MWH

BUILDING A BETTER WORLD

Responses to U.S. Nuclear Regulatory Commission Comments on the report titled *"Supplemental Data Needs Evaluation and Work Plans for Removal Design, Northeast Church Rock Mine Site Removal Action"* dated November 9, 2012

Areas of Potential Concern:

1. *Differential Settlement: Differential settlement could cause damage to components of the repository and the new and old covers. The foundation of the to-be-built repository will be the existing tailings impoundment. One of the current expectations includes the assumption that the tailings are homogenous. If, however, that assumption is not true, differential settlement may occur.*

   Response: The design of the new repository will account for the potential for differential settlement. The proposed tailings investigation discussed in PDS Work Plan for the Mill Site (MWH, 2013) will characterize stratigraphy and heterogeneity of the tailings in the area of the north and central cells. Due to the new repository being constructed over existing tailings, differential settlement cannot be prevented, but can be limited to tolerable amounts. The sloping of the surface of the repository cover will be designed to accommodate small amounts of differential settlement while still providing positive drainage to preclude ponding on the cover surface.

   The cover system proposed for the new repository is an ET Cover which is much more amenable to differential settlement than a multi-layer cover system that includes geosynthetics and/or a clay barrier. Development of tension cracks resulting from differential settlement, and subsequent preferential water flow through the ET cover system is not anticipated due to the characteristics of the proposed borrow soil and its ability to accommodate some settlement without developing tension cracks.

2. *Damage due to Seismic Activity: Seismic activity could cause damage to components of the repository and the new and old covers. The damage may be visible to inspection or hidden. Due to the height of the planned repository with mine waste collocated above the tailings impoundment, strong seismic activity could cause partial collapse of a hypothetical repository (i.e. tailings disposal area) with a poorly thought-out design above an unstable foundation.*

   Response: The NECR site is located in an area of relatively low seismicity, according to general seismic classifications in ASCE7-10 and the Uniform Building Code. As a part of the design of the new repository, previously-prepared seismic hazard evaluations for the impoundment will be reviewed and updated with current data from the US Geological Survey. Updated ground accelerations will be incorporated in the design of the new repository, per US NRC NUREG-1620. The tailings investigation outlined in PDS Work Plan for the Mill Site (MWH, 2013) will also evaluate tailings characteristics to enable the evaluation of the potential for tailings liquefaction.

3. *Breaks/cracks outside Repository Perimeter: Weight from the addition of mine waste within the tailings impoundment may cause future breaks and cracks in components (e.g., compacted clay liner) of the existing impoundment around the perimeter of the repository (i.e. tailings disposal area).*

   Response: The cracks and breaks in components of the existing impoundment envisaged by U.S. NRC could be possible if there was an abrupt spatial change in loading on the tailings caused by the repository. This abrupt change in loading is not planned, since the repository will be constructed with a sloping surface. The perimeter of the repository will be thin, and will increase in thickness and elevation toward the center of the repository. The tapered slope will result in less loading around the perimeter and is not expected to create significant differential settlement around the perimeter that could result in tension cracking in the existing cover or impoundment outside the repository footprint. The plasticity index of the existing cover will be verified during the proposed field investigation, which will determine if the existing cover soils are likely to be subject to tension cracking. The existing erosion protection layer (soil and rock mixture) on the current cover may also help mitigate potential tension cracking.

4. *Repository loading discharges contaminated water: Tailings are compressed, and pore water from the tailings seep out.*

   Additional discharging of contaminated water would require further corrective actions if concentrations were to exceed applicable groundwater protection standards. Environmental impacts to the groundwater could be problematic if consolidation of the existing tailing created significant discharge conditions due to inadequate knowledge of the moisture conditions.

   Response: Additional discharge of contaminated water would occur only if (1) the tailings are saturated or nearly saturated and (2) the seepage would reach underlying groundwater. This will be evaluated by the investigation that will be conducted as described in PDS Work Plan for the Mill Site (MWH, 2013) to obtain information on the current moisture conditions and hydraulic properties of the tailings within the existing impoundment. This information will be used to update the report by Dwyer Engineering (2011), and to evaluate the potential for seepage of pore water out of the tailings as a result of construction of the proposed repository.

   Construction of the new repository on top of the existing impoundment may slightly reduce the porosity of the tailings but this does not necessarily directly relate to a reduction in water storage capacity of those materials. Furthermore, the water in the subsurface profile is moving toward steady state, and will continue to do so. Construction of the proposed repository will not significantly affect the final outcome in a negative way, but may actually help by eliminating much of the current infiltration into the impoundment from ponding on the existing surface.

