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October 14, 2019
File: 233001369
Submitted electronically and via US Mail

Attention: Mr. James Smith, Senior Project Manager
United States Nuclear Regulatory Commission
Uranium Recovery and Materials Decommissioning Branch
Division of Decommissioning, Uranium Recovery and Waste Programs
Office of Nuclear Material Safety and Safeguards

Dear Mr. Smith,

Reference: Responses to Request for Additional Information (Group 2) on the Application for Amendment of USNRC Source Material License SUA-1475 for the United Nuclear Corporation Mill Site, McKinley County, New Mexico

On behalf of United Nuclear Corporation and the General Electric Company (UNC/GE), this letter transmits responses to the USNRC request for additional information (Group 2) on the *Application for Amendment of USNRC Source Material License SUA-1475 for the United Nuclear Corporation Mill Site* dated September 24, 2018. USNRC provided the request to UNC/GE via a letter dated July 31, 2019. The responses included in this submittal are for all RAI comments except 2.2-1, 2.4-1, 4.3-2, 4.3-3, 4.4-1, 4.4-2, and 4.5-1 which will be submitted on November 11, 2019. The responses included with this submittal and associated revised sections of the application have been submitted electronically via the USNRC Electronic Submissions System and the requested modeling files have been submitted on CD via US Mail.

Please contact me with questions on accessing the documents and contact Roy Blickwedel (UNC/GE) with questions on the submittal.

Regards,

Stantec Consulting Services Inc.

Melanie M. Davis

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Attachment: Responses to USNRC Comments on the Application for Amendment of USNRC Source Material License SUA-1475 for the United Nuclear Corporation Mill Site

CC: Roy Blickwedel, GE
Jason Cumbers, Stantec
Steve Dwyer, Dwyer Engineering

ATTACHMENT

Responses to USNRC Comments (Group 2) on the Application for Amendment of USNRC Source Material License SUA-1475 for the United Nuclear Corporation Mill Site

Request for Additional Information – Group 2
Safety Evaluation Report

Section 2 - Geology and Seismology

RAI 2.2-1 Structural and Tectonic Features

Provide additional information on the local structural features discussed in 'Application for Amendment' and Appendix G.1 and identified below.

The Church Rock site is in the vicinity of three local structural features. These local features are:

- Pipeline Canyon Lineament
- Fort Wingate Lineament
- Pinedale Monocline

Although Canonie (1987) describes both the Pipeline Canyon Lineament and the Fort Wingate Lineament as monoclinal hinge zones with sufficient fracturing to modify flow within the site, NRC staff is not clear on if the processes that formed the lineaments with associated fault zones are still active. If the lineaments are some type of faults, it is not clear why they were not included in the analysis similar to the previous analyses. Specifically, seismic hazard analyses were previously conducted by Lawrence Livermore National Lab in 1994 for the design of the uranium mill and the tailings site (NRC, 1997). This deterministic analysis was based on the presence of the Pipeline Canyon and Wingate Lineaments.

The information is required for the NRC staff to determine whether 10 CFR Part 40, Appendix A, Criterion 4(e) is met with respect to the proposed amendment, which requires that an acceptable alternate method of determination of seismic hazard has been used or that tailing impoundments are not located near a capable fault. This information is also needed to determine whether Criterion 6(1) is met.

RESPONSE: *UNC will evaluate the lineaments and monocline referenced to better understand how they formed and the potential level of activity associated with these structures. If necessary, UNC will update the seismic hazard analysis (SHA) to include the lineaments discussed in the 1994 Lawrence Livermore National Lab (LLNL) study. UNC will update the SHA report to document results of evaluating these three structures as well as the SHA results (if necessary). UNC will also revise the SHA report to more clearly discuss results from previous studies. The statement "This deterministic analysis was based on the presence of the Pipeline Canyon and Wingate Lineaments" is not an accurate reflection of what was published in the 1994 LLNL study. UNC will provide the full response with the second submittal of RAI Group 2 responses.*

RAI 2.4-1 Seismicity and Ground Motion Estimates

Identify the fault responsible for the closest seismic event to the Church Rock site: An Mw 4.7 event that occurred on January 5, 1976 approximately 16 miles (26 km) from the site.

Appendix G, Attachment G.1 presents the results of a seismic hazard analysis. Section 4.2 discusses the historic seismic record of the Colorado Plateau and the Fault responsible for the closest seismic event to the Church Rock site. It is not clear to NRC staff why this fault was not identified and why it was not included in the seismic hazard analysis or described in Appendix G, Attachment G.1, Section 4.1.

The information is required for the NRC staff to determine whether 10 CFR Part 40, Appendix A, Criterion 4(e) is met, which requires that an acceptable alternate method of determination of seismic hazard has been used or that tailing impoundments are not located near a capable fault. This information is also needed to determine whether Criterion 6(1) is met.

RESPONSE: *The 1976 earthquake referenced in this comment was included in development of the background earthquake. However, given the proximity to the site, UNC will further evaluate available literature to better understand the source of these earthquakes. UNC will update the seismic hazard analysis and report, as needed, based on conclusions of this additional evaluation. UNC will provide the full response with the second submittal of RAI Group 2 responses.*

RAI 2.4-2 Seismicity and Ground Motion Estimates

Provide the technical basis for not considering the tailings in estimating the shear wave velocity.

Appendix G, Attachment G.1, Section 4.3 explained that the tailings were not considered in estimating the shear wave velocity because this site-wide Seismic Hazard Analysis was performed to estimate peak accelerations at the original ground surface. The shear wave velocity was estimated in the top 100 feet (30 meters, V_{S30}) of the original ground surface. The mine waste repository will be placed over the existing tailings and in some locations the tailings are approximately 20 m thick. With regards to the mine waste repository, it is not clear why the top of the existing tailings would not be considered "the original ground surface."

The information is required for the NRC staff to determine whether 10 CFR Part 40, Appendix A, Criterion 4(e) is met, which requires that an acceptable alternate method of determination of seismic hazard has been used or that tailing impoundments are not located near a capable fault. This information is also needed to determine whether Criterion 6(1) is met.

RESPONSE: *UNC performed the SHA considering a range of V_{S30} values (275 m/s, 420 m/s and 566 m/s) to account for variability in the site foundation conditions. The V_{S30} calculated for the alluvium foundation was approximately 275 m/s. If calculating the V_{S30} from the top of the existing tailings, the resulting average V_{S30} would be similar to the lower bound V_{S30} (275 m/s) developed for the SHA. The design peak ground acceleration (0.3 g) used in the analyses corresponds with the lower bound V_{S30} and no change would be anticipated if the V_{S30} accounted for the existing tailings.*

Section 3 - Geotechnical Stability

RAI 3.2-1 Mine Waste Characteristics

More than 50 percent of the estimated mine site debris volume is composed of organic material, including logs. Provide the technical basis for why any void space created by organic decomposition will not create subsidence in the mine waste repository area or explain why the presence of voids would not be an issue.

