Designated Original

# Rio Algom

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Mr. Joseph J. Holonich,
Deputy Director
U.S. Nuclear Regulatory Commission
Division of Fuel Cycle Safety & Safeguards
Office of Nuclear Material Safety & Safeguards
M/S T-8F42
Washington DC 20555-0001

Dear Mr. Holonich:

I have set forth in the attached paper an historical overview of the groundwater remedial program at our Ambrosia Lake, New Mexico site, leading to our Alternative Concentration Limits application in 2000, and the NRC review and Rio Algom response process which followed that.

The attached paper also sets out the six issues raised by the Center for Nuclear Waste Regulatory Analysis in March 2004, which were discussed during our meetings, along with our responses. On issue number 3, reference is made to a meeting summary by Ms. Caverly in her letter to Rio Algom dated July 12, 2004.

I apologize for the size of the attached paper. However, I think it is of value to set out the very lengthy process that Rio Algom has been through in trying to bring this groundwater remediation issue to a close.

Thank you very much for meeting with us on June 30, and I look forward to responding to any questions you may have in this matter.

Sincerely,

Bruce A. Law

BAL:kb
Attachment

cc: Mr. Gary Janosko, w/attachment
Ms. Jill Caverly, w/attachment

bhpbilliton

**Historical Overview of Ambrosia Lake Groundwater Remedial Program and Outcomes of Meetings with NRC Technical Staff and Management on June 30, 2004**

Representatives from Rio Algom attended two meetings at the NRC's Rockville, Maryland offices on June 30, 2004: (1) a "technical" meeting with NRC Staff and, via telephone, NRC's consultants, the Center for Nuclear Waste Regulatory Analyses (the "Center"), and (2) with a management meeting with NRC Staff and NRC management. The purpose of these meetings was to resolve the outstanding issues raised by the Center in its March, 2004 report regarding Rio Algom's proposed ACL's for its Ambrosia Lake, New Mexico facility. Currently, Rio Algom is pursuing an aggressive closure program at the site, and the resolution of the ACL application is required to discontinue the NRC-approved groundwater corrective action program (GWCAP), a critical path to significant closure objectives.

## I. Historical Overview[1]

Rio Algom began uranium recovery activities at the Ambrosia Lake site in 1957. Three unlined evaporation ponds were put into service that year, and the main tailings disposal facility made up of Tailings Impoundments 1 and 2 and unlined Tailings Pond 3 was first used in 1958. An additional two unlined evaporation ponds on the west side of the site began service in 1961. Two more unlined ponds began service in 1976, the same year that a bypass channel was constructed to divert mine water discharge out of the natural channel of the Arroyo del Puerto. A state-mandated remedial program initiated in 1983 led to removal of the unlined ponds from service and construction of Interceptor Trench 1 on the eastern side of Tailings Impoundment 1 and Pond 3. These actions were intended to prevent contamination of the alluvium by seepage from evaporation ponds and the tailings facility.

NRC groundwater protection jurisdiction began in **1986** with a monitoring program for the alluvial materials and three bedrock units: the Tres Hermanos B Sandstone Unit (TRB), Tres Hermanos A Sandstone Unit (TRA), and the Dakota Sandstone Unit. A proposed GWCAP was accepted by NRC in **1989**, defining monitoring wells to be used as points of compliance (POCs), determining background definitions, and establishing groundwater protection standards. For all units, the GWCAP incorporated previously established measures such as retirement of unlined ponds and construction of interceptor trenches and the arroyo bypass channel. For the bedrock units, the GWCAP also included pumping water from uranium mine shafts and ventilation holes north of the tailings facility, providing draw-down and dilution of facility-derived waters, and limiting the thickness of saturated zones within the sandstone units. For the alluvial materials, the GWCAP includes discharge of treated mine water (from the bedrock corrective action) into the bypass channel which, in conjunction with Interceptor Trench 1, created a "groundwater sweep" in the direction of the trench to capture constituents of concern (COCs) leaching from the tailings facility.

In **1990**, NRC approved Rio Algom's license amendment allowing Rio Algom to install a complex water balance system to address potential contamination from uranium recovery activities (i.e., 11e.(2) byproduct material) in deep bedrock units and alluvial materials. Thus, Rio Algom has maintained a state-mandated GWCAP for the Ambrosia Lake site for

[1] For further discussion regarding this Section, *please see* Center for Nuclear Waste Regulatory Analyses, *Draft Evaluation of Alternate Concentration Limit Applications, Rio Algom Mining LLC Mill Facility, Ambrosia Lake, New Mexico* (June, 2003).

the alluvium since **1978** and an NRC-approved GWCAP for both the alluvium and the bedrock units since **1990**.