5. *The occurrence of drainage, if a liner or low permeability layer is placed beneath the mine waste, may potentially create a perched condition within the mine waste, above the existing tailings impoundment. Failure of the side-slopes or slope instability could result due to pore water pressure increase. The transport and placement of the mine waste prior to final cover completion may allow a significant amount of water to enter into the impoundment (Note this may also include the application of water for dust suppression).*

   Response: Significant flux is not expected though the final cover system. The mine spoils will be placed at a water content dry of optimum water content. Consequently drainage through the profile to a low-permeability layer is not expected, due to the net annual evaporation at the site and the significant excess water storage capacity offered by the proposed ET cover.

   The existing cover will be used as a physical barrier between the tailings and the proposed repository. The anticipated vertical saturated hydraulic conductivity of the low-permeability soil layer will not be significantly different than the mine spoils or alluvium that will be placed as fill. Based on the hydraulic conductivity of the radon barrier, water will not perch on this layer.

Additional "Design Elements" to be Included in Table 3-1:

6. *Design element labeled "Characterization of Coarse Tailings": Geotechnical testing to obtain in-situ properties such as density, porosity, field capacity, hydraulic conductivity, moisture content, standard Proctor compaction, moisture retention characteristics, particle size, and specific gravity should be considered as part of an in-situ sampling program. NUREG-1620 may need to be added to the "Performance Criterion Reference or Guidance." More detailed information is presented in NRC staff's reply to the response to "NRC Overall Comment" in Enclosure 1.*

   Response: An investigation will be conducted as described in PDS Work Plan for the Mill Site (MWH, 2013) to obtain information on the current geotechnical and hydraulic properties of the coarse tailings within the existing impoundment. NUREG-1620 has been added as a "Performance Criterion Reference or Guidance" on Table 1-1 (Table 1-1 replaces the previous Table 3-1). Standard Proctor compaction will not be conducted on tailings samples, since it is not an in-situ property,

7. *Design element labeled "Characterization of Fine Tailings.": Geotechnical testing to obtain in-situ properties such as density, porosity, field capacity, hydraulic conductivity, moisture content, standard Proctor compaction, moisture retention characteristics, particle size, and specific gravity should be considered as part of an in-situ sampling program. NUREG-1620 may need to be added to the "Performance Criterion Reference or Guidance." More detailed information is presented in NRC staff's reply to the response to "NRC Overall Comment" in Enclosure 1.*

   Response: An investigation will be conducted as described in PDS Work Plan for the Mill Site (MWH, 2013) to obtain information on the current geotechnical

and hydraulic properties of the fine tailings within the existing impoundment. NUREG-1620 has been added as a "Performance Criterion Reference or Guidance" on Table 1-1 (Table 1-1 replaces the previous Table 3-1). Standard Proctor compaction will not be conducted on tailings samples, since it is not an in-situ property,

8. *Design element labeled "Characterization of the Alluvium Under the Tailing.": Geotechnical testing to obtain in-situ properties such as density, porosity, field capacity, hydraulic conductivity, moisture content, moisture retention characteristics, and particle size should be considered as part of an in-situ sampling program. NUREG-1620 may need to be added to the "Performance Criterion Reference or Guidance." More detailed information is presented in NRC staff's reply to the response to "NRC Overall Comment" in Enclosure 1.*

   Response: An investigation will be conducted as described in PDS Work Plan for the Mill Site (MWH, 2013) to obtain additional information on the geotechnical and hydraulic properties of the alluvium underlying the tailings impoundment. NUREG-1620 has been added as a "Performance Criterion Reference or Guidance" on Table 1-1 (Table 1-1 replaces the previous Table 3-1).

9. *Design element labeled "Characterization of the Zone 3 sandstone under the tailing": Geotechnical testing to obtain in-situ properties such as density, porosity, field capacity, hydraulic conductivity, moisture content, moisture retention characteristics, and particle size should be considered as part of an in-situ sampling program. NUREG-1620 may need to be added to the "Performance Criterion Reference or Guidance." More detailed information is presented in NRC staff's reply to the response to "NRC Overall Comment" in Enclosure 1.*

   Response: An investigation will be conducted as described in PDS Work Plan for the Mill Site (MWH, 2013) to obtain additional information on the saturated hydraulic conductivity of the Zone 3 sandstone underlying the tailings impoundment. NUREG-1620 has been added as a "Performance Criterion Reference or Guidance" on Table 1-1 (Table 1-1 replaces the previous Table 3-1).

