Mr. Oscar A. Paulson, Facility Supervisor MAY 03 1995
Sweetwater Uranium Company
Kennecott Uranium Company
PO Box 1500
Rawlins, Wyoming 82301

SUBJECT: REVIEW OF REVISED ENVIRONMENTAL REPORT, ENVIRONMENTAL MONITORING MANUAL, AND RESPONSES TO COMMENTS ON THE CONCEPTUAL DESIGN TAILINGS MANAGEMENT STUDY FOR THE SWEETWATER MILL

Dear Mr. Paulson:

The U.S. Nuclear Regulatory Commission staff has completed its review of the Revised Environmental Report (ER), Environmental Monitoring Manual (EMM), and Response Report to NRC comments on the Conceptual Design Tailings Management Study (Response Report) submitted by Kennecott Uranium Company for the Sweetwater Uranium Project, Source Material License SUA-1350. On February 23, 1995, NRC staff and Kennecott representatives met to discuss the staff's preliminary comments related to the ER, EMM, and Response Report. The NRC staff proposed to follow-up that meeting with written comments. This letter serves to transmit the staff's comments.

The staff's review resulted in nine comments on the ER and EMM (Enclosure 1). Enclosure 2 provides the staff's review of the Response Report. All comments should be considered as preliminary until a final design has been presented and the NRC staff has had an opportunity to comment on that final design and the supporting calculations.

If you have any questions regarding this letter or its enclosures, please contact Ms. Charlotte Abrams of my staff at (301) 415-5808.

Sincerely,

/S/

Daniel M. Gillen, Section Leader
Uranium Recovery Projects Section
High-Level Waste and Uranium
Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

cc: R.Fransen, Wyoming
M.Gibson, Kennecott

Enclosures: As stated

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COMMENTS ON THE SWEETWATER REVISED ENVIRONMENTAL REPORT
AND ENVIRONMENTAL MONITORING MANUAL

1. Stratigraphic Description of Battle Spring Sands

COMMENT: The Revised Environmental Report (ER) needs a more detailed description of the aquifers which are being cleaned up by the groundwater corrective action program.

DISCUSSION: On pages 2-71 to 2-73 of the ER, dated August, 1994, it is stated that a perched aquifer and an upper saturated sand of the Battle Spring Aquifer experienced groundwater contamination from the existing tailings impoundment. The ER further states that no contamination has been found in a deeper saturated sand. The deeper sand underlies and is separated from the upper saturated sand by an aquiclude of siltstones and mudstones. Wells were completed in the perched aquifer at depths of less that 80 feet (ER, Page 2-71). Wells were completed in the upper saturated sand from 100 to 150 feet and the deeper saturated sand from 200 to 240 feet.

However, the ER does not describe the thickness, geologic properties, and stratigraphic relationship of the above units. Without this type of information, it is difficult to understand what type of aquifers and sands have been contaminated and are being cleaned up. It also makes it difficult to understand how the contamination has been limited in a vertical sense to the perched zone and upper saturated sand.

RECOMMENDATION: Provide a description of the three geologic units in the area of the impoundment and throughout the area of upper saturated sand contamination. This description should include a description of stratigraphic relationships and types of geologic materials. If possible, the description should also include a description of the hydrologic properties of the upper saturated sand (i.e., some sense as to how good the upper sand would be as a source of water). It is suggested that, in addition to a written description, cross sections should be used to show the stratigraphic relationships.

2. Groundwater Well Completions

COMMENT: The ER should describe the well completions of the point of compliance (POC), down-gradient, and background wells.

DISCUSSION: Wells were completed in the perched aquifer at depths of less that 80 feet (ER, Page 2-71). Wells also were completed in the upper saturated sand from 100 to 150 feet and the deeper saturated sand from 200 to 240 feet. The proposed new POC well (TMW-1) is intended to be a new POC location for the first impoundment and to replace POC well TMW-17 (this well will be plugged, because it will underlie the first planned impoundment). However, State of Wyoming well completion reports suggest that the new POC well (TMW-1) is completed into a sand from 280 to 300 feet. This may be below the aquitard and into the lower sand aquifer. If this were the case, this hole would not be monitoring the upper saturated sand as intended. A similar situation may exist at the down-gradient well (TMW-2), which is also intended to monitor the upper saturated sand. State of Wyoming well completion reports indicate the well is open from 295 feet to 300 feet.