In early **1992**, NRC's Uranium Recovery Field Office (URFO) raised questions about the propriety of using treated minewater, which presumably contained some 11e.(2) byproduct materials from tailings seepage, in the GWCAP for the alluvium. Rio Algom responded by providing data demonstrating that the level of any contaminants from tailings seepage to the bedrock units reaching the mine sumps was insignificant compared to the quality and quantity of the treated minewater discharged into the surface water-course. After conducting a review of the site conditions and data provided by Rio Algom, on **November 4, 1992**, URFO issued a decision stating that the tailings seepage collected from the bedrock units in the treated minewater stream was negligible and that the Ambrosia Lake site was in compliance with 10 CFR Part 40 requirements and Appendix A Criteria. Virtually the same issue was raised again during a site inspection in **1998**, wherein the NRC inspector questioned if 11e.(2) byproduct material was being discharged into the Arroyo del Puerto in violation of 10 CFR Part 20 effluent limits. In response, Rio Algom contacted NRC headquarters and Region IV and provided data showing that the discharges were treated minewater. NRC Staff again agreed.

Since **1992**, no new threat or hazard has appeared or been identified at the Ambrosia Lake site. Since the GWCAPs were started, reduction in the levels of COCs has reached an asymptotic decline. As a result, since the initial ACL petition was submitted over 4 years ago in **2000**, there has been no meaningful reduction in COCs as a result of the ongoing corrective action.

Since groundwater protection standards for COCs in the four protected aquifers were not achievable under the GWCAPs, ACLs were deemed to be necessary. In **February 2000**, Rio Algom submitted an ACL application for the bedrock units to NRC. More than a year passed with no NRC review of that ACL application. In **May 2001**, Rio Algom submitted an ACL application for the alluvial materials that overlie the bedrock units to NRC for review and approval.

For the alluvial materials, ACLs were requested for eight (8) constituents. The proposed alluvial ACLs, as revised, were derived from a background analysis that attempted to account for non-licensed activities and off-site contaminant sources beyond the licensee's control. Rio Algom asserted that all proposed ACLs were as low as reasonably achievable (ALARA) and proposed POEs for each unit at the long-term surveillance and institutional control boundary of the site.

In **July 2001**, Rio Algom was notified that the Alluvial ACL application had undergone initial acceptance review and data gaps were identified. Rio Algom prepared a response document for submittal within a week of the receipt of the acceptance review. On **October 30, 2002**, NRC informed Rio Algom that the Southwest Research Institute, Center for Nuclear Waste Regulatory Analysis (CNWRA) staff had begun familiarization with the submitted documents. At a **November 5, 2002** site meeting, CNWRA was provided a site tour, and Rio Algom was to await a formal RAI before further progress was to be expected. In **January 2003** Rio Algom received an extensive formal RAI that required additional analysis and modeling, and the RAI response was submitted in **April 2003**.

In **June of 2003**, the Center released its *Draft Evaluation of Alternate Concentration Limit Applications, Rio Algom Mining LLC Mill Facility, Ambrosia Lake, New Mexico.* On **August 12, 2003**, a site visit was held at the Ambrosia Lake Facility between NRC and Rio Algom, and an outcome of that meeting was a tentative agreement on a number of issues that required NRC approval before final approval of the ACL applications. Rio Algom agreed to accept CNWRA staff recommendations on modeling in the alluvium and other concessions in the interest of moving forward. On **August 22, 2003**, NRC sent a letter to Rio Algom confirming agreements on follow-up actions for all parties. On **September 2, 2003**, NRC stated in an email that NRC reviewers would accept a value of 50 as an acceptable and conservative retardation factor for use in modeling attenuation of groundwater constituents in the bedrock units and alluvium. The email also noted that the reviewers believed that Rio Algom's cleanup goals could be met using an even more conservative retardation factor of 20. On **October 16, 2003**, Rio Algom submitted a response to NRC's August 22, 2003, letter proposing that the ACL's for the alluvium should be modeled using a retardation factor of 20. As noted above, in **March of 2004**, the Center raised additional issues which were the subject to the above-noted meetings at NRC Headquarters on June 30, 2004. Rio Algom has demonstrated that the ACLs will be protective of human health and the environment. Rio Algom believes that these issues have been addressed and re-addressed *ad nauseam* and hopes that the responses set out below will allow a final, favorable decision to be made on its proposed ACLs.

