward the wells, within the "channel" from all points of the compass, and is constrained only by the thickness of the "channel". This radial flow condition causes groundwater velocities to decrease nearly exponentially with increasing distance from the pumping well. HRI's model was, therefore, guaranteed to generate the very slow travel times calculated for "particles" traveling from the Unit 1 site to the town wells: a wide range of 689 years to 4,765 years under several different assumptions (Unit 1 Sensitivity Analysis at 11) and a more narrow range of 2,103 years to 2,371 years under assumptions described by NRC as "average conditions" (id.; SER at 1-2).

To examine HRI's and NRC's assertions that the travel-time estimates in the Unit I Sensitivity Analysis (at 3) and SER (at 1) are indeed "conservative," I recalculated the travel time from Unit 1 to the Crownpoint town wells using the same parameters and values that HRI used in its sensitivity analysis: a 200-foot channel thickness, porosity of 0.21, transitivity in the channel of 2,550 gpd/ft (gallons per day per foot), and one-half of the

combined pumping rate from the town wells of 372 gpm.[9] In contrast to HRI's critical assumption that the width of the channel is infinite, however, I selected a value of 100 feet, based on HRI's own diagram of the LB Sand of the WCM (Pelizza, 1996a, Response to RAI #50, Figure 50-3).[10] This value for channel width also is reasonable given references in the published literature that sand channels in the Westwater range from a few feet to 200 feet in width. Furthermore, all other hydrologic parameters that I used in my travel-time analysis (i.e., values for channel thickness, porosity, transitivity, and pumping rate for the town wells) were identical to those used in HRI's traveltime calculations, save one, the width of the sand channel. The assumptions I used in my travel-time calculations were based on real-world data cited in HRI's application and in the peer-reviewed literature. I also assumed that the sand channel directly connects the eastern edge of Unit 1 to approximately the center of the main town municipal wells, a distance of roughly 13,200 feet. Using these parameters, the groundwater velocity within the sand channel is approximately 8.5 feet per day. At that rate,

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[9] Because the well receives water from both directions within the sand channel, I used one-half the pumping rate (i.e., 186 gpm) to address the influence of the well on velocities to the west of Crownpoint in the mining region.

[10] In addition, an HRI executive recently testified in a water rights transfer hearing before the New Mexico State Engineer that the ore bodies at the Church Rock site range from "8.6 feet to 14.9 feet" thick. See, Testimony of Mark S. Pelizza in Transcript of Proceedings (Volume 1), In the Matter of the Application of HRI,Inc., to Change Place or Purpose of Use and Points of Diversion of Underground Waters, before the New Mexico State Engineer (March 24, 1998), a copy of which is attached hereto as **Exhibit L.**

a "particle" in the groundwater would take only about *4 years* to move from the eastern edge of the Unit 1 site to the town's municipal wells, a travel time more than *500 times* faster than the "average" travel times calculated by HRI using what NRC called "conservative" assumptions (SER at 1).

I made this calculation to show the dramatic effect at the width of the channel alone can have on travel time estimates and to contrast the result with what I believe to be HRI's nonconservative assumption that the channel is of infinite width. If I had chosen a smaller value for the width, say 30 feet, my estimated travel times would be even shorter (approximately, 1 *year)* and still well within the 20-year lifetime of production and restoration at the Unit 1 site (COP Revision 2.0, Figure 1.4-1 at 14).

In summary, HRI's inaccurate characterization of the geologic and hydrogeologic characteristics of the Westwater Canyon Member allowed for a nonconservative rate flow model, which predicted unrealistically slow travel times. When a real-world value for the width of any one of the many sand channels known to exist in the area of the Unit 1 and Crownpoint mine sites are used, travel times decrease substantially to values clearly within the projected lifetime of the proposed mines. Accordingly, in my professional judgment, the particle travel times estimated in the FEIS, in HRI's Unit 1 Sensitivity Analysis, and in the SER are not scientifically supportable as conservative, and therefore do not demonstrate that the drinking water supply of the Town of Crownpoint will be protected, nor that lixiviant will be controlled within the Church Rock mining zone.

vertical confinement

HRI's aquifer testing is inappropriate for evaluating whether or not a hydraulic connection exists between the mining zone and overlying or underlying aquifers;

It has been argued by HRI that the net impact of a mining event is a 'decrease' in aquifer pressure due to the applied bleed rate. HRI develops this concept further to argue that upper, overlying aquifers have higher heads than the mining zone aquifer, so flow will always be from the overlying aquifer towards the mine zone, and not the reverse. For example, see page 82 of the March 1993 Church Rock Revised Environmental Report, in which, in addition to the above claims, it is stated that Dakota heads are 184 feet higher than Westwater heads.

Yet, as their own modeling and other data demonstrates, there will be points, directly over injection wells, where pressures are extremely high. One might argue that these are only at a few points. However, high pressure at specific points is precisely the principal behind such tools as nails, pickaxes, and jackhammers, and such pressure can have similar effects on aquifers as these tools have on their subjects. Failing actual damage to the host rock, these high pressures will very likely push some lixiviant into overlying and underlying units, and perhaps into overlying and underlying aquifers. In the same document just referred to, on page 164, it is stated that expected pressure heads due to

lixiviant injection will reach 289 feet. Therefore, at those locations, the mining zone heads will be over 100 feet higher than the Dakota heads. This contradicts their earlier claims, and demonstrates yet another mischaracterization upon which the license is based.

The pump tests only involve pumping at approx. 60 gpm for a few days, whereas, in all mine zone cases, both pumping and injection are occurring at several thousand gpm for years. The stresses experienced by the aquifers and intervening units under these conditions are orders of magnitude more severe. This is akin to filling a balloon with water from a typical sink tap, and then claiming that since the balloon did not burst, it will easily accept water from a firehose at full pressure without bursting. In other words, a successful test may be a positive first step, but it does not prove compliance. That is precisely the reason that pump tests are performed on an operational scale prior to the injection of any lixiviant.

Consider the reverse case. When even a mild pump test demonstrates aquifer containment problems, as it did in the Crownpoint test, this is all the more reason to remove such a site from further consideration for ISL mining. If a mild test shows leakage, then a larger operational scale test will show leakage as well, only more so. To argue otherwise, as HRI and NRC have done, is equivalent to saying that, because a balloon burst when being filled from a tap, it would not burst if filled from a firehose at higher pressure. This discussion was necessary to correct numerous mischaracterizations in the record. In my earlier testimony, repeated in part below, I discovered evidence of

aquifer interconnections (in addition to other deficiencies). HRI responded that since newer, larger tests were planned, my discovery was of no interest. The pertinent sections of that earlier testimony follow:

To determine if the WCM is confined (i.e., isolated) from the overlying Dakota Sandstone aquifer and the underlying Cow Springs Sandstone such that lixiviant will not migrate vertically, HRI conducted an aquifer pump test at the proposed Church Rock mine site in 1989, at Crownpoint mining site in 1991 (Crownpoint Technical Report, 1992, at 47-55; FEIS at 3-29, 3-35) and relied on aquifer pump tests conducted at what is now the Unit 1 site by Mobil Oil Corporation in 1982 (Unit 1 Sensitivity Analysis at 10; FEIS at 3-31). I reviewed the pump test data for the Crownpoint site and HRI's summary of the results of Mobil's 1982 test at the Unit 1 site and Churchrock. Based on this review, I believe that the tests themselves were inappropriately designed and implemented in the field, and that the resulting data were analyzed using the wrong hydrologic model. The effect of the poorly designed and analyzed pump tests was to give a false sense of assurance that the Westwater is confined such that lixiviant will not migrate vertically into overlying or underlying aquifers. Using a different model that accounts for a wider range of hydrologic variables, I found that there is strong evidence for hydraulic connection between the Dakota and Westwater aquifers in certain places.

The most straightforward way to establish whether or not an overlying, or "upper,"

aquifer is truly separated from an underlying, or "lower," aquifer is to conduct an aquifer pump test that meets the following minimum requirements:

a pumping well is completed in the aquifer one desires to test, and is pumped at a significant rate for a significant period of time from that aquifer;

an observation well is completed in the upper aquifer <u>nearly directly over</u> the pumping well completed in the lower aquifer, and water levels in the observation wells are observed and recorded;

additional observation wells are completed in the lower aquifer at varying distances from the pumping well, and their water levels are also observed and recorded; and

water-level "drawdown" data are analyzed using a method appropriate for assessing hydraulic connection between aquifers.

A noticeable drop in the water level in the upper observation well during the pumping test would confirm that the aquifers are connected. Secondary effects, such as fluctuations in water levels due to such causes as periodic changes in barometric pressure, are helpful to consider but are not essential to determining if the two aquifers are connected. Most importantly, the upper observation well must be located laterally in close proximity to the pumping well to observe the magnitude of water-level responses in the observation well under the influence of pumping. A significant horizontal separation between the wells, in conjunction with a large vertical separation, will dampen or obscure the effects of pumping, especially during early stages of the test when drawdown will be

greatest at points close to the pumping well.

In the Crownpoint test, initially, two upper observation wells, CP-4 and CP-1, were completed in the Dakota Sandstone within 500 feet and 1,000 feet of the lower (i.e., Westwater) pumping well, CP-5 (Crownpoint Technical Report, 1992, at 46 and Appendix A, Table 4). CP-4 was abandoned because of well completion difficulties (id., at 46). CP-1 was not used as a Dakota observation well because "the usual fluctuations caused by barometric and diurnal influences was considered too poor for its use as a monitor well" (id.). A new upper (Dakota) observation well (CP-10) was installed more than 1,860 feet from the Westwater pumping well (id, at 46 and Appendix A, Table 4).

HRI's reason for abandoning well CP-4 does not justify replacing it with a new well located four times (i.e., 2,000 feet) farther from the pumping well. Nor is HRI's reason for abandoning well CP-1 adequate justification for two reasons. First, no verification of how CP-1 performed poorly due to the influence of barometric pressure was given in the HRI Crownpoint Technical Report. Fluctuations in barometric pressure are of only second importance and are not crucial to this type of test. Such fluctuations are likely to cause water level shifts of only a few centimeters, not meters. Second, HRI also does not provide any reason for replacing this well with a new well located so much farther from the pumping well.

Based on the resulting drawdown data from CP-10, HRI concluded that the Westwater was confined from the Dakota, that is, that there was no connection between

them (id, at 49-55). This result was predictably misleading, however, because of the great distance between the pumping well and observation well. In my professional opinion, the distance alone should have invalidated the test and the data resulting from it. The NRC staff apparently accepted the results of the test, concurring with HRI that the Westwater is confined from the Dakota (FEIS at 3-29, for example).

Inappropriate Model Used by HRI

To compound the problem, HRI used the "Theis Method" to analyze the drawdown data (See, generally, Crownpoint Technical Report, 1992, at 49-55, and Appendix C, Section 2). The basic assumptions of the Theis Method are that the aquifer being tested is of constant thickness and is fully confined above and below by impermeable boundaries so that there is no "leakage" of water from overlying aquifers -- that is, that water "enters" the aquifer only horizontally. Theis results cannot be interpreted to infer that a lower aquifer is hydraulically connected to an overlying aquifer because the model itself is not designed for that purpose. The results shown by using the Theis Method may appear plausible, but they do not prove and cannot be used to infer that there is no connection between the Dakota and the Westwater aquifers.

The best analytical method for determining whether or not hydraulic connections exist between two aquifers (such as the WCM and the Dakota Sandstone) is the Modified Hantush Method (Lohman, 1979 at 32-34). The Modified Hantush Method mathematically accounts for the vertical flow (if any) of water downward from the upper

aquifer in response to pumping in the lower aquifer, along with horizontal flow within the pumped aquifer.[11] Even in the absence of an ideally located observation well in the upper aquifer, the Hantush method provides a means to indirectly measure connections to that zone. The NRC describes the overlying Brushy Basin Member as an "aquitard" in the Unit 1 and Crownpoint area. FEIS at 3-25. By definition, an aquitard slows, or retards, the flow of groundwater, but does not stop groundwater flow. Hence, it was reasonable to assume that the Brushy Basin in the Unit 1-Crownpoint area allows "leakage" from the overlying Dakota into the underlying Westwater. The Hantush Method is a more technically appropriate method for analyzing pump test data than the Theis for such conditions. The Theis Method is virtually useless for testing whether or not a unit is leaking.

Commentator (and former NRC contractor) Dr. William P. Staub agrees that the Modified Hantush Method is most appropriate under these conditions. And, he previously recommended the Modified Hantush as an modification to the Theis Method for leakage in a 1986 work commissioned by the NRC. (Staub et al., 1986). Thus, HRI's use of the Theis method not only is inappropriate for hydrogeologic conditions at the

[11] Because the method compensates for the effect of vertical flow or "leakage" from an overlying aquifer into a lower aquifer, observation wells need not be completed in the overlying aquifer to use this method. The method's standard curves replicate the drawdown (measured in feet in the observation wells) that would be expected over time, given a constant pumping rate at a single well.

Crownpoint, Unit 1 and Church Rock sites, but also is contrary to advice from NRC's own consultants. In their analysis of excursions at selected uranium ISL mines, Staub et al., (1986 at 21-22) concluded that other methods to assess "leaky aquifer conditions," including the Modified Hantush method, should be used (id., at 22). They found that several ISL mines had vertical excursions because the mine operators, having used the Theis Method in their initial studies, had not recognized or acknowledged that lixiviant could flow through "confining layers" and contaminate upper aquifers. Staub et al. (at 29-32). When Staub and his colleagues re-evaluated the pump test data for several of those mines using the Hantush method, they consistently found that it predicted that the upper and/or lower aquifers were indeed hydraulically connected. The consequence of selecting the wrong analytical method was rapid: as shown in Table 1 below, initial excursions occurred within weeks and months of initial injection at six different ISL mines where a leaky aquifer was eventually detected using the Hantush Method.

Table 1.

Summary of Selected Excursions at Uranium ISL mines Where a Leaky Aquifer Was Eventually Determined or Suspected Using the Hantush Method for Pump Test Data (Summarized from Staub et al.,1986)

OPERATION	DATE, TYPE OF OF ISL OPERATION	DATE OF FIRST EXCURSION
Bison Basin	1979; pilot scale	May 1979
Bison Basin	August 21, 1979; commercial	September 3, 1979
Highland	December 1978; pilot	December 26, 1978
Irigary	November 1978; commercial	Spring 1979

Luenberger	January 1980; pilot	February 1980
9 Mile Lake	September 1979; pilot	November 15,1979

The NRC's Draft Standard Review Plan states at 2-25:

> It is important for the reviewer to ensure that where fitted curves deviate from measured drawdown, the applicant explains the probable cause of the deviation(e.g., leaky aquitards, delayed yield effects, boundary effects, etc.)." (emphasis added)

HRI's draw-down curves show a poor fit to the Theis-type, zero-leakage curve. HRI did not explain these deviations, as recommended in the Draft Standard Review Plan. My use of the Modified Hantush Method, which generated draw-down curves that matched Hantush curves showing different degrees of leakage between the Dakota and the Westwater, provides that explanation.

Proper Analysis Indicates Leakage

To verify or refute HRI's conclusion that the Dakota and Westwater are not hydraulically connected,[12] I used the Modified Hantush Method to evaluate the Crownpoint pump test results. This involved inputting HRI's data for the aquifer pumping rate and drawdown observed in two particular observation wells into an equation and generating graphs called "drawdown curves." I selected drawdown data for

[12] My use of Modified Hantush is in the context of verifying or refuting HRI's conclusion, reached from its Theis analysis, that the Dakota and Westwater are not hydraulically connected. Thus, I have not use the Modified Hantush in a vacuum but as a scientifically appropriate choice for the given hydrogeologic conditions.

monitoring wells CP-2 and CP-3 because they are located on the proposed Crownpoint mine site near where initial Crownpoint solution mining would occur (Crownpoint Technical Report, 1992, Figure 2.3-3 at 33), and are located 946 feet and 545 feet, respectively, from the pumping well, CP-5 (Id., Appendix A, Table 3). All of these wells are completed in the WCM.

The results of my evaluation are shown in Figures 4 and 5, attached as **Exhibit M** to this testimony. These figures show a series of computer-generated dots plotted on logarithmic scales; the x-axis shows time elapsed (in minutes) since the beginning of the pump test and the y-axis shows water-level drawdown (in feet) for each point in time. For both plots, I overlaid the graphs on a series of Hantush-derived drawdown "type curves" published by the U.S. Geological Survey (Lohman, 1979, Plate 4). These curves represent the base case of zero leakage. Employing the prescribed methodology, and starting with the Theis-type curve, I moved the plots for each well across each successive curve until I found the curve that best "fit," or matched, the dots on my graphs. Neither of my plots matched the Theis-type, zero-leakage curve. For the plot for well CP-2, the best match was the curve representing B = 10; for the plot for well CP-3, the best match, especially for the point earliest in the test, was the curve representing B = 0.7.[13] These

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[13] Except for the first data point at time = approximately 7 minutes, the plot for CP-3 also was a good match for the curve representing B = 10.

"beta" values represent the ratio of hydraulic properties of the overlying (ie., upper) aquifer to those of the aquifer being pumped; the higher the value, the greater the leakage between aquifers. Hence, my Modified Hantush-derived drawdown "type curves" for monitoring wells CP-2 and CP-3, using HRI's test data, showed leakage between the Dakota and Westwater aquifers

. I then examined HRI's "Theis Curve Fit" plots for the same two monitoring wells,CP-2 and CP-3(Crownpoint Technical Report, 1992, Figure C.2-E and Figure C.3-E, respectively). HRI's curves showed a poor "fit," or match, for drawdown points early in the pump test for both monitoring wells. This poor match was particularly evident for the first three data points for well CP-2, and for the first data point for well CP-3. This is an important point because early-time data are an important feature to match, particularly when investigating leakage. The curves are increasingly insensitive to each incremental decrease as drawdown time progresses. Therefore, the fact that HRI's plots matched the Theis-type curve, as pumping time elapsed, is not surprising. By contrast, the plots derived from my use of the Modified Hantush method shows much better matches to these early-time data than HRI's Theis-curve matches.

License Conditions Inadequate to Remedy Application Defects

It is unlikely that additional aquifer testing, required by Licensing Condition 10.23, will shed any new light on whether there is interaquifer communication. Notwithstanding the proven efficacy of aquifer pump tests to determine aquifer characteristics and

interaquifer connections, it is my professional opinion that the deficiencies observed in the design and implementation of HRI's previous pump tests and in the interpretation of the results of those tests will not be resolved by LC 10.23. The new groundwater pump tests required by LC 10.23 are unlikely to change any of the aquifer parameters or yield new information verifying geologic confinement, since aquifers do not evolve hydraulically over such a short period of time.

Mr. Ford claims that the additional pump tests required by License Condition 10.23 "will lessen the potential for vertical excursions to occur." Ford Affidavit, ¶32 at 20. I must disagree. License Condition 10.23 merely provides for the collection of additional hydrologic data to confirm that monitor wells for a given wellfield "are completed in the Westwater Canyon Aquifer." The purpose of monitoring wells is to detect excursions when they occur so that measures can be taken to control and cleanup the excursion. *A monitoring well cannot* <u>*prevent*</u> *an excursion.* Similarly, there is no reason to believe that the additional pump test data to be collected pursuant to License Condition 10.23 will not support my opinion that the potential for vertical excursions is quite high because the Dakota and Westwater aquifers are connected, especially at the Crownpoint site. This opinion is based on the pump test data that HRI has already submitted to the NRC, and on the professional, peer-reviewed literature that describes the complex geology of the project. Thus, the requirements of License Condition 10.23 will only provide additional information, not reduce the potential for vertical excursions. In any event, the NRC has

not even conducted a review of currently available information (such as structural information) that would expand upon the information these pump tests have already provided.

In summary, my evaluation of HRI's pump test data using the Modified Hantush Method strongly suggests that there is significant hydraulic connection between the Dakota and the Westwater Canyon Member in at least one area of the proposed mining zones. Implicit in these results is that the Brushy Basin Formation, which is sandwiched between the Dakota and the Westwater, is not an impermeable barrier, but a moderately transmissive pathway for groundwater flow between the two aquifers. In my professional judgment, therefore, HRI's aquifer tests cannot be relied on to demonstrate that there is no hydraulic connection between the Dakota and Westwater aquifers[14]. In light of the documented record of vertical excursions at uranium ISL facilities where the wrong pump-test analytical method was used before operations began, I further conclude that HRI has not demonstrated that lixiviant will not migrate into overlying or underlying aquifers. License conditions 10.23, 10.31, and 10.32, which require additional aquifer characterization, coupled with HRI's commitment to carry out Mine Unit Hydrologic

[14] In comparison, I later evaluated a Church Rock pump test, using the Hantush Method, and found for a single well that it matched the limiting Hantush case, which was equivalent to Theis. This shows that the Hantush is not biased and can recognize confinement if it exists. However, as stated before, confinement is relative to the applied pressures, which are extremely weak in all of the HRI pump tests, and not indicative of the pressures to be experienced during ISL operations.

Tests for each site (Consolidated Operations Plan, Revision 2.0 at .82-84), do not resolve this issue. These additional pump tests and step-rate (i.e., fracture) tests should have been conducted prior to licensing because they address the threshold issue of lixiviant containment. To relegate such critical tests until after a license has been issued, ignores important hydrologic acceptance criteria outlined in the Draft Standard Review Plan (Section 2.7.3(4) at 2-25).

To fail to provide potentially detrimental information (such as the details of the first two Dakota observation wells), then to decline to review additional relevant information (such as fault data; this failure is well documented herein), and finally, to license a potentially hazardous facility with the rationale that future testing will somehow show something better is scientfically unsound. The issue of whether this aquifer is appriopriate for ISL operations must be examined as a preliminary matter.

Use of Historic Water Levels is Not Appropriate

In criticizing my use of the Modified Hantush Method to analyze HRI's aquifer pump-test data for certain monitoring wells at the Crownpoint site, Mr. Ford revealed that,

> The [NRC] staff did not rely on the cited pump tests in making decisions on vertical confinement at the HRI project sites .... [T]he staff explained that the test at Crownpoint in question here did not involve enough wells, and was not run long enough, to reach any conclusions that the Dakota Sandstone and Westwater Canyon aquifers are separated hydrologically. Therefore, the NRC did not rely on the cited Crownpoint pump test.

Ford Affidavit, ¶ 10 at 21.

While Mr. Ford did not indicate if NRC now disavows the results of all pump tests

conducted at the three sites, or only the test conducted at the Crownpoint site,[15] the FEIS misleadingly states in plain language, on three different pages, that "[n]o aquifer interconnection were detected by the [pump] test (i.e., no draw down was detected by the Dakota Sandstone monitor wells)." FEIS at 3-29, 3-31 and 3-35.[16] Mr. Ford does not clearly indicate what information NRC did rely on to draw its critical conclusions about vertical confinement in the Westwater ore zones. However, based on information elsewhere in the FEIS (at 4-42, 4-51 and 4-54), and on comments made by Mr. Bartels in his affidavit of January 23, 1998 (¶9), I believe that NRC now relies solely on historic water level data from site monitoring wells to support its conclusion that the overlying Dakota Sandstone is not hydraulically connected to the underlying Westwater Canyon at any of the sites.

Pump tests and pump-test data are the best tools for determining aquifer interconnections (i.e., if done properly, they can detect the existence of an interconnection, whether it is due to faulting, leaking boreholes, or any of a host of other

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[15] Pump tests were conducted at the Unit I site in 1982, at the Church Rock site in 1989, and at the Crownpoint site in 1991, FEIS at 3-31, 3-29 and 3-35, respectively.

[16] This quotation appears in identical form on pages 3-29 and 3-31 of the FEIS in the context of separate discussions of the results of pump tests conducted at the Crownpoint site in 1991 and the Unit I site in 1982, respectively. In regard to the results of a pump test conducted at the Church Rock site in 1989, NRC stated, "No aquifer interconnection was detected by the test (i.e., no draw down was detected by the Dakota Sandstone or Brushy Basin "B" Sand monitoring wells.)" FEIS at 3-35.

reasons). Evaluation of historic water-level data is useful to complement analysis of pump test results, but never to supplant it. Exclusive reliance on water-level data is, in my professional opinion, a totally insufficient basis upon which to conclude that the Dakota and Westwater aquifers are not interconnected.

However, based on my review of the historic water-level data charts provided by Mr. Bartels (Bartels Affidavit, Figure 1 and Figure 2),coupled with my Modified Hantush analysis of HRI's pump-test data for two Crownpoint site monitoring wells, I am even more convinced that the Brushy Basin allows significant groundwater flow between the Dakota and Westwater aquifers and that vertical confinement between these formations, especially at the Crownpoint site, is seriously compromised.

Mr. Bartels claims that I overlooked historic differences in water levels between the Dakota and the Westwater Canyon formations at the Unit 1 and Crownpoint sites in my analysis of the potential for vertical excursions. Bartels Affidavit ¶9. He asserts that large differences in water levels (or, hydrologic "head") between the two formations proves that leakage from the Dakota to the Westwater is not as "dramatic" as I suggested. Id., at 4-5. Contrary to Mr. Bartels' assertions, however, I in fact reviewed the water level data he cites, and I re-reviewed the charts he provided with his affidavit. I found nothing in this material that is inconsistent with my previous findings. The large differences in water levels between the Dakota and Westwater at the Unit 1 and Crownpoint sites exist because the two aquifers are separated by an aquitard, the Brushy

Basin Member. Aquitards are lower in hydraulic conductivity than the aquifers that they separate, but, as I noted above, they simply slow the flow of groundwater, they do not stop it. This lower hydraulic conductivity is the source of the high head differences that I and NRC observed. The incidental fact that the Dakota heads are higher than those of the Westwater is irrelevant; that fact indicates only that flow is downward from the Dakota to the Westwater. It certainly does not, in any way, indicate a lack of flow.[17]

Moreover, the decreasing trend of water-level differences between the Dakota Sandstone and the Westwater Canyon from the Unit 1 site eastward through the Crownpoint site toward NTUA-1, as referenced by Mr. Bartels in ¶9 of his affidavit, provides additional support for my opinion that the Brushy Basin is seriously compromised in the area of proposed mining at the Crownpoint. Using Mr. Bartels' water-level data, I observed that the head difference between the two units drops in half (from about 190 feet to about 90 feet) as one goes east from Unit 1 to Crownpoint. As the head difference drops, the hydraulic conductivity of the Brushy Basin (i.e., its ability to transmit groundwater flow) increases. As the Brushy Basin's hydraulic conductivity increases, so does its leakage potential. Therefore, Mr. Bartels' water-level data suggest that there is greater and greater potential leakage from west to east. Instead of proving

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[17] I note that the historic water levels plotted by HRI and cited by NRC to bolster their views of confinement were recorded in monitoring wells not subject to the hydraulic stress of a pump test or the stress that will be exerted by the Crownpoint municipal wells during the actual mining operation.

that the Dakota and Westwater are not connected, HRI's water-level data, which the NRC apparently relies on, are actually more consistent with my conclusion that the two aquifers are in fact connected.

While the analyses discussed in the paragraphs above revolve around data relevant to the Unit 1 and Crownpoint sites, I have no doubt that they are also relevant to hydrologic conditions at the Church Rock site. NRC's apparent disavowal of all pump-test data, including those for the Church Rock site (Ford Affidavit, n. 10 at 21), combined with its requirements that additional aquifer characterizations will be conducted at all three sites prior to lixiviant injection (NRC License Conditions 10.23 and 10.31), suggests to me that NRC has no confidence in HRI's purported demonstration of vertical confinement at each of the sites, including Church Rock. In addition, the unique characteristics of the Church Rock site - underground mine workings and vertical shafts open to the Westwater and Dakota strata - heighten the potential for interaquifer communication there.

In my view, a very important issue in this case is the proper interpretation of aquifer pump test results. The NRC Staff, and the Intervenors each take different general positions on the use of pump tests, and the differences are significant. In my view, despite deficiencies in the design and implementation of HRI's 1991 pump tests at the Crownpoint site, the results indicated interaquifer communication. HRI interpreted the same tests to show that there is no interaquifer communication. HRI Inc., Crownpoint Project In Situ Technical Report (June 12, 1992), at 55. Reversing an earlier position that

aquifer pump testing is necessary, the NRC distanced itself from relying on any previous pump-test data in favor of much less reliable water level data that, in my professional opinion, do not by themselves prove aquifer confinement.[18] The correct resolution of these differing approaches is significant for all of the proposed mining sites.

Q.6. What is your evaluation of HRI's plan to begin operations at Section 8?

A.6. I have evaluated several aspects of the current proposal concerning section 8. Primarily, I considered the geology, the hydrology, the groundwater modeling (all discussed on a general basis earlier as well), and the new mining sequence, wherein section 8 will be mined first, followed by section 17. Based upon my evaluation, I am of the opinion that section 8 mining will have similar consequences as mining the other sites. Namely, mining will have an adverse impact upon the environment and will be

[18] An NRC Staff hydrologist's statement in February that "[t]he staff did not rely on the cited pump tests in making decisions on vertical confinement at the HRI project site" (Ford Affidavit, n. 10 at 21) stood in stark contrast with the much-repeated conclusion in the FEIS that "[n]o aquifer interconnection was detected by the [HRI pump] test[s]." (FEIS at 3-29, 3-31, 3-35). What was troubling about this admission was not so much NRC's back-tracking on a crucial component of the project, but on its insistence that vertical confinement can be demonstrated on the basis of six different factors, none of which include results of previous pump tests. The six factors cited by the NRC staff were, in summary form, (1) thickness of "confining unit" between Westwater and Dakota;(2)water level differences between the Westwater and Dakota; (3) sealed boreholes in mining areas; (4) lined and grouted mine shafts at Crownpoint site; (5) "lack of significant displacement" of sands in Westwater; and (6) "commitments by the applicant" to conduct new pump tests, monitor overlying aquifers, and test wells for integrity. Holonich Memorandum I at 2-3.

inimical to health and safety.

<u>hydrogeologic problems</u>

The license application takes pains to clarify underlying and overlying aquifers for all sites. It follows with attempts to demonstrate that all such aquifers will be protected from any contamination resulting from any ISL mining activities. Implicit in this discourse is a commitment on the part of the NRC that a license would not be granted if protection of such aquifers could not be demonstrated. Among the demonstrations offered are claims about the thickness of the units that lie between the aquifers and the mine zone. These units have been consistently characterized as aquitards or aquicludes; thick, intact, resilient rock units through which virtually no water can pass.

Recapture Shale Does not Exist at Section 8

One such claimed unit is the underlying Recapture Shale, which separates the Westwater Canyon Formation from the Cow Springs Aquifer. The license docket on numerous occasions characterizes the Recapture Shale as a confining unit that is 180 ft. thick at Section 8. Yet, not a single borehole in Section 8 in the mine zone was referenced to support that claim. In fact, only one borehole is cited, out of 201. If the Church Rock site is considered as a whole, then that is one borehole out of 623. Surprisingly, my investigation revealed that this borehole actually lies over 900 feet outside and to the west of the designated mining area. In all of the documents referring to this thickness value, no mention is ever made that it is for a region far removed from the

actual site. This begs the question, given the fact that there are approximately two hundred boreholes in the mining zone of Section 8, why couldn't any of those be used to support the thickness claim?

I believe the answer is that none of those holes support the claim. In fact, according to Hilpert (1959), much of the mining zone in section 8 is a region where the Recapture has virtually disappeared, such that the Cow Springs Aquifer comes into nearly direct contact with the Westwater. This is demonstrated by his Figure 11, attached hereto as **Exhibit N**, which uses many of the same Phillips borehole logs that HRI used. For clarification, I should emphasize that these cross-sections penetrate through the HRI-proposed mining zones of section 8 and section 17, formerly known as the Church Rock site. From that perspective, they are far more relevant than the borehole from 900 feet to the west.

How can Hilpert say one thing and HRI another? There is a curious history regarding this stratigraphic discrepancy. In the 1988 HRI Church Rock Environmental Report, HRI reports a thin 'AA' clay underlying the WCM. This AA clay is underlain by an AA sand, which is acknowledged as a good quality aquifer. Both the clay and the sand unit are identified as units that are NOT part of the WCM.

For some reason unknown, the later 1993 Church Rock Environmental Report lists those units as part of the WCM. A new claim is made that the AA sand contains uranium mineralization, although this contradicts the FEIS statement (at 3-21) that only the upper

portion of the WCM is mineralized in that location. It is not explained why no attempt will be made to mine the uranium from this region, nor is it explained why it has become merely another part of the WCM. Yet this redefinition has profoundly changed the conception of confinement of the WCM. Now, instead of the WCM separated from a good quality aquifer by a few feet, it is separated from a different, unnamed aquifer by the Recapture Shale that is allegedly 180 ft. thick.

Although it may be convenient for HRI to re-label units (and to make unfounded claims of unit thicknesses) from its licensing perspective, stratigraphic nomenclature is a serious business. It is clear that the very AA sand that HRI has called a unit of the Westwater is the aquifer identified by Hilpert as the Cow Springs Aquifer[19]. The thickness, position, and stratigraphy match up perfectly.

There are clear, identifiable characteristics that separate Cow Springs lithology from WCM lithology. The most obvious one is that Cow Springs sandstones are eolian (ancient dunes) and Westwater sands are fluvial (ancient streambeds). Even a layperson could easily learn to distinguish the difference.[20] HRI has not provided those details to

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[19] Notably, the Cow Springs Aquifer is identified by NTUA as a source of drinking water for the Navajo Nation. [See Abitz testimony Exhibit 1-M].

[20] Also see Peterson, 1980, p. 131: "In the Church Rock area, the Westwater Canyon is underlain by the Cow Springs Sandstone, . .. The Cow Springs-Westwater Canyon contact is easily recognized in both drill cuttings and on electric logs, because of the change to clean, well-sorted sandstone."

justify their renaming of this unit. Nor, apparently, has NRC requested such details (although ENDAUM has requested drillers logs, but HRI refused to provide them) (See Phillips, December 29, 1998, and Pelizza, October 16, 1998).

It is not an acceptable scientific practice to rename a geologic unit that has already been identified in the peer-reviewed literature (such as Hilpert), without providing sound justification. Given the profound implications to vertical containment of this renaming, it was critical for NRC to require (or provide publicly) evidence as part of the license documentation. In fact, NRC did not require such evidence.

I conclude that the NRC was not justified in accepting HRI's current representation that the mining zone in Section 8 is underlain by 180 feet of Recapture Shale. HRI's original representation is more consistent with Hilpert; namely that the sole barrier between the WWC and the Cow Springs Aquifer is a clay layer that in places is only 5 feet thick (perhaps less). It stretches credulity past the limit to claim that such a thin layer is an effective barrier to mining effects over years of operation. It therefore follows that the Cow Springs Aquifer cannot be protected from mining activities in Section 8.

Fractures at Section 8

There are additional problems with this area. For example, Hilpert (1969, p. 77) reports a series of vertical fractures which extend from the mine workings area in section 17 through the ore zones in section 8. As I mentioned earlier, fractures can be conduits for vertical flow between units.

problems with the sequence of mining section 8 prior to section 17

One cannot consider section 8 separately from section 17 and its associated mine workings. Some reasons are straightforward. Unfortunately, others are not, and first require rather extensive correction of the mischaracterizations of section 17 found in the license material. HRI's proposal to split the Church Rock site into two units (i.e., Section 8 and Section 17), and mine Section 8 first, is not defensible scientifically, for several reasons. First, the ore bodies, consisting of several stacked sinuous channels, form continuous zones across Section 8 to the north and Section 17 to the south. In fact, the only "break" between the sections is the section boundary, which is a geographic and political demarcation that has nothing to do with the subsurface environment. Otherwise, the same aquifer, the Westwater Canyon Member, and the same overlying and underlying formations are involved at both sections. See, generally, Section 2.7 of Church Rock Revised Environment Report, HRI, Inc. (March 1993). Moreover, as a practical matter, HRI's license application has considered the Church Rock site as a whole at least since 1993 when Section 17 was added to the CUP. COP Revision 2.0 at 9.

Second, the mining sequence anticipated by HRI would have injection beginning in the southern portion of Section 8 and working northward, in the general down-gradient direction of groundwater flow and the dip of the beds. Id., Figure 1.4-8 at 22. Mining would then move to Section 17, progressing southward in an *upgradient* direction. Id., Figures 1.4-6 and 1.4-7 at 18-19.

Mining Section 8 first and Section 17 second would be extremely imprudent and could compromise the eventual cleanup of the site. This mining sequence is a bad idea hydrologically, because the sequence would proceed in a direction north to south that is *opposite* to that of the groundwater flow, which is south to north. Accordingly, a lixiviant-mobilized contaminant plume escaping from a wellfield in Section 17 would not be recaptured by the nearest wellfield in Section 8, which presumably would already have been mined and restored.

Third, the extensive underground mine workings[21] in Section 17 represent a major hydrologic feature of the entire Church Rock site, and would have to be considered as posing a risk of excursion from Section 8. In other words, the hydrology of Section 8 cannot be considered independent of the hydrology of Section 17 because a single, hydraulically connected hydrologic system underlies the entire site. The mine workings in Section 17 are hydraulically *upgradient* of the ore bodies in Section 8 and therefore are assured of having a profound effect on the hydrology of Section 8.[22] As an experienced, professional groundwater modeler, I would account for the effect of the mine workings in

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[21] The mine workings are shown in Figure 2.6-12 of HRI's ChurchRock Revised Environmental Report (March 1993).

[22] Based on my inspection of various documents in this case, including HRI's Church Rock Revised Environmental Report of March 1993, I do not believe that HRI has ever conducted an aquifer test in Section 17 in or adjacent to the underground mine workings. Thus, the aquifer properties that are in Section 17 are not actually known at this time.

modeling groundwater flows at the Church Rock site. In my opinion, HRI's determination that it was not necessary to account for the hydrologic effects of the mine workings was a serious error in HRI's modeling of the hydrology of the Church Rock site, and throws into question the accuracy and validity of those results.[23] See, HRI Response to NRC Request for Additional Information RAI No. 87, attached to letter from Mark S. Pelizza, HRI, to Joseph Holonich, NRC Staff (April 1, 1996) (NRC PDR ACN 9604030208).

Finally, because of the underground mine workings, Section 17 presents special restoration problems that are not likely to be anticipated by the pilot restoration demonstration, which would occur in Section 8 and is required by License Condition 10.28. Restoration in Section 8 will be done entirely in porous sandstone, not in flooded mine caverns.

Based upon my review of the record, notwithstanding HRI's responses, most of the original reservations expressed by the NRC (Pelizza 1996a, response NRC-RAI 87 and 88) appear to be valid. In particular, it is worth quoting the following from item RAI 88:

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[23] It's worth noting here that, in my opinion, the AQUASIM model used by HRI's consultants is not appropriate for the geologic heterogeneity encountered at the Church Rock site. See, Attachment 87-1 to HRI Response to NRC RAI No. 87. I would note further that HRI's consultants used aquifer parameters derived from pump tests conducted in Section 8 to model groundwater flows in both Section 17 and Section 8. HRI Response to NRC RAI No. 87 at 2. Those parameters may or may not be applicable to flows in Section 17 because they were derived from hydrologic conditions particular to Section 8.

The creation of preferential pathways and the large volume of water stored in the tunnels may create some unique restoration problems. For example, preferential pathways may mean less water flows through the matrix, inhibiting cleanup of the matrix. In addition, water in the tunnels may become contaminated. Since, the tunnels have for all practical purposes a porosity of 100%, a large volume of water may be contaminated. Since wells will not be directly monitoring the water quality in the tunnels, it is possible that a large volume of contaminated water may be left behind in the tunnels. Such a large volume of water could increase clean up costs and might require some novel approaches, such as pumping the water in the shafts.

HRI's response consists of arguments based upon their claim that the mine workings are completely surrounded by rock. If this is true, then what of the shafts? If shafts are sealed, and no holes penetrate the workings, then how have water samples from the shafts been obtained? However, this is a point I will have to defer in order to focus on a basic problem. HRI went into somewhat detailed speculative arguments, all of which involved treating the water-filled mine cavities as if they behave according to Darcy's Law.

Darcy's Law is the basis for analyzing water flow through porous media. It is a simple relation between the permeability of the media, the hydraulic gradient, and the cross-sectional area through which flow occurs.

In its simplest form, it can be written as:

q = -K (dh/dl)

where

q = the volumetric flux [length/time], basically the flow rate

K = hydraulic conductivity [length/time] often called permeability, it is a measure primarily of the resistance to flow caused by the porous media.

dh/dl = hydraulic gradient; change in head divided by distance. water flows from high head to low head

h = hydraulic head, [units of length, commonly feet]. head is a measure of the potential energy of water at a given point.

Furthermore, q can be divided by porosity to obtain an average groundwater velocity.

Darcy's Law cannot be used to characterize flow that does not occur in porous media, as the Reynolds number is simply too high[24]. Cavernous flows are examples of regimes where Darcy's Law gives totally inaccurate results. Such flows require alternative, more complicated equations from other fluid mechanics disciplines. These equations incorporate such features as turbulence, vorticity, eddies, convection cells, stagnation zones, and the like. These phenomena are not found in porous media flow, and therefore

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[24] The Reynolds number is a measure of the ratio of inertial to viscous forces in fluid flow. It is well established that Darcy's Law is only valid for very low Reynolds numbers. See, for example, Freeze and Cherry, pp. 72-74

are not captured in such a simple equation as Darcy's Law. The flow regime in the mine workings is far more closely related to cavernous flow than it could ever be to porous media flow, and would exhibit these turbulent phenomena under the operating ISL conditions, including, in particular, restoration.

This condition is the reason for much of the confusion in item 88. For example, HRI claims that the mine workings are essentially zones of infinite permeability and a porosity of 1. NRC then, applying Darcy's Law, asks, if this is so, then how does a porosity of 1 slow down flow, since infinity divided by 1 is still infinity? HRI, also applying Darcy's Law, then backtracks, and says that by infinite permeability, they merely mean a very large number. But, in fact, the concept of permeability has no role in describing flow within these zones, so the whole argument is absurd, and both parties are wrong.

Does this mean that one must employ turbulent-flow codes to evaluate these mine workings? The answer depends upon the circumstances. If one is concerned with an overall large region, such as the proposed ISL zone in section 17, and if the object is to evaluate containment from the surrounding aquifer zones, then some simplifications may be justified. However, the generalizations employed by G&M in their model study are far too simple. The proper way to approximately model that site would be through a model that can incorporate aquifer heterogeneity.

In such a model, the mine workings would be treated similarly to the way HRI described them above; as high permeability zones with a porosity of 1. However, in

contrast to HRI's claims, modeling in this way would show important effects on the overall and detailed flow patterns within the zone. That is because these zones will cause significant local refractions in the flow field (HRI approached this concept in Figure Q2/88-2, but did not develop it to its final conclusion). G&M's simulation, as usual, treated the entire area as one of uniform permeability (in addition to its many other shortcomings). For that reason alone, the model outcomes are in significant error, and cannot be used to substantiate a decision to license ISL mining there.

But the problems go much deeper than that. HRI argues that flow through the mine workings in response to restoration would be the simplest type of flow of all; namely piston flow. In this mischaracterization, all of the water in a tunnel moves directly through, as if a giant piston were forcing it from one end to the other. This is how HRI justifies that only 1 mine tunnel 'volume' is required to be pumped in order to achieve restoration of those workings. Unfortunately, this is one of the cases where a turbulent flow type of model actually is required.

Imagine a very large, built-in swimming pool, filled with water, and located in an area where the water table is almost at the land surface. Imagine that the walls of the swimming pool are porous and permeable, such that the ground water can move into the swimming pool. Now imagine that the pool was somehow contaminated, but that no pumps were allowed in the pool. A plan is implemented whereby wells are inserted into the aquifer near to the pool and water is pumped out from these wells. Unfortunately, the

pool never gets clean. Although a gradient is applied through the pool, the inevitable eddies, convection cells, and stagnation zones form within the pool, where much of the contaminants linger, unaffected by the pumping. Fresh water from other parts of the aquifer pass through the pool on their way to the pumping wells, but they merely satisfy the hydraulic demand, allowing the stagnant areas to continue to be bypassed. This is a far cry from the idealistic piston flow wished by HRI[25].

It becomes clear that the only way using this method to guarantee that the pool gets clean is to lower the water table to an elevation below the bottom of the pool. This will dry out the pool entirely. This scenario is precisely that of the mine workings (with the only significant differences being that the mine workings are much larger, and are below the water table). Therefore, mine dewatering is the only way to guarantee that the mine workings will be restored, even to their existing (apparently already somewhat corrupted) condition.

I made a rough calculation of the required volume of water that would have to be removed from the subsurface in order to dewater the mine workings. Accounting for flaring, I estimated the mine working zone to be approximately 3400 feet long and 1400 feet wide. The bottom of the mine workings is approximately 600 feet below the water table. Assuming a general porosity of 25%, this leads to a total volume of water

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[25] The only way to achieve piston flow in the mine workings would be if HRI actually had a giant piston.

exceeding five billion gallons (actually, far more would be required, since incredible quantities of water would be constantly flowing in from all directions outside of that area in response to dewatering attempts; and of course one has to ask, where would all this water be treated and released at?). Of course, this number is vastly larger than HRI's optimistic estimate of 22 million gallons. If HRI wishes to contest this physically-based argument, then they would need to conduct a modeling simulation or other experiment that honors the physics and demonstrates their case. Otherwise, merely stating that piston flow is the case doesn't make it so, and runs counter to fundamental principles of fluid mechanics[26].

Section 17 Should be Mined before Section 8

This finally leads to the problem with mining section 8 first, instead of 17 first. Considering that section 8 will presumably have already been mined and restored, this dewatering will lower the water table below parts of the ore horizon in section 8 as well. That will re-introduce oxygen into that area. When the water table is allowed to rise again, it will re-mobilize residual pockets of ore and heavy metals, undermining the original cleanup effort.

