Third Five-Year Review Report

for the

United Nuclear Corporation

Ground Water Operable Unit

Church Rock

McKinley County, New Mexico

September 2008

Prepared by:

United States Environmental Protection Agency, Region 6
Dallas, Texas

THIRD FIVE-YEAR REVIEW

United Nuclear Corporation Superfund Site
EPA ID No: NMD030443303
Church Rock, McKinley County, New Mexico

This memorandum documents the U.S. Environmental Protection Agency (EPA) approval of the United Nuclear Corporation (UNC) Superfund Site Third Five-Year Review Report prepared by EPA Region 6, with the assistance of the U.S. Army Corps of Engineers, Sacramento District (CESPK-ED-GE).

Summary of Five-Year Review Findings

The remedy for the UNC Superfund site (Site) is currently considered protective of human health and the environment because there is no evidence that there is exposure. However, the ground-water remedy may have reached the limit of its effectiveness, as predicted by the 1988 EPA CERCLA Record of Decision (ROD). Operational results for the Zone 1 and Zone 3 extraction well systems demonstrated significant declines in pumping rates over time due to insufficient natural recharge of the aquifers. The loss in saturation reached levels which did not support pumping and the systems were shut off. In the absence of pumping since 1999, ground-water quality in Zone 1 appears to have stabilized. For Zone 3, contaminants continue to migrate toward the Navajo Reservation boundary. Attempts to enhance the ground-water remedy in Zone 3 through hydraulic fracturing and *in situ* alkalinity stabilization pilot testing were unsuccessful and it is now believed that the Zone 3 extraction well system cannot hydraulically stop the migration of tailing-seepage-impacted water northward toward the Navajo Reservation. Although additional pumping will only obtain limited short-term results, the extraction wells at the leading edge of the tailing seepage are being operated to slow contaminant migration to the extent practicable.

In the case of the Southwest Alluvium, operation of the extraction well system provided partial hydraulic containment to seepage migration, but there was little progress in achieving Site cleanup levels over time for some contaminants. The Southwest Alluvium extraction well system was temporarily shut off to conduct a natural attenuation (NA) test. The test showed that concentrations of some contaminants (sulfate and total dissolved solids) are not dependant on the continuation of pumping operations, but rather are controlled by natural geochemical reactions. However, uranium concentrations increased after shut off of the pumping wells. It also appears that bicarbonate may have played a role in the increase of uranium, as the bicarbonate levels have also increased after shut off. Bicarbonate has been shown to be covariant with uranium and was controlled by pumping operations. In light of this, there remain questions regarding the effectiveness of the extraction wells in improving the Southwest Alluvium ground-water quality with respect to uranium.

Over the last few years, the U.S. Nuclear Regulatory Commission (NRC) has approved several revisions to UNC's Source Materials License standards, contaminants of concern, and monitoring programs. Although the EPA discussed those revisions with the NRC, the EPA has never modified the cleanup levels or remedy set forth in the ROD in subsequent decision-making to be consistent with NRC's revisions. Such consistency, where appropriate, would help to integrate and coordinate the ground-water and source control/surface reclamation activities to achieve comprehensive reclamation and remediation of the Site, which is called for in the 1988 Memorandum of Understanding between the EPA and the NRC.

As recommended in the previous Five-Year Review at the direction of the EPA, UNC has initiated a Site-wide supplemental feasibility study (SWSFS) to investigate and evaluate possible remedial alternatives and to support a possible Amended ROD or Explanation of Significant Differences, as appropriate. The SWSFS will re-examine contaminants of concern (COCs), cleanup levels, background water quality, applicable or relevant and appropriate requirements (ARARs), new toxicological information and risk assessment. The SWSFS will also examine technical impracticability (TI) issues; and as an EPA-lead effort, the feasibility of establishing institutional controls (ICs) to restrict the use of contaminated ground water on tribal lands. The EPA has met with the Navajo Nation Environmental Protection Administration (NNEPA) and the U.S. Bureau of Indian Affairs (BIA) on several occasions to discuss ICs, but agreement on the issue has not been reached to date.

Actions Needed

Based on the remedial technical data and the findings of this review, there remains the question as to the long-term protectiveness of the Site ground-water operable unit remedy. Accordingly, I have determined that the ongoing SWSFS is the appropriate action necessary to address most of the issues identified in this report. The SWSFS shall be completed to examine and develop potential remedial alternatives in lieu of the existing ground-water remedy's inability to prevent further migration of contamination and achieve cleanup within a reasonable time frame. It is recommended that the SWSFS support any future CERCLA decision-making regarding remedy modification and, if necessary and appropriate, provide a basis for potentially waiving ARARs due to TI, consistent with the NCP and EPA TI waiver guidance. The remedial alternatives to be developed as part of the SWSFS should include active remediation options, if technically practicable, as well as other options to restrict exposure to contaminated ground water. It is also recommended that other activities be completed as part of, or in connection with, the SWSFS and future CERCLA decision-making; including (1) updating COCs and background water quality estimations, (2) proposing new cleanup levels, (3) reassessing the Southwest Alluvium extraction system's ability to improve ground-water quality with respect to uranium, and (4) adopting the NRC revisions to UNC's Source Materials License ground-water protection standards and monitoring program, if supported by the SWSFS and if appropriate and not inconsistent with the NCP, in order to integrate and coordinate the ground-water and source control/surface reclamation activities to achieve comprehensive remediation and reclamation of the Site. It is further recommended that additional Zone 3 extraction wells be installed and/or operated to continue to slow the advancement of tailing seepage to the maximum extent practicable as an interim measure while performing the SWSFS. Lastly, it is recommended that EPA re-examine the IC issues for restricting the use of contaminated ground water on tribal lands and work toward a potential resolution with the NNEPA and BIA as part of the SWSFS process.

Determinations

I have determined that the ground water operable unit remedy for the Site remains protective, provided that certain recommended actions are accomplished as set forth above.

Samuel Coleman, P.E., Director
Superfund Division (6SF)
U.S. Environmental Protection Agency, Region 6

Date 9/17/08

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Dallas, Texas

6SF-RL: Purcell: x-6707: 090508: Third Five-Year Review Report – UNC

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List of Acronyms

ACL	Alternative Concentration Limits
ALARA	As Low as Reasonably Achievable
ARAR	Applicable or Relevant and Appropriate Requirement
BIA	Bureau of Indian Affairs
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	Chemical of Concern
DOE	United States Department of Energy
DOI	United States Department of the Interior
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Difference
FS	Feasibility Study
gpm	gallons per minute
HRI	Hydro Resources Inc.
IC	institutional control
MCL	Maximum Contaminant Level
mg/L	milligram(s) per liter
MNA	monitored natural attenuation
MOU	Memorandum of Understanding
NA	natural attenuation
NCP	National Contingency Plan
NECR	Northeast Church Rock
NMED	New Mexico Environment Department (formerly NMEID)
NMEID	New Mexico Environmental Improvement Division
NMWQCC	New Mexico Water Quality Control Commission
NNEPA	Navajo Nation Environmental Protection Administration
NPL	National Priorities List
NRC	United States Nuclear Regulatory Commission
O&M	operation and maintenance
OU	Operable Unit
pCi/L	picocurrie(s) per liter
$pCi/m^2/sec$	picocurrie(s) per meter squared per second
PHA	Public Health Assessment
PRG	Preliminary Remediation Goal (Region 9)
POC	Point of Compliance
RAO	Remedial Action Objective
RAP	Remedial Action Plan
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SFS	Supplemental Feasibility Study
SWSFS	Site-Wide Supplemental Feasibility Study

TBC	to be considered
TDS	total dissolved solids
TI	Technical Impracticability
TTHM	total trihalomethane
UAO	Unilateral Administrative Order
UIC	Underground Injection Control
UMTRCA	Uranium Mill Tailings Radiation Control Act
UNC	United Nuclear Corporation
USACE	United States Army Corps of Engineers

Executive Summary

The U.S. Environmental Protection Agency (EPA) has conducted the third five-year review of the United Nuclear Corporation (UNC), Church Rock Uranium Mill Superfund site (Site) in McKinley County, New Mexico. The purpose of this five-year review is to determine whether the remedial actions implemented at the Site are protective of human health and the environment. This five-year review is required because hazardous substances, pollutants, or contaminants (hereinafter "contaminants") remain on-Site above the risk-based levels determined in the Record of Decision (ROD), thereby preventing unlimited use and unrestricted exposure. The methods, findings, and conclusions of the review are documented in this five-year review report (Report). In addition, this Report summarizes issues identified during the review and includes recommendations and follow-up actions for them. Progress on the recommendations from the previous five-year review is discussed. The triggering action for this review was the completion of the Second Five-Year Review report in September 2003.

Site Background

The Site is located 17 miles northeast of Gallup and on the southern border of the Navajo Indian Reservation. The Site also sits along the southern margin of the San Juan Basin. The Site is comprised of the former ore processing mill facilities and a byproduct material (tailing) disposal site (hereinafter Tailing Disposal Site), which cover about 25 and 100 acres respectively. To the northwest and adjacent to the Site is the former Northeast Church Rock (NECR) mine, an underground uranium mine which was also operated by UNC and which is currently subject to EPA response actions directed by EPA Region 9. To the north of the Site is another former uranium mine that was operated by Quivira (formerly Kerr-McGee). The area surrounding the Site is sparsely populated and the primary land use is grazing for sheep, cattle, and horses. Uranium mining using the in-situ leach (ISL) method has been proposed for a nearby area.

From approximately 1969 to 1986, large quantities of ground water were pumped from the nearby NECR and Quivira mines to dewater the underground workings. This mine water was discharged to the local arroyo (known as Pipeline Arroyo), which runs across the Site. A portion of the mine discharge water infiltrated into the subsurface and significantly re-saturated the near-surface alluvium and Zone 1 and Zone 3 of the Upper Gallup Sandstone Formation, creating an artificially high water table beneath the Site.

The UNC uranium mill was operated from 1977 to 1982. Uranium ore was processed at the facility using a combination of crushing, grinding, and acid-leach solvent extraction methods. The milling operation produced acidic slurry of ground rock and fluid (tailing) that was pumped into the Tailing Disposal Site. An estimated 3.5 million tons of tailings were disposed in the tailing impoundment.

The infiltration or seepage of acidic tailing liquids from the Tailing Disposal Site into the subsurface contaminated the shallow alluvium and Zone 1 and Zone 3 aquifers. The affected ground waters have relatively low (acidic) pH and elevated concentrations of

select heavy metals, radionuclides, sulfate, total dissolved solids (TDS), and other constituents.

The Site was listed on the National Priorities List (NPL) of Superfund sites by the EPA, 48 Fed. Reg. 40658 (Sept. 8, 1983), pursuant to section 105 of the Comprehensive Environmental Response, Compensation & Liability Act (CERCLA), 42 U.S.C. §9605, due to the migration of radionuclides and other contaminants into the ground water. The EPA conducted a Site Remedial Investigation (RI) and Feasibility Study (FS) from 1984 through 1988. The RI report concluded that mine discharges to Pipeline Arroyo from the nearby uranium mines and tailing seepage from the Tailing Disposal Site contaminated the alluvial aquifer, and Zone 1 and Zone 3 of the Upper Gallup Sandstone Formation.

Under a 1988 Memorandum of Understanding (MOU) between EPA and the U.S. Nuclear Regulatory Commission (NRC), 53 Fed. Reg. 37887 (September 28, 1988), NRC is designated the lead federal agency responsible for regulating the reclamation and closure activities completed at the Tailing Disposal Site pursuant to the NRC's Source Materials License SUA-1475 (License) and the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, 42 U.S.C. §7901 *et seq*. Under the MOU, the NRC-regulated reclamation and source control actions are subject to EPA monitoring and review to ensure that such actions will allow attainment of the CERCLA requirements outside of the Tailing Disposal Site. Further, EPA is the lead federal agency responsible for remediation of ground-water contamination outside of the Tailing Disposal Site.

Remedial Action

The remedy selected for the Site by EPA in the 1988 ROD is ground-water extraction and evaporation outside of the Tailing Disposal Site, along with ground-water monitoring. As part of the ground-water extraction, the remedy incorporates UNC's ongoing operation of seepage extraction systems (pump-back wells) for the Zone 1 and Zone 3 aquifers, which was under the direction and oversight of the New Mexico Environmental Improvement Division (the predecessor of the New Mexico Environment Department [NMED]). The ROD requires that ground-water extraction be performed in the Southwest Alluvium, and Zone 1 and Zone 3 aquifers to create a hydraulic barrier to further migration of contamination. The remedy is also to be integrated and coordinated with NRC's reclamation and source control efforts at the Tailing Disposal Site to achieve comprehensive reclamation and remediation at the Site. Once the reclamation and remediation activities are complete, the Tailing Disposal Site will be transferred to the U.S. Department of Energy (DOE) for long-term control and oversight.

Beginning in the late 1990s, operation of the extraction wells in all three zones was permanently or temporarily stopped as declining ground-water levels reduced extraction efficiency and pumping was found to inadvertently accelerate contaminant transport away from the Site towards the north. Since then, active remediation has been restarted in Zone 3, following additional studies and testing. Pilot-scale testing was conducted in an effort to improve ground-water recovery or to stabilize contaminant migration. The testing involved hydraulic fracturing of the Zone 3 sandstone to increase pumping rates

and injection of alkalinity-rich water to neutralize the acidic seepage-impacted water and precipitate out contaminants. Neither pilot test was judged successful. Some of the wells constructed as part of the hydraulic fracturing program and new ground-water extraction wells have been operated over the last few years in an attempt to further control the migration of tailing seepage in Zone 3. Although such migration was slowed, and even temporarily arrested with such pumping, the advancing seepage-impacted front could not be stopped. As an interim measure, while EPA re-evaluates the Site remedy, additional extraction wells are being installed in 2008 at the leading edge of the advancing seepage-impacted front to continue to collect contaminated water and slow contaminant migration to the maximum extent practicable. This is anticipated to minimize additional downgradient impacts. Currently, a Site-wide supplemental feasibility study (SWSFS) is underway to comprehensively re-evaluate the remedy.

First and Second Five Year Reviews

The first Five-Year Review was completed in 1998 and the second in 2003. Both Five-Year Reviews concluded that the remedy was protective of human health and the environment because there was no evidence of exposure to the contaminated ground water. Both reviews documented the technical difficulties encountered in achieving all the ROD cleanup levels in a reasonable timeframe by operation of the remedy, due primarily to unique hydrogeological and geochemical complexities at the Site. Operational results for the Zone 1 and Zone 3 aquifer extraction systems demonstrated significant declines in pumping rates over time due to insufficient natural recharge, a condition that was predicted in the ROD. The low extraction rates appear to have prevented the wells from providing an effective hydraulic barrier for stopping contaminant migration. Additionally, the operation of the Zone 3 extraction wells caused the inadvertent acceleration of contaminants away from the Site towards the north. The extraction system for the Southwest Alluvium provided partial hydraulic containment to tailing seepage migration, but there was little progress in achieving Site cleanup levels over time for sulfate and TDS, also a condition predicted in the ROD.

The first Five-Year Review report recommended that extraction wells be converted to monitoring wells and that UNC seek approval for either Alternative Concentration Limits (ACLs), or a Technical Impracticability (TI) Waiver, or an "As Low as Reasonably Achievable (ALARA)" demonstration. The first Five-Year Review report also recommended that additional technical evaluations and studies, including natural attenuation (NA) and TI, be performed to support such approvals. Based on those recommendations, ground-water extraction was temporarily suspended in the Southwest Alluvium to conduct an NA test and TI evaluation. Ground-water extraction was also temporarily suspended in Zone 3 to stop the advancement of seepage-impacted ground water while other hydraulic analyses could be conducted to assess alternate remedial options. Finally, the Zone 1 pumping wells were permanently shut down and decommissioned with EPA and NRC approval and a geochemistry study performed.

The second Five-Year Review report recommended that the SWSFS be completed to identify and evaluate further remedial alternatives in support of possible future CERCLA

response action decision-making. Other significant issues or activities were noted in the review that required follow-up in connection with the SWSFS. They included: (1) further delineation and characterization of seepage-impacted ground water for the Southwest Alluvium, (2) the identification and evaluation of institutional controls (ICs) to restrict use of contaminated ground water on tribal land, and (3) completing an analysis of NA and potential TI Waivers for Zone 1 and the Southwest Alluvium and making decisions with respect to their acceptability in accordance with the National Contingency Plan (NCP) procedures. UNC is currently performing the SWSFS. It includes a comprehensive review and update of contaminants of concern, background water quality, toxicological information and risk assessment, potentially new applicable or relevant and appropriate requirements (ARARs) based on revised or newly promulgated state/federal standards, and an overall update of Site cleanup levels. Other work completed since the second Five-Year Review includes the construction of an additional monitoring well in the Southwest Alluvium to better delineate and monitor the downgradient extent of seepage-impacted ground water and an effort by EPA to examine the feasibility of establishing ICs on Navajo, Tribal Trust and Indian Allotment lands (collectively "tribal lands") to restrict the use of contaminated ground water. The EPA met with key representatives of the Navajo Nation Environmental Protection Administration (NNEPA) in January, March and August of 2006 to discuss ICs. However, to date the NNEPA has not agreed to accept restrictions on the use of ground water on Navajo or Tribal Trust lands, or to accept any new remedial alternative developed in the SWSFS which includes such restrictions or ICs.

Conclusions and Recommendations of this Five-Year Review

The principal conclusion of this third Five-Year Review is that, similar to the previous five-year reviews, the Site remedy is currently protective of human health and the environment because there is no known exposure to the contaminated ground water. However, questions remain about the long-term protectiveness of the ground-water operable unit remedy. As predicted in the 1988 ROD, operational results have demonstrated that it is technically difficult to achieve all cleanup levels in a reasonable time period with the current remedy and, therefore, modification to the remedy is necessary for long-term protectiveness. The SWSFS shall be completed to examine and develop potential remedial alternatives in lieu of the existing ground-water remedy's inability to prevent further migration of contamination and achieve cleanup. It is recommended that the SWSFS support any future CERLCA decision-making regarding remedy modification and, if necessary and appropriate, provide a basis for potentially waiving ARARs due to TI, consistent with the NCP and EPA TI waiver guidance. The remedial alternatives developed as part of the ongoing SWSFS should include active remediation options, if technically practicable, as well as other alternatives to restrict exposure to contaminated ground water.

It is also recommended that other activities be completed as part of, or in connection with, the ongoing SWSFS and future decision-making. They include: (1) updating contaminants of concern and background water quality estimations, especially for chemicals such as uranium, which is critical to determining whether any further

improvement to the Southwest Alluvium water quality can be made with respect to uranium concentrations, (2) proposing new cleanup levels, (3) completing the evaluation of the Southwest Alluvium extraction system's ability to improve ground-water quality with respect to uranium, and (4) adopting the NRC revisions to License ground-water protection standards and monitoring programs, if supported by the SWSFS and if appropriate and not inconsistent with the NCP, in order to integrate and coordinate the ground-water and source control/surface reclamation activities to achieve comprehensive remediation and reclamation of the Site. It is further recommended that additional Zone 3 extraction wells be installed and/or operated to continue to slow the advancement of tailing seepage to the maximum extent practicable as an interim measure while performing the SWSFS. Lastly, it is recommended that EPA re-examine the IC issues for restricting the use of contaminated ground water on tribal lands and work toward a potential resolution with the NNEPA and BIA as part of the SWSFS process.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: United Nuclear Corporation		
EPA ID *(from WasteLAN)*: NMD030443303		
Region: 6	**State:** NM	**City/County:** Church Rock / McKinley County

SITE STATUS	
NPL status: √Final ~~Deleted~~ ~~Other~~ (specify)	
Remediation status (choose all that apply): ~~Under Construction~~ √**Operating** ~~Complete~~	
Multiple OUs? ~~YES~~ √**NO**	**Construction completion date:** 10/31/1989
Has site been put into reuse? ~~YES~~ √**NO**	

REVIEW STATUS	
Lead agency: √**EPA** ~~State~~ ~~Tribe~~ ~~Other Federal Agency~~ _____	
Author name: Mark Purcell (US EPA), Bradley Call (Corps of Engineers)	
Author title: Remedial Project Manager	**Author affiliation:** EPA
Review period: 02/1/2008 to 05/31/2008	
Date(s) of site inspection: 03/19/2008	
Type of review: √**Post-SARA** ~~Pre-SARA~~ ~~NPL-Removal only~~ ~~Non-NPL Remedial Action Site~~ ~~NPL State/Tribe-lead~~ ~~Regional Discretion~~	
Review number: ~~1 (first)~~ ~~2 (second)~~ √**3 (third)** Other (specify) _____	
Triggering action: ~~Actual RA Onsite Construction at OU~~ #____ ~~Actual RA Start at OU#~~____ ~~Construction Completion~~ √**Previous Five-Year Review Report** Other (specify)	
Triggering action date *(from WasteLAN)*: 9 /18 / 2003	
Due date *(five years after triggering action date)*: 9 /18 /2008	

Five-Year Review Summary Form, cont'd.

Issues:

1. The ground-water remedy, as set forth in the ROD, cannot attain the cleanup levels within a reasonable time frame because insufficient natural recharge has resulted in the loss of saturation which reached levels that could not support pumping. The ROD predicted this situation and the need for contingencies and re-evaluation of the remedy.

2. The Zone 3 extraction well system cannot hydraulically control the migration of tailing seepage-impacted water northward toward the Navajo Reservation. Any future pumping to reduce the pressure head will only obtain limited short-term results. Because the structural tilting or dip of the strata drives ground-water flow northward, there is an irreducible elevation head that cannot be decreased by pumping. Counteracting this hydraulic force is the clogging of the formation's pore spaces by the seepage-induced chemical alteration of feldspar to kaolinite clay. This clogging reduces the formation's permeability and impedes the flow of seepage-impacted ground-water. Eventually, there will be a balance between the irreducible hydraulic head and the trapping of seepage-impacted ground water from loss of permeability.

3. Uranium concentrations in the Southwest Alluvium do not exceed the current cleanup level of 5 mg/L. However, they do exceed the newly promulgated MCL for uranium of 0.03 mg/L. UNC has shown that uranium and bicarbonate concentrations may be covariant in the Southwest Alluvium ground water (i.e., uranium levels change when bicarbonate levels change) and that the tailing seepage is more depleted in uranium than the post-mining, pre-tailing background water. However, since elevated levels of bicarbonate are believed to be caused by the acidic tailing seepage reacting with the calcium carbonate in the formation, the increase in uranium may still be attributable to the tailing seepage impacts. UNC contends that the range of uranium concentrations in the post-mining, pre-tailing background water exceed the new MCL of 0.03 mg/L and is the same as the range within the seepage-impacted water. UNC submitted summary statistics for uranium in the Southwest Alluvium for EPA's consideration in assessing background water quality. These findings, if accepted by EPA, may be important to determining whether any further improvement to the Southwest Alluvium water quality can be made with respect to uranium concentrations should EPA revise the cleanup level for uranium.

4. UNC has indicated in its 2007 Annual Review Report that there is no discernable difference between the Southwest Alluvium uranium levels and trends from before shutoff of the pumping wells to after shutoff. The pumping wells were temporarily shutoff in January 2001 to conduct a natural attenuation (NA) test and they have remained off. However, the review of the 2007 Annual Review Report has shown uranium levels, although within historic ranges, increased significantly after shutoff for the GW series wells, the nearest downgradient wells to the pumping wells. In light of this, there remain questions regarding the effectiveness of the extraction wells to improve ground-water quality with respect to uranium. Additionally, as stated in Issue No. 3, above, determining the range of uranium concentrations within the post-mining, pre-tailing background water may be an important factor to determining whether any further improvement to the Southwest Alluvium water quality can be made with respect to uranium concentrations.

Five-Year Review Summary Form, cont'd.

Issues (cont):

5. EPA did not specifically identify the contaminants of concern (COCs) or cleanup levels for the Site in the 1989 ROD, which led to some confusion during the review. This information had to be inferred from the text and several tables in the ROD and Remedial Design Report. The Site-Wide Supplemental Feasibility Study (SWSFS) needs to include (1) a thorough review and update of the Site COCs, based on screening with newly promulgated federal standards (MCLs), health-based criteria, background water quality and ground-water monitoring data, and (2) an update of the Site cleanup levels.

6. Ground-water quality monitoring data have shown a decrease in concentrations of some contaminants (*e.g.*, lead, lead-210, and selenium) to levels which are consistently below cleanup levels over time. As stated in the 2003 Five-Year Review, UNC has recommended investigating the merits of eliminating those contaminants from the monitoring program. EPA has yet to modify the COC list and monitoring program in subsequent decision-making to the ROD A complete review of the COCs and cleanup levels is being conducted in Part 1 of the SWSFS.

7. The NRC has approved several revisions to License standards, contaminants of concern, and monitoring programs recommended by UNC. Although the EPA discussed those revisions with the NRC, the EPA has never modified the cleanup levels or remedy set forth in the ROD in subsequent decision-making to be consistent with those NRC revisions. Such consistency, where appropriate, would help to integrate and coordinate the ground water and source control/surface reclamation activities to achieve comprehensive reclamation and remediation of the Site, which is called for in the MOU between the EPA and the NRC.

NRC revisions are as follows:

- Delete cyanide and naphthalene from monitoring program.
- Establish combined radium -226 and -228 of 5.2 pCi/L for Southwest Alluvium, 9.4 pCi/L for Zone 1, and 5.0 pCi/L for Zone 3.
- Establish Site-wide uranium standard of 0.3 mg/L.
- Change Site-wide chloroform standard to total trihalomethanes (TTHMs) of 0.08 mg/L.

8. In light of the technical difficulties of achieving Site cleanup levels, (as predicted in the ROD), the EPA recognizes the need to consider ICs as a component of remedial alternatives being evaluated in the SWSFS to prevent exposure to contaminated ground water on Navajo, Tribal Trust, or Indian Allotment lands. The use of ICs as a component of a remedial alternative is actually called for in the NCP, as appropriate, for ensuring protectiveness, a threshold evaluation criterion of CERCLA. However, the Navajo Nation Environmental Protection Administration (NNEPA) has informed EPA that it will not recommend the use of ICs as a component of any alternative remedy which would place ground-water restrictions on Navajo or Navajo controlled lands. The Bureau of Indian Affairs (BIA) has supported

Five-Year Review Summary Form, cont'd.

Issues (cont):

NNEPA's position. With this opposition, there has been no further discussion or advancement of UNC's Draft Resolution and Environmental Right-of-Way Procedures, including a proposal to drill a water supply well in the deeper Dakota formation, which were presented to the NNEPA and DOJ in 2001. In a 2003 letter to EPA, the NNEPA stated that it does not have the mechanism, staff, or funds needed to establish, maintain and enforce ICs for restricting the use of ground water. Three meetings in 2006 failed to produce any agreement on ICs.

9. Sulfate and total dissolved solids (TDS) concentrations are not dependent on continuation of pumping operations, but rather are controlled by natural geochemical reactions, primarily the chemical equilibrium of gypsum or anhydrite. UNC's conclusion that concentrations of sulfate and TDS will continue to exceed cleanup levels as long as the Southwest Alluvium and Zone 1 are saturated appears to be well supported. UNC has performed a TI evaluation and recommended that EPA invoke a TI waiver of the sulfate, TDS standards (as well as manganese) at this time.

10. A comprehensive review and update of the post-mining, pre-tailing background water quality is necessary for all three aquifers as part of the reassessment of current cleanup levels, especially in light of newly promulgated MCLs and health-based criteria. In fact, in Appendix C of the ROD, EPA acknowledged the geochemical complexities associated with determining the post-mining, pre-tailing background water quality and the need to continue such evaluation of background. The EPA also acknowledged that any significant change to background estimations could impact the remedial action in each aquifer. As noted above, the reassessment of uranium background concentrations in the Southwest Alluvium will help determine whether any further improvement to water quality can be made with regards to uranium. Additionally, it is noted that the post-mining, pre-tailing background water quality has shown modest exceedances of the cleanup levels for several metals. As part of this effort, and in light of deficiencies found with earlier statistical analysis by UNC, EPA has directed UNC to (1) follow current EPA guidance in performing statistical analyses of ground-water monitoring data and selecting appropriate statistical methodologies, and (2) identify the background and impacted wells to be used for each data set for each aquifer.

11. The local community is not fully informed regarding the nature of the ground-water contamination, the performance of the remedy, and likely future actions necessary to ensure protectiveness.

12. The project lacks a schedule to complete the SWSFS.

Recommendations and Follow-up Actions:

1. Complete the ongoing Site-Wide Supplemental Feasibility Study (SWSFS) to develop remedial alternatives or contingencies in lieu of the existing ground-water remedy's failure to achieve cleanup levels and control the migration of tailing seepage-impacted water outside of the Tailing Disposal Site. The SWSFS will support future EPA decision-making regarding revision to cleanup levels and remedy

Five-Year Review Summary Form, cont'd.

Recommendations and Follow-up Actions (cont):

modification, and provide a basis for potentially waiving applicable or relevant and appropriate requirements (ARARs) due to technical impracticability (TI). The SWSFS will also document the appropriateness of adopting the NRC revisions to the License ground-water protection standards, and monitoring program by identifying or updating COCs, preliminary cleanup levels, including background water quality estimations, and performance monitoring requirements in support of future EPA decision-making under CERCLA or provide other COCs, cleanup levels and monitoring requirements for EPA to consider. Further, as part of the update of COCs, the SWSFS will include a screening-level reassessment of risk, based on more recent toxicological information.

2. In the interim period before the SWSFS is completed and an alternative or contingency remedy is selected by EPA, continue effort to slow or temporarily arrest the advancement of the Zone 3 seepage-impacted water northward and extract contaminated ground water to the maximum extent practicable by installing and operating additional extraction wells at the leading edge of the seepage-impacted front.

3. As part of the ongoing SWSFS, determine post-mining, pre-tailing background concentrations of uranium for comparison to the seepage-impacted uranium levels and assess whether any further improvement to the Southwest Alluvium water quality can be made with respect to uranium.

4. Reassess the effectiveness of the Southwest Alluvium extraction wells to improve ground-water quality with respect to uranium. The reassessment needs to include both temporal and spatial aspects of changing uranium concentrations after shutoff that takes into account the rate of migration of seepage-impacted water, the distance between the shutoff extraction well and the down-gradient monitoring wells, and the period of shutoff. The spatial evaluation needs to include isoconcentration contour maps of uranium.

5. As part of the ongoing SWSFS, identify contaminants of concern (COCs), remedial action objectives (RAOs), and preliminary cleanup levels. This information should be codified in future EPA decision-making. This effort should include investigating the merits of eliminating contaminants from the updated COC list, such as lead, lead-210, and selenium, if they have consistently been detected at concentrations below the revise cleanup levels.

6. After the COCs and cleanup levels are modified in EPA decision-making, the ground-water monitoring program should be updated to ensure that it is consistent with the revised COCs and cleanup levels, and at the appropriate well locations and aquifers.

7. Adopt the NRC revisions to License ground-water protection standards and monitoring programs in future decision-making if appropriate and not inconsistent with the NCP and supported by the SWSFS so that the ground-water remediation will continue to be consistent with the NRC's source control and surface reclamation activities. This will allow the integration and coordination of the EPA and NRC

Five-Year Review Summary Form, cont'd.

Recommendations and Follow-up Actions (cont):

efforts to achieve comprehensive reclamation and remediation of the Site.

NRC revisions are as follows:

- Delete cyanide and naphthalene from monitoring program
- Establish combined radium -226 and -228 of 5.2 pCi/L for Southwest alluvium, 9.4 pCi/L for Zone 1, and 5.0 pCi/L for Zone 3
- Establish Site-wide uranium standard of 0.3 mg/L
- Change Site-wide chloroform standard to Site-wide total trihalomethanes (TTHMs) of 0.08 mg/L

If other cleanup levels and monitoring requirements are established by the EPA inconsistent with the revised NRC standards and monitoring requirements, the NRC should reassess the appropriateness of modifying its License standards and monitoring requirements to be consistent with the CERCLA requirements. As stated in the Memorandum of Understanding (MOU) between the EPA and the NRC, the source control/surface reclamation activities for the Tailing Disposal Site must be consistent with CERCLA requirements so as to allow the CERCLA requirements to be attained outside of the Tailing Disposal Site.

8. In light of the technical difficulties and limitations encountered to attain cleanup levels and control the migration of seepage-impacted ground water, the potential health risk from exposure to seepage-impacted ground water, as well as post-mining, pre-tailing background quality ground water, and the possibility of EPA invoking a TI Waiver of ARARs for sulfate, TDS, and other contaminants, a renewed effort should be made to establish institutional controls (ICs) that will restrict the use of contaminated ground water on Navajo, Tribal Trust and Indian Allotment lands. This effort should include revisiting UNC's Draft Resolution and Environmental Right-of-Way Procedures to define ICs in certain seepage-impacted areas, as well as ways to address the issues raised by the NNEPA in 2003 with regards to staffing and funding needs and mechanism for implementing the ICs.

9. As part of the ongoing SWSFS, include an evaluation of remedial technologies and process options (both conventional and innovative) to achieve the cleanup levels for sulfate and TDS, or provide a basis for EPA to invoke a waiver of those standards for sulfate and TDS due to TI.

10. As part of the ongoing SWSFS, complete the reassessment of post-mining, pre-tailing background water quality as part of the SWSFS based on the considerable body of ground-water monitoring data now available. This reassessment should follow current EPA guidance for performing statistical analyses of ground-water monitoring data and selecting appropriate statistical methodologies.

Five-Year Review Summary Form, cont'd.

Recommendations and Follow-up Actions (cont):

11. Greater effort should be made to meet with and share information with the local community regarding the ground-water remedy, what has been achieved to this point, and what is likely to occur in the future.

12. A schedule for completion of the SWSFS should be developed.

Protectiveness Statements:

The remedy at the United Nuclear Corporation (UNC) Church Rock Superfund Site currently protects human health and the environment because, although tailing-seepage-impacted ground water has migrated beyond the UNC property boundary, there are no known users of the impacted ground water and, consequently, no evidence of exposure. For the remedy to be protective in the long term, the following issues should be addressed in the Site-Wide Supplemental Feasibility Study (SWSFS):

1) Identify changes to the remedy that address the issues identified in this Report, including potential Technical Impracticability (TI) Waivers, newly promulgated federal/state standards as potential new or revised applicable or relevant and appropriate requirements (ARARs)(e.g., maximum contaminant levels under the Safe Drinking Water Act), new health-based criteria as to-be-considered (TBC) material, and related matters;

2) Clarify the Site contaminants of concern, revised cleanup levels, and the points of compliance;

3) Evaluate application of Institutional Controls (ICs) to restrict the use of seepage-impacted ground water beyond the UNC property boundary, which includes the Tailing Disposal Site area;

4) Update the Site background values for ground water;

5) Perform reassessment of risk based on current toxicological information and newly promulgated standards (e.g., MCLs).

A project schedule should be established for this work. Following the completion of the SWSFS, changes to the remedy should be documented in a ROD amendment. Additional outreach should be conducted with the local community regarding the cleanup activities. The monitoring program should be reviewed to ensure that it aligns with the project decision documents.

Five-Year Review Report

1.0 Introduction

The purpose of five-year reviews is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of these evaluations are documented in five-year review reports. In addition, five-year review reports identify issues found during the review, if any, and recommendations to address them. The United States Army Corps of Engineers (USACE) provided support for the performance of this review.