Appendix C.4.2.2, Table C.4-3 gives estimated mine site debris volumes. 10,000 yd^3 is listed as vegetation debris type and 2600 yd^3 is given as wood. This is roughly 55 percent of the overall debris volume of 22,800 yd^3, or almost 2 percent of the total volume within the proposed mine waste repository. As this organic matter decomposes, that volume would be occupied, in time, by void space and, ultimately, by other mine spoils. Subsidence due to such a large volume could impact the integrity of the mine waste repository.

The information is required for the NRC staff to determine whether 10 CFR Part 40, Appendix A, Criterion 1, 3, 4(e), 5(G)(2), and 6(1) would be met.

RESPONSE: *UNC proposed to shred and/or chip the vegetation debris at the mine site and then haul it for placement in the Repository. The shredded vegetation debris will be spread with soil and not permitted to be placed in nested layers. The total estimated debris volume of 12,600 CY, if divided into the five placement areas (Phases 2 through 6) results in 2,520 CY of woody debris per phase mixed with soil. Given the surface area of each Phase (obtained from Drawings 7-02 and 7-03) and a placement volume of 68,040 cubic feet, the maximum thickness of a woody debris layer placed in any phase would be 0.80 inches.*

Since the debris must be mixed with soil during placement and buried, UNC expects decomposition leading to settlement to be only a fraction of the total layer thickness and less than 1 inch total for all of the woody debris. This process of shredding and placing the debris will reduce the effects of decomposition creating large void spaces. Since the debris will be uniformly spread, settlement will be uniform across the layer and differential settlement is expected to be negligible. The calculations are summarized in the table below.

Phase	Surface Area (sq. ft)	Debris Thickness (inches)
2	1,117,593	0.73
3	1,967,947	0.41
4	1,192,506	0.68
5	1,101,512	0.74
6	1,026,461	0.80

RAI 3.8-1 Disposal Cell Hydraulic Conductivity

Provide electronic input and output files, including descriptive labels, of the UNSAT-H runs described in Appendix G, Attachment G.7 and in Appendix Y.

The simulations performed with UNSAT-H provide estimates of the rate of water infiltrating into the future repository, tailings, and aquifer. Electronic copies of these calculations with descriptive labels are needed for the NRC staff's review, as well as to focus staff efforts on risk significant features and processes. The information is required for the NRC staff to demonstrate compliance with the following criteria in 10 CFR Part 40, Appendix A: Criterion 4(c), which provides requirements for the embankment and cover slopes for tailings 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.

RESPONSE: Response from Dwyer Engineering: *Appendix G, Attachment G.7 summarized input parameters, boundary conditions, and output. Attachment 1 of this submittal provides electronic input and output files.*

RAI 3.8-2 Disposal Cell Hydraulic Conductivity

Provide a clear definition for potential evapotranspiration (PET), evaporation (E), and transpiration (T) calculated in UNSAT-H.

It is not clear to NRC staff why two definitions for PET were presented in both Appendix G, Attachment G.7 and in Appendix Y. Penman's equation on page 42 in Appendix G, Attachment G.7 does not include precipitation within the definition of PET while the definition for PET presented on page 47 includes precipitation as part of the definition, but does not include daily wind speed, relative humidity, and net solar radiation. Figures 14 and 15 in Attachment G.7 appear to present monthly PET rates that include precipitation since the two PET rates in the two figures differ. [In addition, although Appendix G, Attachment G.7, Fig. 14 and in Appendix Y, Fig. 12 are representing the same set of values, the figures are different.]

NRC staff is also not clear about the transpiration and evaporation values as calculated by UNSAT-H and as described on page 47, e.g., "potential evaporation is estimated or derived from daily weather parameters." Both components are described as potential (i.e., T_p and E_p); however, the simulated values of "Transp" and "Evap" as presented in Tables A1 - A8 from Appendix Y do not equal the "PET" column from the tables and, instead, may be actual transpiration and actual evaporation.

The information is required for the NRC staff to demonstrate compliance with the following criteria in 10 CFR Part 40, Appendix A: Criterion 4(c), which provides requirements for the embankment and cover slopes for tailings 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.

RESPONSE: Response from Dwyer Engineering: *The PET definition shall be replaced in Appendix G, Attachment G.7 and in Appendix Y with the following: "Potential evapotranspiration (PET) is a measure of the ability of the atmosphere to remove water from the surface through the processes of evaporation and transpiration assuming no control on water supply. Actual evapotranspiration (ET) is the quantity of water actually removed from a surface due to the processes of evaporation and transpiration." Updates to Attachment G.7 of Appendix G and Appendix Y will be submitted with the second submittal of RAI Group 2 responses.*

Figures 14 and 15 in Appendix G, Attachment G.7 and Figures 12 and 13 in Appendix Y graphically summarize the calculated monthly PET values for the typical and wettest year on record, respectively. The graphs for comparative purposes also provide the monthly precipitation values measured for respective years. The graphs are provided to help better understand the expected water balance. There is significantly more climate demand for water or PET than actual supply of water or precipitation for every month of the year in both years presented.

Actual transpiration and actual evaporation are calculated in the UNSAT-H simulations (UNSAT-H output) for each year modeled along with other water balance variables such as runoff, percolation, and water storage changes. It is important to note that PET is how much water the atmosphere wants, but the actual transpiration and surface evaporation (collectively referred to as ET) depends on actual water supply. PET along with precipitation is included in the simulations as the upper boundary conditions, while actual water balance variables (including transpiration and evaporation) are part of the simulation output.

PET is not calculated in UNSAT-H. It was calculated prior to simulations and provided as one of the climate files along with precipitation. There are two files for each climate year modeled: a PET file that supplies daily PET values and a precipitation file that supplies daily precipitation volumes (actually broken out by the hour). Daily PET values were calculated for each climate year modeled using the method described in Samani and Pessarkli 1986; and Hargreaves and Samani 1985. Computed PET values depend on the climate. More specifically, PET depends on the daily maximum and minimum temperatures and site latitude. Therefore, each year modeled will have PET values based specifically on the recorded climate for that year. Tables A1 to A8 in Appendix Y are the actual evaporation and transpiration water balance variables computed through the simulations. Both the PET and precipitation files provide the climate information required for UNSAT-H simulations. PET and precipitation are provided for each year modeled – this is why the typical year and the wettest year on record are different.