In summary, because of the dynamic physical nature of water flow in large open

[26] Anyone who attempts to flush out very sudsy/soapy water from a pot by merely running tap water into the vessel until roughly one volume has been displaced will have a feel for this argument.

cavities, the only way to restore the mine workings following ISL mining is to dewater the mines. The only way to dewater the mines is to lower the regional water table below the bottom elevation of the mine workings. This will also reintroduce oxygen into section 8 ore zone areas, causing the creation and mobilization of more contamination.

Q.7. Does the application demonstrate that an alternative water supply is available if the Crownpoint municipal wells are replaced?

A.7. The NRC has mandated that, prior to lixiviant injection at the Crownpoint mine, HRI will replace the five Crownpoint municipal wells, construct the water system piping, and provide funds to the system's operators to install and connect new water wells (NRC License SUA-1508, Condition 10.27(A)). The new wells must be located so that uranium ISL operations at the Crownpoint site will not cause exceedances of federal primary and second drinking water standards, or exceed a uranium concentration of 0.44 mg/L). To date, HRI has not demonstrated that a suitable alternative water supply can be developed for the people served by the existing municipal water supply wells in Crownpoint. Existing contamination sources hydrologically upgradient from Crownpoint, deteriorating water quality in the WCM hydrologically downgradient of Crownpoint, and the stated unwillingness of the Navajo Tribal Utility Authority to allow its water wells to be replaced are significant obstacles to HRI's compliance with License Condition 10.27.

The WCM is recharged at its outcrops south and southwest of Crownpoint by water

flowing off the Zuni Mountains (Scott, 1995, at 242). It would seem prudent, then, to consider placing new water supply wells at locations hydrologically upgradient, and topographically updip, south and south-west of Crownpoint. Two key factors limit this option, however. First, locating wells anymore than a few miles from the main customer population in Crownpoint may be prohibitively expensive. Second, a rapid elevation increase from about 6,500 feet above sea level at Crownpoint to approximately 8,000 feet above sea level in the Hosta Butte area only six miles south of Crownpoint could present well siting difficulties. And third, dozens of abandoned uranium mines in the Church Rock, Mariano Lake and Smith Lake areas are likely sources of localized contamination of groundwater in the WCM (Chenoweth and Holen, 1980, Figure 2; attached hereto as **Exhibit O**). Most of these mines are located hydrologically upgradient of Crownpoint, at distances ranging from five to 25 miles. There is little published data on the effects of these mines on regional geochemistry. Accordingly, it is reasonable to assume that finding a site for a new water supply well or wells that would not be endangered by previous or future mining activities (past or future) would prove difficult.

Locating new wells north and northeast (i.e., downgradient) of Crownpoint is likely to be as challenging as finding suitable locations south of town. A well or wells sited immediately north or east of Crownpoint would not be permanently protected from future lixiviant excursions emanating from the Crownpoint or Unit 1 sites; they simply would be separated by an additional amount of time afforded by a longer contaminant flow path. A

well or wells sites at greater distance from Crownpoint would likely encounter deteriorating water quality as the Morrison Formation dips deeper into the San Juan Basin (Stone et al., 1983, Figure 75).

It should be noted that the NRC provides contradictory information on replacement of the water supply. In some sections it claims that water of equivalent quantity and quality will be provided. In others, such as the license condition, it merely states that water meeting minimum drinking water standards (except uranium may be exeeded) must be provided. Given the pristine nature of the water that people obtain from the Crownpoint wells currently, this would be a very bad accommodation for that population.

Even if a suitable location for replacement wells can be found, the NTUA Board of Directors has gone on record as being unwilling to agree to plug and abandon any of its Crownpoint wells (Dalton, 1997, at 2, attached hereto as **Exhibit P)**. In a recent resolution, the Board stated:

> The Management Board of NTUA deems the response of the Nuclear Regulatory Commission to be inadequate and not responsive to the needs of NTUA with respect to its water system and the community of Crownpoint to maintain its existing high quality water supply and to allow growth in its use . . .

(id). As a professional groundwater scientist dedicated to protecting water resources for the use and enjoyment of current and future generations, I concur with the NTUA's Board intent to ensure long-term protection of a world-class, sole-source, pristine water supply. HRI's proposed mining project will continue to endanger the public health, even if the town's water

wells eventually are replaced.

Q.8. Is HRI's application complete?

A.8. There are critical deficiencies in HRI's description and discussion of the hydrogeology of the three mining sites in its application. In my view, these deficiencies raise significant questions about HRI's ability to protect groundwater quality in conducting the Crownpoint Uranium Project, such that they should have been resolved before the HRI license was issued. Moreover, resolution of these deficiencies would require much more than the "fine-tuning" asserted by HRI.[27]

Together, the deficiencies I have just described in my testimony leave substantial doubt about whether HRI will be able to contain pregnant lixiviant within the mining zones, detect excursions from the mining zones, and restore polluted groundwater to premining, baseline conditions.

In my view, these problems are too serious and too numerous to be remedied by license conditions. For instance, it was recently been revealed that virtually no structure data were evaluated for faulting, even though numerous allusions to that evaluation were made in the application. See Frederick Phillips Letter, admitting stratigraphic cross-sections were misrepresented as structural cross-sections (December 29,1998). For another example, some pump tests indicated hydraulic connections between the Westwater and the Dakota. By

[27] See HRI Bifurcation Request at 5.

imposing a license condition requiring further pump testing (LC 10.23), the NRC Staff has effectively postponed until a later date resolution of a fundamental issue regarding the safety of the project - whether the CUP has adequate confining layers overlying and underlying the mining zones. Clearly the data already indicates this aquifer is inappropriate for ISL mining. Yet, the Staff seems determined to move ahead with licensing. Moreover, the resolution of this important issue is delegated to HRI's Safety and Environmental Review Panel, not to the NRC Staff.

Q.9. Does this conclude your testimony?

A.9. Yes.

AFFIRMATION

I declare on this 8th day of January, 1999, at Albuquerque, New Mexico, under penalty of perjury that the foregoing is true and correct and the opinions expressed therein represent my best professional judgment.

Michael G. Wallace

Michael G. Wallace

Sworn and subscribed before me, the undersigned, a Notary Public, on this 8th day of January, 1999, at Albuquerque New Mexico.

Dorothy Flores
Notary Public

My Commission expires on:
5/4/2002

OFFICIAL SEAL
Dorothy Flores
NOTARY PUBLIC
STATE OF NEW MEXICO
My Commission Expires: 5/4/2002

Exhibit A

Michael G. Wallace, Hydrogeologist
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Education:
M.S. in Hydrology, University of Arizona, Tucson, AZ, USA (1989)
B.S. in Plant and Soil Science, Southern Illinois University, Carbondale, IL, USA (1980)

Work History:
1997-present, Principal, Earth Science - Earth Art and contractor with the Plus Group
1990-1997, Senior Hydrogeologist, RE/SPEC Inc., Albuquerque, NM
1986 -1990, Staff Hydrogeologist, IT Corp., Albuquerque, NM
1982-1986, Hydrologic Technician, Research Assistant, University of Arizona, Tucson AZ

Technical Experience Summary:

Over 50 hydrogeologic projects since 1982. These projects have been roughly equally divided between ground water site investigations and flow and transport analysis actvities.

Specific experience with a wide array of techniques in the quantitative and statistical analysis of ground water problems. These techniques include 3-D modeling of flow and solute transport, vadose zone modeling, multi-porosity flow and transport modeling, stochastic processes, probability modeling, ground water resource optimization, NAPL transport in the subsurface, hydraulic test analyses, coupling of rock mechanics with ground water flow codes, coupling of geochemical analyses with ground water flow and solute transport analyses, and finite element numerical model development.

Currently a principal analyst in a groundwater flow and transport modeling effort for the Waste Isolation Pilot Project's (WIPP) Performance Assessment (PA) program. Responsibilities include interaction with a large multidisciplinary body of earth scientists, physicists, and mathematicians; assimilation of information and diverse concepts; and the design, implementation, and interpretation of a model acceptable to the client, regulators, various scientific oversight panels, and other stakeholders. Added experience at WIPP working on the consideration of nuclear criticality when disposing of transuranic waste. This work involves simulations of the accretion of radionuclides, including uranium, in a subsurface environment via groundwater transport.

Recently principal investigator on seven (WIPP) scenario screening efforts. Although all of the efforts were completed on schedule and within budget, one effort was successfully completed at less than a tenth of the cost originally estimated by the project. That effort also led to the first water table contour map for the WIPP vicinity.

Co-investigator in a 3-D paleohydrological / climate change conseqence modeling study of the upper groundwater system in the WIPP region.

Extensive experience working as part of interdisciplinary teams to evaluate the hydrologic performance of waste containment systems. On WIPP, helped develop a numerical simulator that analyzed the coupled processes of salt creep and brine inflow, related to excavations into the Salado Formation. On the Stripa project (Sweden) and the Finnish nuclear repository program, helped develop numerical simulators that analyzed the coupled processes of cement seal degradation and ground water inflow.

Experience with a large number of additional ground water modeling projects. These projects include a two dimensional study of ground water flow and contaminant transport through the Capitan Reef aquifer of Southeastern New Mexico, several 3D flow and solute transport modeling projects associated with injection of hazardous wastes into saline aquifers, and several modeling studies associated with the design of ground water remediation systems throughout the U.S.

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Application for Exemption to Continue Underground Injection of Restricted Hazardous Waste, prepared by International Technology Corporation, Austin, Texas, for confidential client, Texas, 1988.

Application for Exemption to Continue Underground Injection of Restricted Hazardous Waste, prepared by International Technology Corporation, Austin, Texas, for confidential client, Ohio, 1988.

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Exhibit B

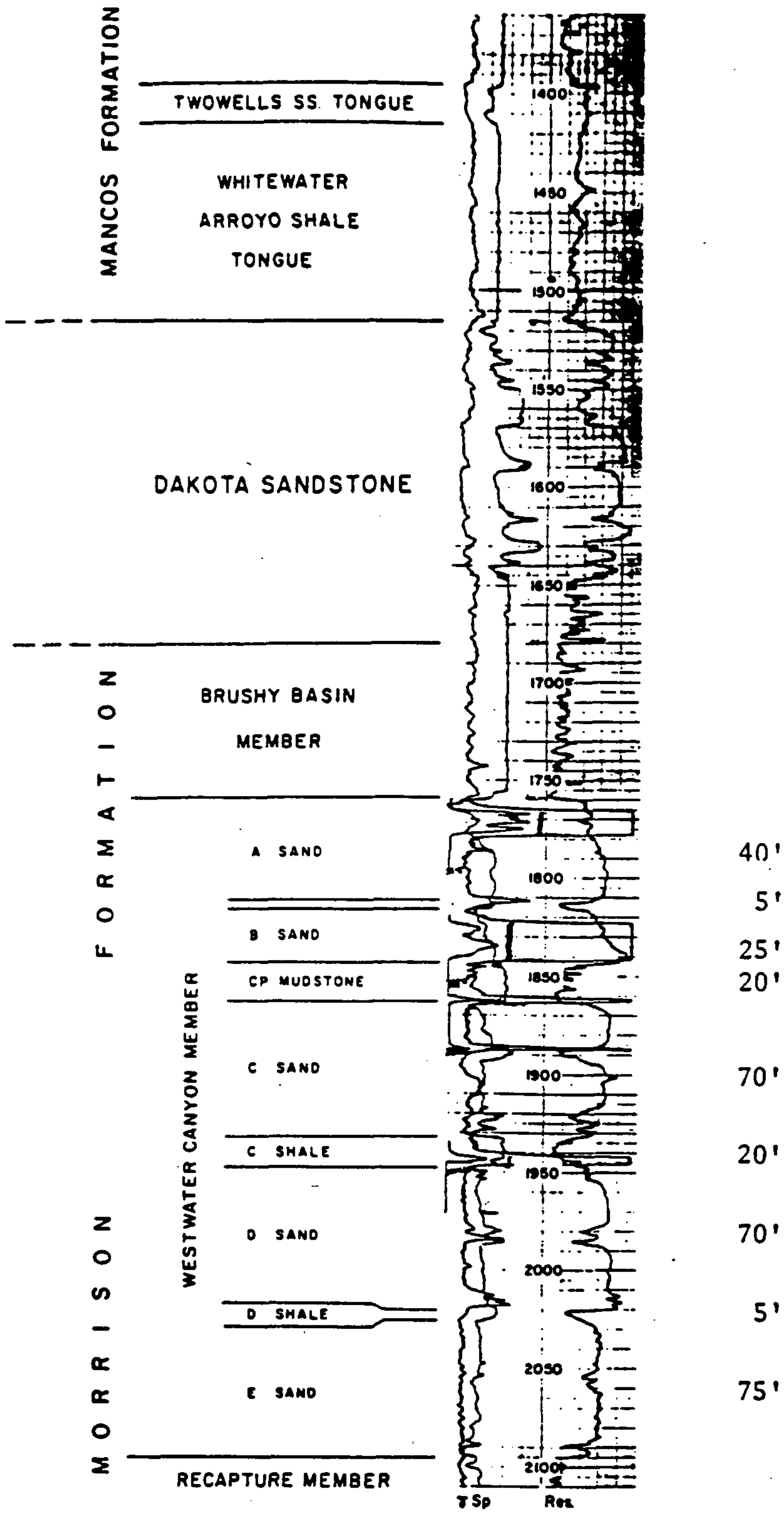

Figure 1. Electric log showing layering within the Westwater Canyon Member of the Morrison Formation and thicknesses (in feet) of each layer. (Adapted from Figure 2 in Wentworth et al., 1980 at 140.)

WALLACE EXHIBIT B

Exhibit C

HRI, INC.

(A Subsidiary of Uranium Resources, Inc.)

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Suite 250, LB 8
Corpus Christi, Texas 78411
Telephone: (512) 993-7731
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April 1, 1996

40 - 8968

Mr. Joe Holonich, Chief
High-Level Waste and Uranium Recovery Projects Branch
United States Nuclear Regulatory Commission
Division of Waste Management
Office of Nuclear Materials Safety and Safeguards
Mail Stop T-7-J9
11545 Rockville Pike
Rockville, MD 20850

RE: Request for Additional Information, Questions 49-91, Water Resources and Protection and Cost/Benefit Analysis; Safety Analysis Review and Environmental Review for Hydro Resources, Inc. (HRI) Uranium Solution Mining License Application, Crownpoint, New Mexico.

Dear Mr. Holonich:

Please find attached the responses to the subject request for additional information. The response to question #92 will be mailed under separate cover.

The responses addressed herein cover many different technical concerns, however, they all are centered around two basic questions pertaining to the proposed mining operations, namely:

1. Can water be controlled during mining?

2. Can restoration be accomplished after mining is completed?

In the case of the Crownpoint properties, these questions require careful consideration due to the location of the community water supply wells.

We believe that our operations will not affect water supply wells because mine solutions cannot reach them during mining activities. We have documented through conservative model output in these responses, that under static conditions, (i.e., mine or restoration bleed is shut off) that water in the Crownpoint mine zone would require 35+ years to migrate to the closest community water

NL05 1/1

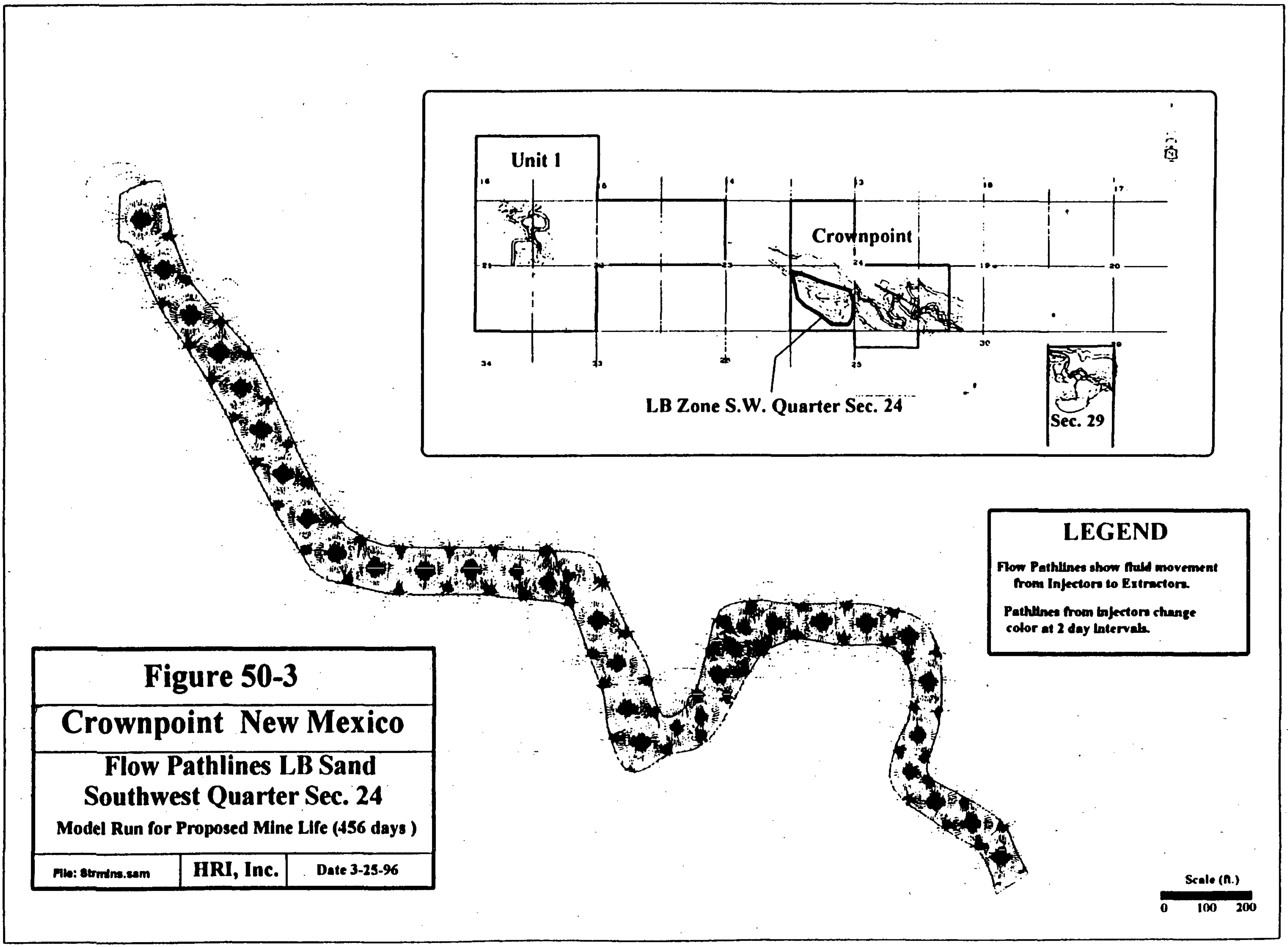

Figure 50-3

Crownpoint New Mexico

Flow Pathlines LB Sand
Southwest Quarter Sec. 24
Model Run for Proposed Mine Life (456 days)

File: Strmlns.sam	HRI, Inc.	Date 3-25-96

Exhibit D

INTERNATIONAL ATOMIC ENERGY AGENCY
in cooperation with the Nuclear Energy Agency of the OECD

Technical Committee Meeting on Recent Developments in Uranium Resources, Production and Demand — 1997

Vienna, 10–13 June 1997

The Crownpoint and Churchrock Uranium Deposits, San Juan Basin, New Mexico: An ISL Mining Perspective

D.W. McCARN

THE CROWNPOINT AND CHURCHROCK URANIUM DEPOSITS, SAN JUAN BASIN, NEW MEXICO: AN ISL MINING PERSPECTIVE

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1. ABSTRACT

The Crownpoint and Churchrock uranium deposits, San Juan Basin, New Mexico are currently being developed by Uranium Resources, Inc. (URI) and its subsidiary Hydro Resources, Inc. (HRI) with an anticipated startup in 1998. Both deposits will be developed using advanced in situ leach (ISL) mining techniques. URI / HRI currently has about 14,583 tU (37.834 million pounds U_3O_8) of estimated recoverable reserves at Crownpoint and Churchrock at a cost less than \$39 / kg U (\$15 / lb U_3O_8). The uranium endowment of the San Juan Basin is the largest of any province in the United States.

In March, 1997, a Final Environmental Impact Statement (FEIS) for the Crownpoint and Churchrock sites was completed by the Nuclear Regulatory Commission which recommends the issuance of an operating license. The FEIS is the culmination of a 9 year effort to license and develop the deposits.

The Westwater Canyon Member of the Jurassic Morrison Formation is an arkosic, fine to coarse grained sandstone bounded by near basinwide confining clays deposited in a wet alluvial fan environment within the San Juan Basin. The primary, trend-ore deposits are hosted by the Westwater Canyon Member as humate-rich, syngenetic tabular deposits which were

subsequently remobilized into roll fronts. Since deposition in the Jurassic, two phases of remobilization have occurred in the basin causing the formation of in situ leach amenable monometallic uranium rolls free of organic debris.

Following in situ mining, ground water restoration of the Crownpoint and Churchrock mines is required to provide a water quality consistent with pre-mining baseline conditions.

The development of in situ mining offers an environmentally sound and cost-effective method for uranium extraction. URI / HRI anticipates a production of 385-1,156 Tonnes U / year (1-3 million pounds U_3O_8) from the New Mexico properties.

2. STRUCTURAL SETTING

The Crownpoint and Churchrock uranium deposits are located in northwestern New Mexico and are part of the Grants Uranium Region in the San Juan Basin (Fig. 1). The San Juan Basin, regionally part of the Colorado Plateau, is bounded on the north by the San Juan Uplift, to the west by the Defiance Uplift, to the south by the Zuni Uplift, and to the east by the Nacimiento Uplift and the Archuleta Arch. Fig. 2 presents an index map of the five mining districts within the region including the Churchrock, Crownpoint, Smith Lake, Ambrosia Lake, and Laguna districts as well as the locations of the three URI / HRI sites. Historically, the Grants Uranium Region represents the largest of all uranium-bearing provinces in the United States. Crownpoint is located in the central portion of the Chaco Slope and Churchrock is located 30 km to the west, also on the Chaco slope. The location of the three URI / HRI properties is also shown in Fig. 2 and are referred to as Churchrock, Crownpoint, and Unit 1.

3. DEPOSITIONAL FRAMEWORK

The Jurassic Morrison Formation is the single most important uranium producer in the United States and is the host for uranium deposits not only in the San Juan Basin, but also

throughout the Colorado Plateau which covers 500,000 km^2 (200,000 mi^2) including portions of Arizona, Colorado, New Mexico and Utah. The deposition of Morrison Formation occurred at a time in which large quantities of volcanic ash provided a source for uranium as the favorable sandstone hosts of the Westwater Canyon Member were being deposited. In the San Juan Basin, sub-aerial alluvial fans draining the Zuni Uplift to the south developed over Recapture Member clays. Following the basin-wide development of the Westwater Canyon Member sandstones, Brushy Basin Member bentonitic claystones and mudstones containing large quantities of volcanic ash were deposited. [1, 2, 3, 4, 5, 6].

Humate from the sediments was mobilized sygenetically [2, 3] and was reconcentrated into the Westwater Canyon Member sandstones. This provided a reductant for the large quantities of uranium in the Morrison system and gave rise to the humate-rich, tabular "trend-ores" throughout the San Juan Basin. The geometric mean of the total carbon content of the Ambrosia Lake "trend ores" is 0.60% [4]. Background concentrations at Ambrosia Lake is 0.14% [4].

Following deposition of the Morrison, transgressive Dakota seas enveloped much of the western United States depositing beach, barrier bar, and distributary deltaic sediments unconformably over the Morrison Formation. This was followed by deposition of the thick offshore sediments of the Mancos Shale.

Structural re-development of the San Juan Basin during Cretaceous and Tertiary times allowed for the redistribution of the tabular trend ores into the remobilized ores occurring at Crownpoint and Churchrock. This remobilization is responsible for the segregation of vanadium, selenium, and molybdenum from the remobilized ores such as Churchrock [4]. The total carbon is very low [4].

4. LOCATION

4.1. Crownpoint and Unit 1

The Crownpoint and Unit 1 sites covers 877 ha (2,192 acres) and is located on Sections 15, 16, 19, 21, 22, 24, and 25 of Township 17 North, Range 13 West and Section 29, Township 17 North, Range 12 West adjacent to the town limits of Crownpoint (Fig. 3). The Crownpoint Trend lies on the central portion of the Chaco Slope to the south of the interior part of the San Juan Basin near the regional redox front at a depth of about 700 m. The Crownpoint trend was discovered in the late 1970's by Conoco and Mobil. Conoco began engineering studies of for a major underground mine in the late 1970s and three deep shafts were completed in 1982.

Unit 1 is located 3.2 km west of the town Crownpoint and covers 512 ha (1,280 acres) in Sections 15, 16, 21, and 22 of Township 17 North, Range 13 West and has very similar geological characteristics to the Crownpoint site. The Unit 1 Site is shown in Fig. 3. This forms a portion of the area leased by Mobil which explored and discovered over 38,500 tU (100 million pounds U_3O_8) within their leases.

Because of the leachable nature of portions of the ore in the area, Mobil completed an in situ pilot operation near what HRI calls the Unit 1 area. This pilot demonstrated the economic viability for ISL production of the Crownpoint ores as well as demonstrating the ability for restoration.

4.2. Churchrock

The Churchrock site is located in the northwest corner of the Zuni Uplift near the boundary of the Chaco Slope and the depth to ore is approximately 250 m. The site is located in Sections 8 and 17 of Township 16 North and Range 16 West and covers an area, as shown in Fig. 4, of 145 ha (360 acres). HRI's mineral rights include 65 ha (160 acres) of patented claims

in Section 8, and 80 ha (200 acres) of leases on Section 17. A portion of the Churchrock site in the northeast corner of Section 17 was previously mined for uranium.

5. RESERVES AND PRODUCTION IN THE GRANTS URANIUM REGION

In the Grants Uranium Region, the estimated total endowment of the Westwater Canyon Member is 3.5 x 10^6 Tonnes U [6]. Cumulative production of uranium from the Grants Uranium Region by January 1, 1997 has been 131,450 tU (341.8 million pounds U_3O_8) [5, 7, 8, 9]. URI / HRI currently has about 14,583 tU (37.834 million pounds U_3O_8) of estimated recoverable reserves at Crownpoint and Churchrock. at a cost less than $39 / kg U ($15 / lb U_3O_8). About 40% of all uranium produced in the United States is from the Grants Mineral Belt [5].

6. REGIONAL GEOLOGY

The San Juan Basin has been a regional depocenter since the Paleozoic. Approximately 3,000 m of section are present and range in age from Precambrian to Holocene. Strata from Permian to upper Cretaceous are identified including the Jurassic Morrison formation which hosts most of the uranium deposits in the basin. Formation Of minor importance are the Cretaceous Dakota Sandstone and the Jurassic Todilto Limestone. Figure 5 is a cross-section between Gallup and Grants, New Mexico showing the regional relationships of the Jurassic Morrison [1].

6.1. Morrison Formation

The Morrison Formation consists of the Recapture, Westwater Canyon, and Brushy Basin Members and may attain a total thickness of about 225 m. A typical section in the Westwater Canyon Member along with a geophysical log is presented in Fig. 6 [1].

6.1.1. Recapture Member

The Recapture Member of the Morrison Formation is composed dominantly of two facies: aeolian and lacustrine. The eolian portion can be up 90 m thick and consists of white, tan, and yellowish-gray, fine- to medium-grained, well sorted, large-scale trough crossbedded sandstone [1]. The lacustrine facies is an interbedded sequences of alternating red and maroon mudstones and white, light-gray, and reddish-brown, fine- to medium-grained, moderately well sorted sandstone. It ranges in thickness in the San Juan Basin from 0 to 152 m [1].

6.1.2. Westwater Canyon Member

The Westwater Canyon Member is an artesian aquifer with a transmissivity of 3.676×10^{-4} to 3.880×10^{-4} m^2/s (2,556-2,698 gal/day/ft) [8] and is tightly confined by aquicludes of the overlying Brushy Basin clays and underlying Recapture Shale. As described by Kirk & Condon [1], the Westwater Canyon Member is a sequence of vertically stacked and laterally coalesced fine- to coarse-grained, arkosic to felspathic, poorly sorted, sandstone beds interbedded with thin, discontinuous mudstone beds. The color ranges from pink to red, grayish-green, and yellowish gray. The Westwater Canyon Member was deposited in a braided fluvial framework and ranges in thickness from 30 to over 125 m and deposited in a synclinal area between the Mogollon and Uncompahgre uplifts [3]. At Crownpoint, the Westwater Canyon Member ranges in thickness from 72 to 105 m. At Churchrock, the average thickness of the Westwater is 80 m. A shown in Fig. 2, the source of the sediment was from the southwest across the area of the Zuni Uplift.

6.1.3. Brushy Basin Member

The Westwater Canyon Member interfingers locally and regionally with the overlying Brushy Basin Member mudstones which also serve as a regional aquiclude. Locally, the Brushy Basin Member hosts braided fluvial sandstones sometimes referred to as "Poison Canyon". The

Brushy Basin Member is composed of light greenish-gray betonitic claystone and mudstone and ranges in thickness from 12 to 40 m [1, 8]. At Crownpoint, the Brushy Basin ranges from 20 to 35 m.

6.2. Dakota Sandstone

The Dakota Sanstone unconformably overlies the Morrison Formation and consists of two distinctive units. The lower portion is a paludal shale and mudstone overlying the Brushy Basin Member occasionally containing fluvial sandstone and locally coal. The upper portion of the Dakota is a well-developed white to light-brown, transgressive beach and barrier-bar marine sandstone unit occasionally containing distributary sandstone channels which are occasionally conglomeratic. These channels occasionally scour into the underlying Brushy Basin Member. [1]. The thickness of the Dakota Sandstone is up to 60 m.

6.3. Mancos Shale

The Mancos shale was deposited in a transgressive offshore marine environment and is a dark-gray claystone, mudstone and very-fine sandstone system and is up to 600 m thick [1, 8]. At the Churchrock Site, the Mancos Shale is present at the surface.

7. DEVELOPMENT OF URANIUM DEPOSITS IN THE WESTWATER CANYON MEMBER

Uranium was deposited in the Westwater Canyon Member penecontemporaneously with the deposition of volcanic ash in a humate rich environment. Syngentic concentration of humate and uranium within tabular sandstone masses created the tabular "trend-ore" deposits. Following structural changes in the basin during Cretaceous times, the trend-ore containing vanadium, molybdenum, and humate was redistributed into secondary "stacked" ore rolls virtually free of organics but containing some molybdenum. A later stage of basin development during Tertiary

further redistributed the uranium into monometallic stacked ores. Both Crownpoint and Churchrock are Tertiary stacked-ore deposits.

The Cretaceous and Tertiary remobilized uranium rolls are considered favorable for bicarbonate-oxygen ISL methods currently employed by URI's Kingsville Dome and Rosita plants.

7.1. Regional Ore Controls

Clear regional controls of the uranium deposits in the San Juan Basin are evidenced by the strong correlation between the regional redox fronts and the location of the ore deposits [1, 2, 3]. This regional redox front is presented in Fig. 7 [1]. The regional redox front is accompanied by discrete zones of hematitic and limonitic alteration within the basin, the hematitic zone being updip of the limonitic zone. Gray, reduced Westwater Canyon Member sandstones occur downdip of the regional redox front. The remobilized ore lies in the limonitic zone downdip of the more intensely oxidized zone of hematitic alteration.

Another important regional and local control for the concentration of uranium is the development of highly transmissive zones in the Westwater Canyon Member fan system which allowed large quantities of uranium bearing solutions to pass through regional redox fronts and be precipitated.

7.2. Local Ore Controls

Local ore controls for the individual rolls within the Westwater Canyon Member appear to be the thin, laterally discontinuous clays within the sandstone. As shown in Fig. 8 of the Crownpoint site, multiple, stacked ore bodies are present throughout the Westwater Canyon Member, each within an individual geochemical cell. Accurate interpretation and delineation of these ore rolls is required to design an effective well field.

8. ISL PROCESS

In order to develop the Crownpoint and Churchrock ore deposits, two distinct producing elements are necessary: the Well Field, and the Ion Exchange Plant. The plant consists of ion exchange columns containing resins with an affinity for uranyl carbonate ions. The flow of dilute solutions of uranyl carbonate (about 50-150 mg U / L) from the extraction wells is maintained at a rate of 10,000 - 20,000 L / m (2,500-5,000 gallons / m) through the plant. This yields between 230 kg U to 4,615 kg U per day (600 to 12,000 pounds of U3O8) for an annual production of 263 - 1,577 tU per year. Following extraction of uranium, oxygen and complexing agent such as sodium bicarbonate is added and the solution is reinjected. Of course, the true key to ISL development is the well field design.

8.1. Well Field Design

The well field is the mechanism by which the leaching solutions, or lixiviant, is circulated through the ore body (Fig. 9). Well field design for the in situ leach mines at Crownpoint and Churchrock will include up to 1,000-2,000 injection and extraction wells for each mine site located as close as possible to the ore. Because of the sinuosity of each individual roll front, wells as closely spaced as 10-50 meters will be used to extract the uranium. Each well field will be surrounded by a ring of monitoring wells not more than 120 m (400 ft) from the nearest production well and not farther than 120 m from each other. Leachate migration to the monitoring wells is called an excursion. Excursion controls consist primarily of the initial engineering design of the wellfield, balancing lixiviant flow in the wellfield, and maintaining a slight production bleed of 1% to create a cone of depression around the ore zone. URI has never had an excursion in its operating history.

9. LICENSING

URI / HRI is currently in the process of obtaining source material license as authorized by the Atomic Energy Act for the Crownpoint, Churchrock, and Unit 1 sites. With the issuance of the FEIS [8] in February, the lengthy re-evaluation by the U.S. Nuclear Regulatory Agency (NRC), the Bureau of Indian Affairs (BIA), and the U.S. Bureau of Land Management (BLM) was completed with a recommendation to issue a combined source and by-product material license from the NRC and minerals operating leases from the BLM and BIA. The FEIS recommended that the license and leases should be conditioned on the commitments made by HRI in the license application and related submittals as well as various recommendations made by the NRC [8]. The FEIS is the culmination of a 9 year effort by HRI to license and develop the deposits. The NRC license will be conditioned on a Safety Analysis Report (SAR) currently being prepared by the NRC and Consolidated Operating Plan (COP) which is currently undergoing review by the NRC.

Other required licenses and conferred rights include the Underground Injection Control (UIC) License, and Surface Discharge Permit, land disposal of treated waste water, and [illegible] quality licenses.

9.1. Underground Injection Control License

In addition to a source material license, URI / HRI has obtained a UIC license from the State of New Mexico Environmental Department. A UIC license allows for the injection of mining fluids into an aquifer for the purpose of extraction of uranium.

9.2. Land Application of Discharged Water

Surface application of treated discharge waters is licensed by the State of New Mexico Environmental Department or the U.S. Environmental Protection Agency depending on the land status.

9.3. Water Rights

Water rights in the State of New Mexico is administered through the New Mexico State Engineer. Applications for water rights are required to be published and are subject to a hearing if protested. Water rights may be approved subject to three conditions: That the application (1) not impair existing water rights, (2) not be contrary to the conservation of water within New Mexico, and (3) not be detrimental to the public welfare. URI / HRI is currently in the process of obtaining water rights for the anticipated projects.

9.4. Comparative Consumptive Water Use

Agricultural use of consumed water in McKinley County, New Mexico for 50 hectares (123.5 acres) is compared to the total consumptive water use for all three proposed ISL projects. As can be seen in Fig. 10, the consumed water use for to support 50 ha of all commercial agricultural products is greater than the average use for in situ uranium mining. By comparison, water use for the former Churchrock mines required at least 6 million m^3 (5,000 acre feet) per annum to dewater the mines or at least 36 times the ISL water requirements.

11. RESTORATION

Based on the experience gained in the industry, three strategies (Table I) are considered in ground water restoration including (a) groundwater sweep (GS); (b) reverse osmosis (RO); and (c) brine concentration (BC) depending on the water budget. Total water use is estimated to

be 13-29 million m^3 for groundwater sweep, 3.3-7.7 million m^3 for RO, and 0.03-0.07 million m^3 for BC. This represents the total water requirements for all currently foreseen projects.

12. RESOURCE & PRODUCTION BASE OF URI / HRI

12.1. Santa Fe Pacific Gold Corporation Agreement

URI / HRI recently signed an agreement with Santa Fe Pacific Gold Corporation in which certain mineral rights were acquired covering 200,000 ha (500,000 acres). These rights were obtained in exchange for 1.2 million shares of URI's common stock and a commitment for $200,000 per year in exploration expenditures for the next 10 years [11, 12]. URI estimates there is approximately 5,700 tU (14.7 million pounds U_3O_8) of proven in-place uranium reserves approximately 3,700 tU (9.6 million pounds U_3O_8) recoverable] that were drilled-out on the acquired land. The potential for further development is very large based on the USGS endowment study of the San Juan Basin completed in 1986 [6]. It is estimated from this study that the endowment at a cutoff grade of 0.10% of the Westwater Canyon Member is 1,392,000 tU (3,280 million pounds of U_3O_8) at ISL minable depths.

12.2. URI / HRI Operations and Production

URI and its subsidiary HRI currently has uranium production operations in South Texas in the Kingsville Dome and Rosita plants. Production in 1996 amounted to 524 tU (1.36 million pounds U_3O_8) making URI one of the largest domestic producer of uranium in the United States [11].

Based on the recent acquisition of Alta Mesa in Texas, the development of the Vasquez, Texas property, a favorable FEIS for three uranium properties in New Mexico, and recent agreements with Santa Fe Pacific Gold Corporation (SFPGC), the in-place uranium reserves of the company are 34,000 tU (88 million pounds U_3O_8) of which 22,000 tU (57 million pounds

U_3O_8) are recoverable [12]. URI / HRI has been extremely active in licensing the Alta Mesa, Texas and New Mexico deposits for production as early as 1998.

13. ACKNOWLEDGMENTS

The author gratefully acknowledges the generous support and technical review by Richard Clement, Craig Bartels, and Frank Lichnovsky of Hydro Resources, Inc. and Mark Pelizza of Uranium Resources, Inc. in the preparation of this paper.

14. REFERENCES

[1] Kirk, Allan R. & Condon, Steven M., Uranium Deposits, Westwater Canyon Member, *in* A Basin Analysis Case Study: The Morrison Formation, Grants Uranium Region ,New Mexico, AAPG Studies in Geology #22, Pp. 105-143, (1986).

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[7] Annual Resources Report 1994, New Mexico Energy Mineral & Natural Resources Department, Table 49, P. 51, (1995), Data for the years 1979-1993.

[8] Annual Resources Report 1996, New Mexico Energy, Mineral & Natural Resources Department, Table 45, P.52, P. 51, (1997), Data for the years 1994-1995.

[9] Annual Operators Report, New Mexico Energy, Minerals & Natural Resources Department, Mining and Minerals Division, Received 1997 for calendar year 1996, unpublished.

[10] Nuclear Regulatory Commission, February, Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico, Docket No. 40-8968, Hydro Resources, Inc., NUREG-1508, in cooperation with U.S. Bureau of Land Management and U.S. Bureau of Indian Affairs - Navajo Area Office, (1997)

[11] Uranium Resources, Inc., Form 10-K, Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934, U.S. Securities and Exchange Commission, (March 19, 1997).

[12] Press Release, April 2, 1997: Dallas - Business Wire, Uranium Resources, Inc., (1997).