The United States Environmental Protection Agency (EPA), Region 6, performed this five-year review pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121(c), 42 U.S.C. §9621(c) and the National Contingency Plan (NCP). CERCLA §121(c) states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each 5 [five] years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section 9604 [104] or 9606 [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The EPA interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii), which states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.*

The EPA has conducted a review of the remedial actions implemented at the United Nuclear Corporation (UNC) Church Rock site (Site), Church Rock, New Mexico. This review was conducted from February to May 2008. It is the third five-year review for the Site. This report, entitled "Third Five-Year Review Report" (Report) documents the results of the review.

The triggering action for the review is the signature date of the previous Five-Year Review report, September 18, 2003.

Statutory review is required for sites where the selected remedy does not allow unlimited use and unrestricted exposure after the Record of Decision (ROD) clean-up actions are completed and the clean-up goals have been met. This Five-Year Review is required because hazardous substances, pollutants, or contaminants (hereinafter "contaminants") remain at the Site above levels that allow for unlimited use and unrestricted exposure.

The United States Nuclear Regulatory Commission (NRC) is the lead federal agency regulating the reclamation, and closure activities at the byproduct material (tailings) disposal site (hereinafter the "Tailings Disposal Site"), pursuant to Source Materials License No. SUA-1475 (License). Once those activities are completed and the NRC terminates the License, the property will be released and turned over to the United States Department of Energy (DOE) for long-term care and surveillance monitoring. This transfer is dictated by Title II of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, which requires that the ownership of the byproduct material be transferred to the United States, or to the State in which the processing occurred.

Under a 1988 Memorandum of Understanding (MOU) between the EPA and the NRC, the EPA is responsible for regulating the remediation of ground-water contamination outside of the Tailings Disposal Site under CERCLA. The NRC is the lead agency responsible for surface reclamation and source control at the licensed site, with EPA to monitor all such activities and provide review and comment directly to the NRC. The objective of EPA's review and comment is to assure that activities to be conducted under NRC's regulatory authority allow attainment of applicable or relevant and appropriate requirements under CERCLA outside of the Tailings Disposal Site. Under the MOU, the NRC assumes the lead role for notification to UNC, except for such notification as EPA might statutorily be required to provide in certain events. The MOU also specifies that no actions will be taken by either the EPA or the NRC without prior consultation with the other.

On September 30, 1988, EPA Region 6 selected a CERCLA ground-water contamination remedial action in a ROD, consisting of ground-water monitoring and containment, contaminant extraction and evaporation, and performance monitoring and evaluation for ground water within the shallow alluvium (Southwest Alluvium) and two zones (Zones 1 and 3) of the Upper Gallup Sandstone Formation. Under the MOU with NRC, this was to be coordinated with a source control action involving reclamation, capping, and mill decommissioning under the NRC UMTRCA regulatory process. Negotiations between UNC and EPA concerning remedial action were unsuccessful and on June 29, 1989, EPA issued a Unilateral Administrative Order (UAO) to UNC for the conduct of the remedial action. Remedial action commenced at the Site in August 1989 with completion of construction by UNC in December 1989.

EPA completed its first Five-Year Review of the Site remedy in September 1998. In the first Five-Year Review report, EPA concluded that for the alluvium, the remedy provided an adequate hydraulic barrier to ground-water migration, but for some contaminants, the cleanup levels could not be reached in a reasonable timeframe. The EPA also concluded that for the two zones of the Upper Gallup Sandstone Formation, a significant decline in

pumping rates due to limited saturation and insufficient natural recharge limited the effectiveness of the extraction well systems to provide a hydraulic barrier to contaminant migration, a condition that was anticipated by EPA (1988 ROD, Appendix A – Contingencies for Selected Remedy). Lastly, EPA concluded that the pumping of downgradient wells in Zone 3 accelerated the movement of the seepage-impacted ground water in a downgradient direction to the north, toward the Navajo Reservation.

From 1999 through 2002, UNC submitted a request for a technical impracticability (TI) waiver; and EPA approved the decommissioning and shut down of numerous extraction wells in Zones 1 and 3 due to insufficient pumping rates and the acceleration of contaminants away from the Site. During this period, the EPA also approved an 18-month natural attenuation test for the Southwest Alluvium and a hydraulic fracturing test for Zone 3, which were both to be conducted by UNC under the UAO.

The second Five-Year Review was completed in 2003. In the second Five-Year Review report, EPA concluded that the remedy was no longer performing as intended. The EPA also restated some of the findings presented in the first Five-Year Review report regarding the insufficient natural recharge within Zones 1 and 3, the acceleration of contaminants away from the Site towards the north in Zone 3, and the partial hydraulic containment to tailing seepage migration and lack of progress in achieving Site cleanup levels over time for the Southwest Alluvium. In the 2003 Five-Year Review report, it was recommended that a supplemental feasibility study be conducted to evaluate additional remedial alternatives, as well as to support other possible EPA decision-making. Recommendations were also made regarding evaluation of the following: institutional controls (ICs), the UNC request for a TI waiver, and the UNC natural attenuation (NA) proposal.

2.0 Site Chronology

A chronology of significant Site events and dates is included in Table 2-1. Sources of this information are listed in Attachment 1.

Table 2-1
Chronology of Events

Event	Date
UNC milling operations begin.	June 1977
Dam on south tailings disposal cell is breached, releasing an estimated 93 million gallons of uranium mill tailings and pond water to Pipeline Canyon and the Rio Puerco. EPA Region 6 and New Mexico Environmental Improvement Division (NMEID) respond to release.	July 1979
New Mexico Environment Improvement Division orders UNC to implement discharge plan to control contaminated tailing seepage.	October 1979
UNC announces mill closing due to depressed uranium market.	May 1982
Site placed on the National Priorities List (NPL) of Superfund Sites due to off-site migration of radionuclides and chemical constituents in ground-water.	1983
EPA conducts Remedial Investigation (RI) field activities to determine the nature and extent of ground-water contamination in the three water-bearing formations at the Site.	March 1984- August 1987
In 1984, UNC blocked EPA access to the Church Rock facility, and EPA brought an action to compel site access. UNC counterclaimed seeking declaratory and injunctive relief. The U.S. District Court granted an EPA motion to dismiss the UNC counterclaims, and UNC provided access to the Site to EPA. *United States v. United Nuclear Corporation,* 610 F Supp. 527, 528 (D.N.M., 1985).	April 18, 1985
NMEID returns Uranium Mill Tailings Radiation Control Act (UMTRCA) federal regulatory program to the U.S. Nuclear Regulatory Commission (NRC).	June 1986
EPA and NRC sign MOU coordinating EPA's CERCLA ground-water remedial action with NRC's reclamation and closure activities under the Source Materials License.	August 26, 1988
EPA releases RI and Feasibility Study (FS) report along with proposed plan of action field sheet.	August 1988
EPA issues ROD for extraction of contaminated water and evaporation of the extracted water as the remedy for ground-water contamination outside of the Tailings Disposal Site.	September 30, 1988
UNC submits Remedial Design Report.	April 1989
Remedial action implemented in Zone 1 – Borrow Pit No. 2 dewatered.	April 1989

Event	Date
EPA issues Unilateral Administrative Order (UAO) Docket No. CERCLA 6-11-89 to UNC requiring UNC to implement the Site CERCLA ground-water operable unit remedy determined by the ROD.	June 29, 1989
Remedial action implemented in Zone 3 – 12 new extraction wells begin pumping.	August 1989
Remedial action implemented in Southwest Alluvium – 3 new extraction wells begin pumping.	October 1989
Ground Water Corrective Action Annual Review 1989 documents remedial action construction completion.	December 1989
United States had brought action against UNC in 1991 for response cost recovery under CERCLA; and in late 1992, the U.S. District Court issued an opinion and order granting a U.S. motion for partial summary judgment on the issue of costs and denying a UNC cross motion for summary judgment. *United States v. United Nuclear Corporation*, 814 F Supp. 1552 (D.N.M., 1992).	December 28, 1992
NRC issues a background-water quality study that recommends higher concentrations of background constituents than presented in the ROD.	1996
First Five-Year Review completed.	September 24, 1998
NRC, EPA, and NMED approve the decommissioning of 10 Zone 3 wells, 3 Zone 1 wells, and 1 Southwest Alluvium well because they meet the decommissioning criteria of producing less than 1 gallon per minute (gpm).	July 30, 1999
NRC approves eliminating the Section 1 portion of Zone 3 as a point of exposure.	September 16, 1999
UNC submits request to terminate all Zone 3 pumping and for Technical Impracticability waiver to EPA, NRC and NMED.	May 2000
All but three Zone 3 wells decommissioned in accord with criterion.	June 2000
EPA approves UNC's request to shut down remaining three Zone 3 wells to slow seepage migration rate.	November 2000
License Amendment No. 31 allows UNC to temporarily suspend the corrective action pumping in Zone 3.	December 29, 2000
License Amendment No. 32 approves the conversion of the Zone 3 Phase II extraction wells to monitoring wells.	March 8, 2001
UNC submits Draft Tribal Resolution and Environmental Right-of-Way to the Navajo Nation to form basis for ICs.	March 2001
EPA gives UNC approval to temporarily shut down Southwest Alluvium extraction wells and an 18-month Natural Attenuation Test is conducted.	February 2001 through July 2002
UNC submits Final Report and Technical Impracticability Evaluation – Southwest Alluvium Natural Attenuation Test to EPA, NRC and NMED.	November 2002
UNC submits proposal to conduct hydraulic fracturing pilot test.	May 21, 2003

Event	Date
UNC conducts the hydraulic fracturing pilot test in Zone 3.	June 2003
Second Five-Year Review completed.	September 18, 2003
Meeting between EPA, Bureau of Indian Affairs (BIA), and the Department of the Interior (DOI) to discuss access issues in connection with the Site ground-water monitoring program on Navajo Allotment lands.	December 5, 2003
UNC submits Final Report – Hydraulic Fracturing Pilot Test Results and Preliminary Full-Scale Design, United Nuclear Church Rock Facility	December 2003
EPA comments on the Final Report – Hydraulic Fracturing Pilot Test Results and Preliminary Full-Scale Design and directs UNC to perform supplemental feasibility study (SFS) for Zone 3.	March 10, 2004 and March 19, 2004
EPA approves Final Report - Hydraulic Fracturing Pilot Test Results and Preliminary Full-Scale Design.	May 21, 2004
UNC conducts the Phase 1 full-scale hydraulic fracturing test in Zone 3.	September 2004
UNC installs well SBL-01 in Section 10, Southwest Alluvium.	October 2004
UNC submits the draft SFS for Zone 3 for review.	October 27, 2004
EPA disapproves draft SFS for Zone 3 and directs UNC to perform a Site-wide SFS (SWSFS) consistent with the NCP.	June 24, 2005
Meeting between EPA, UNC, NRC, NMED, and Navajo Nation EPA (NNEPA) to discuss the SWSFS. UNC generally expresses its opposition to the feasibility study process.	August 17, 2005
Meeting between EPA, NNEPA, BIA and NMED in Window Rock, AZ, to discuss feasibility of ICs restricting the use of contaminated ground water.	January 18, 2006
Meeting between EPA and NNEPA in Dallas, TX, to continue discussions on ICs.	March 16, 2006
EPA approves in-situ alkalinity stabilization pilot study for Zone 3.	May 12, 2006
EPA directs UNC to perform the SWSFS in writing, stating that the feasibility study is appropriate and necessary.	June 23, 2006
Meeting between EPA, NNEPA, BIA, and NMED in Albuquerque, NM to continue discussions on ICs.	August 21, 2006
UNC submits the draft List of Preliminary Assembled Remedial Alternatives for the SWSFS.	September 2006
UNC begins the in-situ alkalinity stabilization pilot study in Zone 3. The study is completed in February 2007.	October 2006
UNC submits the draft SWSFS, Part 1, Church Rock Remediation Standards Update.	February 2007
UNC submits In-Situ Alkalinity Stabilization Pilot Study Report.	June 2007
EPA disapproves SWSFS, Part 1, Church Rock Remediation Standards Update and requires revision to address written comments.	January 2008

Event	Date
Meeting between EPA, State, NRC, NNEPA and UNC to discuss status of remedial activities. UNC notifies regulatory agencies that pumping of hydraulic fracture wells in Zone 3 was unsuccessful in stopping migration of seepage-impacted ground-water. UNC proposes to submit a plan for additional extraction wells for Zone 3.	March 12, 2008
UNC submits summary of hydrogeologic analysis evaluation of ground-water flow and recommended plan for additional extraction wells for interception and recovery of seepage-impacted ground-water in Zone 3.	April 2008
UNC submits white paper on statistics to address some of EPA comments on the SWSFS, Part 1.	May 2008
EPA notifies NRC of approval of UNC's recommendation for additional extraction wells.	June 2008

3.0 Background

3.1 Physical Characteristics

The Site is located 17 miles northeast of Gallup, New Mexico and on the southern border of the Navajo Indian Reservation, see Figure 3-1 (figures found at Attachment 2). UNC operated the Site as a uranium mill facility from 1977 to 1982. The Site includes a former ore processing mill and tailings disposal area, which cover about 25 and 100 acres, respectively (Figure 3-2). The tailings disposal area is subdivided by dikes into three cells identified as the South Cell, Central Cell, and North Cell.

Pipeline Canyon runs through the Site from northeast to southwest. Site alluvium occurs along this drainage feature, including its floodplain. Upslope, Pipeline Canyon passes into Pipeline Arroyo (into which uranium mine water was formerly discharged). Pipeline Canyon is locally flanked by gentle mesas and land that has been regraded in conjunction with milling and former waste handling activities.

The Site lies in an arid, desert climate, with an average annual precipitation of 10.6 inches per year. The evapotranspiration rate is estimated at 61 inches per year (MWH, 2004). Surface water occurs seasonally and flows from northeast to southwest along Pipeline Arroyo.

3.2 Site Hydrogeology

The Site is situated on alluvial valley fill, sandstone, and shale of Cretaceous age at the southern margin of the San Juan Basin. The stratigraphic units identified in the vicinity of the Site, in descending order, are as follows:

- Alluvium
- Dilco Member of the Crevasse Canyon Formation
- Upper Gallup Sandstone
  - Zone 3, upper sandstone
  - Zone 2, shale and coal
  - Zone 1, lower sandstone
- Upper D-Cross Tongue Member of the Mancos Shale

The upper D-Cross Tongue Member of the Mancos Shale, which has a low permeability, acts as an aquitard to prevent or retard the downward migration of ground-water. Lithologic well logs indicate that the thickness of the upper D-Cross Tongue is approximately 130 feet thick in the vicinity of the Site (Canonie Environmental, 1987).

Geologic surface mapping showed the sedimentary bedrock strata are overall very gently dipping (inclined) toward the north (though the bed contacts undulate and are locally flexured).

The ground-water operable unit (OU) consists of the three uppermost water-bearing units or aquifers. From the geologically youngest to the oldest, these units are referred to as: (1) alluvium (Quaternary age unconsolidated materials along Pipeline Canyon, having a maximum thickness of approximately 150 ft and a maximum width of approximately 4,000 ft); (2) Zone 3 (uppermost stratigraphic unit of the Cretaceous age Upper Gallup Sandstone, having a thickness of 70 to 90 ft in the area of the Tailings Disposal Site); and (3) Zone 1 (lowest stratigraphic unit of the Cretaceous age Upper Gallup Sandstone, having a thickness of 80 to 90 ft in the area of the Tailings Disposal Site). Zones 1 and 3 are in contact with the alluvium at the Tailing Disposal Site, thus allowing movement of contaminated ground-water directly into both Zones 1 and 3. The movement of tailing seepage into Zone 1 is believed to have occurred mainly via two borrow pits (Borrow Pit Nos. 1 and 2) that were excavated in the impoundments down to Zone 1. These two borrow pits were later reclaimed to prevent their being an ongoing source of seepage to Zone 1. Zone 1 and Zone 3 are separated by Zone 2, comprising approximately 15 to 20 ft of coal and shale which acts as an aquiclude, strongly inhibiting vertical hydraulic communication and contaminant transport).

Mine water was discharged to the Pipeline Arroyo (Figure 3-2), which infiltrated into the alluvium and then into the Zone 3 and Zone 1 aquifers. The mine-discharge water is referred to as the post-mining, pre-tailing water in the ROD and is considered the background water for the Site. Seepage from the tailings, which were deposited at the Tailings Disposal Site beginning in 1977, then impacted this background water. Impact from the tailings seepage has been observed in the alluvium southwest of the tailings impoundment (Southwest Alluvium) and in Zone 3 and Zone 1 to the northeast and east of the impoundment (EPA, 1998).

The ground-water in the alluvium flows to the southwest along Pipeline Arroyo. The ground waters in both Zone 1 and 3 flow in a northeasterly direction. The source of the water in all three formations is in large measure believed to be the result of historical mine-discharge water infiltration. Water levels in all three formations reached their highest levels between 1977 and 1986 and have been steadily declining since the mine water discharge ceased in 1986 and are returning to pre-mining levels.

3.3 Land and Resource Use

Operation of the Northeast Church Rock uranium mine began in 1968 and uranium milling at the Site began in 1977. Milling activities ceased in 1982, and the tailings disposal areas have since been closed in accord with UNC's License for radioactive material. Currently, activities at the Site are limited to operations and maintenance (O&M) of the ground-water remedial program and the tailings cap.

The surrounding lands include the Navajo Reservation, Tribal Trust Land, Indian Allotment Land, and UNC-owned property. These lands are sparsely populated and the primary land use near the site is grazing for sheep, cattle, and horses. Land use has not changed since the issuance of the ROD. However, it is noted that Hydro Resources Inc. (HRI) has received approval (Source Materials License SUA-1580) from the NRC for an

in-situ leach mining project to be located in Sections 8 and 17, approximately three or four miles south of the Site, and intends to begin mining upon receiving an Underground Injection Control (UIC) permit. It is also noted that the Fort Defiance Housing Corporation, in conjunction with the U.S. Department of Housing and Urban Development and the Navajo Housing Authority, is planning to develop a 1000-unit housing complex in the vicinity of Springstead (seven miles to the southwest of the Site). Lastly, it is noted that the Navajo Nation is building its first casino in the Church Rock Chapter, which may significantly influence future land and resource use.

Four water wells are within a 4-mile radius, the nearest being 1.7 miles northeast of the Site. There is a water pipeline from Pinedale that supplies potable water to area residents. Nearby residents also use bottled water for drinking.

3.4 History of Contamination

The UNC uranium mill was granted a radioactive materials license by the State of New Mexico in May 1977, and operated from June 1977 to May 1982. The mill, designed to process 4,000 tons of ore per day, extracted uranium using conventional crushing, grinding, and acid-leach solvent extraction methods. Uranium ore processed at the Site came from the Northeast Church Rock and the Old Church Rock mines. The average ore grade processed was approximately 0.12 percent uranium oxide. The milling of uranium ore produced acidic slurry of ground waste rock and fluid (tailings) that was pumped to the Tailings Disposal Site. An estimated 3.5 million tons of tailings were disposed in the tailings impoundments (EPA, 1998).

3.4.1 Tailings Disposal and Leaching

Tailings liquids were stored in the areas of Borrow Pits Nos. 1 and 2, the North Cell, and the South Cell. The North Cell has been the primary source of tailings seepage. An estimated 5 million gallons was previously available to migrate into the alluvium and Zone 3 located beneath the North Cell. Zone 1 is not affected by the seepage source in the North Cell, because it is hydraulically separated from this source by Zone 2.

The borrow pits were present in the Central Cell area. Borrow Pit No. 1 was used to dispose of tailings and Borrow Pit No. 2 was used to retain tailings liquids (EPA, 1988). The liquid stored in Borrow Pit No. 2 has been neutralized since 1983. However, it has been proposed that prior to 1983, both borrow pits behaved as a single hydraulic unit and provided a source of acidic seepage to the alluvium, Zone 3, and Zone 1.

3.4.2 Tailings Spill

In July 1979, the dam on the south cell breached, releasing approximately 93 million gallons of tailings and pond water to the Rio Puerco. The dam was repaired shortly after its failure. Cleanup of the resultant spill was conducted according to criteria imposed by state and federal agencies, including the EPA, at that time.

3.4.3 Ground-water Contamination

The Northeast Church Rock Mine was dewatered to access the uranium ore in the deep bedrock. Water from the mine was discharged to the northwest branch of Pipeline Arroyo at a location just north of the mine. Water was also discharged to the arroyo from a nearby mine operated by Quivira (formerly Kerr McGee). Mine water was discharged to the arroyo from March 1969 through February 1986 at an average rate of approximately 3,000 gallons per minute (gpm). The mine water discharges infiltrated the alluvium and Zones 1 and 3 of the Upper Gallup Sandstone Formation, significantly recharging these aquifers and creating an artificially high water table under the Site. In the EPA's Remedial Investigation (RI) report, it was estimated that discharge water infiltrated into the alluvium at a rate of 250 gpm. It is noted that there is some contention between EPA and UNC on just how much saturation may have existed in the formations prior to any infiltration of mine water discharges.

The leaching or seepage of tailing fluid containing radioactive and non-radioactive contaminants and associated constituents (tailing seepage) occurred from the tailings disposal cells downward through the underlying soils and into the ground water. This tailing seepage contaminated the alluvium and Zones 1 and 3, which had already been significantly recharged by the mine water discharges. These seepage-impacted areas are shown on Figure 3-3. The alluvium was impacted in three areas: southwest of the South Cell, north of the North Cell, and in Section 36 to the north of the Tailings Disposal Site (referred to in the ROD as the South or Southwest Alluvium, North Alluvium, and Section 36 Alluvium). They have been mapped by evaluating ground-water chemistry conditions reflecting an effect from tailing seepage. The affected ground waters have relatively low (acidic) pH and elevated concentrations of nitrate, sulfate, total dissolved solids (TDS), bicarbonate, chloride, select heavy metals, and select radionuclides.

The post-mining, pre-tailing background water, unaffected by tailing seepage, exceeds New Mexico Water Quality Control Commission (NMWQCC) numerical ground-water standards for several contaminants, including sulfate and TDS.

3.5 Initial Response

Prior to ROD issuance, UNC undertook the following actions under its NRC License. Initial corrective action to address ground-water concerns began with tailings seepage investigations and neutralization of the acidic tailings. These actions were performed from 1979 through 1982. Tailings neutralization included the addition of ammonia and lime to the tailings. The New Mexico Environment Department (NMED) also required that UNC remediate ground-water in Zones 1 and 3. This remediation, which began in 1982, consisted of installing and operating wells to extract tailings seepage, neutralizing the extracted water, and discharging the neutralized water into the tailings disposal cells.

The processes for reclamation and ground-water remediation were implemented beginning in 1986 under the NRC License. A draft reclamation plan was submitted to NRC in 1987 and the final plan was approved in March 1991. The NRC required that

reclamation construction activities begin in 1988, three years prior to final approval of the reclamation plan. The ground-water remediation, as required under NRC regulations and in the License, was incorporated into the reclamation plan. The Corrective Action Plan (CAP) included cleanup standards for the Site as determined by the NRC.

The EPA's involvement at the Site began in 1981 when the Site was placed on the Interim Priority List under CERCLA. The Site was proposed for listing on the NPL in 1982 and placed on the NPL in 1983, because of seepage from the tailings and the consequent off-site migration of radiological and chemical constituents in the ground-water. The EPA commenced the remedial investigation and feasibility study (RI/FS) in March 1984 with the RI field activities being conducted from March 1984 through August 1987. The objectives of the RI field activities were to determine the nature and extent of ground-water contamination in the alluvium, and Zone 1 and Zone 3 of the Upper Gallup Sandstone. The EPA released the RI and FS reports in August 1988, along with a proposed plan-of-action fact sheet for the Site ground-water remediation. A Public Health Assessment (PHA) was included in the FS report. The PHA addressed the potential hazards to public health associated with the potential use of the impacted ground-water near the Site. The PHA concluded that the potential risk associated with the use of ground-water from Zones 1 and 3 exceeded 10^{-6} and the potential hazard quotient exceeded 1.0.

The RI report concluded the following:

- An area of seepage-impacted ground-water is present that extends a minimum of 1,000 feet past the south cell (Southwest Alluvium). The extent of the seepage-impacted ground-water was beyond the furthest downgradient well (at that time). Alluvial contaminants included TDS, nitrate, sulfate, heavy metals (selenium, manganese, cadmium, and molybdenum), and radionuclides (predominantly gross alpha, but including detections of gross beta, radium-226, and -228).

- In Zone 3, an elongate area of seepage-impacted ground-water was present more than 2,000 feet from the north cell. Contaminants included TDS, ammonia, low pH, sulfate, nitrate, heavy metals (cadmium, chromium, manganese, arsenic, and beryllium), and radionuclides (thorium, uranium, gross alpha, gross beta, radium-226, and -228).

- In Zone 1, seepage-impacted ground-water in two areas had migrated northeast and east at least 800 feet from former Borrow Pit No. 2. Contaminants included TDS, acidic pH, nitrates, heavy metals (cadmium, arsenic, and manganese), and radionuclides (thorium, uranium, gross alpha, and gross beta).

On August 26, 1988, the EPA and NRC signed the MOU that provided for coordination of the NRC reclamation and closure activities at the Tailings Disposal Site and the EPA CERCLA ground-water remedial action. The intent of the MOU was to "establish the roles, responsibilities, and relationship between" the EPA and NRC and to "help assure

that remedial actions occur in a timely and effective manner." The MOU recognized that the EPA would conduct a CERCLA RI/FS and sign a ROD that addresses ground-water contamination outside of the Tailings Disposal Site. The EPA would then require UNC to implement the selected CERCLA remedial action under EPA oversight.

3.6 Basis for Taking Action

This section describes the contaminants found in the ground-water impacted by tailing seepage at the Site. No other media are relevant to this review.

3.6.1 Applicable or Relevant and Appropriate Requirements

Section 121(d)(2)(A) of CERCLA incorporates the CERCLA Compliance Policy, which specifies that Superfund remedial actions must meet any federal standards, requirements, criteria, or limitations legally determined to be Applicable or Relevant and Appropriate Requirements (ARARs). Also included is the provision that state ARARs must be met if they are (1) promulgated, and (2) more stringent than federal requirements. The ARARs established in the ROD for this Site which were evaluated as part of this review include:

- National Primary Drinking Water Standards;
- New Mexico Water Quality Control Commission Regulation Standards (including Human Health "Drinking Water Standards");
- Resource Conservation and Recovery Act Standards applicable to background; and,
- Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 Code of Federal Regulations [CFR] 192), as adopted by 10 CFR 40, Appendix A, pursuant to UMTRCA.

Contaminant-specific ground-water ARARs presented in the ROD are shown in Table 3-1 (below). 40 CFR §300.430 (f)(1)(ii)(B)(*1*) states that *requirements that are promulgated or modified after ROD signature must be attained (or waived) only when determined to be applicable or relevant and appropriate and necessary to ensure that the remedy is protective of human health and the environment.* Accordingly, any new potential ARARs must be attained only under certain specific conditions. The protectiveness of the existing ROD ARARs in light of revised federal or state standards is discussed in Section 7.

3.6.2 Contaminants of Concern

The ROD identified contaminant-specific ARARs from the federal Safe Drinking Water Act (SDWA) National Primary Drinking Water Standards (Maximum Contaminant Levels or MCLs) and the NMWQCC regulation standards. The ROD also identified health-based criteria (for those contaminants where MCLs and NMWQCC standards were not available) as to-be-considered (TBC) criteria, along with background levels where the post-mining, pre-tailing background levels were higher than federal or state standards or health-based criteria. The health-based criteria and background levels

identified for the Site, in addition to ARARs, are collectively referred to as the ROD cleanup levels for the purposes of this five-year review and are shown in Table 3-1 (below). Although not specifically stated as "cleanup levels" in the ROD, these ARARs, health-based criteria, and background levels represent the cleanup levels that have been used throughout the course of the CERCLA cleanup effort. Specifically, the cleanup levels established in the ROD are as follows:

- Post-mining, pre-tailing background levels were established for iron, manganese, sulfate, nitrate, and TDS.

- MCLs were selected as the cleanup levels for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, radium-226 and –228, and gross alpha. The basis for thorium-230 is the gross alpha standard of 15 pCi/L.

- NMWQCC standards were selected as the cleanup levels for aluminum, cobalt, copper, molybdenum, nickel, zinc, chloride, and uranium-238. NMWQCC standards and MCLs were the same for barium, cadmium, chromium, lead, mercury, and silver.

- Health-based criteria were calculated using reference doses, assuming a 70-kilogram individual who consumes 2 liters of water per day, for antimony, beryllium, thallium, and vanadium.

Table 2 of the ROD (Contaminant-Specific Ground Water ARARs) identifies cleanup levels for the twenty-eight contaminants detected in Site ground water during the RI (*see also* Tables 4 and 5 of the ROD). Of the twenty-eight cleanup levels, nineteen are ARARs, four are health-based criteria and five are post-mining, pre-tailing background levels. Table 6 of the ROD identifies those Site contaminants that exceed the cleanup levels and the aquifer(s) in which they were exceeded. This information is summarized in Table 3-1 (below). At the time the ROD was prepared, the alluvium was divided into North Alluvium, South (or Southwest) Alluvium and Section 36 Alluvium target areas. The remedy selected by EPA in the ROD for the alluvium focused on the Southwest Alluvium target area (as shown in Table 3-1, below).

While preparing the Remedial Design in 1989, UNC evaluated the existing ground-water data to determine which contaminants exceeded the ROD cleanup levels. The Remedial Design proposed only those contaminants exceeding the cleanup levels for inclusion in the monitoring program. This evaluation of the ground-water data showed that 14 contaminants were below the cleanup levels (antimony, barium, beryllium, chromium, copper, iron, lead, mercury, silver, thallium, vanadium, zinc, uranium-238, and thorium-230). Radium-226 and -228 combined only exceeded the cleanup level in Zone 3. NRC standards (as documented in the License) were also considered in the Remedial Design Report. The License identified 15 contaminants, included four not previously identified in the ROD (lead-210, chloroform, cyanide, and naphthalene). The NRC's ground-water protection standards were exceeded in Zone 3 for all 15 analytes. However some of these

Table 3-1
ROD Cleanup Levels and Contaminants Exceeding Cleanup Levels

Contaminant	Value	Units	Exceeds ARARs		
			SWA	Zone 3	Zone 1
Aluminum	5	mg/L		X	X
Antimony	0.014	mg/L			
Arsenic	0.05	mg/L		X	X
Barium	1	mg/L			
Beryllium	0.017	mg/L			
Cadmium	0.01	mg/L	X	X	X
Chromium	0.05	mg/L			
Cobalt	0.05	mg/L	X	X	X
Copper	1	mg/L			
Iron	5.5	mg/L			
Lead	0.05	mg/L			
Manganese	2.6	mg/L	X	X	X
Mercury	0.002	mg/L			
Molybdenum	1	mg/L	X	X	X
Nickel	0.2	mg/L	X	X	X
Selenium	0.01	mg/L	X	X	X
Silver	0.05	mg/L			
Thallium	0.014	mg/L			
Vanadium	0.7	mg/L			
Zinc	10	mg/L			
Chloride	250	mg/L			
Sulfate	2160	mg/L			
Nitrate	30	mg/L	X	X	X
Total Dissolved Solids (TDS)	3170	mg/L	X	X	X
Radium 226 & 228	5	pCi/L		X	
Uranium-238	5	mg/L or 1645 pCi/L			
Thorium-230	15	pCi/L			
Gross Alpha	15	pCi/L	X	X	X

Notes 1: SWA = Southwest Alluvium.
2: mg/L = milligram per liter, pCi/L = picocurrie per liter
4: EPA cleanup levels represent NMWQCC standards for Aluminum, Cobalt, Copper, Molybdenum, Nickel, Zinc, Chloride, and Uranium
5. EPA cleanup levels represent MCLs for Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver, Radium -226 and -228, Thorium-230 and Gross Alpha; numerically identical NMWQCC standards existed for Barium, Cadmium, Chromium, Lead, Mercury, and Silver
6. EPA cleanup levels represent background levels for iron, manganese, sulfate, nitrate and TDS
7. EPA cleanup levels represent health-based criteria for antimony, beryllium, thallium, and vanadium
8. Although some NMWQCC standards and MCLs are numerically identical, the state standards represent dissolved concentrations, while the federal MCLs represent total concentrations.

analytes (e.g., arsenic) were detected at concentrations below NRC's standards for Zone 1 and the Southwest Alluvium. Review of the Remedial Design Report (Tables 1.1 and 1.2) suggests that the comparison to cleanup levels and standards may have used different sets of wells (or errors exist in the tables), because unexpected results are noted (for example, the NRC beryllium standard of 0.05 mg/L is exceeded in Zones 1 and 3, while no exceedance is indicated for the EPA cleanup level of 0.017 mg/L). It was also noted that the contaminant sulfate, which is elevated throughout the Site, is not identified as exceeding the cleanup level. At this time, project documents refer to uranium and not uranium-238, as listed in the ROD. Those contaminants identified in the Remedial Design Report as exceeding either the ROD cleanup levels, the NRC standards, or both, are summarized in Table 3-2 (below).

After evaluating all of the exceedances identified in the Remedial Design Report, UNC developed a list of 29 performance monitoring analytes. This list was proposed in the Remedial Design Report and the Remedial Action Plan (RAP), both of which were approved by the EPA and the NRC. Since beginning the Remedial Action in 1989, UNC has monitored this list of analytes. The 29 analytes were incorporated into NRC's License. Several of the 29 analytes monitored by UNC (e.g., ammonia, sodium, potassium, and bicarbonate) are not identified as exceeding either EPA's cleanup levels or the NRC standards, but were required to be monitored under the NRC License.

In 1996, at the request of UNC, the NRC used the existing ground-water monitoring data and knowledge of the Site to conduct a re-evaluation of background concentrations for certain contaminants. Although the NRC did not regulate those contaminants and had no ground-water protection standards for them, it recommended that the background values for manganese, nitrate, sulfate, and TDS, established by EPA as cleanup levels in the ROD, be revised. The NRC recommended the cleanup level for nitrate to be 190 mg/L. Other background studies have been performed by UNC consultants as a compilation of efforts under the NRC License and for EPA. Based on another UNC proposal, the NRC updated the combined radium 226 and 228 License standards to 5.0, 5.2, and 9.4 pCi/L, for Zone 3, the Southwest Alluvium, and Zone 1, respectively. The NRC chloroform standard has been changed to the total trihalomethane (TTHM) MCL value of 0.080 mg/L. The NRC has also removed cyanide and naphthalene from the License monitoring requirements based on a proposal from UNC.

The EPA reviewed those studies and proposed modifications to the background values, NRC standards, and monitoring requirements. The EPA communicated to the NRC that the proposed modifications for removing cyanide and naphthalene from the monitoring program were acceptable. The EPA also communicated to the NRC that the recommended revised nitrate and radium values were acceptable and plans to modify the cleanup levels for those contaminants in future decision-making following completion of the SWSFS, to be consistent with the NRC's License standards. The EPA plans on revising the background cleanup levels, as appropriate, following the completion of the SWSFS, which includes a thorough and comprehensive review of the existing cleanup levels, newly promulgated standards as potential new ARARs, and more recent health-based toxicological information and background water quality data.