10. *Design element dealing with discovering various types and quantities of unexpected material: Since no documentation exists as to what was disposed within the mine spoils, it is possible, despite the assumption of uranium being co-located and proportional to radium, that unexpected hazardous materials may be discovered during the excavation of the mine spoils.*

    Response The mine site Removal Action construction plan will include provisions for identifying the nature and potential for hazardous characteristics, of any unexpected materials found during the Removal Action. There will also be plans to ensure the health and safety of the workers. The results of the Geophysical Survey (MWH, 2007), and the subsequent trenching investigation of

selected metallic anomalies (MWH, 2011), lead to the expectation that no containers or metallic vessels (e.g., drums) that could contain hazardous materials will be encountered. However, it is possible that other hazardous materials could be encountered and the design will provide procedures for identifying, evaluating and managing these materials.

11. *Design element labeled "Requirement for dose criteria.": Criterion 6(6) of Appendix A to 10 CFR Part 40 requires that byproduct material containing concentrations of radionuclides other than radium in soil must not result in a total effective dose equivalent (TEDE) exceeding the dose from cleanup of radium contaminated soil to the above standard (benchmark dose), and must be at levels which are as low as is reasonably achievable. A calculation of the potential peak annual TEDE within 1000 years to the average member of the critical group that would result from applying the radium standard (not including radon) on the site should be provided.*

Response: It is not clear whether this comment specifically refers to the Mine Site, or the Mill Site. However the cleanup criteria for the mine site was selected by EPA and developed based on conservative risk assessments conducted in accordance with CERCLA guidance. The "dose criterion" was developed for uranium recovery sites to address residual radionuclides other than Ra-226 that become highly concentrated during the milling process and are out of secular equilibrium (primarily the Ra-226 parent nuclide Th-230) that would increase the radium activity over the 1,000-year compliance period.

The uranium mine spoils are in secular equilibrium and therefore the Ra-226 concentration is expected to stay constant over the compliance period. In addition, the Ra-226 action level of 1.24 pCi/g (above background) at the site is approximately 25% of the 10 CFR 40 standard of 5 pCi/g (above background). EPA guidance confirms that Criterion 6(6) is a potentially relevant and appropriate requirement only where "the majority of radiological risk is posed by contaminants of concern at a site ... are the same ... as those existing at NRC thorium mills and uranium recovery facilities." (EPA Directive no. 9200.4-35P, "Remediation Goals for Radioactively Contaminated CERCLA Sites Using the Benchmark Dose Cleanup Criteria in 10 CFR 40 Appendix A," April 11, 2000) This is not the case for the mine spoils; as noted in EPA's 2007 TENORM Guidance, uranium mining TENORM is generally characterized by uranium decay products; "in particular, the concentration of radium-226 is a key metric for purpose of classifying waste materials." (EPA 402-R-05-007, Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining).

Furthermore, given the fact that byproduct materials are not present at the mine site, there is no need for the dose criterion requirement since the RAL of 1.24 pCi/g Ra-226 plus background will address any elevated residual radionuclides; and represents a conservative standard that will reduce site radiation exposures to below a level commensurate to a human cancer risk of $1x10^{-4}$.

Specific Comments on Table 3.1

12. *Design element labeled "Maintenance of cover over tailings and construction of new cover over mine spoils.": Please provide additional information about this design element. NUREG-1620 and NUREG-1623 may need to be added to the "Performance Criterion Guidance." This is one of the most critical elements of the design.*

    Response: The intent of the final cover system and storm water control features is minimizing long-term maintenance per 10 CFR Appendix A to Part 40. An ET cover is proposed for the new repository and will be designed to both limit flux into the underlying materials and minimize soil loss due to erosion. The cover will be designed such that the soil quality and storage capacity will enable native vegetation to be established. A simulated 'desert pavement' will be included within the upper portion of the cover to provide erosion protection and mimic natural conditions found in undisturbed areas with similar soils near the Mill Site. The repository slopes and slope lengths will be designed to be stable against the design peak ground acceleration and will minimize the potential for rill and gully formation. Because only natural materials such as soil and rock will be utilized in construction of the repository cover, there are no concerns over material degradation, as there would be if synthetic materials were incorporated in the cover.

    The proposed repository will be designed such that the integrity of the surrounding existing cover will not be negatively impacted by runoff or loading from the repository. The tie-in between the proposed repository and the existing repository cover will be designed for the same minimal long-term maintenance as the new repository, per 10 CFR Appendix A to Part 40. NUREG 1620 and NUREG 1623 have been added to Table 1-1 and will be utilized in this design process. Table 1-1 replaces the previous Table 3-1.

