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Mr. Keith I. McConnell, Deputy Director
Decommissioning and Uranium Recovery Licensing Directorate
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission
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Mr. Mark D. Purcell
Remedial Project Manager
Superfund Division
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Re: Executive Summary
2009 Groundwater Corrective Action Annual Review Report
Materials License No. SUA-1475
United Nuclear Corporation's Church Rock Tailings Site, Gallup, New Mexico

Dear Messrs. McConnell and Purcell:

On behalf of United Nuclear Corporation (UNC), Chester Engineers has prepared this annual performance review of the groundwater corrective action at UNC's Church Rock Mill and Tailings Site near Gallup, New Mexico, pursuant to License Condition 30C. This report is for the 2009 operating year and represents the period from October 2008 through October 2009. This cover letter serves as an Executive Summary of the report.

This report focuses on both active remediation and the groundwater performance of the natural geochemical systems without active remediation. As indicated in the U.S. Environmental Protection Agency's (EPA's) *First Five-Year Review Report* (EPA, 1998) and by the approvals to decommission or temporarily shut off the former pumping systems, the agencies recognized that those corrective action pumping systems had reached the limit of their effectiveness. EPA (1988b) recommended that Technical Impracticability (TI) Waivers, Alternate Concentration Limits (ACLs), and Monitored Natural Attenuation (MNA) be used to complete the corrective action program. Those Record of Decision (ROD) recommendations continue to be timely.

Active Remediation in Zone 3

The Zone 3 extraction system was shut down in June 2000 for maintenance and repairs. Prior to the Zone 3 system being brought back on-line, the agencies agreed that the existing system should be decommissioned (NRC, December 29, 2000 License Amendment). This decision included a provision for UNC to submit a modified corrective action plan, an application for ACLs, or an alternative to the specific requirements of 10 CFR Part 40, Appendix A, if the License standards are not achievable. During 2006 UNC completed an extended pilot investigation to evaluate the suitability of hydrofracturing to enhance the extraction potential within the impacted area of this hydrostratigraphic unit (MACTEC, 2006). The hydrofracture study indicated that the new pumping configuration had achieved nearly complete capture of the northward-advancing impacted water, while causing a notable improvement in the water quality within the northern tracking wells. For these reasons, pumping in this part of Zone 3 continued during 2009 (discussed in Section 3 of this report).

Subsequent analyses indicated that the improvement of water quality in northern tracking wells was temporary and that there was a need for additional extraction wells to enhance groundwater capture. A new extraction well (RW A) was installed and started pumping on September 24, 2007. Based on UNC's hydrogeologic analysis and recommendations for the design of a new pumping system to intercept and recover impacted water (N.A. Water Systems, 2008c), five new extraction wells (the NW-series) were installed during September 2008. During February 2009, these extraction wells started pumping in the northernmost part of Zone 3. The pumping regime for these wells was re-optimized during November 2009 (Chester Engineers, 2009c). Pumping of all Zone 3 extraction wells removed almost 10 million gallons from 2005 through 2009. The pumped water is conveyed to an evaporation pond overlying part of the South Cell.

This annual evaluation of the Site corrective action reaches the following conclusions and recommendations.

Conclusions

- *There are no exceedances of hazardous constituents outside the UNC property within seepage-impacted groundwater – this is the case for all three hydrostratigraphic units.*
- *Groundwater qualilty is in full compliance with the NRC groundwater protection standards in the Southwest Alluvium.*
- *If NRC approves UNC's Zone 1 ACL application (N.A. Water Systems, 2008h), then groundwater quality will be in full compliance with the NRC groundwater protection standards in Zone 1.*
- Groundwater levels in the Southwest Alluvium continued to decline in 2009, indicating that the artificially-recharged zone of saturation continues to become naturally dewatered as the

groundwater drains down the arroyo. However, groundwater to the north of the Nickpoint apparently has become ponded and is no longer flowing to the southwest.