?
✓ look up
wells

RECOMMENDATION: Well completions should be described for all existing POC, background, and down-gradient wells. Where possible, proposed well completions should also be described for all future POC wells. The well completions should contain a description of the geologic materials and units (i.e., perched aquifer, upper or deep saturated sands) penetrated by the hole, as well as cased and open or screened intervals. Descriptions should be detailed enough to determine what units are being monitored by the holes.

3. Determination of Background for Future Impoundments

COMMENT: The method used to determine background groundwater quality for future impoundments needs to be described.

DISCUSSION: In order to set detection or POC corrective action standards for future POC wells, background groundwater quality will have to be established. To date, well TMW-5 has been used to establish background for wells monitoring the existing impoundment. The "Response Report to NRC Comments on the Conceptual Design, Tailings Management Study" (Response Report) dated January, 1995, states that TMW-5 will be plugged when Impoundment 3 (cell 3) is constructed. At that time a new background will be established based on the sampling histories of other wells in the area.

The Response Report and the ER are silent on how background will be established for future impoundments. For example;

a. It is unclear if TMW-5 will be used to determine background for other impoundments prior to the construction of impoundment 3 or if other wells also will be used.

b. If TMW-5 is used for future impoundments, what time periods will be used to establish background?

c. How will background and detection standards be established for future POC wells located in an existing plume of contamination (as may be the case for a POC well for impoundment one)?

RECOMMENDATION: Describe how background groundwater quality will be established for future impoundments (cells) relative to the sequence of impoundment construction. If a detailed description cannot be done for all the impoundments, detailed descriptions should at least be provided for the initial impoundments.

Down gradient wells 3 - 2 - 4
POC - 7 16, 18 15₂
Background - 5

4. Location of POCs for future impoundments.

COMMENT: POC locations for future impoundments need to be described.

DISCUSSION: The ER does not describe POC locations for the new impoundments. Rather, in the Response Report, it is stated that a new POC well (or wells), will be established based on guidance in Regulatory Guide 4.14 (NRC, 1980). One proposed POC well for the proposed cells is TMW-1. Additional POC wells may be established as required.

The problem with this approach is that Regulatory Guide 4.14 does not describe how POC wells should be located since it was written prior to the creation of 10 CFR 40, Appendix A. Guidance on the location of POCs is provided in 10 CFR 40 Appendix A, 5B(1), which states, "The objective in selecting the point of compliance is to provide the earliest practicable warning that the impoundment is releasing hazardous constituents to the groundwater. The point of compliance must be selected to provide prompt indication of groundwater contamination on the hydraulically downgradient edge of the disposal area." Further, in the Statement of Considerations for 10 CFR 40, the Commission stated that for 5B(1) it is intended that the POC was to be located in the center of the flow of contaminated groundwater based upon developed data and site information as to the flow of groundwater or contaminants.

Although the Title II program does not directly correlate with the Title I program, the two programs are similar with regard to the location of POCs. Therefore, additional guidance for the location of POC wells may be obtained from the "Final Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings Sites under Title I of the Uranium Mill Tailings Radiation Control Act" (SRP), Revision 1, (NRC, 1993). Page 61 of the SRP contains a discussion of the POC.

In applying Title I guidance, it is anticipated that modifications may be necessary to conform to the realities of an operating Title II impoundment. For example, well locations at operating impoundments may have to be located to accommodate impoundment construction and operational vehicular access. Furthermore, when impoundments are built close together, it may not be practical to locate POC wells between impoundments. In these situations, it may be more practical to establish POCs that can monitor more than one impoundment. In addition, in areas where mining has locally altered the dominant regional flow direction in the past and might do so in the future, POCs may need to be established for more than one flow direction.

The SRP may provide some additional guidance in the definition of the down-gradient limit of the waste management area. By defining this area as the edge of the cover side slopes, POC wells could be located at the edge of the future cover side slopes as opposed to the edge of the impoundment liner. This would allow existing POC wells to be used after the impoundment has been reclaimed. The Title I guidance also indicates that more than one POC location is expected. This should be particularly true for large impoundments.