Table 3-2
ROD Cleanup Levels, NRC Standards, and Contaminant Exceedances Identified in UNC's 1989 Remedial Design Report

Contaminant	ROD Cleanup Level	NRC Standard	Units	Exceeds Cleanup Levels or Standards		
				SWA[1]	Zone 3	Zone 1
Aluminum	5	None	mg/L	-/na	CL/na	CL/na
Antimony	0.014	None	mg/L	-/na	-/na	-/na
Arsenic	0.05	0.05	mg/L	-/-	CL/S	CL/S
Barium	1	None	mg/L	-/na	-/na	-/na
Beryllium	0.017	0.05	mg/L	-/-	-/S	-/S
Cadmium	0.01	0.01	mg/L	CL/-	CL/S	CL/S
Chromium	0.05	None	mg/L	-/na	-/na	-/na
Cobalt	0.05	None	mg/L	CL/na	CL/na	CL/na
Copper	1	None	mg/L	-/na	-/na	-/na
Iron	5.5	None	mg/L	-/na	-/na	-/na
Lead	0.05	0.05	mg/L	-/S	-/S	-/-
Manganese	2.6	None	mg/L	CL/na	CL/na	CL/na
Mercury	0.002	None	mg/L	-/na	-/na	-/na
Molybdenum	1	None	mg/L	CL/na	CL/na	CL/na
Nickel	0.2	0.05	mg/L	-/S	CL/S	CL/S
Selenium	0.01	0.01	mg/L	CL/S	CL/S	CL/S
Silver	0.05	None	mg/L	-/na	-/na	-/na
Thallium	0.014	None	mg/L	-/na	-/na	-/na
Vanadium	0.7	0.1	mg/L	-/-	-/S	-/-
Zinc	10	None	mg/L	-/na	-/na	-/na
Chloride	250	None	mg/L	-/na	-/na	-/na
Sulfate	2160	None	mg/L	-/na	-/na	-/na
Nitrate	30	None	mg/L	CL/na	CL/na	CL/na
Total Dissolved Solids (TDS)	3170	None	mg/L	CL/na	CL/na	CL/na
Radium 226 & 228	5	5	pCi/L	-/S	CL/S	-/S
Uranium	5	0.3	mg/L	-/-	-/S	-/-
Thorium-230	15	5	pCi/L	-/S	-/S	-/S
Gross Alpha	15	15	pCi/L	CL/S	CL/S	CL/S
Lead-210	None	1	pCi/L	na/-	na/S	na/S
Chloroform	None	0.001	mg/L	na/-	na/S	na/-
Cyanide	None	0.005	mg/L	na/S	na/S	na/S
Naphthalene	None	0.001	mg/L	na/-	na/S	na/-

Notes 1: SWA = Southwest Alluvium.
2: Exceeds Cleanup Levels or Standards:
CL = exceeds EPA's cleanup level
S = exceeds NRC's standard
"-" = no exceedance
"na" = no EPA cleanup level or NRC standard established.
3: mg/L = milligram per liter, pCi/L = picocurrie per liter

The relationship between the ROD cleanup levels, the current NRC standards, and the current ground-water monitoring program is shown on Table 3-3 (below). As indicated on this table, a number of Site-related contaminants identified in the ROD have never been or are no longer monitored as part of the remedial activities because either they were never detected, were originally below the established cleanup levels, or have since decreased in concentration below the established cleanup levels.

Table 3-3
Comparison of ROD Cleanup Levels and NRC Standards with Current Monitoring Program

Contaminant	ROD Cleanup Level	NRC Standard	Units	Current Monitoring Program		
				SWA[1]	Zone 3	Zone 1
Aluminum	5	None	mg/L		X	X
Antimony	0.014	None	mg/L			
Arsenic	0.05	0.05	mg/L		X	X
Barium	1	None	mg/L			
Beryllium	0.017	0.05	mg/L	X	X	X
Cadmium	0.01	0.01	mg/L	X	X	X
Chromium	0.05	None	mg/L			
Cobalt	0.05	None	mg/L		X	X
Copper	1	None	mg/L			
Iron	5.5	None	mg/L			
Lead	0.05	0.05	mg/L	X	X	X
Manganese	2.6	None	mg/L	X	X	X
Mercury	0.002	None	mg/L			
Molybdenum	1	None	mg/L	X	X	X
Nickel	0.2	0.05	mg/L	X	X	X
Selenium	0.01	0.01	mg/L	X	X	X
Silver	0.05	None	mg/L			
Thallium	0.014	None	mg/L			
Vanadium	0.7	0.1	mg/L	X	X	X
Zinc	10	None	mg/L			
Chloride	250	None	mg/L	X	X	X
Sulfate	2160	None	mg/L	X	X	X
Nitrate	30	None	mg/L	X	X	X
Total Dissolved Solids (TDS)	3170	None	mg/L	X	X	X
Radium 226 & 228	5	5.2 (SWA) 5.0 (Z-3) 9.4 (Z-1)	pCi/L	X	X	X
Uranium	5	0.3	mg/L	X	X	X
Thorium-230	15	5	pCi/L	X	X	X
Gross Alpha	15	15	pCi/L	X	X	X
Lead-210	None	1	pCi/L	X	X	X
TTHM	None	0.080	mg/L	X	X	X
Cyanide	None	0.005	mg/L			
Naphthalene	None	0.001	mg/L			

Note 1: SWA = Southwest Alluvium.
2: Chloroform replaced with total trihalomethane (TTHM). The TTHM MCL is 0.080 mg/L.
3: "X" = contaminant in the current monitoring program.
4: mg/L = milligram per liter, pCi/L = picocurrie per liter

4.0 Remedial Actions

4.1 Remedy Selection

Extraction and evaporation of contaminated ground-water was selected as the remedy in the ROD signed on September 30, 1988. As stated in the ROD, the selected remedy incorporates source control remedial action (surface reclamation, capping, and mill decommissioning) under the NRC's licensing requirements as specified in the MOU between the EPA and the NRC. Both ground-water and source control/surface reclamation remedial actions were to be integrated and coordinated to achieve comprehensive reclamation and remediation of the Site. Both the NMED and the NRC reviewed and commented on the ROD and endorsed the remedy. The selected remedy expanded upon the remediation previously required by the NRC under the License for Zone 1 and Zone 3 and added a requirement for ground-water extraction in the Southwest Alluvium. For purposes of integrating and coordinating the ground-water remediation, the NRC ground-water Corrective Action Plan (CAP) was subsequently amended to include remediation in the Southwest Alluvium.

The remedy set forth in the ROD consists of the following six components:

1. Implementation of a monitoring program to detect any increases in the areal extent, or concentration of, ground-water contamination outside the tailings disposal area;

2. Operation of existing seepage extraction systems in the Upper Gallup Aquifers (because seepage from tailings had migrated into the underlying Zone 1 and Zone 3 sandstones, the selected remedy included operation of the existing East Pump-Back wells in Zone 1 and the Northeast Pump-Back wells in Zone 3 until adequate dissipation of the tailing seepage mound has been achieved; operation of the two pump-back systems were to be integrated with active seepage remediation that may be required by the NRC inside the tailings disposal area);

3. Containment and removal of contaminated ground water in Zone 3 of the Upper Gallup Sandstone utilizing existing and additional wells (the ROD states that "Seepage collection in Zone 3 will be designed to create a hydraulic barrier to further migration of contamination");

4. Containment and removal of contaminated ground water in the Southwest Alluvium utilizing existing and additional wells (the ROD states that "Seepage collection in the Southwest Alluvium will be designed to create a hydraulic barrier to further migration of contamination while the source is being remediated");

5. Evaporation of (extracted) ground water using evaporation ponds supplemented with mist or spray systems to enhance the rate of evaporation;

6. Implementation of a performance monitoring and evaluation program to determine water level and contaminant reductions in each aquifer, and to evaluate the extent and duration of pumping actually required outside the tailings disposal area.

The goal of the selected remedy at the Site was to restore ground water outside the Tailings Disposal Area Site to federal and state standards, health-based criteria, or background levels, to the maximum extent practicable, and to the extent necessary to adequately protect public health and the environment. However, as stated in Appendix A of the ROD, it was recognized by EPA that cleanup levels might not be reached within a reasonable time period due to the physical characteristics of the aquifers. In Appendix A, EPA discusses hydrogeologic uncertainties and contingencies for the selected remedy. The contingencies are stated in the following way: *"...However, operational results may demonstrate that it is technically impracticable to achieve cleanup levels in a reasonable time period, and a waiver to meeting certain contaminant-specific ARARs may require re-evaluation as a result. Operational results may also demonstrate significant declines in pumping rates with time due to insufficient natural recharge of the aquifers. The probability of significant reductions in saturated thickness of aquifers at the Site must be considered during performance evaluations since much of the water underlying the tailings disposal area is the result of mine water and tailings discharge, both of which no longer occur. In the event the saturated thicknesses cease to support pumping, remedial activity would be discontinued or adjusted to appropriate levels"*. (1988 ROD, Appendix A – Hydrologic Impact of Selected Remedy).

4.2 Remedy Implementation

4.2.1 General

Ground-water remediation by UNC is required under CERCLA by the ROD and an EPA Unilateral Administrative Order (UAO), Docket No. CERCLA 6-11-89, issued June 29, 1989.

The key dates of remedial design, remedial action, and relevant agreements and documents are listed in Table 2-1. The performance of the remedial action in each of the three formations is described in the following sections.

Remedial activities pursuant to UMTRCA began in 1982 and 1984 in Zone 1 and Zone 3 seepage-impacted areas, respectively, before the issuance of the ROD, with the installation and operation of pump-back wells under NMEID direction and oversight in its capacity as a UMTRCA agreement state. The extracted contaminated ground water was neutralized by the addition of lime and stored in Borrow Pit No. 2, which was lined with a one-foot thick layer of compacted clay. This remedial action also included the addition of lime to the tailings disposal cells to neutralize tailings liquid and cause precipitation of metals.

The remedy set forth in the 1988 EPA ROD was implemented by the remedial action activities described in the following sections.

4.2.2 Zone 3

The purpose of the Zone 3 extraction well system was to create a hydraulic barrier to control further contaminant migration and to dewater the target area. The volume required to dewater the target area identified in the remedial design was estimated at 200 million gallons.

The extraction well system for this area consisted of the five existing Northeast Pump-Back wells originally installed under NMEID direction, as well as an additional twelve Stage I wells and seven Stage II wells located downgradient of the pump-back wells. The location of the extraction wells and the target area for remediation are shown on Figure 3-2. The Northeast Pump-Back wells began operating in 1982 and were incorporated into the extraction well system by the NRC and the EPA, after the return of the UMTRCA regulatory program from NMEID to the NRC in 1986. The Stage I wells began operating in 1989.

In 1991, after ground-water recovery rates from the pump-back and Stage I wells began to decline, the Stage II wells were added. The Stage II wells were expected to enhance system performance as predicted saturation declines reduced the productivity of the Stage I and Northeast Pump-Back extraction wells.

The system design included decommissioning criteria that allows shutdown of individual wells, or the system, if the efficiency of the wells declines so much that continued operation provides no benefit. The latter has been defined as not meeting a minimum yield of 1.0 gpm. Wells that produce less than 1.0 gpm were to be cleaned and stimulated, and if the well still did not produce 1.0 gpm then it was to be decommissioned.

The Northeast Pump-Back wells and Stage I wells met the decommissioning criteria and were shut down. The Stage II wells were determined to be accelerating the movement of tailing seepage in the down-gradient direction and, therefore, were also shut down in 2000, with the approval of the EPA, the NMED, and the NRC. Approximately 162 million gallons of ground water had been extracted at system shut down.

With the shut down of the Stage II extraction wells, active remediation of the Zone 3 ground-water seepage-impacted area ceased until 2003. At that time UNC initiated the pilot-scale hydraulic fracturing test in Zone 3 to explore the possibility of enhancing permeability, thus improving ground-water extraction efficiency. The pilot test was conducted in 2003 to determine the applicability of the technology to the Site. The technology was judged to be feasible, and it was decided to proceed to the first phase of full-scale implementation. This work began in 2004 with the following goals: (1) providing hydraulic containment of the leading edge of the tailing seepage, (2) allowing the formation's remaining buffering capacity to attenuate the tailing seepage, and (3)

initiating dewatering in the main body of the seepage-impacted area. Seven recovery wells were successfully installed and hydrofractured using the hydraulic fracturing technology (MACTEC, 2006). However, the recovery wells did not achieve the anticipated improvement in pumping efficiency. Since the seven wells were determined to be better position to capture seepage-impacted ground-water, they continued to be pumped to extract ground-water.

Extraction well pumping that originated with the hydrofracture program (seven RW-series extraction wells) continues to present, but has been modified by shutting off some wells and adding an additional extraction well (RW-A) at a new downgradient location and converting a down-gradient monitoring well (PB-02) into an extraction well in 2007. Ground-water extraction with this new pumping configuration has continued at the best possible rate in an effort to slow the northward migration of the Zone 3 tailing seepage. An additional 6.8 million gallons of ground water (for a cumulative total of 168.6 million gallons) had been extracted from 2003 to 2007.

In addition, UNC conducted an in-situ alkalinity stabilization pilot study from October 2006 to February 2007. The strategy of the pilot study involved injecting alkalinity-rich ground water from a non-impacted deeper aquifer below Zone 3 and the Mancos Shale (Dakota Formation) via the onsite Mill Well into areas where seepage-impacted acidic conditions exist in the Zone 3 aquifer. The injected water would flow through the Zone 3 formation to recovery wells where the water would be pumped for treatment and disposal. The pilot objective was for the alkaline rich water to neutralize the acidity along a mixing front and, hence, displace the seepage-impacted ground water. It was anticipated that increasing the pH would reduce migration and/or immobilize contaminants by chemical precipitation and surface adsorption reactions.

The pilot study well field consisted of an extraction well surrounded by four injection wells. Outside of the injection wells were four additional extraction wells to provide overall hydraulic control during the study. Newly installed and existing wells were utilized for the study. During the study, observed injection and extraction rates were significantly lower than anticipated. Because of these low rates, UNC decided to core the entire thickness of the Zone 3 formation within the pilot study area for petrologic analysis. The analysis of this core, along with several historic Zone 3 cores, showed that the pore spaces between the sand grains in the saturated zone were clogged with finely crystalline kaolinite clay. Samples from the unsaturated zone and those from other historic cores did not contain the kaolinite. Based on these analyses, UNC concluded that reactions between the feldspars and tailings seepage produce a secondary mineral, kaolinite. The kaolinitic clay had significantly reduced the hydraulic conductivity by partially clogging the pore spaces between the sand grains, thus significantly limiting the potential for water to flow through the formation (ARCADIS BBL, 2007). UNC concluded that it would not be possible to effectively implement the in-situ alkalinity stabilization technology to enhance the Zone 3 remedy.

UNC is continuing to operate extraction wells at the downgradient edge of the seepage-impacted ground water to slow the northward movement of seepage-impacted ground

water to the maximum extent practicable. UNC has also proposed the installation of additional extraction wells further downgradient as the seepage-impacted front continues to advances toward the Navajo Reservation boundary. *See also* Section 6.2.3, below.

The current Zone 3 monitoring programs consist of taking water elevation measurements from 23 of the monitoring wells and collecting water quality data from 11 wells.

4.2.3 Zone 1

The remedial action in Zone 1 has consisted of source remediation (neutralization and later dewatering of Borrow Pit No. 2) and pumping a series of extraction wells from 1984 through 1999. Water elevation measurements are taken from 15 of the Zone 1 monitoring wells and water quality samples are collected from 8. The locations of these features are shown on Figure 3-2. The wells were shut off and decommissioned in 1999, with the approval of the EPA, NMED, and NRC because pumping rates had significantly declined over time due to insufficient natural recharge and the loss in saturation reached levels that did not support operation. With the shut down and decommissioning of the extraction wells, active remediation of the Zone 1 ground-water seepage-impacted area ceased. A total of 2.9 million gallons of ground water had been extracted when the system was decommissioned.

4.2.4 Southwest Alluvium

The remedial action for the Southwest Alluvium has consisted of four extraction wells (801, 802, 803 and 808) that were designed as a barrier/collection system in the target area. The system was located approximately 400 feet downgradient from the southern edge of the South Cell of the tailings impoundment and up-gradient of the NRC's four point of compliance (POC) wells (EPA 28, GW 1, GW 2, 632) for the Southwest Alluvium. The locations of extraction wells and monitoring wells are shown on Figure 3-2.

The wells were designed to create a hydraulic barrier for controlling further migration of contaminated ground water while the source was being remediated. Source control was achieved by regrading and re-contouring the South Cell and installing a low-permeability soil cover. Water elevation measurements are taken from 17 of the Southwest Alluvium monitoring wells and water quality samples are collected from 15. Six of the hydraulically upgradient monitoring wells have gone dry. Downgradient monitoring well SBL-01 was installed in October 2004 to better define the down-gradient limit of the seepage-impacted area.

Active remediation of the Southwest Alluvium seepage-impacted area was temporarily discontinued in February 2001 to evaluate the ability of the contaminants to naturally attenuate in the aquifer (i.e., Natural Attenuation (NA) Test). Such testing was part of UNC's effort to evaluate the appropriateness of obtaining a TI waiver for the state standards for sulfate and TDS, which are identified as ARARs in the ROD. Concentrations of those contaminants had shown little change over time during operation

of the extraction system. The TI waiver evaluation report, submitted by UNC in 2002, recommended a TI waiver for the sulfate and TDS standards. It will be considered during performance of the Site-Wide Supplemental Feasibility Study (SWSFS) and future EPA decision-making. In the interim, UNC has been allowed to leave the extraction wells shut off. A total of approximately 131.1 million gallons of ground-water had been extracted when the system was temporarily decommissioned in 2001.

4.2.5 Water Collection and Treatment

Ground water produced from all Site extraction wells is evaporated in two five-acre, evaporation ponds (Figure 3-2), and a spray evaporation system installed on the surface of the re-graded and covered tailings. An evaporation mist system constructed on the interior berm between the two evaporation ponds is available to enhance the disposal of the extracted water. Additionally, the Site is equipped with 28 water cannons distributed across the surface of the re-graded and covered tailings. The cannons were designed to spray water at a rate to optimize evaporation and prevent saturation of the tailings. Both the mist system and cannons are only to be used during the summer months. During the winter months, water is stored in the evaporation ponds. Based on observations and a study of water levels in the evaporation ponds in 2005 and 2007, no evidence of leakage has been observed (*see, e.g.,* Technical Memorandum from Roy Blickwedel, GE, to Larry Bush, UNC, Mark Purcell, EPA, and William von Till, NRC; May 14, 2005). It has not been necessary to operate the evaporation mist system or the water cannons since 2001 when the rate of ground-water extraction declined significantly. These systems remain in good repair should they be needed again.

4.3 NRC-Lead Surface Reclamation and Source Control

The MOU between the EPA and the NRC clarified that the NRC would exercise its authority over surface reclamation and source control. The ROD stated that, "...Upon approval of a final reclamation plan, both ground-water and source control/surface reclamation remedial actions will be integrated and coordinated to achieve comprehensive reclamation and remediation of the Site" (ROD, p. 41). The following section provides a background for the source control portion of the remedy, which falls under the purview of NRC's License.

4.3.1 Source Control

The source-control measures include regrading and recontouring the tailings, placing a low permeability compacted soil cover over the regraded tailings, and constructing drainage swales on and around the reclaimed impoundments. The cover consists of an initial interim cover of compacted soil, followed by the final cover of compacted soil and rock as a radon barrier and for erosion protection. The source-control measures were designed primarily to effectively minimize infiltration, seepage, and mobilization of contaminants from the tailings (EPA, 1998).

Reclamation of the South Cell occurred between 1991 and 1996 and included regrading and recontouring of the tailings and placement of the interim and final covers over those portions of the South Cell not occupied by the evaporation ponds. The interim cover comprised 12 inches of compacted soil with average permeability measurements of $3x10^{-8}$ centimeters per second (cm/sec). The final radon cover comprises an additional six inches of compacted soil and a six-inch soil/rock matrix layer for erosion protection. The area of the South Cell occupied by the evaporation ponds will be reclaimed after the ground-water remedation is complete and the evaporation ponds are no longer needed (EPA, 1998).

The remediation of the North Cell began in 1989 and consisted of regrading and recontouring of the tailings area and placement of twelve inches of compacted soil as the interim cover. Similar to the South Cell, the interim cover eliminated direct contact of surface precipitation with tailings material and minimized future infiltration. Final reclamation of the North Cell was performed in 1993 and consisted of placing a radon cover consisting of an additional six inches of compacted soil and a six-inch soil/rock matrix layer for erosion protection. Drainage swales on the North Cell maximize surface drainage from the cover while controlling the velocity of surface runoff to prevent excessive erosion (EPA, 1998)

Reclamation of the Central Cell and Borrow Pit No. 2 occurred between 1989 and 1995. The work consisted of dewatering Borrow Pit No. 2, regrading and recontouring the tailings, backfilling the borrow pit with debris from mill decommissioning, and placement of the interim and final cover layers. For the Central Cell, the interim cover was completed in 1991 and the final radon cover was placed in 1994. The backfilling of Borrow Pit No. 2 occurred from 1991 to 1994. The placement of the interim and final covers was completed in 1994 and 1995, respectively (EPA, 1998).

The results of the Emanation Testing of the Final Radon Cover Over UNC's Church Rock Tailings' Site were reported to the NRC on January 3, 1997 (UNC, January 1997). The report documented the tests conducted on September 26, 1996. Sampling included the collection of 115 radon samples from the surface of the radon cover and resulted in an average radon flux for the tailings of 6.46 picocuries (pCi) per meter squared (m^2) per second (sec). All areas were less than the Site License standard of 20 $pCi/m^2/sec$ with the exception of the South Cell in the vicinity of the evaporation ponds, where the radon barrier has not been installed yet.

4.4 System Operations and Maintenance (O&M)

4.4.1 System Operations and O&M Requirements

Required operation and maintenance (O&M) activities at the Site are stipulated in the NRC License. The O&M activities are also specified in a number of internal documents kept at the Site. Ground-water O&M is required under CERCLA by the EPA ROD and UAO. The O&M activities include:

- Operation, maintenance, and monitoring of the ground-water extraction wells and associated piping.
- Maintenance of the final radon barrier and interim covers on the tailings piles.
- Operation and maintenance of the evaporation ponds, misters, and cannons.
- Maintenance and sampling of ground-water monitoring wells.
- Maintenance of fences and gates.

As discussed above, the operation of the extraction well systems for the Southwest Alluvium and Zone 1 aquifers has been discontinued. Ground-water extraction continues at Zone 3 at several wells along the seepage impacted front. Apart from the low rate of extraction at Zone 3, only maintenance and monitoring activities for those systems are being performed at this time. Personnel are at the Site daily during the week to perform O&M activities.

4.4.2 Problems with Implementing System Operations/O&M

The remedial systems at the Site were implemented as directed by the ROD and have operated as intended. As areas have been dewatered, extraction well efficiency declined and the wells were decommissioned in accord with decommissioning criteria set forth in the ROD.

4.4.3 O&M Costs

The O&M costs are not stipulated in any of the decision documents for the Site. The NRC License contains a condition requiring UNC to provide a financial surety to cover the cost to implement the remaining reclamation and closure activities. The EPA UAO also requires UNC to submit financial assurances to the EPA Region 6.

Current O&M costs are associated primarily with ongoing performance monitoring and ground-water extraction at Zone 3. Ground-water samples are collected quarterly from a total of 33 wells. The analytical program is shown in Table 3-3. Ground-water elevations are measured at 55 wells, also on a quarterly basis. Annual O&M costs are summarized in Table 4-1.

Table 4-1
Annual System Operations/O&M Costs

Year	Annual O&M Cost
2003	$425,000
2004	$496,718
2005	$372,682
2006	$591,931
2007	$1,292,567

The annual system operations/O&M values shown in Table 4-1 are estimates that take into account O&M costs for both the ground-water remediation and the NRC License

compliance. These costs are closely interrelated and are tracked together. Costs have risen appreciably from 2005 through 2007 and are currently more than twice what they were since the last review.

5.0 Progress Since the Last Review

The 2003 Five-Year Review included the following protectiveness statement:

The remedy at the UNC Church Rock Site, OU1 currently protects human health and the environment because, although tailing-seepage impacted ground water is migrating beyond the UNC property boundary, there are no known users of the impacted ground water and, consequently, no evidence of exposure. However, in order for the remedy to be protective in the long term, the following actions need to be taken:

- *Implement a Supplemental Feasibility Study (SFS) to identify further remedial alternative [sic] in support of future CERCLA response action decision making in the light of a number of issues raised in this Report, including potential ICs, potential TI Waivers, newly promulgated MCLs, potential state ARAR revisions for certain contaminants, and other matters;*

- *Evaluate Institutional Controls as a part of the SFS process in order to restrict the use of seepage-impacted ground water in the Southwest Alluvium in Section 3 and Section 10, and in Zone 1 of the Gallup Formation in Section 1;*

- *Perform further characterization of the Southwest Alluvium contaminant plume.*

The recommendations (in addition to those listed above) also included the following:

- *Investigate the merits of eliminating lead, lead-210, and selenium from the site monitoring program; and*

- *Perform regular trend analysis and graphical presentation for specific COCs in specific wells for the COCs proposed for TI waivers.*

The progress made since the last review is described below:

- In 2004 UNC began preparation of a Zone 3 supplemental feasibility study. It was intended to complete the study by the date specified in the 2003 Five-Year Review (March 2005). Later the EPA decided that the study should not focus exclusively on Zone 3, but should be Site-wide in scope, and therefore this first effort was incorporated into the Site-Wide Supplemental Feasibility Study (SWSFS) initiated in 2006. The SWSFS is proceeding in stages and preliminary work has been performed for Part 1 to reassess existing or baseline cleanup levels set forth in the ROD and potential changes to those levels that may be necessary to ensure protectiveness of any remedial alternative being considered in future decision-making. The reassessment of existing cleanup levels will include a thorough review and screening of all historic and current contaminants of concern (COCs) with newly promulgated or revised federal/state standards (*e.g.,* MCLs), to-be considered (TBC) health-based

screening level criteria and current background water quality. It will also include a reassessment of risk, based on new toxicological information.

It is important to note that the EPA protocols for risk assessment require screening of contaminants with health-based screening level criteria and evaluation of baseline risk prior to taking into account any background considerations. EPA believes that in cases where background levels are high or present health risk, the information may be important to the public.

The intent of the SWSFS is to holistically address all the issues identified in the previous five-year review (potential Institutional Controls (ICs), potential Technical Impracticability (TI) waivers, etc). UNC has expressed frustration with EPA in not earlier invoking a TI waiver for certain chemical-specific ARARs and modifying the remedy to Monitored Natural Attenuation (MNA) for the Southwest Alluvium and Zone 1, as it has recommended. UNC has also indicated that it believes the SWSFS to be unnecessary and inappropriate, given the hydraulic and geochemical limitations at the Site and the mechanisms that the 1988 ROD and First Five-Year Review invoked to modify the remedy (UNC August 15, 2008 letter to EPA). However, EPA considered the FS process to be the appropriate and necessary step to investigate and evaluate other remedial alternatives and to support possible future CERCLA decision-making. Further, EPA considered the performance of the SWSFS to be an appropriate way to ensure consistency with the NCP, remedial action objectives, and applicable or relevant and appropriate requirements (ARARs), while engaging a comparative analysis of remedial technologies and a thorough examination of such potentially germane factors as TI and ICs. Therefore, EPA decided to use the FS process and UNC is currently undertaking the SWSFS as EPA has ordered. It is also noted that EPA's Guidance for Evaluating Technical Impracticability of Ground Water Restoration (OSWER Directive 9234.2-25) states that a TI evaluation must include "A demonstration that no other remedial technologies (conventional or innovative) could reliably, logically, or feasibly attain the cleanup levels at the site within a reasonable time frame." The EPA has decided to use the SWSFS as this demonstration. If it is demonstrated by the SWSFS that there are no viable alternatives that can attain certain ARARs in a reasonable time frame, the SWSFS will provide the basis for waiving such ARARs under CERCLA in future decision-making.

- ICs for restricting the use of ground-water on Navajo, Tribal Trust, and Indian Allotment lands to prevent exposure to contamination are being evaluated as a part of the ongoing SWSFS, with EPA taking the lead in this part of the study. The evaluation of ICs as a component of remedial alternatives in the SWSFS to prevent exposure to contaminated ground-water was deemed necessary in light of the technical difficulties encountered in achieving the state standards for sulfate, TDS and other contaminants, and the geochemical characteristics of the aquifers. UNC prepared draft ICs in 2001 that were presented to the Navajo Nation Environmental Protection Administration (NNEPA) (*see also* Section

7.1.3, below). However, the ICs were never established. Since the last Five-Year Review, EPA has met with the NNEPA several times, as well as with the Bureau of Indian Affairs (BIA), to continue discussions on the feasibility of establishing ICs on such lands. To date, the NNEPA has not agreed to accept restrictions on the use of its ground-water as part of any modification to the remedy.

- In further characterizing the Southwest Alluvium, monitoring well SBL-01 was installed in 2004 on Indian Allotment Land (Section 10), downgradient of the seepage-impacted front. Based on geochemical analysis of ground-water samples, it was determined that Well SBL-01 was not impacted by tailing seepage. Hence, the leading edge of the seepage-impacted front was more accurately determined to be between SBL-01 and the nearest up-gradient impacted Well 0624.

- Lead, lead-210, and selenium all remain in the monitoring program. It should be noted that lead-210 is a standard identified in the NRC License, and not a cleanup level identified in the EPA ROD. The EPA intends to assess whether or not it is appropriate to drop these contaminants from the monitoring program as part of the ongoing review and reassessment of contaminants of concern and cleanup levels, which is Part 1 of the SWSFS

- As recommended in the previous Five-Year Review, the annual monitoring reports contain comprehensive trend analyses and graphical presentations for the COCs that may likely be included in any proposed TI waivers.

6.0 Five-Year Review Process

6.1 Administrative Components, Community Notification, Document Review

This five-year review has been conducted in accordance with the EPA's Comprehensive Five-Year Review Guidance, dated June 2001 (EPA, June 2001). The following activities were conducted:

- a fact sheet (Attachment 3) was distributed to the local community;
- a public notice (Attachment 4) was placed in two local newspapers, the Gallup Independent and the Navajo Times;
- the project documents listed in Attachment 1 were reviewed;
- interviews (Attachment 7) were conducted with representatives from the New Mexico Environment Department, the U.S. Nuclear Regulatory Commission, United Nuclear Corporation, General Electric Company, the Navajo Environmental Protection Administration and the local community; and
- a Site inspection was conducted on March 19, 2008.

The public notice was placed in the Navajo Times and Gallup Independent in February 2008 to announce the start of the Five-Year Review. Copies of the fact sheet were distributed to persons on EPA's Site mailing list in February 2008. At the same time, copies of the fact sheet were also placed in the following information repositories maintained for this Site:

Octavia Fellin Public Library
115 West Hill Avenue
Gallup, NM 87301
(505) 863-1291

Navajo Nation Superfund Office
Highway 264/43 Crest Road
St. Michaels, AZ 86511
(520) 871-6859

Local residents living in close proximity to the Site were interviewed on May 24, 2008. The EPA also made several attempts to meet with the president of the Pinedale Chapter House to conduct an interview, but the president was not available.

Upon completion of the Five-Year Review, copies of the Report will be placed in the information repositories. Additionally, a public notice will be issued announcing completion of the Five-Year Review and the availability of the Report at the information

repositories. A community meeting will be held to present the results of the Five-Year Review in the Fall of 2008.

6.2 Data Review

Remedy performance has been evaluated through review of the ground-water monitoring data and the results obtained from various pilot-scale tests. As noted in Section 3, some contaminants are no longer monitored. In the ROD, EPA established a background nitrate concentration of 30 mg/L as the cleanup level. However, the NRC has revised its License standard to 190 mg/L (based on its re-evaluation of background). The EPA has discussed the revised standard with the NRC, but has yet to modify the cleanup level established in the ROD with subsequent decision-making. Therefore, the ROD nitrate value of 30 mg/L will be used in this section of the review. It is noted that there are currently no exceedances of the NRC standard for nitrate.

General observations related to all three aquifers are discussed first, followed by aquifer-specific considerations.

6.2.1 General Information

As discussed in Section 4, currently ground-water extraction is occurring only in Zone 3. The Southwest Alluvium extraction system was temporarily shut off in 2001 to perform the NA test and, therefore, did not operate at any time during the period of this review. The Zone 1 extraction system was shut off and decommissioned in 1999, and like the Southwest Alluvium extraction system, did not operate at any time during the period of this review.

A review of the *Annual Review Report - 2007 Groundwater Corrective Action, Church Rock Site, Church Rock, New Mexico* (N.A. Water Systems, 2008) has shown that the annual review reports provide excellent temporal evaluations of contaminants for each well by presenting graphs of contaminant concentrations over time. Those graphs allow the reader to assess temporal variations in contaminant levels for each individual well and as a comparative analysis between wells on the same graph. Yet it is difficult to perform spatial evaluations of an individual contaminant and the variation in its concentration over the entire area of interest within an aquifer without isoconcentration contour mapping. With regards to UNC's ongoing assessment on the effects of the discontinuance of pumping on contaminant concentrations (e.g., uranium) at individual wells for the Southwest Alluvium, the effects need to be evaluated from both temporal and spatial perspectives, considering the rate of seepage migration, distance between the extraction well and down-gradient monitoring well, and period of shutoff.

UNC and others have conducted several background water quality studies, most largely focused on relationships between major anion concentrations (nitrate, TDS, and sulfate) and the post-mining, pre-tailing ground-water (Canonie Environmental 1988, 1992; NRC 1996). More recently, UNC provided summary statistics for arsenic and uranium (GE 2006). In a letter to UNC in January 2008, EPA notified UNC of deficiencies in the

arsenic and uranium statistics. The EPA directed UNC to follow EPA's current statistical guidance when performing statistical analyses of ground-water monitoring data and selecting appropriate statistical methodologies for background water quality studies. This work will be included in Part 1 of the SWSFS on the comprehensive review of cleanup levels, COCs, ARARs, TBC health-based criteria and background water quality.

UNC has gathered information on the mineralogy of the formation (alluvial sediments), conducted field experiments, and has performed geochemical analysis. Evaporite minerals, capable of producing concentrations of nitrate, sulfate and TDS upon contact with water, are present in the alluvial sediments. Water column, and field infiltration experiments performed at the Site, confirms the potential for much of the nitrate, sulfate, and TDS concentrations observed in the ground water to be sourced by the dissolution of naturally-occurring evaporitic and related minerals upon being exposed to water. Both the ground water and the mine discharge water are believed to be affected by such minerals in which the mine discharge water flows through while infiltrating into the subsurface. It is estimated that 16 billion gallons of water discharged into the arroyo from the mine and that up to 2 billion gallons of that water infiltrated into the subsurface (Canonie Environmental, 1988). A total of approximately 300 million gallons was extracted from 1982 to 2007.

These same geochemical evaluations have also provided information on attenuation capacity. The alluvium includes the mineral calcite which, if present in sufficient quantities, is capable of buffering the acidity of the tailing seepage. UNC has shown that natural attenuation is occurring in the Southwest Alluvium. This demonstration is based on chemical relationships and trends observed in the monitoring data.

Site-wide, ground-water elevations have continued the gradual decline observed since remedy implementation in 1989. These downward trends have continued after the cessation of ground-water extraction. The continued ground-water elevation decline is consistent with a conceptual model of temporary or perched water accumulating from infiltration of mine water discharged into Pipeline Arroyo, and a gradual dissipation of that water after mine dewatering was halted.