## II. Rio Algom's Responses to Specific Findings

Rio Algom is providing responses to each of the findings provided in the Summary of the March 2004 report.

**Finding 1** - *The proposed set of POC and trend wells is acceptable for the alluvial and bedrock aquifers.*

**Response** – Rio Algom agrees with this finding.

**Finding 2** – *Although the retardation factor employed in the alluvial aquifer transport modeling was acceptable, the attenuation factor for setting ACLs in the alluvial aquifer does not consider the high degree of model sensitivity to the simulation period. Given the poorly constrained nature of the alluvial transport modeling as well as the rapid rise in attenuation factor with time at approximately 100 years, we recommend use of an attenuation factor of 0.02.*

**Response** – Rio Algom does not agree that the simulation period contributes an unusually significant amount of uncertainty with respect the development of ACLs using the SOLUTE model because there are multiple layers of conservatism incorporated into the retardation factor used in the model with respect to actual site conditions. Rio Algom has used a retardation factor of 20 for uranium in the alluvium for the development of the proposed ACLs for concentrations of the COCs. This was arrived at as a consequence of the following: Rio Algom initially used a retardation factor of 100, which is believed to provide a high measure of conservatism in the modeling, (i.e. one-third to one quarter of the value EPA publications suggest may be conservative). The Center recommended the use of a retardation factor of 50 for further conservatism, and to further accentuate conservatism, Rio Algom used a retardation factor of 20 for uranium. This is but one of several factors that

allow confidence in the conservative nature of alluvial modeling. The modeling is conservative for the following reasons:

a. U.S. EPA published scientific literature shows that, at pH values above approximately 4.5 and below 7.5-8, Kd's range from 100 to more than 10,000 ml/g . Using the lowest value for the pH range in the alluvium, results in a retardation factor for uranium of 384. This calculation uses the most conservative end of the range of published values for each of the other parameters needed to calculate a retardation factor (bulk density and porosity) and results in a highly conservative estimate of retardation.

b. Rio Algom's modeling used the extremely conservative assumption that the *source* of the COCs will be *constant* throughout the model period. In point of fact, once the surface water discharges are discontinued, the primary source of recharge to the alluvium will disappear, causing water levels to decline dramatically and reducing the system's ability to transport constituents. Indeed, the alluvium essentially will be dry within 65 and 100 years. At the same time, since the tailings pile has been covered in accordance with an NRC approved reclamation plan, the source term from the tailings pile will decline over time as tailings seepage declines, resulting in a further diminished source of contamination, and providing an additional level of conservatism that addresses uncertainty related to the time that the alluvium actually goes dry.

c. Hydrologic modeling that provided the input for the transport model and the prediction that the alluvium will dewater after mine pumping ceases, was calibrated to steady state conditions before transient modeling was employed in making hydrologic predictions. The quantitative methods used to evaluate model calibration included comparison of simulated heads to measured heads at target locations and comparison of simulated groundwater fluxes to measured and estimated fluxes. After each calibration run, the residual at each target node was calculated, the residual being the difference between the measured heads and simulated heads at target nodes. Residual statistics were used as one criterion to judge the degree to which calibration of the model improved through successive runs. Finally, a sensitivity analysis was conducted to identify which parameters most influence model results. The sensitivity analysis also helped to quantify the uncertainty in the calibrated model caused by uncertainty in the estimates of model parameters. The parameters included in the sensitivity analysis included hydraulic conductivity, influx from Tailings Impoundment 1, and the porosity of the alluvium. Rigor in the hydrologic modeling of alluvial material adds additional confidence in transport modeling.

d. The SOLUTE Model describes constituent transport by the processes of advection and dispersion. Reversible sorption processes are simulated by modifying advective and dispersive processes with a retardation factor that reduces the highest concentration seen at any location and slows the velocity of the solute pulse. No credit has been taken for the many *non-reversible* processes that are known to occur in geochemical environments, which are similar to the alluvial material and/or in changes to geochemical conditions that occur along a flowpath in soils under and around western uranium mill tailings facilities. Neutralization of low pH solutions causes many metals to be removed from groundwater by precipitation of a variety of mineral phases, and reductive processes cause pH-sensitive constituents to be removed as oxide minerals (for example, uranium) or sulfide minerals (pyrite, etc.). *See* Nuclear Regulatory Commission, Generic Environmental Impact Statement on Uranium Milling, NUREG-0706, Vol. I (1980). The

decision not to take any credit for these well-known processes adds another layer of conservatism to Rio Algom's alluvial modeling.

e. Finally, to verify the transport model and the conservative factors built-in to the approach, Rio Algom will commit to using the proposed stability monitoring data to assess the predictive results of the model. The stability monitoring program will consist of quarterly sampling of the compliance monitoring wells fro two years, followed by semi-annual sampling until license termination.

