SAFETY EVALUATION REPORT
PROPOSED ALTERNATE ON-SITE DISPOSAL CELL LOCATION
RIO ALGOM MINING CORPORATION, GRANTS, NEW MEXICO

DOCKET NO.:	40-8905
LICENSE NO.:	SUA-1473
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FACILITY:	Rio Algom Ambrosia Lake
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SUMMARY AND CONCLUSIONS

By letter dated April 26, 2010, Rio Algom Mining LLC (Rio Algom), submitted a license amendment request to the U.S. Nuclear Regulatory Commission (NRC) for an alternate disposal cell location at its Ambrosia Lake facility. The proposed alternate disposal cell is located in the former ore processing area; which is west of the existing mill office area and consists of an approximately 35 feet deep excavation. The staff reviewed the geotechnical, surface water hydrology, and radiation protection aspects of the license amendment request and concluded the proposed action is in compliance with the applicable regulations in Appendix A to Part 40 of Title 10 of the Code of Federal Regulations (10 CFR Part 40, Appendix A). Therefore, the staff recommends approving the license amendment request.

BACKGROUND

In July, 1995, Quivira Mining Company, the predecessor to Rio Algom, submitted to the NRC a request to amend License Condition No. 32 for disposal of contaminated byproduct materials in two designated disposal areas. Subsequently, in November 1995, the NRC agreed to the license condition amendment. Disposal Area #2, which is adjacent to the much larger Pond 2 Disposal Cell, is being used for disposal of byproduct material and may reach capacity before demolition and disposal of the remaining mill buildings and material has been completed. The area designated as Disposal Area #1 is now in the Diversion and Discharge Channel north of the Pond 2 Disposal Cell and cannot be used for disposal of byproduct material. The current request is for an alternate disposal cell location.

Rio Algom proposes to use the former ore-storage area west of the existing mill office area as the alternate disposal cell. This location was used for the below grade transfer of ore from the mine haul trucks. The area was excavated into bedrock for the transfer of ore from haul trucks and the start of ore processing. It is approximately 300 feet long by 340 feet wide and 35 feet deep. This area will need to be filled prior to completion of decommissioning activities anyway due to safety reasons, to prevent unauthorized dumping, and to control surface water drainage in the area. The planned closure actions for isolation of the materials is intended to provide: (1) control of radiological hazards for 1,000 years to the extent reasonably achievable; (2) limitation

of the release of radon-222 from uranium by-product, and radon-220 from thorium by-product materials to the atmosphere so as not to exceed an average of 20 pCi/m^2/sec; (3) reduction of direct gamma exposure from the reclaimed tailings cell to background levels; (4) avoidance of proliferation of small waste disposal sites; and (5) a final site that is geotechnically stable and provides protection of water resources for the long term. In undertaking this project, the licensee committed to complying with all applicable Federal and State regulations.

The licensee has indicated that this proposed alternate disposal cell design is one component of the overall site decommissioning plan. The licensee has previously addressed and NRC has approved the remaining site-wide decommissioning plan elements through separate licensing actions, including closure of tailings pond 1 and 2, mill demolition, relocation of lined evaporation pond sediments, soil decommissioning plan, groundwater remediation, and the surface water diversion channel.

REGULATORY REQUIREMENTS

The licensee must demonstrate that the proposed action meets the requirements of Criteria 3, 4, 5, and 6 of 10 CFR Part 40, Appendix A as well as the requirements of 40 CFR 192.32(b)(1)(i).

TECHNICAL REVIEW

This Safety Evaluation Report (SER) describes the NRC staff's review of geotechnical engineering and surface water hydrology issues related to the proposed alternate on-site disposal area. In the April 26, 2010, submittal, Rio Algom provided the following:

- Identification of the byproduct materials proposed for disposal at the alternate location.
- A description of the alternate disposal cell.
- A summary of the proposed action.
- A discussion of geotechnical stability.
- A discussion of surface water protection.
- A discussion of groundwater protection.
- A discussion of radon emanation.
- A discussion of the requirement of the minimum maintenance design.
- An environmental evaluation of the alternate disposal cell.