6.2.2 Southwest Alluvium

The Southwest Alluvium remedial pumping system remained idle over the entire period of this review (2003 – 2007). In evaluating water levels, monitoring wells 0805, 0807, 0808, GW-1, GW-2, and GW-3 showed a small water level response (increase) when the extraction wells (0801, 0802, and 0803) were shut down in February 2001, but have since showed decreasing levels. Other monitoring wells (EPA-13, 0509D, 0624, 0627, EPA-23, and EPA-25) did not show any response when pumping ceased, as the ground-water elevations in those wells continued to decrease. In general, those wells located closest to the extraction wells and with the higher saturated thickness seemed to demonstrate a response to the shut down. Overall, from 2003 to 2007, ground-water elevations generally continued to decrease, illustrating the overall long-term trend of decreasing levels as water continues to drain out of the Southwest Alluvium.

The area of ground-water currently impacted by tailing seepage in the Southwest Alluvium is shown on Figure 6-1. The area of seepage impact extends southwest along the western margins of the tailing disposal cells and continues approximately 1,400 ft. across the southeastern corner of Section 3 and approximately 340 ft. into the north-central portion of Section 10. As explained in UNC's annual reports and the natural attenuation evaluation by EarthTech (2002), bicarbonate concentrations are the main indicator of the presence and extent of seepage impacts. The seepage-impacted area has near-neutral pH values as a result of the ability of the alluvium to buffer or neutralize the acidic tailing seepage with large amounts of calcite. The neutralization capacity has also prevented the migration of metals from the former tailing impoundment. Hence, the fate and transport of tailing seepage in the Southwest Alluvium involves geochemical and physical processes that attenuate some of the contaminants.

UNC has calculated the velocity of the tailing seepage to be approximately 34 ft/yr. At this velocity, it is estimated that the seepage-impacted front will take approximately 4.7 years, or until 2012, to migrate the 150 ft. from its present inferred position to the down-gradient, non-seepage-impacted Well SBL-01, located in Section 10.

The most recent ground-water monitoring indicates that the concentrations of six contaminants exceeded the EPA cleanup levels (as identified in the ROD) during 2007. These are sulfate, TDS, nitrate, chloride, manganese and nickel. However, when considering that nitrate is below NRC's recommended background level of 190 mg/L, of the remaining contaminants, only sulfate and TDS exceed the current cleanup levels in the seepage-impacted ground water beyond the Tailing Disposal Site for the Southwest Alluvium. Unlike Zone 1 and 3 impacted waters, the pH of the Southwest Alluvium impacted water is nearly neutral. Consequently, there are no exceedances of the metals or radionuclides cleanup levels within the seepage-impacted ground water. It is noted that although uranium is below the current EPA cleanup level of 5.0 mg/L, it is above the newly promulgated MCL of 0.03 mg/L in both seepage-impacted and non-seepage-impacted (background) water within the Southwest Alluvium.

Sulfate and TDS exceed the ROD cleanup levels in both seepage-impacted water and the background water in the Southwest Alluvium. The highest concentration of sulfate (4,960 mg/L) of any well in the Southwest Alluvium was measured from Well SBL-01. Only two wells, GW 1 and GW 2, showed any significant variation in sulfate and TDS levels since the shutoff of the extraction wells in January 2001. Sulfate levels in Well GW 1 increased modestly after shutoff until January 2002 and then leveled off. In Well GW 2, sulfate levels were stable after shutoff through October, 2004, when an increasing trend started that continues to present. The TDS levels in those wells showed similar variations since TDS is comprised mostly of sulfate. Sulfate and TDS levels have not decreased in response to the operating extraction system nor shown any discernable difference since shutoff of the system because they are dependant on the chemical equilibrium of gypsum (or anhydrite) within the alluvium (NA Water Systems 2008).

Out in front of the seepage-impacted water, the dissolution of gypsum or anhydrite associated with earlier flushes of the alluvium, most likely by the mine water discharges, have produced sulfate in the background water at concentrations which can significantly exceed the cleanup levels (as seen in Well SBL-01). This earlier evolution of background water chemistry associated with the infiltration of mine-water discharges led to elevated sulfate and TDS water (i.e., the post-mining, pre-tailing background water) that is likely to be present down-gradient within the alluvium for miles (N.A. Water Systems, 2008). Although the seepage-impacted front continues to migrate southwestward, as does sulfate and TDS within the seepage at concentrations above cleanup levels, the extraction of seepage-impacted water by the existing remedial system for the Southwest Alluvium will not effectively reduce the levels of sulfate and TDS to the cleanup levels because they are controlled by natural geochemical reactions (i.e., equilibrium between ground water and naturally occurring gypsum or anhydrite). Therefore, sulfate and TDS are not expected to meet the ROD cleanup levels in the Southwest Alluvium (EarthTech 2000; NA Water Systems 2008).

As noted above, nitrate is above the ROD cleanup level, but is below the NRC's recommended background level of 190 mg/L.

Chloride exceeds the cleanup level consistently only at Well 509D. It sporadically exceeds the cleanup level at Wells 632, 801, and GW 1. All of these wells are located within the Tailing Disposal Site, with the exception of GW 1, which is just outside of the boundary of Section 2.

Manganese is the only metal that exceeds the cleanup level in seepage-impacted areas (Wells 801, EPA 23, and 509D), with concentrations being relatively flat since 2004 in Well 801 and 2000 in Wells EPA 23 and 509D. All three of these wells are located within the Tailing Disposal Site. For the remainder of the wells in the seepage-impacted area, manganese is below the cleanup level. Based on long-term trends, exceedances are expected to continue at these wells. Manganese also exceeds the cleanup level, as well as nickel, in background Well SBL 01. As discussed above, the geochemistry of ground-water at SBL-01 reflects background conditions most likely related to the dissolution of soluble evaporitic minerals associated with the initial discharge of mine waters.

Uranium concentrations do not exceed either the current ROD cleanup level of 5 mg/L or the NRC License standard of 0.3 mg/L. However, they do exceed the newly promulgated MCL of 0.03 mg/L throughout most of the Southwest Alluvium. In UNC's 2007 Annual Review Report (N.A. Water Systems, 2008), graphs are presented showing uranium concentrations over time for all of the wells in the Southwest Alluvium in an effort to show whether the discontinuation of pumping of Wells 0801, 0802, and 0803 in January 2001 had any discernable effect on the long-term trend of uranium concentrations at wells within the zone of influence of the former pumping wells and down-gradient of those pumping wells. Further discussion of these graphs is warranted in this review. The uranium graphs show that for those downgradient wells in closest proximity to the extraction wells (i.e., GW-1, GW-2, and GW-3), uranium concentrations increased after shutdown in January 2001 for the start of the natural attenuation (NA) test.

GW-1: This well is located approximately 350 feet down-gradient of extraction Well 0801 and along the same trend of bicarbonate concentrations as Well 0801 (*see* Figure 3-2). Uranium concentrations appear to increase slightly in 2000, before the start of the NA test. Post-shutoff concentrations immediately increased at an accelerated rate through July 2002 and then decreased slightly through January 2004. Since then, concentrations have been fairly stable. Concentrations are at levels consistent with the early- to mid-1990s, but approximately twice that reached before the NA test. With the slight increase in uranium concentrations before the start of the NA test, the post-shutoff levels at GW-1 may not be solely attributable to cessation of pumping. However, this does not appear to be the case for GW-2 and GW-3 (see below)

GW-2: This well is located approximately 350 feet downgradient of extraction Well 0802 and along the same trend of high bicarbonate concentrations as Well 0802 (*see* Figure 3-2). Uranium concentrations had been historically decreasing since 1989 and relatively stable for the last three years leading up to the NA test in January 2001. Post-shutoff concentrations were fairly stable through October 2002, then increased at an accelerated rate until January 2005, after which they appear to have stabilized at levels consistent with the early- to mid-1990s, but nearly twice that before the start of the NA test. The post-shutoff concentrations at GW-2 appear to be attributable to cessation of pumping.

GW-3: This well is located approximately 300 feet downgradient of extraction Well 0802, but slightly off trend of the high bicarbonate levels at Well 0802 (*see* Figure 3-2). Like GW-2, uranium concentrations had been historically decreasing since 1989 and relatively stable for the last few years leading up to the NA test in 2001. Post-shutoff concentrations were fairly stable into 2002, then increased at an accelerated rate until January 2005, after which they appear to have stabilized at levels consistent with the early- to mid-1990s, but approximately twice that before the NA test. The post-shutoff concentrations at GW-3 appear to be attributable to cessation of pumping.

The wells further downgradient of the extraction wells and the GW series wells are the seepage-impacted Wells 0624 and EPA 25, and the background Wells EPA 28, 0627, and SBL-01. For seepage-impacted Wells 0624 and EPA 25, there is no discernable difference in the uranium concentrations or trends from before to after cessation of pumping. However, these wells are over 1400 feet downgradient of the line of extraction wells and, based on the rate of seepage migration estimated by UNC (N.A. Water Systems, 2008) for the Southwest Alluvium, may be too far downgradient to yet see a response in water quality from cessation of pumping six years ago.

For background Wells EPA 28 and 0627, there is also no discernable difference in uranium concentrations from before to after cessation of pumping. Concentrations have remained fairly stable along the historic trend that is associated with a low range. These two background wells are over 2,000 feet and 3,000 feet downgradient of the extraction wells respectively and, as stated for seepage-impacted Wells 0624 and EPA 25, are most

likely too far downgradient to expect a response in water quality from cessation of pumping six years ago.

Well SBL-01 was installed after the start of the NA test. Therefore, there are no data prior to shutoff to make comparisons. Concentrations at this newest downgradient background well are fairly low and have varied from 0.017 mg/L to 0.0332 mg/L.

This increase in uranium levels at the downgradient GW series wells appears to be attributable to, or partly attributable to, cessation of pumping. However, it can be noted that such relationship may be an indirect one, as the uranium concentration trends observed since the shut down of the pumping wells appear to correlate with concentration trends of bicarbonate. Bicarbonate concentrations are related to the dissolution of carbonate minerals that result when the acidic tailing seepage is neutralized as it infiltrates through the alluvium. When pumping ceases, the bicarbonate concentrations should adjust to the new hydraulic regime, and uranium concentrations are believed to follow the bicarbonate, since uranium solubility is considered to be very sensitive to bicarbonate concentrations (*see* discussion of covariance in uranium and bicarbonate concentrations, below).

It should also be noted that the source of the uranium is not believed to be the tailing seepage. The source is considered more likely to be either the natural uranium contained in the alluvial sediments at the time of their deposition, or the uranium that precipitated or adsorbed onto the alluvium from any infiltration of mine discharge water. Therefore, further pumping could indirectly influence the distribution of uranium from these sources by influencing the distribution of the bicarbonate, since it is the bicarbonate concentration that is believed to determine whether or not the non-tailings-sourced uranium is dissolved, precipitated or adsorbed (UNC August 15, 2008 letter).

In light of these interpretations, any conclusions about the effect the discontinuation of pumping has on the geochemistry at individual wells should consider both the temporal and spatial influence of the system shutdown on the changing water chemistry (uranium and bicarbonate), as well as the changing configuration of the steady-state hydraulics. In other words, when pumping wells are shut off, where and when are effects of the shut off expected, given the estimated rate and direction of seepage (and bicarbonate) migration?

If bicarbonate continues to migrate, then uranium would be expected to migrate accordingly; albeit the uranium may not be derived from the tailing seepage, but from the alluvium itself. However, UNC apparently believes that the bicarbonate concentrations in the "GW" wells have re-stabilized such that there is not necessarily an expectation that bicarbonate concentrations further downgradient will continue to increase. Accordingly, UNC has recommended that bicarbonate concentrations in well SBL-1 be closely monitored for trend to indicate the magnitude and extent of the re-stabilization (UNC August 15, 2008 letter).

UNC has demonstrated that there may be a covariance in uranium and bicarbonate concentrations within the Southwest Alluvium (i.e., when the concentration of

bicarbonate changes, uranium changes with it) (GE, 2006). This covariance helps explain the significant variation in uranium levels observed from well to well within the aquifer. Seepage-impacted areas with high bicarbonate levels have correspondingly high uranium levels. However, UNC concludes that uranium concentrations in the Southwest Alluvium are not related to the migration of uranium in tailings fluids and that tailing seepage is far more depleted in uranium than is the post-mining, pre-tailing background water. Further, UNC has concluded that the range of uranium concentrations in the post-mining, pre-tailing background water is similar to the range within the seepage-impacted water, based on summary statistics provided to EPA (GE, 2006). In light of the relationship between uranium and bicarbonate and the high background uranium levels, UNC concludes that there is no further improvement in alluvial water quality that can be made with respect to uranium concentrations (N.A. Water Systems, 2008). It is noted that EPA notified UNC in January 2008 that the summary statistics were inadequate for EPA to fully evaluate the statistical results and conclusions. UNC, in working with EPA and the other regulatory stakeholders, is conducting further statistical analyses of the ground-water monitoring data in accordance with current EPA guidance as part of the SWSFS.

UNC's geochemical evaluation of the Southwest Alluvium concludes that NA will effectively retard the downgradient movement of metals and radionuclides, including uranium by neutralizing the acidic tailing seepage and subsequently attenuating the metals and radionuclides by chemical precipitation and adsorption.

UNC's conclusion that concentrations of sulfate and TDS in seepage-impacted water, as well as background water, will continue to exceed the cleanup levels as long as the alluvium is saturated appears to be well supported. In as much as the sulfate and TDS concentrations largely result from the reaction of water with evaporite minerals in the formation, there are no remedial technologies known to be available to address these contaminants short of dewatering the alluvium.

6.2.3 Zone 3

Active remediation in Zone 3 was restarted in 2003 with the start of the hydraulic fracturing pilot study. Several extraction wells installed as part of the full-scale hydraulic fracturing testing program, along with an additional extraction well and conversion of a downgradient monitoring well into an extraction well have been operated as a new pumping configuration since late 2004. These wells are located at and near the seepage-impacted front.

Ground-water monitoring data collected since the last Five-Year Review in 2003 for Zone 3 continue to show the presence of several contaminants at elevated concentrations. The 2007 ground-water monitoring found that the concentrations of 16 contaminants exceeded EPA's cleanup levels. These are aluminum, arsenic, beryllium, cadmium, cobalt, manganese, molybdenum, nickel, vanadium, nitrate, sulfate, TDS, radium-226 and -228, uranium, thorium-230, and gross alpha. Most of these are exceeded at the wells closest to the Tailing Disposal Site. The concentrations of seven contaminants

(cobalt, manganese, molybdenum, nickel, sulfate, TDS, and radium 226 and 228) exceed the cleanup levels at monitoring well 0504B, the furthest most downgradient well within the seepage-impacted area.

In January 2004, UNC submitted the results of a study undertaken to evaluate the potential for the covered tailings to continue to source seepage and recharge to the updip part of Zone 3 from leakage (US Filter, 2004). The report concluded that it was unlikely, but one area of concern required additional investigation. In July 2004, two piezometers (Z3 M-1 and Z3 M-2) were constructed north of the northeast boundary of the Central Cell. The piezometers were effectively dry, indicated that the southeasterly portion of Zone 3 is entirely unsaturated. UNC reported that such findings indicate that neither ground-water recharge nor seepage impact into Zone 3 are occurring (Veolia, 2004).

Since cessation of mine water discharge, most water levels have been declining at this Site. Water-level data collected since the last Five-Year Review in 2003 continue to show most wells with decreasing water levels (usually with small fluctuations). The saturated thickness of Zone 3 has declined by 68 percent on average since 1989. The continued loss of saturated thickness over time results in a decrease in the efficiency of the extraction wells. Contour mapping of saturated thickness in 2007 (N.A. Water Systems, 2008) shows effects of former pumping, current pumping, and natural drainage on Zone 3. The decrease in water levels and loss of saturation over the last five years indicate that the Zone 3 potentiometric field that drives ground-water flow and contaminant migration continues to become lower as the ground-water further drains away (N.A Water Systems, 2008).

While the ground-water extraction system had been designed to create a hydraulic barrier, it was found during system operation that it was having the inadvertent result of accelerating the downgradient movement of tailing seepage impacted ground-water. Most of the extraction wells are decommissioned, but pumping continues at a low rate in the downgradient toe of the seepage-impacted front at the hydraulic fracturing test site.

The work performed during the Zone 3 in-situ alkalinity stabilization test led to the understanding that the acidic tailings seepage had reacted with feldspar minerals in the sandstone formation resulting in clay formation and the subsequent reduction in formation permeability (ARCADIS BBL, 2007).

Neither the hydraulic fracturing nor the in-situ alkalinity stabilization testing were judged successful to prevent the continued migration of tailing seepage to the north toward the Navajo Reservation boundary. The new pumping configuration at the downgradient (and northern most) part of the Zone 3 seepage-impacted front temporarily caused a marked improvement in the water quality along the northern monitoring wells (PB-03, PB-04) and UNC reported that, for the first time, the seepage-impacted front had receded southward during 2006. UNC also reported that the location of this seepage-impacted front remained unchanged during 2007 (N.A. Water Systems, 2008). However, in a meeting between UNC, EPA and the other regulatory stakeholders in March 2008, UNC informed EPA that the most recent monitoring data showed that the seepage-impacted

front, although temporarily slowed by the pumping of RW 11, RW 12, RW 13 and PB-2 in 2006 and 2007, had now begun to advance again to the north.

At the March 2008 meeting, UNC indicated that it was uncertain as to what other viable technology could stop the advancing seepage-impacted front, but proposed to install additional extraction wells at the leading edge of the advancing seepage-impacted front every year or so for the next few years to slow it down. UNC suggested that, as ground-water levels continue to drop in the kaolinitic clay-altered formation, a balance will be reached between the driving head and residual saturation so that seepage migration will eventually cease. However, it is not known where or when this condition will be reached.

The EPA agreed to this approach in the interim, until other feasible technologies and remedial alternatives, if any, that could contain and withdraw seepage-impacted ground-water, are developed and screened during the SWSFS. In June 2008, EPA approved, as an interim effort, an additional pumping system consisting of five new extraction wells (NW-1 through NW-5) to be installed along the seepage-impacted front near NBL-01 in 2008. Three of the new wells will be operated initially, with the other two used for monitored water levels for a period of several months, until it is determined whether it is necessary to expand the pumping regime to all five wells. UNC expects this additional pumping system to slow the advancing seepage-impacted front and collect additional contaminated water to minimize the overall long-term downgradient impacts. As the seepage-impacted front migrates past the new wells, additional extractions wells will be proposed at the leading edge of the front to continue such effort.

6.2.4 Zone 1

The Zone 1 remedial system has been decommissioned since 1999 and did not operate during the period of review. The Zone 1 performance monitoring program, consisting of quarterly monitoring of water levels and water quality, is ongoing.

The water level data collected during the period of this review (2003 – 2007) show changes of ground-water elevations in updip and downdip wells, indicating the broad pattern of the shift in the potentiometric field caused by continued ground-water drainage to the northeast in Zone 1. Zone 1 remains completely saturated in most of the downdip wells along the northern boundary of Section 36. Ground-water levels in Well 504 A, located in the middle of Section 36, have continued to rise gradually and this portion of Zone 1 may become fully saturated as ground-water migrates into this area. Similarly, slowly rising ground-water levels at downdip Wells 142, 143, and 412 represent increasing potentiometric levels within the 100-percent saturated parts of the fully confined Zone 1. Long-term decreasing water levels in up-gradient portions of the aquifer, at locations under less than fully saturated conditions, represent the slow dissipation of potentiometric head levels there, as ground-water continues to flow downdip toward the fully saturated part of the aquifer (N.A. Water Systems, 2008).

Earlier ground-water flow in Zone 1 was approximately eastward, reflecting ground-water mounding and recharge from the alluvium to the west. As the mounding has

dissipated, ground-water flow has changed to the northeast (*see* Figure 6-2) (N.A. Water Systems, 2008).

Ground-water monitoring data collected since the last Five-Year Review in 2003 continue to show the presence of contaminants above the EPA cleanup levels. The most recent ground-water monitoring from 2007 found that the concentrations of eight contaminants exceeded the cleanup levels for Zone 1. These are aluminum, cobalt, manganese, nickel, chloride, nitrate, sulfate, and TDS. The combined radium concentration in Well 0604 was just below the EPA cleanup level of 5 pCi/L (the revised NRC standard for combined radium is 9.4 pCi/L) and total trihalomethanes exceeded the NRC standard of 80 ug/L. However, it is noted that nitrate does not exceed the NRC's recommended background level of 190 mg/L. Of the others, the only contaminants to exceed the cleanup levels outside of the Tailings Disposal Site are TDS (Wells EPA 5 and EPA 7), sulfate (Wells EPA 4, EPA 5, and EPA 7), and manganese (Well EPA 4). It should be noted that the exceedances of cleanup levels in some wells represent background water quality. Background Well EPA 4 has persistently shown exceedances of sulfate, and generally shown exceedances of manganese. Additionally, the exceedances of TDS and sulfate in seepage-impacted Wells EPA 5 and EPA 7 reflect geochemical equilibrium of the ground water with gypsum (N.A. Water Systems, 2008).

The extent of seepage impacts, as delineated by a chloride concentration greater than 50 mg/L, has not changed perceptibly in the last five years, all since the shutoff of the pumping wells. However, based on the NA system performance evaluation of Zone 1, UNC concludes that many aspects of water quality continue to improve since shutoff, indicating that the degree of seepage impact is diminishing (N.A. Water Systems, 2008).

The Zone 1 NA system appears to be successfully attenuating the seepage impacts by processes of neutralization, precipitation, adsorption, and mixing with post-mining, pre-tailing background water. However, some contaminants are expected to remain at concentrations above cleanup levels because of the inherent geochemical characteristics of the Zone 1 post-mining, pre-tailing background water. Sulfate and TDS are not expected to meet the cleanup levels because their concentrations are controlled by the chemical equilibrium of gypsum. Manganese may meet the cleanup levels if a sufficient amount of bicarbonate is available for attenuation. The remaining metals and radionuclides are expected to meet the cleanup levels through attenuation (N.A. Water Systems, 2008).

6.2.5 Conclusions

Overall, the remedy selected by EPA is not performing as designed because saturated thicknesses decreased to levels which do not support pumping due to insufficient natural recharge (as predicted) for Zones 1 and 3 and sulfate and TDS levels within all three aquifers are not dependent on the continuation of pumping, but are controlled by natural geochemical reactions, primarily the equilibrium of gypsum or anhydrite. The operational results and performance monitoring data have demonstrated that it is

technically difficult to achieve all of the cleanup levels within a reasonable time frame by the existing remedy because of these geochemical and physical conditions.

In the Southwest Alluvium, the only contaminants that exceed the current cleanup levels beyond the Tailings Disposal Site are sulfate, TDS, and manganese. They exceed the cleanup levels in both seepage-impacted and background wells. The Southwest Alluvium successfully attenuates the seepage-impacted water. Acidic seepage is being neutralized (buffered) by reactions with calcium carbonate, resulting in the attenuation of metals and radionuclides through chemical precipitation and adsorption. Uranium does not exceed the current cleanup level of 5 mg/L, but exceeds the newly promulgated MCL of 0.03 mg/L throughout most of the seepage-impacted area. UNC has shown that uranium and bicarbonate concentrations are covariant in the Southwest Alluvium ground-water (GE, 2006). UNC has concluded that uranium concentrations are not related to the migration of uranium in tailings fluids, but change when the bicarbonate levels within the alluvium change (i.e., uranium concentrations increase when bicarbonate levels increase). UNC has also concluded that the tailing solutions are far more depleted in uranium than are the post-mining, pre-tailing background waters (N.A. Water Systems, 2008). However, since the bicarbonate levels in the Southwest Alluvium increase when the acidic tailing liquids react with the carbonate-bearing minerals present within the alluvium, the resulting increase in uranium concentrations is nevertheless attributed to the seepage-impacted water. Whether or not such seepage-impact-related increases in uranium levels are relevant to remedial efforts for the Southwest Alluvium may depend on whether they exceed the post-mining, pre-tailing background uranium concentration or range of concentrations rather than the new MCL of 0.03 mg/L for uranium. UNC has provided summary statistics for uranium and, based on those statistics, concludes that the post-mining, pre-tailing background range of uranium concentrations exceeds the new MCL and is similar to the range of the seepage-impacted water (GE, 2006).

However, UNC did not provide EPA with adequate information to evaluate those statistical results. UNC did not identify the statistical methodologies and data used for the statistical analyses, nor did it identify the background and impacted wells used for the population data sets. EPA notified UNC in a January 2008 letter of such deficiencies and directed UNC to follow appropriate EPA guidance when selecting statistical methodologies and performing statistical analyses of ground-water monitoring data as part of the review of cleanup levels (Part 1 of the SWSFS).

The shutdown of the Southwest Alluvium extraction well system for the NA test in January 2001 appears to have resulted in an increase of uranium levels at the GW series wells, the nearest downgradient wells to the extraction wells, to levels nearly twice that detected just before the start of the test.

In Zone 3, there are 16 contaminants that exceed the current cleanup levels outside of the Tailings Disposal Site. These are aluminum, arsenic, beryllium, cadmium, cobalt, manganese, molybdenum, vanadium, nitrate, sulfate, TDS, radium-226 and -228, uranium, thorium-230, and gross alpha. Hydraulic fracturing and in-situ alkalinity stabilization tests proved unsuccessful at enhancing the existing extraction system to

contain and recover contaminated ground-water. UNC determined that acidic tailing seepage damaged the Zone 3 aquifer by causing the alteration of feldspar minerals to kaolinitic clay, which clogged the pore spaces and decreased hydraulic conductivity. The new pumping configuration initiated in Zone 3 in 2005 from the hydraulic fracturing program actually contained and arrested the advancing seepage-impacted front and improved ground-water quality temporarily. Pumping rates eventually declined, similar to other pumping wells in the past, and the seepage-impacted front began to advance to the north again. With EPA approval, UNC will install five additional extraction wells in 2008 at the leading edge of the advancing seepage-impacted front to slow the front and minimize the impacts to downgradient water quality. This will be performed in the interim, while UNC completes the SWSFS to evaluate if there are other viable remedial alternatives in which to contain and remove contaminated ground-water.

In Zone 1, there are only three contaminants that exceed the current cleanup levels outside of the Tailing Disposal Site. These are sulfate, TDS, and manganese. The seepage-impacted water is being attenuated in Zone 1. Acidic seepage is being neutralized, resulting in attenuation of metals and radionuclides. Ground-water quality continues to improve outside of the Tailing Disposal Site and contaminant concentrations appear to be stable.

In summary, all of the cleanup levels established in the ROD have not been attained and are not expected to be attained by the existing remedy within a reasonable time frame. However, there is no known exposure to contaminated ground-water. In Appendix A of the ROD, under Contingencies for Selected Remedy, EPA anticipated that the remedy might not be effective at achieving the cleanup levels within a reasonable time frame. In the 2003 Five-Year Review, EPA recognized the need to explore other contingencies or alternatives for remediating Site ground water and recommended a supplemental feasibility study. UNC is currently performing the SWSFS to review existing cleanup levels, including a reassessment of health-based criteria and background levels, and develop and analyze other remedial alternatives capable of achieving the remedial action objectives set forth in the original ROD. This SWSFS will be used by EPA to support future decision-making on remedy modification, revision to cleanup levels and invoking a TI waiver for certain chemical-specific ARARs, if appropriate.

6.3 Site Inspection

The Site inspection was conducted on March 19, 2008. Those in attendance included representatives from United Nuclear Corporation (UNC), General Electric Company (GE), the New Mexico Environment Department (NMED), and the U.S. Army Corps of Engineers (USACE). The EPA's Project Manager was ill and could not participate in the inspection. The Site inspection checklist and photographs documenting Site conditions are found at Attachments 5 and 6, respectively. The purpose of the Site inspection was to obtain familiarity with the Site, review the records, examine the extraction and treatment systems and associated documentation, assess the protectiveness of the remedy, and conduct interviews with representatives of key stakeholders. The only interview which was completed during the Site inspection was with representatives from the NMED.

The following areas were visited; 1) the main office, 2) the Zone 3 wells, 3) the Zone 1 wells, 4) the tailing impoundment area, 5) the Southwest Alluvium wells, and 6) the bedrock outcrop exposed within Pipeline Arroyo (known as the "nickpoint"). It was noted that on-Site staff monitors visitors. They also take measures to identify livestock belonging to local residents that may enter the Site looking for grazing. The existing fencing is intended to discourage livestock. A construction company was observed making improvements to a pipeline running along an easement located to the east of the Site. There was no evidence of unauthorized development or construction activities. Monitoring and extraction wells appeared to be in good condition. Apart from Pipeline Arroyo there was no evidence of erosion or slope failure. Native vegetation has established itself on the radon barrier and protective rock cover placed on top the tailings disposal cells. A fence and locked gates surround the tailing impoundment area. Barriers and warning signs surrounded the evaporation pond within the tailings impoundment area. Overall the Site appears to be well managed.

Both full-time and part-time employees work at the Site. One employee residence is located on the Site near the former milling building. Both the residence and the Site use bottled water for drinking. An on-Site well drilled into the Westwater Formation, well below the Gallup Formation, supplies other domestic uses.

6.4 Interviews

Interviews for this Five-Year Review were conducted by the EPA and the Corps of Engineers with representatives of the NMED, the NRC, UNC, GE, the Navajo Nation Environmental Protection Administration (NNEPA), and the local community. Representatives of UNC and GE declined to be interviewed directly by the EPA, but did provide written statements to EPA's interview questions. Those interviewed are listed in the following table:

Table 6-1
Interviewees

Name	Affiliation
David Mayerson	NMED
Earle Dixon	NMED
Paul Michalak	NRC
Diana Malone	NNEPA
Roy Blickwedel	GE
Larry Bush	UNC
(b) (6) [redacted]	Local Resident
[redacted]	Local Resident
[redacted]	Local Residents
[redacted]	Local Resident

Those interviewed expressed no indication of problems related to the current protectiveness of the remedy. But opinions were expressed regarding concerns and possible improvements. Mr. Mayerson and Mr. Dixon both had a positive overall impression of the project. Ms. Malone expressed concern regarding the ability of the remedy to physically remove all the contamination. Mr. Mayerson, Mr. Dixon, and Ms. Malone all suggested that greater effort should be devoted to public outreach and meetings with the local community. The topic of uranium mining in general is of concern to local residents and this can result in unfavorable impressions regarding the Site activities.

Mr. Michalak also had a generally overall favorable impression of the project. He noted the Navajo community may have an unrealistic expectation that the remedy will completely remove all contamination from the ground-water.

Mr. Bush and Mr. Blickwedel both expressed the opinion that the existing remedy had performed about as well as could be expected and it was time to acknowledge that further efforts at ground-water extraction would not be cost effective. Mr. Blickwedel also expressed concerns regarding the EPA's failure to act on UNC's TI waiver recommendation and NA proposal. He also suggested that it is time to focus the remedy on the tailing seepage, while bearing in mind the limits to what can be attempted with the ground-water in Zone 3 due to the low permeability of the formation. Mr. Blickwedel encouraged the EPA to advance the process towards a conclusion. Mr. Bush also indicated a desire to focus project activities on the goal of bringing the project to closure.

The EPA also met with local residents to discuss their concerns. Representatives of the Navajo EPA, attended the meeting to support EPA in this effort. The community members expressed concerns regarding the mining industry in general. Regarding the Site, they lack confidence that the contamination issues will be addressed (or addressed in a timely manner). Some feel that current health problems are linked to contamination from this or other sites in the area. Interview record forms are provided in Attachment 7.

7.0 Technical Assessment

The Five-Year Review must determine whether the Site remedy is protective of human health and the environment. The EPA guidance provides three questions that are used to organize and evaluate data and information, and to ensure that all relevant issues are considered when determining the protectiveness of a remedy. These questions are answered for the Site in the following sections. Section 7 is concluded with a summary of the technical assessment.

7.1 Question A: Is the remedy functioning as intended by the decision documents?

7.1.1 Remedial Action Performance and Operations

The ground-water remedy was implemented and operated as specified in the ROD. The remedies for tailings and mill reclamation (described by the NRC Reclamation Plan), that support the ground-water remedy, have been implemented as specified, with the exception of final closure and installation of the radon barrier over the South Cell that will occur after the ground-water remediation is complete and the evaporation ponds are removed.

As discussed in Section 3, ground-water extraction is no longer occurring, except in Zone 3, therefore the overall Site ground-water remedial action is no longer operating and functioning as designed.

The remedial action performed as expected until the ground-water extraction well systems were determined to have reached the limit of their effectiveness either due to a loss in saturation from insufficient recharge (Zone 1 and Zone 3) or an inability to achieve some of the cleanup levels because contaminant levels were not dependant on pumping, but controlled by natural geochemical reactions, in particular, the pervasive equilibrium between the ground-water and naturally occurring gypsum or anhydrite (Zone 1, Zone 3 and Southwest Alluvium). In light of these limitations, the extraction systems were turned off for all three aquifers.

Although UNC concludes that uranium, as well as the other metals and radionuclides, are naturally attenuating within the Southwest Alluvium, based on the results of the NA system performance evaluation, the data clearly show that the discontinuance of the pumping system has led to significant increases in uranium levels from levels observed before the extraction wells were shut off at wells located down-gradient. Hence, the extraction system appears to have been effective to some degree at reducing uranium levels beyond the Tailing Disposal Site. Whether such effort could achieve the newly promulgated MCL for uranium of 0.03 mg/L, if established as an ARAR for the Site by EPA in future decision-making, will have to be assessed as part of the ongoing SWSFS.

The Zone 3 extraction system was restarted in 2003 as part of the hydraulic fracturing pilot test and it has continued to be operated. The Zone 3 pumping configuration has

been modified several times over the life of the system, when operating, to attempt hydraulic containment of the continually-advancing seepage-impacted front and removal of contaminated ground-water at successively down-gradient locations at the edge of the advancing front. UNC recognizes that this effort will not completely stop the advance of the seepage-impacted front at this time, but hopes it will slow it down and lessen its impact to uncontaminated, downgradient water. The pumping effort in 2005 and 2006 was found to temporarily arrest the advance of the seepage-impacted front and even reverse it, before pumping rates declined to levels which were ineffective at establishing hydraulic containment (N.A. Water Systems, 2008). It must be noted that the hydraulic head that drives the flow of ground-water comprises the elevation head plus the pressure head. The elevation head is a result of the structural tilting (i.e., dipping) of the stratigraphic units to the north, which causes the ground water to flow northward. The long history of pumping in Zone 3 has reduced the pressure head, but cannot reduce the dip-related elevation head. The continued pumping has been helping in the short-term, but saturated thicknesses in this formation are quite low and there will eventually be no further reduction in the pressure head. As the well yields decrease to levels that do not support pumping, the reduction in head will gradually approach practical limits (N.A.Water Systems). At some time in the future, UNC estimates that a balance will be reached between the tendency for irreducible elevation head to drive the continued northward migration of the seepage-impacted water and the tendency for the seepage-induced permeability reductions from the alteration of feldspar minerals to kaolinitic clay to stop the movement of the ground-water. However, although this condition should occur to stop the advancement of the seepage-impacted front, the exact timing and location for this critical balance to be achieved cannot be predicted (N.A. Water Systems, 2008).

The cleanup levels have not been achieved for all of the contaminants in any of the three aquifers, nor does UNC believe that they can be achieved with the existing remedy selected by EPA for the reasons discussed above and in Section 6.