RECOMMENDATION: Describe the planned POC locations for proposed future impoundments and how these locations will comply with 10 CFR 40, Appendix A. If a description cannot be provided for all the impoundments, descriptions should at least be provided for the initial impoundments.

5. Identification of Groundwater Detection Standards

COMMENT: Detection standards need to be developed for new impoundment POC locations.

DISCUSSION: The ER does not describe the detection standards that will apply to new impoundment POC locations. Criterion 7A of 10 CFR 40, Appendix A, states that "the licensee shall establish a detection monitoring program needed for the Commission to set the site-specific ground-water protection standards..." and that "For all monitoring under this paragraph the licensee or applicant will propose for Commission approval as license conditions which constituents are to be monitored on a site specific basis".

Criterion 7A also states that "A detection monitoring program has two purposes. The initial purpose of the program is to detect leakage of hazardous constituents from the disposal area so that the need to set ground-water protection standards is monitored. If leakage is detected, the second purpose of the program is to generate data and information needed for the Commission to establish the standards under 5B(i)" (i.e., groundwater protection standards).

The first objective of POCs for new impoundments is to determine if the new impoundments are leaking hazardous constituents into the groundwater. This may be accomplished by monitoring constituents which are reasonably expected to be in or derived from the byproduct materials in the disposal area or by using surrogate indicators. Whether expected or indicator (surrogate) parameters are used, groundwater concentration levels for each detection parameter must also be determined.

If expected parameters are chosen as the detection parameters, background data could be used to (1) derive detection parameters or (2) derive groundwater protection standards. If the first option is chosen and at a later time hazardous constituents are detected in the groundwater, the following events would occur; (1) background data would be used to derive groundwater protection standards, (2) a compliance monitoring program would be implemented, and (3) if the groundwater protection standards are exceeded, a corrective action program would have to be put into operation as soon as is practicable, but no later than eighteen (18) months after the Commission finds that the standards have been exceeded (10 CFR 40, Appendix A, Criterion 5D).

Therefore, if the purpose of the POCs is to set detection parameters equivalent to groundwater protection standards, then baseline data and 10 CFR 40, Appendix A, Criterion 5C (i.e., maximum concentration limits) are used to establish the POC groundwater protection standard. Using this option, when the groundwater protection standards are exceeded a corrective action program would have to be put into operation as soon as is practicable, but no later than eighteen (18) months after the Commission finds that the standards have been exceeded.

If indicator parameters are chosen as the detection parameters and the release of hazardous constituents into the groundwater is indicated, then the POC wells will have to be sampled to determine if any expected hazardous constituents are leaking into the groundwater. If it is determined that no expected hazardous constituents are leaking into the groundwater, new detection parameters or concentrations will have to be derived. If hazardous constituents are determined to be leaking into the groundwater, groundwater protection standards must be derived.

RECOMMENDATION:

Develop detection standards for new impoundment POC locations. If indicator parameters are proposed, explain how they will be adequate to detect the leakage of expected hazardous constituents into the groundwater.

6. POC Groundwater Sampling Frequency

COMMENT: The groundwater sampling frequency for new POCs needs to be specified.

DISCUSSION: The ER should describe the groundwater sampling frequency for new POCs. A frequency of sampling needs to be determined so that the POC wells can be used to detect the leakage of expected hazardous constituents from the disposal area into the groundwater.

RECOMMENDATION: Specify the groundwater sampling frequency for new POCs and discuss why this frequency is adequate to detect leakage into groundwater from the disposal area.

7. Radon-222 Effluent

COMMENT: The Radon-222 effluent derived air concentration listed in the Environmental Monitoring Manual (EMM) in Appendix G of 1×10^{-9} μCi/ml needs justification.[1]

DISCUSSION: Appendix G of the EMM lists the Radon-222 effluent concentration to be used to show compliance at the site boundary as 1×10^{-9} μCi/ml. The 10 CFR Part 20, Appendix B, Table 2 values for Radon-222 effluent concentrations vary between 1×10^{-8} μCi/ml and 1×10^{-10} μCi/ml, for zero percent equilibrium with daughter products and