Fig. 1 Location & Structural Setting of the San Juan Basin

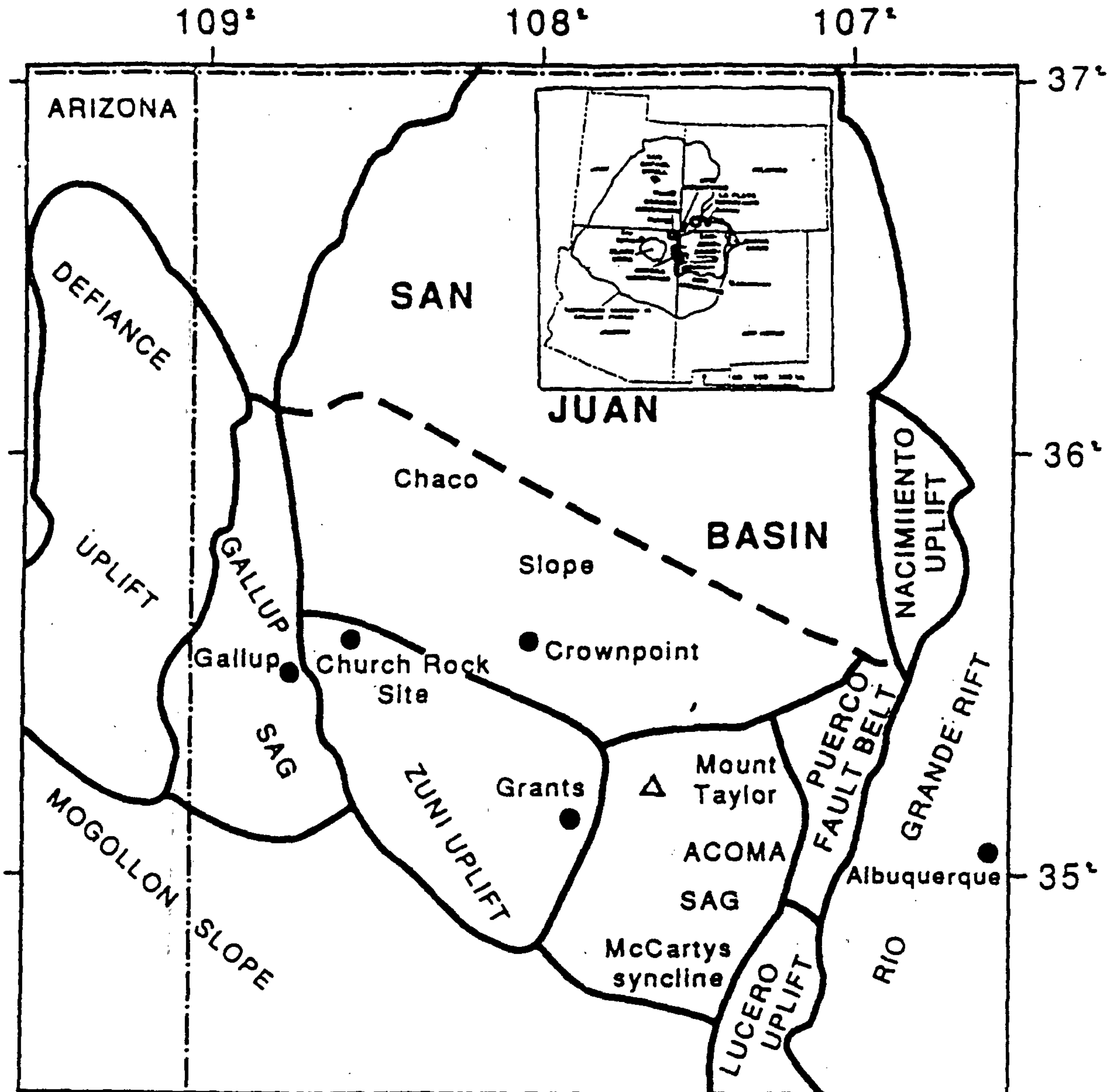


Fig. 2: Grants Uranium Region Depositional Framework of Westwater Canyon Member

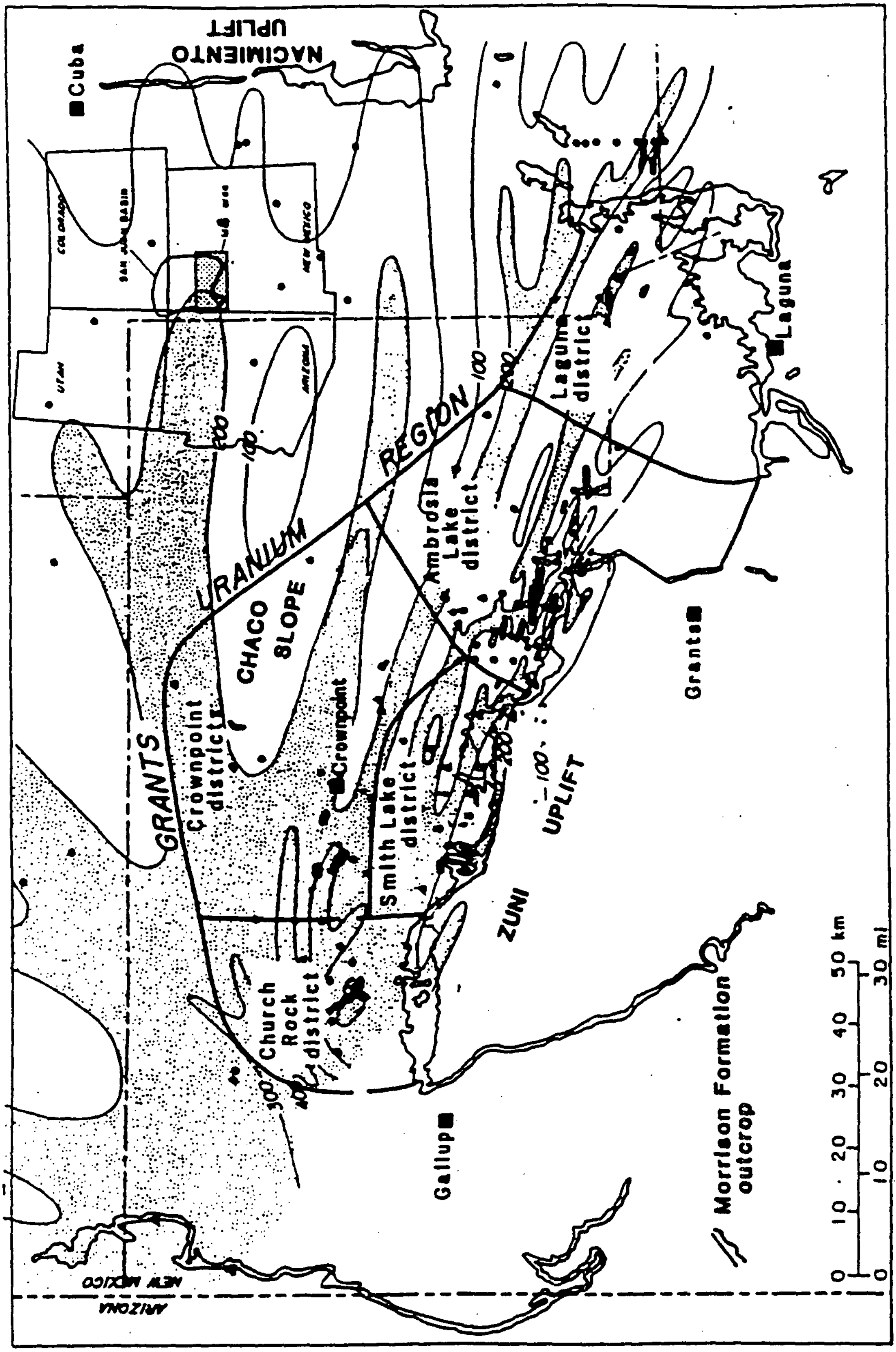


Fig. 3: Crownpoint and Unit 1 Site Map

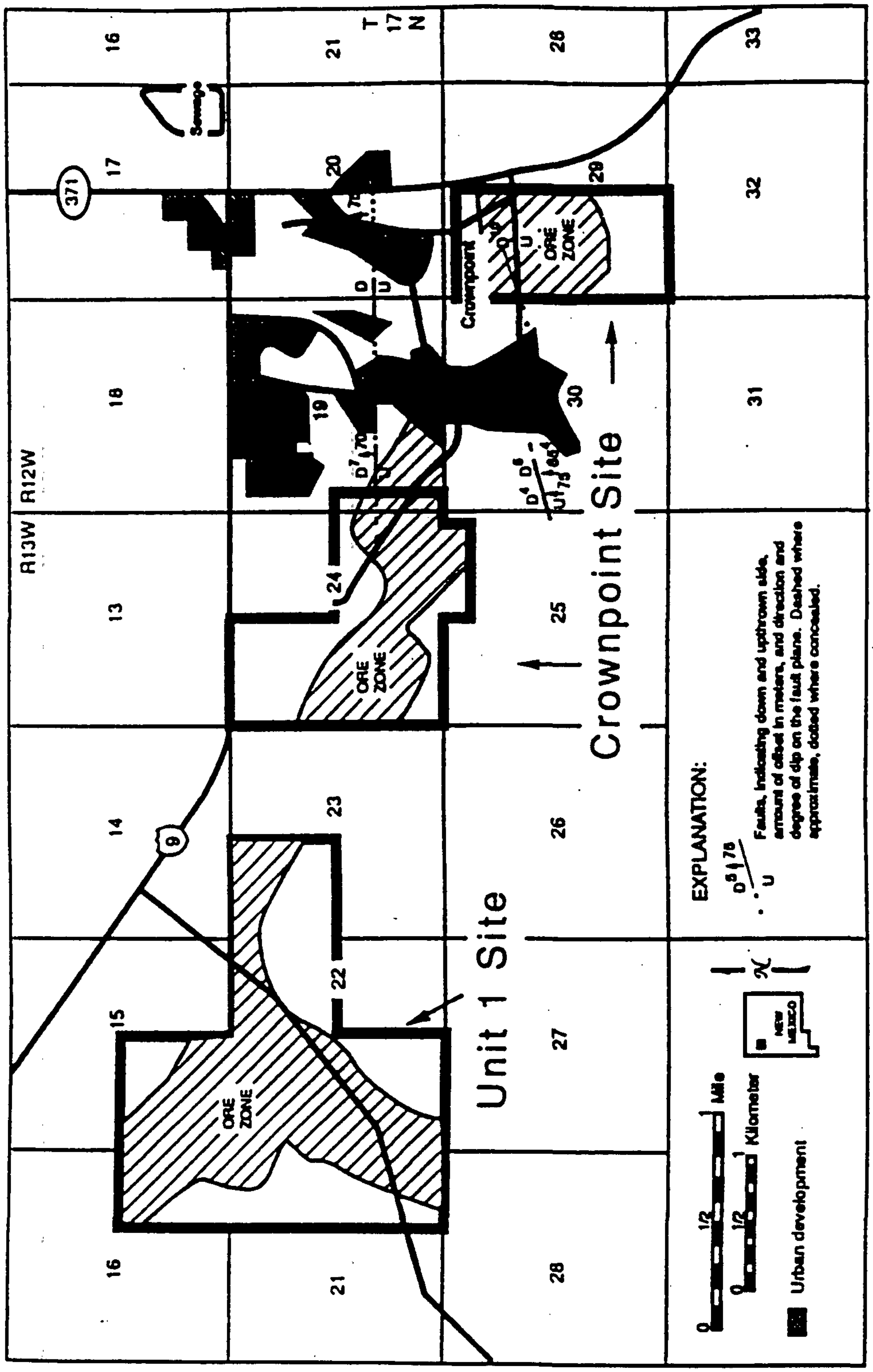


Fig. 4: Churchrock Site Map

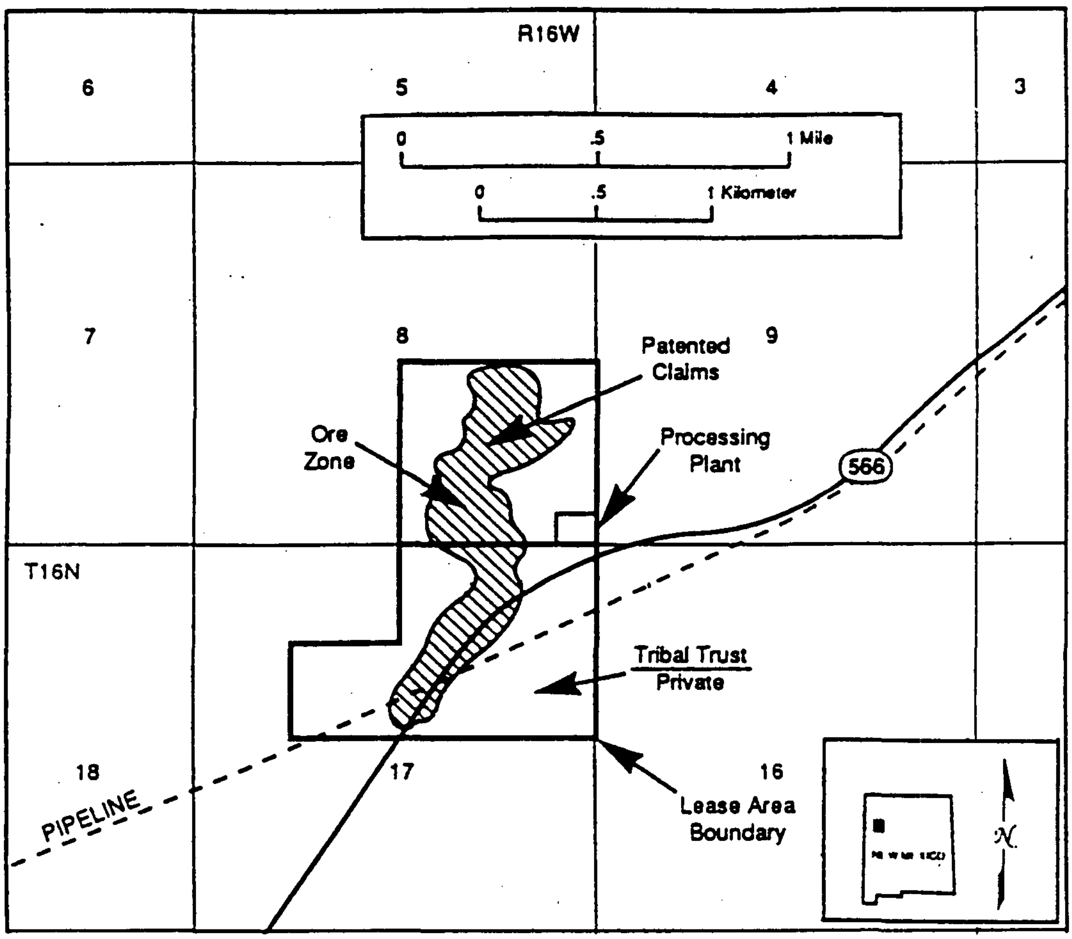


Fig. 5: Cross-Section Between Gallup and Grants, New Mexico [1]

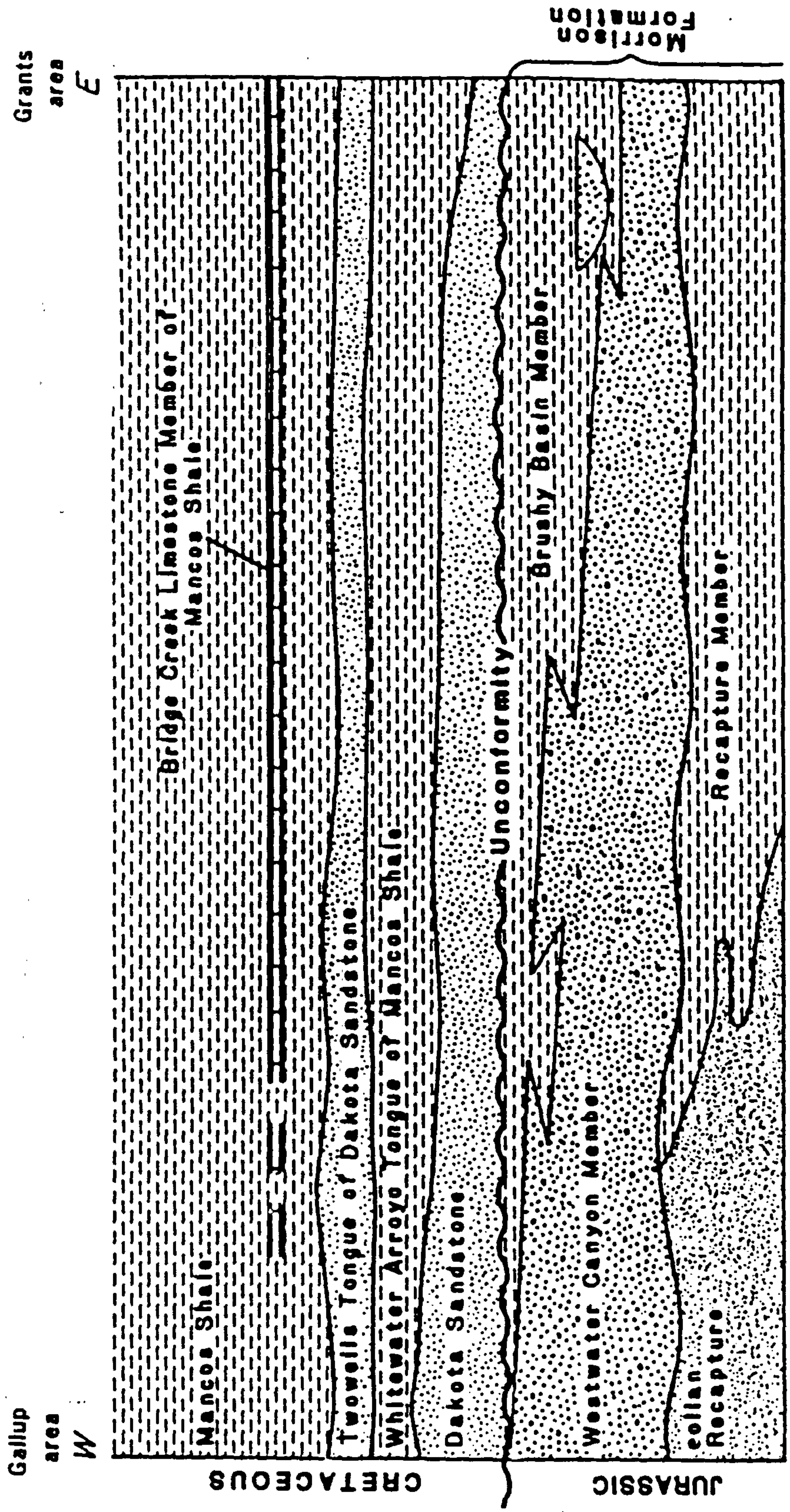


Fig. 6 Typical section of the Westwater Canyon Member

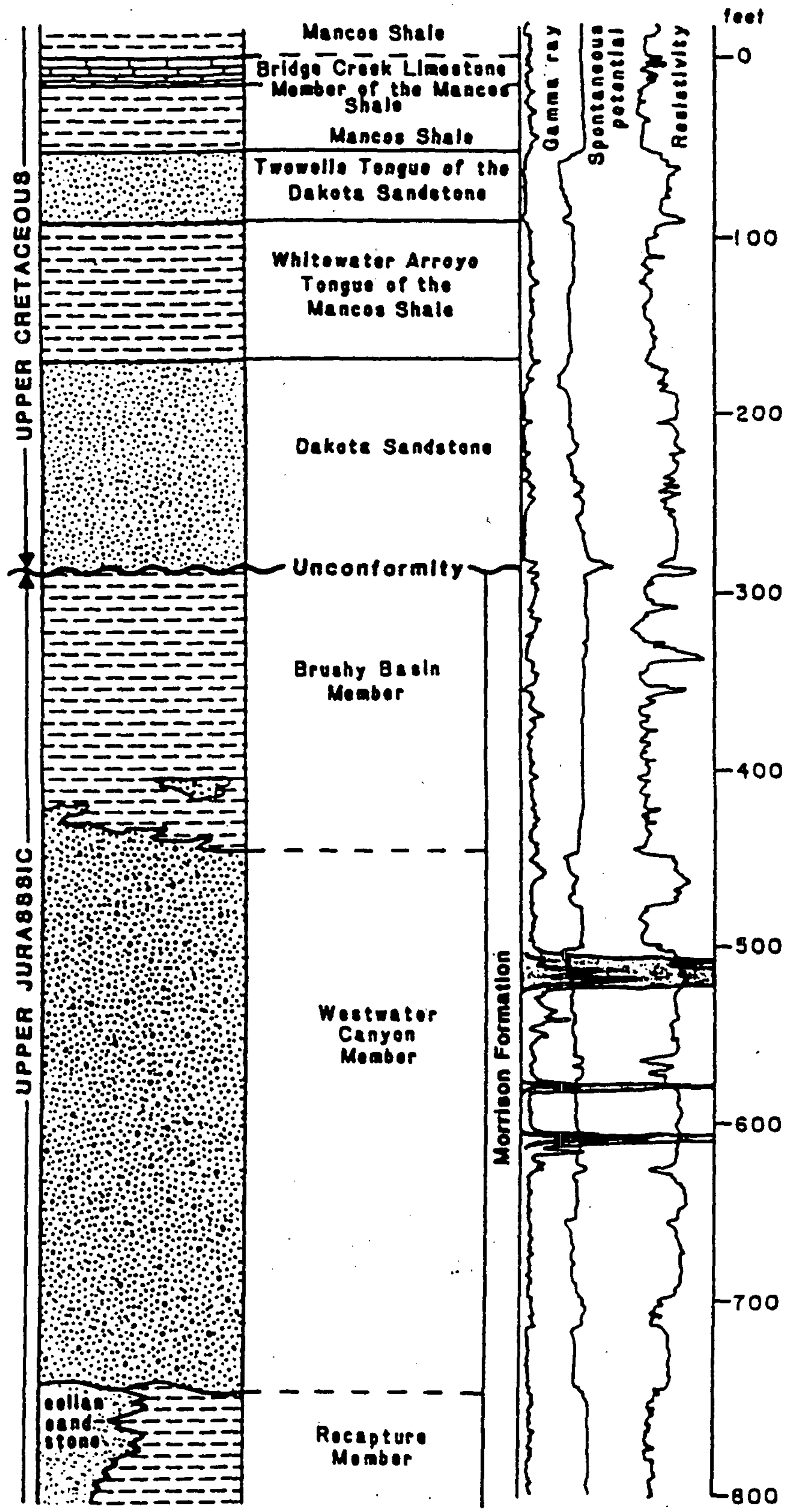


Fig. 7: Regional Redox Interface - From [1]

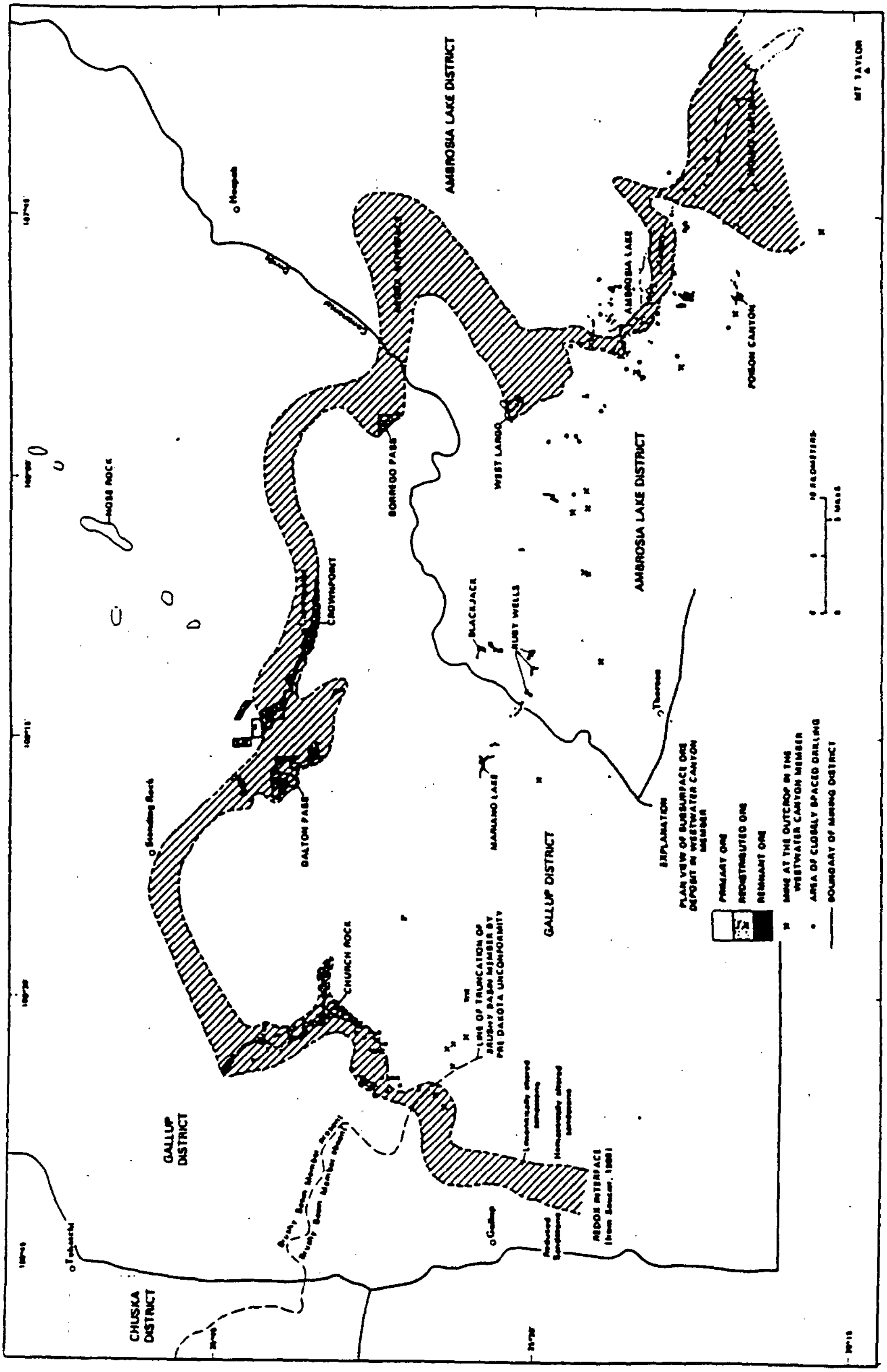


Fig. 8: Stacked Roll Fronts in the SE ¼ of Section 24 at Crownpoint

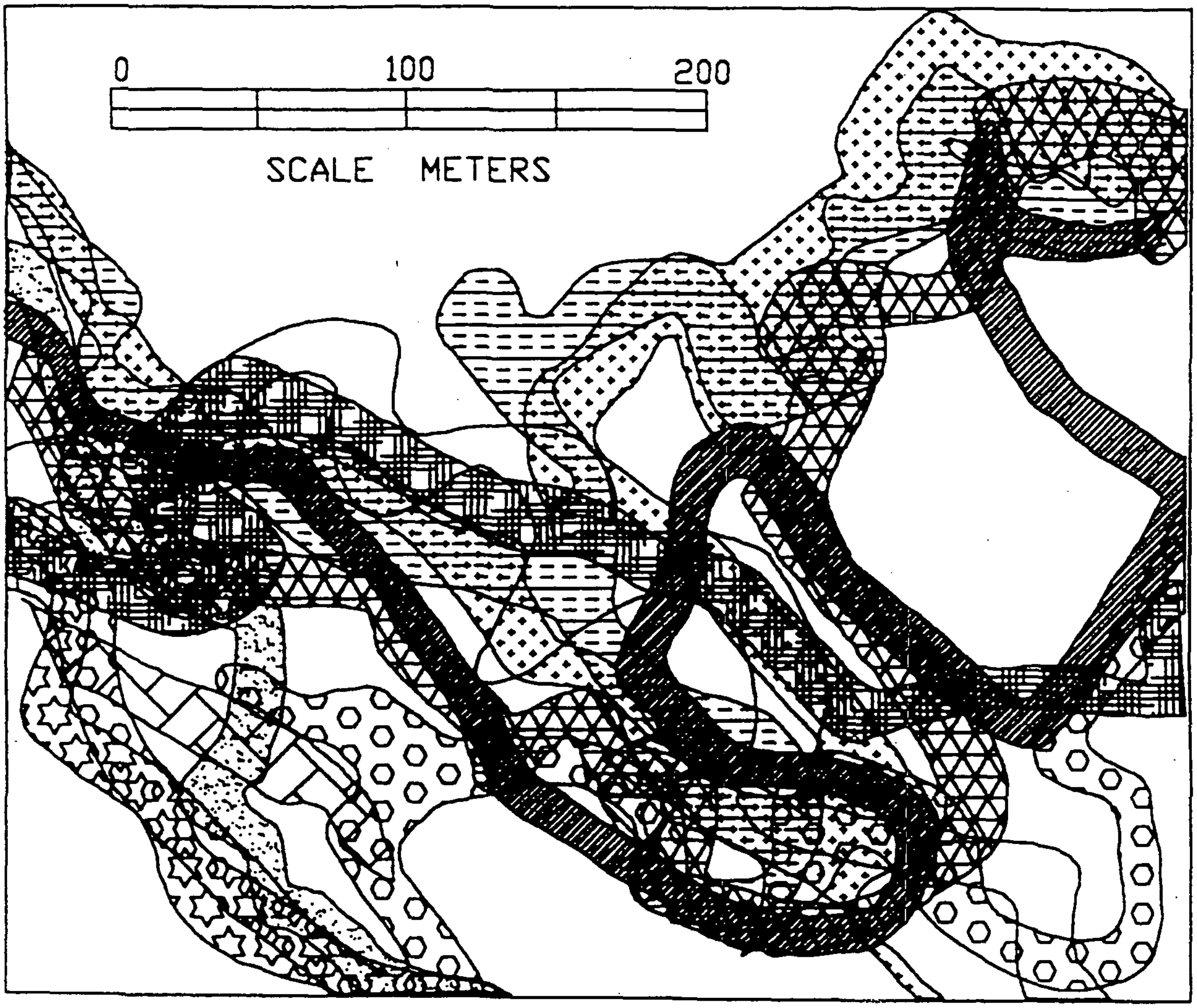


Fig. 9: Typical Wellfield Design

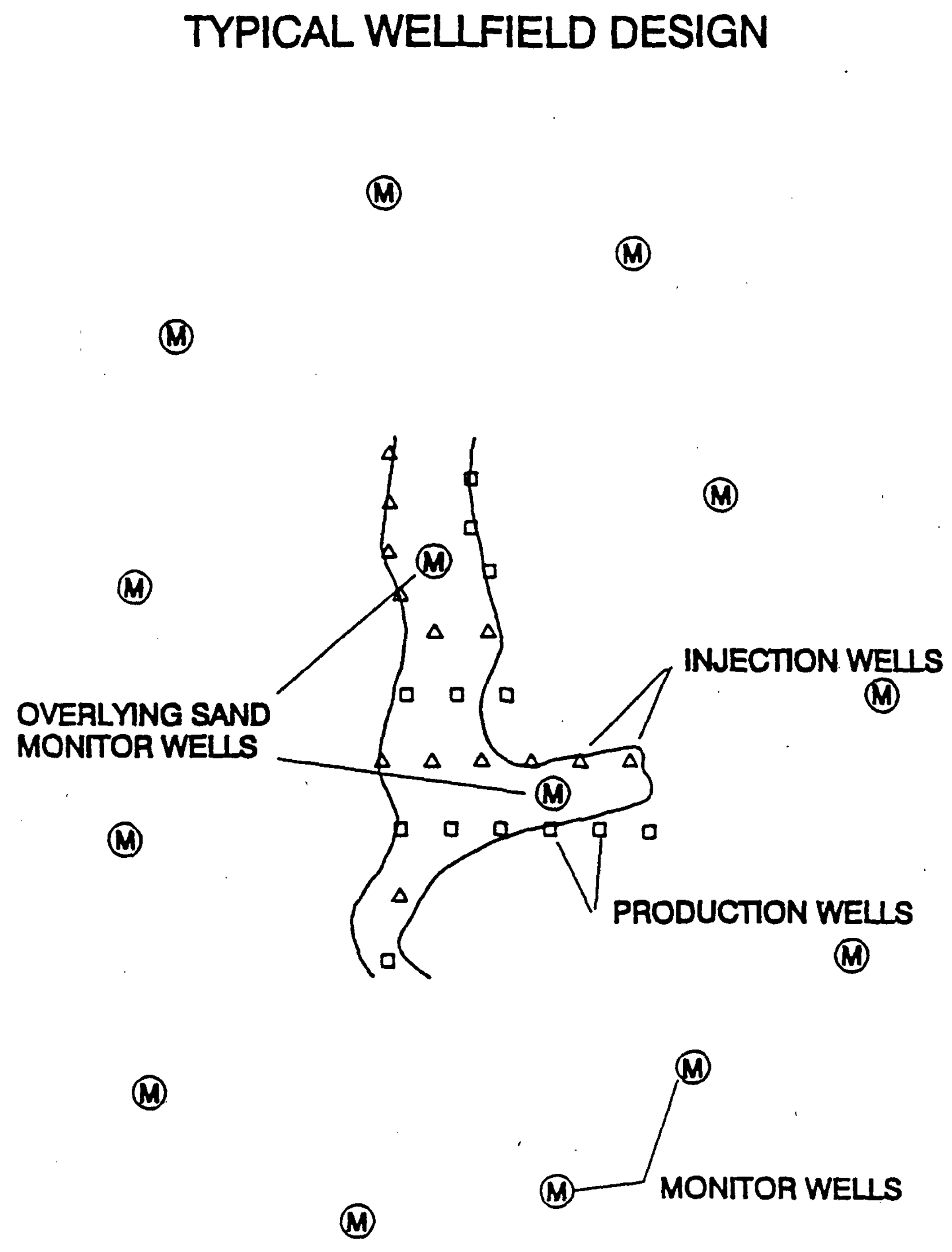
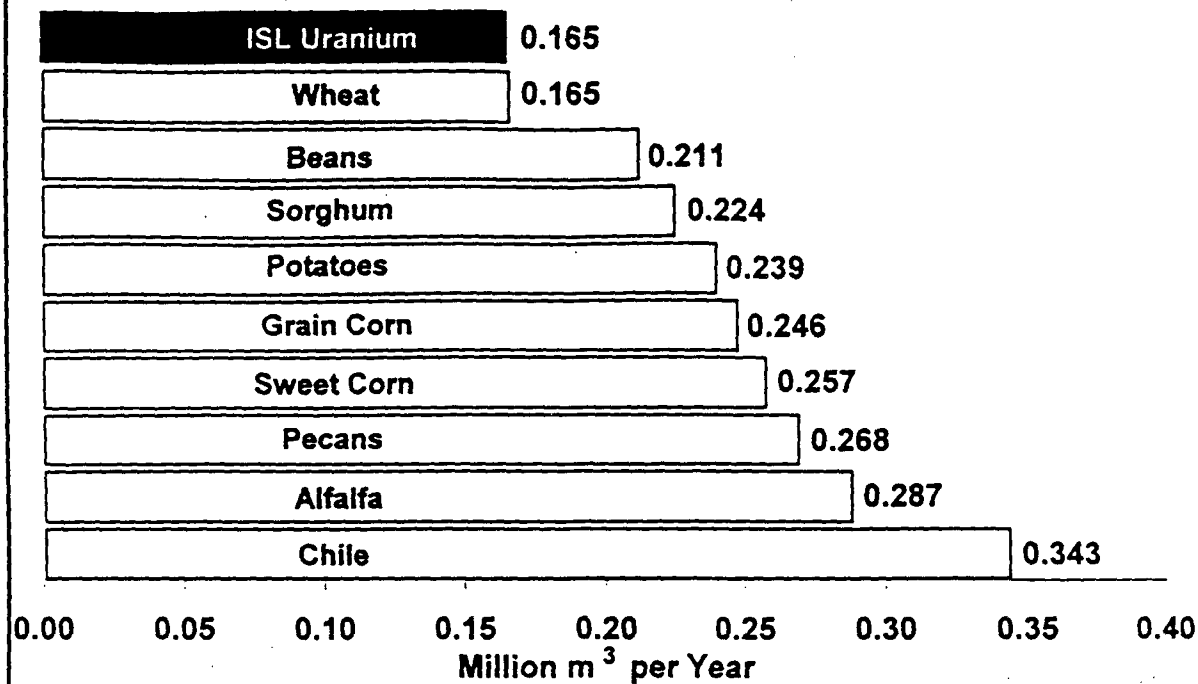


Figure 10: Comparative Consumptive Water Use
50 Hectares of Crops and ISL Mining



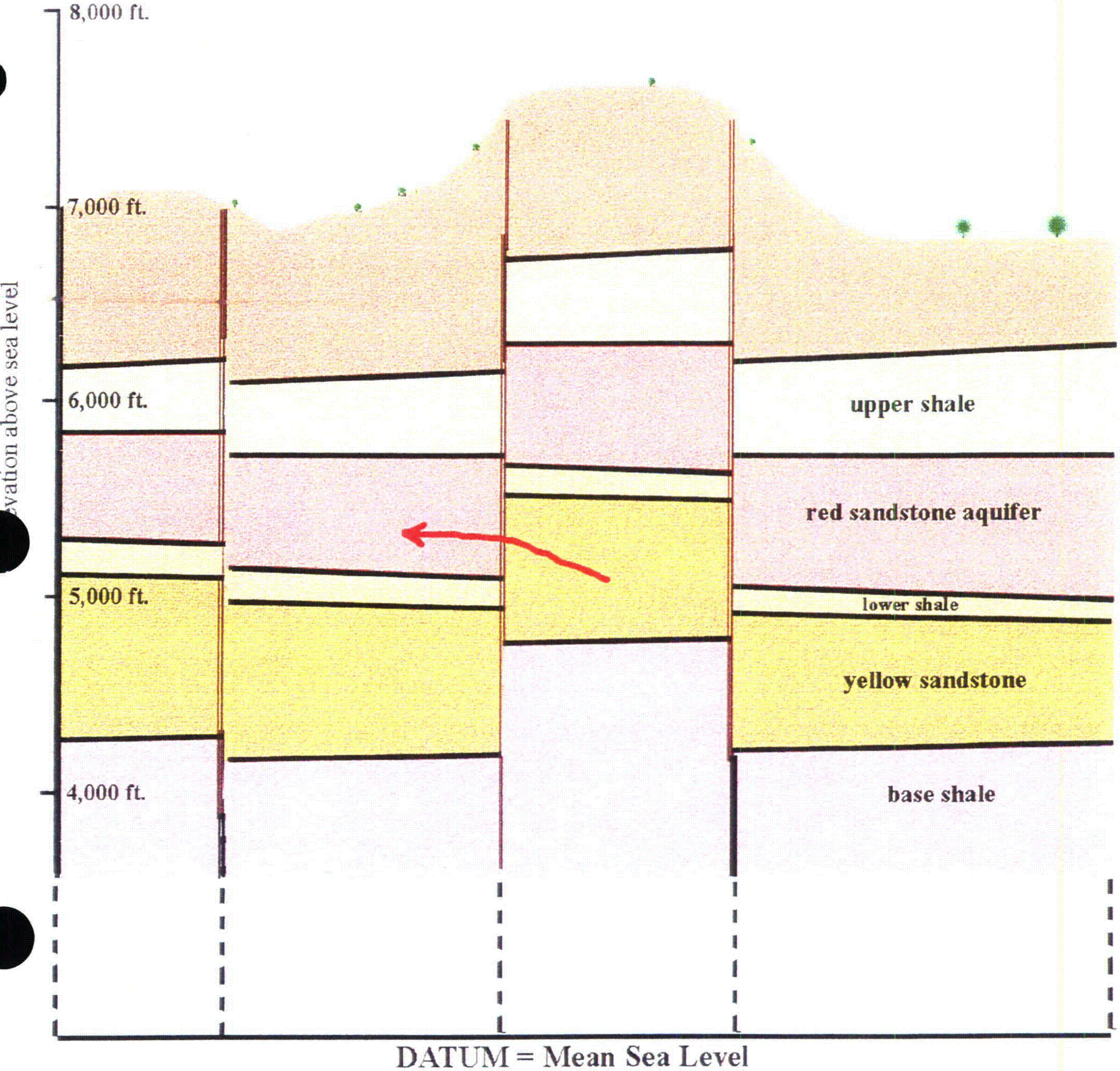
Based on 3.3 x 10^6 m^3 water requirement for all foreseen mining projects over 20 years
Restoration by reverse osmosis - 4 pore volumes
Source: USDA, Natural Resources Conservation Service, Grants, New Mexico, 1997

Table I:

Water Requirements for Crownpoint, Unit 1, and Churchrock [8]

Restoration Method	4 Pore Volumes (Millions M^3)	9 Pore Volumes (Millions M^3)
Groundwater Sweep	13	29
Reverse Osmosis	3.3	7.7
Brine Concentrator	0.03	0.07

Exhibit E

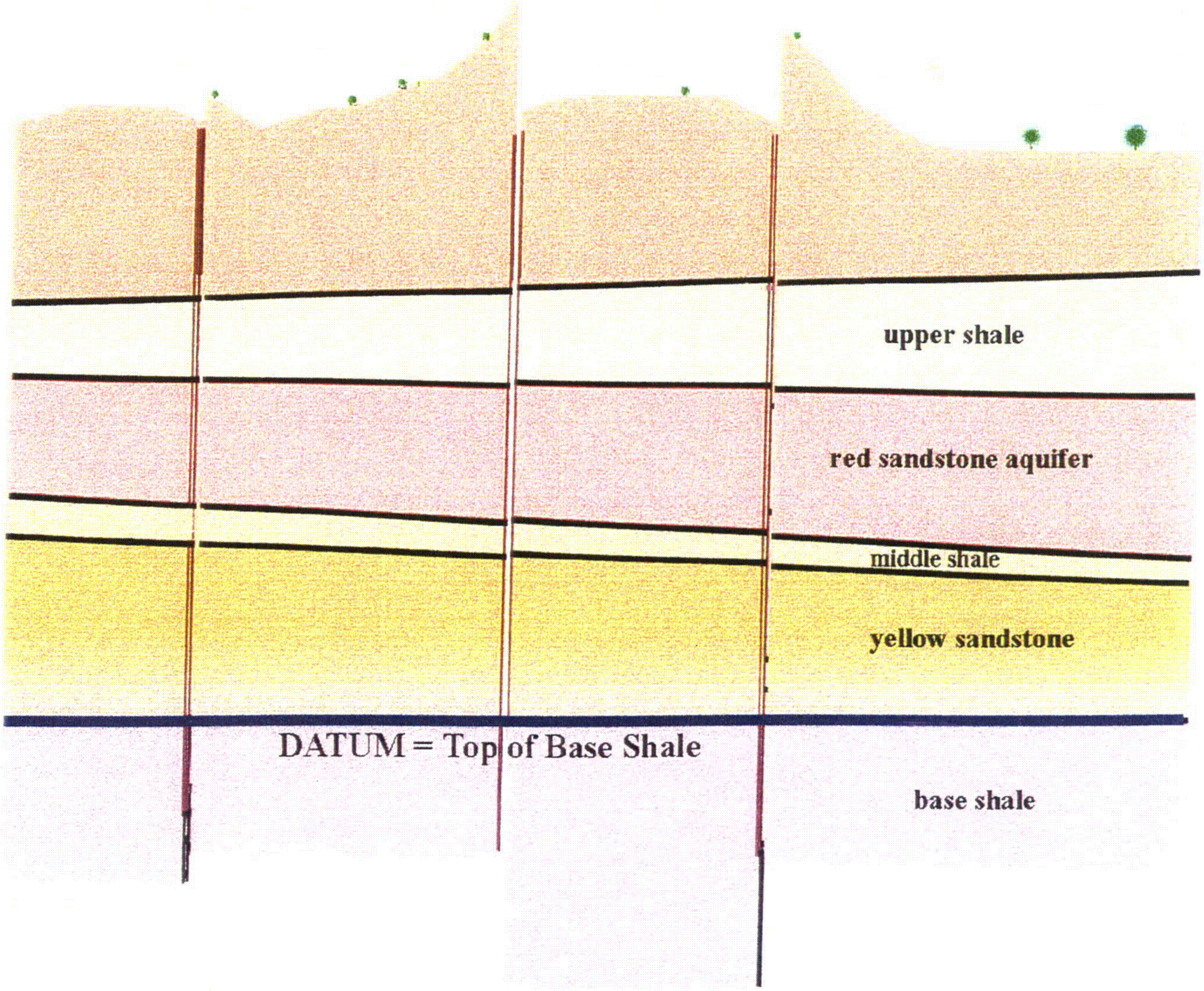


A Structural Cross Section recreates the actual elevations and thicknesses of each unit, measured from a common reference elevation (sea level, in most cases). This type of cross section honors the true elevations, thereby making it possible to determine if faulting causes one layer to be juxtaposed against another.

The red arrow indicates how this juxtaposition could allow water (or lixiviant) to easily travel from a lower geologic formation to an overlying aquifer

Figure 1. A Structural Cross Section. Part 1 of 2 parts, drawn to illustrate the important differences between a stratigraphic and a structural cross section.

Michael Wallace, December, 1998



A Stratigraphic Cross Section aids in recreating aspects of the original depositional environment of the buried units of concern. Geologic units are shifted up or down by the analyst in order to make a single layer have a perfectly horizontal top (thus, the absurd land surface profile in this example).

Because of this shifting by the analyst, the actual displacements caused by faulting are lost*. Therefore, this type of diagram CANNOT be used to determine whether or not the Dakota is connected to the WWC. These are the only types of cross sections that were reviewed by the NRC in this application.

Figure 2. A Stratigraphic Cross Section. Part 2 of 2 parts, drawn to illustrate the important differences between a stratigraphic and a structural cross section

*If top-of-borehole elevations were available, then a structural cross section could be drawn from this. Currently, HRI refuses to provide such information, making it impossible to evaluate whether or not aquifers are juxtaposed.

Michael Wallace, December, 1998

Exhibit F

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JAN - 8 1999

December 29, 1998

Johanna Matanich
New Mexico Environmental Law Center
1405 Luisa Street, Suite 5
Santa Fe, NM 87505

Re: In the Matter of Hydro Resources, Inc.:
ENDAUM's and SRIC's Requests for Documents

Dear Johanna:

On December 10, 1998, Intervenors Eastern Navajo Dine Against Uranium Mining ("ENDAUM") and Southwest Research and Information Center ("SRIC") (hereinafter, jointly, "Intervenors") brought a motion requesting that the Presiding Officer issue a subpoena requiring Hydro Resources, Inc. ("HRI") and the U.S. Nuclear Regulatory Commission ("NRC") Staff to provide Intervenors with specified documents or, in the alternative, to supplement the hearing record with the requested documents the "Motion"). Judge Bloch denied that Motion on December 16, 1998.

As set forth in the Motion, Intervenors were seeking three sets of documents:

1. Structural cross-sections *and* structural contour maps for each of the sites at which HRI proposes to mine pursuant to License No. SUA-1508;

2. Drillers' logs for each of the proposed 10 Crownpoint monitoring wells at the Crownpoint site, for each of the 12 proposed Church Rock monitoring wells, and for a representative sample (which ENDAUM and SRIC's expert will assist in selecting) of the 100 plus boreholes at the Unit One site; and

4. The surface elevations for each of the boreholes at each of the sites at which HRI proposes to mine.[1]

The information sought by Intervenors either is already in the hearing record, does not exist, or does not pertain to Churchrock. HRI reminds Intervenors that the Presiding Officer's September 22, 1998 Order limited the first phase of this hearing to matters pertaining to the Crownpoint Uranium Project generally or to Section 8 specifically. Accordingly, to the extent that Intervenors' requests concern site-specific information for sites other than Section 8 (each of the requests seek site-specific, non-Section 8 information), HRI will not address such requests.

[1] Intervenors' Motion at 2-3.

1. Structural cross-sections and structural contour maps: Structural cross sections have never been prepared for Section 8. Intervenors make an issue of the fact that Mr. Reed referenced structural cross sections in the Geraghty and Miller "Hydrodynamic Control" Report. Reed erred by referring to the cross sections as "structural" when in fact those were stratigraphic cross-sections. The cross sections described in the Geraghty and Miller report are the same cross sections labeled as Figures 2.6-6 through 2.6-10 of the Churchrock Revised Environmental Report, March 1993 (updated October 11, 1993). Structural contour maps have not been completed for the Churchrock site. Intervenors reference the February 4, 1997 letter from Mark Pelizza, HRI, to Jim Walker, U.S. EPA, as evidence that such contour maps exist. They ignore that the purpose of that letter was to address Unit 1, not Churchrock. No permit application has been submitted to EPA for Churchrock.

Intervenors state that they want the information that would be contained in structural cross-sections and contour maps to determine if fracturing is present and would facilitate vertical migration of fluids from the mine zone. As Intervenors are well aware,[2] pump tests are the most reliable tool for determining fracturing resulting in aquifer interconnection. Geological cross sectional analysis is potentially ambiguous and thus of limited value. Pump tests are the industry standard.

A pump test has been conducted across the Section 8 orebody. As stated above, Intervenors should depend on pump tests reports dated 12-1-88 in - Churchrock Project Revised Environmental Report, March 1993. Appendix E. The Churchrock pump test demonstrates that there is no leakage. The pump test results were presented at the New Mexico Environment Department Hearing; SRIC was a party to that hearing. Faulting was addressed in the FEIS at 3-18.

2. Drillers' logs for each of the proposed 10 Crownpoint monitoring wells at the Crownpoint site, for each of the 12 proposed Church Rock monitoring wells, and for a representative sample (which ENDAUM and SRIC's expert will assist selecting) of the 100 plus boreholes at the Unit One site.

Again, Intervenors ignore the bifurcation order by requesting data pertaining to portions of the CUP other than section 8. There exist only 8 monitoring wells at Churchrock, not 12. HRI has geophysical logs and lithology logs for these wells. HRI is not sure what Intervenors mean by "drillers'" logs. Geophysical logs are reproduced on the stratigraphic cross sections contained in the application. Specifically, geophysical logs of monitor wells CR1 through CR6, along with logs from select exploration holes, are duplicated on Figures 2.6-6 through 2.6-8 of the Churchrock Revised Environmental Report, March 1993. Full scale logs are provided in the Churchrock Environmental Report, 1988, Appendix, for monitor wells CR1 –CR6.

The logs identified above and the surface elevations described below give Intervenors what they need to generate structural cross sections.

---

[2] See Wallace Affidavit II at paragraph 20; Affidavit III, paragraph 11.

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4. The surface elevations for each of the boreholes at each of the sites at which HRI proposes to mine.

Location of surface elevations for the monitor wells CR1-CR8 have been provided in the Pump Test Report dated December 1, 1988 - Churchrock Project Revised Environmental Report, March 1993. Appendix E, Tables B.1 through B.7.

Although we have provided this information previously, I hope that this letter proves helpful.

Sincerely,

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202.663.8000

cc: Judge Peter B. Bloch
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Mitzi Young
Diane Curran, Esq.
Douglas Meiklejohn, Esq.
Roderick Ventura, Esq.
W. Paul Robinson
Chris Shuey
Mr. Richard Clement, Jr.
Mr. Mark Pelizza

Document #: 697315 v.1

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WASHINGTON DC
DEC 30 '98
0.32

Johanna Matanich
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87505-4011 26

Exhibit G

FROD. & UTIL. FAC. 40-8968-ML

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

DOCKETED
USNRC

February 27, 1998

'98 MAR -4 A10:47

MEMORANDUM TO: B. Paul Cotter, Presiding Officer
Atomic Safety and Licensing Board

FROM: Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SERVED MAR - 4 1998

SUBJECT: NEW INFORMATION POTENTIALLY RELEVANT AND MATERIAL TO THE PROCEEDING IN THE MATTER OF HYDRO RESOURCES, INC. (ASLBP NO. 95-706-01-ML)

Pursuant to Commission Policy on Notification to Licensing Boards of new relevant and material information, the attached document is considered potentially relevant and material to the Hydro Resources, Inc. (HRI) proceeding, and is forwarded herewith. This information consists of a set of slides developed by Professor Shlomo P. Neuman, Department of Hydrology and Water Resources, University of Arizona. Professor Neuman` is the Principal Investigator on a Nuclear Regulatory Commission, Office of Nuclear Regulatory Research (RES) funded research project entitled "Evaluating and Testing Conceptual Ground-Water Flow and Transport Models." In that role, Professor Neuman made an oral presentation to the NRC staff on January 29, 1998, (this was not a public meeting, but rather an internal working meeting with the NRC staff). His presentation focused on his new generic research project dealing with evaluation and testing of conceptual ground-water flow and transport models. The purpose of Professor Neuman's RES-funded research is to develop a methodology which will have broad application to many radioactive waste problems. Prior to his presentation, Professor Neuman requested that general information be provided to him as background material to acquaint him with NRC issues related to his research focus, and to familiarize him with uranium in situ leach mining. A copy of NUREG-1508, "Final Environmental Impact Statement for the Crownpoint In Situ Leach Mining Project," (FEIS) was provided to him.