7.1.2 Opportunities for Optimization

While there may be opportunities to optimize the existing remedy, the geochemical and physical conditions and limitations of the aquifers which result in declining ground-water levels and pumping rates, reduced permeability from alteration of the formation by acidic tailing seepage, and the elevated concentrations of sulfate and TDS associated with gypsum/anhydrite equilibrium reactions make it unlikely. It seems more likely that fundamental remedy changes, if any, will be addressed more holistically during performance of the SWSFS.

7.1.3 Implementation of Institutional Controls

The ROD did not formally establish any institutional controls (ICs), however certain enforcement documents, governmental controls, and informational controls are in place. Unilateral Administrative Order, Docket No. CERCLA 6-11-89 (issued on June 29, 1989), remains in force and it requires ground-water remediation. In addition, the Site

Source Materials License No. SUA-1475 remains in effect. It requires that the Site be managed to prevent contaminant exposure, including exposure to those contaminants in the ground water. Restrictions to the use of the Site ground water will continue after the License is terminated by the NRC and the property is turned over to the U.S. Department of Energy (DOE) for long-term care and surveillance monitoring. Informational controls such as signs are found near the Tailings Disposal Site. Barbed-wire fence (with "No Trespassing" signs) surround the Site.

No proprietary controls establishing land use restrictions are in place. However, discussions continue regarding their potential utility and effectiveness. It is likely that some form of land and/or ground-water use control will become necessary to ensure long-term protectiveness, by preventing exposure to contaminated ground water that has migrated off-Site.

It should be noted that UNC provided a Draft Resolution and Environmental Right-of-Way Procedures to the Navajo Nation EPA (NNEPA) and the U.S. Department of Justice (Davis, Graham & Stubbs, LLP, March 23, 2001). This document presented a draft Tribal Resolution to define ICs in certain seepage-impacted areas in the Southwest Alluvium in Section 3 and Section 10, and in Zone 1 of the Gallup Formation in Section 1.

The approximate areas covered by the proposed ICs are shown on Figure 7-1. The ICs would cover approximately 40 acres of Navajo Trust lands in Sections 3 and 10, and individual allotments, if necessary. The ICs for Section 1 would cover approximately 35 acres located in the northwest corner of the section. Grazing and surface activities would not be affected by the ICs. UNC also provided the procedures to establish an environmental right-of-way under the U.S. Department of Interior regulations. The duration of the right-of-way would be 50 years, subject to right of renewal. In the Draft Resolution, UNC has proposed to drill a water supply well into the underlying Dakota formation. The Dakota is a higher yielding and better water-quality aquifer in comparison to the ground-water aquifers in the Gallup Formation and the alluvium. It is noted that in a letter to the EPA, dated September 3, 2003, the NNEPA stated that it did not recommend the use of ICs on any projects, especially Superfund activities where ground-water is impacted. The NNEPA also stated that it does not have a mechanism in place to enforce the ICs and that a permanent staff would be required to oversee the project. Further, it stated that a lack of funds might hinder the establishment of such an oversight program for ICs. The EPA has since engaged in further substantial discussions with the NNEPA and BIA on the question of ICs; but as noted above, agreement on the utility and necessity of ICs has not been achieved. The EPA intends to continue to examine the IC issue, which it plans to address in the SWSFS.

7.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

As shown in the protectiveness evaluation (Attachment 8), there are a number of newly promulgated or revised MCLs. Additionally, background evaluations for select

contaminants have been conducted post-ROD by UNC and others. However there has been no formal EPA decision-making to change cleanup levels to reflect any proposed new background concentrations, so the original background concentrations remain in effect as cleanup levels for some contaminants. The MCLs or EPA Region 9 Preliminary Remedial Goals (PRGs) ("to be considered" or TBC health-based criteria) for 12 contaminants have changed since the ROD was prepared. Eight of these values have been reduced and 4 have increased. This is summarized below:

Contaminant	ROD	Most Recent Change
Antimony	0.014 mg/L	0.006 mg/L (MCL)
Arsenic	0.05 mg/L	0.010 mg/L (MCL)
Barium	1.0 mg/L	2 mg/L (MCL)
Beryllium	0.017 mg/L	0.004 mg/L (MCL)
Cadmium	0.01 mg/L	0.005 mg/L (MCL)
Chromium	0.05 mg/L	0.1 mg/L (MCL)
Copper	1.0 mg/L	1.3 mg/L (MCL)
Lead	0.05 mg/L	0.015 mg/L (MCL)
Selenium	0.01 mg/L	0.05 mg/L (MCL)
Thallium	0.014 mg/L	0.002 mg/L (MCL)
Vanadium	0.07 mg/L	0.036 mg/L (PRG)
Uranium	5.0 mg/L	0.03 mg/L (MCL)

There have been no changes to land use and no drinking water wells have been installed near the Site. Therefore, there is no current exposure pathway and, hence, the remedy remains protective in the short term. However, the long-term protectiveness of the remedy is contingent upon achieving protective cleanup levels within the aquifers. The new federal MCLs and PRGs identified above are based on updated toxicological information and, therefore, are considered by EPA to be protective. To ensure the long-term protectiveness of the remedy, it is recommended that these new MCLs and PRGs be established as revised ARARs and TBCs for this Site and lead to the modification of the cleanup levels in future EPA decision-making. It should be noted that some of the changes made to the federal MCLs and PRGs are, or may be, below Site background concentrations and would, therefore, not be appropriate requirements or TBC material. In such cases, the background concentration would be selected as the cleanup level in lieu of the new or revised standard or criterion.

The remedial action objectives (RAOs) (Operable Unit Feasibility Study goals, EPA 1988) were described as follows:

- contain down-gradient contaminant migration within each target area;
- restore ground water down-gradient of the Tailing Disposal Site, to the maximum extent practicable, to meet the clean-up criteria; and
- restore ground water at the Tailing Disposal Site to a level that allows attainment of clean-up criteria at its boundary.

The RAOs are still considered to be valid objectives. However, as discussed above, it has not been possible to completely achieve the RAOs. For these and other reasons it will probably be necessary to modify the remedy to ensure protectiveness.

7.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could affect the protectiveness of the remedy.

8.0 Issues

Issues related to the current Site operations, conditions, and activities that may prevent the remedy from being protective are listed below in Table 8-1.

Table 8-1
Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
1. The ground-water remedy, as set forth in the ROD, cannot attain the cleanup levels within a reasonable time frame because insufficient natural recharge has resulted in the loss of saturation which reached levels that could not support pumping.	N	Y
2. The Zone 3 extraction well system cannot hydraulically control the migration of tailing seepage-impacted water northward toward the Navajo Reservation. Any future pumping to reduce the pressure head will only obtain limited short-term results. Because the structural tilting or dip of the strata drives ground-water flow northward, there is an irreducible elevation head that cannot be decreased by pumping. Counteracting this hydraulic force is the clogging of the formation's pore spaces by the seepage-induced chemical alteration of feldspar to kaolinite clay. This clogging reduces the formation's permeability and impedes the flow of seepage-impacted ground-water. Eventually, there will be a balance between the irreducible hydraulic head and the trapping of seepage-impacted ground-water from loss of permeability.	N	Y
3. Uranium concentrations in the Southwest Alluvium do not exceed the current cleanup level of 5 mg/L. However, they do exceed the newly promulgated MCL for uranium of 0.03 mg/L. UNC has shown that uranium and bicarbonate concentrations may be covariant in the Southwest Alluvium ground-water (i.e., uranium levels change when bicarbonate levels change) and that the tailing seepage is more depleted in uranium than the post-mining, pre-tailing background water. However, since elevated levels of bicarbonate are believed to be caused by the acidic tailing seepage reacting with the calcium carbonate in the formation, the increase in uranium may still be attributable to the tailing seepage impacts. UNC contends that the range of uranium concentrations in the post-mining, pre-tailing background water exceed the new MCL of 0.03 mg/L and is the same as the range within the seepage-	N	Y

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
impacted water. UNC submitted summary statistics for uranium in the Southwest Alluvium for EPA's consideration in assessing background water quality. These findings, if accepted by EPA, may be important to determining whether any further improvement to the Southwest Alluvium water quality can be made with respect to uranium concentrations should EPA revise the cleanup level for uranium.		
4. UNC has indicated in its 2007 Annual Review Report that there is no discernable difference between the Southwest Alluvium uranium levels and trends from before shutoff of the pumping wells to after shutoff. The pumping wells were temporarily shutoff in January 2001 to conduct a natural attenuation (NA) test and they have remained off. However, the review of the 2007 Annual Review Report has shown uranium levels, although within historic ranges, increased significantly after shutoff for the GW series wells, the nearest downgradient wells to the pumping wells. Apparently, similar trends in bicarbonate levels were also observed after shutoff. If the source of the uranium is the alluvial sediment, the increase in bicarbonate levels, as believed to be controlled by the shutoff, would be expected to influence the distribution and concentration of uranium. The bicarbonate levels are believed to determine whether or not the non-tailing-sourced uranium is dissolved, precipitated or adsorbed. Thus, if bicarbonate continues to migrate, then any uranium which could be sourced from the alluvium is expected to mimic the bicarbonate and migrate accordingly. In light of this, there remain questions regarding the effectiveness of the extraction wells to improve ground-water quality with respect to uranium. Lastly, as stated in Issue No. 3, above, determining the range of uranium concentrations within the post-mining, pre-tailing background water will also be important to determining whether any further improvement to the Southwest Alluvium water quality can be made with respect to uranium concentrations.	N	Y
5. EPA did not specifically identify the contaminants of concern (COCs) or cleanup levels for the Site in the 1989 ROD, which led to some confusion during the review. This information had to be inferred from the text and several tables in the ROD and Remedial Design Report. The Site-Wide Supplemental Feasibility Study (SWSFS) needs to include (1) a thorough review and update of the Site COCs, based on screening with newly promulgated federal standards (MCLs), health-based criteria, background water quality and ground-water monitoring data, and (2) an update of the Site	N	Y

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
cleanup levels.		
6. Ground-water quality monitoring data have shown a decrease in concentrations of some contaminants (*e.g.*, lead, lead-210, and selenium) to levels which are consistently below cleanup levels over time. As stated in the 2003 Five-Year Review, UNC has recommended investigating the merits of eliminating those contaminants from the monitoring program. EPA has yet to modify the COC list and monitoring program in subsequent decision-making to the ROD A complete review of the COCs and cleanup levels is being conducted in Part 1 of the SWSFS.	N	Y
7. The NRC has approved several revisions to License standards, contaminants of concern, and monitoring programs recommended by UNC. Although the EPA discussed those revisions with the NRC, the EPA has never modified the cleanup levels or remedy set forth in the ROD in subsequent decision-making to be consistent with those NRC revisions. Such consistency, where appropriate, would help to integrate and coordinate the ground-water and source control/surface reclamation activities to achieve comprehensive reclamation and remediation of the Site, which is called for in the MOU between the EPA and the NRC. NRC revisions are as follows: - Delete cyanide and naphthalene from monitoring program - Establish combined radium -226 and -228 of 5.2 pCi/L for Southwest Alluvium, 9.4 pCi/L for Zone 1, and 5.0 pCi/L for Zone 3 - Establish Site-wide uranium standard of 0.3 mg/L - Change Site-wide chloroform standard to total trihalomethanes (TTHMs) of 0.08 mg/L	N	N
8. In light of the technical difficulties of achieving Site cleanup levels, (as predicted in the ROD), the EPA recognizes the need to consider ICs as a component of remedial alternatives being evaluated in the SWSFS to prevent exposure to contaminated ground-water on Navajo, Tribal Trust, or Indian Allotment lands. The use of ICs as a component of a remedial alternative is actually called for in the NCP, as appropriate, for ensuring protectiveness, a threshold evaluation criterion of CERCLA. However, the	N	Y

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Navajo Nation Environmental Protection Administration (NNEPA) has informed EPA that it will not recommend the use of ICs as a component of any alternative remedy which would place ground-water restrictions on Navajo or Navajo controlled lands. The Bureau of Indian Affairs (BIA) has supported NNEPA's position. With this opposition, there has been no further discussion or advancement of UNC's Draft Resolution and Environmental Right-of-Way Procedures, including a proposal to drill a water supply well in the deeper Dakota formation, which were presented to the NNEPA and DOJ in 2001. NNEPA also has rejected EPA suggestions for potential ground-water control ordinances or regulations. In a 2003 letter to EPA, the NNEPA stated that it does not have the mechanism, staff, or funds needed to establish, maintain and enforce ICs for restricting the use of ground water.		
9. Sulfate and total dissolved solids (TDS) concentrations are not dependent on continuation of pumping operations, but rather are controlled by natural geochemical reactions, primarily the chemical equilibrium of gypsum or anhydrite. UNC's conclusion that concentrations of sulfate and TDS will continue to exceed cleanup levels as long as the Southwest Alluvium and Zone 1 are saturated appears to be well supported. UNC has performed a TI evaluation and recommended that EPA invoke a TI waiver of the sulfate, TDS standards (as well as manganese) at this time.	N	N
10. A comprehensive review and update of the post-mining, pre-tailing background water quality is necessary for all three aquifers as part of the reassessment of current cleanup levels, especially in light of newly promulgated MCLs and health-based criteria. In fact, in Appendix C of the ROD, EPA acknowledged the geochemical complexities associated with determining the post-mining, pre-tailing background water quality and the need to continue such evaluation of background. The EPA also acknowledged that any significant change to background estimations could impact the remedial action in each aquifer. As noted above, the reassessment of uranium background concentrations in the Southwest Alluvium will help determine whether any further improvement to water quality can be made with regards to uranium. Additionally, it is noted that the post-mining, pre-tailing background water quality has shown modest exceedances of the cleanup levels for several metals. As part of this effort, and in light of deficiencies found with earlier statistical analysis by UNC, EPA has directed UNC to (1) follow current EPA guidance in performing statistical	N	N

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
analyses of ground-water monitoring data and selecting appropriate statistical methodologies, and (2) identify the background and impacted wells to be used for each data set for each aquifer.		
11. The local community is not fully informed regarding the nature of the ground-water contamination, the performance of the remedy, and likely future actions necessary to ensure protectiveness.	N	N
12. The project lacks a schedule to complete the SWSFS.	N	N

9.0 Recommendations and Follow-up Actions

Required and suggested improvements to current Site operations and activities are presented below in Table 4.

Table 9-1
Recommendations and Follow-up Actions

Recommendation	Party Responsible	Oversight Agency	Milestone Date
1. Complete the ongoing Site-Wide Supplemental Feasibility Study (SWSFS) to develop remedial alternatives or contingencies in lieu of the existing ground-water remedy's failure to achieve cleanup levels and control the migration of tailing seepage-impacted water outside of the Tailing Disposal Site. The SWSFS will support future EPA decision-making regarding revision to cleanup levels and remedy modification, and if necessary, provide a basis for potentially waiving applicable or relevant and appropriate requirements (ARARs) due to technical impracticability (TI). The SWSFS will also examine the appropriateness of adopting the NRC revisions to the License ground-water protection standards, and monitoring program by identifying or updating COCs, preliminary cleanup levels, including background water quality estimations, and performance monitoring requirements in support of future EPA decision-making under CERCLA or provide other COCs, cleanup levels and monitoring requirements for EPA to consider. Further, as part of the update of COCs, the SWSFS will include a screening-level reassessment of risk, based on more recent toxicological information	UNC	EPA, NMED	TBD
2. In the interim period before the SWSFS is completed and an alternative or contingency remedy is selected by EPA, continue effort to slow or temporarily arrest the advancement of the Zone 3 seepage-impacted water northward and extract contaminated ground water to the maximum extent practicable by installing and operating additional extraction wells at the leading edge of the seepage-impacted front.	UNC	EPA, NRC, NMED	TBD
3. As part of the ongoing SWSFS, determine post-mining, pre-tailing background concentrations of uranium for comparison to the seepage-impacted uranium levels and assess whether any further	UNC	EPA, NRC	TBD

Recommendation	Party Responsible	Oversight Agency	Milestone Date
improvement to the Southwest Alluvium water quality can be made with respect to uranium.			
4. Reassess the effectiveness of the Southwest Alluvium extraction wells to improve ground-water quality with respect to uranium. The reassessment needs to include both temporal and spatial aspects of changing uranium concentrations after shutoff that takes into account the rate of migration of seepage-impacted water, the distance between the shutoff extraction well and the down-gradient monitoring wells, and the period of shutoff. The spatial evaluation needs to include isoconcentration contour maps of uranium. The reassessment also needs to more closely examine the issue of whether there are correlations between uranium concentrations and bicarbonate concentrations, their relationship to tailings seepage, and what implications, if any, they have for remediation of uranium in the Southwest Alluvium.	UNC	EPA, NRC	TBD
5. As part of the ongoing SWSFS, identify contaminants of concern (COCs), remedial action objectives (RAOs), and cleanup levels. This information should be considered in future EPA decision-making. This effort should include investigating the merits of eliminating contaminants from the updated COC list, such as lead, lead-210, and selenium, if they have consistently been detected at concentrations below the revise cleanup levels.	UNC	EPA, NRC	TBD
6. If the COCs and cleanup levels are modified in EPA decision-making, the ground-water monitoring program should be updated to ensure that it is consistent with any revised COCs and cleanup levels, and at the appropriate well locations and aquifers.	UNC	EPA, NRC	TBD
7. Consider adoption of the NRC revisions to License ground-water protection standards and monitoring programs in future decision-making if appropriate under the NCP and supported by the SWSFS so that the ground-water remediation will continue to be consistent with the NRC's source control and surface reclamation activities. This would allow the integration and coordination of the EPA and the NRC efforts to achieve comprehensive reclamation and remediation of the Site.	UNC	EPA	TBD

Recommendation	Party Responsible	Oversight Agency	Milestone Date
NRC revisions are as follows: - Delete cyanide and naphthalene from monitoring program - Establish combined radium -226 and -228 of 5.2 pCi/L for Southwest Alluvium, 9.4 pCi/L for Zone 1, and 5.0 pCi/L for Zone 3 - Establish Site-wide uranium standard of 0.3 mg/L - Change Site-wide chloroform standard to Site-wide total trihalomethanes (TTHMs) of 0.08 mg/L If other cleanup levels and monitoring requirements are established by the EPA inconsistent with the revised NRC standards and monitoring requirements, the NRC should reassess the appropriateness of modifying its License standards and monitoring requirements to be consistent with the CERCLA requirements. As stated in the Memorandum of Understanding (MOU) between the EPA and the NRC, the source control/surface reclamation activities for the Tailing Disposal Site must be consistent with CERCLA requirements so as to allow the CERCLA requirements to be attained outside of the Tailing Disposal Site.			
8. In light of the technical difficulties and limitations encountered to attain cleanup levels and control the migration of seepage-impacted ground-water, the potential health risk from exposure to seepage-impacted ground-water, as well as post-mining, pre-tailing background quality ground-water, and the possibility of EPA invoking a TI Waiver of ARARs for sulfate, TDS, and other contaminants, a renewed effort should be made to establish institutional controls (ICs) that will restrict the use of contaminated ground water on Navajo, Tribal Trust and Indian Allotment lands. This effort should include revisiting UNC's Draft Resolution and Environmental Right-of-Way Procedures to define ICs in certain seepage-impacted areas, as well as ways to address the	UNC, Navajo Nation Council, and BIA	EPA, NRC	TBD

Recommendation	Party Responsible	Oversight Agency	Milestone Date
issues raised by the NNEPA in 2003 with regards to staffing and funding needs and mechanism for implementing the ICs. EPA should also engage in further analysis and review of alternative property and regulatory IC mechanisms for discussion with NNEPA and BIA. EPA will continue to examine the IC question and to work toward a potential resolution of it, as a part of the SWSFS.			
9. As part of the ongoing SWSFS, include an evaluation of remedial technologies and process options (both conventional and innovative) to achieve the cleanup levels for sulfate and TDS, or provide a basis for EPA to invoke a waiver of those standards for sulfate and TDS due to TI, if appropriate to do so under the NCP and requisite EPA TI Waiver guidance.	UNC	EPA, NRC	TBD
10. As part of the ongoing SWSFS, complete the reassessment of post-mining, pre-tailing background water quality, based on the considerable body of ground-water monitoring data now available. This reassessment should follow the NCP and current EPA guidance for performing statistical analyses of ground-water monitoring data and selecting appropriate statistical methodologies.	UNC	EPA, NRC	TBD
11. Greater effort should be made to meet with and share information with the local community regarding the ground-water remedy, what has been achieved to this point, and what is likely to occur in the future.	EPA, NRC, NMED, and NNEPA	NA	TBD
12. A schedule for completion of the SWSFS should be developed.	UNC	EPA, NRC	TBD

10.0 Protectiveness Statements

The remedy at the United Nuclear Corporation (UNC) Church Rock Superfund Site currently protects human health and the environment because, although tailing-seepage-impacted ground water has migrated beyond the UNC property boundary, there are no known users of the impacted ground water and, consequently, no evidence of exposure. For the remedy to be protective in the long term, the following issues should be addressed in the Site-Wide Supplemental Feasibility Study (SWSFS):

- Identify changes to the remedy that address the issues identified in this Report, including potential Technical Impracticability (TI) Waivers, newly promulgated federal/state standards as potential new or revised applicable or relevant and appropriate requirements (ARARs)(e.g., maximum contaminant levels under the Safe Drinking Water Act), new health-based criteria as to-be-considered (TBC) material, and related matters;
- Clarify the Site contaminants of concern, revised cleanup levels, and the points of compliance;
- Conduct further evaluation, analysis, selection, and implementation, if possible, of Institutional Controls (ICs) to restrict the use of seepage-impacted ground water beyond the UNC property boundary, which includes the Tailing Disposal Site area;
- Update the Site background values for ground water;
- Perform risk-based reassessment utilizing current toxicological information and newly promulgated standards (e.g., MCLs).

A project schedule should be established for this work. Following the completion of the SWSFS, any significant changes to the remedy should be documented in either a ROD amendment, or Explanation of Significant Differences as appropriate, including those temporary measures already employed which may be determined appropriate as part of a selected remedial alternative. If it appears that the completion of the SWSFS will be delayed, or in any event, the EPA notes and reserves its discretionary right to engage in response action determinations concerning this Site not inconsistent with the NCP. Additional outreach should be conducted with the local community regarding the cleanup activities. The monitoring program should be reviewed to ensure that it aligns with the project decision documents.

11.0 Next Review

The next five-year review will be due in September 2013.

ATTACHMENT 1

LIST OF DOCUMENTS REVIEWED

DOCUMENTS REVIEWED

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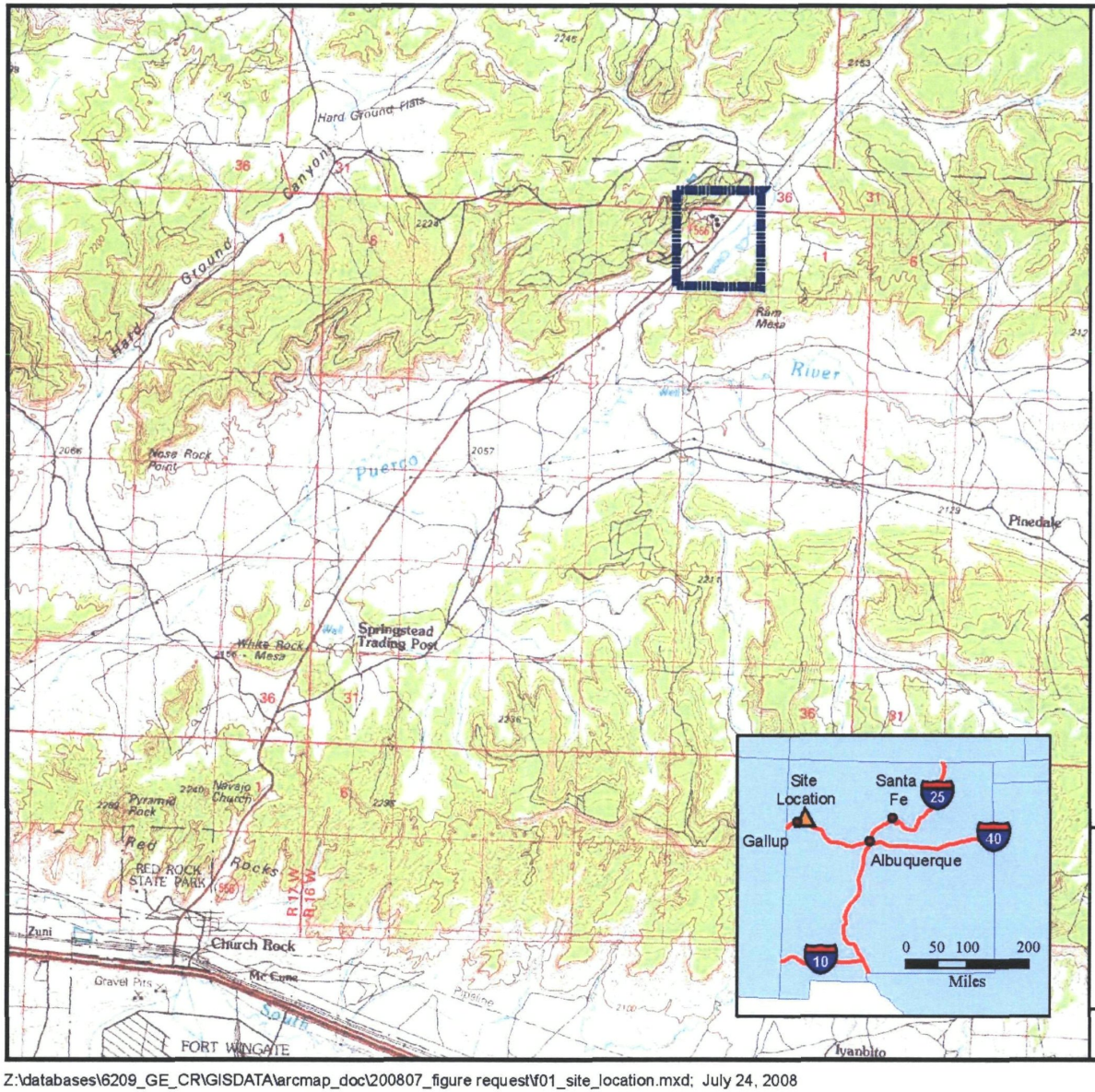
ATTACHMENT 2
FIGURES



LEGEND

Approximate Site Location

NEW MEXICO INSET LEGEND

- Major City
- Church Rock Site Location
- Interstate Highway
- State Boundary

Notes:

1. Topographic basemap taken from the United States Geologic Survey 30x60 minute, 1:100,000 scale, Gallup, New Mexico Topographic Map, 1981.
2. Data for New Mexico Inset map taken from ESRI Data & Maps 2002 CD-ROM set.

1 0.5 0 1
Miles

FIGURE 3-1

Site Location Map
2008 Five-Year Review

United Nuclear Corporation Church Rock Site, Church Rock, New Mexico

N.A. Water Systems

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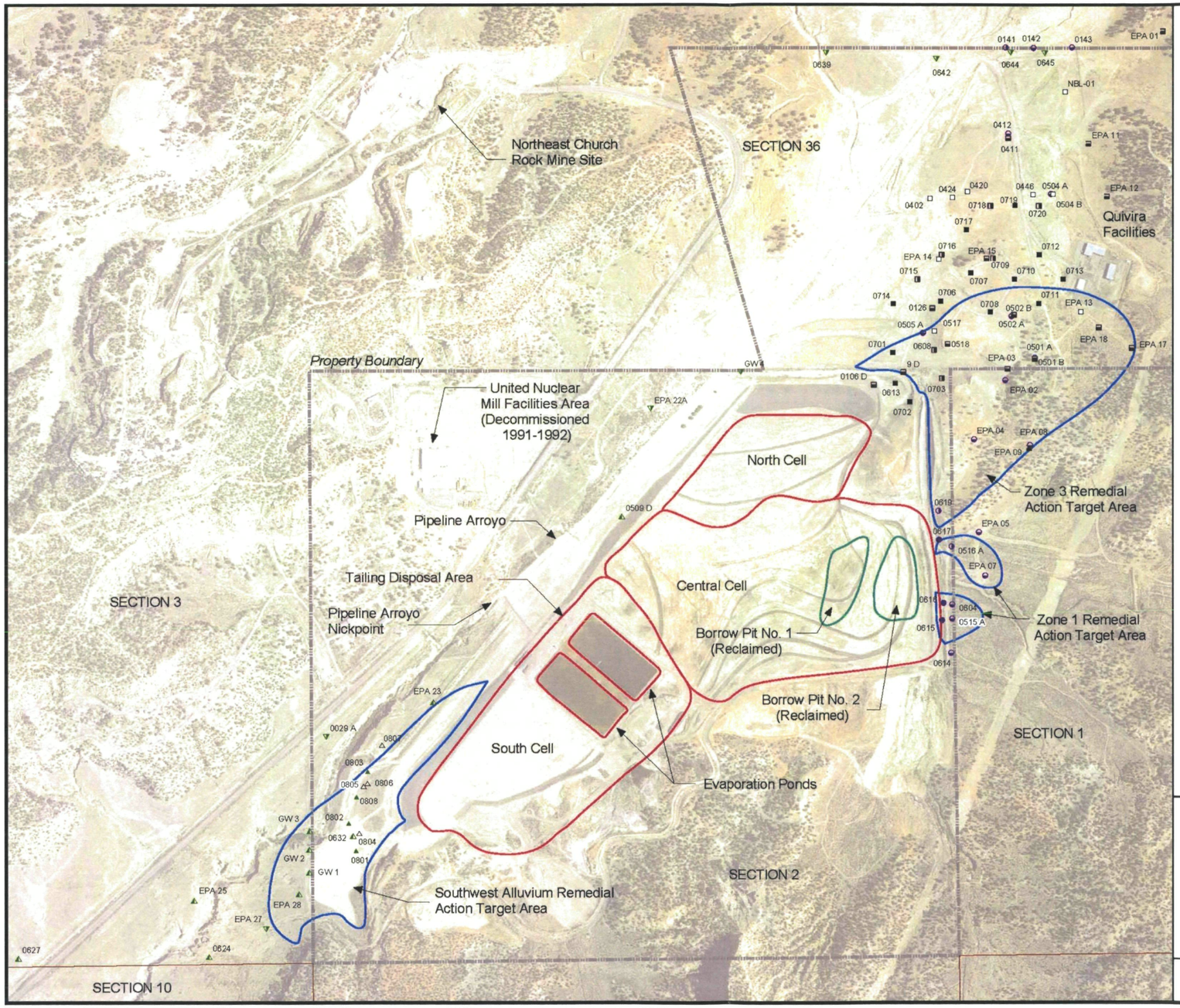

FIGURE 3-2

Site Layout and Performance Monitoring Well Locations
2007 Operating Year
2008 Five-Year Review

United Nuclear Corporation Church Rock Site, Church Rock, New Mexico

N.A. Water Systems

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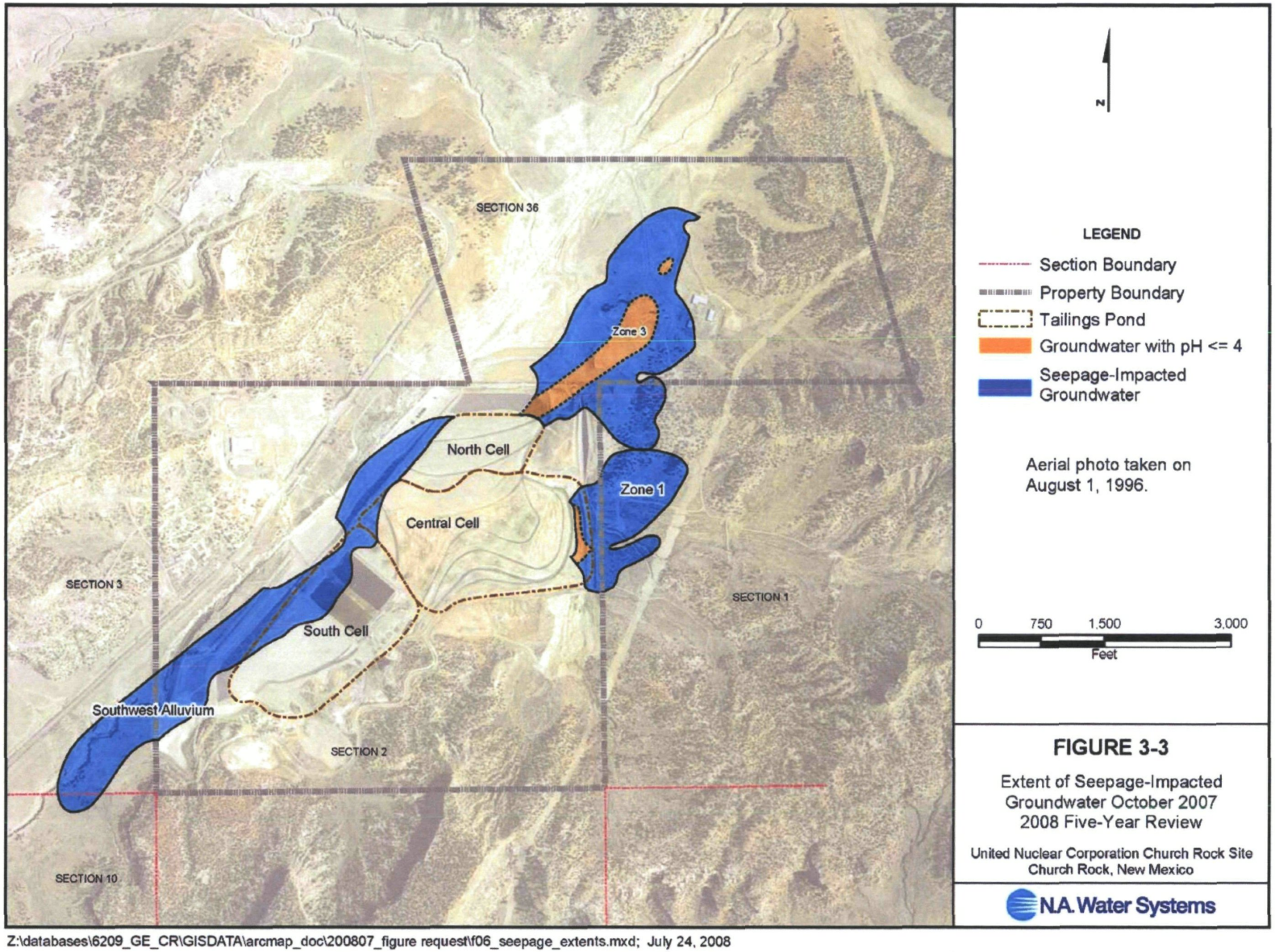