Below is further discussion of actual transpiration and evaporation that are part of the UNSAT-H output.

<u>Transpiration:</u>
The UNSAT-H model simulates the effects of plant transpiration using the PET concept. Plant information is supplied to the code to partition the PET into potential evaporation (E_p) and potential transpiration (T_p). E_p is estimated or derived from supplied daily PET values. Within, UNSAT-H, T_p is calculated using a function based on the value of the assigned leaf area index (LAI) and an equation developed by Ritchie and Burnett (1971) as follows:

$$T_p = PET\,[a + b(LAI)^c],\; d \leq LAI \leq e$$

The T_p is applied to the root zone using the root distribution to apportion it among the computational nodes that have roots. Water withdrawal from a particular node depends on the suction head of the node. The user provides suction head values *that define how the T_p rate applied to a particular node is reduced. Below the minimum value, sometimes known as the wilting point, transpiration is unable to remove any water. When all nodes with roots reach this level of suction head, transpiration is reduced to zero.*

Evaporation:
The UNSAT-H model simulates evaporation in the isothermal mode using the PET concept. The user supplies daily values of PET. UNC computed these daily PET values externally to the UNSAT-H model and supplied it as a boundary condition file. During each time step, the code attempts to apply the potential evaporation rate. If the soil surface dries to a value at or above a user-defined matric potential limit, the time step is solved again using a Dirichlet condition at the surface. In this situation, the surface potential is held constant at the matric potential limit, and evaporation is set equal to the flux from below.

RAI 3.8-3 Disposal Cell Hydraulic Conductivity

Provide additional information to support the claim made in Appendix G, Attachment G.7, Section 5.1 that even if infiltration events could potentially move deeper than the $CaCO_3$- bearing horizon, this moisture would likely move back up in the profile and be removed via evapotranspiration (ET).

Although pages 33 and 51 in Appendix Y state that there is no simulated percolation in the model, the application states that water that would infiltrate deeper would be pulled back up and removed as evaporation. Figure 20 presets the 63-year long run results including the first three years without vegetation. For those first years, the annual flux appears to drop especially fast (over 10 cm/yr) within the upper few centimeters of the proposed mine spoil repository. Since transpiration is no longer a mechanism without vegetation, the evaporation process is the most significant process by which water is removed from the cover during this period. Even with vegetation present, evaporation is still the dominant process to remove water from the disposal system in the simulation results presented in Appendix G, Attachment G.7, Appendix A, showing evaporation rates removing more than 50 percent of the rainfall per year for all sensitivity analysis runs including simulated wet years. Consequently, NRC staff is especially interested in the evaporation process and the significant factors that can influence Fick's law (used to calculate evaporation), such as soil compaction, hydraulic conductivity, soil type, and thickness of the 4-ft admixture / no-rock soil layer. A comparison with the existing cover and the surrounding area is also of interest: Is there recharge in the borrow areas and the area surrounding the Church Rock site? If yes, why is the evaporation rate insufficient to stop deep percolation in these areas and in the existing radon barrier cover on the Church Rock mill tailings cell (see, e.g., Appendix Y, page 38). That is, what factors enhance the evaporation rates for the future evapotranspirative (ET) cover design?

In addition, what is the depth limit for the effect of evaporation and what factor determines that limit? For example, Figure 22 in Appendix Y shows the mine spoils losing water and becoming drier down to circa 5 m. Appendix Y, Figure17 indicates that the upward movement of moisture and subsequent evaporation is responsible. The depth between upward movement of moisture and downward movement of moisture should be identified within the mine spoil repository. If the mine spoils are drying out by moving water to the upper ET layers, how much does this contribute in percentage to the overall water budget calculated by the UNSAT-H model? In addition, a technical basis and detailed explanation should be provided for the upward movement of water in the mine spoil repository layers?

The information is required for the NRC staff to demonstrate compliance with the following criteria in 10 CFR Part 40, Appendix A: Criterion 4(c), which provides requirements for the embankment and cover slopes for tailings 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.

RESPONSE: Response from Dwyer Engineering: *Water is expected to be drawn upward due to the large difference in climatic demand for water or PET versus the actual supply of water or precipitation. The demand for water is so much greater than the supply that the tendency is for the upper portions of the profile (ET Cover) to be very dry and thus have high matric potential. These suction values will be higher (except during precipitation event and infiltration) compared to gravity and so the gradient will be upward. This is why ET Covers work well in dry climates. Figures 12 and 13 in Appendix Y summarize the comparison of PET and precipitation.*

The output shows no percolation through the ET Cover due to meteoric water. Furthermore, computer simulations output shows a negative flux for the cover system, meaning that given the water within the modeled profile; some of this water will actually move upward through the cover and into the atmosphere.

The most sensitive parameter for future evaporation of infiltrated water from the ET Cover is the climate or PET. As long as PET is significantly higher than precipitation, evaporation will be very high.

When comparing the existing rock cover with the proposed new ET Cover, the most significant difference is the surface condition. The existing cover is 18 inches of compacted soil covered with 6 inches of rock. This rock has been in-filled with fine grained sand. This is not a very conductive layer and allows significant infiltration. It also forms a capillary barrier in reverse – the moisture in the fine-grained underlying soils is restricted from moving up into the surface rock layer. Additionally, the existing cover has areas that allow ponding. The high infiltration rate in the existing cover keeps moisture in the subsurface. This is evidenced by vegetation (such as Tamarisk) visible on the existing cover. This vegetation requires significant moisture to survive in the NECR climate. The proposed ET Cover will be sloped and have positive drainage to eliminate ponding. The proposed ET Cover surface is more conductive and will not hinder evaporation.

There is no specific depth limit that defines how far moisture can go up or down. Moisture movement is governed by energy gradients. Since the ET Cover and underlying soils are expected to remain unsaturated, the governing energy gradients are matric potential or soil suction and gravity (assuming no ponding). If the surface soils dry to near residual moisture content during dry periods, the soil suction is large (orders of magnitude greater than gravity) and draws up moisture from underlying soil. This effect is amplified near the surface and has less effect as the profile depth increases.

RAI 3.8-4 Disposal Cell Hydraulic Conductivity

Provide water budget tables for the 4-foot "store and release" cover (i.e., the admixture and the soil cover without rock) showing the soil water storage capacity of this important unit over time. Current tables do not show what amount of water is stored in that layer, the amount of water infiltrating through the bottom of the store-and-release unit (i.e., 4 ft.), and the amount of water moving back up into the store-and-release unit by means of evaporation.