Professor Neuman prepared a series of talking points in the form of view graphs to discuss his initial research strategies and to facilitate interaction with the NRC staff. The attached package is from the background material that he used during the meeting. These particular view graphs were neither shown nor discussed in the meeting. In particular, the detailed information and conclusion on the last page of the package was not presented or discussed with the staff. The Office of Nuclear Material Safety and Safeguards/Division of Waste Management (NMSS/DWM) staff working on the Crownpoint Project were provided copies of the view

CONTACT: Robert Carlson, NMSS/DWM
(301) 415-8165

graphs, but have not discussed Professor Neuman's observations and conclusion with him. Professor Neuman was not requested to formally review or comment on the FEIS, as this was outside the scope of his original work. His presentation discussed research strategies in the context of NRC licensing applications, using the limited, publicly available information provided to him on site decommissioning management plan reviews and in situ leach uranium mining, and his extensive expertise in high-level radioactive waste.

The information in the attached slides is considered potentially relevant and material to the subject proceeding because they provide Dr. Neuman's view on the FEIS regarding the HRI license application. Many of the questions raised in Professor Neuman's slides were also raised by the petitioners in their petitions for leave to intervene. Essentially, the staff's understanding of the slides is that Professor Neuman believes that the FEIS needed to consider a number of other factors related to the pumping test used to determine the confinement of the mining aquifer. The areas where Professor Neuman discussed that additional information on pumping tests needed to be considered in the FEIS are given on the last page of his slides. In addition, Professor Neuman concludes that the conceptual framework of the FEIS is indefensible.

Because the NMSS/DWM staff was unable to attend Professor Neuman's briefing, he did not present the information in the attachment. Instead, the slides were given to the NMSS/DWM staff as information copies only. The staff has done an evaluation of the information, and is able to provide an assessment of it based solely on the content of the slides. If the staff had received a presentation of this work, it may have had better insight into what Professor Neuman meant, and could provide the best possible analysis of the slides. Based on its review of just the information presented in Professor Neuman's slides, the staff is in general agreement with the broad, individual points raised. However, the staff considers that Professor Neuman did not have a complete understanding of all information evaluated by the staff to determine the specific acceptability of HRI's application, since his review was limited to only the FEIS. Information not considered by Professor Neuman included: 1) the application filed by HRI containing extensive data used as the basis for the staff's review; 2) results from other licensing reviews conducted by staff and Agreement States; 3) experience from operating in situ leach facilities at other licensed sites; and 4) other data such as geologic borings used to determine the stratification of the mining units.

As mentioned above, although the staff agrees with the general points in Professor Neuman's summary slide that appear to fault pump tests that were used to demonstrate non-hydraulic interconnection between the Dakota Sandstone and Westwater Canyon aquifers at the Crownpoint site, the staff does not agree with Professor Neuman's overall conclusion that the FEIS is seriously technically flawed and indefensible. This is based in part on his lack of background information as enumerated above, and the fact that pumping tests conducted at the Crownpoint site were not used by the staff to make its conclusion on vertical confinement as summarized in the FEIS. Instead, the staff based its decision on the following information (See FEIS Section 4.3.1.1, pages 4-42 and 4-43):

(1) The large thickness of the confining unit between the Westwater Canyon aquifer and the overlying Dakota Sandstone Aquifer;

(2) The significant differences in water levels between the Dakota Sandstone aquifer and the Westwater Canyon aquifer, indicating the two aquifers are not interconnected;
(3) The possession of borehole sealing records by HRI, which increases the confidence that the holes were sealed correctly and should not leak during ISL mining activities;
(4) The observation that the Crownpoint mine shafts are lined with steel and grouted to the surface and so that they do not present an avenue for the vertical movement of groundwater;
(5) The lack of significant displacement in the Westwater sands indicating that there is little potential for faults to act as vertical pathways;
(6) and the commitments by the applicant to: (a) perform groundwater pump tests to determine if overlying confining units are adequate confining layers prior to injection of lixiviant in a well field; (b) monitor overlying aquifers; and (c) conduct well integrity tests.

The staff recognizes Professor Neuman's experience and contributions to the advancement of ground-water science and does not dispute his credentials. However, the staff is not clear on the specific basis Professor Neuman used to reach the conclusion of FEIS indefensibility presented in the slides, given the staff's understanding that other pertinent information was not reviewed by Professor Neuman. Therefore, the staff plans to discuss Professor Neuman's concerns with him to gain a better understanding of his issues, and to ensure he has the full breadth of information that the staff had to arrive at its conclusion.

Docket Number 40-8968-ML

Attachment: As stated

ATTACHMENT

"Hydrogeologic Conceptualization for Environmental Safety Assessment: Case Studies and Steps Toward a Strategy"

Speaker: Professor Shlomo P. Neuman
Department of Hydrology & Water Resources
The University of Arizona

Time: 10:30 a.m. - 3:00 p.m, January 29, 1998

Room: T8-A1

Abstract:

Conceptual/mathematical hydrogeologic models of subsurface flow and transport are introduced and analyzed through case studies of: a decommissioning site in Ohio; a uranium solution mining project in New Mexico; the unsaturated and saturated zones surrounding potential high-level nuclear waste repositories such as the Whiteshell research area in Manitoba, Canada. These cases illustrate the complexity of hydrogeologic conceptualization, its numerous pitfalls and potential to constitute a major source of uncertainty in assessing the expected safety performance of such sites. These cases also demonstrate the need for a well-articulated and defined strategy that one could follow in developing and evaluating conceptual/mathematical flow and transport models in the context of performance assessment. Some key elements of such a strategy are outlined in a preliminary fashion with emphasis on the postulation of alternative conceptual models, the testing of such models and the process of discriminating among them. The latter are illustrated qualitatively and quantitatively via case studies concerning: the large apparent hydraulic gradient at a potential high-level waste repository site; interaction between fractures and matrix during unsaturated flow and transport at that site; type-curve interpretation and geostatistical analysis of single- and cross-hole air-permeabilities at the Apache Leap Research Site in Arizona; inverse modeling of pumping tests in fractured crystalline rock at Chalk River in Ontario, Canada; and inverse modeling of ground-water flow in the semiarid evaporitic basin of Los Monegros, Spain. Additional relevant examples can be found, among others, in reports of the INTRAVAL Project.

Contact: T. Nicholson, WMB/DRA/RES at (301) 415-6268 if you have any questions.

NUREG-1508
BLM NM-010-93-02
BIA EIS-92-001

Final
Environmental Impact Statement
to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico

Docket No. 40-8968
Hydro Resources, Inc.

Manuscript Completed: February 1997
Date Published: February 1997

Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

in Cooperation With

Albuquerque District
U.S. Bureau of Land Management
Albuquerque, New Mexico 87107

Navajo Area Office
U.S. Bureau of Indian Affairs
Gallup, New Mexico 83701

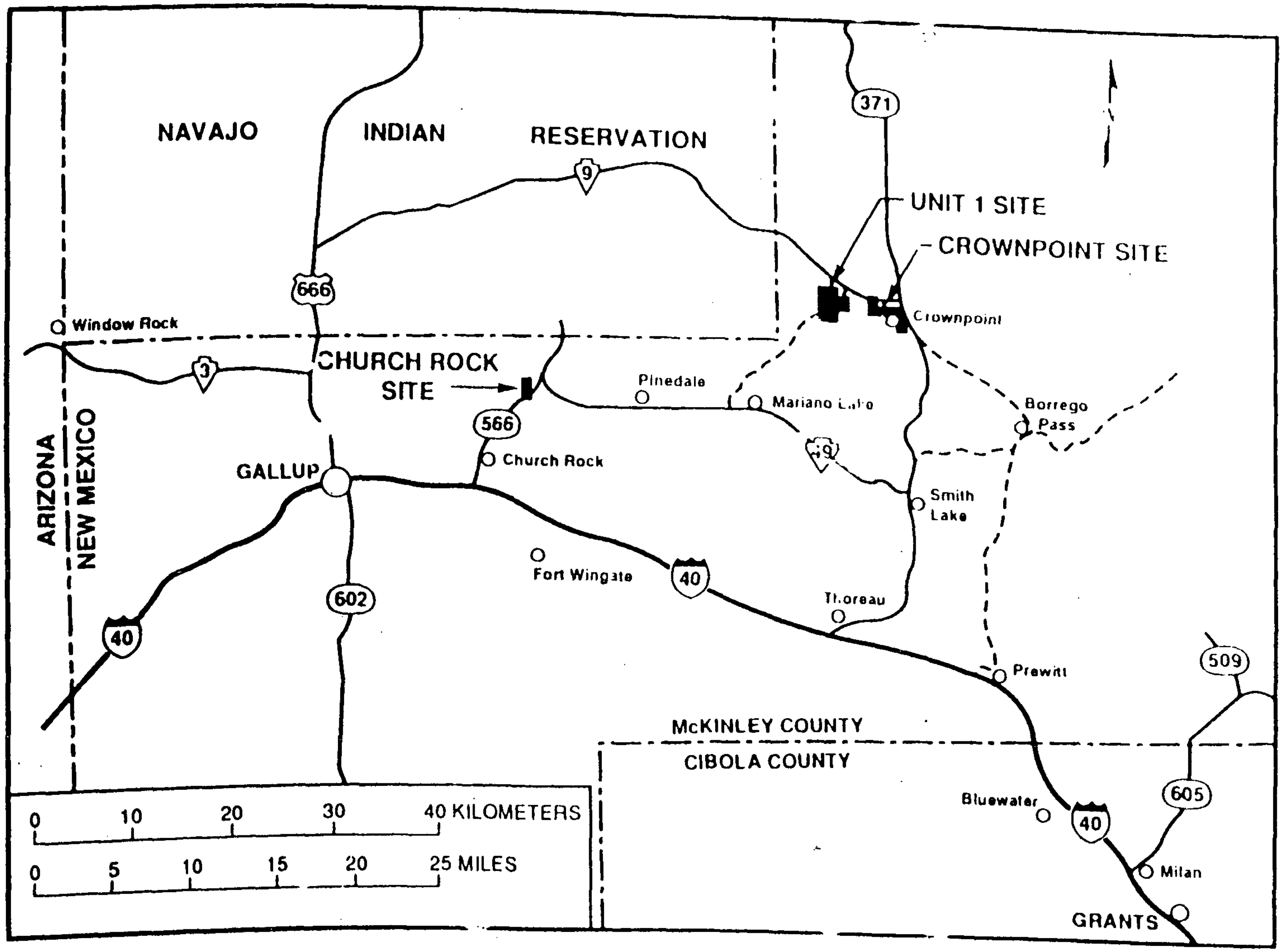

Figure 1.1. Regional index map of west-central New Mexico and the project site locations.

- Proposal by Hydro Resources, Inc. (HRI) to conduct in-situ leach (ISL) uranium mining in Westwater Canyon aquifer.
- Aquifer restoration via sweep (pumping with treatment) and permeate injection, balanced so as to maintain flow toward mining center.
- If evaporation pond capacity is exceeded consider surface application/discharge or deep injection into Abo/Yeso, TDS > 10,000 mg/L.
- Wells to be plugged/abandoned, facilities decontaminated/decommissioned, solid waste removed to licensed disposal facility, site restored and released for unrestricted use.
- FEIS evaluates 4 alternatives: as proposed; alternative combinations of sites and/or liquid waste disposal methods; as proposed with additional mitigation measures; no action.
- The NRC staff concludes that potential significant impacts of proposed project can be mitigated and recommends licensing subject to specified requirements/recommendations.

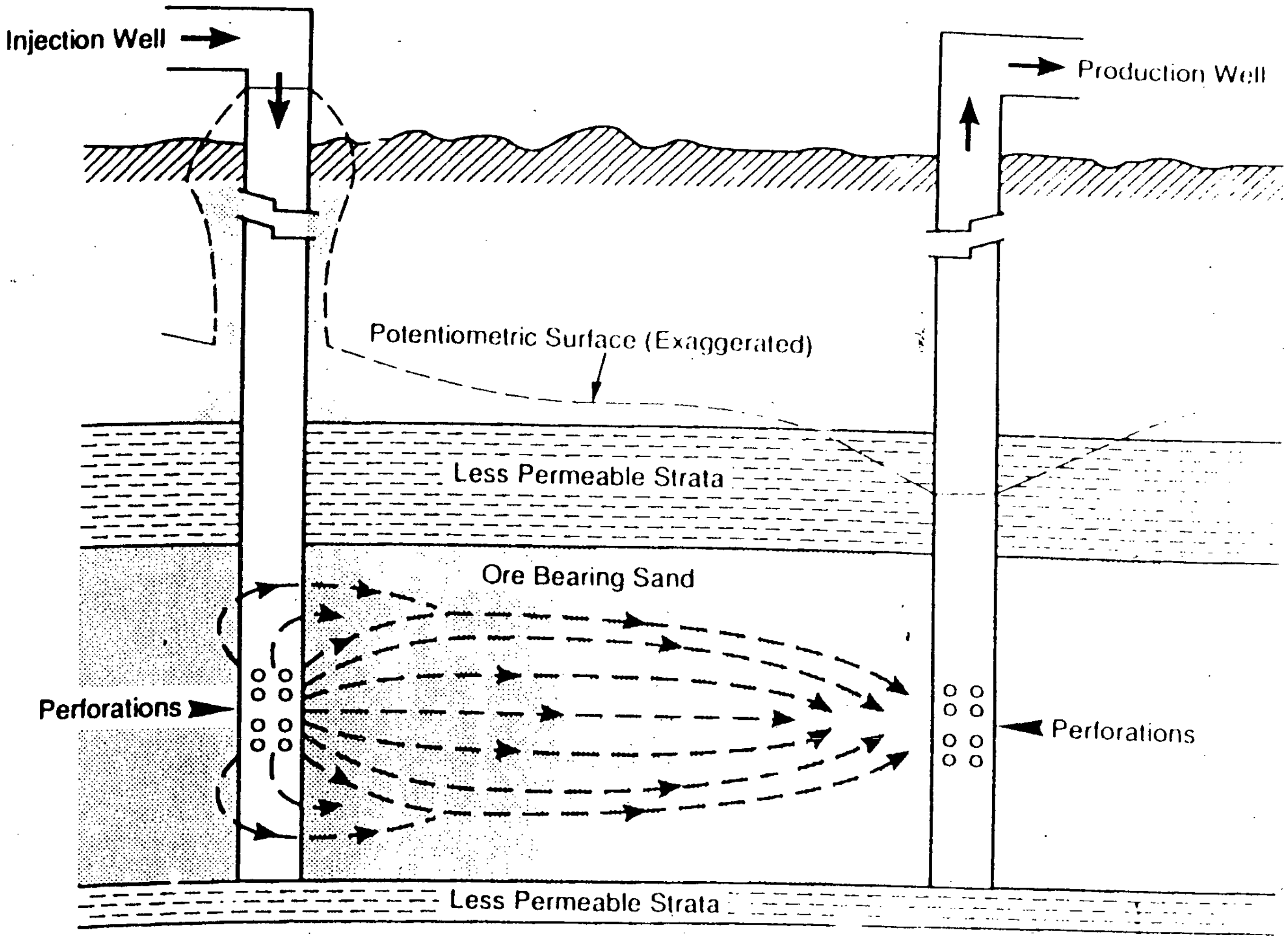

Figure 2.4. Schematic cross-section illustrating ore-zone geology and lixiviant migration from an injection well to a production well.

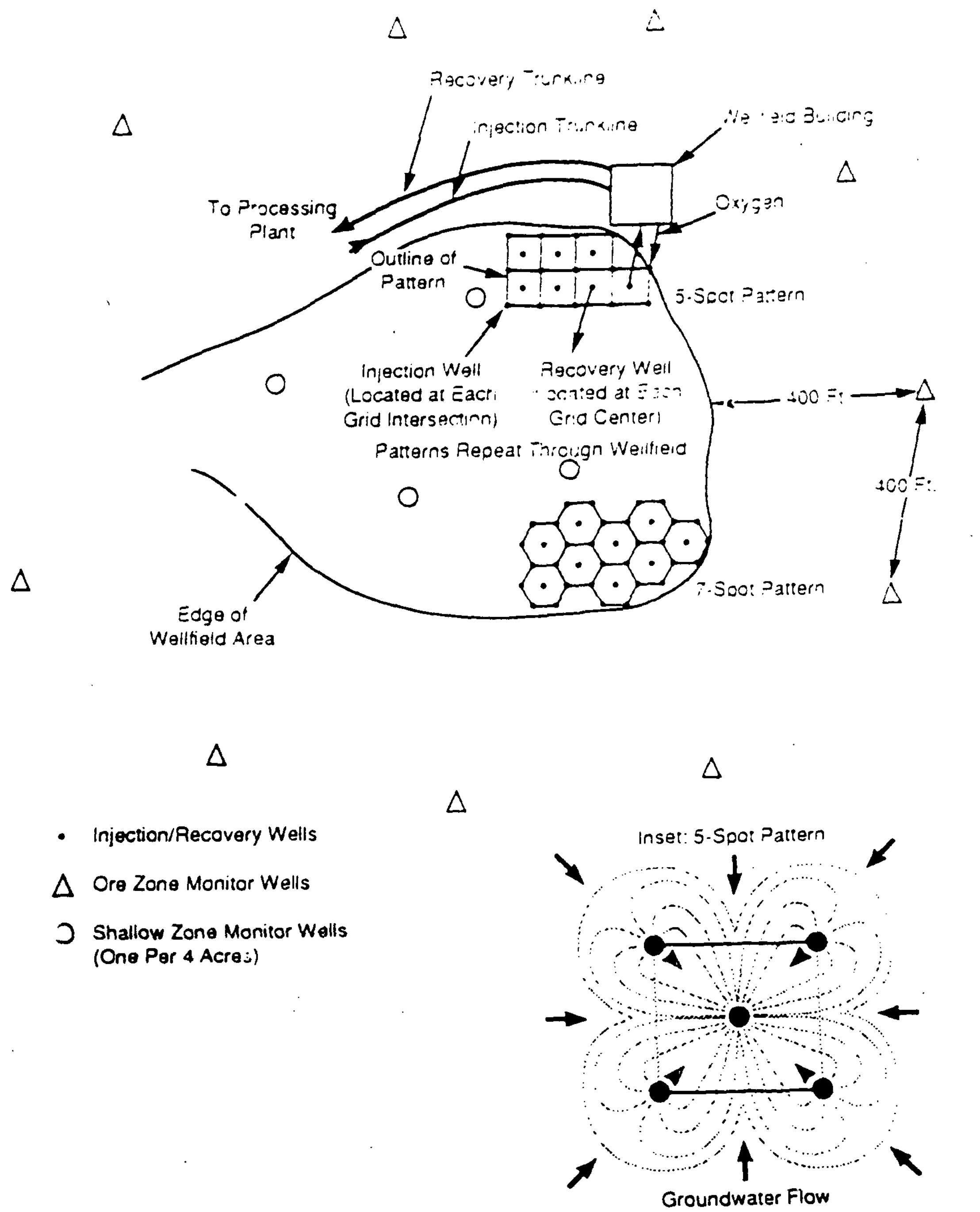

Figure 2.1. Schematic diagram of a well field showing injection/production well patterns, monitor wells, manifold building, and pipelines.

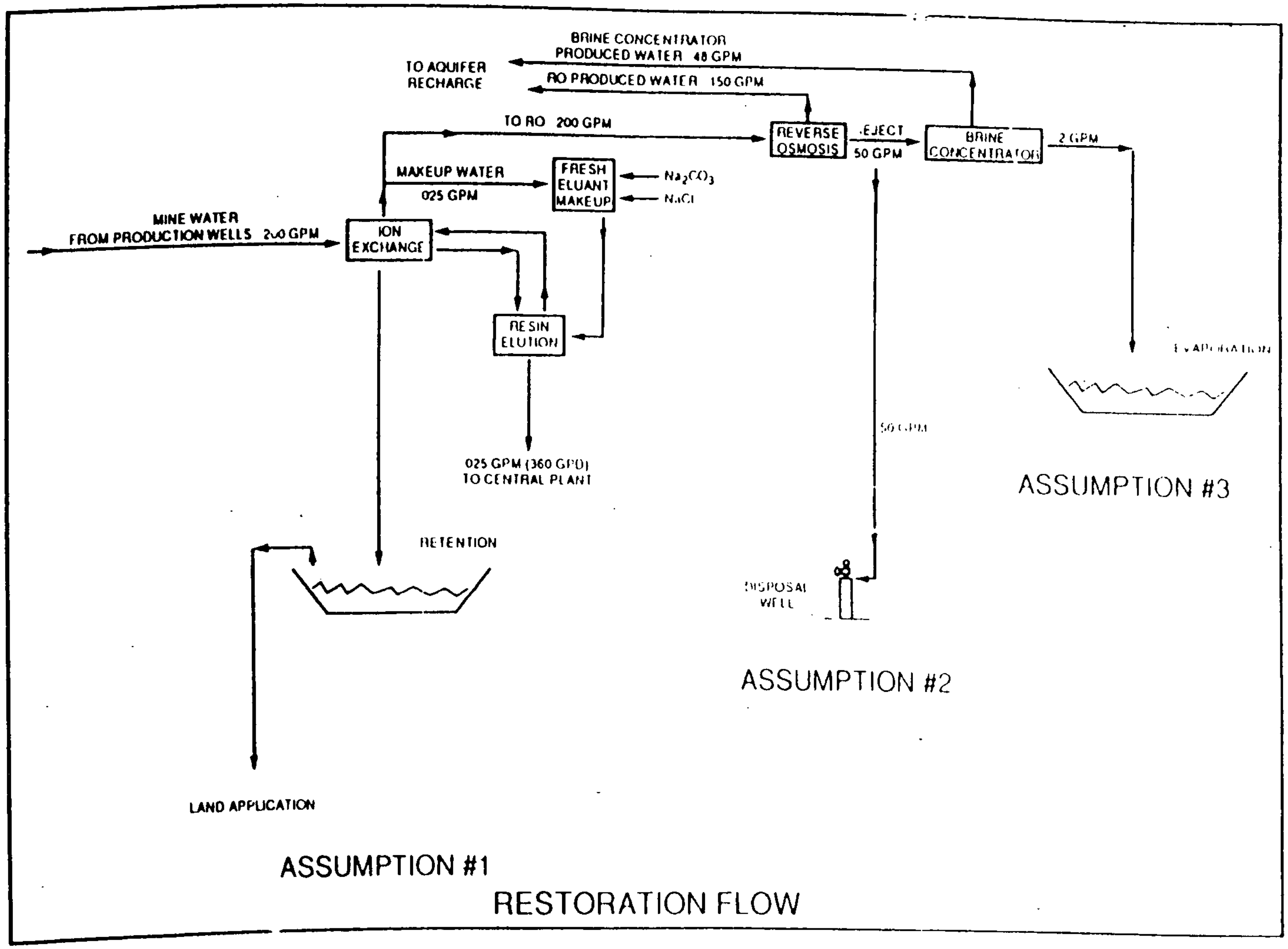

Figure 2.7. Schematic flow diagram and approximate flow rates of restoration wastewater treatment systems.

Geology/Hydrogeology

- Westwater Canyon is high-quality regional artesian aquifer of interbedded sandstone, claystone, mudstone.
- Uranium as carbonaceous pore filling/coating in sandstone units; ore bodies several hundred to a thousand feet long parallel to strike.
- At Unit 1 & Crownpoint, Westwater Canyon is 72 - 105 m thick at depth 560 m (at Church Rock its depth is 140 - 230 m); total length of ore bodies exceeds 8 km, width 290 - 760 m.
- It is overlain at by Brushy Basin Member (locally 20 - 35 m of shale or claystone interbedded with sandstone lenses) and underlain by Recapture Member (75 - 80 m).
- Extensive mine workings at Church Rock; believed not to extend beyond boundaries of proposed solution mining area.
- Heads in overlying Dakota Sandstone aquifer are higher than in Westwater Canyon.
- Local faults have minor offsets.

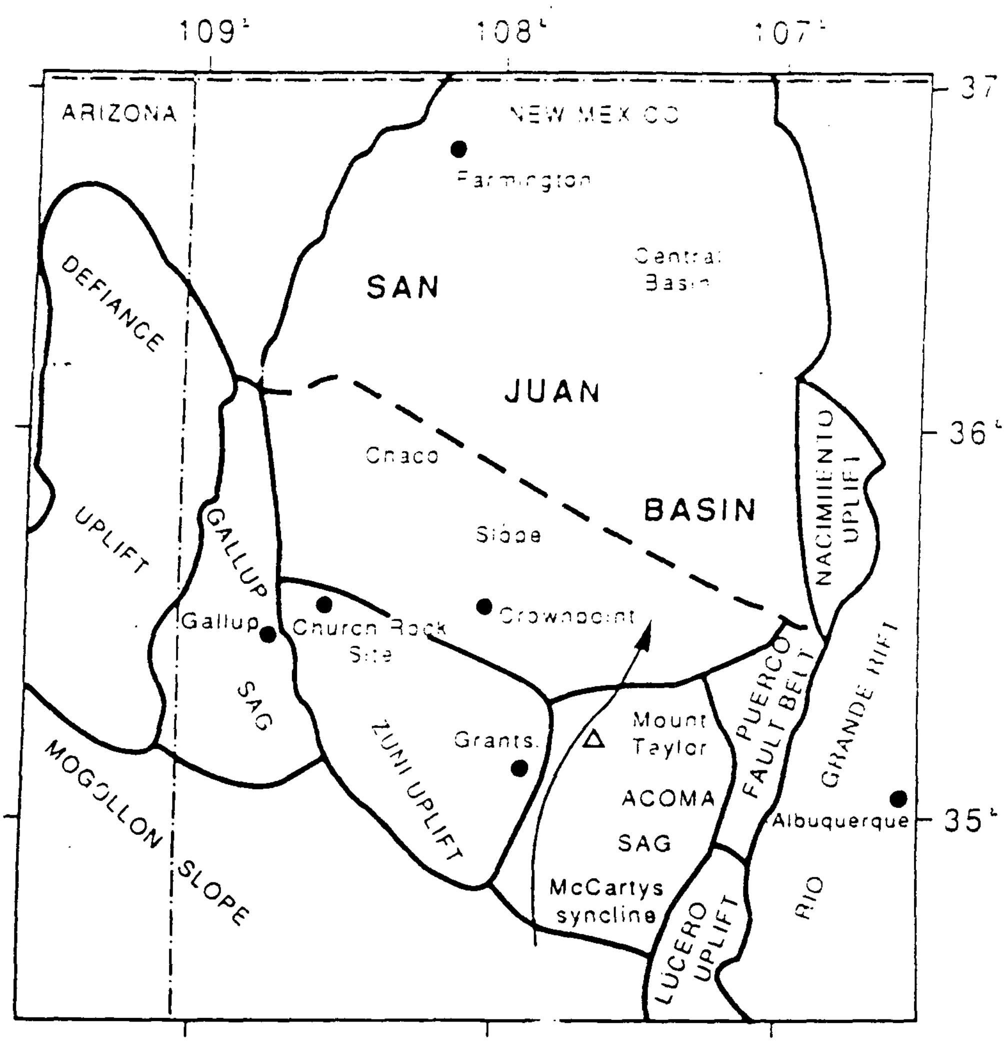

Figure 3.2. Structural setting of the San Juan Basin. *Source*: Kelley 1963; Kelley and Clinton 1960.

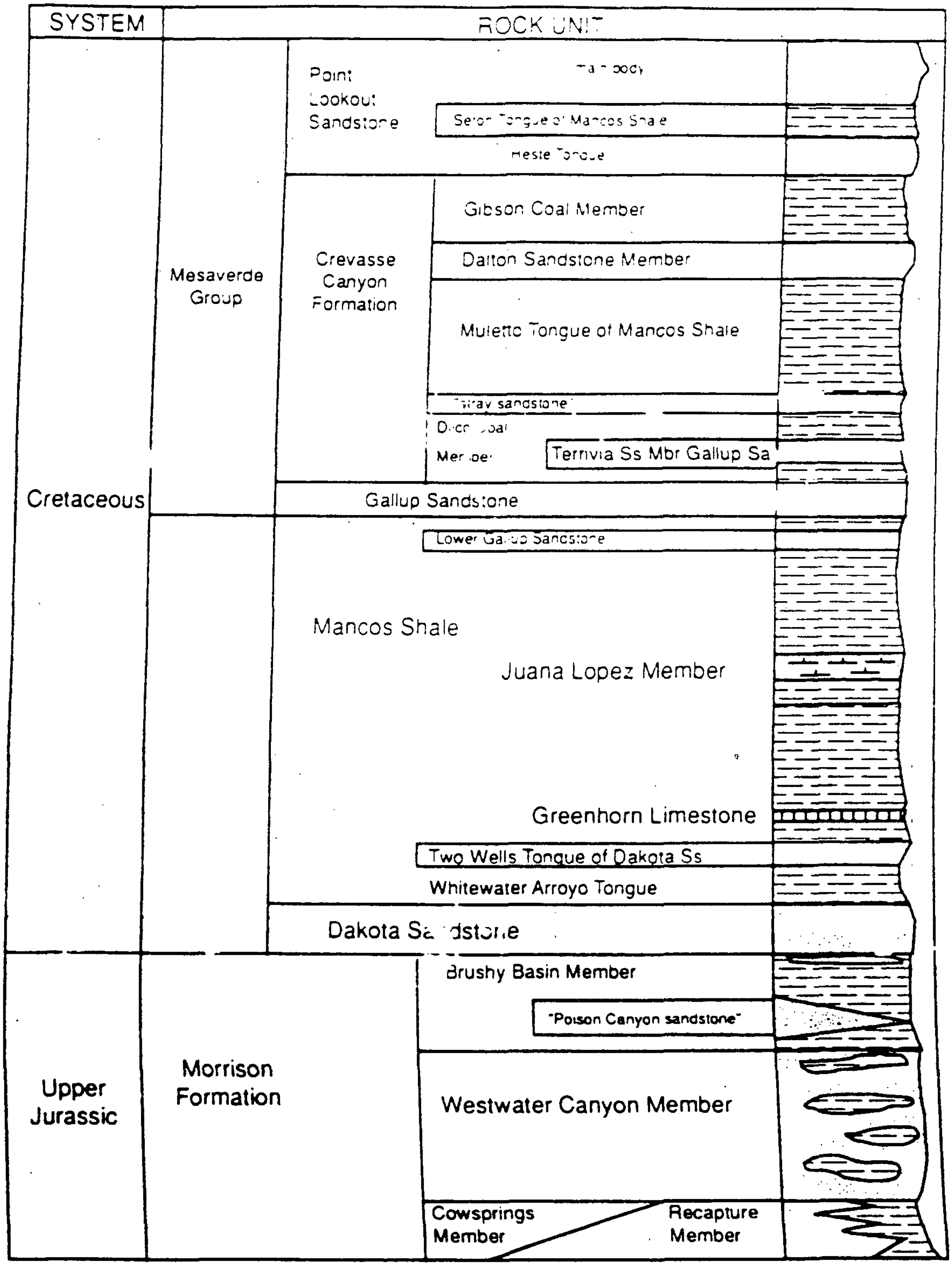

Figure 3.5. Stratigraphic column of the Unit 1 and Crownpoint sites.

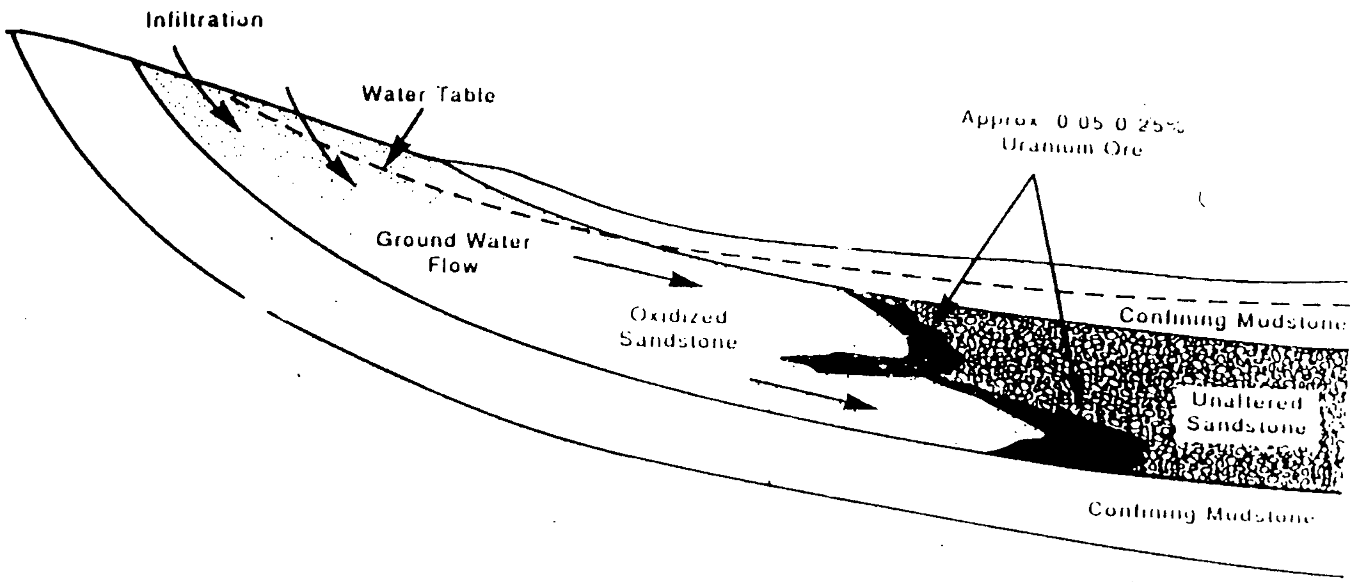

Figure 3.4. Simplified cross-section of roll-front uranium deposits formed by regional groundwater migration.

Potential for Contaminant Excursions

- Monitoring to detect excursions long before mining solutions seriously degrade ground-water quality outside well field area.
- Horizontal excursions easy to detect/ control.
- Contamination due to **vertical excursions** takes much **longer to detect/correct**.
- **Vertical excursion into Dakota** Sandstone or Cow Springs aquifers could **contaminate Crownpoint water supply**. **Monitoring** will be done in **aquifers above and below** mine zone; not in Cow Spring (poor producer; drilling enhances possibility of excursion).
- NRC staff consider that **upper monitor wells may not detect excursion** if strong gradient.
- They therefore propose to rely on pre-mining **pump tests to confirm aquifer confinement**.
- They associate **vertical pathways** with thin or missing confining units; open faults, fractures, boreholes; broken casings; high injection pressures that fracture confining units; but **primarily** with **inadvertent leakage** from **installed wells**.

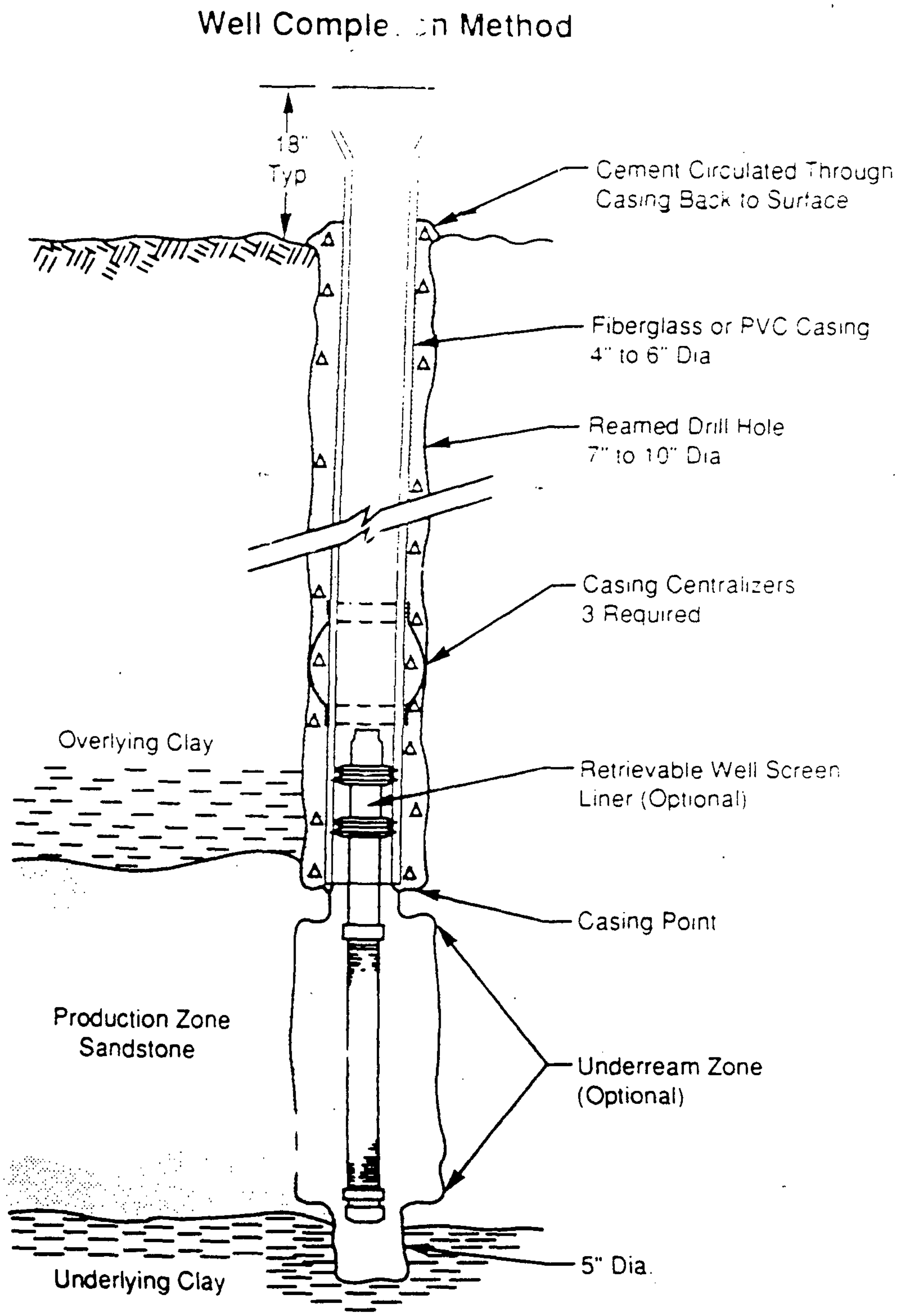

Figure 2.2. Cross-section of a typical injection, production, or monitor well completed using the underreamed method.

- **Wells in Dakota** and intervening **Brushy Basin B** sand aquifers **did not respond** to **3-day pumping tests** of underlying Westwater Canyon; NRC staff concluded that **Westwater Canyoon** is **not hydraulically connected to** either of the **overlying aquifers** in the area.
- Based on this, geology, borehole sealing and integrity testing programs, the staff considers the **risk of vertical excursion** to be **low**.

Modeling of ambient and operational flows in the Westwater Canyon was conducted by HRI. Though details are not given, it appears that the unit was considered to be hydraulically **uniform**, **isotropic** and **perfectly confined**.

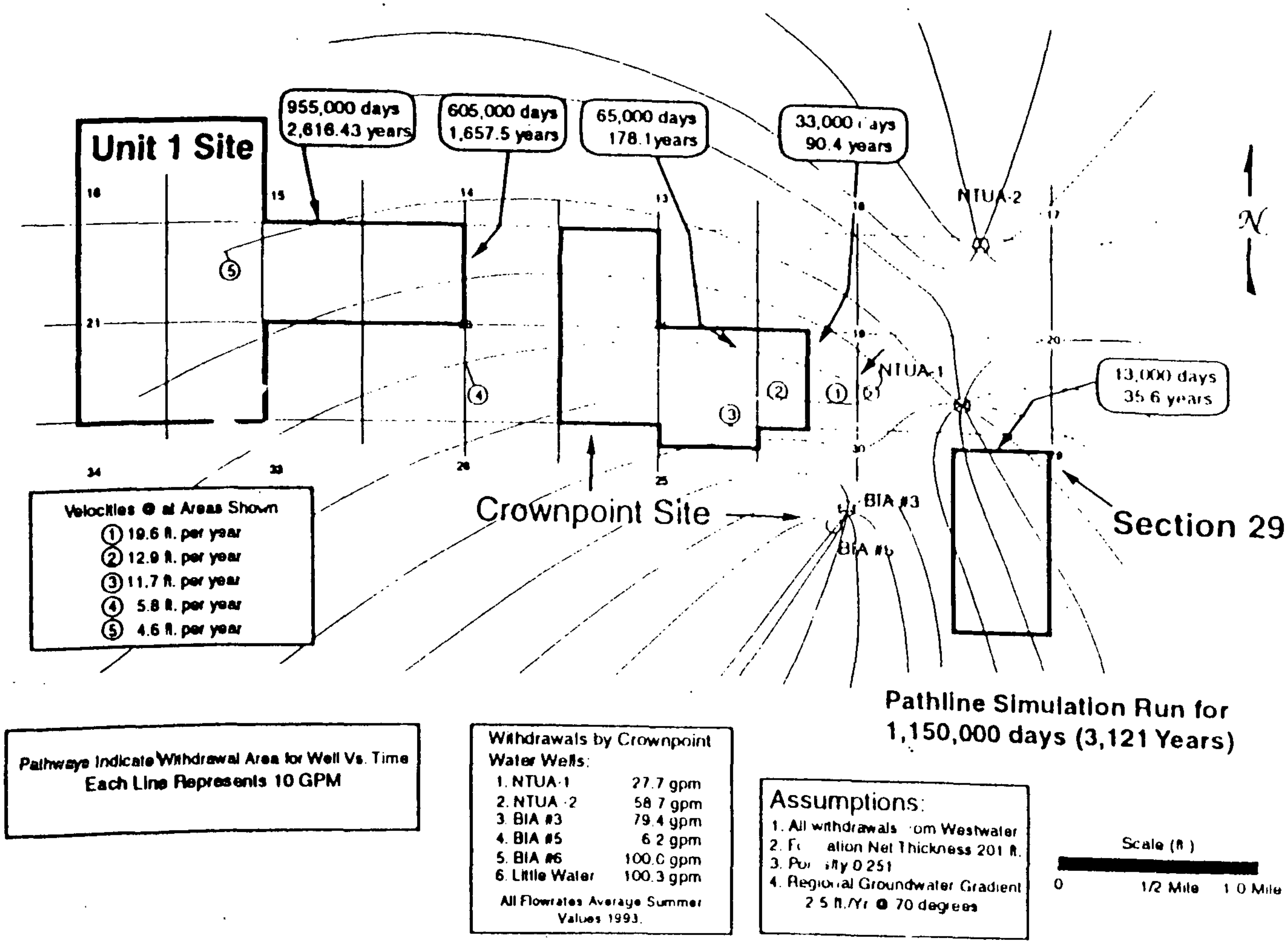

Figure 3.10. Modeled groundwater flow pathways for the Unit 1 and Crownpoint sites.

The above **fails to consider**

- The **multiaquifer theory** (*WRR* 5(4), 1969) and **large-scale long-term field experiment** (*WRR* 8(5), 1972) of **Neuman and Witherspoon** which **demonstrate** that
- During a standard pumping test, **drawdowns in overlying/underlying aquifers** take **weeks** or **months** to **develop** and are **hard to detect** due to ubiquitous background noise;
- **Drawdowns in pumped aquifer**, especially within/near pumping well, are often **not sufficient** to **detect leakage** or **establish hydraulic properties** of **confining units**;
- To do so unambiguously may necessitate installing **monitoring wells in confining units** and interpreting drawdowns using the **ratio method of Neuman and Witherspoon.**
- **Injection at high pressures** may cause **major leakage without** creating hydraulic **fractures.**

Hence hydrogeologic **Conceptual Framework** behind the FEIS is **flawed (neither realistic nor conservative)** and therefore **indefensible**.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of

HYDRO RESOURCES, INC.

Docket No.(s) 40-8968-ML

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing MEMO HOLONICH TO COTTER have been served upon the following persons by U.S. mail, first class, except as otherwise noted and in accordance with the requirements of 10 CFR Sec. 2.712.

Office of Commission Appellate
Adjudication
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Administrative Judge
B. Paul Cotter, Jr.
Presiding Officer
Atomic Safety and Licensing Board Panel
Mail Stop - T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Administrative Judge
Thomas D. Murphy
Special Assistant
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John T. Hull, Esq.
Mitzi A. Young, Esq.
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Attorney for Hydro Resources, Inc.
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Mervyn Tilden
Mary Lou Jones
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Docket No.(s)40-8968-ML
MEMO HOLONICH TO COTTER

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Mervyn Tilden
P.O. Box 457
Church Rock, NM 87311

Grace Sam
Marilyn Sam
P.O. Box 800
Gallup, NM 87305

Dated at Rockville, Md. this
4 day of March 1998

Adria T. Byrdsong
Office of the Secretary of the Commission

Exhibit H

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 20, 1998

MEMORANDUM TO: Peter B. Bloch, Presiding Officer
Atomic Safety and Licensing Board

FROM: Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: SUPPLEMENT TO FEBRUARY 27, 1998, NOTIFICATION OF NEW INFORMATION POTENTIALLY RELEVANT AND MATERIAL TO THE PROCEEDING IN THE MATTER OF HYDRO RESOURCES, INC. (ASLBP NUMBER 95-706-01-ML): MARCH 19, 1998, TELECONFERENCE WITH PROFESSOR NEUMAN

Pursuant to Commission policy on notifying Licensing Boards of new information that is potentially relevant and material to an ongoing proceeding, the U.S. Nuclear Regulatory Commission (NRC) staff provides this supplemental notification and assessment of the subject information.