FIGURE 3-3

Extent of Seepage-Impacted Groundwater October 2007
2008 Five-Year Review

United Nuclear Corporation Church Rock Site
Church Rock, New Mexico

N.A. Water Systems

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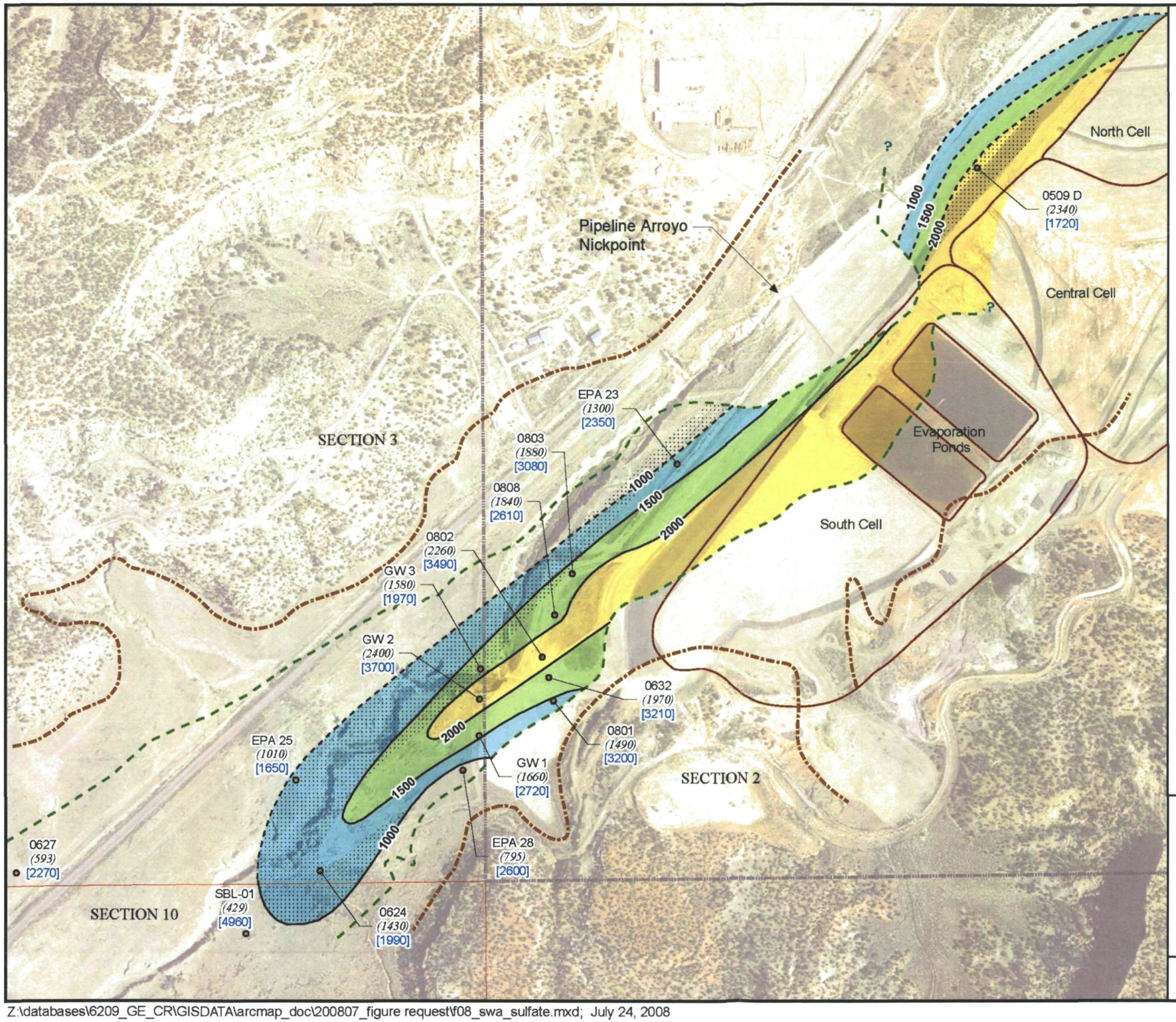

Legend

- Southwest Alluvium Well
- Approximate Extent of Saturated Alluvium
- Approximate Extent of Alluvium
- Bicarbonate Isoconcentration Contour in mg/L
- Inferred Bicarbonate Isoconcentration Contour in mg/L

Bicarbonate Concentrations (mg/L)

- 1000 - 1500
- 1500 - 2000
- >2000
- Property Boundary
- Section Boundary
- Tailings Pond
- Sulfate Below 2125 mg/L
- (2350) Bicarbonate result in mg/L
- [3580] Sulfate result in mg/L

Notes:

1. Well names are displayed with black text.
2. Aerial photo taken on August 1, 1996.

0 250 500 1,000
Feet

FIGURE 6-1

Southwest Alluvium Bicarbonate Isoconcentration Map and Distribution of Sulfate Below 2125 mg/L, October 2007 2008 Five-Year Review

United Nuclear Corporation Church Rock Site, Church Rock, New Mexico

N.A. Water Systems

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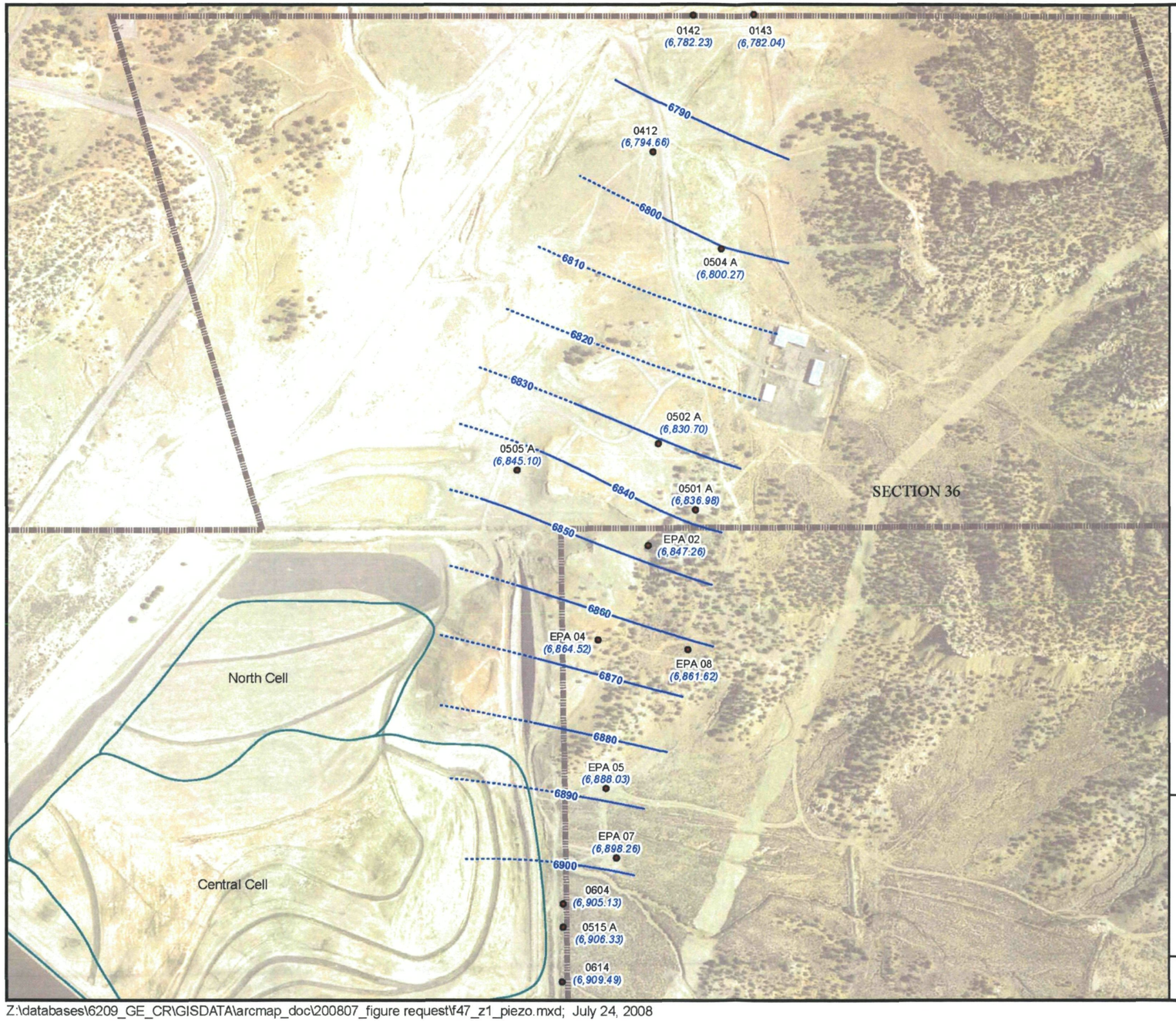

Legend

- Zone 1 Monitoring Well
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- Cell Boundary
- Property Boundary

Notes:

1. Groundwater elevation values are displayed in feet above mean sea level.
2. Well names are displayed with black text.
3. Groundwater elevations are shown with blue text and enclosed in parentheses.
4. Aerial photo taken on August 1, 1996.

0 250 500 1,000
Feet

FIGURE 6-2

Zone 1 Potentiometric Surface Map
October 2007
2008 Five-Year Review

United Nuclear Corporation Church Rock Site,
Church Rock, New Mexico

N.A. Water Systems

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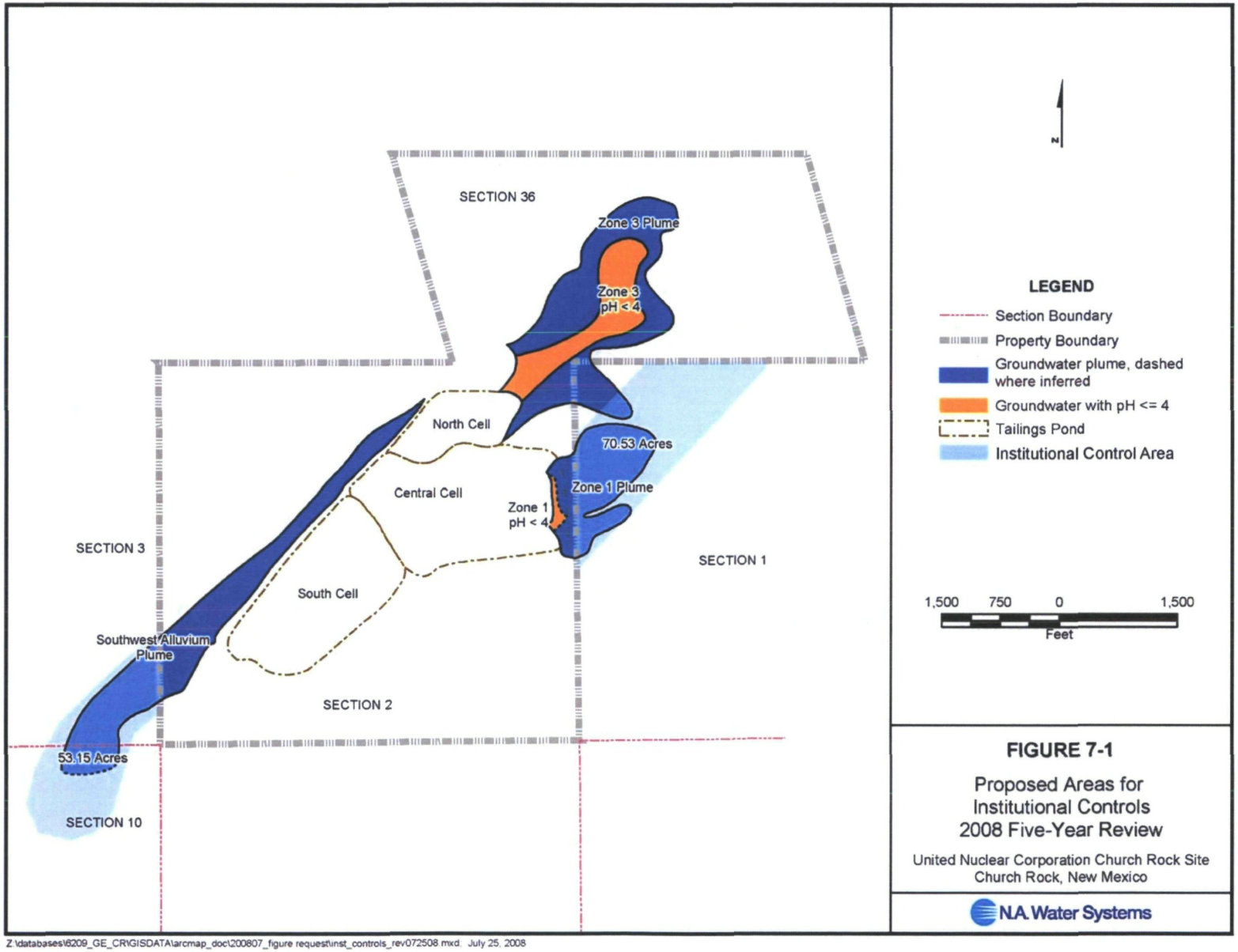


FIGURE 7-1

Proposed Areas for
Institutional Controls
2008 Five-Year Review

United Nuclear Corporation Church Rock Site
Church Rock, New Mexico

N.A. Water Systems

ATTACHMENT 3

FACT SHEET

EPA
United States
Environmental Protection
Agency

Status of Ground-Water Cleanup

United Nuclear Corporation Church Rock Superfund Site
Church Rock, McKinley County, New Mexico February 2008

THIS FACT SHEET WILL TELL YOU ABOUT...

- Purpose of Five-Year Review
- Upcoming Five-Year Review Activities
- Status of Ground-water Cleanup
- Site Description and History
- How to find out more about the Site

EPA STARTS THIRD FIVE-YEAR REVIEW

The U.S. Environmental Protection Agency (EPA) has started the third five-year review of the ground water cleanup activities at the United Nuclear Corporation (UNC) Church Rock Superfund site (Site). The purpose of the five-year review is to evaluate the performance of the remedy in order to determine the protectiveness for public health and the environment. The first two five-year reviews were completed in 1998 and 2003. The results of the third five-year review will be summarized in an informational bulletin and presented to the community at an Open House meeting to be held in late 2008.

FIVE-YEAR REVIEW ACTIVITIES

EPA will reassess the performance of the ground water remedy during the third five-year review. As part of this review, EPA will review the additional studies, testing results, and performance monitoring data generated since the previous five-year review in 2003.

EPA's third five-year review is scheduled to be completed in September of 2008. During the review, EPA plans to conduct a Site inspection. EPA also plans to conduct interviews with key individuals or groups associated with the Site cleanup, including the UNC Site manager, representatives of other federal, state, and tribal regulatory agencies, and members of the community. A Five-Year Review Report (Report) will be prepared documenting the results of EPA's review. The U.S. Army Corps of Engineers will assist EPA in the review.

As part of its community outreach effort, EPA will notify the community when the Report is complete, prepare and distribute a brief summary of the results in an information bulletin, and place a copy of the Report in the Site information repositories. EPA also plans to hold an Open House meeting to present a summary of the five-year review results to the community.

STATUS OF GROUND-WATER CLEANUP

From 1999 to 2001, the ground water extraction wells were temporarily shut off for all three aquifers. For Zone 1 and Zone 3, the pumping rates in wells decreased significantly over time due to declining water levels and a gradual dewatering of the rock. This was caused by insufficient natural recharge of water to the aquifers. The loss of water reached levels that did not support pumping and the wells were shut off. The Zone 3 pumping wells were also shut off because pumping at those locations accelerated the movement of contaminated water away from the tailings disposal area. For the Southwest Alluvium, the operation of the pumping wells showed no continuing progress towards achieving the Site cleanup criteria for a few, non-hazardous, regulated constituents and, therefore, pumping was temporarily discontinued.

Monitoring shows that some constituents still exceed the cleanup levels established in the EPA's 1988 Record of Decision (ROD). In Zones 1 and 3, the cleanup levels are exceeded for several heavy metals and/or radionuclides. However, in the Southwest Alluvium, the cleanup levels are being achieved for all hazardous constituents. Non-hazardous regulated constituents such as sulfate and total dissolved solids still exceed the cleanup levels for all three units, but they are also above cleanup levels at background locations (background refers to constituents or locations that are not influenced by the tailings seepage).

In 2005 and early 2006, UNC conducted hydrofracturing at several new wells in an attempt to increase water production from Zone 3 at more desirable locations. Although hydrofracturing did not improve water production, the new wells were in better position to capture tailing-impacted water and, therefore, were kept in operation. In October 2006 through February 2007, UNC conducted a pilot study involving the injection of less acidic water from an unimpacted aquifer into an area of Zone 3 acidic water to neutralize the acidity and reduce migration of constituents of concern. The pilot test was unsuccessful and, therefore, discontinued.

Based on the findings of the 2003 five-year review, EPA directed UNC to conduct a Site-wide supplemental study to evaluate the feasibility of other cleanup options and support further possible EPA-decision making with respect to the remedy. It is referred to as the Supplemental Feasibility Study and is currently ongoing. The Supplemental Feasibility Study will include an assessment of whether current cleanup levels specified in the ROD need to be modified to reflect newly-established federal or state standards or health-based criteria to continue protecting public health and the environment.

SITE DESCRIPTION

The Site is a former uranium mill facility located approximately 17 miles northeast of Gallup, along State Highway 566, in McKinley County, New Mexico. It included an ore processing mill and disposal area for tailings, an acidic waste of ground ore and fluids. The tailings disposal area was subdivided by cross-dykes into three cells identified as the South Cell, Central Cell, and North Cell. In addition, two soil borrow pits were present in the Central Cell area. See Site Map (Figure 1).

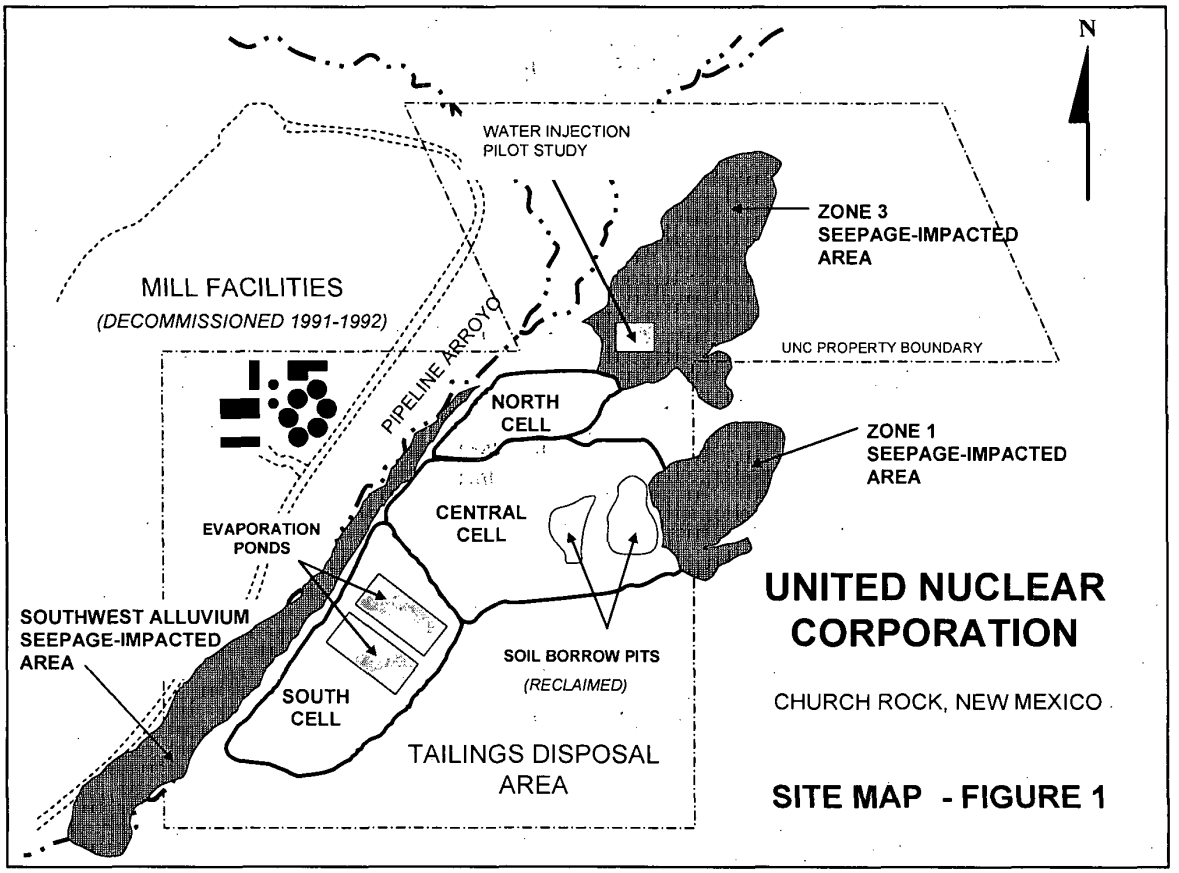
The area around the Site is sparsely populated and includes Tribal Trust and allotted land, as well as UNC-owned property. The Navajo Reservation is located less than a mile north of the Site. The nearest residence is located approximately 1.5 miles northwest of the Site. Land use near the Site is primarily grazing for sheep, cattle and horses.

SITE HISTORY

UNC operated the Site from 1977 to 1982. The ore processed at the mill primarily came from two of United Nuclear's nearby mines: Northeast Church Rock and Old Church Rock. Ore was also obtained from the nearby Kerr-McGee (Quivira) mine.

In 1979, the dam on the South Cell breached, releasing tailings and pond water to the Rio Puerco. The dam was repaired and the resultant spill cleaned up under the direction of state and federal regulatory agencies, including EPA.

EPA placed the Site onto the National Priorities List of Superfund sites in 1983 because of tailings seepage that had contaminated the underlying ground water. Acidic tailings liquids had seeped from the unlined cells into the



underlying alluvium deposits (referred to as the Southwest Alluvium) and two deeper zones (Zones 1 and 3) of the Upper Gallup Sandstone Formation, contaminating the ground water with heavy metals, radionuclides such as uranium and radium, and other chemical constituents. The location of the tailing seepage impacts are depicted on Figure 1.

In 1986, the U.S. Nuclear Regulatory Commission (NRC) assumed responsibility for the licensing and regulating of uranium mills within the State of New Mexico at the request of the Governor.

In 1988, NRC approved a closure plan for reclamation of the Site. In the same year, EPA and NRC signed a Memorandum of Understanding for the coordination of EPA's ground water cleanup effort and NRC's reclamation work. Under the Memorandum of Understanding, EPA was given the responsibility for cleaning up the ground-water contamination outside of the tailings disposal area.

In the 1988 ROD, EPA selected extraction of contaminated water and evaporation of the extracted water as the ground water remedy.

The mill facility was disassembled and tailings cells capped as part of the surface reclamation activities directed by the NRC. Two evaporation ponds have been constructed on top of the South Cell as part of EPA's groundwater cleanup.

For more information, please contact:

Mark Purcell, Remedial Project Manager
U.S. EPA Region 6
214.665.6707 or 1.800.533.3508 (toll-free)

Bob Johnson, Community Involvement Coordinator/SEE
U.S. EPA Region 6
214.665.6676 or 1.800.533.3508 (toll-free)

Diana Malone
Navajo Nation Superfund Office
Highway 264/43 Crest Road
St. Michaels, AZ 86511
520.871.6859

Larry Bush
United Nuclear Corporation
P.O. Box 3077
Gallup, NM 87305-3077
505.722.6651

Media inquiries should be directed to the EPA Region 6 Press Office at 214.665.2200 or 214.665.2261.

Information Repositories

Octavia Fellin Public Library
115 West Hill Avenue
Gallup, NM 87310
505.863.1291

Navajo Nation Superfund Office
Highway 264/43 Crest Road
St. Michaels, AZ 86511
520.871.6859

On the web...

Information can also be accessed via the U.S.EPA Internet Homepage at:
U.S.EPA Headquarters: www.epa.gov
U.S.EPA Region 6: www.epa.gov/region6

Call U.S. EPA at 1.800.533.3508 (toll-free) to receive a Spanish translation of this fact sheet.

Para recibir una traducción en español de esta Hoja de Datos, comunicarse con la Agencia de Protección del Medio Ambiente de los EEUU (la EPA) al número de teléfono 1.800.533.3508 (llamada gratis).

United States
Environmental Protection
Agency

Region 6
1445 Ross Ave. (6SF-TS)
Dallas, TX 75202

ATTACHMENT 4

PUBLIC NOTICE

EPA STARTS THIRD FIVE-YEAR REVIEW UNITED NUCLEAR CORPORATION SUPERFUND SITE PUBLIC NOTICE

On January 23, 2008, the U.S. Environmental Protection Agency (EPA) Region 6 started the third five-year review of the ground-water cleanup activities at the United Nuclear Corporation (UNC) Church Rock Superfund site, a former uranium mill facility located 17 miles northeast of Gallup, McKinley County, New Mexico. The purpose of the five-year review is to evaluate the performance of the remedy in order to determine the protectiveness for public health and the environment. The first two five-year reviews were completed in 1998 and 2003, respectively.

In the third five-year review, EPA will assess the performance of the ground-water remedy by evaluating performance monitoring data and other work generated since the last five-year review. The five-year review will include an evaluation of any changes in federal and state standards and toxicity information and how they may affect the protectiveness of the remedy.

EPA's third five-year review is scheduled to be completed in September of 2008. Once completed, the results of the five-year review will be made available to the public at the following information repositories:

Octavia Fellin Public Library
115 West Hill Avenue
Gallup, NM 87310
505.863.1291

Navajo Nation Superfund Office
Highway 264/43 Crest Road
Michaels, AZ 86511
520.871.6859

Information about the site is also available on the EPA Internet Homepage at www.epa.gov/region6 and www.epa.gov/region6/superfund.

Questions related to the site should be directed to Mark Purcell, EPA Remedial Project Manager, at 214.665.6707 or 1.800.533.3508 (toll free), Bob Johnson, EPA Community Involvement Coordinator/S.E.E., at 214.665.6676 or 1.800.533.3508 (toll-free), or David Mayerson, the New Mexico Environment Department Project Manager, at 505.476.3777.

For publication in the Gallup Independent and the Navajo Times

ATTACHMENT 5

SITE INSPECTION

Site Inspection Checklist

I. SITE INFORMATION	
Site name: United Nuclear Corporation	**Date of inspection:** March 19, 2008
Location and Region: McKinley County, Region 6	**EPA ID: NMD030443303**
Agency, office, or company leading the five-year review: US EPA	**Weather/temperature:** Clear and cool, ~60 degree F

Remedy Includes: (Check all that apply)

Landfill cover/containment	Monitored natural attenuation
Access controls	Groundwater containment
× Institutional controls	Vertical barrier walls
× Groundwater pump and treatment	
Surface water collection and treatment	

Other: Extracted water storage and evaporation system_____

_____

Attachments: × Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** __Larry Bush___ (Name) ___UNC Vice President___ (Title) __Mar 19, 2008___ (Date)
   Interviewed at site × at office by phone Phone no. ____(505) 722-6651_____
   Problems, suggestions; ____See attached trip report_____
   _____

2. **O&M staff** _____ (Name) _____ (Title) _____ (Date)
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; _____Four site staff, two of whom are UNC employees._____
   _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency __New Mexico Environmental Department___
Contact __David Mayerson_____ _____RPM_____ _Mar 19, 08_ _(505) 476-3777_
Name Title Date Phone no.
Problems; suggestions; __See interview form_____

Agency __ New Mexico Environmental Department ___
Contact ___Earle Dixon_____ _____RPM_____ _ Mar 19, 08_ _(505) 827-2890_
Name Title Date Phone no.
Problems; suggestions; ___See interview form_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; _____

4. **Other interviews** (optional)

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

O&M manual	× Readily available	Up to date	N/A
As-built drawings	× Readily available	Up to date	N/A
Maintenance logs	Readily available	Up to date	× N/A

Remarks___UNC has all project work plans, designs, drawings and related material on site._____
_Many different well configurations, so no standardized plans._____

2. **Site-Specific Health and Safety Plan** × Readily available Up to date N/A
Contingency plan/emergency response plan × Readily available Up to date N/A
Remarks____Available at the site office._____

3. **O&M and OSHA Training Records** × Readily available × Up to date N/A
Remarks: _____Radiation Safety Officers on site._____

4. **Permits and Service Agreements**

Air discharge permit	Readily available	Up to date	× N/A
Effluent discharge	Readily available	Up to date	× N/A
Waste disposal, POTW	Readily available	Up to date	× N/A
Other permits____NRC Permit____	× Readily available	× Up to date	N/A

Remarks: _____

5. **Gas Generation Records** Readily available Up to date × N/A
Remarks_____

6. **Settlement Monument Records** × Readily available Up to date N/A
Remarks_____

7. **Groundwater Monitoring Records** × Readily available Up to date N/A
Remark: _____

8. **Leachate Extraction Records** Readily available Up to date × N/A
Remarks_____

9. **Discharge Compliance Records**

Air	Readily available	Up to date	× N/A
Water (effluent)	× Readily available	Up to date	N/A

Remarks_____

10. **Daily Access/Security Logs** × Readily available Up to date N/A
Remarks: _____The site staff monitors site access, visitors must report to office and sign-in._____

IV. O&M COSTS

1. **O&M Organization**
   State in-house — Contractor for State
   PRP in-house — × Contractor for PRP
   Federal Facility in-house — Contractor for Federal Facility
   Other_____MACTEC is the contractor._____
   _____

2. **O&M Cost Records**
   × Readily available × Up to date
   Funding mechanism/agreement in place
   Original O&M cost estimate____Not available_____ Breakdown attached

   Total annual cost by year for review period if available

   For _____ _____
   Date Total cost

   For _____ _____
   Date Total cost

   For _____ _____
   Date Total cost

   For _____ _____
   Date Total cost

   For _____ _____
   Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
   Describe costs and reasons: _ None identified _____
   _____

V. ACCESS AND INSTITUTIONAL CONTROLS × Applicable N/A

A. Fencing

1. **Fencing** Location shown on site maps Gates secured × N/A
   Remarks:__Fencing is in place and the site is patrolled. The "permanent" fence will be installed at site closure. _____
   _____

B. Other Access Restrictions

1. **Signs and other security measures** Location shown on site map N/A
   Remarks: _____Signs limiting access to the restricted area are in place and monitored._____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs properly implemented × Yes No N/A
Site conditions imply ICs being fully enforced × Yes No N/A

Type of monitoring : (e.g., self-reporting, drive by)___Self reporting & agency visits.___
Frequency _____No less than monthly._____
Responsible party/agency _____
Contact_____ _____ _____ _____
Name Title Date Phone

Reporting is up-to-date × Yes No N/A
Reports are verified by the lead agency × Yes No N/A
Specific requirements in deed or decision documents have been met Yes No × N/A
Violations have been reported Yes No × N/A
Other problems or suggestions:
____The State of New Mexico does not impose ICs._____
_____

2. **Adequacy** ICs are adequate × ICs are inadequate N/A
Remarks: __The project team is currently considering expanding the ICs related to off-site _____
__groundwater use._____

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident
Remarks: __There is occasional trespassing related to grazing and trash dumping. No vandalism.____
_____

2. **Land use changes on site** N/A
Remarks: _____No land use changes on site._____
_____

3. **Land use changes off site** N/A
Remarks: _____No land use changes off site._____
_____

VI. GENERAL SITE CONDITIONS

A. Roads × Applicable N/A

1. Roads damaged Location shown on site map × Roads adequate N/A
Remarks_____
_____

B. Other Site Conditions

Remarks:

_____

_____

_____

_____

VII. LANDFILL COVERS Applicable × N/A

A. Landfill Surface

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____
   _____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

5. **Vegetative Cove** Grass Cover properly established No signs of stress
   NoTrees/Shrubs (indicate size and locations on a diagram)
   Remarks_____
   _____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____
   _____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks_____
   _____

8. **Wet Areas/Water Damage** Wet areas/water damage not evident
   Wet areas Location shown on site map Areal extent_____
   Ponding Location shown on site map Areal extent_____
   Seeps Location shown on site map Areal extent_____
   Soft subgrade Location shown on site map Areal extent_____
   Remarks_____
   _____

9.	**Slope Instability**	Slides	Location shown on site map	No evidence of slope instability
	Areal extent_____			
	Remarks_____			
	_____			
B. Benches		Applicable	N/A	
	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)			
1.	**Flows Bypass Bench**		Location shown on site map	N/A or okay
	Remarks_____			
	_____			
2.	**Bench Breached**		Location shown on site map	N/A or okay
	Remarks_____			
	_____			
3.	**Bench Overtopped**		Location shown on site map	N/A or okay
	Remarks_____			
	_____			
C. Letdown Channels		Applicable	N/A	
	(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)			
1.	**Settlement**	Location shown on site map		No evidence of settlement
	Areal extent_____	Depth_____		
	Remarks_____			
	_____			
2.	**Material Degradation**	Location shown on site map		No evidence of degradation
	Material type_____	Areal extent_____		
	Remarks_____			
	_____			
3.	**Erosion**	Location shown on site map		No evidence of erosion
	Areal extent_____	Depth_____		
	Remarks_____			
	_____			

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment	Applicable	N/A
1. **Gas Treatment Facilities** Flaring Thermal destruction Collection for reuse Good condition Needs Maintenance Remarks_____		
2. **Gas Collection Wells, Manifolds and Piping** Good condition Needs Maintenance Remarks_____		
3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) Good condition Needs Maintenance N/A Remarks_____		
F. Cover Drainage Layer	Applicable	N/A
1. **Outlet Pipes Inspected** Functioning N/A Remarks_____		
2. **Outlet Rock Inspected** Functioning N/A Remarks_____		
G. Detention/Sedimentation Ponds	Applicable	N/A
1. **Siltation** Areal extent_____ Depth_____ N/A Siltation not evident Remarks_____		
2. **Erosion** Areal extent_____ Depth_____ Erosion not evident Remarks_____		
3. **Outlet Works** Functioning N/A Remarks_____		
4. **Dam** Functioning N/A Remarks_____		

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable × N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching_____
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES	× Applicable	N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines × Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**

   Good condition All required wells properly operation Needs Maintenance × N/A
   Remarks____Most extraction wells are temporarily inactive, awaiting possible changes to the_____
   __remedy. Those wells operating are in good condition._____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

   × Good condition Needs Maintenance
   Remarks_____The on-site O&M staff keep the equipment in good condition._____

3. **Spare Parts and Equipment**

   × Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable × N/A

1. **Collection Structures, Pumps, and Electrical**

   Good condition Needs maintenance
   Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

   Good condition Needs maintenance
   Remarks_____

3. **Spare Parts and Equipment**

   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

C. Treatment System × Applicable N/A

1. **Treatment Train** (Check components that apply)
   Metals removal Oil/water separation Bioremediation
   Air stripping Carbon adsorbers
   Filters_____
   Additive (*e.g.*, chelation agent, flocculent)_____
   Others: ____Extracted groundwater is evaporated._____
   × Good condition Needs Maintenance
   Sampling ports properly marked and functional
   Sampling/maintenance log displayed and up to date
   Equipment properly identified
   Quantity of groundwater treated annually: _Approximately 2,000,000-gallons and decreasing____
   Quantity of surface water treated annually: _____N/A_____
   Remarks: _____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   N/A × Good condition Needs Maintenance
   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   × N/A Good condition Proper secondary containment Needs Maintenance
   Remarks_____

4. **Discharge Structure and Appurtenances**
   N/A × Good condition Needs Maintenance
   Remarks_____The evaporation pond and sprayers are in good condition._____

5. **Treatment Building(s)**
   × N/A Good condition (esp. roof and doorways) Needs repair
   Chemicals and equipment properly stored
   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   × Properly secured/locked × Functioning × Routinely sampled × Good condition
   All required wells located Needs Maintenance N/A
   Remarks:

D. Monitoring Data

1. Monitoring Data
   × Is routinely submitted on time × Is of acceptable quality

2. Monitoring data suggests: (see report text for discussion on this topic)
   Groundwater plume is effectively contained Contaminant concentrations are declining

D. Monitored Natural Attenuation × N/A

1. **Monitoring Wells** (natural attenuation remedy)

Properly secured/locked	Functioning Routinely sampled	Good condition
All required wells located	Needs Maintenance	N/A

Remarks_____

_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. Note that there are no other remedies.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

___Most of the groundwater extraction remedy has been temporarily inactivated. Pumping _____
__ efficiency has declined significantly. The intent of the remedy was to remove tailing-leachate___
__impacted groundwater. The project team is currently conducting a supplemental FS. _____

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

___O&M measures are adequate and has had no effect on the protectiveness_____
___of the remedy._____

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. Currently most of the remedy is non-operational, therefore O&M costs are low. There will be significant costs to repair and re-start the groundwater extraction should there be a decision to put it back into operation.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. The project team is discussing opportunities to both optimize the remedy and monitoring. This will be done in conjunction with preparation of the site-wide supplemental feasibility study. Changes to the remedy will be documented in a ROD Amendment.