13. *Four design elements in Table 3-1 include:*
    - *Consolidation of mine spoils onto tailings facility*
    - *Placement of contaminated soils*
    - *Placement of comingled TPH and Ra-226 soils, and*
    - *Placement of mine debris/filling of void spaces*

13a) What is the difference between "consolidation" and "placement" and between "mine spoils" and "contaminated soils?"

Response: 13a) Consolidation refers to minimizing the footprint and area of the repository, as well as to consolidation of the mine spoils onto the existing tailings impoundment, to avoid proliferation of small waste disposal sites per 10 CFR Appendix A to Part 40. Placement refers to the general order and methods used to physically place the materials in lifts and compact them. The term mine spoils refers to soils at the mine site that were excavated and placed on the ground surface during mining. Contaminated soil refers to mine spoils and in-place soils (e.g., surface soils within step-out areas) containing Ra-226 above the Removal Action Level of 2.24 pCi/g. Placement of the material involves placing the

material within the proposed repository. The definitions of these items have been clarified in PDS Work Plan for the Mill Site (MWH, 2013).

13b) Will these four actions results in four distinct separate repository layers, or will the soils be mixed together?

Response: 13b) These four items do not result in four distinct separate repository layers. Instead they refer to considerations which will be incorporated into the design of the proposed repository. The design of the repository will include specifications for placement of the different material types in order to minimize settlement and radon emanation.

13c) If these actions result in four distinct separate layers, would geotechnical testing be appropriate for each soil type? Currently, contaminated soils are the only soil type that will have geotechnical testing results (includes moisture content, saturated hydraulic conductivity, standard Proctor compaction, moisture retention characteristics, particle size, and specific gravity).

Response: 13c) PDS Work Plan for the Mine Site (MWH, 2013) includes a Field Sampling Plan for characterizing density and volume relationships for the soils at the Mine Site. This information will be used to design the specifications for placement of the mine spoils, including ~~soils~~ and comingled TPH and Ra-226 soils. Results of quality control testing during construction will be applicable to both the mine spoils and comingled TPH and Ra-226 soils. A method specification will be developed during design to address placement of debris and filling of any void spaces. The strategy for material placement within the repository profile will be developed during design.

14. Design element labeled "Cover (general)": Please provide additional details explaining what this element is about since no description is provided. Include NUREG-1623 as one of the guidance documents in the "Performance Criterion Reference or Guidance" column.

Response: This item is specific to cover construction materials, and has been updated accordingly.

15. Four design elements in Table 3-1 include:

- *Cover (general)*
- *Cover permeability*
- *Cover infiltration, and*
- *Freeze/thaw, slope stability, and biointrusion*

The potential data gaps for the design elements state that the design element properties will be obtained by characterization of the borrow areas. Obtaining the particle size of the borrow area soil is useful. However, most of these activities will be capturing the in-situ hydro-geotechnical parameters of the borrow soil only and not the properties of in-

situ repository cover. Many of the properties will change after the material is transported to the site, larger places broken apart, and compacted after placement.

How will the following in-situ properties of the various repository layers be obtained or determined?

- *Density*
- *Porosity*
- *Field capacity*
- *Hydraulic conductivity*
- *Moisture content*

Response: In-situ properties of materials to be placed and compacted in the repository are not necessary, as these materials will be excavated and recompacted as the repository cover is constructed. Compacted properties of these materials will be tested on remolded or compacted samples, as described in the Field Sampling Plan for the borrow investigation in PDS Work Plan for the Mill Site (MWH, 2013).

Soil samples of the proposed soil cover will be excavated from the potential borrow sources and remodeled in the laboratory to a target density. This target density will be representative of the typical in-situ density and porosity of that soil in a natural undisturbed setting. This density will also be the target density for the placement of the cover, as the design intent of the ET cover is to mimic natural conditions.

Borrow soils will be excavated and tested to determine compaction characteristics (per ASTM D698 or D1557) which will provide a density versus moisture content relationship for the soil. Specimens will then be remolded to match the appropriate target density and moisture content of the ET cover soils, to determine moisture retention (field capacity) properties. These tests will utilize pressure plates and hanging columns to measure the relationship of matric potential (suction) versus moisture content for each given soil. The measured moisture characteristic curves will yield the saturated moisture content, residual moisture content, and field capacity of the given soil.