On March 19, 1998, the NRC staff held a teleconference with Professor Shlomo Neuman of the Department of Hydrology and Water Resources at the University of Arizona, who is also an NRC consultant. As previously indicated in the February 27, 1998, Board Notification, and in the letter to Susan Jordan dated March 18, 1998, this teleconference was made to gain a better understanding of Professor Neuman's views on NUREG-1508, and to ensure he had the full breadth of information that the staff used to arrive at the conclusions stated therein.

Consistent with the Final Policy Statement on Meetings Open to the Public, 59 FR 48340 (September 20, 1994), the teleconference was not open to the public. The teleconference was attended by the following NRC personnel:

Ralph Cady	Office of Nuclear Regulatory Research (RES)
Robert Carlson	Office of Nuclear Material Safety and Safeguards (NMSS)
William Ford	NMSS
Dan Gillen	NMSS
Joe Holonich	NMSS
John Hull	Office of the General Counsel
Mike Layton	NMSS
Tom Nicholson	RES

In the teleconference, Professor Neuman stated that his opinions about NUREG-1508 for the Crownpoint *in situ* leach (ISL) mining project were shaped by his review of: (1) NUREG-1508; (2) the Draft Standard Review Plan for *In Situ* Leach Uranium Extraction License Applications

(Published October 1997, NUREG-1569); and (3) other generally relevant hydrologic literature. Regarding the bases for the staff's conclusion that the potential for vertical excursions to occur in the Dakota Sandstone aquifer is low at the Crownpoint site (*see* NUREG-1508, at 4-42 and 4-43), Professor Neuman stated that he did not dispute the staff's findings, with one exception: the significant difference in water levels between the Dakota Sandstone aquifer and the Westwater Canyon aquifer does not indicate a lack of connection between these two aquifers.

Professor Neuman's opinion is based on his conceptual model of groundwater, where in his view, it is appropriate to consider all geologic materials as having some permeability to ground water -- no matter how small. Therefore, given enough time, water will move through any geologic material, hence making it appropriate to view all aquifers as being in hydrologic communication. This conceptual view was Professor Neuman's basis for the conclusions presented in his slides. However, Professor Neuman did not indicate it was his opinion that the staff's conclusions were wrong regarding the potential for vertical excursions to occur at the site. Furthermore, he did not specifically identify anything in NUREG-1508 that he believed would disqualify the site from ISL mining. Instead, he was concerned the staff had assumed the aquifers beneath the proposed sites are not hydraulically connected, and that NUREG-1508 does not contain a compelling argument showing the geologic materials of the Brushy Basin Shale will adequately prevent vertical excursions.

Professor Neuman could not find where the rate of water movement through the Brushy Basin Shale was described in NUREG-1508. He is concerned that during solution mining, lixiviant could slowly move through the Brushy Basin Shale and cause a vertical excursion into the overlying Dakota Sandstone aquifer. Professor Neuman opines that if monitor wells were located in the Brushy Basin Shale, they would be well situated to identify the vertical movement of lixiviant before it could reach the Dakota Sandstone aquifer during an excursion. He also observed that sandstone layers interbedded within the shales and siltstones of the Brushy Basin Shale would be excellent locations for vertical monitor wells. In conclusion, Professor Neuman stated it was his "gut feeling" that the proposed ISL operation was safe; however, in his opinion, NUREG-1508 does not adequately demonstrate a complete technical understanding by the staff of vertical hydraulic communication.

The NRC staff agrees with Professor Neuman's observation that the geologic materials of the Brushy Basin Shale contain measurable permeabilities. At the Unit 1 and Crownpoint sites, the Brushy Basin Shale is predominantly composed of siltstone, mudstone, and shale layers with discontinuous, comparatively thin beds of sandstone. The siltstone, mudstone, and shale layers have low permeability levels, and water movement through this medium is considered extremely slow when compared to the much more permeable sandstone beds of the Dakota and Westwater Canyon aquifers. Moreover, the permeability of the siltstone, mudstone, and shale beds is so low that it does not require a great thickness of this material to prevent the movement of lixiviant between aquifers over the relatively short period of time (3-4 years) that ISL mining takes place in a well field. Some solution mines routinely mine in sandstone aquifers that are overlain by 25 to 30 feet of siltstone and shale without causing vertical excursions from lixiviant movement through the confining unit. At the Crownpoint property, the Brushy Basin Shale appears to range in thickness from 100 to 250 feet, while at the Unit 1 site, the thickness appears to be on the order of 250 to 300 feet. At the Church Rock site, there is

16 to 32 feet of mudstone between the Westwater Canyon Aquifer and the first overlying aquifer (Brushy Basin "B" Sand).

During the teleconference, it became apparent that confusion existed over what the NRC staff meant by the word "interconnected" when referring to the stratigraphy of the Brushy Basin Shale. As used in NUREG-1508, the term "interconnected" means that siltstone, mudstone, and shale layers are absent or extremely thin, such that for all practical purposes, the Dakota and Westwater Canyon aquifers are connected by sandstone beds. This term was used in recognition of the practical considerations concerning the very low permeabilities of the siltstones, mudstones, and shales, and the short period of mining relative to the extremely low rate of water movement through these geologic materials. Historically, almost all vertical excursions at ISL mining operations have been caused by faulty well completions or unsealed exploration boreholes. The staff is aware of only one ISL site (Irigaray, Wyoming) where vertical excursions may have been caused by stratigraphic interconnections. In this instance, the licensee tried to prevent lixiviant from moving across a confining unit of one to 3 feet in total thickness. However, even in this case, it could not be established that the failure of the confining unit was the cause of the excursion. This was because open exploration boreholes and badly constructed injection wells were also found to be contributing to the excursion.

To quickly detect excursions, vertical monitor wells are placed inside the well fields so they will be near the injection wells which could be the cause of vertical excursions. If monitor wells were placed within the siltstones, mudstones, and shales of the confining units, there is a high probability that vertical excursions caused by open exploration holes, faults, or fractures would go undetected because the permeability of these materials is so low. Similarly, if monitor wells are placed in the comparatively thin sandstone layers within the confining unit, the discontinuous nature and low rate of ground-water movement within these layers means that there is an increased probability vertical excursions would go undetected. In addition, the completion of monitor wells into the siltstones, mudstones, shales, and thin sandstone layers of the confining unit would make it very difficult, if not impossible, to obtain good water-quality samples. This is because wells completed in this medium would have very low production rates.

The identification of excursions through geochemical means may also be more difficult if monitor wells are placed in the confining units. This is because the water quality of the interbedded sands, siltstones, mudstones, and shales will probably contain much poorer water quality than either the Westwater Canyon or Dakota Sandstone aquifers. Therefore, this might make it difficult to derive effective upper control limits. Also, the large clay content of siltstones, mudstones, and shales, and the increased clay content of thin bedded sands could significantly retard, if not for all practical purposes stop, the movement of many of the dissolved chemical constituents in the lixiviant. Again, this would increase the difficulty of identifying excursions.

Injection and production wells are cased and cemented through the confining unit. However, in order to obtain water quality samples, the completion of monitor wells within the confining unit would require the creation of open, uncemented voids over several feet within the confining unit. Placement of such wells would have to be accomplished with special care so that the confining unit is not compromised. For the foregoing reasons, the NRC staff does not require or recommend that monitor wells be placed in confining units to monitor for vertical excursions.

It is important to note that in NUREG-1508, the staff did not assume vertical excursions cannot occur at the Crownpoint site. Instead, at 4-17, the NUREG contains a description of the causes of vertical excursions. Additionally, at 4-40 to 4-58, for each of the three sites, a description of the relative potential for vertical excursions to occur as the result of each cause is provided. The NUREG concludes that given the tests to be conducted prior to lixiviant injection in each well field, the potential for vertical excursions to occur is considered low. However, the NUREG further states that should a vertical excursion occur, it would be detected by the overlying monitor wells and the licensee would be required to (1) stop the excursion, and (2) restore the water quality in the upper aquifer.

During the licensing of an ISL uranium mine, not all of the detailed information required to fully describe a project is available at the time of licensing. As well fields are developed, final well locations are adjusted as additional data from previously drilled wells is obtained. Therefore, prior to licensing, only enough well field information is required to adequately describe the environmental impacts and make a decision concerning the safety of the proposed activities. Given the license requirements and commitments made by Hydro Resources, Inc. (HRI) to mitigate environmental impacts as documented in its license and application, the staff determined that HRI had submitted enough well field information to satisfy the aforementioned objectives.

In summary, the staff agrees with Professor Neuman's observation that the geologic materials of the Brushy Basin Shale possess some measurable level of permeability. However, the staff believes that the Brushy Basin Shale contains more than adequate thickness of siltstones, mudstones, and shale beds to prevent the movement of lixiviant between aquifers over the relatively short period of time (3-4 years) that mining takes place in a well field.

Docket Number 40-8968-ML

cc: Service List
Prof. Shlomo Neuman, Univ. of Arizona

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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

CERTIFICATE OF SERVICE

I hereby certify that copies of MEMO FROM J. HOLONICH TO PETER B. BLOCH RE: SUPPLEMENT TO FEBRUARY 27, 1998, NOTIFICATION OF... have been served on the following by deposit with Federal Express as indicated by triple asterisk; by deposit in the United States Mail, express mail by double asterisk; or as indicated by a single asterisk through deposit in the Nuclear Regulatory Commission's internal mail system, in accordance with the requirements of10 CFR Sec. 2.712.

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Dated at Rockville, MD, this
20th day of April 1998

Betty Barrett

Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
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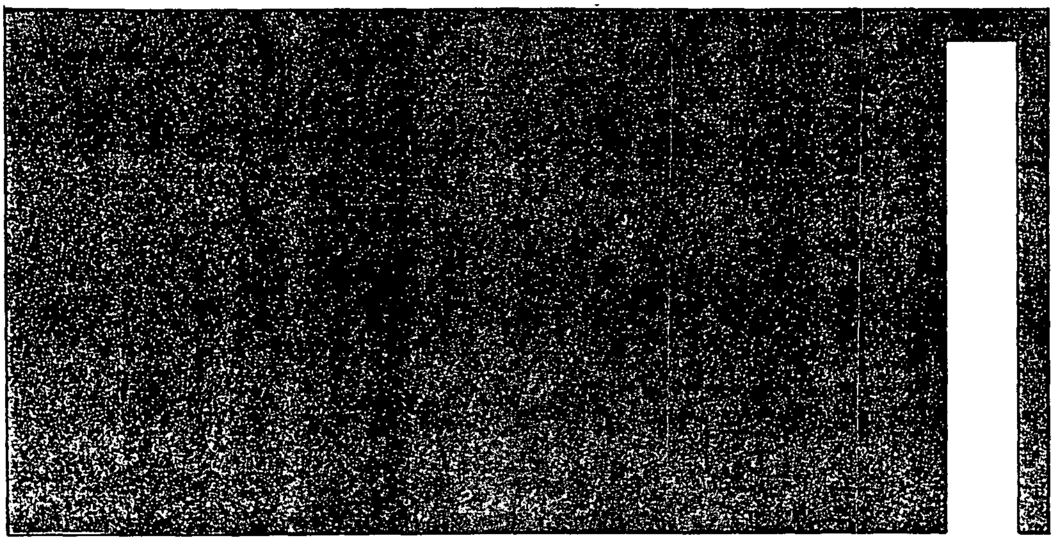
Exhibit I



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GROUNDWATER

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Upper and Lower Limits of Darcy's Law

Even if we limit ourselves to the consideration of specific discharge on a macroscopic scale through the Darcian continuum, there may be limitations on the applicability of Darcy's law. Darcy's law is a linear law. If it were universally valid, a plot of the specific discharge v versus the hydraulic gradient dh/dl would reveal a straight-line relationship for all gradients between 0 and ∞. For flow through granular materials there are at least two situations where the validity of this linear relationship is in question. The first concerns flow through low-permeability sediments under very low gradients and the second concerns large flows through very high permeability sediments. In other words, there may be both a lower limit and an upper limit to the range of validity of Darcy's law. It has been suggested that a more general form of the porous media flow law might be

$$v = -K\left(\frac{dh}{dl}\right)^m \tag{2.84}$$

If $m = 1$, as it does in all the common situations, the flow law is linear and is called Darcy's law; if $m \neq 1$, the flow law is not linear and should not be called Darcy's law.

For fine-grained materials of low permeability, it has been suggested on the basis of laboratory evidence that there may be a threshold hydraulic gradient below which flow does not take place. Swartzendruber (1962) and Bolt and Groenevelt (1969) review the evidence and summarize the various hypotheses that have been put forward to explain the phenomenon. As yet, there is no agreement on mechanism, and the experimental evidence is still open to some doubt. In any event, the phenomenon is of very little practical importance; at the gradients being considered as possible threshold gradients, flow rates will be exceedingly small in any case.

Of greater practical importance is the upper limit on the range of validity of Darcy's law. It has been recognized and accepted for many years (Rose, 1945; Hubbert, 1956) that at very high rates of flow, Darcy's law breaks down. The evidence is reviewed in detail by both Todd (1959) and Bear (1972). The upper limit is usually identified with the aid of the *Reynolds number* R_e, a dimensionless number that expresses the ratio of inertial to viscous forces during flow. It is widely used in fluid mechanics to distinguish between *laminar flow* at low velocities and *turbulent flow* at high velocities. The Reynolds number for flow through porous media is defined as

$$R_e = \frac{\rho v d}{\mu} \tag{2.85}$$

where ρ and μ are the fluid density and viscosity, v the specific discharge, and d a representative length dimension for the porous medium, variously taken as a mean pore dimension, a mean grain diameter, or some function of the square root of the

permeability k. Bear (1972) summarizes the experimental evidence with the statement that "Darcy's law is valid as long as the Reynolds number based on average grain diameter does not exceed some value between 1 and 10" (p. 126). For this range of Reynolds numbers, all flow through granular media is laminar.

Flow rates that exceed the upper limit of Darcy's law are common in such important rock formations as karstic limestones and dolomites, and cavernous volcanics. Darcian flow rates are almost never exceeded in nonindurated rocks and granular materials. Fractured rocks (and we will use this term to refer to rocks rendered more permeable by joints, fissures, cracks, or partings of any genetic origin) constitute a special case that deserves separate attention.

Flow in Fractured Rocks

The analysis of flow in fractured rocks can be carried out either with the *continuum* approach that has been emphasized thus far in this text or with a *noncontinuum* approach based on the hydraulics of flow in individual fractures. As with granular porous media, the continuum approach involves the replacement of the fractured media by a representative continuum in which spatially defined values of hydraulic conductivity, porosity, and compressibility can be assigned. This approach is valid as long as the fracture spacing is sufficiently dense that the fractured media acts in a hydraulically similar fashion to granular porous media. The conceptualization is the same, although the representative elementary volume is considerably larger for fractured media than for granular media. If the fracture spacings are irregular in a given direction, the media will exhibit trending heterogeneity. If the fracture spacings are different in one direction than they are in another, the media will exhibit anisotropy. Snow (1968, 1969) has shown that many fracture-flow problems can be solved using standard porous-media techniques utilizing Darcy's law and an anisotropic conductivity tensor.

If the fracture density is extremely low, it may be necessary to analyze flow in individual fissures. This approach has been used in geotechnical applications where rock-mechanics analyses indicate that slopes or openings in rock may fail on the basis of fluid pressures that build up on individual critical fractures. The methods of analysis are based on the usual fluid mechanics principles embodied in the Navier-Stokes equations. These methods will not be discussed here. Wittke (1973) provides an introductory review.

Even if we limit ourselves to the continuum approach there are two further problems that must be addressed in the analysis of flow through fractured rock. The first is the question of non-Darcy flow in rock fractures of wide aperture. Sharp and Maini (1972) present laboratory data that support a nonlinear flow law for fractured rock. Wittke (1973) suggests that separate flow laws be specified for the linear-laminar range (Darcy range), a nonlinear laminar range, and a turbulent range. Figure 2.28 puts these concepts into the context of a schematic curve of specific discharge vs. hydraulic gradient. In wide rock fractures, the specific discharges and Reynolds numbers are high, the hydraulic gradients are usually less

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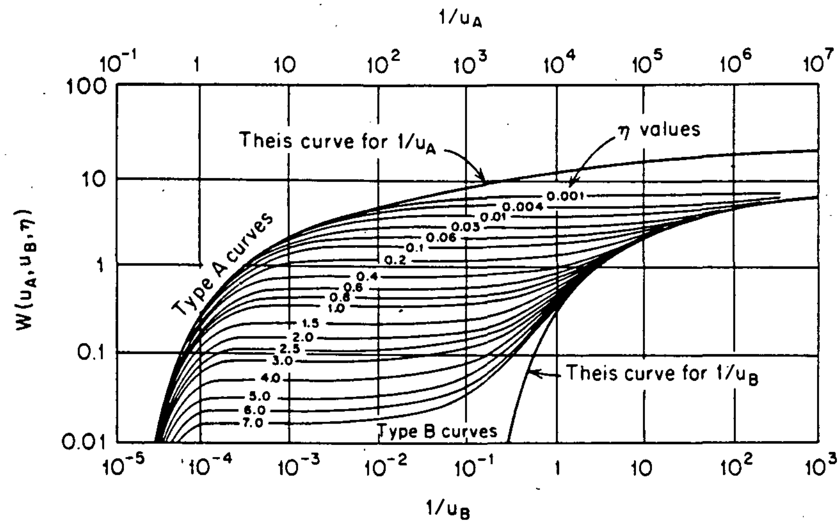

Figure 8.12 Theoretical curves of $W(u_A, u_B, \eta)$ versus $1/u_A$ and $1/u_B$ for an unconfined aquifer (after Neuman, 1975a).

and S_y is the specific yield that is responsible for the delayed release of water to the well.

For an anisotropic aquifer with horizontal hydraulic conductivity K_r and vertical hydraulic conductivity K_z, the parameter η is given by

$$\eta = \frac{r^2 K_z}{b^2 K_r} \tag{8.15}$$

If the aquifer is isotropic, $K_z = K_r$, and $\eta = r^2/b^2$. The transmissivity T is defined as $T = K_r b$. Equations (8.12) through (8.15) are only valid if $S_y \gg S$ and $h_0 - h \ll b$.

The prediction of the average drawdown at any radial distance r from a pumping well at any time t can be obtained from Eqs. (8.13) through (8.15) given Q, S, S_y, K_r, K_z, and b.

Multiple-Well Systems, Stepped Pumping Rates, Well Recovery, and Partial Penetration

The drawdown in hydraulic head at any point in a confined aquifer in which more than one well is pumping is equal to the sum of the drawdowns that would arise from each of the wells independently. Figure 8.13 schematically displays the drawdown $h_0 - h$ at a point B situated between two pumping wells with pumping rates $Q_1 = Q_2$. If $Q_1 \neq Q_2$, the symmetry of the diagram about the plane $A - A'$ would be lost but the principles remain the same.

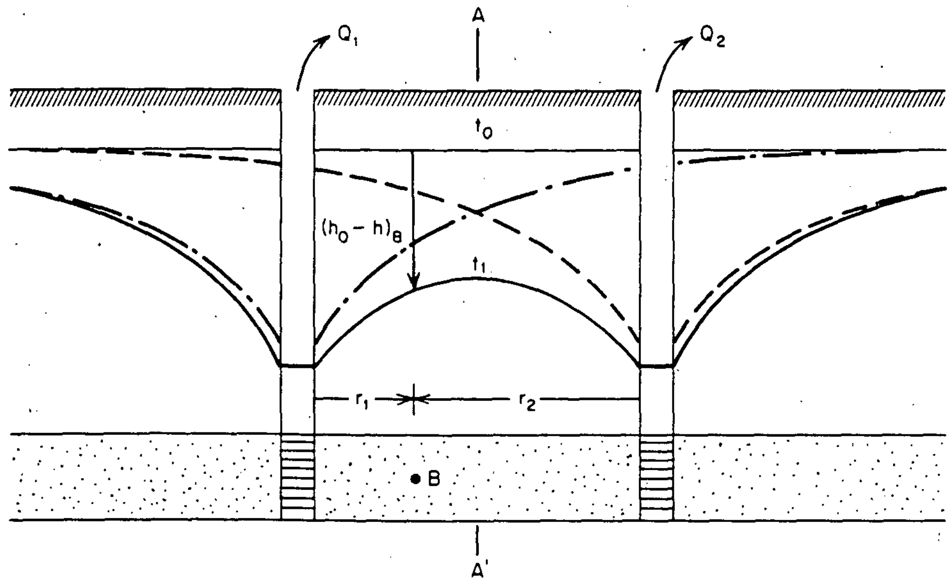

Figure 8.13 Drawdown in the potentiometric surface of a confined aquifer being pumped by two wells with $Q_1 = Q_2$.

For a system of n wells pumping at rates $Q_1, Q_2, \ldots, Q_n$, the arithmetic summation of the Theis solutions leads to the following predictive equation for the drawdown at a point whose radial distance from each well is given by $r_1, r_2, \ldots, r_n$

$$h_0 - h = \frac{Q_1}{4\pi T} W(u_1) + \frac{Q_2}{4\pi T} W(u_2) + \cdots + \frac{Q_n}{4\pi T} W(u_n) \qquad (8.16)$$

where

$$u_i = \frac{r_i^2 S}{4Tt_i} \qquad i = 1, 2, \ldots, n$$

and t_i is the time since pumping started at the well whose discharge is Q_i.

The summation of component drawdowns outlined above is an application of the principle of superposition of solutions. This approach is valid because the equation of flow [Eq. (8.1)] for transient flow in a confined aquifer is linear (i.e., there are no cross terms of the form $\partial h/\partial r \cdot \partial h/\partial t$). Another application of the principle of superposition is in the case of a single well that is pumped at an initial rate Q_0 and then increased to the rates $Q_1, Q_2, \ldots, Q_m$ in a stepwise fashion by the additions $\Delta Q_1, \Delta Q_2, \ldots, \Delta Q_m$. Drawdown at a radial distance r from the pumping well is given by

$$h_0 - h = \frac{Q_0}{4\pi T} W(u_0) + \frac{\Delta Q_1}{4\pi T} W(u_1) + \cdots + \frac{\Delta Q_m}{4\pi T} W(u_m) \qquad (8.17)$$

where

$$u_j = \frac{r^2 S}{4Tt_j} \qquad j = 0, 1, 2, \ldots, m$$

and t_j is the time since the start of the pumping rate Q_j.

A third application of the superposition principle is in the recovery of a well after pumping has stopped. If t is the time since the start of pumping and t' is the time since shutdown, then the drawdown at a radial distance r from the well is given by

$$h_0 - h = \frac{Q}{4\pi T}[W(u_1) - W(u_2)] \qquad (8.18)$$

where

$$u_1 = \frac{r^2 S}{4Tt} \quad \text{and} \quad u_2 = \frac{r^2 S}{4Tt'}$$

Figure 8.14 schematically displays the drawdowns that occur during the pumping period and the residual drawdowns that remain during the recovery period.

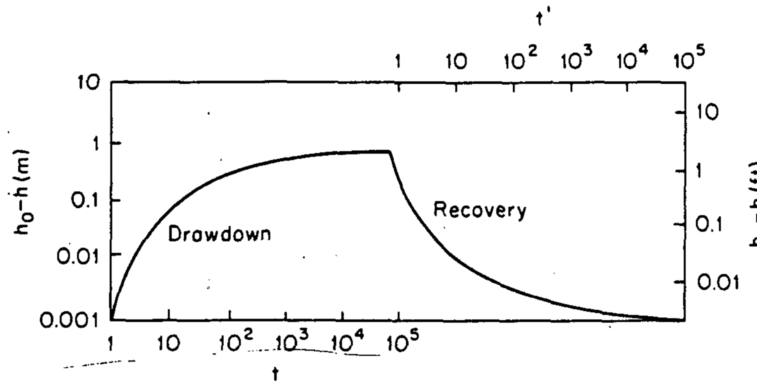

Figure 8.14 Schematic diagram of the recovery in hydraulic head in an aquifer after pumping is stopped.

It is not always possible, or necessarily desirable, to design a well that fully penetrates the aquifer under development. This is particularly true for unconfined aquifers, but may also be the case for thick confined aquifers. Even for wells that are fully penetrating, screens may be set over only a portion of the aquifer thickness.

Partial penetration creates vertical flow gradients in the vicinity of the well that render the predictive solutions developed for full penetration inaccurate. Hantush (1962) presented adaptations to the Theis solution for partially penetrating wells, and Hantush (1964) reviewed these solutions for both confined and leaky-confined aquifers. Dagan (1967), Kipp (1973), and Neuman (1974) considered the effects of partial penetration in unconfined aquifers.

Bounded Aquifers

When a confined aquifer is bounded on one side by a straight-line impermeable boundary, drawdowns due to pumping will be greater near the boundary [Figure 8.15(a)] than those that would be predicted on the basis of the Theis equation for an aquifer of infinite areal extent. In order to predict head drawdowns in such systems, the method of images, which is widely used in heat-flow theory, has been adapted for application in the groundwater milieu (Ferris et al., 1962). With this approach, the real bounded system is replaced for the purposes of analysis by an

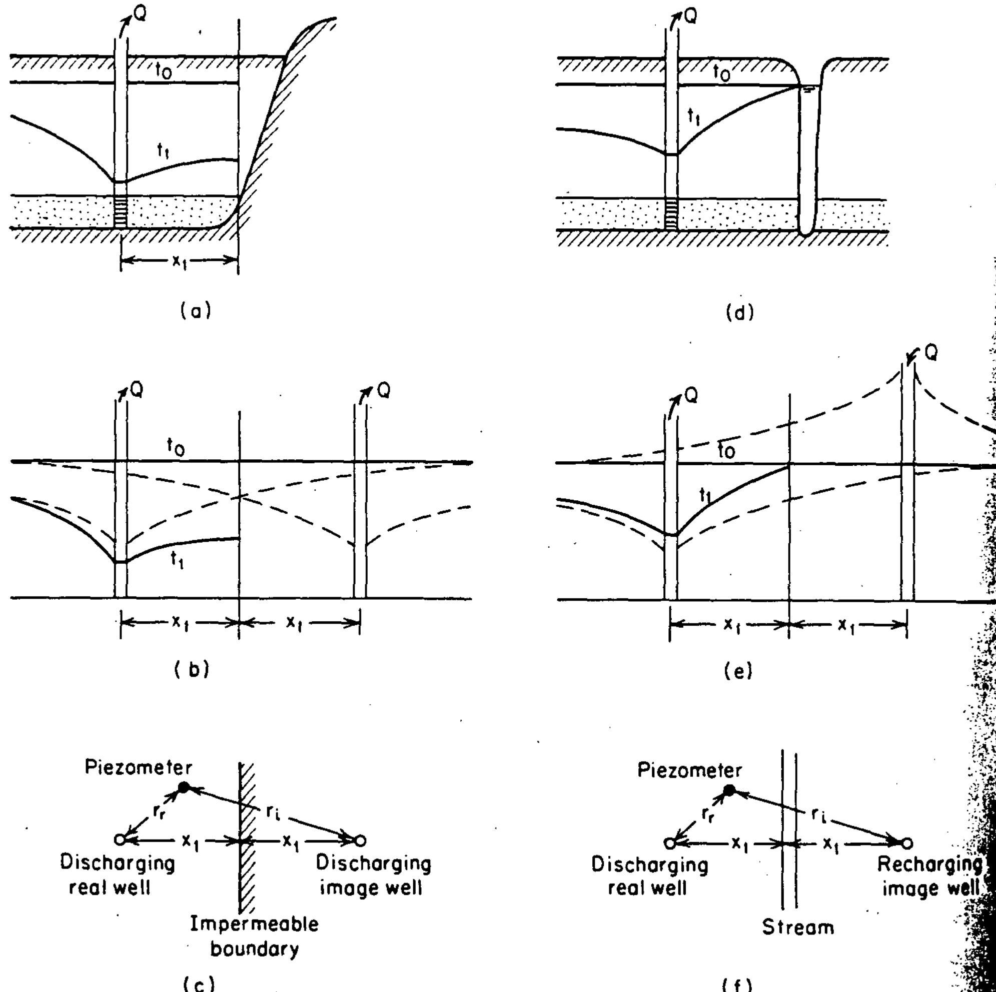

Figure 8.15 (a) Drawdown in the potentiometric surface of a confined aquifer bounded by an impermeable boundary; (b) equivalent system of infinite extent; (c) plan view.

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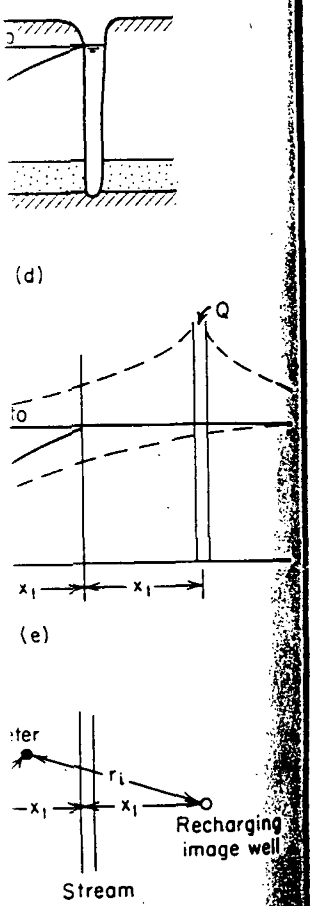

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imaginary system of infinite areal extent [Figure 8.15(b)]. In this system there are two wells pumping: the real well on the left and an image well on the right. The image well pumps at a rate, Q, equal to the real well and is located at an equal distance, x_1, from the boundary. If we sum the two component drawdowns in the infinite system (in identical fashion to the two-well case shown in Figure 8.13), it becomes clear that this pumping geometry creates an imaginary impermeable boundary (i.e., a boundary across which there is no flow) in the infinite system at the exact position of the real impermeable boundary in the bounded system. With reference to Figure 8.15(c), the drawdown in an aquifer bounded by an impermeable boundary is given by

$$h_0 - h = \frac{Q}{4\pi T}[W(u_r) + W(u_i)] \tag{8.19}$$

where

$$u_r = \frac{r_r^2 S}{4Tt} \quad \text{and} \quad u_i = \frac{r_i^2 S}{4Tt}$$

One can use the same approach to predict the decreased drawdowns that occur in a confined aquifer in the vicinity of a constant-head boundary, such as would be produced by the slightly unrealistic case of a fully penetrating stream [Figure 8.15(d)]. For this case, the imaginary infinite system [Figure 8.15(e)] includes the discharging real well and a recharging image well. The summation of the cone of depression from the pumping well and the cone of impression from the recharge well leads to an expression for the drawdown in an aquifer bounded by a constant-head boundary:

$$h_0 - h = \frac{Q}{4\pi T}[W(u_r) - W(u_i)] \tag{8.20}$$

where u_r and u_i are as defined in connection with Eq. (8.19).

It is possible to use the image well approach to provide predictions of drawdown in systems with more than one boundary. Ferris et al. (1962) discuss several geometric configurations. One of the more realistic (Figure 8.16) applies to a pumping well in a confined alluvial aquifer in a more-or-less straight river valley. For this case, the imaginary infinite system must include the real pumping well R, an image well I_1 equidistant from the left-hand impermeable boundary, and an image well I_2 equidistant from the right-hand impermeable boundary. These image wells themselves give birth to the need for further image wells. For example, I_3 reflects the effect of I_2 across the left-hand boundary, and I_4 reflects the effect of I_1 across the right-hand boundary. The result is a sequence of imaginary pumping wells stretching to infinity in each direction. The drawdown at point P in Figure 8.16 is the sum of the effects of this infinite array of wells. In practice, image wells need only be added until the most remote pair produces a negligible effect on water-level response (Bostock, 1971).

Exhibit J

HRI, INC.

(A Subsidiary of Uranium Resources, Inc.)

40-8968
X60676

5656 South Staples
Suite 250, LB 8
Corpus Christi, TX 78411
Telephone (512) 993-7731
Telecopy (512) 993-5744

12750 Merit Drive
Suite 1210, LB 12
Dallas, Texas 75251
Telephone: (214) 387-7777
Telecopy: (214) 387-7779
TWX: 910-867-4701

Post Office Box 777
Crown Point, New Mexico 87313
Telephone (505) 786-5845

October 18, 1993

'93 OCT 21 A9:47

Mr. Ramon Hall
U.S. Nuclear Regulatory Commission
P.O. Box 25325
Denver, Colorado 80225

RE: Geraghty and Miller Report, "Analysis of Hydrodynamic Control, HRI, Inc., Crownpoint and Churchrock New Mexico Uranium Mines

Dear Mr. Hall:

You are on the distribution list for the subject report. Three copies are attached. HRI, Inc. requests that this report serve as a supplement to the Applicant's Environmental Report, which is currently under review for the HRI New Mexico uranium production operations.

Please feel free to contact me with questions pertaining to this matter.

Yours very truly,

Mark S. Pelizza
Environmental Manager

MSP/dlg
Encl.

Addl Info
94-0033

9310210098

40-8968

ANALYSIS OF HYDRODYNAMIC CONTROL, HRI, INC. CROWNPOINT AND CHURCHROCK NEW MEXICO URANIUM MINES

October 7, 1993

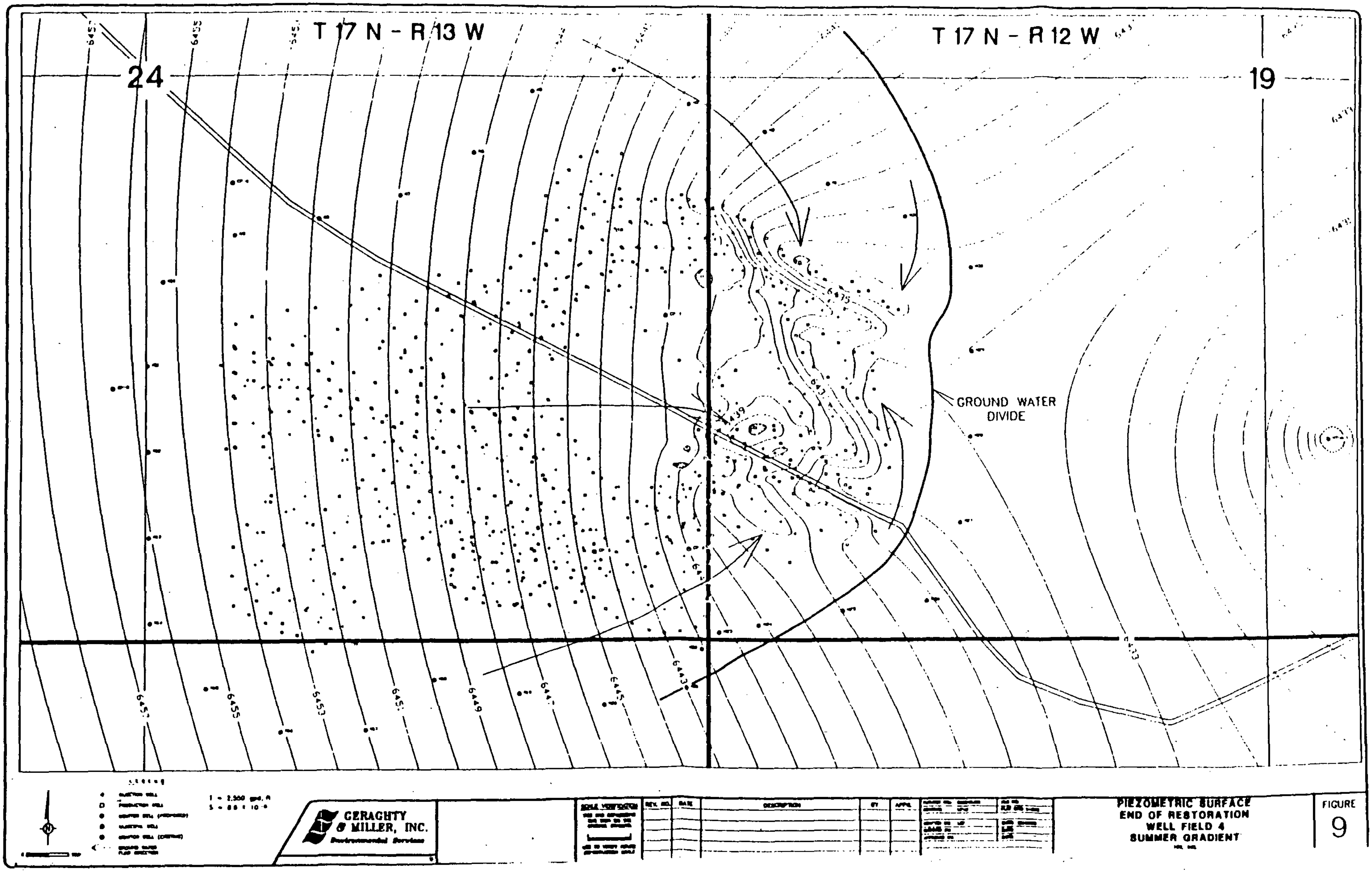
Prepared for

HRI, Inc.
12750 Merit, Suite 1210
Dallas, TX 75251

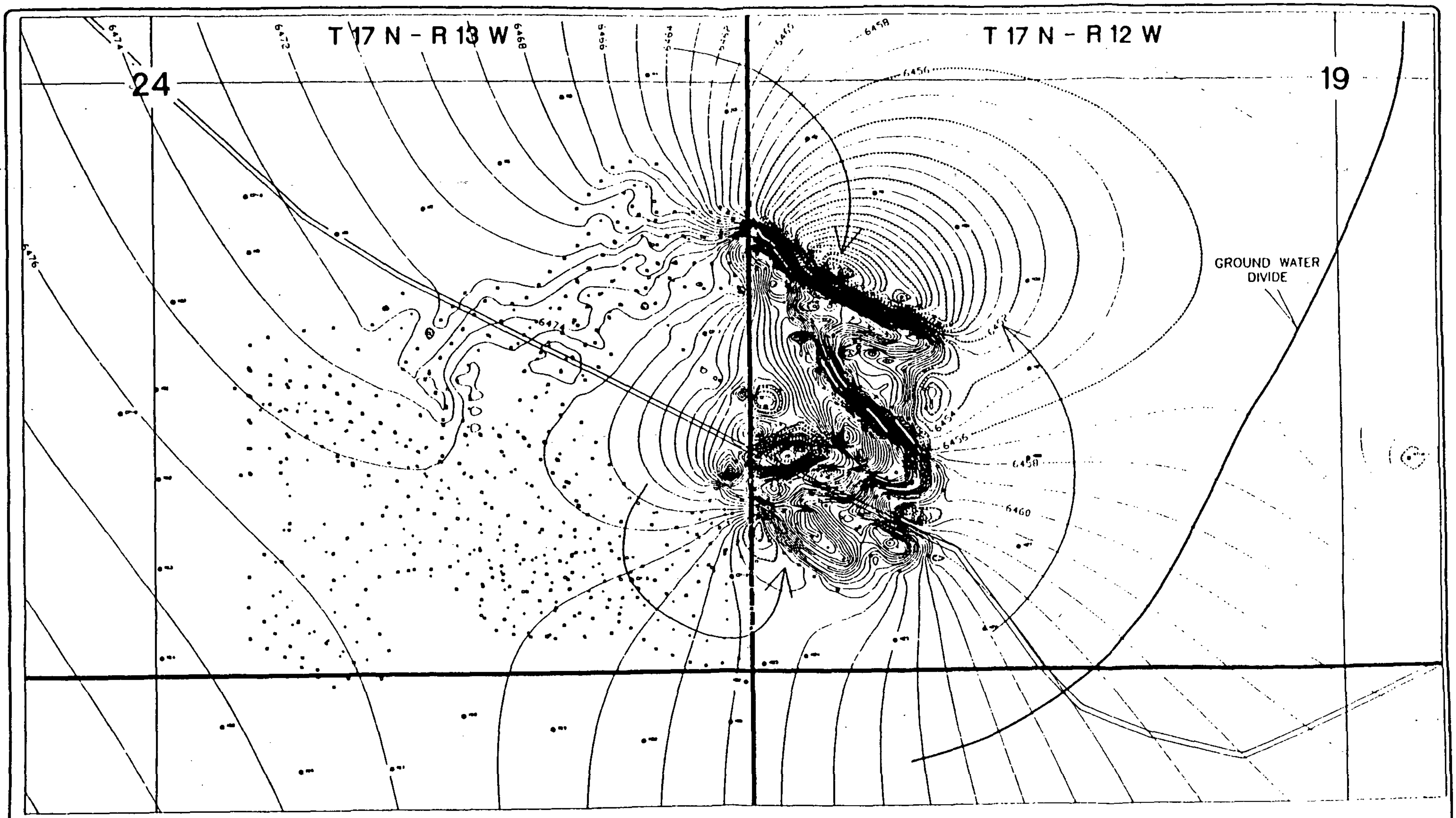
Prepared by

Geraghty & Miller, Inc.
American Bank Plaza
711 North Carancahua, Suite 1700
Corpus Christi, TX 78475-1801
(512) 883-1353

w/ltr 10/18/93
94-0033



T 17 N - R 13 W
T 17 N - R 12 W
24
19
GROUND WATER DIVIDE
6457
6455
6453
6451
6449
6447
6445
6443
6433
GERAGHTY & MILLER, INC.
Environmental Services
PIEZOMETRIC SURFACE
END OF RESTORATION
WELL FIELD 4
SUMMER GRADIENT
FIGURE
9

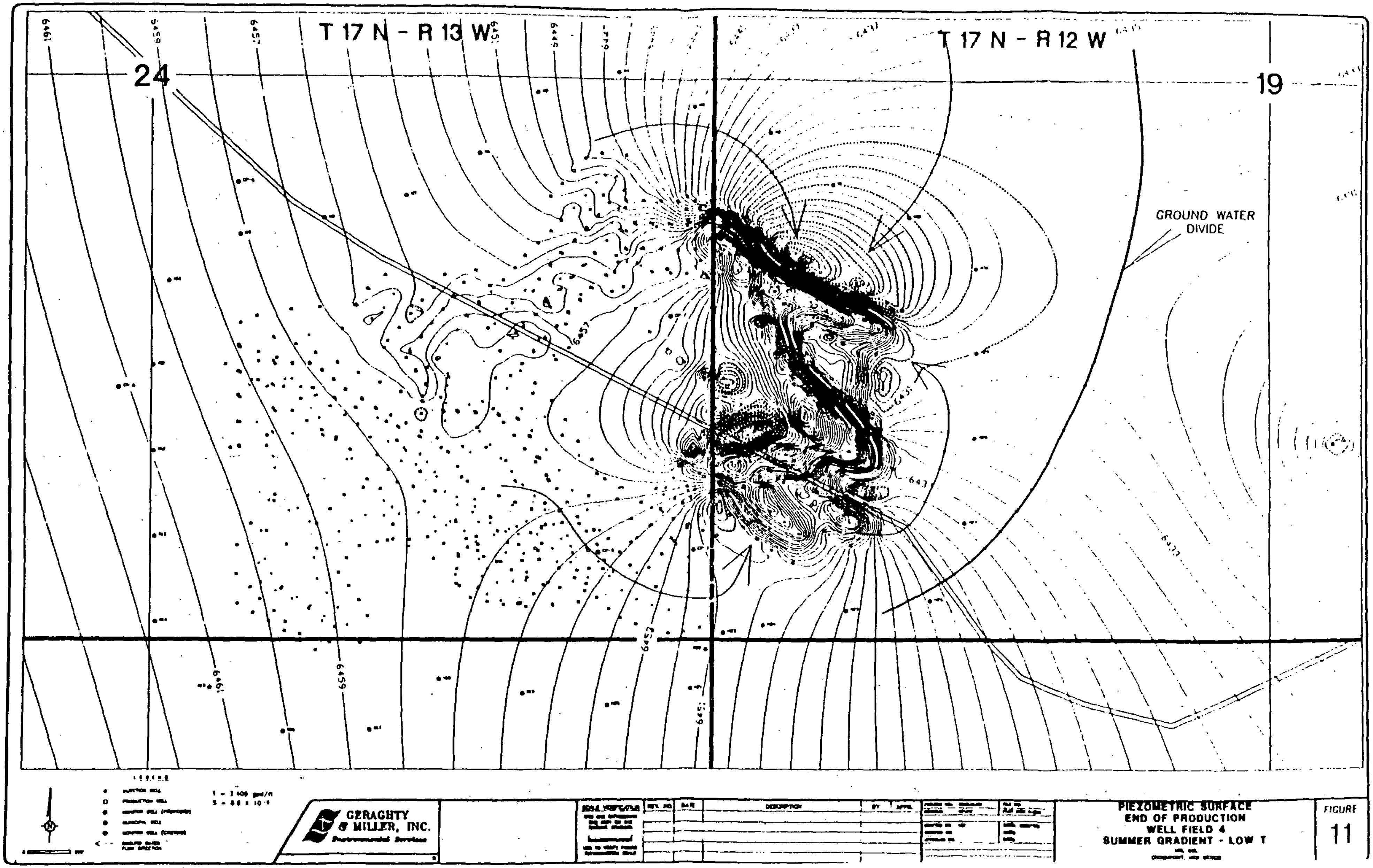


T = 2,330 gpd/ft
S = 8.8 x 10

GERAGHTY & MILLER, INC.