CESPK-ED-GE March 24, 2008

MEMORANDUM FOR FILE

SUBJECT: Five-Year Review Site Visit, United Nuclear Corporation (UNC) Church Rock Site.

1. Brad Call and Teresa Rodgers arrived in Albuquerque, NM the evening of 18 Mar 2008 and drove to Gallup, NM. The next morning, we drove to the United Nuclear Corporation (UNC) Church Rock site about 10 miles northeast of Gallup, NM. The drive to the UNC site revealed mountainous terrain which is generally arid with small amounts of snow left on north-facing slopes and a little snowmelt in the arroyos. We met Larry Bush, former president and current vice-president of UNC, at 9:00 a.m., 19 Mar 2008. Mr. Bush gave us a briefing on the history of the Church Rock site during its time as a uranium processing facility and described remediation efforts after the site closed and was designated an Environmental Protection Agency (EPA) Superfund site.

Two representatives of the New Mexico Environment Department (NMED) arrived about 10:00 a.m.: David Mayerson (current Remediation Project Manager) and Earle Dixon (new project manager in a few months). Part of the briefing focused on implementing institutional control (IC). Both NMED representatives and Mr. Bush predicted difficulty enforcing ICs at this site. Livestock from the local area come onto the site at least several times a month, and staff spend a significant portion of their workdays repairing fences and removing cows, horses, and sheep from the site. Then, an extended conversation followed on the status of the groundwater remedy and current remediation efforts.

Roy Blickwedel, a remedial project manager for General Electric Company, arrived at the meeting just before lunch. He discussed the site's geochemistry and how it affects remediation efforts.

Mr. Bush took us and the NMED team on a driving tour of the UNC site after lunch. We were able to take photographs during the tour, and these will be appended to the 2008 5-year report. The first stop was a ridge overlooking the entire site. We could see the North and South cells, where tailings piles are now covered. South of the cells, two evaporation ponds remain and are signed as a radiation hazard. We also saw many monitoring wells throughout the entire site, some of which were being sampled when we drove by, and the site of the alkalinity stabilization pilot study. We finished the tour with a look at the arroyo (and its nick point) that bisects the site and parallels the main access road. From oldest to youngest, all three zones of the Upper Gallup Sandstone were visible; above that, the Dilco Coal Member of the Crevasses Canyon Formation cropped out; and finally, moderate amounts of Quaternary Alluvium remain in the vicinity of the Arroyo nick point. Mr. Bush and Mr. Blickwedel reported several billion gallons of mine water flowed through this arroyo while the Church Rock mine operated. Since remediation of the UNC site began, groundwater has been draining from Zones 1 and 3 of

Upper Gallup Sandstone as well as the alluvial material. Over the years, as groundwater drains down gradient, it appears that sulfate and total dissolved solids concentrations are increasing in the remaining groundwaters. The alluvial, Zone 3, and Zone 1 aquifers have a very low rate of recharge.

After the site tour, we interviewed Mr. Mayerson and Mr. Dixon for the five-year report. We left the site at 5:00 p.m. and returned to Gallup, NM.

The next day, 20 Mar 2008, we drove back to Albuquerque, NM, wrote up some of our field notes, and flew to Sacramento, CA. for a 9:30 p.m. arrival.

2. I can be reached at 916-557-6624.

Teresa Rodgers
Geologist
Environmental Design Section

ATTACHMENT 6

PHOTOGRAPHS

Photographs of the United Nuclear Corporation Superfund Site (19 Mar 2008)

Photo 1. North Cell, now covered (looking northwest).

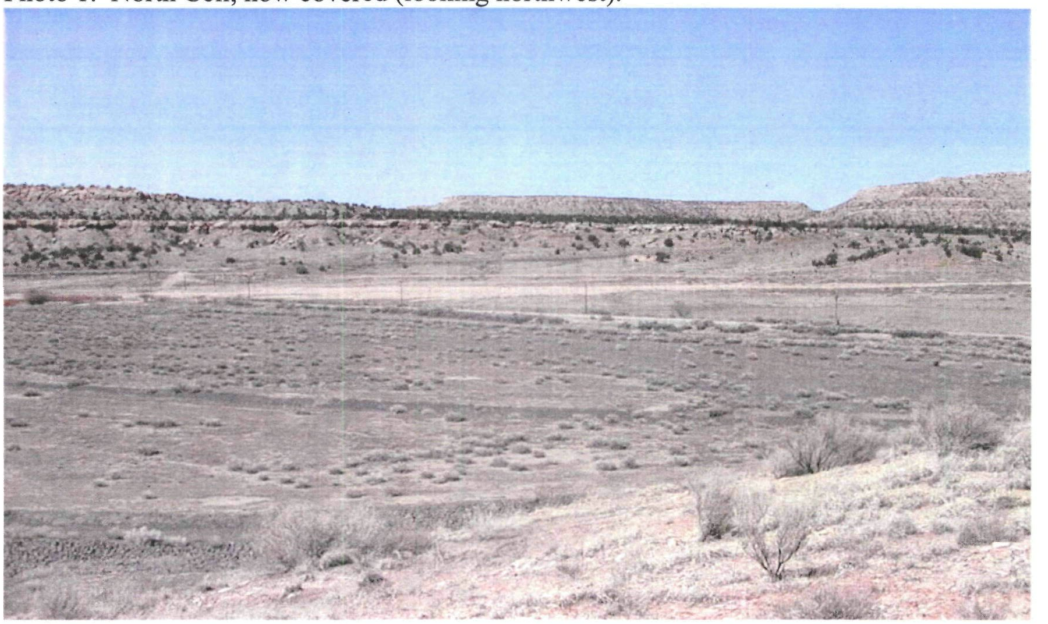


Photo 2. South Cell, now covered (looking southwest). UNC buildings in background.

Photo 3. Zone 1 Monitoring Well and EPA Well (extraction system shut off in 1999).

Photo 4. Southwest Alluvium Pumping System Well (shut off in 2001).

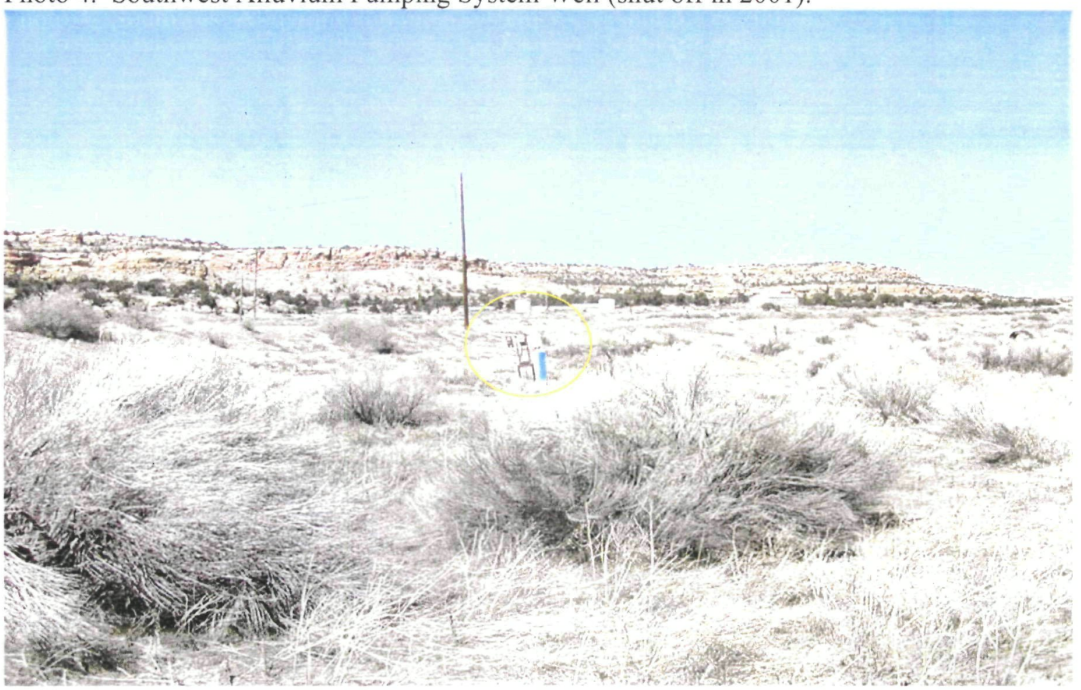


Photo 5. Zone 3 Well RW11 in foreground. Installed for hydrofracturing study; now an extraction well. Zone 3 monitoring wells in background. Well sampling ongoing in center background (looking north).

Photo 6. In Situ Alkalinity Stabilization Pilot Study site. Injection well in center; three extraction wells in middle ground.

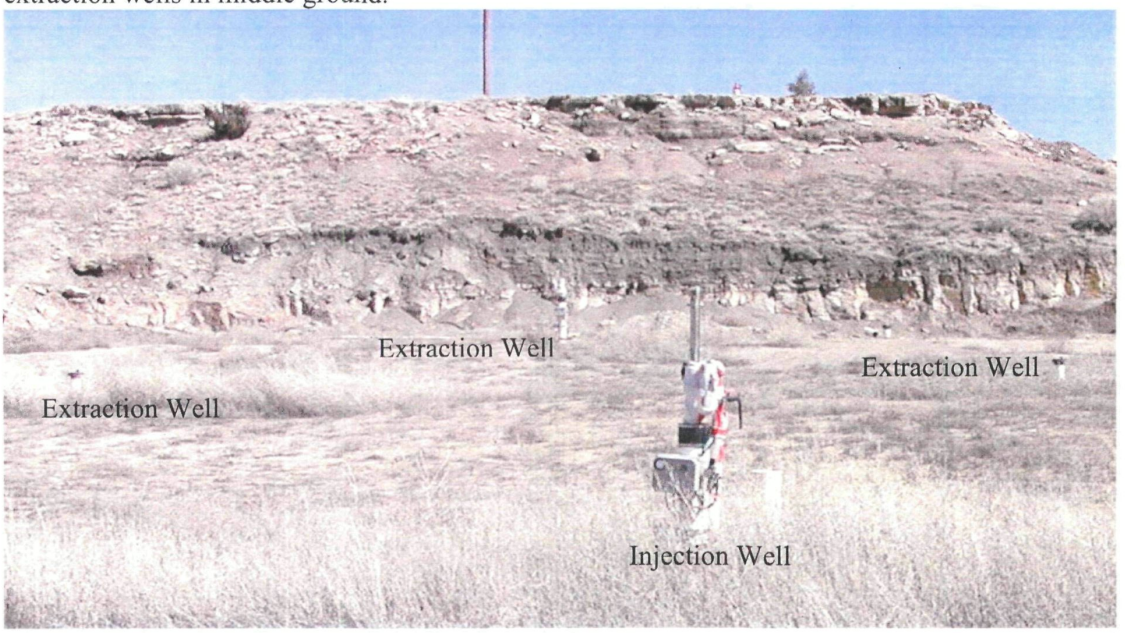


Photo 7. Dilco Member of Crevasse Canyon Formation overlying Zone 3 of the Upper Gallup Sandstone.

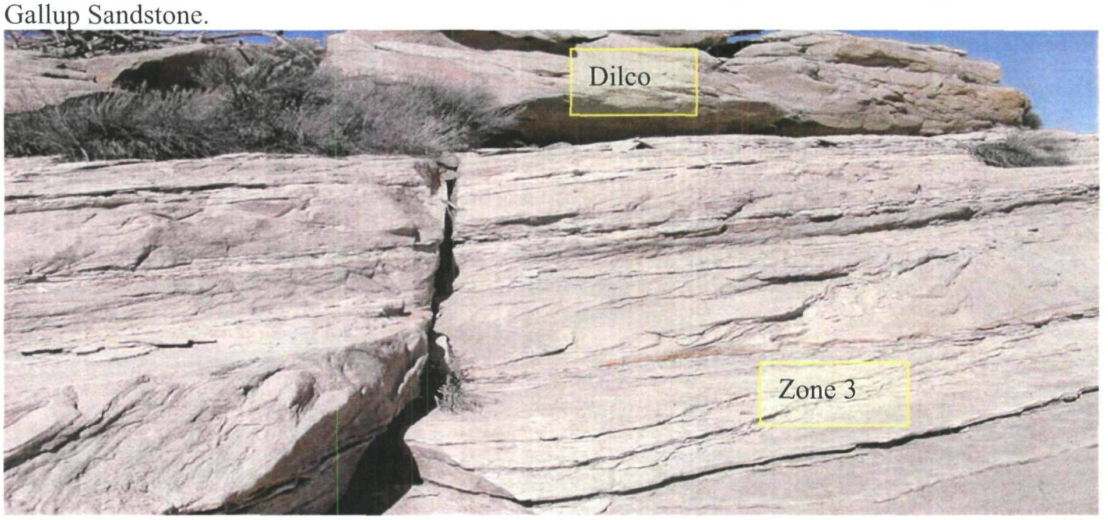


Photo 8. Zone 3 - Upper Gallup Sandstone. Zone 3 (sandstone) overlies Zone 2 (shale and coal), & Zone 1 (sandstone).

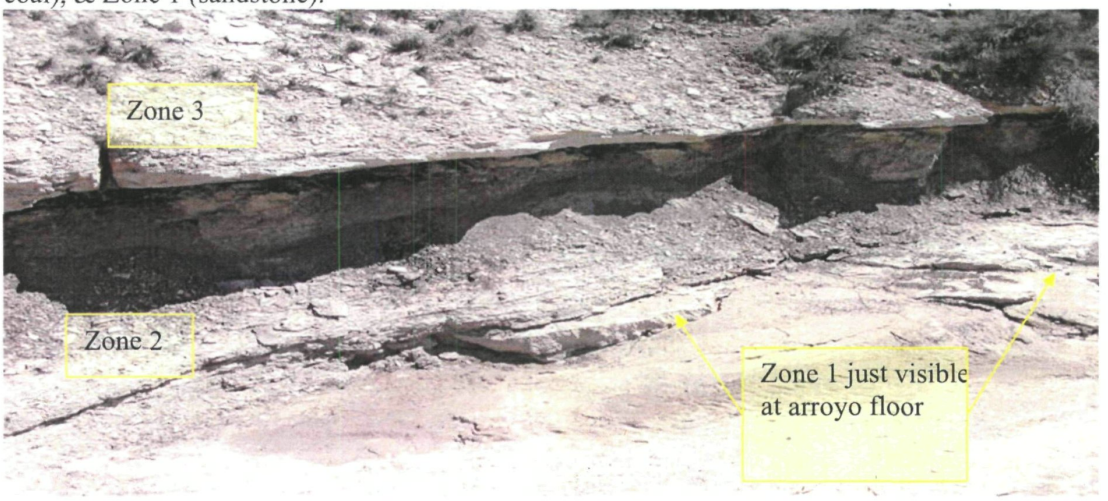
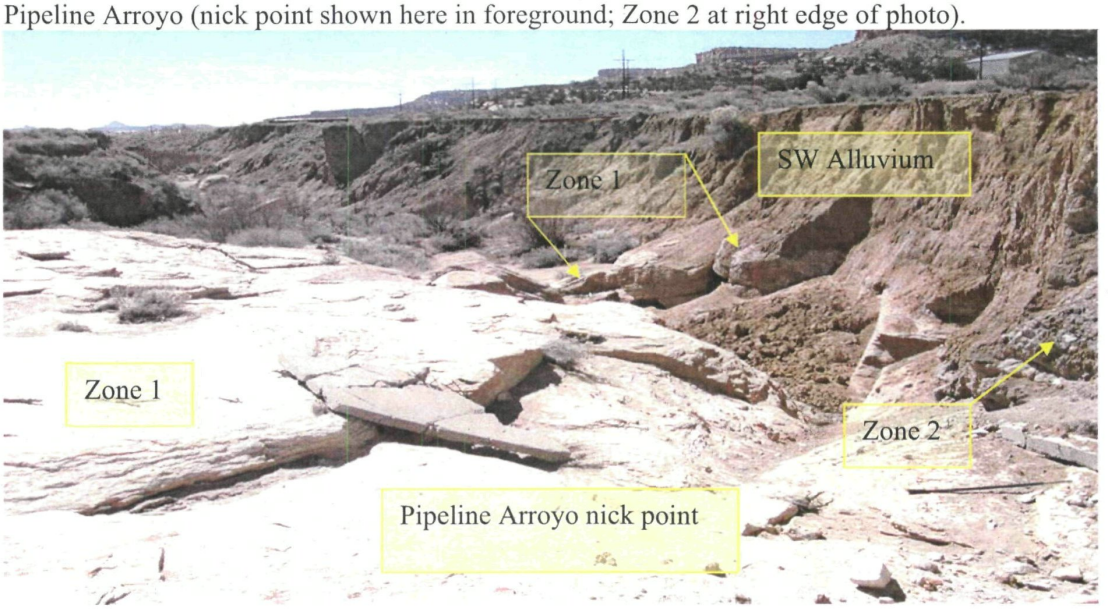


Photo 9. Southwest Alluvium overlies Zone 1 of Upper Gallup Sandstone in west wall of Pipeline Arroyo (nick point shown here in foreground; Zone 2 at right edge of photo).



ATTACHMENT 7

INTERVIEW RECORDS

United Nuclear Corporation 2008 Five-Year Review

Interview with Mr. David Mayerson, Remedial Project Manager, New Mexico Environmental Department, Ground Water Quality Bureau, Superfund Oversight Section, P.O. Box 26110, Santa Fe, New Mexico, 87505

Interview conducted on March 19, 2008 by Brad Call and Teresa Rogers, U.S. Army Corps of Engineers.

1. What is your overall impression of the project? (general sentiment)

Mr. Mayerson feels that UNC has been doing a good job during the time he has been involved with the project. UNC has been open and forthcoming regarding the site and remedial activities. They have produced good reports and have submitted documents in a timely manner. In addition, their work has been relatively unbiased and of good quality.

2. What effects have site operations had on the surrounding community?

Mr. Mayerson is not familiar with any potential effects on the local community.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

The one community concern that he is aware of involves the issue of water availability. He has been told by others involved with the project that UNC offered to drill a production well for the nearby Navajo Pinedale chapter. Mr. Mayerson was not directly involved in those discussions.

4. Have there been routine communications or activities (e.g., site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please describe purpose and results.

Mr. Mayerson was last on-site approximately a year ago, not long after he re-joined the Superfund Section of his department. This was about the time that UNC was beginning operation of the alkalinity stabilization project. The Five-Year Review site visit on March 19, 2008 was his second visit to the site in about three years. Communications have been good on this project with timely submittals of reports, annual monitoring data, and technical reports (like the alkalinity stabilization study).

5. Have there been any complaints, violations, or other incidents related to the site that required a response by your office? If so, please describe the events and results of the responses.

He is not aware of any ground water remedy related citizen complaints during his tenure on the project. Mr. Mayerson did note that there have been citizen concerns expressed regarding other uranium-mining activities, not related to the UNC ground water remedy.

He noted that local residents do not always distinguish among the effects related to specific sites at which various uranium-mining related remedies are currently underway.

6. Is the ground water remedy progressing in accordance with NMED's expectations for the site? Please explain.

Yes, the ground water remedy is progressing in accordance with NMED expectations. The technical situation at this site is currently difficult due to declining saturation levels. The ability to apply the remedy is limited by the technical challenges associated with declining ground water levels.

7. From NMED's perspective, have any of the changes in site operations had an affect on the protectiveness or effectiveness of the ground water remedy? Please explain.

NMED does have concerns with clean-up activities in Zone 3. There were opportunities earlier during the active remediation phase of this project to have better addressed the problem in Zone 3. Earlier action may have prevented the movement of contaminated ground water so close to the northern property boundary. UNC might have been more responsive to prevent off-site migration of contamination.

8. Are you aware of any changes in state environmental standards since the time the remedial approach was delineated which may call into question the protectiveness or effectiveness of the remedial approach?

Mr. Mayerson notes that the uranium ground water standard has changed recently. This change has affected several other similar sites where he provides oversight. In fact, NMED is currently developing policy regarding uranium-contaminated ground water, for both open and closed sites. His department is evaluating this change in the uranium standard to determine how it may affect protectiveness.

9. Do you feel well informed about the site's activities and progress?

Yes, Mr. Mayerson does feel well informed about site activities and progress.

10. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Mr. Mayerson feels that the regulators are not performing as efficiently as they should be on this project. They should respond to UNC document submittals in a more timely fashion. He went on to note that there are difficult jurisdictional issues related to the UNC site because of the involvement of the Navajo Nation, and various agencies of the U.S. Federal and New Mexico State governments. This at times makes it difficult to get things done. He feels that progress would be facilitated by engaging the Navajo more directly in the project. Currently the project team does not receive much Navajo input until the final decision making stage. It is preferable to work with them throughout the process.

United Nuclear Corporation 2008 Five-Year Review

Interview with Mr. Earle Dixon, Remedial Project Manager, New Mexico Environmental Department, Ground Water Quality Bureau, Superfund Oversight Section, P.O. Box 26110, Santa Fe, New Mexico, 87505

Interview conducted on March 19, 2008 by Brad Call and Teresa Rogers, U.S. Army Corps of Engineers.

1. What is your overall impression of the project? (general sentiment)

Mr. Dixon has an overall positive impression of the project. He also feels that the project team has made good technical decisions. UNC follows through on regulatory directives. Mr. Dixon notes that UNC has tried to apply technology to resolve the contamination issues and they have not been shortcutting the process. This is not an easy site but UNC has put forth a good effort.

2. What effects have site operations had on the surrounding community?

In their application of the ground water remedy UNC has encountered community concern as they strive to escape the shadow of suspicion that is the legacy of the uranium-mining industry. The ground water remedy bears the brunt of this stigma. The local residents are suspicious of technical explanations and assurances. Few local citizens truly understand the ground water remedy situation because few Navajo have the specialized technical knowledge related to environmental restoration.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

Yes, Mr. Dixon is aware of the concerns associated with the mistrust of the uranium-mining industry as discussed above. Local residents have concerns regarding excess incidents of cancer and other health problems. There are also concerns regarding their livestock who might be exposed to contamination. Incidents connected with the site such as the tailing pond breech, and reports about the constituents in the water (low pH, radioactivity, etc.), cause concern. The local residents are not actively reading the reports prepared by UNC or others; therefore they have no first-hand knowledge. Mr. Dixon notes that there have been no recent public meetings regarding the ground water remedy, perhaps periodic public meetings should be considered.

4. Have there been routine communications or activities (e.g., site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please describe purpose and results.

Yes there have been communications conducted by his office. They participate in meetings and site visits. His office also reviews reports and provides comments.

5. Have there been any complaints, violations, or other incidents related to the site that required a response by your office? If so, please describe the events and results of the responses.

Mr. Dixon is aware of local complaints regarding the Northeast Church Rock mine. These concerns are related in a general manner to the UNC ground water remedy. Some local residents were living on mine waste. A portion of these mine wastes contained contaminants that exceeded regulatory standards – and these soils were removed. The local residents have not expressed concerns specific to the ground water remedy because they consider the entire site to be a uranium-impacted area.

6. Is the ground water remedy progressing in accordance with NMED's expectations for the site? Please explain.

For the most part the ground water remedy is proceeding in accordance with NMED expectations. Some constituents are in locations that the State of New Mexico is concerned with (close to the property boundary). Mr. Dixon's office is concerned that the contamination may still be moving. The contamination migration must be brought under control. They want the ground water plume to be stable. For example, in the Southwest Alluvium the alkalinity front is still moving and it is unusual for New Mexico to grant a waiver under those conditions.

7. From NMED's perspective, have any of the changes in site operations had an affect on the protectiveness or effectiveness of the ground water remedy? Please explain.

The remedy involves ground water extraction and treatment by evaporation. UNC has performed ground water extraction for as long as possible. This remedy has reached the limit of effectiveness. Mr. Dixon posed the question, can the team enhance the protectiveness? Has the remedy reached the limits of protectiveness? Mr. Dixon thinks that the remedy is not as solid as it should be, but perhaps they have reached the limits afforded by nature and technology. UNC has transparently communicated their views regarding monitoring and placement of future sentinel wells. There is the potential to address the required monitoring locations with the existing wells. Establishing a good quality monitoring program is very important.

8. Are you aware of any changes in state environmental standards since the time the remedial approach was delineated which may call into question the protectiveness or effectiveness of the remedial approach?

Yes there have been changes in the standards. The uranium standard has changed from 5000 µg/L to 300 µg/L, and then to 30 µg/L. This is similar to what has occurred with arsenic standards.

9. Do you feel well informed about the site's activities and progress?

Yes, he feels well informed. He just needs to become familiar with the material related to the site.

10. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Mr. Dixon does have suggestions. He feels that there has been a lack of progress. This has not been on a technical level. The long-term decision-making by the state, the Navajo Nation, EPA, and others needs improvement. One suggestion is to establish a schedule. The team should be thinking of how it can assist the site to meet the schedule. It is unacceptable not to have a schedule. Without one, the team is not working in the best interests of the stakeholders and the public.

He went on to suggest that EPA's estimated 3 to 5-year schedule for the Site-Wide Supplemental Feasibility Study and ROD amendment seems too long. A maximum of 2 to 3 years is better. The project team has recently discussed establishing a project schedule. Mr. Purcell provided the 3 to 5-year estimate based on his previous experience with similar sites, his current project workload, and the need to follow the detailed guidance related to feasibility study preparation. Mr. Dixon recommends that the team should identify and address the issues as soon as possible and then get on with the job. The goal should be to complete the clean-up as soon as possible. The regulatory team should not hold UNC responsible for all uranium related problems. Concerns about uranium mining impacts in Indian Country should be weighed against earlier and ongoing decisions to work with the mining industry in the region because of the economic benefits it provides to tribal nations and employees.

United Nuclear Corporation 2008 Five-Year Review

Interview with Ms. Diana Malone, Navajo Environmental Protection Administration (Navajo EPA), P.O. Box 2946, Window Rock, Arizona, 86515

Interview conducted on April 2, 2008 by Mark Purcell, U.S. Environmental Protection Agency and Brad Call, U.S. Army Corps of Engineers.

1. What is your overall impression of the project? (general sentiment)

Ms. Malone first became involved in this project in the late 1990s and participated in the preparation of the first two five-year reviews. She indicated that the Site was moving in a positive direction when the 1998 Five-Year Review was prepared, but that progress since has become somewhat questionable. Ms. Malone indicated that currently the project is at a standstill and there is no clear path forward.

2. What is the Navajo EPA's role in this project?

In the early days of this project the role of the Navajo EPA was to interface with the local community. This changed approximately 10 years ago and the Navajo EPA is now viewed as a government agency that assists the U.S. Environmental Protection Agency, continues to act as a liaison with the community, explains technology to residents, and generally has more of a technical role. Their primary role is review, oversight, and outreach to the local community. Ms. Malone is one of the technical members of the Navajo EPA.

3. From the Navajo EPA's perspective, what effects have Site operations had on the surrounding community?

The local community has concerns regarding uranium mining in general and the possibility of adverse health effects. They realize that this project only addresses groundwater impacts related to the uranium milling operations. Navajo EPA is concerned that gaps can develop when these uranium sites are addressed separately. For example, uranium mine spoils from the Northeast Church Rock mine remain to be addressed. Ms. Malone also indicated that her agency is aware that the reason these sites are not addressed more holistically is due to the manner in which legislation has been established, as well as overlapping agency jurisdiction. She expressed concern that the Navajo EPA are beginning to learn that groundwater impacts may be more extensive at and near the Site (the Northeast Church Rock mine is nearby). A solution has not yet been determined, and meanwhile impacts are continuing.

4. Are you aware of any community concerns regarding the Site or its operation and administration? If so, please give details.

There have been community concerns regarding uranium mining in general. Ms. Malone noted that there has not been a recent public meeting for the Site. Currently there is a

high level of public interest in this topic due to the upcoming Congressional uranium mine hearings. Overall the public does not feel that the federal agencies are doing a good job at the Site. Therefore they continue to ask questions. Project documents and discussions have suggested that the remedy may need to be modified to include institutional controls and/or monitored natural attenuation. Ms. Malone indicated that such a change to the remedy will be considered, in the minds of the community, equivalent to leaving the contamination in place. The local community is concerned about exposure resulting from contamination that remains on Site. Such concerns are linked to an overall uneasiness with uranium mining in general. Ms. Malone suggests that the project team should consider working closer with the local community to avoid any perception that information has been withheld. She notes that the community has considered arranging for independent studies to confirm conclusions set forth in project documents.

5. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

The local authorities have not made Ms. Malone aware of any such incidents. It is her understanding that Mr. Larry Bush indicates that fewer trespassing incidents have occurred in recent years. United Nuclear Corporation has been erecting better quality fences to keep out the livestock. She is not aware of any vandalism issues.

6. Have there been any complaints, violations, or other incidents related to the Site that required a response by your office? If so, please describe the events and results of the responses.

Ms. Malone is not aware of any such complaints at this site, but there have been complaints regarding other uranium mining-related sites. For example there have been concerns expressed by the local community regarding the nearby Northeast Church Rock mine.

7. Have there been routine communications or activities (e.g., Site visits, inspections, reporting activities, etc.) conducted by your office regarding the Site? If so, please describe purpose and results.

Yes she does. Her office has made recent visits to nearby uranium sites and Ms. Malone always takes the time to stop by the Site when she is in the area. She also stays in contact with the local residents. The Navajo EPA has also performed site visits during quarterly groundwater sampling at this Site, even going so far as to assist with sample labeling. She feels well informed and welcome when she visits the Site.

8. Is the ground water remedy progressing in accordance with the Navajo EPA's expectations for the Site? Please explain.

No, the remedy is not progressing as they would like. Ms. Malone indicated that the remedy has removed some of the contaminants, but concentrations of others remain

unacceptably high. The clean-up process is taking far too long. She also notes that the project is moving in the direction of institutional controls and the Navajo EPA will not accept such a decision.

9. From Navajo EPA's perspective, have any of the changes in Site operations had an affect on the protectiveness or effectiveness of the ground water remedy? Please explain.

No they have not. Some of the new technologies tried recently (such as the alkalinity injection and hydraulic fracturing that are not in the ROD) were intended to stop the movement of contaminated groundwater, but unfortunately they were not successful.

10. Do you feel well informed about the Site's ground water cleanup activities and progress?

Yes, she feels very well informed.

11. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

Ms. Malone recommends that the project team should work closer with the community, especially at this time given the heightened level of interest sparked by the Congressional hearings. The local residents want to know what is going on at these uranium sites and they would appreciate more outreach from both the Navajo EPA and the U.S. EPA. The project team should work with the local community on the topic of institutional controls, and she feels that the Site-Wide Supplemental Feasibility Study underway is intended to get at these types of issues. Here parting recommendation is to be honest and forthcoming with the local community.

United Nuclear Corporation 2008 Five-Year Review

Interview with Mr. Paul Michalak, Senior Project Manager, U.S. Nuclear Regulatory Commission, Mail Stop: T8F42, Washington, D.C., 20555-0001

Interview conducted on April 9, 2008 by Mark Purcell, U.S. Environmental Protection Agency and Brad Call, U.S. Army Corps of Engineers.

1. What is the U.S. Nuclear Regulatory Commission's (NRC's) role on this project?

From about 1974 to 1986, the UNC Church Rock site was under New Mexico regulatory authority derived through the Atomic Energy Commission (AEC – forerunner of NRC)/NRC Agreement State Program. New Mexico handed uranium recovery regulatory authority (including the UNC Church Rock source material license) back to the NRC in 1986. The licensee (UNC) must remain in compliance with the stipulated license conditions, which include ground water quality standards for all three aquifers; the Southwest Alluvium, Zone 1, and Zone 3. The NRC also works closely with the EPA regarding the CERCLA ground water action and ground water remedy at the Site.

2. What is your overall impression of the ground water remediation effort at the Site?

Mr. Michalak's overall impression is that UNC had made a good effort. They have conducted cleanup actions in all three aquifers; the Southwest Alluvium, Zone 1, and Zone 3. They have made an effort in all three of the aquifers to improve the ground water conditions.

3. From your perspective, what effects have Site operations had on the surrounding community?

There have not been any quantitative adverse effects to the local community resulting from Site operations. This is a sparsely populated area with few drinking water wells near the Site. There have been no impacts to current drinking water sources off-Site.

4. Are you aware of any community concerns regarding the Site or its operation and administration? If so, please give details.

The community would like for the ground water remediation efforts to proceed at a faster pace. The Navajo have also expressed their desire that the ground water be cleaned to background levels. They are not pleased to learn that it may not be possible to return the ground water to a pristine condition.

5. Have there been any complaints, violations, or other incidents related to the Site that required a response by your office? If so, please describe the events and results of the responses.

No violations to the conditions of the license were noted during the past two inspections of the Site (July 2005 and July 2007).

6. Have there been routine communications or activities (e.g., site visits, inspections, reporting activities, etc.) conducted by your office regarding the Site? If so, please describe purpose and results.

Mr. Michalak indicated that yes, there have been routine communications. Biannual inspections are performed and he has visited the site informally a number of times. UNC submits annual reports on the Ground Water Corrective Action to the NRC. In addition the NRC requires that the licensee conduct and submit the results of its annual As Low As Reasonably Achievable (ALARA) radiological surveys. The purpose of these surveys is to determine if the Site is within regulatory limits. One area that currently exceeds the radiological standards is the evaporation ponds located on the mill tailings impoundment, where the final erosion protection and radon barrier is yet to be installed. It should be noted that UNC maintains proper radiological posting in this area.

7. Is the ground water remedy progressing in accordance with the NRC's expectations for the Site? Please explain.

He has been involved with this project for three years and he believes that it is progressing in accordance with the regulatory agency's expectations. This is a very difficult site due to challenges that include the geochemical reactions within the formation matrix resulting from the discharge of mine water into the arroyo. UNC has conducted several pilot scale tests in Zone 3. The alkalinity injection test did not work; however the hydraulic fracturing test was moderately successful. Mr. Michalak's experience is that most ground water remedies do not proceed as quickly as people expect. It takes time for these remedies to achieve their goal despite the fact that many people desire a faster response.

8. Are you aware of opportunities to optimize the operation, maintenance, or sampling efforts at the Site?

Mr. Michalak is not aware of any opportunities to optimize the remedy.

9. From NRC's perspective, have any of the changes in Site operations had an affect on the protectiveness or effectiveness of the ground water remedy? Please explain.

No, none of the changes at the Site have affected the protectiveness of the remedy.

10. Have there been any changes in NRC standards since the time the remedial approach was delineated which may call into question the protectiveness or effectiveness of the ground water remedy?