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[1] This comment was resolved by a letter of March 27, 1995, from Oscar Paulson of the Sweetwater Uranium Facility. The comment has been retained only to provide a complete record of concerns expressed by the NRC staff at the February 23, 1995, meeting with representatives of Kennecott Uranium Company and the Sweetwater Facility.

one hundred percent, respectively. An effluent concentration value of $1x10^{-9}$ μCi/ml equates to a daughter equilibrium level of 10%. Justification is required, as per 10 CFR §20.1302(c), to modify the effluent concentration value for the site-specific environmental conditions, such as degree of decay equilibrium. Without prior approval, the Radon-222 effluent concentration for compliance, using 10 CFR §20.1302(b)(2)(i), would be $1x10^{-10}$ μCi/ml. Therefore, use of $1x10^{-9}$ μCi/ml in an environmental procedure may result in a violation of 10 CFR Part 20.

RECOMMENDATION: The licensee needs to provide justification to support a decay equilibrium value of 10% at the site boundary, or the point of exposure, used to show compliance with 10 CFR §20.1301.

8. MILDOS-AREA Results

COMMENT: The MILDOS-AREA results use the old Part 20 allowable air concentrations instead of the effluent concentrations listed in Part 20.[2]

DISCUSSION: The MILDOS-AREA code models the airborne releases from the uranium mill and tailing cells. To show compliance with regulations, the code calculates the air concentration for the effluents at user-defined receptor locations. The code then divides the air concentration by the maximum continuous concentration. The code then sums all the fractions to calculate the total fraction of the maximum concentration at the receptor location. The code was written in 1989 and incorporates the maximum permissible concentrations (MPC) in old Part 20 instead of the current effluent concentration values in Part 20, Appendix B, Table 2. 10 CFR Part 20 was revised, effective January 1, 1994. The revision included a change in the methodology used to calculate internal doses. Therefore, the use of MPC values from old Part 20 are inappropriate. For many of the radionuclides present in uranium mill tailings, the calculated fraction of the effluent concentrations will be greater than that calculated using the old Part 20 MPC.

RECOMMENDATION: The licensee needs to revise all of the results of the MILDOS-AREA to incorporate Part 20 effluent concentration values rather than old Part 20 maximum permissible concentrations. This could include rerunning the MILDOS-AREA code with revised data files, or, simply, recalculating all the fractions to use Part 20 effluent concentration values. Note that MILDOS-AREA calculates the fraction of a Working Level rather than the concentration for Rn-222 and its daughters; therefore, the Appendix B Rn-222 value needs to be converted to a fractional Working Level (approximately 1/900).

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[2] Revisions to the MILDOS tables in the ER were provided to the NRC by a letter dated April 10, 1995, from O. Paulson, Kennecott, to J. Holonich, NRC. The comment has been retained to provide a complete record of concerns expressed by the NRC staff at the February 23, 1995, meeting with representatives of Kennecott Uranium Company and the Sweetwater Facility.

9. Seismic Evaluation

COMMENT: The estimated peak ground acceleration from a random earthquake may be too low. In addition, the capability of the Chicken Springs fault system should be addressed.

BACKGROUND: The ER states that a random event of magnitude 6.5 has a 10^{-5} probability of occurrence within a 24 km radius of the site, and the peak acceleration from this event would be 0.18g. The SRP (NRC, 1993) states that 15 km should be used as the site-to-source distance for floating earthquakes. Moreover, the Chicken Springs fault system is shown on the supplied geologic maps, but the capability of this system is not addressed.

RECOMMENDATION: The more detailed seismic hazard assessment planned by Kennecott should evaluate the peak acceleration from a floating earthquake located 15 km from the site. The seismic hazard assessment should also examine the potential hazard from the Chicken Springs fault system.

REFERENCES

NRC, 1980, Radiological effluent and environmental monitoring at uranium mills: U.S. Nuclear Regulatory Commission Regulatory Guide 4.14.

NRC, 1993, Final standard review plan for the review and remedial action of inactive mill tailings sites under Title I of the Uranium Mill Tailings Radiation Control Act, Revision 1: U.S. Nuclear Regulatory Commission, June 1993.