**Finding 3** – *An incorrect modeling method, resulting in overestimation of the attenuating capacity (i.e. underestimation of attenuation factor), was used for establishing an attenuation factor for the bedrock aquifers. The licensee should revise the modeling method and propose a new set of ACL's. The retardation factor employed in bedrock modeling is acceptable.*

**Response** – In the technical meeting, Rio Algom agreed to address the modeling issues raised by the Center if there was merit to performing the additional work. The approach discussed in that meeting included the following:

a. It was agreed amongst the attendees at the meeting that a significant geochemical change that is described as a pH change occurs between the actual source (Pond #7 and #8) and the Dakota POC (well 36-06 Kd). The difference of opinion centers on whether the geochemical change between the source and POC, thus, potential impacts at the POC, can/should be limited to a discrete period of 22 years due to the 22 years of unlined pond use, or whether, additional dispersion resulting from the travel distance of 800 feet should extend the timeframe for the active source in model runs. Rio Algom agrees that the potential for additional dispersion over a longer time frame, theoretically, may exist, but does not believe that, given the site-specific conditions and the proposed institutional controls (i.e., distance to the LTSM boundary (i.e., POEs)), that the groundwater concentrations at the POEs will be exceeded using Rio Algom's proposed ACLs.

b. One approach discussed with the Center was to perform the SOLUTE model between the source and the POC. Using the data generated at the POC, Rio Algom would run the SOLUTE model using the accepted retardation factors between the POC and the proposed POE well (36-04 Kd for the Dakota). Rio Algom suggested that, if such modeling were to be performed, rather than using that proposed POE, the POE should be modeled at what will be the actual institutional control boundary (i.e., the true POE).

c. However, Rio Algom is reluctant to undertake this additional modeling, because any potential benefits to the protection of human health or the environment appear to be minimal. The attendees at the meeting agreed to defer this issue to the meeting with NRC management.

d. In discussions with NRC management on June 30, 2004, Rio Algom noted that 36-06 Kd and the other POC wells have been monitored since the ACL application was submitted in early 2000. During that time, significant closure activities occurred at or near the source areas (Ponds 7 and 8) resulting in a minor spike in COCs at the POC well 36-06 Kd, located 800 feet from the source. However, these levels are well below the proposed ACLs (see Figure 1 attached). The spike trended upward for a period of time as expected and, recently, that trend has leveled and is expected to decline. The meeting discussions

were summarized by Ms. Jill Caverly in her letter to Rio Algom dated July 12, 2004 as follows:

"Based on information from Rio Algom regarding the modeling of the bedrock aquifer, Rio Algom, NRC management and NRC staff concluded that the uncertainties noted by the NRC staff can be addressed if Rio Algom can demonstrate that the concentrations at the current Point of Compliance (POC) groundwater well are leveling off. Rio Algom stated that the actual POC concentration for constituents are well below the assumed [modeled] concentration and that the trend in the data showed the concentrations to be leveling off. The NRC agreed that if the data could definitively show that the constituent concentration trend was not upward but flat, then it would consider this result as a conservative parameter when addressing uncertainties with the current model."

e. Figure 1 shows uranium concentrations in POC well 36-06 leveling off after rising over several sampling rounds following source disturbance during remedial activities. Note that while uranium concentrations are leveling off, pH values continue to rise, increasing uranium retardation. Thus, the model using the accepted retardation factor adequately predicts impacts of the geochemical environment on the transport of COCs to the proposed POE in the initial ACLs application, much less the amended POE, which will be 2,700 feet farther away from the POC.

**Finding 4** – *Revised ACL's should not be higher than any previously proposed, because those previous values were assumed to be ALARA.*

**Response** – Rio Algom disagrees with this finding. NRC and Rio Algom agreed during the meeting with NRC management that the ACL's, regardless of concentration, are ALARA if the concentrations at the POE remain protective and the GWCAP has reached the limits of effectiveness and no practical and economic option for incremental improvement exists. Rio Algom has demonstrated these two factors, and in the August 2003 Draft Evaluation prepared by the Center, the assessment of the corrective action resulted in the conclusion that the site conditions are ALARA.