The remainder of this TER addresses the geotechnical engineering, surface water hydrology and erosion protection, and radon attenuation aspects of the proposed action.

GEOTECHNICAL ENGINEERING

Introduction

The NRC staff has reviewed the geotechnical engineering aspects of the April 26, 2010, submittal. The proposed action by Rio Algom includes the placement of building demolition debris, mill equipment, concrete, wood, and byproduct materials into a proposed alternate disposal cell, the former ore transfer area. A cover system, consisting of a radon/infiltration

barrier, overlain by a frost protection layer and rock erosion protection layers will be installed. The final contours of the disposal area would mimic the natural topography.

This review included an assessment of: (1) information related to the waste disposal site; (2) the characterization of materials associated with reclamation activities, including the cell foundation and excavation materials, the pond sediments and ancillary materials, and other radioactive materials; (3) the design and construction details; and (4) the long-term stability of the waste disposal cell and its cover.

Site and Material Characterization

The proposed alternate disposal cell is located in the northern portion of the site on a topographic ridge formed by the Tres Hermanos C sandstone. The proposed alternate disposal cell was formerly used for the transfer of uranium ore and the start of ore processing. The area is approximately 300 feet by 400 feet with a depth of 35 feet. Mancos Shale is visible at the bottom of the excavated area. Groundwater monitoring well 31-66 was located immediately adjacent to the southwest side of the proposed alternate disposal cell. The boring log for this well indicates approximately 45 feet of Mancos Shale and 35 feet of the Tres Hermanos C sandstone underlie the proposed alternate disposal cell. At the proposed alternate disposal cell location, there is no ground water in the Tres Hermanos C sandstone. Additional discussion of the geology of the Rio Algom site can be found in reclamation plan for tailings cell 2 (Rio Algom, 2007).

As the proposed alternate disposal cell is located on a bedrock outcrop, and the boring log from monitor well 31-66 confirmed the site geology, no additional geotechnical borings or laboratory investigations to determine soil properties were performed. The staff visited the proposed alternate disposal cell on July 13, 2010. During the visit, the staff noted that the conditions present appeared to be consistent with the descriptions provided in the license amendment request (Rio Algom, 2010). The staff notes that Rio Algom plans to use soil from existing on-site borrow sources to construct the radon barrier and frost protection layers of the cover system and for the backfill soils within the disposal area. The engineering properties of these materials have been described in the Tailings Cell 2 Expansion Plan (Rio Algom, 2007).

The materials proposed for disposal at the alternate disposal cell are the same as what is identified in license condition (LC) 32 in Amendment 60 of the Rio Algom license (NRC, 2009). These materials include: building demolition debris, mill equipment, concrete, wood, and byproduct materials. The properties of these materials have been outlined in the submittals dated July 20, 1995, and Rio Algom proposes no changes to the materials for disposal. Since the materials proposed for disposal are dry, the formation immediately underneath the proposed alternative disposal cell is dry (i.e. no ground water) and is further underlain by the Mancos Shale, and the disposal cell will be capped with a low permeable clay, the staff makes a finding that pursuant to the provisions in Criterion 5A(3), an exemption to Criterion 5A(1) of Appendix A to 10 CFR Part 40 is granted. The licensee will not be required to install a liner in the proposed alternate disposal cell.

Rio Algom has described the aspects of the site and the nature of the materials proposed for disposal in the alternate disposal cell. The geotechnical engineering characterization of the site and waste materials is sufficient to support engineering assessments related to waste isolation characteristics, permeability characteristics, and long-term stability of the proposed alternate

disposal cell for controlling radiological hazards. On the basis of the information presented in the amendment request, the NRC staff concludes that the characterization information, along with other information such as the results of design analyses, provides an acceptable basis to enable the staff to make a finding on compliance with applicable criteria of Appendix A to 10 CFR Part 40.