Tables in Appendix G, Attachment G.7, Appendix A do not provide this information. Using Table 64, Wet Year #1 as an example (and ignoring the PET value), inflow does not match the outflow and the difference (60.35 – 7.9 - 44.875 - 4.295 – 0 = 3.28 cm) may represent the storage capacity for that year, but it is not identified as such. What is the limit that the design store-and-release layer can hold as storage water before water moves downward into the mine spoils themselves?

The information is required for the NRC staff to demonstrate compliance with the following criteria in 10 CFR Part 40, Appendix A: Criterion 4(c), which provides requirements for the embankment and cover slopes for tailings 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.

RESPONSE: Response from Dwyer Engineering: *This submittal includes water balance variables for each year of the computer simulations. There are two sets of output files, the first to satisfy RAI 3.8-1 (Attachment 1). These are the output files created for each year of each respective simulation. The second set (Attachment 1, files titled bsum.* in each folder) summarizes all years in one file providing the water balance variables for each year to include: transpiration, evaporation, precipitation, runoff, drainage, and change in water storage. The drainage is the value through the entire profile modeled and is a consequence of the unit gradient lower boundary condition that is part of the assembled model. The unit gradient condition forces drainage at the specified saturated hydraulic conductivity for the bottom node. This drainage does not mean that drainage is really occurring. The change in water storage is for the entire profile modeled, not just the cover.*

RAI 3.8-5 Disposal Cell Hydraulic Conductivity

i. Provide additional information concerning the uncertainty involved with the UNSAT-H output. Produce additional sensitivity runs to provide reasonable assurance that the chosen parameter values conservatively bound performance and therefore bound uncertainty.
ii. Although validating the UNSAT-H model associated with the license amendment is not practicable, confidence that the model performs for the purposes for which it is designed is important. For example, documents describing other sites or projects that validated UNSAT-H percolation estimates (i.e., subsequent field studies verified that the simulated results for those sites were close to actual results) would support current UNSAT-H model results.
iii. Provide references or validation documents that UNSAT-H can meaningfully predict the amount of percolation or infiltration when the

precipitation is in the form of snow.

i. Provide additional information concerning the uncertainty involved with the UNSAT-H output. Specifically, how much uncertainty is involved with the Point of Diminishing Returns (PODR) calculation results as seen in Appendix G, Attachment G.7, Figure 18. A deterministic approach can be useful to bound uncertainty when the analysis can be demonstrated to be conservative. Appendix G, Attachment G.7, Section 7 states that although the varied input parameters such as soil, vegetation and cover profile geometry showed some sensitivity, the most sensitive item was the climatic variation. If precipitation is the dominant process influencing performance, additional sensitivities case should be run to provide reasonable assurance that the chosen parameter values conservatively bound performance. Appendix Y, Section 4.2.2 claims that the 20-year UNSAT-H run average-wet-average precipitation is conservative. Provide additional information to support this conclusion, since the reports do not show how the soil water storage capacity is reacting. Figures 21 and 22 do provide some information in this regard; however, the extremely high soil suction in the fill layers (initial suction is in the millions of -cm) prevents a close analysis of what is happening in the "store and release" cover. Because precipitation is assessed in the application to be the most sensitive item, various combinations of long-term dry, average, and wet cycles, for example, could show which combinations are the most plausible, and thus demonstrate conservatism in the approach. These could be combined with additional scenarios, e.g., fire or drought may destroy the vegetation so that transpiration is minimal for several years. The ranges in the parameters selected should be consistent with the variability and uncertainty in the parameters, and the selected ranges should provide the NRC staff with sufficient information to conclude that uncertainty on performance is bounded. If the factors that affect the evaporation rate are included in the UNSAT-H code as adjustable parameter variables, these factors should be varied and included in additional sensitivity runs.

ii. Gauging uncertainty through formal validation exercises, such as model calibration, history matching, and prediction, is difficult for long-term disposal projects. But confidence that the models perform as they are designed, capture relevant features and processes of the disposal system being modeled, and reflect the uncertainty in system knowledge remains central. Previous applications of predicting long-scale recharge using UNSAT-H may have been later validated by subsequent field studies. Providing such documentation would help support current model results.

iii. The Fort Wingate weather data set contained the wettest year on record (1906), having an annual precipitation volume of 23.8 inches (84.8 cm). Much of the precipitation came in as snow from January to April and October to December. This is a period when PET should be low and transpiration of moisture through vegetation is minimized or completely ceased in the modeling, although Appendix Y's Figures 12 and 13 still show relatively high PET for these months. Even on sunny days, evaporation from a layer of snow would be minimal, besides a small amount of sublimation, so that most of the snow thickness would melt and infiltrate unhindered into the soil. NRC staff is not clear during what time of the year potential evaporation rates at the Church Rock site are sufficiently high enough to draw water back up from the soil, but this appears to not be possible during the winter months.

The information is required for the NRC staff to demonstrate compliance with the following criteria in 10 CFR Part 40, Appendix A: Criterion 4(c), which provides requirements for the embankment and cover slopes for tailings 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.

RESPONSE: Response from Dwyer Engineering:

i. Uncertainty in UNSAT-H output comes from uncertainty in input parameters and upper boundary conditions or climate. To overcome this, multiple simulations were performed to provide a full suite of sensitivity analyses that evaluated the envelope of possibilities for soil, vegetation, and climate. The worst case results or results that required the deepest cover profile to minimize flux were provided as output in the reports.

ii. The UNSAT-H computer code was developed and is managed by the Hydrology Group at the Pacific Northwest National Laboratory, a U.S. Department of Energy multipurpose laboratory. UNSAT-H has undergone a number of validation studies (e.g., Dwyer 2003; ITRC 2003; Khire et al. 1997; Khire et al. 1999; Roesler et al. 2002; Scanlon et al. 2002; Scanlon et al. 2005; Ogorzalek et al. 2008; Bohnhoff et al. 2009). UNSAT-H verification and validation was also performed for INL projects (Baca and Magnuson 1990; Magnuson 1993).

iii. The UNSAT-H computer code does not specifically have a snow option for precipitation. The precipitation files used for all simulations conservatively applied precipitation at a rate slow enough to allow all precipitation to infiltrate in most cases. This is conservative because much of the precipitation for NECR runs off, including snow that melts while the underlying ground is still frozen. The complete infiltration adds conservatism, but also accounts for slow snow melt that may infiltrate more than a typical summer thunderstorm. With regard to snow, it is further conservative given that a significant amount of snow that accumulates on the ground is subject to loss from sublimation.