EVALUATION OF KENNECOTT RESPONSE REPORT TO NRC COMMENTS
ON THE CONCEPTUAL DESIGN TAILINGS MANAGEMENT STUDY (RESPONSE REPORT)

Based on the review of the "Response Report to NRC Comments on the Conceptual Design Tailings Management Study" (Response Report), dated January 18, 1995, the following comments were generated by the NRC staff. The numbering system used below corresponds with the numbering system used in the staff's April 22, 1994, submittal to Kennecott Uranium Company (letter to M. Gibson, Kennecott, from R. Hall, NRC, regarding review comments on the Sweetwater Conceptual Design Tailings Management Study). In some cases, additional comments have been generated based on Kennecott's initial response.

1. SOIL TESTING

Geotechnical Evaluation of the Existing Tailings

COMMENT: A more detailed discussion of the degree of characterization of the existing tailings is needed. Adequate characterization of the existing tailings will be necessary to allow a reasonable estimation of the total and differential settlements of the existing tailings.

DISCUSSION: As proposed, the existing tailings will be regraded and will serve as the foundation of a new evaporation pond. On page 15 (Task 5), the Kennecott Response Report states that tailings consolidation data will be obtained. Slimes samples will be obtained from the surface for laboratory consolidation testing, but it is unclear whether the sand tailings will be characterized. The staff also is concerned about the performance of the evaporation geomembrane liner in response to differential settlement. To better quantify the magnitude and variation of tailings settlement, the horizontal and vertical distribution and fluctuation of both the sand tailings and slimes should be adequately characterized.

The timing of the construction of the new evaporation pond relative to the dewatering of the existing tailings was not addressed. The constructability of the evaporation pond must be considered. If the evaporation pond is built without dewatering the tailings, the effects of pore pressure build-up on the geomembrane, and the rate of consolidation of the tailings resulting from confined drainage, should be evaluated. Means to control the excess pore pressures should be explored.

RECOMMENDATION: Characterization of the existing tailings, sufficient to serve as a basis for the settlement analyses, should be performed. Detailed analyses of the time-rate and magnitude of the settlement of the existing tailings under the load of the new evaporation pond should be performed. Estimates of total and differential settlements over the design life should be provided. The effect of the estimated total and differential settlements on the clay cover and liner system should be addressed. Constructability issues should be addressed in the final design.

Laboratory Testing

COMMENT: Shear strength parameters for the embankment and foundation materials should be determined using appropriate methods.

BACKGROUND: On page 12 of the Response Report, Kennecott states that embankment materials shear strength parameters will be determined by triaxial testing methods for fine-grained soils and direct shear methods for granular soils. Consolidated undrained (CU) triaxial shear tests are preferred by the staff over consolidated drained (CD) direct shear tests for several reasons. Direct shear tests measure plane shear resistance which is generally higher than triaxial shear resistance. Also, the direct shear method is a drained test. For soils with appreciable amounts of fines (over 15 to 20 percent), the strain rate must be small to properly insure that drained conditions are maintained. Therefore, the test method is considered to be strain sensitive. Direct shear tests are considered appropriate for granular soils with low fines content.

Kennecott's Response Report states that shear strength parameters for in-situ materials will be developed from standard penetration tests. This approach is appropriate for materials which are either too dense or too granular to be sampled using thin-wall tubes. Laboratory determination of shear strength for representative foundation materials is considered appropriate for a project of this scale.

RECOMMENDATION: CU triaxial shear tests are preferred over CD direct shear tests. Where feasible, the licensee should consider using triaxial shear tests to evaluate soil strength. The licensee should also consider performing a limited number of laboratory shear tests on undisturbed samples.

2. SETTLEMENT

Geomembrane Design

COMMENT: The maximum geomembrane strain should be quantified using conservative settlement analyses based on adequate characterization of the existing tailings. The effects of the strain on the sheet material and the seams should be addressed.

DISCUSSION: On page 20 of the Response Report, Kennecott provides an estimate of the consolidation settlement of the existing tailings. This magnitude of settlement is used in calculating the geomembrane thickness. The staff considers the estimate of the Beta value (angle of deformation) to be non-conservative. Considering the depositional method of the tailings, large settlements over a much shorter distance are not inconceivable.

On page 23 of the Response Report, Kennecott estimated the factor of safety against a sliding failure of the liner at 1.1. Based on published sources, this value is considered marginal.