Slope Stability and Liquefaction Potential

Rio Algom provided a final grading plan for the proposed alternate disposal cell in Figure 4 of the April 26, 2010, submittal. The alternate disposal cell was excavated into bedrock and was used as the ore transfer area during the time the mill operated. Rio Algom has proposed filling the excavation and re-establishing the natural topography of the area. The staff reviewed Figure 4 and verified that the disposal is below grade and that the maximum slope of the final cover system is approximately 1.5 percent. This slope meets the requirement in 10 CFR Part 40, Appendix A, Criterion 4(c) which requires cover slopes to be relatively flat and suggests having final slopes of less than 10 percent. The staff notes that the proposed alternate disposal cell is consistent with the "prime option" for below grade disposal identified in 10 CFR Part 40, Appendix A, Criterion 3. The "prime option" is placement below grade so that no special retention structures are needed.

Rio Algom did not perform a static or seismic slope stability analysis for the proposed alternate disposal cell. The licensee cited the below grade disposal options, subgrade conditions, shallow final cover system slope, and lack of groundwater in the Tres Hermanos C sandstone as justification for not performing a stability analysis. The staff visually confirmed the subgrade conditions and geology surrounding the proposed alternate disposal cell location during the July 13, 2010, site visit.

The NRC staff has reviewed the portion of Rio Algom's Environmental Evaluation addressing the potential for liquefaction of the materials placed in the proposed alternate disposal cell. Rio Algom cited the below-grade setting of the proposed alternate disposal cell and lack of groundwater in the Tres Hermanos C sandstone as reasons why liquefaction is not an issue. The staff notes that the materials placed for disposal will be compacted and will not be saturated. Based on the location and conditions at the proposed alternate disposal cell, as well as the nature of the materials planned for disposal, the staff considers Rio Algom's justification to be adequate.

The NRC staff concludes that these aspects of the design provide an acceptable basis to demonstrate compliance with the applicable long-term stability criteria in 10 CFR Part 40, Appendix A. The slopes are in compliance with the requirements of 40 CFR Part 192.32(b)(1)(i) and 10 CFR Part 40, Appendix A, Criterion 6(1), which require that impoundment designs provide reasonable assurance of control of radiological hazards to be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years.

Settlement

The licensee has addressed settlement at the proposed alternate disposal cell. Rio Algom will follow the construction techniques described in the 1995 submittal when placing materials at the alternate disposal cell. These techniques were approved by the NRC under license amendment 33 (NRC, 1995) and were developed to place materials in a compact and tight manner to

minimize development of voids. Minimization of voids within the materials is crucial to avoiding differential settlement. Prior to placement, materials will be dismantled, crushed, or cut open. The materials will then be placed in a flat, horizontal layer. When the layer of materials reaches a thickness of between two and four feet, clean fill will be brought in and spread over the materials. The clean fill placed to a thickness of between 6 and 12 inches and will be compacted prior to the next layer of materials being placed. The staff agrees that this process will minimize the presence of voids, and therefore, minimize the potential for differential settlement.

As the proposed construction techniques have been previously approved by the NRC staff and no changes are proposed, NRC staff concludes that the licensee has acceptably demonstrated compliance with the criteria in 10 CFR Part 40, Appendix A applicable to cover integrity.

Construction Considerations

Rio Algom's submittal does not appear to address quality control aspects of the cover system construction. However, by license condition, Rio Algom will be required to follow the quality assurance program that was described in the Reclamation Plan for the Tailings Cell 2 Expansion (Rio Algom, 2007). The license condition will read as follows:

> The licensee shall follow the quality assurance program outlined in the Reclamation Plan for the Tailings Cell 2 Expansion when placing materials and constructing the final cover in the alternate disposal area.

The staff notes that the quality assurance program for the construction of the Tailings Cell 2 Expansion included the following major components:

- Third party quality assurance;
- Daily field observations to document construction activities and daily progress;
- Appropriate density testing methods and frequency to verify compaction for the waste materials placed, as well as the radon barrier, and frost protection layers; and
- In-situ density testing for the radon barrier and frost protection layers.

As this quality assurance program has already been reviewed and approved by the NRC (NRC, 2007), no additional review or discussion is included in this TER. In the previous review, the staff concluded that Rio Algom demonstrated compliance with 10 CFR Part 40, Appendix A, Criterion 4(c), which provides criteria for long-term stability for the slopes of the tailings impoundment and its cover; and Criterion 6(1), which requires that impoundment designs provide reasonable assurance of control of radiological hazards to be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years.