- Hydraulic containment is not a necessary feature of the corrective action program in the Southwest Alluvium because of the geochemical attenuation that occurs naturally.
- Evaluation and prediction of constituent concentrations in the Southwest Alluvium is predicated on understanding the geochemical evolution of both the background water quality and later changes associated with passage of the seepage-impact front. Hazardous constituents derived from seepage impact continue to be attenuated.
- Sulfate, total dissolved solids (TDS), and manganese are non-hazardous constituents that exceed standards outside the Site boundary in both seepage-impacted and background (post-mining/pre-tailings) wells. Ahead of the current seepage-impact front in the Southwest Alluvium, downgradient background well SBL 1 has shown the highest sulfate and TDS concentrations and exceedances of manganese, cobalt, and nickel. Similarly, background waters in the other two hydrostratigraphic units also have shown exceedances of Site standards. For example, in Zone 3, Well NBL 1 has shown background exceedances of arsenic, cobalt, molybdenum, nickel, and combined radium. In Zone 1, Well EPA 4 has shown background exceedances of sulfate, manganese, combined radium, and lead-210.
- The upward trend in TDS at Well GW 2 can be explained by either declining saturation levels and/or continued dissolution of alluvium mineral salts (NRC, 1996). Heterogeneous distribution of the soluble alluvium minerals very likely affects the inter-well variations in concentrations of common dissolved ions.
- Concentrations of uranium in the Southwest Alluvium are an indicator that natural attenuation is at least as effective a remedy as pumping. With the exception of POC Well GW 3, uranium concentrations and concentration time trends have either stabilized (e.g., Wells GW 1 and GW 2) or shown decreasing trends (e.g., Well 802) since the pumps were turned off. The gradual increasing trend of concentrations at GW 3 post-dates, for the most part, the shutoff. However, this does not necessarily indicate a causal relationship. For example, nearby Southwest Alluvium Wells GW 1 and GW 2 have exhibited different concentration changes over the same time-frame. It is not clear what physical or chemical mechanism stemming from the shutoff could account for changes so heterogeneous in degree and timing over a relatively small downgradient area. Many Southwest Alluvium wells have shown that variously gradual to steep uptrends and downtrends in uranium are typical, whether they occur during pumping or in the absence of pumping.
- Uranium concentrations in the Southwest Alluvium are not related to the migration of uranium in tailings fluids. In fact, tailings solutions are far more depleted in uranium than are background solutions. This is an important consideration for the Site-Wide Supplemental

Feasibility Study (SWSFS, in preparation by UNC) because it means the following: (1) uranium in tailings-impacted water is not degrading the water quality, and (2) there is no further improvement in alluvial water quality that can be made with respect to uranium concentrations. The range of uranium concentrations in the background water has been empirically shown to be the same as the range within impacted water (GE, 2006). Uranium and bicarbonate concentrations are usually covariant in the Southwest Alluvium groundwater, i.e., when the concentration of the bicarbonate parameter changes, uranium changes with it provided that there is uranium available for dissolution or desorption in the sediments. This observation has held for both the 11 years of active pumping and the 8.7 years of post-pumping monitoring, and is theoretically expected based on principles of aqueous chemistry.

- At downgradient Well 624 the increase in bicarbonate to a chart plateau starting in May 2000 is attributed to the migration of the bicarbonate "front" associated with tailings seepage impact. However, this well shows no covariance between the bicarbonate and uranium concentrations. At least two interpretations are possible: (1) at this well location there is little to no adsorbed or precipitated uranium (i.e., solid phase) within the alluvial sediments; and (2) aqueous uranium that originated from upgradient tailings seepage impact has been strongly attenuated during transport and it has not reached this location.

- *Both the Southwest Alluvium and Zone 1 natural systems are at least as effective as the former active remediation systems in attenuating the seepage-impacted water.* Acidic seepage is being neutralized, resulting in attenuation of metals and radionuclides. Natural geochemical conditions related to gypsum equilibrium and bicarbonate availability will control sulfate and manganese concentrations in both hydrostratigraphic units, regardless of whether or not the extraction wells are operated.

- Groundwater quality along the northern tracking wells in Zone 3 has been oscillating between degrading and improving trends over the last seven years. Individual well water-quality trends of improvement and degradation have become collectively asynchronous since May 2007, which approximately coincides with an increase in the size and rapidity of water-quality oscillations. The variations in water quality indicate that there have been local and variable degrees of mixing of impacted water with background water drawn in from the west. This is interpreted to have been a consequence of the designed actions of extraction wells upgradient and, since February 2009, downgradient of the northern tracking wells.