RAI 3.8-6 Disposal Cell Hydraulic Conductivity

Cedar Creek (2014) documented vegetation characterization and biointrusion surveys. The biointrusion survey appears to have been confined to mammals. NRC staff have observed on several occasions that there are numerous ant colonies on the current Church Rock cover, so that one could assume that the future cover will also have such colonies. In addition, the report states that the root system of a fourwing saltbush may extend 2 to 6 m below the surface and the root system of big sagebrush may extend 1 to 4 m below the surface. Could deeper ant colonies and plants with longer taproots bring mine spoil material to the surface, or does the licensee believe that a lack percolation will affect the vegetation growing on the cover such that these characteristics would not be in common with the current cover; please provide the basis for this conclusion. Does the licensee have a basis for concluding that hydraulic conductivity values are not sufficiently altered so that UNSAT-H results are influenced, or if not, what would that impact be?

In addition, provide references for the projected communities that are expected to inhabit the repository for the following timeframes (page 2):
Reclaimed: 0 - 50 years; grassland: 25 - 100 years; shrubland: 50 - 1,000 years.

The information is required for the NRC staff to demonstrate compliance with the following criteria in 10 CFR Part 40, Appendix A: Criterion 4(c), which provides requirements for the embankment and cover slopes for tailings 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.

RESPONSE: Response from Dwyer Engineering: *Biointrusion is not a performance objective for the NECR final cover system. Ants reside on the existing cover and will likely reside on the proposed ET Cover. Fourwing saltbushes and other vegetation expected on the proposed ET Cover are capable of roots penetrate deeper than the cover system. The tendency for these roots to go deeper in the case of the ET Cover is not necessarily following infiltrated meteoric water, but chasing existing water deeper in the profile during dry periods where minimal water is available near surface.*

Ants and roots can transport small amounts of waste to the surface. However, the proposed ET Cover is more than twice as thick as the existing cover. The planned mine spoils placement and new ET Cover put significantly more distance between the surface and the radioactive mill tailings. This significantly reduces existing risks associated with biointrusion.

Response from Cedar Creek: *The expected ecological succession among the projected repository cover communities follows the same sequence as reclaimed grassland and shrubland. UNC expects the reclaimed community to be dominated by fourwing saltbush, a diversity of early/mid seral grasses species, and annual/biennial weedy species. The grassland community is expected to replace all early/mid grass species with blue grama dominance. Likewise, the fourwing saltbush, a short-lived species, and annual/biennial weedy species are expected to die back and be replaced by blue grama and broom snakeweed. Finally, big sagebrush is expected to invade to form the shrubland community.*

The timescale of the transition between communities is difficult to predict. Typically, these communities develop and transition as a result of or in association with land management and climatic factors. While the repository will be subject to the same climatic factors found in natural landscapes, land management activities will be controlled during the repository lifetime. Ecosystems in the arid west have developed and progressed through succession with grazing from native and/or domestic grazers. Institutional controls are planned to preclude grazing on the repository. Therefore, the impact of restricted land use on the progression of ecological communities is difficult to predict, since no examples exist to use as a basis. Succession is expected to progress through the communities sampled and the best estimate for timeframe is the following ranges:

- *Reclaimed Community: 0 – 50 years*
- *Grassland Community: 25 - 100 Years*

- *Shrubland Community: 50 - 1,000 Years*

RAI 3.8-7 Disposal Cell Hydraulic Conductivity

There are several items in Appendix Y that require clarification. A statement or question is associated with each item below. NRC staff asks that the sufficient additional information be provided for each item.

From Appendix Y:

a) Table 9:
Why does the radon barrier have a higher K_s value than the fill ($3.6x10^{-5}$ vs. $2.5x10^{-5}$ cm/s)?
Why does the K_s value for the recompacted radon barrier after the construction of the repository ($3.6x10^{-5}$ cm/s in Tab. 11) have the same K_s value of the existing radon barrier ($3.6x10^{-5}$ cm/s in Tab. 9)?

b) Table 12:
Why are the initial suction values for the fill soil so high (4407686039.0-cm)? Why is the initial suction value for the middle of the radon barrier/liner so high in Figure 23 (over 6000-cm)? Does the compacted radon barrier need to stay moist for it the function as a radon barrier?

c) Figure 16:
Why is there no wet 12th year in the simulation results for profile B2? Why does the annual flux (cm/year) value drop below that of the 10th year?

d) Figures 21 and 22:
Provide labels for the units or layers presented in these figures.

e) Figure 24:
What occurs in the middle of the mine spoils to cause the relatively abrupt change in matric potential around the year 2025?

f) Table A3:
  i. Why is T (transpiration) from the existing cover for Year 1 less than half of the T value from the future cover in Table A4?
  ii. Why is there no change in T at Years 11 and 12?
  iii. Some years have a combined value of T and E that is higher than Precipitation; do these values include contribution from upward movement of water from the mine spoils?

g) Table A4:
  i. Why do values for E seem very high for years 11 and 12? Is any of the precipitation water not accessible for evaporation, or is all precipitation water available to the evaporation process at all times, and what is the licensee’s basis for this assumption?
  ii. For Year 11 there are 4.22 cm of precipitation that is not removed through transpiration, evaporation, or runoff. For Year 20 there are 0.391 cm of precipitation that is not removed through transpiration, evaporation, or runoff. Is this extra water storage within the 4 ft? Water storage data are needed.
  iii. For most years, ET plus runoff does not balance out with

precipitation, i.e., outflow does not equal inflow.

iv. Is “Drain” the same as percolation or deep infiltration?

v. Why are the transpiration values generally higher for the results presented in Appendix A of Appendix Y than for Appendix G, Attachment G.7, Appendix A?

The information is required for the NRC staff to demonstrate compliance with the following criteria in 10 CFR Part 40, Appendix A: Criterion 4(c), which provides requirements for the embankment and cover slopes for tailings 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.

RESPONSE: Response from Dwyer Engineering:

Appendix Y

a. *The radon barrier and the fill ($3.6x10^{-5}$ vs. $2.5x10^{-5}$ cm/s, respectively) Ks values were from the cited samples chosen to best represent those specific layers. For practical purposes, these two saturated hydraulic conductivities are about the same.*

The Ks value for the recompacted radon barrier after the repository construction ($3.6x10^{-5}$ cm/s in Tab. 11) has the same Ks value of the existing radon barrier ($3.6x10^{-5}$ cm/s in Tab. 9). They have the same value because they are the same soil. UNC assumed that the radon barrier was compacted when it was initially installed. The soil is intended to be left in place and recompacted to about the same compaction effort to produce similar hydraulic conductivity values.

b. *There was a footnote in the table stating that suction values were computed based on the assumed saturation level and acquired van Genuchten parameters. This value is only the initial condition.*

Radon barrier moisture content is a sensitive parameter for reducing radon flux based on the RAECOM model. UNC performed the radon flux analysis using a long-term moisture content computed as described in NRC Regulatory Guide 3.64 (NRC, 1989).” Analysis results estimated a radon flux less than the allowable 20 pCi/m^2s.