PIEZOMETRIC SURFACE
END OF PRODUCTION
WELL FIELD 4
WINTER GRADIENT

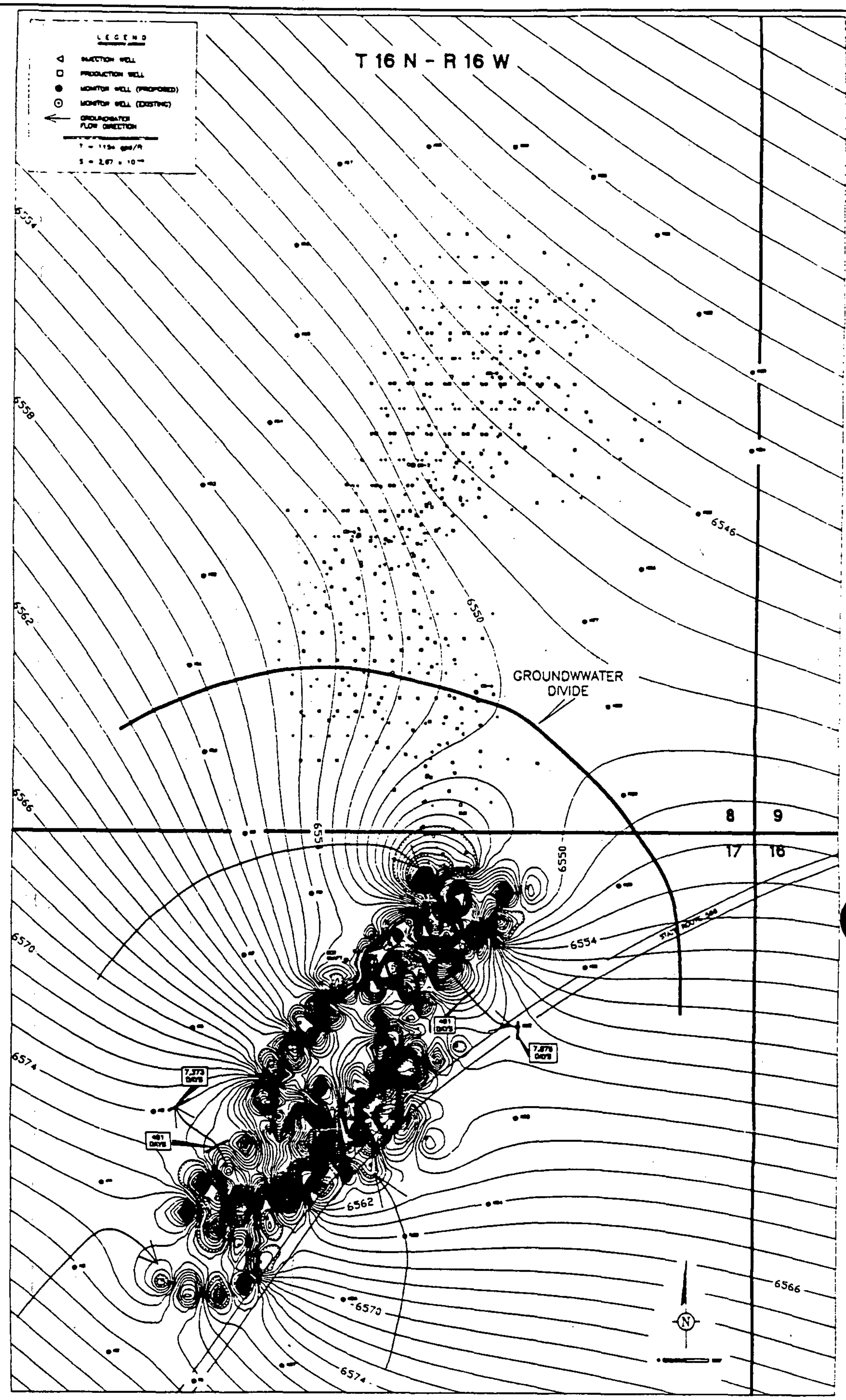
FIGURE 10



GERAGHTY & MILLER, INC.
Environmental Services

PIEZOMETRIC SURFACE
END OF PRODUCTION
WELL FIELD 4
SUMMER GRADIENT - LOW T

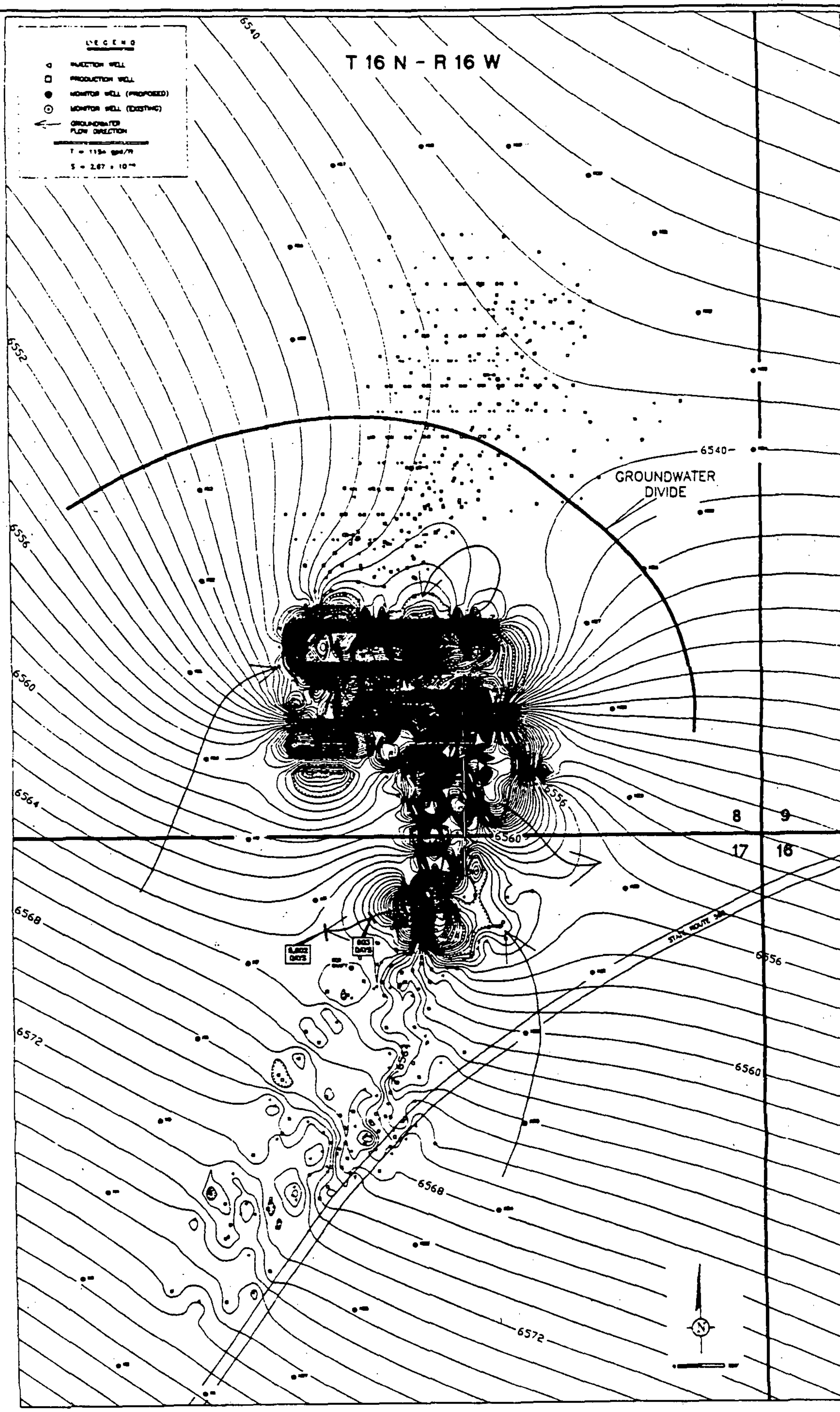
FIGURE 11



GERAGHTY & MILLER, INC.
Environmental Services

PIEZOMETRIC SURFACE
END OF PRODUCTION
WELL FIELD 1

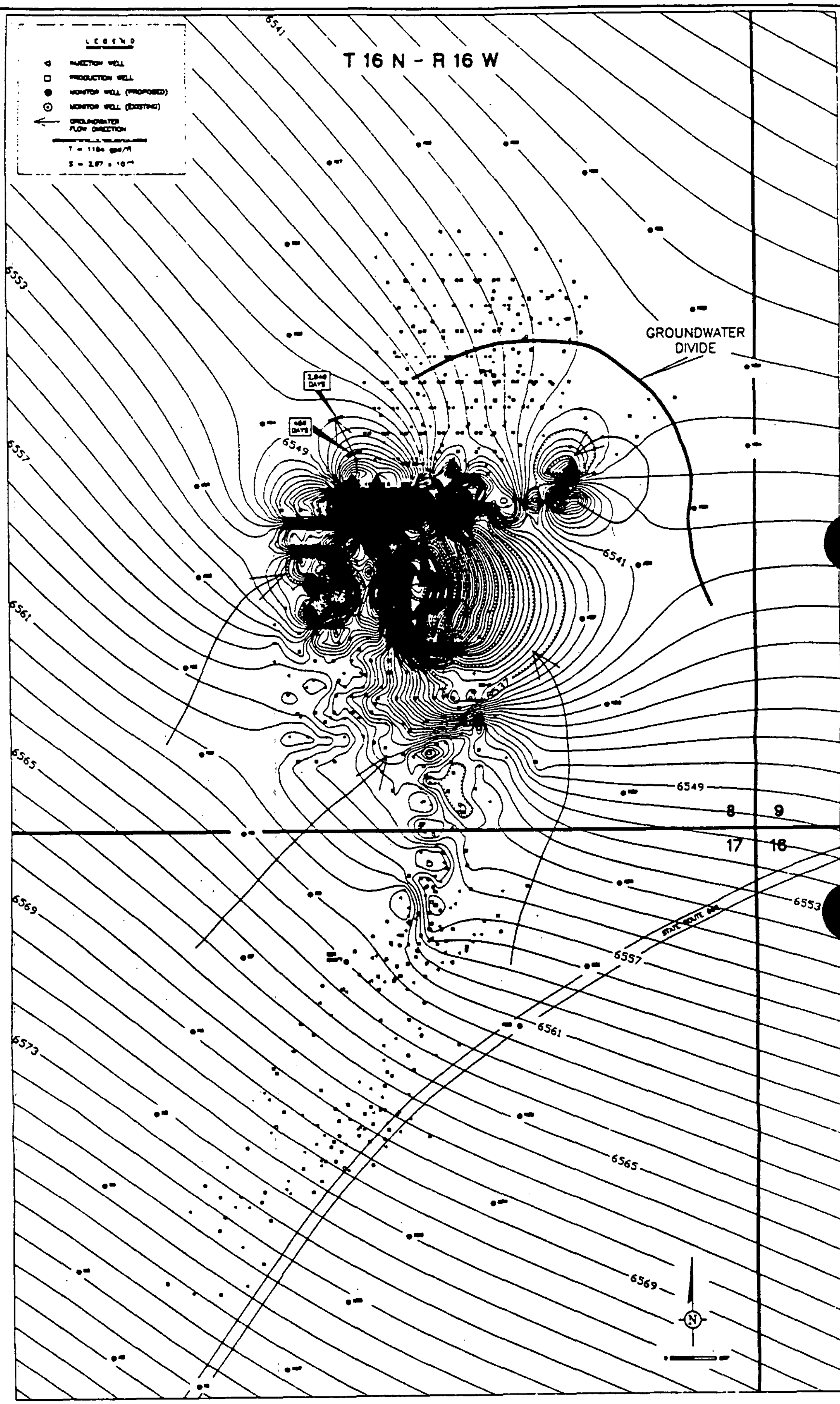
FIGURE
22



GERAGHTY & MILLER, INC.

PIEZOMETRIC SURFACE
END OF PRODUCTION
WELL FIELD 2

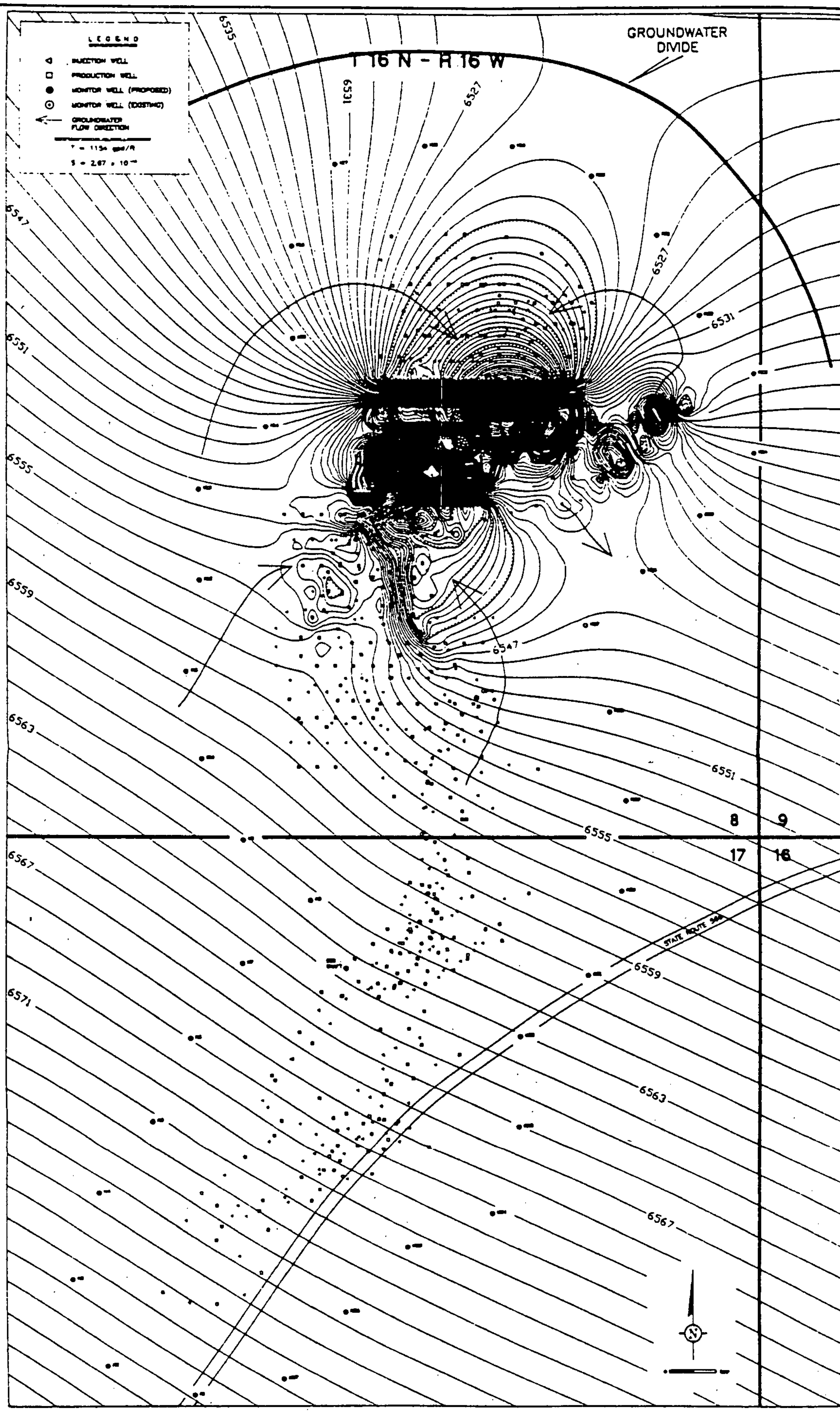
FIGURE 23



GERAGHTY & MILLER, INC.
Environmental Services

PIEZOMETRIC SURFACE
END OF PRODUCTION
WELL FIELD 3

FIGURE 24

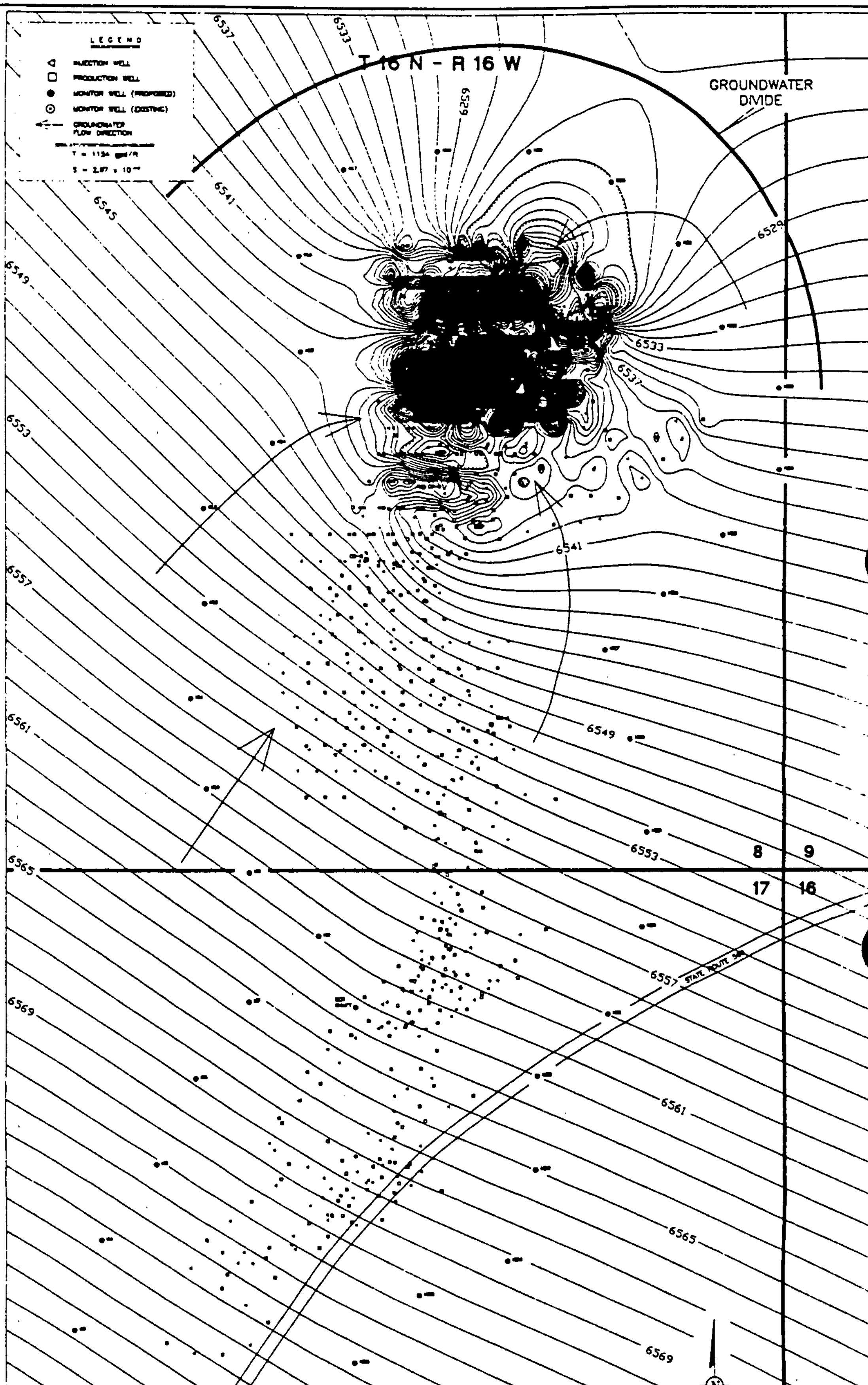


GERAGHTY & MILLER, INC.

Environmental Services

PIEZOMETRIC SURFACE
END OF PRODUCTION
WELL FIELD 4

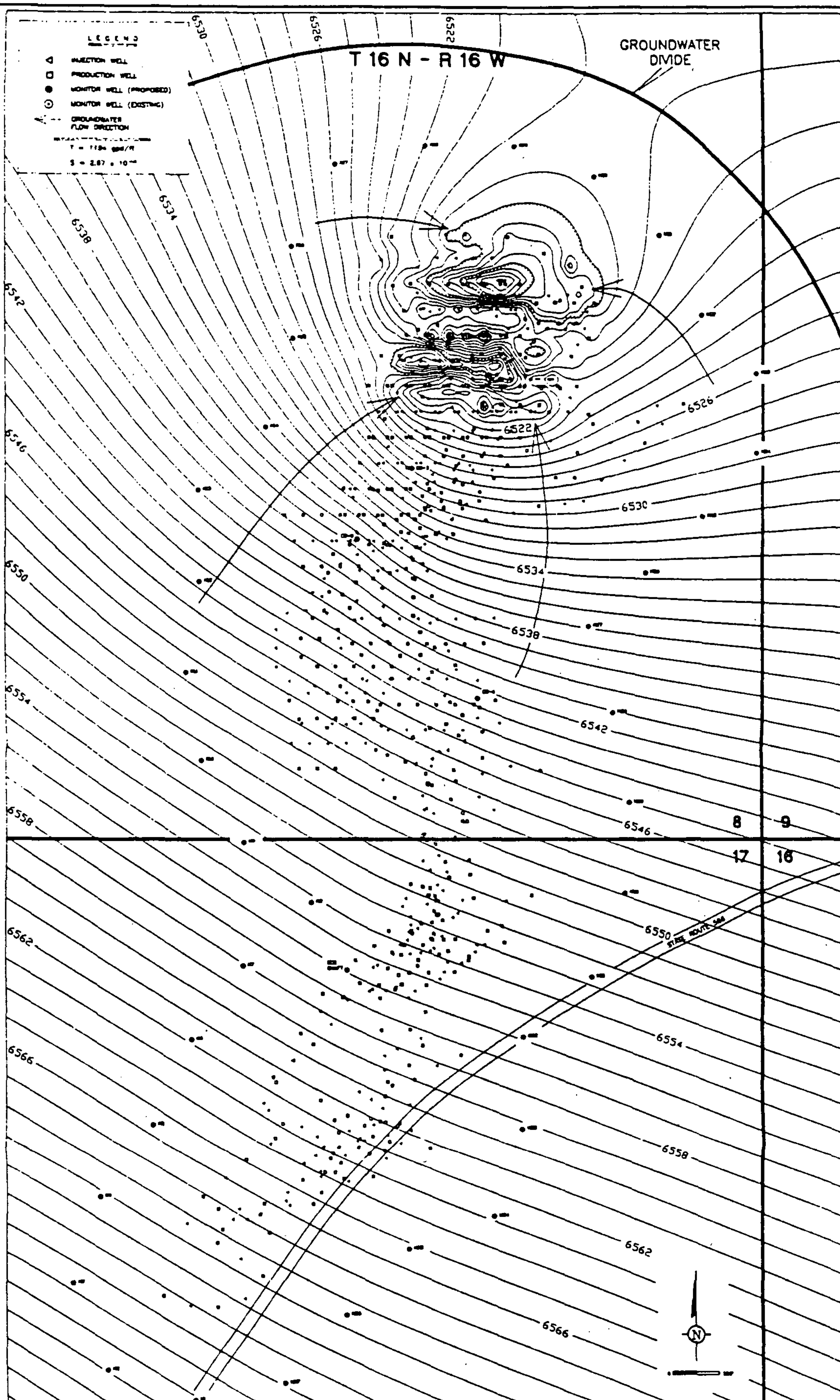
FIGURE 25



GERAGHTY & MILLER, INC.

PIEZOMETRIC SURFACE
END OF PRODUCTION
WELL FIELD 5

FIGURE 26



GERAGHTY & MILLER, INC.

PIEZOMETRIC SURFACE
END OF RESTORATION
WELL FIELD 5

FIGURE 27

Exhibit K

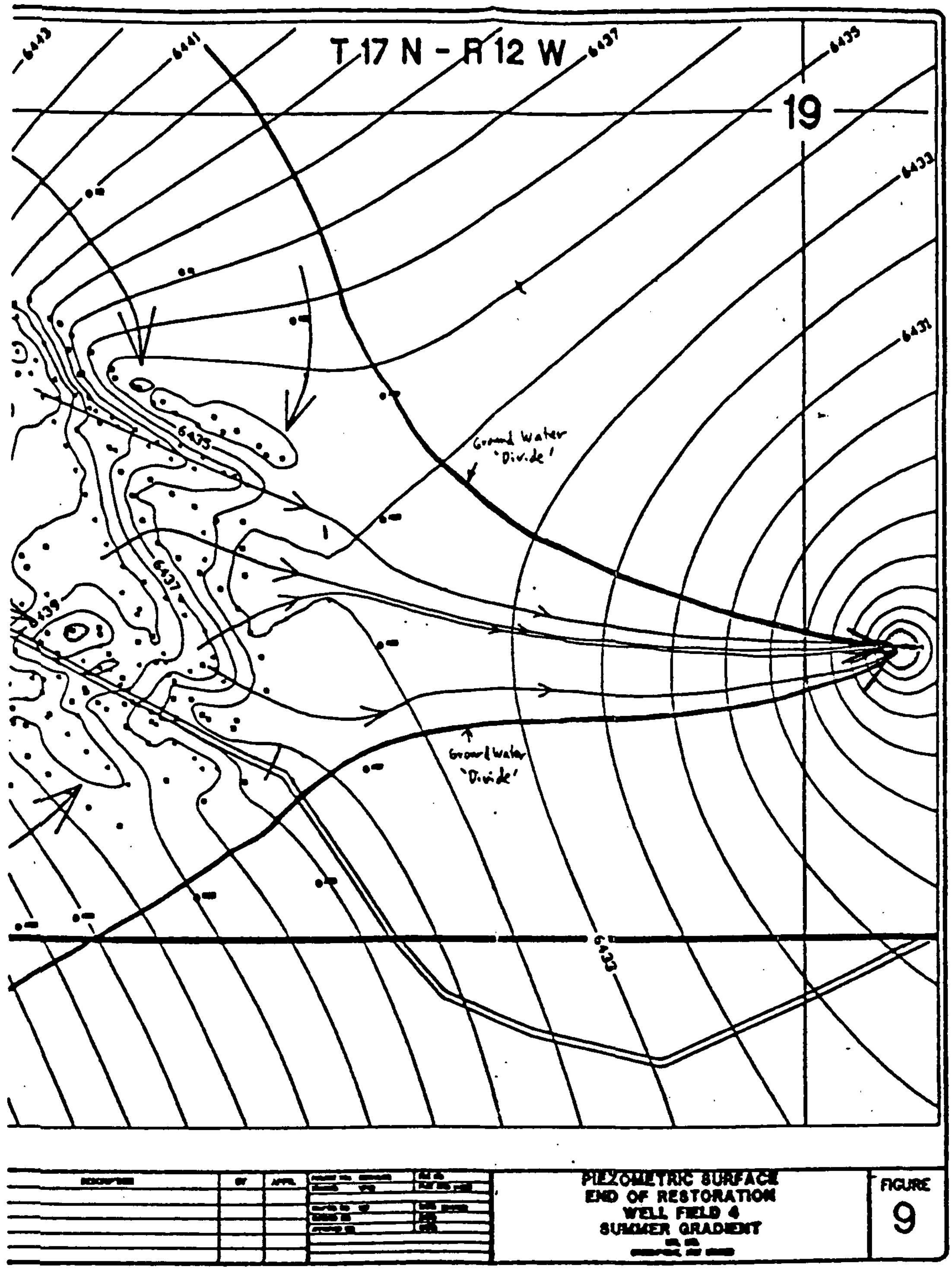


Figure 4. Revised groundwater divide and groundwater pathlines for modeled groundwater flows at the end of restoration at Crownpoint site Wellfield No. 4. Adapted from Geraghty and Miller, 1993, Figure 9.

WALLACE EXHIBIT K

Exhibit L

BEFORE THE NEW MEXICO
STATE ENGINEER

COPY

IN THE MATTER OF THE APPLICATION OF HRI, INC., FOR A PERMIT TO CHANGE LOCATION OF WELL AND PLACE AND PURPOSE OF USE AND POINTS OF DIVERSION OF UNDERGROUND WATERS IN THE GALLUP UNDERGROUND WATER BASIN

APPLICATION NO. G-11-A

Gallup City Courthouse
City Commission Room
Gallup, New Mexico

TRANSCRIPT OF PROCEEDINGS
March 24, 1998
9:00 a.m.
Volume I

BEFORE: Robert Q. ROGERS, Hearing Examiner

REPORTED BY: AUGUSTINA J. MARTINEZ, CCR #215
Paul Baca Professional Court Reporters
400 Gold Avenue, Southwest, Suite 200
Albuquerque, New Mexico 87102

Page 26

Our hydrology expert will testify that despite a very conservative model that he constructed, drawdowns in wells of nearest other ownership are small and that the Westwater Canyon Aquifer will not be dewatered through the pumping on the part of HRI that they proposed under G-11-A. Thank you.

HEARING OFFICER ROGERS: Thank you. Well, that concludes opening statements. Are you ready to begin?

MR. INDALL: Yes, we are, Your Honor. We would like to call Mark Pelizza.

MARK S. PELIZZA

was called as a witness by the Applicant,
after having been first duly sworn under oath,
was questioned and testified as follows:

DIRECT EXAMINATION

BY MR. INDALL:

Q. Would you please state your name for the record.

A. My name is Mark S. Pelizza.

Q. And what is your address?

A. My address is 3217 Breton Drive, Plano, Texas.

Q. And how are you employed, Mr. Pelizza?

Page 27

A. I am Vice President of Health, Safety and Environmental Affairs with Uranium Resources, Inc.

Q. Okay. Can you briefly describe your educational background?

A. I have a Bachelor's Degree in Geology from Fort Lewis College, I have a Master's Degree in Geologic Engineering from Colorado School of Mines.

Q. How about your employment background?

A. I have been with Uranium Resources in either a management or an officer-type position for 18 years in the environmental area. Prior to that, I was with Union Carbide at an in situ leach operation. I have been actively working in the in situ leach business for some 20 years.

Q. And how many ISL properties have you been involved with in the permitting process?

A. Eleven.

Q. Would you please look at binder number 1 there and turn to Exhibit 7?

A. Seven, did you say?

Q. Seven, please. And can you describe what that exhibit shows?

A. This is a copy of my resume.

Q. Did you prepare that?

A. Yes, I did.

Page 28

MR. INDALL: Mr. Hearing Examiner, we would move the admission of Exhibit 7 at this time.

HEARING OFFICER ROGERS: Any objection?

MR. FRYE: No objection.

MS. DOOLEY: No objection.

HEARING OFFICER ROGERS: Exhibit 7 is accepted.

(Applicant's Exhibit 7 was admitted.)

Q. (By Mr. Indall) Mr. Pelizza, can you tell me, is your employer, Uranium Resources, publicly traded?

A. Uranium Resources is a publicly traded company.

Q. And can you describe the relationship between HRI and URI?

A. HRI is an operating company which is fully owned by the parent Uranium Resources, Incorporated. HRI is the company that is registered to do business as an operating company in New Mexico.

Q. Would you describe URI's business?

A. URI is an in situ leach recovery company. We specialize in identifying uranium ore bodies that are amenable to the in situ leach process, whether it be through acquisition or exploration and discovery. We develop these properties through the permitting

Page 29

process and then the in situ recovery process, and then we sell the material that is produced as a product.

Q. And how long has the company been doing this?

A. Twenty years.

Q. And can you describe the properties that URI is currently operating?

A. URI has two operations ongoing in South Texas. We have an operation called Kingsville Dome Mine, which is in Kleberg County, Texas, which is operational. We have a mine called our Rosita Mine, which is in Duval County, Texas, which is operational.

Q. Okay. Do you have anything that you're currently permitting in Texas?

A. We have two properties in Texas that are in various phases of the permitting cycle. One is called our Vasquez. It is essentially completely permitted. We have a few details there, but that is a property that is in the permitting process. It is slated to go into production mid-year this year.

We also have a property called the Alta Mesa property. It is in the permitting process. It is not quite as far along as Vasquez. It is slated to go into production after the Vasquez property.

question again.

HEARING OFFICER ROGERS: Yes. Ask the question again.

Q. (By Ms. Atcitty) So if we convert 4,000 GPMs into acre-feet per year, wouldn't that number be 6,450 acre-feet per year?

A. If this process was operating -- let me be very slow in the way that I explain this because you are leaving out 50 percent of the equation in the way you are viewing this. If this process were operating and we were extracting 4,000 gallons per minute, according to our NRC license, and running the water to an arroyo continuously over a period of a year at a rate of 4,000 gallons per minute -- and I am not going to use the 1.6 because I would have to figure that out in my own mind. But if you were to take -- and 1.6 may be the simple conversion.

But to get to that number and the way I would do it in a more detailed way is I would take those gallons. I would use some arithmetic and calculate the number of minutes in a year and convert from gallons to feet and come up with a number. And assuming that the 1.6 was the proper conversion, then that would say that we are extracting on an annual basis 6,500 acre-feet per year.

Q. And that is my question to you.

A. Yes.

Q. Is that the amount that is being withdrawn?

A. That is the amount that is being withdrawn, but --

Q. Thank you. That was my question.

MR. INDALL: Your Honor, I think the witness ought to explain his answer.

MS. ATCITTY: I think he was able to explain it on direct, and this is cross.

MR. INDALL: Well, I think the proper form of question and answer, Mr. Hearing Officer, is that the witness --

HEARING OFFICER ROGERS: She asked the question and he answered the question. That is fine.

MR. INDALL: Okay.

Q. (By Ms. Atcitty) Earlier this morning, counsel for the Applicant dropped off on our table what is called Church Rock Project-Groundwater Volume Calculated By Zone. And in your deposition, there were a number of questions raised regarding the corpus amounts, the 780 number, the 6,500 acre diversion, and I believe you submitted this to clarify some of those points; isn't that true?

MR. INDALL: Excuse me. Is that this

piece of paper that I gave you?

MS. ATCITTY: Yes.

MR. FRYE: Can we number that?

MR. INDALL: I am going to call it Exhibit 57, I think is the next number.

(Applicant's Exhibit 57 was marked for identification.)

Q. (By Ms. Atcitty) Mr. Pelizza, did you prepare this document?

A. I supervised its preparation.

Q. Is this your latest and best known calculation for the resource volume?

A. This is a number that, as a result of the deposition, I went back and looked at my records and pulled out of my files.

Q. And from the column labeled "Feet," our calculations are that the feet is now about 10 feet? The thickness of the ore is 10 feet and not 80 feet, as testified to in the deposition?

A. Well, what I think I said in the deposition is that the overall thickness of the ore zone was -- and my recollection is that you asked me if it was 80 feet, and I said, "Well, approximately 80 feet."

So that was the context of what I said in the deposition. At the deposition, we were talking in

generalities. I didn't have these numbers in front of me. I think I said that in the deposition. We were talking about the general thickness of the Westwater Formation in the deposition, and that's what I was referring to there.

Q. So what does the column refer to in this document?

A. What we have here is the detailed analysis that I referred to in the deposition. What this shows is -- you notice under the column called "Zones" -- and for example, let's take Section 8. This is how a uranium geologist would break down individual uranium bearing ore zones in the Westwater Formation. For example, on that model I depict two. I wouldn't do this many zones in that because I didn't have patience to build the model to that many zones, but --

Q. Are you saying there are more than two zones?

A. I am saying that, according to this tabulation, there are more than two zones. Each zone is -- we can take the data from exploration bore holes and map the uranium ore body analogous to the gray uranium ore body in that model zone by zone.

What this shows is that the thickness of these zones in Section 8 now, because there is less

of them, ranges from somewhere around 8.6 feet to 14.9 feet thickness of individual zones.

Now, some of those zones may be superimposed upon each other, where if you were to drill an exploration bore hole in any one place, you may encounter more than one within the straight vertical plane, and this would be analogous to various levels in a conventional mine. But this is a very accurate representation of the volumes at the Church Rock site.

Q. We did some quick calculations of these numbers. For the Section 8 ore body or ore zone, our calculation of the volume would be 930 acre-feet.

A. Okay. That disagrees with this number. This one shows it at 508.

Q. No, I'm looking at the Volume category. The number we have is 930 acre-feet. If you add those up and divide them by --

A. I guess I could just say okay. Your witness will have to explain what he did.

Q. Okay. And I will just represent to you, based on our calculations, the volume for Section 17 is about 1429.3 acre-feet per year.

MR. INDALL: Mr. Hearing Officer, I would like to object to that question. What they represent

has no foundation. I mean, I don't think that is a proper question.

HEARING OFFICER ROGERS: Okay.

You can have your expert discuss that.

MS. ATCITTY: Okay.

Q. (By Ms. Atcitty) We will go through this in detail with our expert. But the bottom line here is the 780 on your document is more than the 650 acre-feet per year that has been applied for?

A. The 780 represents the quantity or the volume, pore volume, of the entire mine. We will not ever mine that entire quantity in any one year. It is a physical impossibility. It is completely contrary to the proposed mine plan, and it is an assumption which has no bearing with the realities of the plan that is proposed in this EIS.

What I mentioned early on to one of the questions, I can't remember which one, is that we plan on producing 800,000 to a million pounds per year. You will also note in my earlier testimony that I showed the Church Rock reserves in the excess of 8 million pounds.

In order to produce 800,000 to a million pounds per year, and if you have a total reserve -- we are not just going to -- we are adding two and two

and coming up with ten. This mine will take place over a number of years. 780 is the entire amount. We will affect only a fraction of that amount per year. If it is only one-fourth -- I think I said one-fourth or one-fifth in my deposition -- I have reviewed some information, and it is actually six mine blocks if you look in the EIS. Six divided by 780 is less than 650.

Q. But didn't you state that the 780 represents a fraction, not the total?

A. No, I did not. What I said -- and if I did say that, let we withdraw my statement and say what I mean. The 780 -- what the geologist did on this sheet of paper is mapped from our information each and every zone that exists at the Church Rock property. He has calculated an area. He has calculated a thickness, an average thickness, for each zone, which gives us a volume. And if we were to look at this model, the volume would be the permitted area in cross-section of that uranium or times its depth.

HEARING OFFICER ROGERS: Thickness?

THE WITNESS: Yes. It would be the average thickness times its depth.

A. Now, that is not a solid void. That is

sandstone. Much like all the sandstones, it has a porosity number. That is the volume of water in the rock. We take and multiply that volume by the porosity, and that gives you the quantity of water.

We convert that to gallons with a standard 7.48 conversion factor on a zone-by-zone basis. We put in what we believe are industry standard horizontal and dispersion factors to allow for fla outside that ore zone.

You can see on this chart we have a horizontal dispersion of 1.5. We have a vertical dispersion of 1.3. That gives us a restoration volume in gallons which we have in the chart, and then we have it converted to acre-feet. That is done for the entire lease area. If you do it for the entire lease area, you come out, according to this calculation, to 780.

NRC has done a separate evaluation of what they consider this number to be. And I believe they used similar information in their analysis, but I can't guarantee it because I didn't do the analysis. But as it turns out and subsequent to the peer review that this EIS underwent, their number of 780 is the same as this number of 780 when they determine impacts of water use on the surrounding environment.

Exhibit M

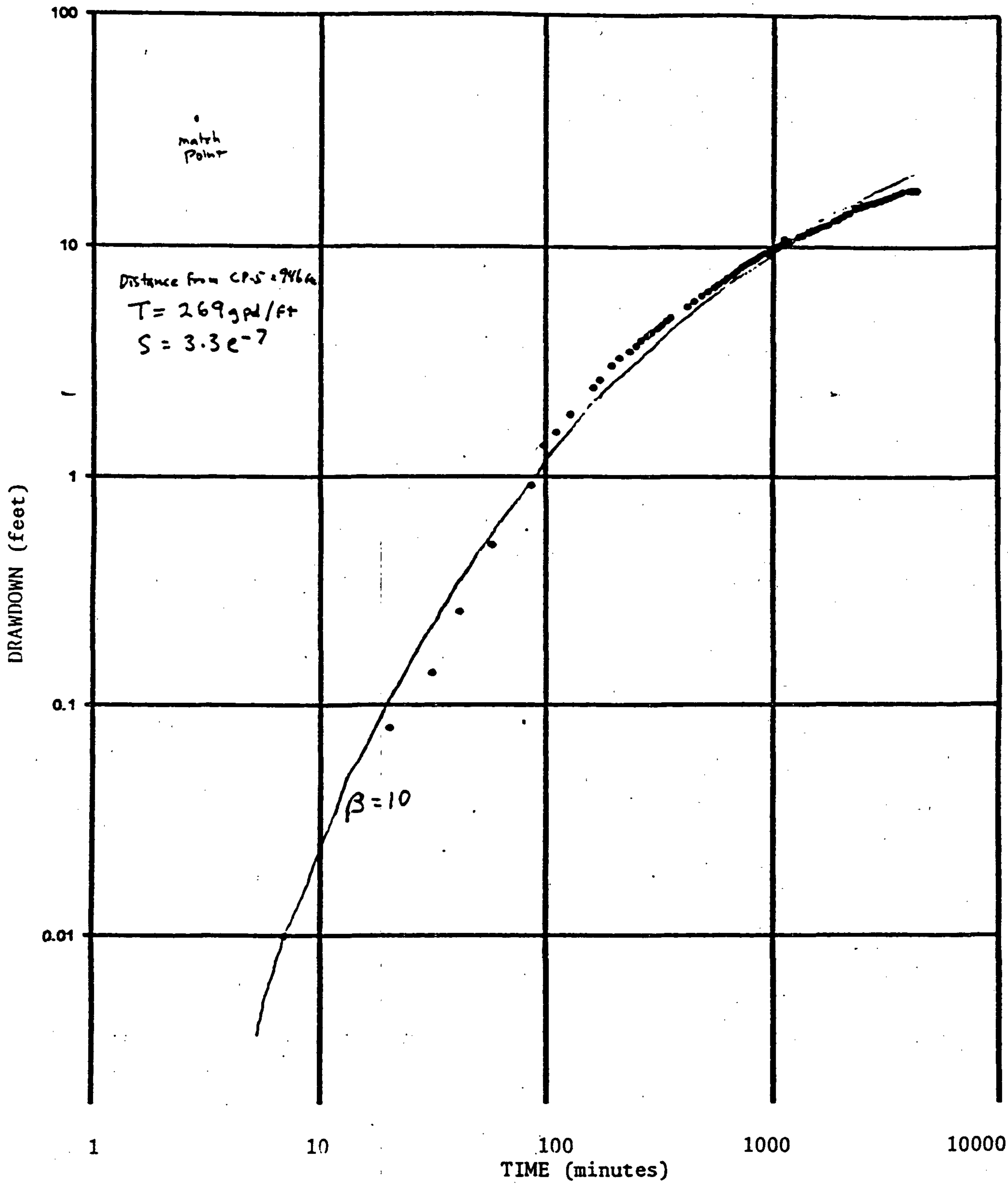


Figure 2. Plot of drawdown points for monitoring well CP-2 matched to Modified Hantush Curve.

WALLACE EXHIBIT M

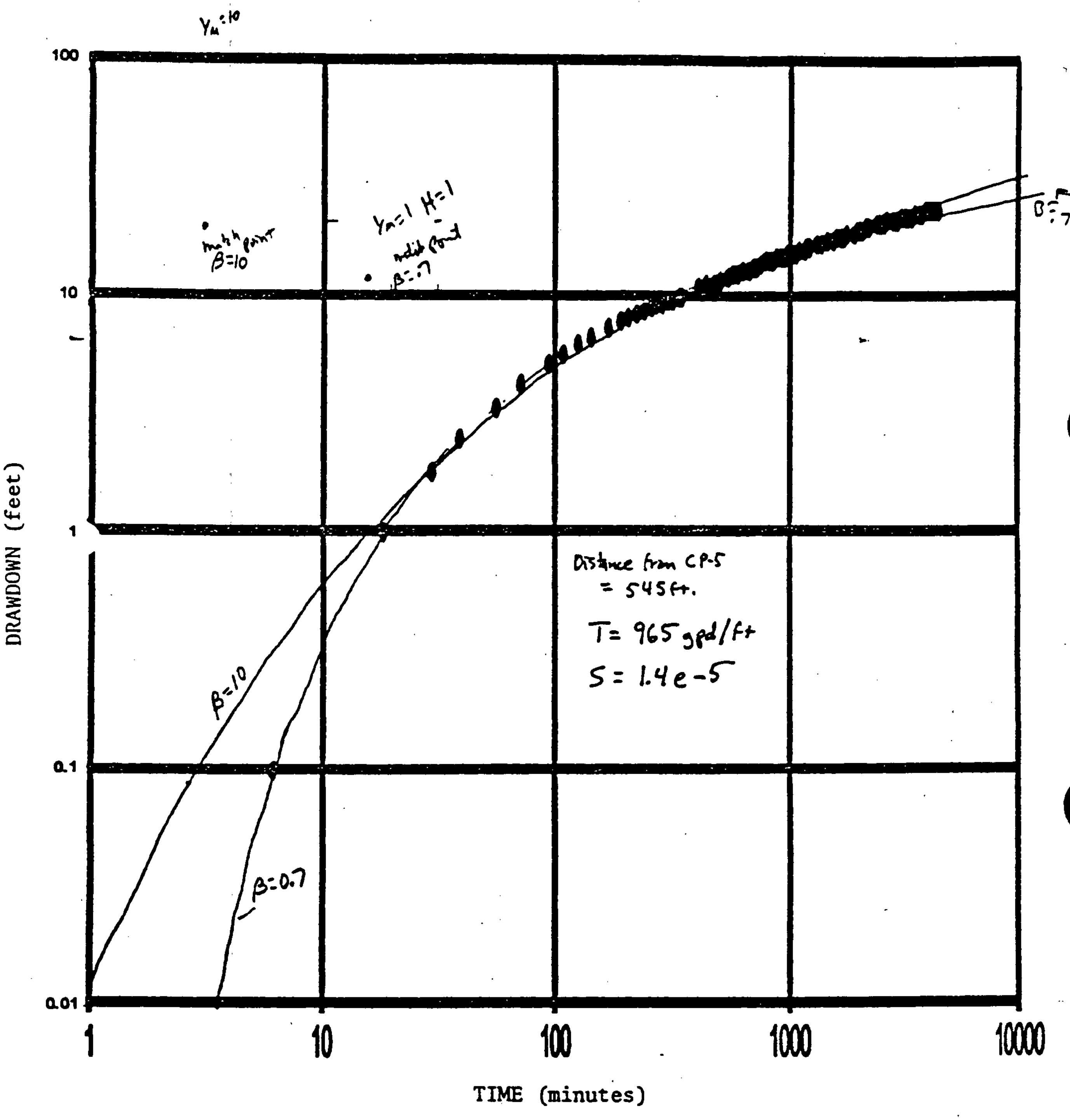


Figure 3. Plot of drawdown points for monitoring well CP-3 matched to Modified Hantush Curve.