- During October and November 2009, Zone 3 northern background Well NBL 2 was subjected to injection testing, in order to determine the amount of water that non-impacted areas might accept. The results of this testing were reported in Chester Engineers (2009d), which included a proposal to install a new array of injection wells (with alkalinity-amended injection water) between the NW-series wells and the northern property boundary.

- The degree and extent of seepage impact in Zone 1 is diminishing. Outside the UNC property boundary in Zone 1, the post-pumping groundwater quality continues to improve overall (Tables 17 and 18). The exceedances of sulfate and TDS in Wells EPA 5 and EPA 7 reflect geochemical equilibrium of the groundwater with gypsum; these constituents are non-hazardous.
- In Zone 1, the continuing improvement in offsite water quality, combined with the stability of onsite concentrations, leads to the conclusion that the Zone 1 groundwater corrective action program has achieved success. However, closure requires meeting the Site standards, which will require that ACLs be established for POC Wells 604 (aluminum, manganese, and nickel) and 614 (TTHMs and chloride). UNC has submitted an ACL application to NRC requesting revised groundwater protection standards for nickel in Well 604 and TTHMs in Well 614 (NRC's License does not have standards for aluminum, manganese, or chloride).
- *The screened and assembled remedial alternatives for the Site have been presented in the Revised SWSFS Part II (Chester Engineers, 2009b). The proposed Site remedy has been presented for the operable unit, while incorporating key factors for each of the three hydrostratigraphic units. UNC believes that the main requirements for achieving closure of corrective action are largely administrative in nature for the Southwest Alluvium and Zone 1. Zone 3 continues to be the focus of active Site remediation.*

Recommendations

Southwest Alluvium

Predicted performance of the Southwest Alluvium natural attenuation system is summarized on Table 6. The continuing assessment of natural attenuation in this annual report is the basis for the following recommendations for the Southwest Alluvium corrective action system:

1. Decommission the offline pumping wells. Attenuation via natural geochemical processes has been shown to be at least as effective as pumping. Implement a No Further Action remedial alternative.
2. Change performance monitoring from quarterly to an annual basis because the seepage-impacted water quality is largely stable, the offsite impacted water quality is not hazardous, and a yearly frequency is sufficient for tracking the migration of the seepage-impact front (estimated to be moving southwestward toward Well SBL 1 at an average rate of 22 ft per year).
3. EPA should consider adopting the revised NRC standards for chloroform (revised to a TTHMs Site-wide standard of 80 ug/L) and combined radium (revised to 5.2 pCi/L standard for the Southwest Alluvium). EPA should also consider (a) revising their current ROD uranium standard of 5 mg/L and adopting the NRC site-wide standard of 0.3 mg/L (based on

the review of dissolved uranium occurrences in the Southwest Alluvium presented by UNC (GE, 2006)), and (b) adopting the NRC (1996) standard for nitrate (throughout all three Site hydrostratigraphic units). Sulfate, TDS and manganese should be waived as constituents of concern based on NRC's (1996) background water quality analysis report and multiple reports by UNC (all of which are summarized in the Revised SWSFS Part I; N.A. Water Systems, 2007b).

4. The Southwest Alluvium is in full compliance with the NRC groundwater protection standards. EPA's longstanding reluctance to issue a TI Waiver for sulfate and TDS is confusing because there are no known groundwater analyses anywhere in the Southwest Alluvium, seepage-impacted or not, that meet the New Mexico Standards for sulfate and TDS. In lieu of eliminating sulfate and TDS concentrations as ARARs, a TI Waiver for sulfate and TDS could best be applied in a non-traditional sense in that there would not be a classic TI zone. Instead, UNC proposes that the projected 200-year seepage front (as extrapolated during 2004) be used, which we understand to be compatible with NRC guidance. Background water quality has shown modest exceedances of manganese, cobalt, and nickel; it is appropriate that the EPA consider revising the ROD to recognize the historic background water quality for these constituents in the Southwest Alluvium. We now have available statistically derived background concentrations for all constituents (data permitting) in all three hydrostratigraphic zones (N.A. Water Systems, 2008f).