RECOMMENDATION: As suggested by Kennecott in the Response Report, the use of textured high density polyethylene (HDPE) should be studied. Settlement calculations and supporting data should be submitted. The final design should provide assurance that seams will perform satisfactorily in response to the settlement induced strains. Design calculations for the evaporation pond geomembrane should be provided in the final design. QA/QC program documentation should be submitted for all geomembranes and geocomposites.

3. STABILITY

Seismic Evaluation

See Comment 9 of Enclosure 1.

New Cell Design

COMMENT: The seismic coefficient used in the pseudo-static analyses is considered non-conservative. Additional criteria outlined in Regulatory Guide (RG) 3.11 (NRC, 1977), including liquefaction potential and elastic settlement, were not addressed.

DISCUSSION: Should the detailed earthquake study yield a higher seismic coefficient, the slope stability analyses should be reevaluated. Liquefaction potential of the new tailings cells has not been thoroughly addressed. In addition, the discussion of settlement analysis on page 12 of the Response Report mentions only consolidation settlement. To adequately estimate total and differential movement of the cover, elastic settlements should also be considered in the reclamation design.

RECOMMENDATION: The slope stability analyses should be revised based on use of seismic parameters selected in accordance with the "Final Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings sites under Title I of the Uranium Mill Tailings Radiation Control Act" (SRP; NRC, 1993). Liquefaction potential and other RG 3.11 criteria should be addressed for both the foundation and embankment materials.

4. RADON BARRIER

Existing Tailings

COMMENT: The data presented are not adequate to justify the long-term radon flux estimate.

DISCUSSION: Page 25 of the Response Report states that the Ra-226 activity and emanation coefficient for the existing tailings were calculated based on lab data and a 70%-30% sand-slime mixture. The justification for the mixture proportions was not presented.

The NRC staff determined that the tailings Ra-226 and emanation coefficient parameter values for the radon attenuation model are not representative of the existing cell. According to Attachment B of Appendix I of the Kennecott Conceptual Design Tailings Management Study (Kennecott, 1993) the values are based on one slime tailings (slimes) analysis composed of 4 samples over 2-4 feet depth and one sand tailings (sands) analysis composed of 8 samples over 0-4 feet depth. Slimes contain much higher levels of Ra-226 than the sands, and the radon model is sensitive to the Ra-226 concentration-depth profile. If the slime and sand fractions are not fairly homogeneous in the upper 10 feet of tailings, the model must reflect the distribution of Ra-226. However, the plan indicates that the slimes will not be uniformly mixed with the sands portion. The average of two composite samples over the limited depths sampled cannot provide a representative Ra-226 value, especially since a true slimes sample was not analyzed. The sample results labeled as slimes had gradation information indicating that only 8.6% passed the #200 sieve. Slimes would be expected to have at least 70 percent of the material passing the #200 sieve.

The Ra-226 value used in the model is not conservative. Based on the approximate ore grade (0.029) used in the mill, the staff estimated the average Ra-226 concentration of the tailings would be 81.5 pCi/g. A conservative value, based on the 135 pCi/g results of one sample, could have been considered for the radon flux model instead of the average value of the two sand tailings samples (64.3 pCi/g). Also, areas containing a significant volume of slime tailings in the upper 10 feet should have been modeled separately from the primarily sands area and an area-weighted average radon flux for the cell calculated.

The licensee's radon model was conservative in that the 3.5 feet of frost protection soil was not included. To determine if this conservatism balanced the under-estimation of the Ra-226 concentration, the staff modeled the radon flux with the frost protection layer (assumed 10 percent moisture content) and a tailings Ra-226 value of 135 pCi/g. The staff also assumed that the clay layer would have a long-term moisture content of 16 percent. The resulting calculated radon flux was 20.2 $pCi/m^2/s$ from the clay and 13.7 $pCi/m^2/s$ from the top of the frost protection layer. Therefore, the conceptual design of the cover for the existing cell is adequate to meet the radon flux standard, assuming that the slimes tailings are not in the upper 8 feet of contaminated material and the long-term stability of the cover is demonstrated.

RECOMMENDATION: The plan for reclamation should provide adequate characterization data for the contaminated materials and radon barrier soil and include a radon model that reflects the placement of the various types of contaminated materials.