WALLACE EXHIBIT M

Exhibit N

Uranium Resources of Northwestern New Mexico

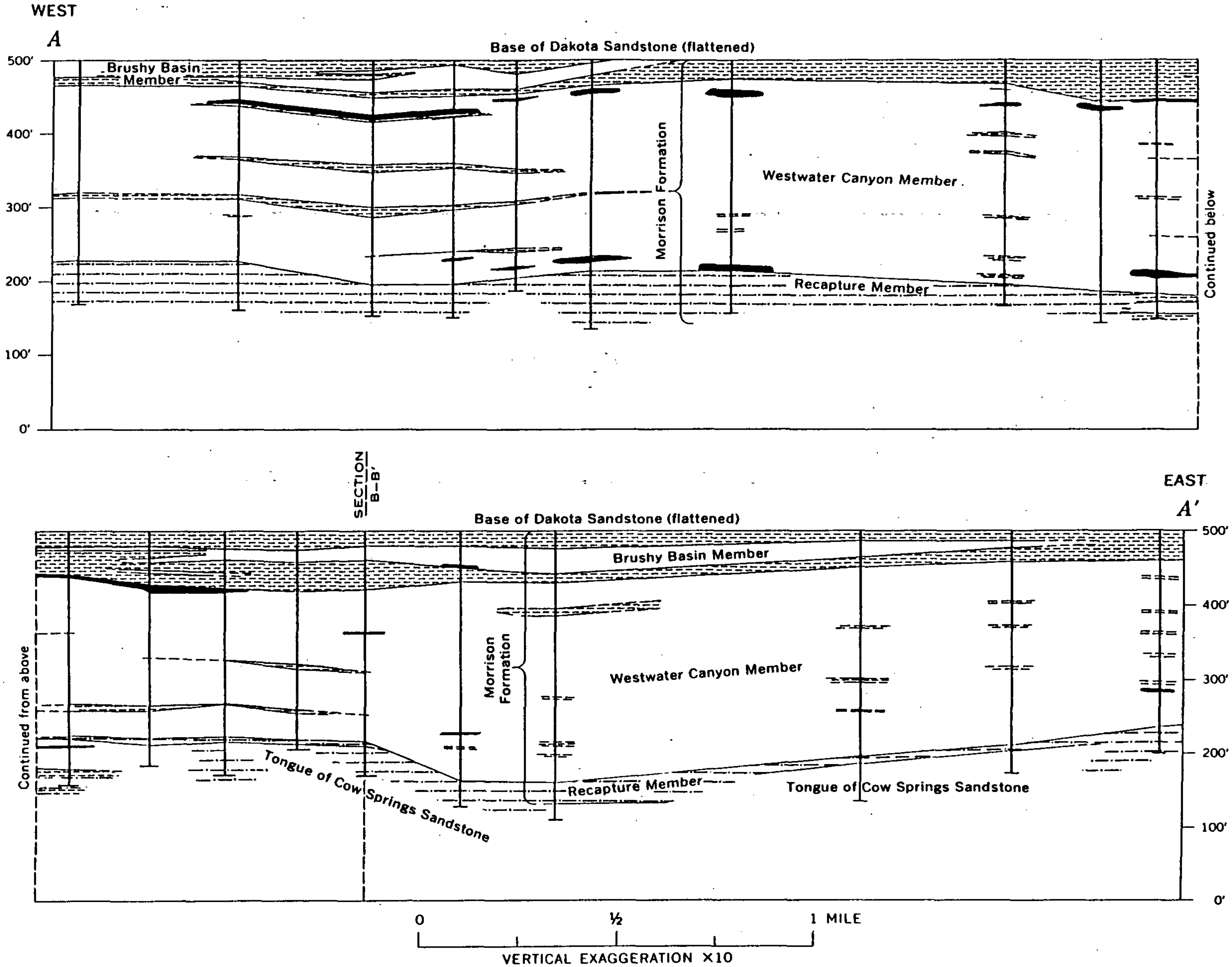
By LOWELL S. HILPERT

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1969


WEST
A
Base of Dakota Sandstone (flattened)
500'
400'
300'
200'
100'
0'
Brushy Basin Member
Morrison Formation
Westwater Canyon Member
Recapture Member
Continued below
SECTION B—B'
EAST
A'
Base of Dakota Sandstone (flattened)
Brushy Basin Member
Morrison Formation
Westwater Canyon Member
Continued from above
Tongue of Cow Springs Sandstone
Recapture Member
Tongue of Cow Springs Sandstone
500'
400'
300'
200'
100'
0'
0
½
1 MILE
VERTICAL EXAGGERATION ×10

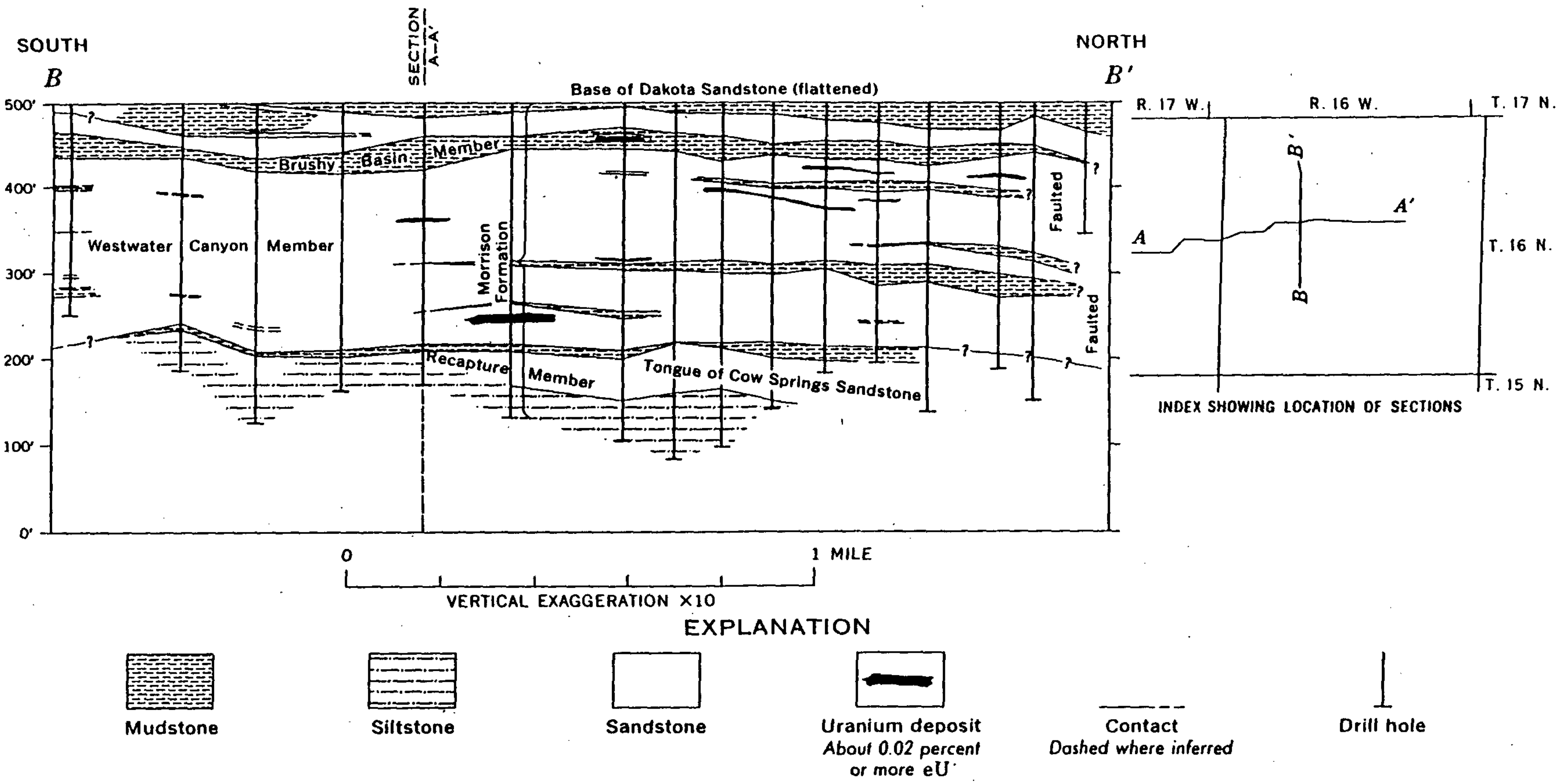


Figure 11.—Geologic sections in the western part of the Gallup district showing the stratigraphic relations of the uranium deposits to the members of the Morrison Formation and the Cow Springs Sandstone. Compiled from electric logs in 1957–59, provided by courtesy of Phillips Petroleum Co. and Tidewater Oil Co.

Exhibit O

Figure 5. Map of uranium mines and deposits in the Grants Mineral Belt as of 1980. From Chenoweth and Holen, 1980, at 19.

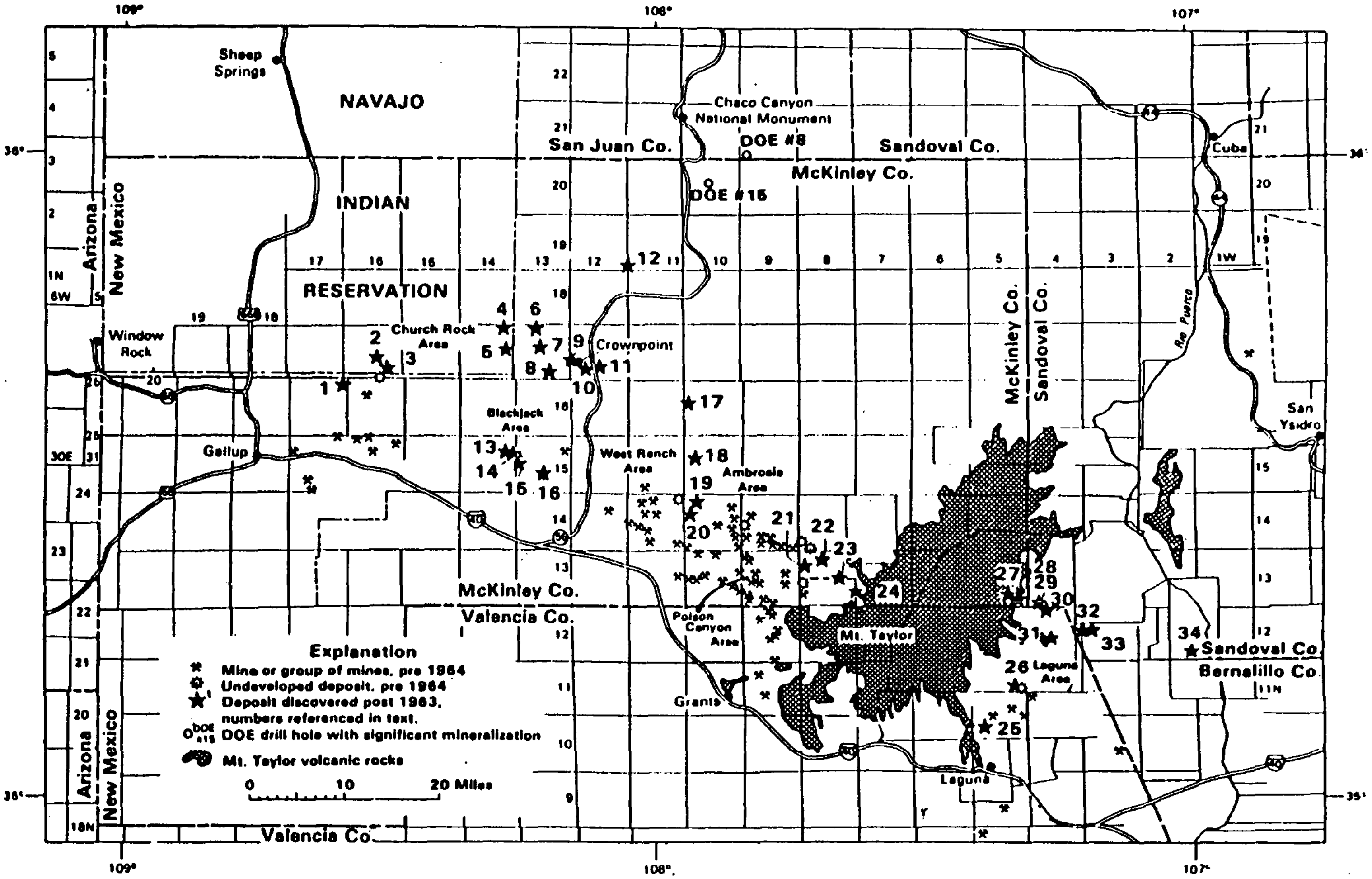


FIGURE 2—INDEX MAP OF THE GRANTS URANIUM REGION SHOWING MINES AND DEPOSITS

WALLACE EXHIBIT O

Exhibit P

DOCKETED
USNRC

'98 JAN -2 A10:12

NAVAJO TRIBAL UTILITY AUTHORITY

AN ENTERPRISE OF THE NAVAJO NATION

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

December 23, 1997

SERVED JAN - 5 1998

Office of the Secretary
Attn: Rulemaking and Adjudications Staff
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Docket No. 40-8968-ML

Dear Sir or Madam:

This is to advise the Nuclear Regulatory Commission that the Navajo Tribal Utility Authority Management Board has enacted Resolution NTUA-11-97 (copy enclosed), opposing the proposed in situ leach mining of uranium by Hydro Resources, Inc., at Crownpoint, New Mexico.

Sincerely yours,

[signature]

Malcolm P. Dalton
General Manager

MPD/lmb
Enclosure

RESOLUTION OF THE
MANAGEMENT BOARD OF THE
NAVAJO TRIBAL UTILITY AUTHORITY

NTUA-11-97

<u>Stating the Position of Navajo Tribal Utility Authority on Proposed Uranium Solution Mining in Eastern Navajo Agency by Hydro-Resources, Inc.</u>

WHEREAS:

1. The Management Board of the Navajo Tribal Utility Authority ("NTUA") is delegated authority and responsibility for the management and operation of the Authority, 21 N.T.C. §7(a)(1); and

2. The mission of NTUA pursuant to its Plan of Operation is to provide electric, gas and water utility services to the Navajo Indian reservation where such service is economically feasible; and

3. NTUA has two operating wells in the vicinity of Crownpoint, New Mexico, which provide water to a consumer population of approximately 10,000 in Crownpoint, New Mexico, and surrounding Navajo communities; and

4. Hydro-Resources, Inc., a New Mexico subsidiary of Uranium Resources, Inc., a Texas corporation, has filed for a license with the Nuclear Regulatory Commission to mine uranium at Crownpoint and Churchrock, New Mexico, using an in situ process; and

5. Previously, NTUA has provided comment in response to an Environmental Impact Statement on the proposed solution mines and stated a concern that its wells and parts of its distribution system will have to be replaced if HRI is granted a license to proceed with mining; and

6. The Nuclear Regulatory Commission is proposing in the Final Environmental Impact Statement to require HRI to plug and abandon NTUA's Crownpoint wells and to drill and equip new wells to be located farther from the mining areas, and to replace NTUA's affected water distribution system; and

7. The Nuclear Regulatory Commission's proposal does not address future operation and maintenance expenses that NTUA may incur due to calcification of its water distribution system, nor does it address future water quality and quantity concerns in connection with the relocated water supply wells and restoration of groundwater after mining; and

8. The Management Board of NTUA deems the response of the Nuclear Regulatory Commission to be inadequate and not responsive to the needs of NTUA with respect to its water system and the community of Crownpoint to maintain its existing high quality water supply and to allow growth in its use; and

9. It is in the best interest of NTUA and its customers that the Management Board state a position on the Nuclear Regulatory Commission's requirement that HRI plug and abandon NTUA's Crownpoint wells and replace its water supply wells and parts of its distribution system affected by solution mining.

NOW THEREFORE BE IT RESOLVED THAT:

1. The Management Board of the Navajo Tribal Utility Authority states its opposition to the proposed in situ leach mining by Hydro-Resources, Inc., in Eastern Navajo Agency at Crownpoint.

2. The Management Board directs NTUA management to inform HRI and the Nuclear Regulatory Commission that it will not agree to plug and abandon its Crownpoint wells.

C E R T I F I C A T I O N

I hereby certify that the foregoing Resolution was duly considered by the Management Board of the Navajo Tribal Utility Authority at a duly called meeting at Tucson, Arizona, at which a quorum was present, and that same was passed by a vote of 7 in favor and 0 opposed, this 11th day of December, 1997.

Benjamin Hanley

Benjamin Hanley
Assistant Secretary, NTUA

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of

HYDRO RESOURCES, INC.

Docket No.(s) 40-8968-ML

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing NTUA RESOLUTION ENACTED 12/11 have been served upon the following persons by U.S. mail, first class, except as otherwise noted and in accordance with the requirements of 10 CFR Sec. 2.712.

Office of Commission Appellate
Adjudication
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Administrative Judge
B. Paul Cotter, Jr.
Presiding Officer
Atomic Safety and Licensing Board Panel
Mail Stop - T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Administrative Judge
Thomas D. Murphy
Special Assistant
Atomic Safety and Licensing Board Panel
Mail Stop - T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555

John T. Hull, Esq.
Mitzi A. Young, Esq.
Office of the General Counsel
Mail Stop - 0-15 B18
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Diane Curran, Esq.
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Docket No.(s)40-8968-ML
NTUA RESOLUTION ENACTED 12/11

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Dated at Rockville, Md. this
5 day of January 1998

Adria T. Byrdsong
Office of the Secretary of the Commission

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judge Peter B. Bloch

In the Matter of	)	
	)	
HYDRO RESOURCES, INC.	)	Docket No. 40-8968-ML
(2929 Coors Road, Suite 101	)	ASLBP No. 95-706-01-ML
Albuquerque, NM 87120)	)	
	)	

INTERVENORS WRITTEN PRESENTATION IN OPPOSITION TO HYDRO RESOURCES, INC.'S APPLICATION FOR A MATERIALS LICENSE WITH RESPECT TO:

GROUNDWATER PROTECTION

January 11, 1999

VOLUME V

EXHIBITS

Project No. NM81-433
Dec. 81

Volume I
Text and Tables

State of New Mexico Environmental Improvement Division Uranium Mill License Renewal Application-Environmental Report License No. NM-UNC-ML

UNC Mining and Milling
Church Rock Operations
Division of United Nuclear Corporation

Church Rock Mill
Gallup, New Mexico

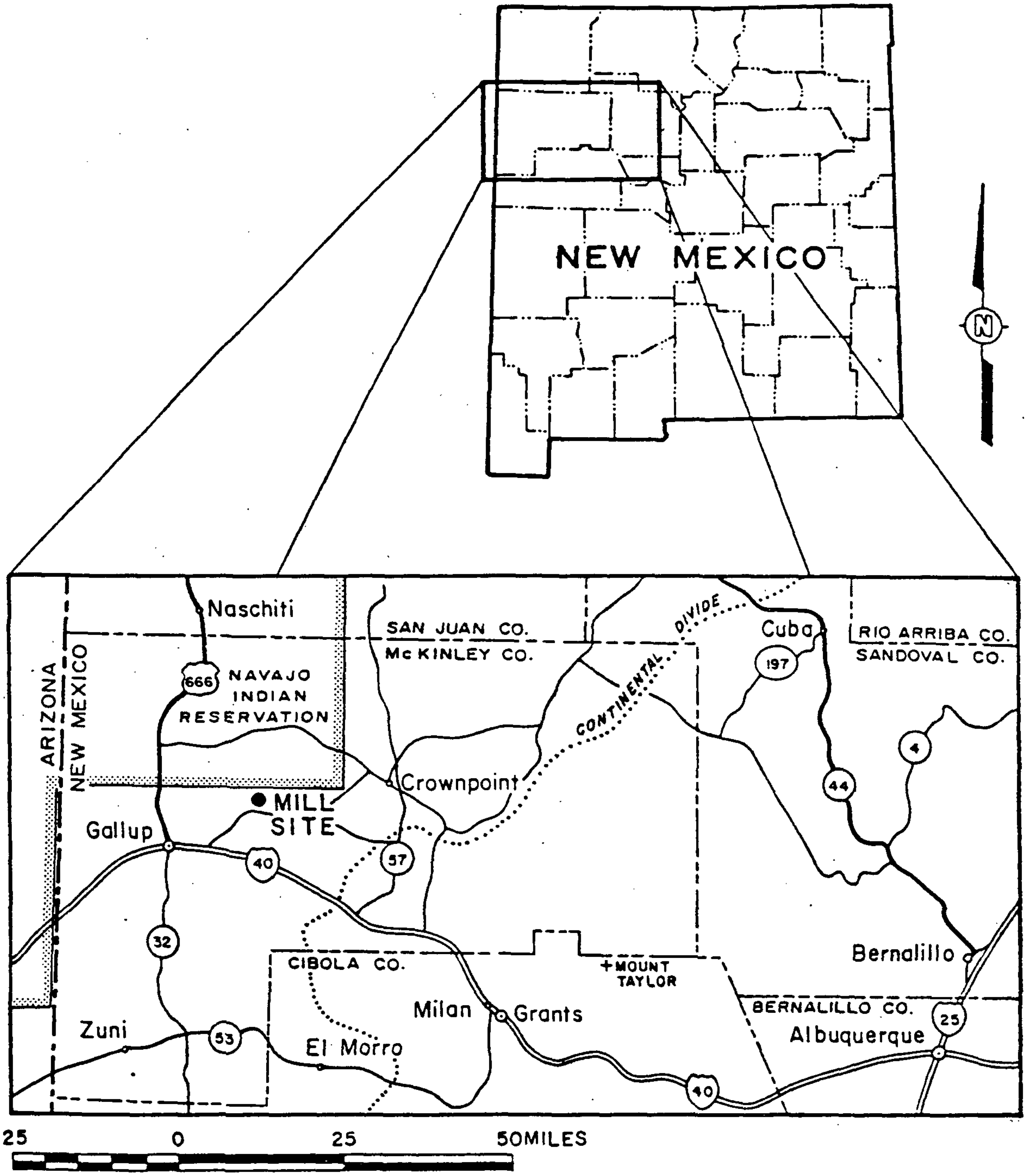


FIGURE A1-1

SITE LOCATION MAP

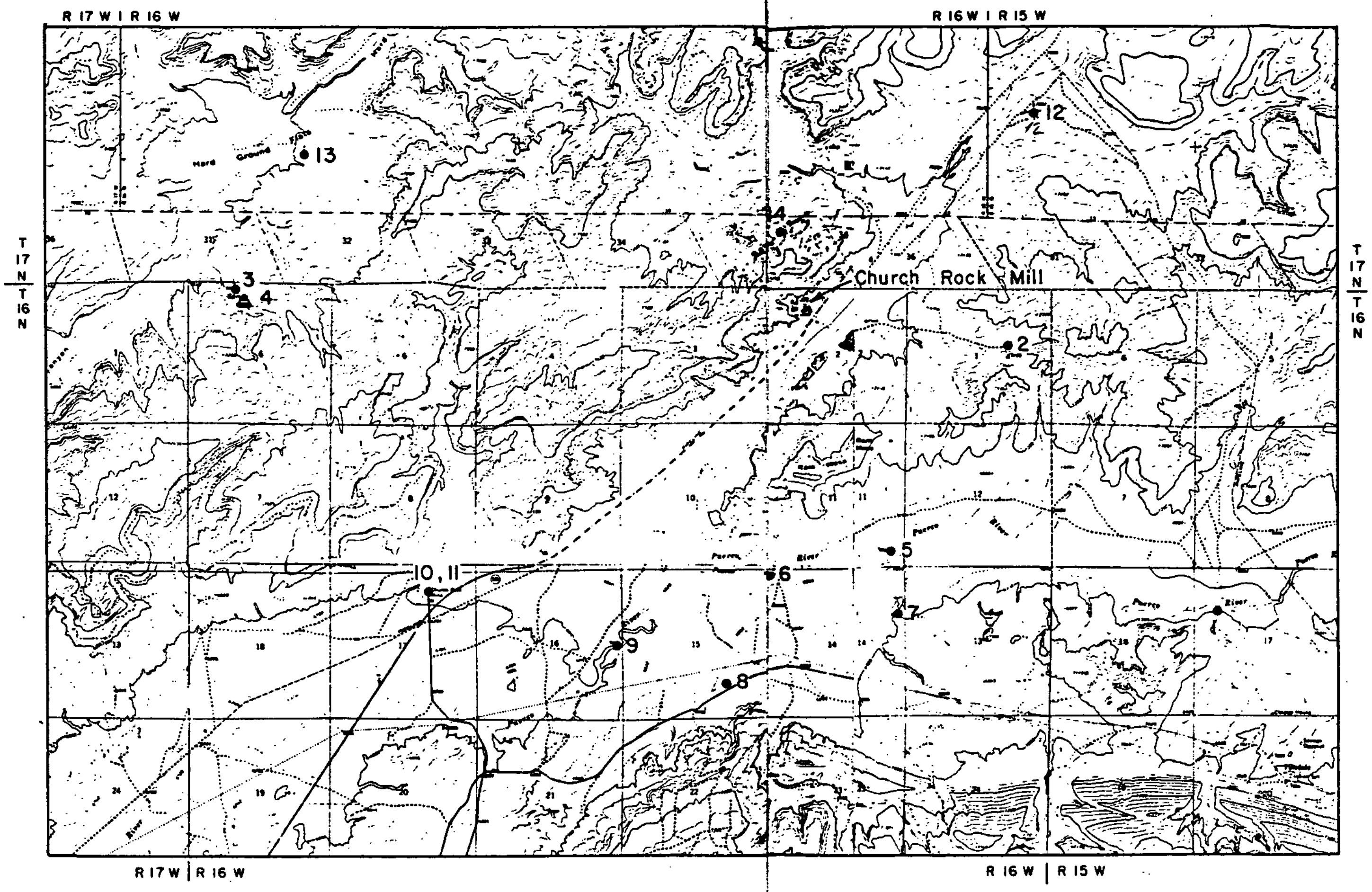
PREPARED FOR

UNC MINING AND MILLING
CHURCH ROCK OPERATIONS

D'APPOLONIA

EF 10/29/81 | CHECKED BY | APPROVED BY KGK 12/21/81 | DRAWING NUMBER NM -A1

DRAWN BY EF 11/4/81 | CHECKED BY | APPROVED BY | DRAWING NUMBER NM81-433-B2



LEGEND

- ● 6 WELL LOCATION
- ▲ 4 SPRING LOCATION

1 0 1 2 KM

1 0 1 MILE

SCALE

NOTE:
SEE TABLE B3.15 FOR WELL AND SPRING CHARACTERISTICS.

REFERENCES: USGS 7.5 MINUTE SERIES QUADRANGLE MAPS PINEDALE, NEW MEXICO (1963); OAK SPRING, NEW MEXICO (1963); HARD GROUND FLATS, NEW MEXICO (1979); CHURCH ROCK, NEW MEXICO (1979)

FIGURE B3-8

EXISTING WELL AND SPRING LOCATIONS

PREPARED FOR

UNC MINING AND MILLING
CHURCH ROCK OPERATIONS

D'APPOLONIA

TABLE B3.15

Records of Wells and Springs in the Vicinity of Church Rock Mill Site(1)

Reference Number	Location(2)	BIA Number	Elev. (Feet)	Depth (Feet)	Aquifer(3)	Water Level (Feet)	Water Level (Date)	Yield During Test, (gpm)	Use of Water(4)
1	16.15.17	16T-348	6900	410	Kd	flow 87	1957 1974	8	D,S
2	16.16. 1	16-K319	7128	963	Kd	320	1948	7	D,S
3	16.16. 6	14N-70	7010	---	Kcd	---	----	0.5	D,S
4	16.16. 6		7030						
5	16.16.11		68755		Qal				
6	16.16.14		6838		Qal				
7	16.16.14		6905	525	Jmw	54	1974		D,S
8	16.16.15	16T-513	6875	318	Jmw	181 275P(5)	1959 1974	33	D,S
9	16.16.16		6799		Qal	 144	 1968		
10	16.16.17		6808		Jmw	319	1974		
11	16.16.17	16T-532	6810	450	Kd				
12	17.15.30	15T-303	7038	614	Kg	305 318P	1952 1974	23	D,S
13	17.16.32	14K-313	7010	622	Kg	235	1953	20	D,S
14	17.16.35		7180	1650	Jmw-Kd	900	1969	20	D

(1) Shomaker, (1974).

(2) See Figure B3-8 for locations.

(3) Aquifers: Qal, alluvium, Kcc - Crevasse Canyon Formation, Kcd - Dalton Sandstone Member of Crevasse Canyon Formation, Kmf - Menefee Formation, Kpl - Point Lookout Sandstone, Kg - Gallup Sandstone, Km - Mancos Shale, Kd - Dakota Sandstone, Jmw - Westwater Canyon Sandstone Member of Morrison Formation, Jcs - Cow Springs Sandstone

(4) D = Domestic.
S = Stock Watering.

(5) P = Pump level data

NAVAJO NATION / OSE
HEARING G-11-A

SIMULATED LOADING OF EXISTING WELLS

Date:
3/10/95

Produced By:
SES

Checked By:
WPB

File Name:
MODEL.apr

EXHIBIT 30

BGW

BALLEAU GROUNDWATER, INC.

DAKOTA WELLS WITH SIMULATED 30 YEAR LOADINGS

NUMBER	WELL NUMBER	WELL NAME	WELL USE	OPERATOR	ELEVATION (FEET AMSL)	DEPTH (FEET)	STATIC WATER LEVEL (FEET)	DATE	MODEL ROW_COL	30 YEAR DAKOTA DRAWDOWN (FEET)	DRAWDOWN AS PERCENTAGE OF STATIC WATER-LEVEL
1	16T-540	MANUELITO	DOM	TRIBE O&M	6278	400	n/a	n/a	56 - 11	0.0	-
2	HASSEL	USIS HASSEK WELL	UNK	HASSEL	7140	1000	n/a	n/a	31 - 43	0.1	-
3	TIDEWATER001	TIDEWATER OIL CO	IND	TIDEWATER	7420	494	n/a	n/a	36 - 39	0.1	-
4	18T-328	18 108-05.10X16.70	DOM	TRIBE O&M	6740	1358	n/a	n/a	55 - 7	0.1	-
5	16-0678	NA 95-795	DOM	IHS/OEHE	6330	1916	-31	9/20/96	54 - 12	0.8	-
6	16T-544	SPENCER VALLEY	DOM	TRIBE O&M	6395	1190	n/a	n/a	54 - 12	0.8	-
7	14-UNK-0004	06N 17W 05 411	LIV	BRUTON	6950	405	n/a	n/a	28 - 14	6.1	-
8	16T-588	CASAMERA LAKE	MUN	NTUA	7080	700	443	7/26/76	29 - 45	0.05	0.01
9	16T-501		LIV	TRIBE O&M	7270	995	665	8/26/59	28 - 47	0.1	0.01
10	SMIT LAKE 01	SMITH LAKE MISSION	DOM	MISSION	7250	679	355	6/8/55	33 - 42	0.1	0.02
11	16T-597	SMITH LAKE #2	MUN	NTUA	7228	1939	474.6	11/16/78	31 - 42	0.1	0.03
12	16B-37		LIV	PRIVATE	7186	812	360	n/a	28 - 44	0.1	0.04
13	16T-594	SMITH LAKE #1	MUN	NTUA	7216	2024	407	2/27/78	30 - 42	0.2	0.04
14	15-UNK-0013	16N 10W 18 133B	OTH	CONOCO	6924	1902	350.5	8/5/82	24 - 45	0.3	0.1
15	16K-318	TIDEWATER OIL CO WELL	UNK	UNKNOWN	7410	292	230	10/3/48	33 - 39	0.3	0.1
16	16T-592	16N 14W 11 2223	UNK	TRIBE O&M	7365	1400	602	5/1/77	27 - 36	1.4	0.2
17	16-0671		DOM	MANUELITO	6278	423.5	15	7/26/94	56 - 11	0.0	0.3
18	15-UNK-0009	17N.12W.28.1413	OTH	MOBIL OIL	6817	1750	219.9	5/5/82	24 - 40	0.7	0.3
19	16P-101	17N.13W.16.442	OTH	MOBIL OIL	6765	1800	123.5	8/1/83	25 - 37	1.3	1.0
20	15-UNK-0002	17N 14W 13 1144C	OTH	NUCLEAR	6757	1728	76.2	8/4/82	25 - 35	1.8	2.4
21	16T-608		LIV	TRIBE O&M	6780	417	79	7/3/80	41 - 24	3.4	4.3
22	16T-510	NOSE ROCK WELL	LIV	TRIBE O&M	6818	680	103.5	8/30/60	44 - 18	7.7	7.4

WESTWATER WELLS WITH SIMULATED 30 YEAR LOADINGS

NUMBER	WELL NUMBER	WELL NAME	WELL USE	OPERATOR	ELEVATION (FEET AMSL)	DEPTH (FEET)	STATIC WATER LEVEL (FEET)	DATE	MODEL ROW_COL	30 YEAR WESTWATER DRAWDOWN (FEET)	DRAWDOWN AS PERCENTAGE OF STATIC WATER-LEVEL
1	16K-525		LIV	TRIBE O&M	7240	1221	n/a	n/a	31 - 42	0.9	–
2	28U-321P	17N 12W 28 1413	OTH	MOBIL OIL	6816	2106	n/a	n/a	24 - 40	2.3	–
3	PATH 320	17N R13W 32 231	OTH	PATHFINDER	7150	2000	n/a	n/a	26 - 37	5.0	–
4	VWC-1	17 14W 13 114HA	OTH	NUCLEAR	6759.5	2225	n/a	n/a	25 - 35	7.3	–
5	BRNHM WSW1	NR048.0400X1690	LIV	EPNG	5746	5250	n/a	n/a	9 - 15	0.8	–
6	BRRGO PS PM3	BORREGO PASS PM3	DOM	BIA	7300	2023	756	9/7/72	26 - 44	0.8	0.1
7	SMIT LAKE 03	SMITH LAKE T.P. TEST WELL	OTH	TRDG POST	7260	1100	600	11/30/72	32 - 42	0.8	0.1
8	15-UNK-0012	16N 10W 18 133D	OTH	CONOCO	6924	2111	424.8	4/1/83	24 - 45	0.8	0.2
9	16T-558		LIV	TRIBE O&M	7585	1600	790	8/5/71	28 - 38	3.6	0.5
10	15-UNK-0010	17N.12W.28.1413	IND	MOBIL OIL	6820	2140	371.4	6/25/85	24 - 40	2.3	0.6
11	LANCE BJ-2	LANCE CORP BLACKJACK -2	IND	LANCE CORP	7426	350	210	7/11/61	37 - 39	1.4	0.7
12	15-0581	CONOCO #2 (NTUA)	MUN	NTUA	6875	2377	443.2	6/21/83	24 - 39	2.9	0.7
13	15-0579	CROWNPOINT #1	MUN	NTUA	6950	2345	423	3/13/75	24 - 39	2.9	0.7
14	15-0580	15-UNK-0006/17N 12W 173333	OTH	CONOCO	6874	2450	349.6	12/13/75	24 - 39	2.9	0.8
15	PU-279	17N 13W 09 321	OTH	MOBIL OIL	6702	2060	274.2	6/28/85	24 - 37	4.5	1.6
16	15L-73	MOBIL 15L-73	OTH		6752	2100	293.9	8/1/83	25 - 37	4.8	1.6
17	94-202	17N 13W 09 3212	OTH	MOBIL OIL	6699	2120	269.7	6/28/85	24 - 37	4.5	1.7
18	15-UNK-0001	17N 14W 13 1144B	OTH	NUCLEAR	6757	2225	332.4	8/4/82	25 - 35	7.3	2.2
19	KM CR II W-2	KERR-MCGEE W-2	OTH	KERR-MCGEE	7290	2514	1370.5	4/24/80	32 - 23	34.0	2.5
20	16T-534	NR106.0820X1070	DOM	TRIBE O&M	6825	410	250	7/29/65	47 - 17	8.1	3.3
21	15-0586	STANDING ROCK #1	MUN	NTUA	6497	2688	87.3	6/7/80	24 - 33	8.6	9.8
22	16T-513	16N 16W 15 4322	DOM	TRIBE O&M	6875	318	182	7/27/59	40 - 28	42.3	23.3

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF THE
GENERAL COUNSEL

January 5, 1998

10

By________

Chief Administrative Judge
B. Paul Cotter, Jr., Esq.*
Presiding Officer
Atomic Safety and Licensing Board
Mail Stop T-3 F23
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Administrative Judge
Thomas D. Murphy*
Special Assistant
Atomic Safety and Licensing Board
Mail Stop T-3 F23
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

In the Matter of
HYDRO RESOURCES, INC.
Docket No. 40-8968-ML

Dear Judges Cotter and Murphy:

The Staff is issuing a source material license to Hydro Resources, Inc. (HRI) in the above-captioned matter. The Staff's letter to HRI dated January 5, 1998 and a copy of the license are attached.

Sincerely,

John T. Hull
Counsel for NRC Staff

Attachments: As Stated

cc w/attachments: Service List

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 05, 1998

Mr. Richard F. Clement, Jr., President
Hydro Resources, Inc.
2929 Coors Blvd., NW
Suite 101
Albuquerque, NM 87120

SUBJECT: ISSUANCE OF SOURCE MATERIAL LICENSE SUA-1508, FOR THE IN SITU LEACH URANIUM MINING PROJECT AT CROWNPOINT, NEW MEXICO

Dear Mr. Clement:

The U.S. Nuclear Regulatory Commission staff has completed its review of Hydro Resources, Inc.'s (HRI's) license application, dated April 25, 1988 (as supplemented by the licensee submittals listed in Attachment A of the enclosed source material license SUA-1508), and the Crownpoint Uranium Project Consolidated Operations Plan (COP), Rev. 2.0, dated August 15, 1997. Based on its review of these documents as discussed below, the NRC staff hereby issues HRI a source material license SUA-1508 for its in situ leach uranium mining project at Crownpoint, NM, effective January 5, 1998.

The NRC staff determined, in accordance with 10 CFR 51.20 and 10 CFR 51.25, that preparation of an environmental impact statement (EIS) was necessary to document its review. The NRC staff issued a final EIS (FEIS) for the Crownpoint Project in February 1997 documenting its environmental review. Based on its review, the NRC staff concluded that HRI's proposed Crownpoint Project was environmentally acceptable, and that potential impacts of the proposed project could be mitigated. These mitigative measures are enumerated as conditions in the enclosed source material license.

In addition, the NRC staff conducted its safety review of the Crownpoint Project, and documented its analyses in the Safety Evaluation Report, dated December 4, 1997. Based on its review, the NRC staff concluded that issuance of a source material license, with certain conditions specified in the enclosed license, would not be inimical to the common defense and security or to the public's health and safety, and otherwise meets the applicable requirements of 10 CFR Parts 19, 20, 40, and 71, and the Atomic Energy Act of 1954, as amended.

The SER and the FEIS provide the bases for the NRC's decision to issue a 10 CFR Part 40 source material license to HRI. As such, HRI's source material license SUA-1508 is enclosed, and is valid for five years from its effective date. HRI will be required to submit a license renewal application six months prior to the expiration date of January 5, 2003.

If you have any questions concerning this subject, please contact Mr. Robert Carlson of my staff at (301) 415-8165.

Sincerely,

Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated

Docket No. 40-8968
License No. SUA-1508

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee

1. Hydro Resources, Inc.
2929 Coors Blvd, NW
Suite 101
Albuquerque, NM 87120

2.

3. License Number SUA-1508

4. Expiration Date January 5, 2003

5. Docket or Reference No. 40-8968

6. Byproduct, Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum Amount that Licensee May Possess at Any One Time Under This License
Uranium	Any	Unlimited

SECTION 9: ADMINISTRATIVE CONDITIONS

9.1 The authorized place of use shall be the licensee's Crownpoint Uranium Project which includes the Crownpoint, Unit 1, and Church Rock uranium recovery and processing facilities in McKinley County, New Mexico.

9.2 All written notices and reports required under this NRC license (with the exception of effluent monitoring reports required under License Condition (LC) 12.3 and 10 CFR Part 40.65, which shall also be submitted to Region IV) shall be addressed to the Chief, Uranium Recovery Branch, Division of Waste Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Mail Stop T-7J9, Washington, DC 20555. Incidents and events that require telephone notification shall be made to the NRC Operations Center at (301) 816-5100.

9.3 The licensee shall conduct operations in accordance with all commitments, representations, and statements made in its license application submitted by cover letter dated April 25, 1988 (as supplemented by the licensee submittals listed in Attachment A), and in the Crownpoint Uranium Project Consolidated Operations Plan (COP), Rev. 2.0, dated August 15, 1997 - except where superseded by license conditions contained in this license. Whenever the licensee uses the words "will" or "shall" in the aforementioned licensee documents, it denotes an enforceable license requirement.

9.4 A) The licensee may, without prior NRC review or approval: (i) make changes in the Crownpoint Project's facilities or processes as described in the COP (Rev. 2.0); (ii) make changes in its standard operating procedures; and (iii) conduct tests or experiments, if the licensee ensures that the following conditions are met:

(1) the change, test, or experiment does not conflict with any requirement specifically stated in this license, or impair the licensee's ability to meet all applicable NRC regulations;

(2) there is no degradation in the safety or environmental commitments made in the Crownpoint Uranium Project Consolidated Operations Plan (COP), Revision 2.0, or in the approved reclamation plan for the Crownpoint Project; and

(3) the change, test, or experiment is consistent with NRC's findings in NUREG-1508, the Final Environmental Impact Statement (FEIS, dated February 1997) and the Safety Evaluation Report (SER, dated December 1997) for the Crownpoint Project.

If any of these conditions are not met for the change, test, or experiment under consideration, the licensee is required to submit a license amendment application for NRC review and approval. The licensee's determinations as to whether the above conditions are met will be made by a Safety and Environmental Review Panel (SERP). All such determinations shall be documented, and the records kept until license termination. All such determinations shall be reported annually to the NRC, pursuant to LC 12.8. The retained records shall include written safety and environmental evaluations, made by the SERP, that provide the basis for determining whether or not the conditions are met.

B) The SERP shall consist of a minimum of three individuals employed by the licensee, and one of these shall be designated the SERP chairman. One member of the SERP shall have expertise in management and shall be responsible for managerial and financial approval changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and, one member shall be the Environmental Manager, with the responsibility of ensuring that changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP as appropriate, to address technical aspects such as health physics, groundwater hydrology, surface-water hydrology, specific earth sciences, and other technical disciplines. Temporary members or permanent members, other than the three above-specified individuals, may be consultants.

9.5 As a prerequisite to operating under this license, the licensee shall submit an NRC-approved surety arrangement to cover the estimated costs of decommissioning, reclamation, and groundwater restoration. Generally, these surety amounts shall be determined by the NRC based on cost estimates for a third party completing the work in case the licensee defaults. Surety for groundwater restoration of the initial well fields shall be based on 9 pore-volumes. Surety shall be maintained at this level until the number of pore volumes required to restore the groundwater quality of a production-scale well field has been established by the restoration demonstration described in LC 10.28. If at any time it is found that well field restoration requires greater pore-volumes or higher restoration costs, the value of the surety will be adjusted upwards. Upon NRC approval, the licensee shall maintain the NRC-approved financial surety arrangement consistent with 10 CFR Part 40, Appendix A, Criterion 9.

Annual updates to the surety amount, required by 10 CFR Part 40, Appendix A, Criterion 9, shall be provided to the NRC at least 3 months prior to the anniversary date of the license issuance. If the NRC has not approved a proposed revision 30 days prior to the expiration date of the existing surety arrangement, the licensee shall extend the existing arrangement, prior to expiration, for 1 year. Along with each proposed revision or annual update of the surety the licensee shall submit supporting documentation showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation (i.e., using the approved Urban Consumer Price Index), maintenance of a minimum 15 percent contingency, changes in engineering plans, activities performed, and any other conditions affecting estimated costs for site closure.

The licensee shall provide an NRC-approved updated surety before undertaking any planned expansion or operational change which has not been included in the annual surety update. This surety update shall be provided to the NRC at least 90 days prior to the commencement of the planned expansion or operational change.

The licensee shall also provide the NRC with copies of surety-related correspondence submitted to the State of New Mexico, a copy of the State's surety review, and the final approved surety arrangement. The licensee must also ensure that the surety, where authorized to be held by the State, identifies the NRC-related portion of the surety and covers the above-ground decommissioning and decontamination, the cost of off-site disposal, soil and water sample analyses, and groundwater restoration activities associated with the site. The basis for the cost estimate is the NRC-approved site closure plan or the NRC-approved revisions to the plan.

9.6 The licensee shall dispose of 11e.(2) byproduct material from the Crownpoint Project at a waste disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. At each project site, the licensee shall maintain an area within the restricted area boundary for storing contaminated materials prior to their disposal. The licensee's approved waste disposal agreement must be maintained on-site. Should this agreement expire or be terminated, the licensee shall notify the NRC pursuant to LC 12.6. A new agreement shall be ratified within 90 days of expiration or termination of the previous agreement, or the licensee will be prohibited from further lixiviant injection.

9.7 The licensee shall implement and maintain a training program for all site employees as described in Regulatory Guide 8.31, and as detailed in the COP of the approved license application. All training materials shall incorporate the information from current versions of 10 CFR Part 19 and 10 CFR Part 20. Additionally, classroom training shall include the subjects described in Section 2.5 of Regulatory Guide 8.31. All personnel shall attend annual refresher training, and the licensee shall conduct regular safety meetings on at least a bi-monthly basis, as described in Section 2.5 of Regulatory Guide 8.31

The Radiation Safety Officer (RSO), or his designee, shall have the education, training and experience as specified in Regulatory Guide 8.31. A Radiation Safety Technician (RST) shall have the qualifications specified in Regulatory Guide 8.31. Any person newly hired as an RST shall have all work reviewed and approved by the RSO as part of a comprehensive training program until appropriate course training is completed, and at least for 6 months from the date of appointment.