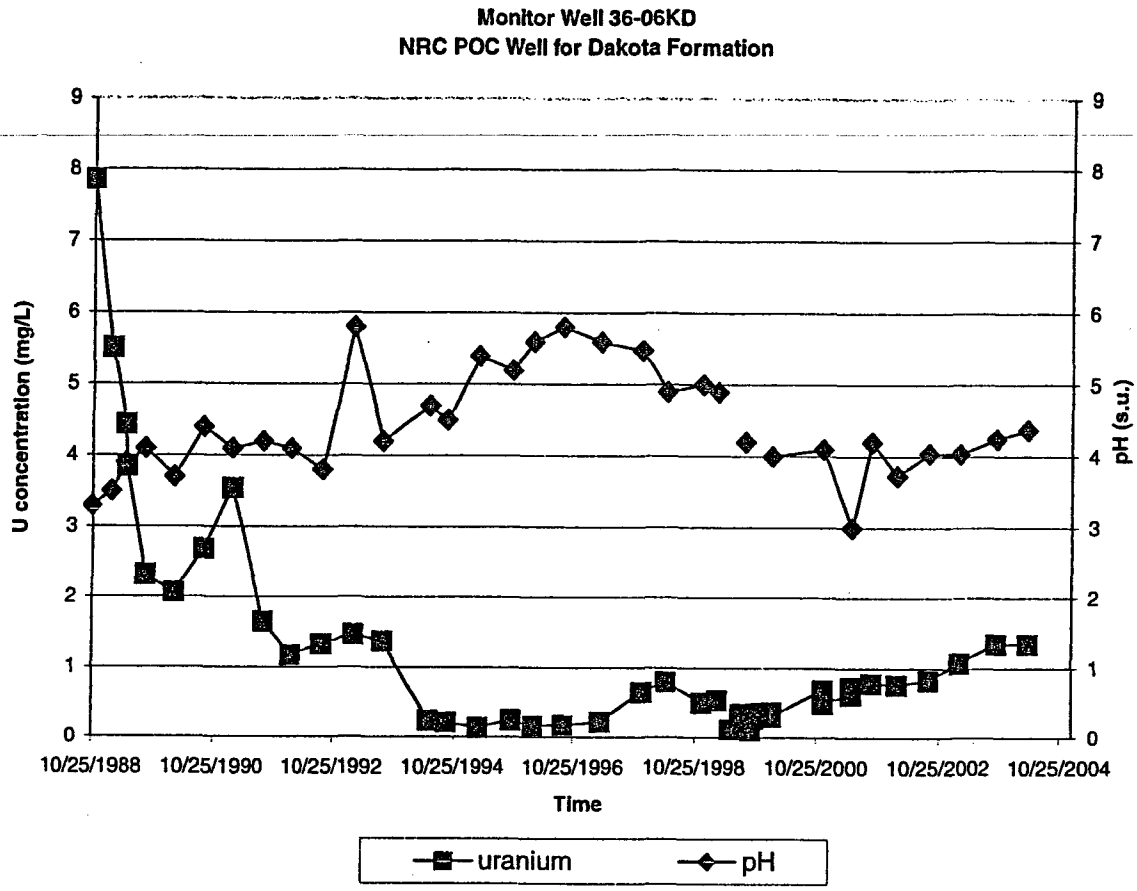
**Finding 5** – *The NRC staff should consider making monitoring schedule decisions based on objective criteria. This approach is particularly important for the alluvial aquifer, because of uncertainty in its flow and attenuation behavior.*

**Response** - Rio Algom agreed to propose a monitoring program that will maintain a quarterly sampling program for two years, followed by semi-annual sampling until license termination, to verify the results of the modeling used to justify the proposed ACLs.

**Finding 6** – *The NRC staff should consider making the lists of analytes for monitoring the same as the current lists in the site license.*

**Response** - Rio Algom agreed to increase the number of constituents included in the monitoring program at the compliance monitoring wells to match those currently monitored under the existing monitoring programs.

Figure 1


Monitor Well 36-06KD
NRC POC Well for Dakota Formation
U concentration (mg/L)
pH (s.u.)
0
1
2
3
4
5
6
7
8
9
10/25/1988
10/25/1990
10/25/1992
10/25/1994
10/25/1996
10/25/1998
10/25/2000
10/25/2002
10/25/2004
Time
uranium
pH