Long-term Moisture

COMMENT: The NRC staff determined that a conservative moisture value should have been used in the radon attenuation model to reflect the value uncertainty and the long-term drying of the radon barrier (clay).

DISCUSSION: Long-term moisture of the clay was determined through a 15-bar suction test and a Proctor test. Page 26 of the response indicates that the clay long-term moisture value for the radon model is based on the optimum moisture value (material will be placed at 0 to 2 percentage points above optimum). This selected value was the lower of the results derived from the two methods.

RECOMMENDATION: In evaluating long-term moisture in the Reclamation Plan, the staff suggests comparing a number of methods in addition to those stated above. Suggested methods include the Rawls equation, in-situ measurements recommended in Regulatory Guide 3.64, (NRC, 1989) and the residual moisture determination presented in NUREG CR-3533 (Rogers and others, 1984). Sufficient laboratory testing should be performed to justify the values used in determining the long-term moisture of the cover soils. The Reclamation Plan should address the construction quality control plan to justify that the clay would not dry before placement of the next layer, and address the drying of the clay layer in the semi-arid climate over the next 200 years, including the effect of the vegetated cover.

Biointrusion

COMMENT: The potential for animals or deep-rooted plants to decrease the radon attenuation capacity of the cover should be addressed.

DISCUSSION: Page 27 of the Response Report indicates that intrusion of vegetation into the radon barrier could affect its performance, but that there is no consensus among the scientific community, nor regulatory guidance on how to address the problem.

The NRC staff supplied general recommendations for addressing the potential for biointrusion at the meeting on February 23, 1995.

RECOMMENDATION: Address the potential for biointrusion impacts on the radon barrier in the Reclamation Plan.

Freeze-thaw Damage

COMMENT: The potential for freeze-thaw damage of the cover soils needs to be determined. The extent and effects should be further quantified.

DISCUSSION: Kennecott has roughly estimated the extent of frost penetration in the range of 4 to 6 feet. The staff understands a detailed estimate of freeze-thaw will be addressed in the final design. DOE has published a study on the effects of freezing and thawing on UMTRA covers (DOE, 1988). In addition to quantifying the effects of frost damage, the DOE publication provides a method for 200-year prediction of frost depth. These approaches have been previously accepted by NRC staff.

On pages 26 and 28 of the Response Report, Kennecott suggests several scenarios to model the effects of freeze-thaw. Scenario 1 includes using 6 feet of soil cover which would not be considered in the radon attenuation model to protect the clay radon barrier. Scenario 2 considers the soil cover in the radon model; however, it is unclear to what extent frost damage was considered. Scenario 3 eliminates the clay layer and utilizes entirely sand/silt cover soils. This approach will affect the evaluation of long-term "bath-tubing."

RECOMMENDATION: The Reclamation Plan should address the potential for freeze-thaw damage, including an estimate of the maximum frost depth and the effects of frost damage. A radon model that considers freeze-thaw damage of the soil layers could be submitted.

5 - 8. SURFACE WATER HYDROLOGY

COMMENT: The information provided by Kennecott is presented as an approach to resolution of NRC staff comments. In general, the staff has no problems with the proposed methods of resolution. However, it must be recognized that a detailed review can be performed only when a final design is presented and detailed calculations are provided.

9. USE OF VEGETATION

COMMENT: The conceptual design indicates that a vegetated soil cover may be used, and that methods developed by Temple and others (1987) will be used for designing the cover. The staff concludes that the methods recommended should be used with caution, and that some parameters recommended by Temple and others are not appropriate for long-term applications.

DISCUSSION: As indicated by Temple and others, the design methods for vegetation are to be used primarily for designs that receive maintenance and in cases where the long-term density and viability of vegetation can be assured. For this design application in an arid area of Wyoming, the staff concludes that a vegetated cover, similar to one envisioned by Temple and others, cannot be achieved.

RECOMMENDATION: The design of the vegetated cover should be based on little or no credit for vegetation. Using methods discussed by Temple and others, the stability of the cover should be evaluated based on the particle size and cohesiveness of the soil that will be used. If a minor amount of additional credit is claimed for the vegetation, such credit will be evaluated on a case-by-case basis and will be dependent on other conservatisms present in the design.

REFERENCES

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