9.8 Written standard operating procedures (SOPs) shall be established and followed for: (1) all operational activities involving radioactive materials that are handled, processed, stored, or transported by employees; (2) all non-operational activities involving radioactive materials including in-plant radiation protection and environmental monitoring; and (3) emergency procedures for potential accident/unusual occurrences including significant equipment or facility damage, pipe breaks and spills, loss or theft of yellowcake or sealed sources, and significant fires. The SOPs shall include appropriate radiation safety practices to be followed in accordance with 10 CFR Part 20. SOPs for operational activities shall enumerate pertinent radiation safety practices to be followed. A copy of the current written procedures shall be kept in the area(s) of the production facility where they are utilized. All SOPs for activities described in the COP shall be reviewed and approved as presently described in the COP.

9.9 Release of equipment, materials, or packages from the restricted area shall be in accordance with NRC staff position, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials,"

dated May 1987, or suitable alternative procedures approved by the NRC prior to any such release.

9.10 Any corporate organization changes affecting the assignments or reporting responsibilities of the radiation safety staff as described in the COP of the approved license application shall conform to Regulatory Guide 8.31.

9.11 The licensee is hereby exempted from the requirements of 10 CFR Section 20.1902(e) for areas within the process facility, provided that all entrances to the facility are conspicuously posted in accordance with Section 20.1902(e), and with the words, "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

9.12 Before engaging in any construction activity not previously assessed by the NRC, the licensee shall conduct a cultural resource inventory. All disturbances associated with the proposed development will be completed in compliance with the National Historic Preservation Act of 1966, as amended, and its implementing regulations (36 CFR Part 800), and the Archaeological Resources Protection Act of 1979, as amended, and its implementing regulations (43 CFR Part 7).

In order to ensure that no unapproved disturbance of cultural resources occurs, any work resulting in the discovery of previously unknown cultural artifacts shall cease. The artifacts shall be inventoried and evaluated in accordance with 36 CFR Part 800, and no disturbance shall occur until the licensee has received written authorization to proceed from the State and Navajo Nation Historic Preservation Offices.

9.13 Prior to injection of lixiviant, the licensee shall have all applicable Memoranda of Agreements (MOAs) between the licensee and local authorities, the fire department, medical facilities, and other emergency services, ratified and in effect. At a minimum, the MOAs shall identify individual party responsibilities, coordination requirements, and reporting procedures for all emergency incident responses.

9.14 Prior to injection of lixiviant, the licensee shall obtain all necessary permits and licenses from the appropriate regulatory authorities.

SECTION 10: OPERATIONS, CONTROLS, LIMITS, AND RESTRICTIONS

10.1 The licensee shall use a lixiviant composed of native ground water, carbon dioxide gas or sodium bicarbonate, and dissolved oxygen or air, as specified in the COP of the approved license application.

10.2 The processing plant flow rate at each site (Church Rock, Unit 1, or Crownpoint) shall not exceed 4000 gal/min (15,140 L/min), exclusive of restoration flow. Total yellowcake production from all three sites shall not exceed 3 million lbs (1.36 million kg) annually.

10.3 Injection well operating pressures shall be maintained at less than formation fracture pressures, and shall not exceed the well's mechanical integrity test pressure.

10.4 Only steel or fiber glass well casing shall be used at the Unit 1 and Crownpoint sites for all wells completed into the Dakota Sandstone, Westwater Canyon, and Cow Springs aquifers.

10.5 A leak detection monitoring system shall be installed for all retention ponds. The licensee shall measure and document pond freeboard and fluid levels in the leak detection system daily, including weekends and holidays. If fluid levels greater than 6 in (15.2 cm) are detected

in the leak detection sumps, the fluid in the sumps shall be sampled and analyzed for specific conductance and chloride. Elevated levels of these parameters shall confirm a retention pond liner leak, at which time the licensee shall take the following corrective actions: (a) analyze standpipe water quality samples for leak parameters once every 7 days during the leak period, and once every 7 days for at least 14 days following repairs; and (b) locate and repair the area of liner damage. After a confirmed leak, the licensee shall also file a report pursuant to LC 12.2. At all times, sufficient reserve capacity shall be maintained in the retention pond system to enable transferring the contents of one pond to the other ponds. In the event of a leak and subsequent transfer of liquid, the freeboard requirements may be suspended during the repair period.

10.6 At the Crownpoint site, from initial lixiviant injection through the completion of groundwater restoration activities, the licensee shall at all times maintain sufficient emergency generator capacity to provide a 50 gal/min (189 L/min) bleed from the Westwater Canyon aquifer. The licensee shall document all required uses of the emergency generator, pursuant to LC 11.1.

10.7 Liquid oxygen tanks shall be located within the well fields. Other chemical storage tanks shall be located on the concrete pad near a waste retention pond. All yellowcake shall be stored inside the designated restricted area.

10.8 For all required types of surveys, the licensee shall, at a minimum, use the survey locations, frequencies, and lower limits of detection established in Table 2 of Regulatory Guide 8.30. Additionally, all radiation survey instruments shall be operationally checked in conformance with Regulatory Guide 8.30.

10.9 The licensee shall ensure that the manufacturer-recommended vacuum pressure is maintained in the drying chamber during all periods of yellowcake drying operations. This shall be accomplished by continuously monitoring differential pressure and installing instrumentation which will signal an audible alarm if the air pressure differential falls below the manufacturer's recommended levels. The alarm's operability shall be checked and documented daily. Additionally, yellowcake drying operations shall be immediately suspended if any emission control equipment for the yellowcake drying or packaging areas is not operating within specifications for design performance.

10.10 All liquid effluents from process buildings and other process waste streams, with the exception of sanitary wastes, shall be disposed of in accordance with the requirements of 10 CFR Part 20, Subpart K.

10.11 Within restricted areas, eating shall be allowed only in designated eating areas.

10.12 An excursion shall have occurred if, in any monitor well: (a) any two upper control limit parameters exceed their respective upper control limits; or (b) a single upper control limit parameter exceeds its upper control limit by 20 percent. A verification sample shall be taken within 24 hours after results of the first analyses are received. If the second sample shows that either of the excursion criteria in (a) or (b) are present, an excursion shall be confirmed. If the second sample does not show that the excursion criteria in (a) or (b) are present, a third sample shall be taken within 48 hours after the second set of sampling data was acquired. If the third sample shows that either of the excursion criteria in (a) or (b) are present, an excursion shall be confirmed. If the third sample does not show that the excursion criteria in (a) or (b) are present, the first sample shall be considered to be an error.

10.13 If an excursion is not corrected within 60 days of confirmation, the licensee shall either: (a) terminate injection of lixiviant within the well field until aquifer cleanup is complete; or (b)

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increase the surety in an amount to cover the full third-party cost of correcting and cleaning up the excursion. The surety increase for horizontal and vertical excursions shall be calculated using the method described on page 4-22, Section 4.3.1 of the FEIS. The surety increase shall remain in force until the NRC has verified that the excursion has been corrected and cleaned up. The written 60-day excursion report, filed pursuant to LC 12.1, shall identify which course of action [(a) or (b) listed above] the licensee is taking.

10.14 At the Unit 1 or Crownpoint sites, if a vertical excursion is confirmed in the Dakota Sandstone aquifer, the licensee shall complete and sample monitor wells to determine if the vertical excursion has impacted any other overlying aquifers that could sustain yields greater than 150 gal/day (568 L/day). The specific aquifers to be monitored shall be identified in the licensee's 60-day excursion report, filed pursuant to LC 12.1.

10.15 At the Crownpoint site, from initial lixiviant injection through the completion of groundwater restoration activities, the licensee shall maintain a continuous bleed (pumping) until the groundwater quality in the well fields has been determined by the NRC to be fully restored to the required limits established pursuant to LC 10.21.

10.16 During groundwater restoration activities at production-scale well fields within either the Unit 1 or Crownpoint sites, the licensee shall reimburse the operators of the Crownpoint water supply wells for any increased pumping and well work-over costs associated with a drop in water levels due to groundwater restoration activities. This reimbursement requirement does not apply to restoration demonstrations of small-scale well fields.

10.17 Prior to injection of lixiviant in a well field, monitor wells shall be completed in the Westwater Canyon aquifer and shall encircle the well field at a distance of 400 ft (122 m) from the edge of the production or injection wells and 400 ft (122 m) between each monitor well. The angle formed by lines drawn from any production well to the two nearest monitor wells shall not exceed 75 degrees. At the Church Rock site, Westwater Canyon aquifer monitor wells shall be located by treating production mine workings as if they were injection or production wells. Sampling frequencies for all monitor wells completed in the Westwater Canyon aquifer shall be as stated in LC 11.3.

10.18 Prior to injection of lixiviant in a well field at the Unit 1 or Crownpoint sites, monitor wells shall be completed in the Dakota Sandstone aquifer. Such wells shall be placed at a minimum density of one well per 4 acres (1.62 ha) of well field. Sampling frequencies for these wells shall be as stated in LC 11.3.

10.19 Prior to injection of lixiviant at the Unit 1 site, the licensee shall complete a minimum of three monitor wells in the overlying Dakota Sandstone aquifer between the well fields and the town of Crownpoint water supply wells, in addition to the wells required by LC 10.18. Groundwater restoration goals and upper control limits for these wells will be established pursuant to LCs 10.21 and 10.22, except that upper control limits shall be established for these wells on a well-by-well basis. Sampling frequencies for these wells shall be as stated in LC 11.3.

10.20 Prior to injection of lixiviant in a well field at the Church Rock site, monitor wells shall be completed in: (a) the Brushy Basin "B" sand aquifer; and (b) the Dakota Sandstone aquifer. Monitor wells completed in the Brushy Basin "B" sand aquifer shall be placed at a minimum density of one well per 4 acres (1.62 ha) of well field. Monitor wells completed in the Dakota sandstone aquifer shall be placed at a minimum density of one well per 8 acres (3.24 ha) of well field. Any openings of the existing mine workings into the Brushy Basin "B" sand, or Dakota Sandstone aquifers, shall be monitored by Brushy Basin "B" sand or Dakota Sandstone monitor wells placed within 40 ft (12 m) of the openings. These wells shall be

placed down-gradient from the openings. Sampling frequencies for all monitor wells completed in the Brushy Basin and Dakota Sandstone aquifers shall be as stated in LC 11.3.

10.21 Lixiviant shall not be injected into a well field before groundwater quality data is collected and analyzed to establish groundwater restoration goals for each monitored aquifer of the well field, as follows:

A) The licensee shall establish groundwater restoration goals by analyzing three independently-collected groundwater samples of formation water from: (1) each monitor well in the well field; and (2) a minimum of one production/injection well per acre of well field. Samples shall be collected a minimum of 14 days apart from each other. Groundwater restoration goals shall be established on a parameter-by- parameter basis, with the primary restoration goal to return all parameters to average pre-lixiviant injection conditions. If groundwater quality parameters cannot be returned to average pre-lixiviant injection levels, the secondary goal shall be to return groundwater quality to the maximum concentration limits as specified in the U.S. Environmental Protection Agency (EPA) secondary and primary drinking water regulations. The secondary restoration goal for barium and fluoride shall be set to the State of New Mexico primary drinking water standard. The secondary restoration goal for uranium shall be 0.44 mg/L (300 pCi/L).

B) In establishing restoration goals, the following parameters shall be measured: alkalinity, ammonium, arsenic, barium, bicarbonate, boron, cadmium, calcium, carbonate, chloride, chromium, copper, fluoride, electrical conductivity, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrate, pH, potassium, combined radium-226 and radium-228, selenium, sodium, silver, sulfate, total dissolved solids, uranium, vanadium, zinc, gross Beta, and gross Alpha (excluding radon, uranium, and radium). The restoration goal for each of these parameters shall be established by calculating the baseline mean of the data collected. Prior to calculating a groundwater restoration goal for a parameter, outliers shall be eliminated using methods consistent with those specified in EPA's 1989, "Statistical Analysis of Ground-Water Monitoring Data at RCRA [Resource Conservation and Recovery Act] Facilities, Interim Guidance." Parameter concentrations determined to be high or low outliers will not be used in establishing groundwater restoration goals.

10.22 Lixiviant shall not be injected into a well field before groundwater quality data is collected and analyzed to establish upper control limits for each monitored aquifer of the well field, as follows:

A) The licensee shall analyze three independently-collected groundwater samples of formation water from each monitor well in the well field. Samples shall be collected a minimum of 14 days apart from each other.

B) The upper control limit parameters shall be chloride, bicarbonate, and electrical conductivity [corrected to a temperature of 25°C (77°F)]. The concentrations of these upper control limit parameters shall be established for each well field by calculating the baseline mean of the upper control limit parameter concentration, and adding 5 standard deviations. Prior to calculating upper control limits, outliers shall be eliminated using methods consistent with those specified in EPA's 1989, "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance". Values determined to be high and low outliers will not be used in the calculation of upper control limits.

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10.23 Prior to injection of lixiviant in a well field, groundwater pump tests shall be performed to determine if overlying aquitards are adequate confining layers, and to confirm that horizontal monitor wells for that well field are completed in the Westwater Canyon aquifer.

10.24 The licensee shall perform mechanical well integrity tests on each injection and production well: (a) before the well is first used for *in situ* leach uranium extraction; (b) after each time the well has been serviced with equipment or otherwise subjected to procedures that could damage well casing; and (c) at least once every 5 years the well is in use. After a well has been completed and opened into the aquifer, a packer shall be set above the well screen and each well casing shall be filled with water. The well shall be pressurized with either air or water to 125 psi (862 kPa) at the land surface, or 25 percent above the expected operating pressure, whichever is greater. A well shall have passed the test if a pressure drop of no more than 10 percent occurred over 30 minutes.

10.25 If it is determined that a vertical connection exists in a well field between the Westwater Canyon aquifer and the Cow Springs aquifer, monitor wells will be completed in the Cow Springs aquifer within that well field at a minimum density of one well per 4 acres (1.62 ha) of well field. Groundwater restoration goals and upper control limits will be established for these wells, pursuant to LCs 10.21 and 10.22. Sampling frequencies for all monitor wells completed in the Cow Springs aquifer shall be as stated in LC 11.3.

10.26 Prior to injecting lixiviant at a site, or processing licensed material at the Crownpoint site, HRI shall provide and receive NRC acceptance - for that site - information, calculations, and analyses to document the adequacy of the design of waste retention ponds and their associated embankments (if applicable), liners, and hydrologic site characteristics. HRI shall demonstrate that the criteria described in the following documents have been met: 10 CFR Part 40, Appendix A, Criterion 5A regarding surface impoundment design; Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills"; WM-8201, "Hydrologic Design Criteria for Tailings Retention Systems,"; and Final Staff Technical Position, "Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites." As applicable, based on the designs selected, HRI shall provide information in the following areas:

A) maps and detailed drawings outlining drainage areas of principal water courses and drainage features at the site;

B) drainage basin characteristics, including soil types and characteristics, vegetative cover, local topography, flood plains, geomorphic characteristics, and surficial and bedrock geology;

C) maps and detailed drawings showing the location of site features, particularly the location of the retention ponds and diversion channels;

D) analyses and calculations for peak flood flows, including the PMF, and documenting the methods and assumptions used to compute the floods;

E) analyses and calculations for water surface profiles and velocities associated with the ability of the retention ponds or diversion channels to resist or limit erosion and flooding;

F) analyses and computations of riprap or erosion protection needed to protect the retention ponds;

G) specific details on the design, construction, maintenance, and operation of the waste retention ponds and embankments (where applicable);

H) specific details on the design, construction, maintenance, and operation of the liners and leak detection system.

I) any other analyses and computations which demonstrate that applicable design criteria have been met.

10.27 Prior to the injection of lixiviant at the Crownpoint site, the licensee shall:

A) Replace the town of Crownpoint's water supply wells NTUA-1, NTUA-2, BIA-3, BIA-5, and BIA-6, construct the necessary water pipeline, and provide funds so the existing water supply systems of the Navajo Tribal Utility Authority (NTUA) and the Bureau of Indian Affairs (BIA) can be connected to the new wells. Any new wells, pumps, pipelines, and other changes to the existing water supply systems, made necessary by the replacement of the wells specified above, shall be made such that the systems can continue to provide at least the same quantity of water as the existing systems. The new wells shall be located so that the water quality at each individual well head does not exceed the EPA's primary and secondary drinking water standards, and does not exceed a concentration of 0.44 mg/L (300 pCi/L) uranium, as a result of *in situ* leach uranium extraction activities at the Unit 1 and Crownpoint sites. To determine the appropriate placement of the new wells, the licensee shall coordinate with the appropriate agencies and regulatory authorities, including BIA, NTUA, the Navajo Nation Department of Water Development and Water Resources, and the Navajo Nation EPA.

B) Abandon and seal wells NTUA-1, NTUA-2, BIA-3, BIA-5, and BIA-6 in accordance with applicable requirements so these wells cannot become future pathways for the vertical movement of contaminants.

10.28 Prior to the injection of lixiviant at either the Unit 1 or Crownpoint site, the licensee shall submit NRC-approved results of a groundwater restoration demonstration conducted at the Church Rock site. The demonstration shall be conducted on a large enough scale, acceptable to the NRC, to determine the number of pore volumes that shall be required to restore a production-scale well field.

10.29 Before starting uranium extraction operations beyond the first well field at the Church Rock site, the licensee shall submit an NRC-approved groundwater restoration plan for the entire project. At a minimum, this plan shall include: (a) a proposed restoration schedule; (b) a general description of the restoration methodology; and (c) a description of post-restoration groundwater monitoring.

10.30 Prior to injecting lixiviant at any of the sites, the licensee shall submit an NRC-approved procedure-level, detailed effluent and environmental monitoring program. In addition, the licensee shall develop and administer its radiological effluent and environmental monitoring program consistent with Regulatory Guide 4.14. The licensee shall maintain, at a minimum, three airborne effluent monitoring stations at each site, at the locations described in COP (Rev.2.0) Table 9.5-1.

10.31 Prior to the injection of lixiviant at the Church Rock site, the licensee shall conduct a Westwater Canyon aquifer step-rate injection (fracture) test within the Church Rock site boundaries, but outside future well field areas. One such test at the Unit 1 or Crownpoint site shall also be performed before lixiviant injection begins at either of these sites.

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10.32 Prior to the injection of lixiviant at any of the sites, the licensee shall: (a) collect sufficient water quality data to generally characterize the water quality of the Cow Springs aquifer beneath each of the project sites, by completing and sampling wells for the following water quality parameters: alkalinity, ammonium, arsenic, barium, bicarbonate, boron, cadmium, calcium, carbonate, chloride, chromium, copper, fluoride, electrical conductivity, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrate, pH, potassium, combined radium-226 and radium-228, selenium, sodium, silver, sulfate, total dissolved solids, uranium, vanadium, zinc, gross Beta and gross Alpha (excluding radon, uranium, and radium); and (b) *conduct sufficient pumping tests to determine if the Cow Springs aquifer beneath each of the* sites is hydraulically confined from the Westwater Canyon aquifer.

SECTION 11: MONITORING, RECORDING AND BOOKING REQUIREMENTS

11.1 The results of the following activities, operations, or actions shall be documented: sampling; analyses; surveys or monitoring; survey/ monitoring equipment calibrations; reports on audits and inspections; emergency generator use and maintenance records; all meetings and training courses required by this license; and any subsequent reviews, investigations, or corrective actions. Unless otherwise specified in a license condition or applicable NRC regulation, all documentation required by this license shall be maintained for a period of at least five (5) years by the licensee at its facility, and is subject to NRC review and inspection.

11.2 Flow rates on each injection and production well, and injection manifold pressures on the entire system, shall be measured and recorded daily.

11.3 Formation water, from monitoring wells at well fields undergoing uranium extraction or groundwater restoration activities, shall be sampled for upper control limit parameters at least once every 14 days, and the results documented pursuant to LC 11.1. During corrective action for a confirmed excursion, sample frequency shall be increased to once every seven days for the upper control limit parameters until the excursion is concluded. An excursion shall be considered corrected when all upper control limit parameters are reduced to their upper control limits.

11.4 Radiation Work Permits shall include, at a minimum, the information described in Section 2.2 of Regulatory Guide 8.31.

11.5 Site inspections and reviews shall be completed and documented by the licensee as described in Section 2.3.1 and 2.3.2 of Regulatory Guide 8.31.

11.6 The licensee shall implement a comprehensive bioassay sampling program that conforms to Regulatory Guide 8.22.

11.7 Until license termination, the licensee shall maintain documentation on all spills of source or 11e.(2) byproduct materials, and all spills of process chemicals. Documented information shall include date, volume of spill, total activity, survey results, corrective actions, results of remediation surveys, and a map showing spill location and impacted area. After any spill the licensee shall also determine whether the NRC must be notified, pursuant to LC 12.4.

11.8 Prior to land application of waste water, the licensee shall submit and receive NRC acceptance of a plan outlining how the licensee will monitor constituent buildup in soils resulting from the land application. The plan should identify the constituents resulting from land application that will be monitored, constituent threshold values for discontinuing land application and justification for the values selected.

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SECTION 12: REPORTING REQUIREMENTS

12.1 The licensee shall notify the NRC by telephone within 24 hrs of confirming a lixiviant excursion, and by letter within 7 days from the time the excursion is confirmed, pursuant to LC 10.12. A written report describing the excursion event, corrective actions taken, and the corrective action results shall be submitted to NRC within 60 days of the excursion confirmation. If wells are still on excursion when the report is submitted, the report shall also contain a schedule for submitting additional reports to the NRC describing the excursion event, corrective actions taken, and results obtained. In the case of a confirmed vertical excursion, the report shall also contain a projected completion date for characterization of the extent of the vertical excursion.

12.2 The licensee shall notify the NRC by telephone within 48 hours of confirming a retention pond liner leak, pursuant to LC 10.5. A written report shall be submitted to the NRC within 30 days of the leak confirmation. This report shall include analytical data, describe the corrective action taken, and discuss the results of that action.

12.3 The licensee shall submit the required effluent reports in accordance with 10 CFR Part 40.65. The licensee shall submit the information specified in Section 7 of Regulatory Guide 4.14, in addition to the reports required by 10 CFR Part 40.65.

12.4 The licensee shall notify the NRC by telephone within 48 hours of any spill of source or 11e.(2) byproduct materials, and all spills of process chemicals, that might have a radiological impact on the environment. The notification shall be followed, within 7 days, by submittal of a written report detailing the conditions leading to the spill, corrective actions taken, and results achieved. This shall be done in addition to meeting the requirements of 10 CFR Part 20 and 40.

12.5 In addition to reporting exposures of individuals to radioactive material in accordance with 10 CFR Part 20.2202, the licensee shall submit to the NRC a written report within 30 days of such reportable incidents, detailing the conditions leading to the incident, corrective actions taken, and results achieved.

12.6 In the event the licensee's approved waste disposal agreement expires or is terminated, the licensee shall notify the NRC in writing within 7 working days after the expiration date.

12.7 As part of the licensee's decommissioning activities for a site, the licensee shall submit to the NRC for review and approval a detailed site reclamation plan. The plan shall be submitted at least 12 months prior to the planned final shutdown of uranium extraction operations at the site. If depressions appear at the land surface due to subsurface collapse from *in situ* leach uranium extraction activities, the licensee shall return the land surface to its general contour as part of the surface reclamation activities. Before release of any site to unrestricted use, the licensee shall provide information to the NRC verifying that radionuclide concentrations, due to licensed materials, meet radiation standards for unrestricted release.

12.8 The licensee shall provide in an annual report to NRC, a description of all changes, tests, and experiments made or conducted pursuant to LC 9.4, including a summary of the safety and environmental evaluation of each such action. As part of this annual report, the licensee shall include any COP pages revised pursuant to LC 9.4.

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FOR THE NUCLEAR REGULATORY COMMISSION

Date: Jan 5, 1998

Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

ATTACHMENT A

The licensee shall conduct its operations in accordance with all commitments, representations, and statements made in the following submittals, which are hereby incorporated by reference, except where superseded by license conditions in this license:

- May 8, 1989 (Crownpoint Facility Supplemental Environmental Report)
- July 13, 1989 (Crownpoint Cultural Resources Survey)
- January 6, 1992 (Unit 1 Allotted Lease Program Environmental Assessment (EA))
- July 31, 1992 (Unit 1 and Crownpoint Project Environmental Reports)
- October 9, 1992 (Unit 1 Underground Injection Control (UIC) Application)
- October 30, 1992 (Cultural Resources-Environmental Assessment and Management Plan for Crownpoint, NM)
- March 16, 1993 (Churchrock Project Revised Environmental Report)
- March 16, 1993 (Section 9 Pilot Summary Report)
- April 5, 1993 (page changes)
- April 6, 1993 (page changes)
- July 26, 1993 (page changes)
- October 11, 1993 (page changes)
- October 18, 1993 (Analysis of Hydrodynamic Control at Crownpoint and Churchrock)
- October 19, 1993 (Churchrock Surface Hydrology Analysis)
- October 19, 1993 (Churchrock and Crownpoint Aquifer Modeling Supplement)
- November 11, 1993 (page changes)
- January 24, 1994 (page changes)
- November 20, 1993 (Response to NRC Request for Additional Information)
- February 23, 1994 (Description of Radon Emission Controls)
- January 6, 1995 (EA Allotted Lease Program Unit 1)
- October 9, 1995 (Unit 1 UIC Application)
- February 20, 1996 (Response to NRC Comments)
- April 10, 1996 (Response to NRC Comments)
- May 3, 1996 (Response to NRC Comments)
- June 18, 1996 (Unit 1 Water Quality Information)
- August 15, 1996 (Response to NRC Comments)
- August 16, 1996 (Response to NRC Comments)
- August 21, 1996 (page changes)
- August 30, 1996 (Response to NRC Comments)
- September 5, 1996 (Surface Water Drainage Analysis at Churchrock)
- September 6, 1996 (page changes)
- September 13, 1996 (Response to NRC Comments)
- September 27, 1996 (Response to NRC Comments)
- September 30, 1996 (Crownpoint Uranium Project COP, Rev. 0.0)
- October 15, 1996 (Response to NRC Comments)
- October 18, 1996 (Restoration Standards Commitment)
- October 20, 1996 (Response to NRC Comments)
- October 29, 1996 (Response to NRC Comments)
- November 18, 1996 (Response to NRC Comments)
- November 26, 1996 (Response to NRC Comments)
- December 20, 1996 (NRC Proposed Requirements and Recommendations)
- December 26, 1996 (HRI Acceptance Letter to NRC Proposed Requirements and Recommendations)
- April 1, 1997 (NRC Proposed Requirements)
- April 25, 1997 (HRI Acceptance Letter to NRC Proposed Requirements)
- May 15, 1997 (Crownpoint Uranium Project COP, Rev 1.0)
- June 16, 1997 (Churchrock Design Specifications for Surface Water Diversion Channel)
- July 9, 1997 (HRI Electric Power Supply Commitment)
- August 18, 1997 (Response to NRC Comments)
- October 24, 1997 (HRI Commitment on Groundwater Baseline Sampling)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

November 23, 1993

REPLY TO: (6W)

Ms. Kathleen Sisneros, Director
Water and Waste Management Division
New Mexico Environment Department
1190 Francis Drive
P.O. Box 26110
Santa Fe, New Mexico 87502

Dear Ms. Sisneros:

On April 7, 1993, we were requested by your office to approve a Temporary Aquifer Designation (TAD) extension, into Section 17 of the previously exempted portion of the Westwater Canyon Member for Hydro Resources, Inc.'s (HRI's) proposed operations at Church Rock. Subsequent to this, we became aware of a jurisdictional issue on the mining site which would involve the Navajo Nation. Therefore, we would like to clarify any confusion that may exist concerning HRI's proposed operations under the Underground Injection Control (UIC) program pursuant to the Safe Drinking Water Act, 42 U.S.C. §300f, et seq.

Based on our review of available information, all of Section 17, Township 16 North, Range 16 West, (excluding minerals) is held in trust by the United States for the Navajo Nation. Land held in trust for an Indian tribe is part of "Indian Country" (18 U.S.C. §1151) and, therefore, meets the definition of "Indian lands" (40 C.F.R. §144.3). Our determination is that an extensive amount of Indian land is involved in HRI's proposed operations, and because of disputes over this land it may be prudent for EPA to oversee these lands as stated in 40 C.F.R. §147.1603 and 53 Federal Register 43097 (IV) (B), of October 25, 1988. It is our conclusion that HRI should submit its permit application to EPA. We plan to notify HRI in the near future of our decision.

If you have any questions, please contact me or David Abshire of my staff at (214)655-7188.

Sincerely yours,

Myron O. Knudson, P.E.
Director
Water Management Division (6W)

cc: Harry Seraydarian, Director, Water Management Division, EPA Region 9
Mark S. Pelizza, Environmental Manager, HRI
Sadie Hoskie, Director, Navajo Environmental Protection Adm.
Peg Rogers, Attorney, Natural Resources Unit, Navajo Nation
Susan McMichael, Attorney, New Mexico Environment Department
Phyllis Hedges, Hearing Officer

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Susan McMichael, Attorney, New Mexico Environment Department
Phyllis Hedges, Hearing Officer

bcc: Mark Chandler, Asso. Region Counsel, (6C)
Doris Betuel, Region 9, Water Management Division
Richard Ohrbom, Groundwater Section, New Mexico Environment Department

Navajo Nation Department of Justice
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

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JUL 14 1997

OFFICE OF THE
REGIONAL ADMINISTRATOR

Mark E. Weidler, Secretary
New Mexico Environment Department
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502

Dear Mark:

Thank you for your response to my February 11, 1997 letter regarding the proposed in-situ uranium mining project of Hydro Resources, Inc. (HRI) at Church Rock, New Mexico. In this letter, I want to follow up on our conversation at the All-States Meeting, address the issues raised in your recent letters and talk about the next steps that we should take.

Before discussing your specific points, let me express my deep concern that NMED believes that EPA's actions are contrary to the intent of Congress and recent court decisions, and that EPA may be inappropriately interfering with NMED's issuance of a state permit pursuant to state law. I want to reassure you that EPA is as committed as NMED to following Congressional direction and applicable court decisions. Further, our focus over the last several years has been on the requirements of the federal Safe Drinking Water Act (SDWA). We have not questioned NMED's independent authority or obligations to issue a permit to HRI under state law.

What I believe we have is a basic disagreement about what Congress and the courts have said. As explained in the enclosure to this letter, EPA does not share NMED's interpretation of the federal case law. We believe the federal court decisions that NMED cites did not resolve the status of Sections 8 and 17 but rather have indicated that the Indian country status of land within the Executive Order 709/744 area is to be determined on a case by case basis. Accordingly, from our perspective, EPA's actions are fully consistent with federal law and Congressional intent.

You have also indicated that the Indian country status of Sections 8 and 17 was adjudicated in the context of NMED processing HRI's permit application for Section 17 and in a state court decision concerning water rights. As explained in the enclosure, it appears that the NMED hearing officer recognized that her opinion as to Section 17 pertained only to NMED's authority under state law and was not binding as to the federal SDWA. Further, the hearing did not address the status of Section 8. However, to the extent NMED interprets that decision as applying to EPA, under well established federal case law concerning Indian rights, neither the NMED permitting decision nor the state court water rights decision binds the federal government since it was not a party to the proceedings.

For these reasons and those explained in my last letter, EPA's position remains that HRI must obtain its federal SDWA permit for Section 17 from EPA, not NMED. Although EPA believes that Section 17 clearly is Indian country, we have also cited a second basis for EPA permitting HRI's proposed project on Section 17 under the federal SDWA -- EPA's retained authority to issue permits on disputed lands. Our decision to treat the status of Section 17 as in dispute does not require NMED to concede jurisdiction, nor does it grant the Navajo Nation jurisdiction. Rather, EPA has determined only that there is a dispute such that EPA will issue the permit until the status of Section 17 is resolved.

Additionally, EPA has determined that a dispute exists regarding the Indian country status of Section 8, and, therefore, HRI must obtain its federal SDWA permit for Section 8 from EPA as well. As I indicated in my previous letter, EPA was not ready to conclude that a dispute existed based simply on the assertion of the Navajo Nation. However, after carefully reviewing the materials submitted by the Navajo Nation and NMED, EPA believes the Navajo Nation has presented substantial arguments to support its claim that Section 8 is within Indian country. (See the attachment for further analysis.) EPA would not be discharging EPA's trust responsibilities to the Navajo Nation if we were to ignore the information submitted by them. Consequently, given the different positions of NMED and the Navajo Nation, EPA is treating the status of Section 8 as in dispute. Clearly, it would have been much preferable if the Section 8 issue had been brought to EPA's attention prior to NMED issuing a permit. Nevertheless, that did not happen, and EPA has an obligation to examine the status of Section 8 when requested by the Navajo Nation. I want to emphasize, though, that EPA has not taken a final position on the Indian country status of Section 8, only that the status is in dispute.

You have indicated that NMED believes that EPA's retention of permitting authority is inapplicable because NMED has the clear authority to regulate all UIC wells outside the formal boundaries of the Navajo Reservation. From our perspective, however, it is that very authority under the federal SDWA that is in dispute. Further, it is EPA's position that the UIC regulations do authorize EPA to retain permitting authority in cases like this. The regulations at issue, 40 CFR Part 147, subpart HHH, were specifically promulgated for Indian country and clearly stated EPA's intent that EPA would retain SDWA permitting authority over disputed lands. Unlike the type of dispute you referred to between two states and a private party (where EPA would not get involved), EPA has a direct and vital interest where Indian tribes and the federal SDWA are involved.

I would like to reiterate that EPA has never indicated that our authority under the SDWA would prevent NMED from issuing a permit to meet applicable state requirements. I remain willing to work closely with you to coordinate our permits and am a little puzzled by your perception that EPA is unwilling to do so. Given the overlapping technical and policy issues for the Church Rock, Crownpoint, and Unit 1 portions of HRI's proposed project, EPA has made several written and oral requests to arrange meetings with NMED, but your staff has not taken us up on our offers. I would like to start these discussions as soon as possible.

With respect to pursuing discussions on joint permitting, you asked me to clarify why EPA concluded that it did not make sense to pursue that path at this time. There are several reasons,

which I am happy to review. First, you may remember that a major premise of pursuing a joint permitting approach was that there would be a three-way agreement between NMED, EPA, and the Navajo Nation, so that the three sovereigns would not devote substantial resources to an agreement only to have it challenged in court by one of the parties. As I stated in my previous letters, the Navajo Nation did not believe that it was in its interest to engage in this effort. Without the participation of the Navajo Nation, the joint permit approach would not achieve the goals we set out.

Second, as my staff has discussed with NMED staff on several occasions, EPA did not believe that joint permitting could provide the substantial benefits that NMED anticipated. Given the heightened level of concern that HRI's project has generated, we thought that it would be difficult to eliminate the potential for someone to challenge the permit in EPA and NMED appeal proceedings on both jurisdictional and technical grounds. If the agencies or courts reached different conclusions on the jurisdictional issue, we would be in the untenable position of having conflicting versions of the "same" permit. In addition, in order to implement the permit, it would be necessary to know which provisions were enforceable by EPA under the SDWA and which by NMED under state law. For these and other reasons, it seemed to us that joint permitting was not likely to reduce significantly jurisdictional conflicts.

Third, I have been pessimistic about the likelihood of our agreeing on a joint permitting approach to this problem. Despite a number of attempts, NMED and EPA had made little progress in this area. In addition, NMED staff seemed to believe that having HRI submit a permit application to EPA infringed on New Mexico's jurisdiction, even though it is the company, not the State, which would submit the application. Moreover, under any of the approaches that EPA and NMED have discussed, HRI must apply to EPA for a SDWA UIC permit. Given all of these factors, I thought that it would be best to begin the EPA permitting process now.

EPA, therefore, is informing HRI of the need to submit a SDWA permit application to EPA for its proposed project on Section 8 and, as previously requested, for Section 17. To the extent we can, we will use the information already submitted to NMED. However, some type of application is a legal prerequisite for federal law as it is for state law. Whether EPA and NMED proceeded under a joint or dual permitting approach, HRI would need, as a matter of law, to submit a SDWA permit application to EPA. This course of action does not preclude the possibility of an agreement later. If NMED is still interested, EPA is willing to engage in further legal discussions with NMED and the Navajo Nation concurrent with the start of our permitting process.

I realize that requiring a federal permit for Section 8 will be disruptive to some degree, especially since NMED and HRI have assumed until recently that the NMED-issued permit would be effective for the purposes of the federal SDWA. However, since HRI must still obtain a license and other approvals from the Nuclear Regulatory Commission, the Bureau of Indian Affairs, and the Bureau of Land Management before it can operate, I am optimistic that EPA can assure compliance with the SDWA and act in a timely manner, especially with your cooperation. Moreover, I will be asking HRI to meet with EPA to discuss the schedule for reviewing HRI's permit applications for Sections 8 and 17.

HRI's proposed project involves a number of complex legal, policy and technical issues that cannot be resolved by a continuing exchange of letters. Whatever permitting scheme will be in place, all of the agencies will need to work together. I hope you will cooperate with me to make the transition to EPA SDWA permitting for Section 8 as smooth as possible to minimize the impact on HRI. To meet our mutual goal of maximizing environmental protection, our staffs (and the Navajo Nation EPA) need to start talking about the permits for HRI's proposed project. Apart from Church Rock, EPA is reviewing the permit application for Unit 1, and will need to coordinate with the Navajo Nation EPA and NMED. Therefore, I am again asking my staff to arrange a meeting between Region 9, NMED, and the Navajo Nation.

Please don't hesitate to call me if you would like to discuss this matter further. If your staff has any questions, please have them contact Jim Walker at (415) 744-1833 on technical issues, and Greg Lind at (415) 744-1376 for legal questions.

Yours,

Felicia

Felicia A. Marcus
Regional Administrator

Enclosure

cc: Bennie Cohoe
Executive Director
Navajo Nation EPA

James Bellis
Navajo Nation DOJ

Jerry Clifford
Acting Regional Administrator
EPA Region 6

UNITED STATES COURT OF APPEALS
FOR THE TENTH CIRCUIT

DOCKETING STATEMENT

Case Name: HRI, Inc., Petitioner v. United States Environmental Protection Agency, Respondent

Court/Agency Appeal From: United States Environmental Protection Agency

Court/Agency Docket No. None District Judge: Not applicable

Party or Parties filing Notice of Appeal/Petition: HRI, Inc.

I. TIMELINESS OF APPEAL OR PETITION FOR REVIEW

A. APPEAL FROM DISTRICT COURT

1. Date notice of appeal filed: ____________

   a. Was a motion filed for an extension of time to file the notice of appeal? If so, give the filing date of the motion, the date of any order disposing of the motion, and the deadline for filing notice of appeal: ____________

   b. Is the United States or an officer or an agency of the United States a party to this appeal? ____________

2. Authority fixing time limit for filing notice of appeal:

   Fed. R. App. 4 (a)(1) ____ Fed. R. App. 4(a)(4) ____
   Fed. R. App. 4 (a)(2) ____ Fed. R. App. 4(a)(5) ____
   Fed. R. App. 4 (a)(3) ____ Fed. R. App. 4(b) ____
   Other: ____________

EXHIBIT C

VIII. **PLEASE IDENTIFY ON WHOSE BEHALF THE DOCKETING STATEMENT IS FILED:**

A. ☐ Appellant

☒ Petitioner

☐ Cross-Appellant

B. **PLEASE IDENTIFY WHETHER THE FILING COUNSEL IS**

☒ Retained Attorney

☐ Court-Appointed

☐ Employed by a government entity
(please specify________________________________)

☐ Employed by the Office of the Federal Public Defender.

______________________ 9/10/97
Signature Date

☒ Attorney at Law

NOTE: A copy of the court or agency docket entries, the final judgment or order appealed from, any pertinent findings and conclusions, opinions, or orders, any motion filed under Fed. R. Civ. P. 50(b), 52(b), 59, 60(b), including any motion for reconsideration, for judgment of acquittal, for arrest of judgment, and for new trial, and the dispositive order, any motion for extension of time to file notice of appeal and the

IN THE UNITED STATES COURT OF APPEALS FOR THE TENTH CIRCUIT

HRI, INC.,	§	
	§	
Petitioner	§	
	§	
v.	§	PETITION FOR REVIEW
	§	
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY,	§	
	§	
	§	
Respondent	§	

DOCKETING STATEMENT
Attachment B

IV. ISSUES RAISED ON APPEAL

Subject to receipt and review of the Respondent's Docketing Statement and subject to receipt of the record from EPA, HRI identifies the following issues raised in this proceeding. HRI respectfully requests the right to amend this list of issues after it has had opportunity to review Respondent's Docketing Statement and the record:

1. Whether, on the facts of this case, the USEPA has exceeded its authority under the Federal Safe Drinking Water Act (SDWA) in requiring HRI to secure directly from USEPA one or more additional underground injection control (UIC) permits under the federal Safe Drinking Water Act for UIC-related activities at HRI's Churchrock mine site for which HRI already holds one or more UIC permits issued by the New Mexico Environment Department under its USEPA-approved UIC regulatory program.

2. Whether, on the facts of this case, there exists any legitimate dispute as to whether any portion of the HRI Churchrock mine site lies within "Indian lands" as that term is defined at 40 C.F.R. § 144.3 for the purposes of the federal Safe Drinking Water Act.

3. Whether the USEPA has erred in invoking or applying its "jurisdictional dispute" rule, as stated at 53 Fed. Reg. 43095, 43097 (October 25, 1988), to summarily revoke or amend the effect of a previously issued permit (DP-558), where, as here, (i) New Mexico is already exercising primary enforcement responsibility for the lands in question, (ii) there is no question of a gap in regulatory coverage on the Churchrock site, (iii) the lands in question do not lie within "Indian country" and (iv) the lands in question have already been determined judicially and administratively to lie within the jurisdiction of the State of New Mexico.

4. Whether after issuance by the New Mexico Environment Department (NMED) of its permit DP-558, authorizing HRI's proposed underground injection activities at HRI's Churchrock mine in McKinley County, New Mexico and after USEPA's grant of an aquifer exemption covering the portion of HRI's Churchrock mine site lying on Section 8, Township 16N, Range 16W, USEPA may revoke or amend the effect of the NMED permit by summarily finding or declaring the site of the issued permit to lie wholly or partly upon "Indian lands" or by summarily finding or declaring State regulatory jurisdiction over such site to be "in dispute" between the State of New Mexico and the Navajo Nation.

5. Whether USEPA has, on the facts of this case, violated HRI's Due Process or property rights by summarily curtailing or revoking the force and effect of HRI's permit DP-558 by requiring HRI to obtain one or more additional permits from USEPA under the federal Safe Drinking Water Act to cover the same activities already authorized by HRI's DP-558, issued by the New Mexico Environment Department under its Underground Injection Control (UIC) program as expressly approved by USEPA under the SDWA.

NAVAJO NATION

PRIMARY DRINKING WATER REGULATIONS

Public Water Systems Supervision Program
Navajo Nation Environmental Protection Agency
Post Office Box 339
Window Rock, Arizona 86515
(520) 871-7755

18	93-72-1	2,4,5-TP	0.05
19	50-32-8	Benzo[a]pyrene	0.0002
20	75-99-0	Dalapon	0.2
21	103-23-1	Di(2-ethylhexyl)adipate	0.4
22	117-81-7	Di(2-ethylhexyl)phthalate	0.006
23	88-85-7	Dinoseb	0.007
24	85-00-7	Diquat	0.02
25	145-73-3	Endothall	0.1
26	72-20-8	Endrin	0.002
27	1071-53-6	Glyphosate	0.7
28	118-74-1	Hexachlorobenzene	0.001
29	77-47-4	Hexachlorocyclopentadiene	0.05
30	23135-22-0	Oxamyl (Vydate)	0.2
31	1918-02-1	Picloram	0.5
32	122-34-9	Simazine	0.004
33	1746-01-6	2,3,7,8-TCDD (Dioxin)	3×10^{-8}

§ 209 MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CONTAMINANTS

A. [Reserved]

B. The MCLs for inorganic contaminants (2)-(6), (10), and (11)-(15) of Table 200.7 apply to community water systems and non-transient, non-community water systems. The MCL specified in (1) of Table 200.7 only applies to community water systems. The MCLs specified in (7), (8), and (9) of Table 200.7 apply to community water systems; non-transient, non-community water systems; and transient non-community water systems.

TABLE 200.7 MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CONTAMINANTS

#	CONTAMINANT	MCL (mg/l)
1	FLUORIDE	4.0
2	ASBESTOS	7 (million fibers/liter (longer than 10μm)
3	BARIUM	2
4	CADMIUM	0.005
5	CHROMIUM	0.1

6	MERCURY	0.002
7	NITRATE	10 (as Nitrogen)
8	NITRITE	1 (as Nitrogen)
9	TOTAL NITRATE AND NITRITE	10 (as Nitrogen)
10	SELENIUM	0.05
11	ANTIMONY	0.006
12	BERYLLIUM	0.004
13	CYANIDE (as free Cyanide)	0.2
14	NICKEL	0.1
15	THALLIUM	0.002

C. The following are identified as the best technology, treatment technique, or other means available for achieving compliance with the maximum contaminant levels for inorganic contaminants identified in subsection (B) of this section, except fluoride:

TABLE 200.8 BAT FOR INORGANIC COMPOUNDS LISTED IN TABLE 200.7

CHEMICAL	BAT(s)
Antimony	2,7
Asbestos	2,3,8
Barium	5,6,7,9
Beryllium	1,2,5,6,7
Cadmium	2,5,6,7
Chromium	2,5,6[2], 7
Cyanide	5,7,10
Mercury	2[1],4,6[1],7[1]
Nickel	5,6,7
Nitrate	5,7,9
Nitrite	5,7
Selenium	1,2[3],6,7,9
Thallium	1,5

[1] BAT only if influent Hg concentrations ≤10 micrograms/liter.