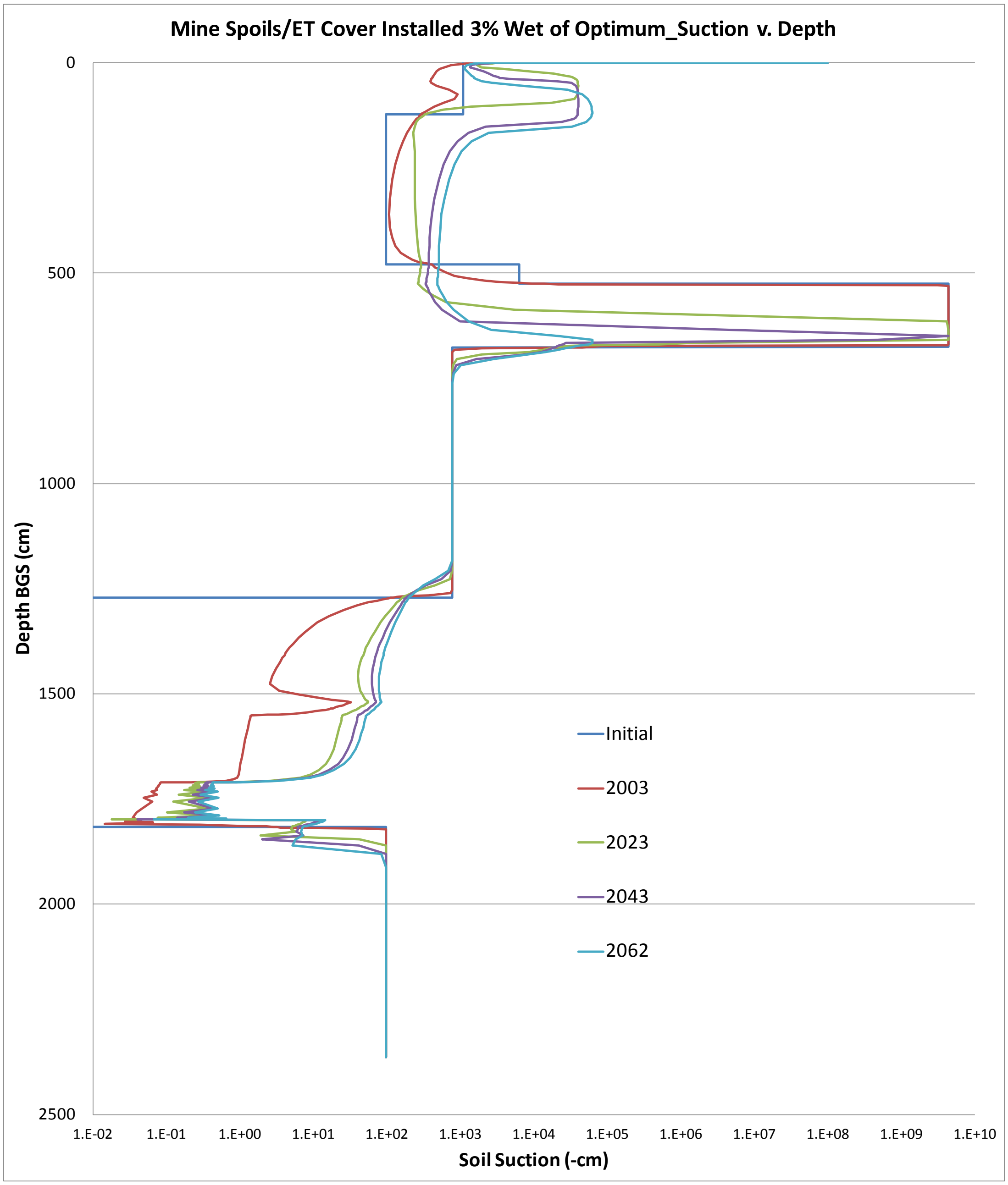
It should be noted that the proposed ET Cover over mine spoils poses less risk for radon flux than the existing thinner cover overlying tailings.

c. *There is a wet 12^{th} year. However, due to the condition of the modeled profile during this 12^{th} year, there was 5.371 cm of runoff produced. This is the reason the net annual flux for that year is not as high as the previous wet year. Refer to the supplied output files.*

The modeled profile (Profile B2) represents the north cell where there are no coarse-grained tailings and only a thin amount of fine-grained tailings. Much of the north cell has no fine-grained tailings, only fill soil. This profile also has the shallowest fine-grained tailings modeled. The shallow fine-grained tailings with *a low saturated hydraulic conductivity keep recently infiltrated moisture above the tailings layer and closer to the surface for an extended time period compared to other areas with deeper fine-grained tailings. The 12th year as previously noted yielded 5.371 cm of runoff. This is meteoric water that did not infiltrate into the profile and was not available for percolation in subsequent years. This large amount of runoff did not occur in any other simulation. Additionally, the transpiration reduced while evaporation increased in years 13 to 20. This is presumed to be due to the shallower profile and reduced storage capacity of the upper portion of the profile above the fine-grained soils that slow downward water movement. The infiltrated water is held closer to the surface and more readily available for evaporation.*

d. *Figures 21 and 22 have units shown on both axes (y axis – depth BGS is cm; x-axis – soil suction is -cm) and have a legend identifying the soil suction values for the entire profile for five of the simulated years (initial, 2003, 2023, 2043, 2062) intended to show how the soil suction within the profile changes over time.*

e. *It is a consequence of the node chosen to represent the middle of the mine spoils. The profile is slowly moving toward a steady state condition. As such, the soil suction in each soil layer is moving closer to the adjacent layer. The node chosen to be graphed here just moved past a time where the transition of soil suction from the overlying node changed significantly. It is easier to see in the graph below. As time progresses, the suction values are smoothing from the initial condition where they are straight lines to curves that smooth with time due to the interaction of the moisture values in adjacent nodes. The smoothing is more noticeable near the intersection of layers.*



f. Table A3

i. The root parameters used in the model for the existing profile were for shrub land vegetation with a depth of 155 cm. Shrubs are the predominant vegetation on the existing cover. The rooting parameters for the profile with the ET Cover were that for reclaimed vegetation at a depth of 147 cm. This is because the reclaimed type vegetation is expected for this initial 20-year period.