General Geotechnical Conclusions

The licensee has adequately addressed the aspects required for demonstrating an acceptable plan for the cover system at the proposed alternate disposal cell. From a geotechnical engineering standpoint, Rio Algom has provided an acceptable design, and has demonstrated its compliance with applicable criteria in 10 CFR Part 40, Appendix A. The NRC staff recommends including the following condition addressing quality assurance for the proposed

alternate disposal cell:

> The licensee shall follow the quality assurance program outlined in the Reclamation Plan for the Tailings Cell 2 Expansion when placing materials and constructing the final cover in the alternate disposal area.

SURFACE WATER HYDROLOGY AND EROSION PROTECTION

Introduction

This section of the SER describes the NRC staff review of surface water hydrology and erosion protection issues related to long-term stability of the alternate disposal cell. In this section, the staff provides the technical bases for the acceptability of the licensee's erosion protection design. Review areas that are covered include: estimates of the probable maximum precipitation (PMP); sizing of riprap to be used for erosion protection; long-term durability of the erosion protection; and testing and inspection procedures to be implemented during construction.

Hydrologic Description and Site Conceptual Design

To comply with Criterion 6 of 10 CFR Part 40, Appendix A, which requires stability of the tailings for 1,000 years to the extent reasonably achievable and, in any case, for 200 years, the licensee proposes to dispose of materials in the former ore transfer area. The erosion protection design is based on the PMP for the site, which is considered to have a very low probability of occurring during the 1,000-year stabilization period.

The final grading plan for the alternate disposal cell shows that the site is located along a ridge and has a minimal upstream catchment area. The top surface will be configured to drain in various directions at a slope of between one and two percent. Rio Algom has proposed constructing a layer of rock on top of the frost protection layer to provide protection against erosion. Rio Algom has also proposed constructing a rock apron at the transition between the cover system and the natural ground surface.

Runoff Calculations

The computation of runoff values for the proposed design was performed by the licensee in several steps. These steps included: (1) selection of a design rainfall event; (2) determination of times of concentration; (3) determination of appropriate rainfall distributions and intensities, corresponding to the computed times of concentration; and (4) calculation of runoff.

Selection of Design Rainfall Event

The licensee utilized the PMP value of 9.6 inches, which was used in the design for the Tailings Cell 2 Expansion. The PMP is a site-specific value that has been defined as the most severe reasonably possible rainfall event that could occur as a result of a combination of the most severe meteorological conditions occurring over a watershed. The PMP is considered by the NRC staff to provide an acceptable design basis. As the licensee has proposed using the same PMP that has been previously reviewed and approved by the NRC staff (NRC, 2007), the staff accepts the PMP value of 9.6 inches for the alternate disposal cell.

Infiltration Losses

In computing the peak flow rate for the alternative disposal site, the licensee used the Rational Formula (USBR, 1977). In this formula, the runoff coefficient was assumed to be 1.0; that is, the licensee assumed that all rainfall would runoff the site and no infiltration would occur. The NRC staff concludes that this is an acceptable assumption because it represents a worst case scenario.

Times of Concentration

The time of concentration (t_c) is the amount of time required for runoff to reach the outlet of a drainage basin from the most remote point in that basin. Times of concentration for the riprap design were estimated by the licensee using the Kirpich Method (USBR, 1977). This method is generally accepted in engineering practice and is considered by the staff to be appropriate for estimating times of concentration at this site. The licensee estimated that the t_c for the site is 7.55 minutes. The licensee computed a t_c of 2.75 minutes for the top slope and 4.8 minutes for the run-on area and added these together to identify the t_c for the site. Based on a review of the calculations provided, the staff concludes that the licensee acceptably derived and calculated the t_c values.