Additional laboratory testing will include saturated hydraulic conductivity, geotechnical index testing, and agronomic testing. The complete list of soil tests on the borrow material is provided in Table 3-4 of PDS Work Plan for the Mill Site (MWH, 2013). Porosity corresponding to the target density and moisture conditions will be calculated.

The laboratory results obtained during the borrow investigation will be used to develop a specification for material placement and compaction in the proposed repository, including dry density and moisture content. Following placement of each lift of material during construction of the cover, the density and moisture content of the cover will be measured in the field. Samples may also be collected for confirmatory index testing. Having already tested the borrow soils for moisture retention characteristics and hydraulic conductivity at typical densities and water content, the field density and water content tests conducted during placement of the cover (the same soil) can be used to evaluate in-place field capacity and hydraulic conductivity of the completed cover. This approach will result in the most efficient, timely placement of materials.

16. *Design element labeled "Tie into existing site features.": Please provide additional details on what site features this design element refers to (e.g. diversion channels, swales, etc...?). Details are necessary since the remedial action's intention is to utilize existing erosion protection features if possible.*

    Response: "Site features" is a general term intended to include the existing topography, cover surface, and surface water control features at the Mill Site. The proposed repository will be designed to blend in aesthetically and functionally with the existing features outside of the footprint of the new repository, including branch swales, site slopes, etc. If during the design process, some of the existing site features require modification, those modifications will be included in the design. The overall intent of this design element is to portray the fact that the proposed repository will be designed and constructed in such a manner as to maintain the general site appearance and functionality as it currently exists.

17. *Design element labeled "Design life for evaluation of facility components.": Add NUREG-1623 and NUREG-1757, Volume 2, Revision 1, Appendix P as part of the "Performance Criterion Reference or Guidance." Although NUREG-1757 is written for decommissioning sites, Appendix P contains information about the use of natural analogs to demonstrate indirect evidence of resistance to weathering of a selected rock source.*

    Response: Agreed, NUREG-1623 and NUREG-1757, Volume 2, Revision 1, Appendix P will be added.

18. *Due to the potential significance on future performance, sufficient information should be available, or should be gathered during the upcoming site evaluation and characterization activities that is expanded to include an in-situ sampling program, so as to construct a cross-section of a typical branch swale or diversion channel as it exists on the current cover. All its components/layers should be included, and the significant property values of these components should be labeled.*

    Response: The as-built reports for the reclamation of the current impoundment cells include detailed information regarding construction of the branch swales, including geotechnical properties of the materials used for construction, and typical as-built construction details. In the case of the branch swales that will be incorporated into the new design, MWH will assess current geometries of the swales, the physical conditions of the rock, and evidence of siltation in the swales, as discussed in PDS Work Plan for the Mill Site (MWH, (2013), in order to determine their capacity for conveyance of the design storm event. PDS Work Plan for the Mill Site (Information provided in the as-built reports (Canonie Environmental, 1994, 1995; Smith Environmental Technologies Corp., 1996, 1997), as well as the additional data that will be collected, will provide sufficient information about the branch swales that will not be covered by the repository.

19. *Section 3.1.2, first bullet states: "The repository will be designed to hold the contaminated mine material excavated from the NECR Mine Site. The design specifications will comply with CERCLA requirements, and specifically all Applicable or Relevant and Appropriate Requirements (ARARs)." This statement does not reference NRC requirements. Please include NRC requirements as part of the design specifications.*

    Response: An additional sentence has been added to state: "*The repository design will also comply with applicable NRC requirements (including Appendix A of 10 CFR 40 and NUREG-1623).*"

References:

Canonie Environmental. 1994. *As-Built Report, North Cell Final Reclamation*. November.

Canonie Environmental. 1995. *As-Built Report, Central Cell Final Reclamation*. June.

MWH, 2007. *Geophysical Survey Report*. June.

MWH, 2011. *Geophysical Anomaly Trenching Report*. February.

MWH, 2013. *Pre-Design Studies Sampling and Analysis Plan, Northeast Church Rock Mine Site Removal Action. Volume I: Pre-Design Studies Work Plan, Church Rock Mill Site.* August 16.

MWH, 2013. *Pre-Design Studies Sampling and Analysis Plan, Northeast Church Rock Mine Site Removal Action. Volume II: Pre-Design Studies Work Plan, Northeast Church Rock Mine Site*. August 16.

Smith Environmental Technologies Corporation. 1996. *As-Built Report, Final Reclamation, Borrow Pit No. 2*. August.

Smith Environmental Technologies Corporation. 1997. *As-Built Report, 1996 Final Reclamation Construction*. March.