Figure 17 shows that annual flux is significantly greater for the existing cover than for the proposed ET Cover. The drainage provided in the Tables A3 and A4 is the drainage for the entire profile, not the cover system. This drainage is produced due to the bottom boundary condition as a unit gradient. The difference in flux through the cover is the primary *reason for the difference in ET (transpiration and evaporation) between the profiles. This is the reason for the difference in transpiration.*

- *ii.* *There is a slight difference in T from year 11 (11.181 cm) to 12 (11.239 cm). UNC assumes the intent of the comment is a request to explain why no significant increase in T from year 10 (11.316 cm) to year 11 (11.181 cm) occurred even though the precipitation increased from 29.743 cm to 60.35 cm. The increase in infiltrated moisture in years 11 and 12 compared with years 1 to 10 is removed via evaporation. The evaporation increased in year 11 (27.932 cm) compared to year 10 (17.573 cm) due to the difference in precipitation amounts applied.*

- *iii.* *Yes, combined with changes in water storage of the profile. The E plus T in Year 1 is greater than Precipitation due to the assumed initial conditions for the simulation – relatively wet profile. Years 2 to 12 the combined value of E and T is less than Precipitation. Much of the difference is associated with the change in water storage for the modeled profile. Refer to the submitted output files (Attachment 1). Years 1 to 10 and 13 to 20 are typical precipitation years (29.743 cm). Years 11 and 12 are the wet years (60.35 cm). The greater ET in year 13 is because the change in water storage of the profile after the two wet years has increased and there is more available water to be removed via E and/or T.*

g. Table A4

- *i.* *The Precipitation for years 1 to 10 is 29.743 cm per year. In years 11 and 12, the Precipitation is increased to 60.35 cm. Evaporation increased significantly between years 1 to 10 and years 11 and 12 due to the removal of much of the infiltration (increase in water storage within the profile) resulting from the increased precipitation.*

- *ii.* *Yes, there is an increase in stored water and infiltration within the modeled profile due to increased precipitation (wettest year on record) in year 11. Water storage was not included because UNC felt the information may confuse the reader. The computed change in water storage is for the entire profile modeled and not just the cover. All input and output files are provided with this submittal (Attachment 1). The output files contain the change in water storage for the simulations.*

- *iii.* *Correct. The water balance equation is precipitation = transpiration + evaporation + runoff + drainage + change in water storage. The drainage in the table is that through the modeled profile and is due to application of a bottom unit gradient boundary condition. See reply above.*

- *iv.* *Drain is drainage though the entire modeled profile. This drainage is due to the application of a bottom unit gradient boundary condition and does not necessarily represent reality. UNSAT-H and any other unsaturated flow model require upper and lower boundary conditions on the modeled profile. The most common bottom boundary is the unit gradient condition. This boundary condition forces drainage from the bottom node at a steady state rate equal to the assigned saturated hydraulic conductivity of that node. The bottom boundary condition was placed deep in the modeled profile far enough from the upper transient moisture activity so as not to* *affect the transient moisture activity during the simulation.*

v. *It is a consequence of the difference in the profile modeled. Values shown in Appendix G, Attachment G.7, Appendix A are for the sensitivity analyses performed to evaluate the available cover soil borrow sources and vegetation possibilities. The profile was consistently 300 cm deep varying the upper portion for the admixture depth. The cover soil used was consistent through the profile. The values in Appendix A of Appendix Y are from Profile B8 that takes into account the cover over the multiple layers of existing fill, tailings and alluvium. The difference in profiles affects the water movement within the respective profile even though the applied precipitation is the same. This affects the output. The transpiration values are generally lower but the evaporation is higher in the profiles represented in Appendix G, Attachment G.7, Appendix A compared to those summarized in Appendix A of Appendix Y.*

Section 4 - Surface Water Hydrology and Erosion Protection

RAI 4.1-1 Hydrologic Description of Site

Please either add Figure 4.2-12 in Appendix I or indicate a correct figure number for NRC's technical review.

Section 3.1.3 of the SRP directs the NRC staff to review the description of structures, facilities, and erosion protection designs to determine if they are sufficiently complete to allow for an independent evaluation of flooding. In Section 4.2.3, the licensee stated, *"…The chute will slope longitudinally at 5.3 percent for about 56 feet vertically, where the flood flows will discharge into a sunken riprap basin. A 5.3 percent slope was selected over steeper slopes that would have less excavation volumes because the 5.3 percent slope grades the chute beyond the steep drop in the arroyo bed (see Appendix I, Figure 4.2-12)."*

The Figure 4.2-12 is missing in Appendix I. The missing information is related to the flood flow analysis for the design of riprap chute and the hydraulic design for the sunken riprap basin.

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criterion 1 is met, which relates to minimization of erosion, disturbance, and dispersion by natural forces**.**

RESPONSE: *In Section 4.2.3 of License Amendment Request (LAR), the text incorrectly cross-referenced Appendix I, Figure 4.2-12. The correct reference is Figure I.7-12. This correction was made to Section 4.2.3 and updated text is included as Attachment 2.*

RAI 4.2-1 Flooding Determinations

In attachment G.7 of the LAR, the licensee uses the Rational Method to estimate the amount of runoff in its calculation of the rock sizing for the top slopes of the final cover system over the mine waste repository. In the calculation, the licensee uses a runoff coefficient of 0.3, which is not consistent with the guidance in NUREG-1620 and not otherwise supported. Please justify the use of this value.

Alternatively, the licensee can revise the calculation based on a runoff coefficient of 0.8.

NUREG-1620, Section 3.2.3, acceptance criteria states that correct model input parameters should be used in the analysis. The NRC staff observes that NUREG-1623 recommends using a value of 0.8 for the runoff coefficient (see page D-7). Additionally, the NRC staff observes that the calculation for rock sizing along the 20 percent slope in Attachment G.8 uses a runoff coefficient of 0.8.

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criterion 1 is met, which relates to minimization of erosion, disturbance, and dispersion by natural forces.

RESPONSE: Response from Dwyer Engineering: *Long-term stability of the proposed cover system per NUREG 1623 was satisfied in that the cover surface given the respective slope, slope lengths and rock size used as shown in Appendix G, Attachment G.7, Section 4.2 and Section 4.3, Tables 6 and 8. These tables show the computer stable slopes are greater than the proposed slopes and given the proposed design are expected to be stable for the long-term as defined in NUREG 1623, Appendix A.*

NUREG 1623 simply assumes a Runoff Coefficient (C) factor 0.8 with no justification for this assumption on page D-7. Furthermore, this value is not consistently assumed throughout NUREG 1623. For example, on page A-7 the C value is assumed to be 1.0, again with no justification for this assumption.