Rainfall Intensity

After the PMP is determined, it is necessary to identify the rainfall intensity that corresponds to the time of concentration at the specific site. A typical PMP value is derived for periods of about one hour. If the time of concentration is less than one hour, it is necessary to extrapolate the data presented in the various hydro-meteorological reports to shorter time periods. The licensee developed a rainfall depth-duration curve using guidelines in HMR-55 and calculated the rainfall intensities for the alternate disposal cell to be about 35.85 inches per hour (in/hr). The staff concludes that the licensee used appropriate methodology to compute the rainfall intensity at the alternate disposal cell.

Effects of Off-Site Flooding on Alternate Disposal Cell

The staff evaluated the potential effects of off-site flooding on the alternate disposal cell during the July 13, 2010, site visit. During the site visit, the staff observed that the alternate disposal cell is located on a topographic high, which is expected to minimize the effects of off-site flooding.

Computation of Peak Flow Rate

To estimate runoff from the proposed alternate disposal cell, the licensee used the Rational Method (Chow, 1959). This method is a simple procedure for estimating flood discharges that is recommended in NUREG-1623 (NRC, 2002). In using the Rational Method, the licensee assumed a runoff coefficient equal to 1.0, a drainage area of 0.0184 acres, and an intensity of 35.85 in/hr. Based on these parameters, the licensee estimated the peak flow rates to be approximately 0.66 cubic feet per second per foot of width (cfs/ft).

Based on a review of the calculations, including the time of concentration, rainfall intensity, and runoff coefficient, the staff concludes that the licensee's estimated peak flow rate is acceptable.

Sizing of Erosion Protection

Riprap layers of various sizes and thicknesses are proposed for use at the alternate disposal cell, and the design of each layer is dependent on its location and purpose. To ease construction of the erosion protection layers, the licensee has purposely over-designed the erosion protection layer by selecting larger diameter rock than the calculated value. The proposed alternate disposal cell will be protected by a 3-inch thick rock layer with a D_{50} of 1.0 inch. For the rock apron around the perimeter of the alternate disposal cell, the licensee proposes to use 6-inch layer of rock with a minimum D_{50} of 3.2 inches. The licensee used methods suggested in NUREG-1623 (NRC, 2002) to determine the required rock sizes.

Based on review of the licensee's analyses and the use design methods recommended by the NRC staff, the staff concludes that the proposed rock sizes for the top slopes and rock apron are adequate.

Rock Durability

NRC regulations require that control of residual radioactive materials be effective for up to 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. The previous sections of this SER examined the ability of the erosion protection to withstand flooding events reasonably expected to occur in 1,000 years, as required by Criterion 6 of 10 CFR Part 40, Appendix A. The licensee has committed to using the same rock source and following the same quality control production criteria that were used for the Tailings Disposal Cell #2 cover (Rio Algom, 2007). These procedures include: having trained personnel monitor rock quality at the quarry; avoiding overburden rock and rock with undesirable features; and performing testing and scoring of rock quality every 10,000 cubic yards of material produced. This rock source and quality control criteria have been previously reviewed and approved by the NRC (NRC, 2007).

Surface Water Hydrology and Erosion Protection Conclusions

Based on review of the information submitted by the licensee as discussed above, the NRC staff concludes that the erosion protection design is adequate to provide reasonable assurance of protection for 1,000 years, as required in Criterion 6 of 10 CFR Part 40, Appendix A.

RADIATION PROTECTION AND RADON COVER DESIGN

Design of the Cover

The NRC staff has completed its review of the radiation protection aspects of the proposed cover for the alternate disposal cell. At the alternate disposal cell, Rio Algom has proposed the same cover for that was used for the Pond 2 Disposal Cell expansion. This cover consists of the following components, from top to bottom:

- An erosion protection layer;
- A 12 inch thick layer of frost protection soils;
- An 18 inch thick layer of clay compacted to 90 percent of the Standard Proctor dry density to serve as the radon barrier.

This design will provide a minimum of 2.5 feet of protective cover over the waste materials. The final cover system will have a maximum top slope of approximately 1.5 percent. The proposed cover for the alternate disposal cell is intended to control the release of radon from the materials, promote stormwater runoff, protect the materials from erosion, and protect the radon barrier from freeze-thaw effects.