There have been changes to Site standards. These are not NRC standards, per se, but are site specific values subject to adjustment upon petition by the licensee. There have been

two changes to the standards. The first involves chloroform (a chemical in the trihalomethane family) which originally had a standard of 1 ppb. The EPA promulgated a MCL of 80 ppb for total trihalomethanes (TTHM) and UNC petitioned to amend the license standard to that value. The second change involves radium 226 and 228, the standards for these radionuclides were amended, based on a UNC statistical evaluation, to make them specific to each of the three aquifers at the Site. The NRC evaluates each petition based on its technical merit and potential health effects before granting the amendment. Site standards are not set lower than background levels.

11. What is the status of the NRC license for the Site?

The NRC license is active and there are a number of conditions that UNC must meet. This includes ground water standards. UNC's license is in good standing and they have provided their financial surety bond.

12. Do you feel well informed about the Site's ground water cleanup activities and progress?

Mr. Michalak does feel well informed about progress at the Site. The Site is inspected every two years, annual ground water monitoring reports are prepared, and he has been provided copies of all the pilot test reports and the initial portions of the Site-Wide Supplemental Feasibility Study.

13. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

UNC has approached the NRC about removing requirements related to cleanup of the Southwest Alluvium from the license. This UNC request was based on the fact that standards for total dissolved solids and sulfate are not included in the Site license. Mr. Michalak discussed this with the EPA and it was decided that it would be premature to approve such a request in advance of the completion of the Site-Wide Supplemental Feasibility Study (SWSFS). The NRC has notified UNC that they prefer that the SWSFS play-out before considering such an amendment to the license.

United Nuclear Corporation 2008 Five-Year Review

Questions for Roy Blickwedel, General Electric Corporation

1. What is your overall impression of the project? (general sentiment)

Remediation has operated as expected and has generally been effective in addressing hazardous constituents in the three water-saturated strata. The remediation remains protective of human health and the environment.

2. What is the current status of the ground-water remediation at the Site?

The active groundwater pumping systems in two of the three water-saturated strata that were impacted by tailings seepage migration have been discontinued. Zone 1 was discontinued in July 1999 with the approval of the Nuclear Regulatory Commission (NRC) because the decommissioning criteria were achieved. Groundwater quality in the offsite portion of Zone 1 is in compliance with the NRC groundwater protection standards.

In the Southwest Alluvial system, active pumping was discontinued with NRC approval to conduct an 18-month natural attenuation test. The report, completed in December 2002, recommended the replacement of the current remedy with a natural attenuation remedy for metals and radionuclides, and a Technical Impracticability Waiver for sulfate and TDS. The Southwest Alluvium is currently in compliance with all of the NRC groundwater protection standards.

Zone 3 pumping was discontinued in December 2000 with the approval of NRC. EPA recognized during the Five-Year Review of 1998 that Zone 3 pumping was not effective, and was perhaps detrimental to the containment of seepage-impacted water in Zone 3. Approval to cease pumping was granted in December 2000, pending the installation of a sentinel monitoring well and the evaluation of other remedy enhancement alternatives. Two alternative remedy enhancements were pilot tested between 2003 and 2008. One involved hydraulic fracturing the recovery wells to improve yields, and the other tested the injection of alkalinity-enhanced water to treat the seepage-impacted water insitu. Neither test was successful in enhancing the effectiveness of the remedy. However, the hydraulic fracturing test resulted in the placement of some new extraction wells that avoid the problems associated with the former pumping system. Pumping from the new Zone 3 wells continues.

3. Did the ground water remedy function as expected in the Southwest Alluvium and Zone 1? How well did the ground water remedy perform?

The remedy has functioned as well as was expected when EPA chose it in the June 1988 Record of Decision (ROD). While the groundwater pumping remedy did not attain all of the remediation goals that were established in the ROD, this was anticipated in the ROD. EPA expected that significant desaturation of the impacted media could occur and that it would be necessary to change the performance goals that were established in the ROD. Despite the anticipated technological limitations, groundwater quality in the offsite portion of Zone 1 is in compliance with the NRC groundwater protection standards, and the Southwest Alluvium is in full compliance with the NRC groundwater protection standards.

The impacted media have a high natural capacity to neutralize the effects of tailings seepage so that in some ways the remedy performance can be considered to have been better than expected. In fact, further improvements in the groundwater quality in Zone 1 and the Southwest Alluvium will only be realized through natural geochemical processes.

As acknowledged in the 2nd Five-Year Review, sulfate and dissolved solids concentrations are not expected to achieve the New Mexico drinking water standards because of natural geochemical conditions in the environment of this part of New Mexico. UNC has requested technical impracticability waivers for these constituents, beginning in 2000. To date, there has also not been any formal action taken to approve the waivers. This is both significant and unfortunate because the waivers were the last administrative step needed to achieve the cleanup standards in the Southwest Alluvium and in the offsite part of Zone 1. Remedy completion will not be possible without the waivers under any set of circumstances. As recommended in the 2nd Five-Year Review, UNC believes that EPA should complete the analysis of the natural attenuation and TI Waivers for Zone 1 and the Southwest Alluvium and make decisions with respect to their acceptability in accordance with NCP procedures.

4. Is the ground water remedy performing as expected in Zone 3?

The remedy functioned as well as was expected when EPA chose it in the June 1988 Record of Decision (ROD). While the groundwater pumping remedy has not attained all of the remediation goals that were established in the Record of Decision (ROD), this was anticipated in the ROD. EPA expected that significant desaturation of the impacted media could occur and that it would be necessary to change the performance goals that were established in the ROD.

UNC has expended tremendous effort and resources to enhance the effectiveness of EPA's selected remedy for Zone 3 as recommended in the 2nd Five-Year Review. While UNC's efforts have improved upon the original remedial design, they too are reaching the limit of their effectiveness. Migration of the Zone 3 plume has been slowed, but it will only cease to migrate when certain unchangeable hydraulic forces are balanced by the chemical reactions that are attenuating and restricting the movement of the seepage-impacted water. UNC has not identified other proven, innovative, or emerging technologies that will achieve cleanup goals in Zone 3 because of declining saturated thicknesses, the alteration of arkosic sandstone to clay, encrustation; and the resultant poor formation yields. UNC believes that the EPA should use the administrative tools that it has available to attain remedy completion in Zone 3.

5. What does the monitoring data show? During the operation of the remedial systems, were there any trends that showed contaminant levels were decreasing?

Descriptions of contaminant trends depend on the compound considered and whether one is discussing Zone 1, Zone 3, or the Southwest Alluvium, and so the annual review reports should be consulted for detailed answers to this question. In general, the trends for hazardous constituents, such as some metals and radionuclides have diminished both with distance from the tailings disposal area and through time. The trend continues today, and it is the result of the natural capacity of the formation to immobilize the hazardous constituents rather than the former pumping that took place.

Some other constituents, such as sulfate, are controlled solely by equilibration with naturally occurring minerals in the formation that the water moves through. As a consequence, the monitoring data for sulfate are remarkably stable through time.

6. From the General Electric Corporation's perspective, have any of the remedial systems for ground water reached their limit of effectiveness? If so, please explain.

First, let me explain the General Electric Company's (GE's) role on this project. In September 1997 UNC became a wholly-owned, indirect subsidiary of GE. GE Corporate Environmental Programs was retained through a separate administrative services agreement to assist UNC both technically and administratively with environmental issues at Church Rock.

As to GE's perspective, it is clear that the current remedy has reached the limits of effectiveness for Zone 1 and the Southwest Alluvium. Moreover, the remedial systems have achieved what was anticipated in the ROD.

Water quality due to tailings seepage has remained stable or improved since the cessation of pumping operations in both of these units. As recommended in the 2nd Five-Year Review, UNC believes that EPA should complete the analysis of the natural attenuation and TI Waivers for Zone 1 and the Southwest Alluvium and make decisions with respect to their acceptability in accordance with NCP procedures.

In Zone 3, the new pumping configuration has slowed the rate at which seepage-impacted water can migrate. This is beneficial because it allows natural restorative processes to be more effective. Over, the next few years, UNC intends to adjust the configuration by adding wells and removing them as needed to maximize control over the seepage-impacted water. Eventually, this approach will reach the limits of its effectiveness, and it will be necessary to change the remedial goals for the CERCLA process to attain closure

7. Are there any trends that show contaminant levels are increasing in the Southwest Alluvium since shut down? Please explain.

There are no water quality trends, which are attributable to the seepage of tailings-impacted water, to indicate that contaminant levels are increasing in the Southwest Alluvium. There has been some re-equilibration in the water quality attributes of some of the wells due to the system responding to the changed pumping conditions.

For example, uranium concentrations trended upwards for a couple of years in three wells following the pumping shut down. Alkalinity trended upwards in the same wells, and it is a well-understood geochemical principle and a common occurrence that uranium concentrations correlate with alkalinity. Naturally, UNC and the agencies want to know whether the concentration changes were the result of the cessation of pumping seepage-impacted groundwater or something else. In this case, the uranium concentration increase had nothing at all to do with uranium in the tailings-seepage. In fact, it could only be explained by a natural re-equilibration of background uranium in a system that responded to changed stresses. The pumping never fully captured the tailings-seepage to begin with. We know that tailings-seepage had been migrating through these particular wells for the duration of pumping; we know that uranium concentrations correlated with alkalinity, and we know that uranium concentrations do not correlate as well with the pumping that had taken place.

I use this example to illustrate two important points. First, the geochemistry and hydrology of the Church Rock site is complicated, and it is usually necessary to take these factors into consideration. Second, the

question that should be asked is not whether contaminant levels increased or decreased after altering pumping conditions, but rather, whether the changes are attributable to tailings seepage.

8. From the General Electric Corporation's perspective, have any of the changes in the Site operations affected the protectiveness or effectiveness of the ground water remedy? Please explain.

It is UNC's perspective that the cessation of pumping has not affected protectiveness. The remediation remains protective of human health and the environment. The remedy functioned as well as was expected when EPA chose it in the June 1988 Record of Decision (ROD). EPA expected that significant desaturation of the impacted media could occur and that it would be necessary to change the performance goals that were established in the ROD.

UNC believes that it is the attenuative capacity of the natural system, more than the pumping remedy, which has produced most of the remedial progress that has been observed in the Southwest Alluvium and in Zone 1. The stable to improving water chemistry that has occurred post-shutdown attests to this conclusion.

As for Zone 3, UNC recommends that pumping be continued for the next two to three years at some specific wellsites within UNC property so as to minimize the migration of seepage-impacted water.

9. How will conclusions from the Zone 3 In-Situ Alkalinity Stabilization Study and the Hydraulic Fracturing Pilot Test influence the preparation of the Site-Wide Supplemental Feasibility Study?

The two pilot tests that were attempted by UNC represented some potentially creative enhancements to the available technology; however, there have not been technological advances over the past 20 years that change the fundamental way that the Zone 3 remediation can be viewed. UNC has not identified other proven, innovative, or emerging technologies that will achieve cleanup goals in Zone 3 because of declining saturated thicknesses, the alteration of arkosic sandstone to clay, encrustation; and the resultant poor formation yields.

10. Do you have any comments, suggestions, or recommendations regarding the project?

EPA recognized as early as the ROD and as late as the First 5-year Review, that technical limitations would be reached with respect to meeting the goals that were established for the site. In the First 5-year review in 1998, EPA validated the technical limitations that it anticipated in the ROD using the 10 years of operational data in existence at that time. EPA recommended that UNC begin to use other available tools to fully close the site, such as Alternate Concentration Limits and Technical Impracticability Waivers. UNC embarked upon a program to develop the EPA's recommendations and for the next several years conducted appropriate investigations and reported on its progress.

In the Second 5-year Review in 2003, EPA changed course with the recommendation that a new Feasibility Study be undertaken in place of the course of action that it had recommended in the First 5-year Review. UNC has been complying with the requirement for the past two years despite its concern that the FS would delay completing the remedy. When the FS is completed, the fundamental technical limitations that EPA anticipated will not change. The CERCLA process will have to be completed using EPA's available and appropriate administrative tools. UNC understands that EPA believes that performing a second FS is the best approach to make sure that the stakeholders are fully involved. UNC urges EPA to return to the recommended course of action from the First 5-Year Review; it too enables the full involvement of stakeholders. Alternatively, UNC wants to engage EPA with ways to speed-up FS progress. For example, UNC has recommended to EPA that its consultants form a small working group with the appropriate EPA technical experts to minimize the review cycles.

*The FS will not change what EPA anticipated 20 years ago in the ROD. As stated in Appendix A of the ROD: "**However, operational results may demonstrate that it is technically impractical to achieve all cleanup levels in a reasonable time period, and a waiver to meeting certain contaminant-specific applicable or relevant and appropriate requirements (ARARs) may require re-evaluation as a result. Operational results may also demonstrate significant declines in pumping rates with time due to insufficient natural recharge of aquifers. The probability of significant reductions in the saturated thickness of aquifers at the site must be considered during performance evaluations since much of the water underlying the tailings disposal area is the result of mine water and tailings discharge, both of which no longer occur. In the event that saturated thicknesses cease to support pumping, remedial activity would be discontinued or adjusted to appropriate levels.**" This is precisely what has taken place over the nearly 20 years of performance monitoring, and more importantly, the remedy has always and continues to be considered effective. The new FS will not change the fact that the original cleanup goals cannot be met, and that waivers and other administrative tools will have to be adopted before the Church Rock site can be transferred to the Department of Energy's Long-term Stewardship Program.*

UNC understands that USEPA may evaluate institutional controls as a potential supplement to any natural attenuation remedy or Technical Impracticability Waivers for the Church Rock site. As EPA is aware, UNC worked with the Navajo Nation over a two-year period to develop an institutional control plan to prevent potential use of seepage-impacted water. To UNC's knowledge, however, neither the Tribal Resolution nor environmental right-of-way that were developed have been formally accepted or adopted by the authorities since they were proposed in March 2001.

United Nuclear Corporation 2008 Five-Year Review

Questions for Larry Bush, UNC

1. What is your overall impression of the project? (general sentiment)

   The project has accomplished several of its final goals and is moving toward completion.

2. What is the current status of the ground-water remediation?

   The Southwest Alluvial and Zone 1 systems remain shut down due to the success of the natural attenuation. Some of the Zone 3 wells installed during the hydro-frac tests are still being pumped and are behaving exactly like the conventional wells. Migration of the Zone 3 seepage-impacted water has been slowed, but it cannot be entirely prevented due to the slope of Zone 3 which adds appreciably to the overall hydraulic head. No available well system design will change this condition. Other remedies have been contemplated and tested, but none appear to represent an improvement over the present well design. A plan to install additional wells has recently been submitted to EPA with the intent to minimize the migration of seepage-impacted water in Zone 3.

3. Is ground water monitoring being performed? If so, please describe what activities are performed. How often are samples collected for analysis and what laboratory(ies) perform the analyses?

   Yes. The wells indicated in SUA-1475 continue to be sampled and measured on a quarterly basis. Several new wells are being observed and pumped to mitigate the Zone 3 plume. Some are tested monthly for various criteria and other are on a quarterly schedule.
   All samples are sent to Energy Laboratories in Casper, Wyoming for analysis. Some non-license well observations are tested by UNC via HACH kit.

4. Have any problems or difficulties been encountered which have impacted implementability of the ground water remedy or monitoring programs (e.g., access issues for well installation)? If so, please describe in detail.

   None, which have affected the remedy or monitoring plan. One access problem was encountered from the BIA, but was finally permitted after a two year delay.

5. Have there been any changes to federal, state, or local laws that affect the Site or the protectiveness of the remedy.

   UNC is not aware of any changes to federal, state, or local laws that affect the protectiveness of the remedy. UNC submitted last year the first part of the Supplemental, Site-wide Feasibility Study, a reassessment of remedial action objectives that takes into consideration changes to regulatory standards and site conditions since the 1988 ROD was issued. While there have been several standards that have been changed since the ROD, UNC believes that amending the ROD (or issuing an ESD) to incorporate the changes is unnecessary to ensure the protectiveness of the remedy and does not change the need for decisions on TI Waivers, etc. to bring the project to closure.

6. Is there a continuous on-Site O& M presence? If so, please describe staff and activities. If there is not a continuous of on-Site presence, describe staff and frequency of Site Inspections and activities.

   Yes. The Site RSO, and MACTEC operations team are on site during the regular working hours all week.

7. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since the last five-year review? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

   No significant changes have occurred in the O&M requirements and sampling routines. Maintenance has always been an ongoing affair, with it increasing and decreasing based on the age of the well and well location in the plume area. Protectiveness has never been jeopardized and effectiveness is dependent, once again, by age and location.

8. Have there been unexpected O&M difficulties or costs at the Site in the last five years. If so, please give details.

   No well field difficulties have identified from an O&M point of view. Various new extraction methods to increase efficiency have been tested, but none have proven effective in increasing the extraction rates or longevity of wells.

9. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

   Efforts to make the O&M more cost effective have mainly be centered around attempts to pump from the wells on a steady basis, versus the pump and rest of the earlier controller. Some improvement in pump life may have been realized, but low production levels make the task of constant flow a hard goal to obtain and sustain. Cost saving were not evident and costs may have actually increased due to the new generation pumps not being able to cope with the low production environment.

10. What are the annual O&M costs for calendar years 2003 through 2007? It will be acceptable to provide the combined groundwater remediation and NRC license compliance costs, as was done for the 2003 Five-Year Review.

Year	Totals
2003	$425,000
2004	$496,718
2005	$372,682
2006	$591,931
2007	$1,292,567

11. What effects have Site operations had on the surrounding community?

    The Site operations have not affected the surrounding community, other than to improve road conditions during adverse weather conditions and flash floods.

12. Are you aware of any community concerns regarding the Site or its operation and administration? If so, please give details.

    No

13. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

    On several occasions local law enforcement was summoned to have party groups on the property removed. No damage was observed to the extraction wells or recovery system. Illegal grazing remains a problem, but has been greatly remedied by new higher fences and cattle guards.
    Deer poaching has occurred on the Sections around the site and their remains left on the site, but a new gate has restricted access to this area. Woodcutting has also been reduced due to the new gate, but has increased along the public highway and along the gravel roads.
    A pickup truck was driven through the front gate and the driver proceeded to dump garbage on the site. It has only occurred once and appears to be an isolated event. The gates were repaired, new locks installed, and trash removed.

14. If any events, incidents, or activities have occurred at the Site did they require a response from you or your staff? Please explain.

    The responses are outlined in Question 13.

15. Do you have any comments, suggestions, or recommendations regarding the project?

    The project is protective of the public and is preventing exposure to hazardous materials. Ground water quality has stabilized and has achieved all attainable goals in two of the three impacted zones. Best efforts are being pursued in the third zone to reduce the migration of seepage-impacted water to the greatest extent that is practicable. As long as the goals of the project are not changed, then the process to bring the project to closure can be realized.

United Nuclear Corporation 2008 Five-Year Review

April 24, 2008 Interview with Resident

(b) (6) [redacted]

1. What is your overall impression of the project? (general sentiment)

   I worked at both the UNC mine and Kerr-McGee mine for seven years. I also worked on the 1979 tailing spill.

2. What effects have Site operations had on the surrounding community?

   Folks use to have a lot of livestock, but many of them died. They were drinking water from the arroyo. Then UNC put up water stock tanks. We also use to haul water from Gallup. Now we are hooked up to the community water supply (NTUA). People cannot use the ground water in this area.

3. Are you aware of any community concerns regarding the Site or its operation and administration? If so, please give details.

   People are still concerned about the 1979 tailing spill when the dam broke. They are also concerned that their health problems could be caused by exposure from this spill.

   I am having some health problems. My wife also worked in the mines underground.

4. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

   No. Raise livestock, cattle, horses, sheep. I have water hauled up from Gallup. I have a private well on my property. I do not use it.

5. Do you feel well informed about the Site's activities and progress?

   I am not really well informed.

6. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

When will mine site be cleaned up? Chris Suey placed a radon canister on my property. It was part of the CRUMP project. I was told the radon levels were high. Is there radiation in this area?

United Nuclear Corporation 2008 Five-Year Review

April 24, 2008 Interview with Resident

(b) (6) [redacted]

1. What is your overall impression of the project? (general sentiment)

   I moved here in 1987. I didn't work for the mine and shouldn't have moved here. I believe that no one will fix the problems here. But they need to fix them.

2. What effects have Site operations had on the surrounding community?

   The community cannot use ground water with private wells. The mining companies are ruining our world and need to consider the dangers before they mine. My brother Daniel worked at the Kerr McGee mine. He is 52 years old. He is having some health problems. I get public water now. My horse died this past winter, but I still have one horse left. The horse drinks water from the arroyo. Some people (believed to be from the Southwest Research Institute) have placed some radon canisters at my property to monitor radon levels in the air.

3. Are you aware of any community concerns regarding the Site or its operation and administration? If so, please give details.

   The community is concerned about the ground water and the air that they breathe. They are concerned about getting sick. The people are suffering here. There is lots of sickness. Some people have diabetes, some have cancer.

4. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

   I noticed the soil removal work done at homes north of here. There were also some buildings demolished in the past, along with dumping along the arroyo.

5. Do you feel well informed about the Site's activities and progress?

   I am not well informed about what is going on at this site.

6. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

I have no comments.

United Nuclear Corporation 2008 Five-Year Review

April 24, 2008 Interview with Resident

(b) (6) [redacted]

1. What is your overall impression of the project? (general sentiment)

   No comment as long as it gets cleaned up.

2. What effects have Site operations had on the surrounding community?

   Around here there have been no affects. I did note the soil being cleaned up at homes north of here.

3. Are you aware of any community concerns regarding the Site or its operation and administration? If so, please give details.

   No. We use the public water supply. We are concerned about the quality of the water supply. I don't raise any livestock, but I plan to.

4. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

   I am not aware of any.

5. Do you feel well informed about the Site's activities and progress?

   Yes. I know what is going on.

6. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

   No comment.

United Nuclear Corporation 2008 Five-Year Review

April 24, 2008 Interview with Resident

(b) (6) [redacted]

1. What is your overall impression of the project? (general sentiment)

   (b) (6) [redacted] *Why is it taking so long to clean up? I don't think it will ever be cleaned up. We are probably breathing it in. That is very sad.*

   (b) (6) [redacted] *It doesn't affect us. I raise horses and cattle. I don't use the land or water. I use to work at the mill in 1975, in the grinding section. When the pumps failed, there was overflow up to the knees. And during milling, you could smell something in the air.*

   When I was hired, there was an orientation. We were given a safety hat, goggles, rubber boots. I have heard in July that people at the UNC mine can fill out an application at the Chapter house. It asks if, during orientation, were you informed that you were suppose to take showers, change clothes, after work. I did not know I was suppose to do that. I went home in dirty wet clothes.

2. What effects have Site operations had on the surrounding community?

   People that lived down by the arroyo were affected by environmental problems. Livestock get onto the mill property. In the late 1980's, the homes were hooked up to public water supply. The livestock now use public water. Prior to then, we had to haul water from Gallup or use the well/windmill east of the tailing disposal area.

3. Are you aware of any community concerns regarding the Site or its operation and administration? If so, please give details.

   I believe I got contaminated from the ore while working at the mill. It was when the pumps failed and there was overflow up to our knees. My knees to feet broke out into sores afterward. The sores lasted three to four months.

4. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

   No.

5. Do you feel well informed about the Site's activities and progress?

   No. The folks working on the Dine Project water studies (Southwest Research Institute) have asked some questions in the past.

6. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

   I have no comments.

ATTACHMENT 8

PROTECTIVENESS EVALUATION

PROTECTIVENESS DETERMINATION FOR
United Nuclear Corporation Superfund Site
April 14, 2008

This section addresses Question B (Section 7.2 of the Report): "Are the exposure assumptions, toxicity data, cleanup levels and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

HUMAN HEALTH

Changes in Toxicity

Based on the EPA 1988 Record of Decision (ROD), a number of chemicals exceeded standards in ground water at the United Nuclear Corporation (UNC) Superfund site (Site). Chemicals that exceeded standards in the shallow alluvium and Zone 1 and Zone 3 of the Upper Gallup Sandstone Formation in 1988 are: aluminum, arsenic, cadmium, cobalt, manganese, molybdenum, nickel, selenium, nitrate, total dissolved solids (TDS), radium-226 and radium -228, and gross alpha emission. Other chemicals for which cleanup goals were defined are: antimony, barium, beryllium, chromium, copper, iron, lead, mercury, silver, thallium, vanadium, zinc, chloride, sulfate, uranium and thorium-230. Later monitoring showed that sulfate also exceeded the standard. The cleanup criteria for these chemicals were based on the New Mexico Water Quality Act (NMWQA) ground-water standards, federal Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs), health-based criteria or estimated background ground-water values. The NMWQA standards were to protect present and potential use and consisted of human health standards, other standards for domestic water supply, and irrigational use. Toxicity factors were used to develop health-based cleanup levels for four contaminants: antimony, beryllium, thallium and vanadium. Some of the toxicity data used to develop these cleanup values, as well as the MCLs used to establish other cleanup levels are not valid 20 years after the ROD. Preliminary Remediation Goals (PRGs) that have been developed by EPA for various chemicals, including antimony and vanadium, are based on more recent toxicity data. Additionally, newly promulgated MCLs and corresponding New Mexico Water Quality Control Commission (NMWQCC) ground-water standards are likely based on more recent toxicity data. For example, although the uranium cleanup level of 5 mg/L selected by EPA in 1988 was based on a New Mexico irrigational use standard, an MCL of 0.03 mg/L has been recently promulgated under the SDWA and adopted by New Mexico. These new MCLs and PRGs are discussed below. It is noted that a thorough evaluation of more recent toxicity data, risk screening, background water quality, and reassessment of cleanup levels is being performed as part of an ongoing Site-wide supplemental feasibility study (SWSFS). It is also noted that any new toxicity data which may be incorporated into the SWSFS to develop PRGs or cleanup levels are not believed to affect the current protectiveness of the remedy since there is no evidence of exposure to the contaminated ground water.

Changes in Standards and To-Be-Considered Materials

The information provided on Table 1 (attached) is pertinent to the remediation objectives stated for the ground-water treatment system at UNC. Table 1 provides the ground-water cleanup levels as established by the ROD. Also provided on Table 1 are the current MCLs, New Mexico Water Quality Control Commission (NMWQCC) standards, EPA (Region 9) PRGs, and/or estimated background values for comparison. The EPA PRGs and background values are to-be-considered (TBC) materials, while the other values are applicable or relevant and appropriate requirements (ARARs) established by EPA in the 1988 ROD.

As shown in Table 1, there have been changes in standards for antimony, arsenic, beryllium, cadmium, lead, selenium, thallium, and uranium. A revised background value for nitrate of 190 mg/L in ground water has been recommended by the U.S. Nuclear Regulatory Commission (NRC) in 1996. The current cleanup level for nitrate of 30 mg/L is a background value selected by EPA in 1988. None of these changes are believed to affect the current protectiveness of the remedy since there is no evidence of exposure to the contaminated ground water. Further, the standards for TDS (1,000 mg/L), sulfate (600 mg/L), and nitrate (10 mg/L) are well below the background values of 3,170 mg/L, 2,160 mg/L and 30 mg/L respectively, indicating that beneficial use of ground water from the Site aquifers would require some type of treatment. With these changes in state and federal standards and health-based criteria (PRGs) for several of the contaminants and the potential need to revise cleanup levels to reflect such changes, the background levels for each contaminant with a new (lower) standard or health-based criterion needs to be estimated to determine whether or not they exceeds such standards or criteria. It is generally EPA's policy to clean up site contamination in ground water to background levels if they are above the standards or health-based criteria.

Changes in Risk Assessment Methods

The human health risk assessment method and results for the Site are detailed in the Public Health Assessment Portion of the Remedial Investigation and Feasibility Study report (CH2M Hill, 1988). There are no significant changes to the exposure assumptions outlined in the risk assessment. The exposure parameters used were standard default EPA values and are considered valid and appropriate. However, there have been changes in the EPA's risk assessment approach for radionuclides since 1988. A screening level reassessment of risk is being performed as part of the ongoing SWSFS.

Changes in Exposure

The surrounding lands are sparsely populated and include the Navajo Reservation, Tribal Trust and Indian Allotment lands, and UNC-owned property. The primary land use near the Site is grazing for sheep, cattle, and horses. Land use has not changed since issuance of the ROD. However, it is noted that Hydro Resources Inc. (HRI) has received approval from the NRC for an in-situ leach (ISL) mining project to be located in Sections 8 and 17, approximately three or four miles south of the Site and intends to commence ISL mining once it receives an Underground Injection Control (UIC) permit. It is also noted that the Fort Defense Housing Corporation, in conjunction with the U.S. Department of Housing and Urban Development and the Navajo Housing Authority, is planning to develop a 1,000-unit housing complex in the vicinity of Springstead (seven miles to the southwest of the Site). Lastly, it is noted that the Navajo Nation is building its first casino in the Church Rock Chapter, which may significantly influence future land and resource use.

The Tailing Disposal Site will ultimately be turned over to the U.S. Department of Energy for long-term care and monitoring. No changes in exposure or water use are therefore expected.

Significant Finding:

The information on human health in this memo indicates that the cleanup levels do not meet all of the current state/federal standards and health-based criteria for some of the contaminants at the Site. However, the selected remedy is currently protective since there is no known exposure to the contaminated ground water. The protectiveness of the remedy in the long-term is uncertain.

ENVIRONMENTAL HEALTH (ECOLOGICAL ASSESSMENT)

The EPA believes that there is no endangerment to the environment presented by the Site, since the contaminated medium at the Site which is addressed by the EPA's CERCLA remedy is ground water and no known ecological receptors are exposed to the contaminants. Under the 1988 Memorandum of Understanding between EPA and the NRC, EPA is responsible for cleaning up the ground water contamination (tailing seepage) outside of the Tailings Disposal Site, while the NRC is responsible for surface reclamation and closure of the uranium mill and Tailings Disposal Site and active seepage remediation required inside the Tailing Disposal Site under the Uranium Mill Tailings Radiation Control Act (UMTRCA). The EPA believes that the NRC has followed proper remediation procedures under UMTRCA and its regulations and guidance.

Significant Finding

The EPA remedy is considered protective of the environment.

Table 1: Chemical Specific Standards for Groundwater.

Contaminant	Media	Current Remediation Goal[1] (source)	Current Standard (source)
Aluminum	groundwater	5.0 mg/L (NMWQA)	5.0 mg/L (NMWQCC), for irrigation use
Antimony	groundwater	0.014 mg/L (health-based)	**0.006 mg/L (MCL), 0.015 mg/L (USEPA Region IX PRG)**
Arsenic	groundwater	0.05 mg/L (MCL)	**0.010 mg/L (MCL)**
Barium	groundwater	1.0 mg/L (MCL)	**2 mg/L (MCL),** 1.0 mg/L (NMWQCC)
Beryllium	groundwater	0.017 mg/L (Health-based)	**0.004 mg/L (MCL)**
Cadmium	groundwater	0.01 mg/L (MCL, NMWQA)	**0.005 mg/L (MCL),** 0.01 mg/L (NMWQCC)
Chromium	groundwater	0.05 mg/L (MCL)	**0.1 mg/L (MCL),** 0.05 mg/L (NMWQCC)
Cobalt	groundwater	0.05 mg/L (NMWQA)	0.05 mg/L (NMWQCC), for irrigation use
Copper	groundwater	1.0 mg/L (NMWQA)	**1.3 mg/L (MCL)** , 1.0 mg/L (NMWQCC)
Iron	groundwater	5.5 mg/L (background)	1.0 mg/L (NMWQCC)
Lead	groundwater	0.05 mg/L (MCL)	**0.015 mg/L (MCL),** 0.05 mg/L (NMWQCC)
Manganese	groundwater	2.6 mg/L (background)	0.2 mg/L (NMWQCC)
Mercury	groundwater	0.002 mg/L (MCL)	0.002 mg/L (MCL)
Molybdenum	groundwater	1.0 mg/L (NMWQA)	1.0 mg/L (NMWQCC), for irrigation use
Nickel	groundwater	0.2 mg/L (NMWQA)	0.2 mg/L (NMWQCC), for irrigation use
Selenium	groundwater	0.01 mg/L (NMWQA)	**0.05 (MCL), 0.05 mg/L (NMWQCC)**
Silver	groundwater	0.05 mg/L (MCL)	0.05 mg/L (NMWQCC)
Thallium	groundwater	0.014 mg/L (health-based)	**0.002 mg/L (MCL)**
Vanadium	groundwater	0.7 mg/L (health-based)	**0.036 mg/L (USEPA Region IX PRG)**

Contaminant	Media	Current Remediation Goal[1] (source)	Current Standard (source)
Zinc	groundwater	10.0 mg/L (NMWQA)	10.0 mg/L (NMWQCC)
Chloride	groundwater	250.0 mg/L (NMWQA)	250.0 mg/L (NMWQCC)
Sulfate	groundwater	2160.0 mg/L (background)	600.0 mg/L (NMWQCC)
Nitrate	groundwater	30.0 mg/L (background)	10 mg/L (MCL), 190 mg/L (1996 background value)
TDS	groundwater	3170 mg/L (background)	1000.0 mg/L (NMWQCC)
Ra-226-228	groundwater	5 pCi/L (MCL)	5 pCi/L (MCL), **30 pCi/L (NMWQCC)**
Uranium	groundwater	5 mg/L (NMWQA)	**0.03 mg/L (MCL), 0.03 mg/L (NMWQCC)**
Thorium-230	groundwater	15 pCi/L (MCL)	As gross alpha, 15 pCi/L (MCL)
Gross Alpha	groundwater	15 pCi/L (MCL)	15 pCi/L (MCL)

MCL =Maximum Contaminant Level
Mg/L = Milligrams per liter
NMWQA = New Mexico Water Quality Act
NMWQA = New Mexico Water Control Commission

Pci.L = Pico curies per liter
PRG = Preliminary Remediation Goal for tapwater
[1] USEPA Superfund Record of Decision, EPA/ROD/RO6-88/044, based on New Mexico Water Quality Control Commission Regulation standard
2 http://www.epa.gov/safewater/contaminants/index.html#listmcl
Bold values indicate a change from the ROD value.

Applicable or Relevant and Appropriate Requirements (ARARs)

Applicable or relevant and appropriate requirements (ARARs) are those federal standards, standards of control, and other environmental requirements, criteria or limitations and state standards that are more stringent than federal requirements that have been promulgated and are of general applicability. In the case of the Site, the ARARs selected by EPA in the 1988 ROD are the federal SDWA MCLs, the NMWQA ground-water standards if above estimated background water quality. The more recent promulgated state and federal standards are being reviewed as part of the ongoing SWSFS to determine whether any change to the existing ARARs, as cleanup levels, is warranted.

To-Be-Considered (TBC) Material

More recent toxicity data has led to the development of new PRGs for several of the contaminants of concern. The new PRGs need to be considered as new TBCs for cleanup levels to ensure protectiveness of the remedy. Additionally, background water quality needs to be reassessed to determine whether estimated background levels for contaminants are above the new PRGs or MCLs. If the estimated background levels are above the new PRGs or MCLs, then consideration of such background levels as revised cleanup levels for the Site will be warranted. The reassessment of background water quality is being performed as part of the ongoing SWSFS.

Documents reviewed in the preparation of this Section

H2MHill, 1988. Draft Final Remedial Investigation, United Nuclear Corporation Church Rock ite, EPA No. 124-6L15, Volumes 1 and 2, August.

SEPA, 1988. Superfund Record of Decision, United Nuclear Corp., EPA ID: NMD030443303, OU 01, Church Rock, NM, EPA/ROD/R06-88/044