5. It has been long established that there is no method to achieve the standards for sulfate, TDS and manganese -- short of dewatering the alluvium. The last drop of water left in the alluvium would exceed the standards for these parameters. *UNC once again respectfully requests that EPA approve a TI Waiver for sulfate and TDS to the extrapolated, downgradient impact zone in the year 2204 shown in Figure 58.* The ongoing development of a SWSFS will formally evaluate and prioritize the most appropriate remedial course of action; however, the main actions required to meet closure are administrative.

Zone 3

1. Continue Zone 3 remediation using the natural system to improve the seepage impacts, in conjunction with the current pumping system that intercepts and removes seepage-impacted water.

2. UNC has recently proposed (Chester Engineers, 2009d) the installation of an array of injection wells in northern Zone 3 between the NW-series wells and the northern property boundary. Alkalinity-amended injection water will serve two purposes: to neutralize impacted groundwater, and to provide a hydraulic barrier to the northward advance of the impacted water. Some of the alkalinity-amended water will flow to the south toward extraction by the NW-series of wells, while some of the alkalinity-amended water will flow

to the north onto Navajo land. The proposed injection array will lead to a mixing zone of impacted and non-impacted, amended waters along the NW-series wells. Non-impacted background water may also be drawn in locally from the west.

The proposed plan intends to neutralize and geochemically stabilize the impacted water; continue to extract impacted water flowing from the south; and to impede northward advance of the impacted water. UNC recommends that the agencies approve the proposed injection well installation, and that this program be implemented as soon as practicable.

3. Declining yields from the current extraction-well array indicate that hydraulic control is temporary. This has always been the case for pumping in Zone 3. Zone 3 saturated thicknesses are quite low, and any future pumping to reduce the pressure head will obtain only limited short-term results. UNC recommends that consideration be given to other regulatory tools to manage the inherent physical limitations to the Zone 3 bedrock-groundwater system. As with Zone 1 and the Southwest Alluvium, the tools might include: ACLs, TI Waivers, monitored natural attenuation, and institutional controls (ICs).

4. EPA should consider revision of the ROD background concentrations for the following metals in Zone 3: arsenic, molybdenum, nickel, cobalt and manganese. Uranium should also be addressed unless EPA adopts the NRC standard for uranium.

5. Sulfate, TDS and manganese should be waived as constituents of concern based on NRC's (1996) background water quality analysis report.

Zone 1

Predicted performance of the Zone 1 natural attenuation system is summarized on Table 18. Implement the following recommendations toward closure of the Zone 1 corrective action system:

1. EPA should consider adopting the current NRC Site-wide groundwater protection standard of 80 ug/L for TTHMs. This value is the current MCL.

2. EPA should consider adopting the current NRC standard of 9.4 pCi/L for combined radium in Zone 1. This value is based on background water quality statistical analysis that was done for NRC in 2006 (N.A. Water Systems, 2006a), as part of an approved License amendment.

3. The Zone 1 seepage-impacted area has attained as-low-as-reasonably-achievable (ALARA) goals. Toward completing the corrective action program for Zone 1 UNC has recently submitted to NRC an ACL application for nickel in POC Well 604 and TTHMs in POC Well 614.

4. As first put forth by the NRC (1996), and further developed in several geochemistry (Earth Tech, 2000c) and annual reports (Earth Tech, 2000e; N.A. Water Systems, 2004, 2005b),

there is no method to achieve the standards for sulfate and TDS, and Zone 1 has already been dewatered to the extent that is feasible (all pumping wells were decommissioned in 1999 because their yields were less than the decommissioning limit). *It is not appropriate to tie remediation progress to sulfate or TDS concentrations. Even the last drop of water left in Sections 1 and 2 of Zone 1 would exceed the standards for these parameters. EPA should approve a TI Waiver for sulfate and TDS in the TI zone shown in Figure 58. Remedial alternatives to be presented in the pending SWSFS should be closely coordinated with the necessary TI Waiver(s), ACL applications, and other potentially appropriate changes in Site remediation standards, or, ICs (EPA, 2008b).*

Please contact Mr. Roy Blickwedel (General Electric Corporation) at (610) 992-7935 if you have any questions or need additional information.

Sincerely,

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Project Manager

MDJ: 09-6209-SC-93

Enclosures (2 hard and 2 pdf copies for each addressee)

cc with enclosure: Yolande Norman, Nuclear Regulatory Commission (2 copies)
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