Rio Algom estimated the weighted average concentrations of Ra-226 and Th-230 of the materials that will be placed in the alternative disposal site and used these concentrations to estimate the total Ra-226 concentration after 1,000 years. The licensee estimated the Ra-226 concentration after 1,000 years to be 185.3 pCi/g; this value includes both the decay of Ra-226 and Ra-226 in growth from Th-230. The staff notes that the projected 1,000 year Ra-226 concentration for the Tailings Cell 2 expansion was estimated to be 307.5 pCi/g (Rio Algom, 2007). As the Ra-226 concentrations for the alternative disposal site are lower than for the Pond 2 Disposal Cell Expansion, use of the same cover system design provides an adequate level of protection.

The NRC has previously approved the use of a 12-inch thick frost protection layer at the Rio Algom site (NRC, 1994). The staff notes that the proposed 12-inch thick frost protection layer, in combination with the rock erosion protection layer will allow the radon barrier to remain below the frost penetration depth. Therefore, the radon barrier will be provided adequate protection from freeze-thaw effects.

Radon Attenuation

The limit for the average long-term release of radon-222 (Rn-222) from uranium byproduct materials to the atmosphere is 20 picocuries per square meter per second (pCi/m^2/s) from the surface of the tailings cell for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years, as stated in Criterion 6(1) of 10 CFR Part 40, Appendix A. Rn-222, the decay product of Ra-226, is a gas, has a short half-life, and decays to a solid particle. The long-term Rn-222 flux rate can be estimated from the physical and radiological characteristics of the contaminated and radon barrier materials using a series of calculations or a computer code. For the Tailings Cell 2 Expansion, the licensee used the RADON computer code to estimate the radon flux from the cell. For the Tailings Cell 2 radon attenuation evaluation, the licensee used a Ra-226 concentration of 307.5 pCi/g at 1,000 years. For the cover system described above, the licensee calculated the radon flux to be 12.9 pCi/m^2/s for Tailings Cell 2 Expansion. As discussed in the previous section, the Ra-226 concentration at 1,000 years for the proposed alternate disposal cell was estimated to be 185.3 pCi/g. The licensee demonstrated compliance with the radon flux criteria using the following justification:

- The Tailings Cell 2 Expansion had a Ra-226 concentration of 307.5 pCi/g and an estimated radon flux of 12.9 pCi/m^2/s.
- The alternate disposal cell has an estimated Ra-226 concentration of 185.3 pCi/g.

- The same cover system design for the Tailings Cell 2 Expansion, which has been demonstrated to meet the radon flux criteria for a higher Ra-226 concentration, will be used at the proposed alternate disposal cell.

The NRC staff considers this adequate justification that the radon flux criteria have been met.

Radon Barrier Design Conclusions

The NRC staff has determined that the radon flux was calculated appropriately using conservative estimates and site specific data where appropriate. NRC staff has also determined the cover is adequate to meet the requirements set forth in Criterion 6(1) of 10 CFR Part 40, Appendix A.

CONCLUSION

Based on its technical review of the plan submitted by Rio Algom, the NRC staff concludes that the proposed alternate disposal cell will: (1) control radiological hazards for 1,000 years to the extent reasonably achievable; (2) limit the release of radon to the atmosphere to less than 20 $pCi/m^2/sec$; (3) avoid proliferation of small waste disposal sites; and (4) provide a final site that is stable and provides protection of water resources for the long term. The plan will ensure that the remaining materials at the Rio Algom site are disposed of in a manner that is protective of human health and the environment and in accordance with the Uranium Mill Tailings Radiation Control Act, as amended, and regulations in 10 CFR Part 40.

Acceptance and approval of the Rio Algom Reclamation Plan for the proposed alternate disposal cell will be documented in an amendment of License No. SUA-1473. The NRC staff proposes the following addition to Condition No. 32 of the license:

> In addition, final disposal of remaining byproduct material and construction debris shall be performed in accordance with the Alternate Disposal Cell plan submitted by letter dated April 26, 2010. The licensee shall follow the quality assurance program outlined in the Reclamation Plan for the Tailings Cell 2 Expansion when placing materials and constructing the final cover in the alternate disposal cell.

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