The reference cited for the use of C=0.3 is the Civil Engineering Reference Manual (Lindeburg, 1989). This is one of the most common references cited for input parameters for civil engineering applications such as calculating runoff. Values recommended for unimproved soil surfaces are 0.1 to 0.3; farmland values of 0.05 to 0.3; and pasture 0.05 to 0.3. The most conservative value recommended for an applicable surface condition for C (0.3) was used.

The suggested value of 0.8 is applicable for a surface such as concrete, a shingle roof, or asphalt road. This value is not applicable for a soil cover with a slope less than 5 percent. Therefore, the use of 0.8 is not recommended and overly conservative. The final cover system is improved by adding the surface layer composed of a mixture of rock and soil. The surface admixture composed of rock and soil follows a design method developed to mimic nature. That is, provide an armored surface that allows for native vegetation. If the design method uses overly conservative input parameters, the computed rock sizes and mixture depths become impractical to build and ineffective. Calculations performed substituting a C value of 0.8 in lieu of 0.3 changes the largest rock size to almost 6 inches in diameter. This defeats the purpose of the surface admixture.

RAI 4.2-2 Flooding Determinations

Please justify the use of the Brandt and Oberman method used to calculate the time of concentration in Attachment G.7 and in Attachment G.8 of the LAR. Neither the SRP or additional guidance in NUREG-1623 identify this method as one to consider when estimating the time of concentration. Alternatively, the licensee can consider using a method identified in the SRP or NUREG-1623 to calculate the time of concentration.

NUREG 1620, Section 3.2.3, acceptance criteria states that correct model input parameters should be used in the analysis and that the computational methods used for the design flood estimates are adequate. The time of concentration is a key factor in estimating the peak runoff. The NRC staff performed an independent check of the time of concentration calculations using a different method. The NRC staff's estimated times of concentration that were consistently shorter than what the licensee provided in Tables 3 and 4. As the relationship between time of concentration and peak discharge is inverse (a shorter time of concentration results in higher discharge), the licensee's calculations may not represent a conservative analysis.

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criterion 1 is met, which relates to minimization of erosion, disturbance, and dispersion by natural forces.

RESPONSE: *The Department of Energy (DOE) Technical Approach Document dated December 1989 (DOE/UTMTRA – 050425-0002) recommends the Brant and Oberman (1975) method to estimate time of concentration on a rock cover slope. This document describes the technical approaches and design criteria adopted by the DOE to implement remedial action plans and final designs for uranium mill tailings facilities that comply with EPA standards. Section 4.2 (Rock Cover Design) of the DOE document presents the Brant and Oberman equation for determining the time of concentration of sheet flow off a stabilized pile. The Brant and Oberman equation is similar to the Kirpich methods presented in Section 2.1.2 of NUREG-1623 in that it was developed for overland flow on steep slopes and accounts for the overland flow length and gradient. Using the Brant and Oberman equation is consistent with the NUREG-1623 guidance that states that a method such as the Kirpich method should be used. An advantage of the Brant and Oberman equation is that it also includes parameters to account for the land cover type and the rainfall intensity and can be tailored for site-specific conditions more than the Kirpich method, which only includes length and gradient parameters.*

Response from Dwyer Engineering: *NUREG 1623 was satisfied in that the cover surface with respective slope and slope lengths was shown to be stable given the rock size utilized as shown in Appendix G, Attachment G.7, Section 4.2 and Section 4.3, Tables 6 an 8.*

The Technical Approach Document published by the Department of Energy for design of UMTRA sites (DOE 1989) recommends the Brandt and Oberman method to compute the time of concentration.

*NUREG-1623, page D-11 states that the "Kirpich Method **or other methods** may be used" to calculate the time of concentration.*

RAI 4.2-3 Flooding Determinations

Please explain the 1.73 parameter that is used as a 'scale factor from 10-min to D' on the calculation worksheet in Attachment G.8. The NRC staff was not able to locate an explanation or source for this number.

NUREG-1620, Section 3.2.3 directs the staff to verify that model input parameters are accurate. It is not apparent to the NRC staff why the value of 1.73 was chosen or where it came from. This number is used in a calculation package to estimate the unit slope discharge for the 20 percent side slope on the proposed mine waste repository.

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criteria 1, Criteria 4(a), Criteria 6(1) and Criteria 12 are met.

RESPONSE: *The method for designing rock cover in NUREG-1623 and in DOE/UMTRA – 050425-0002 requires determination of the probable maximum precipitation (PMP) intensity that corresponds to the time of concentration. The time of concentration computed using the Brant and Oberman method from DOE/UMTRA – 050425-0002 was less than 2.5 minutes and was, therefore, set to 2.5 minutes per the guidance of DOE/UMTRA – 050425-0002. The Arizona Department of Water Resources (ADWR) PMP estimation tool, which was used to estimate PMP intensities, does not provide precipitation depths for time intervals finer than 10 minutes. Consequently, the 2.5-minute-PMP intensity needed to be estimated by "scaling-up" from the 10-minute-PMP intensity.*

Table 4.1 in Section 4.2 of DOE/UMTRA – 050425-0002 provides a basis for scaling sub-hourly rainfall intensities using the following equation:

$$PMP\% = \frac{RD}{0.0089 * RD + 0.0686}$$

Where:
PMP% = the percent of the 1-hour PMP depth that falls in the given rainfall duration
RD = rainfall duration

This equation relates the PMP depth of a sub-hourly time duration to the hourly PMP depth. By further development of this equation the ratio of the 2.5-minute-PMP intensity to the 10-minute-PMP intensity can be developed, as shown in the equation set below:

$$2.5\ minute\ PMP\ Intensity = \left(\frac{2.5}{0.0089*2.5+0.0686}\right) * \frac{60\ minutes/hour}{2.5\ minutes} * \text{1-hour PMP Depth}$$

And

$$10\ minute\ PMP\ Intensity = \left(\frac{10}{0.0089*10+0.0686}\right) * \frac{60\frac{minutes}{hour}}{10\ minutes} * \text{1-hour PMP Depth}$$

So that

$$\frac{2.5\ minute\ PMP\ Intensity}{10\ minute\ PMP\ Intensity} = \left(\frac{660\ inches/hour}{380\ inches/hour}\right) = 1.73$$

RAI 4.2-4 Flooding Determinations

Please correct the apparent inconsistencies indicated in the table below and provide this information to NRC. Because this correction is also related to RAI 4.2-5, please provide complete corrections related to the modeling input, output data, and modeling parameters where applicable.

NUREG-1620, Section 3.2.3 directs the NRC staff to verify that model input parameters and computational methods are accurate. The licensee provided the HEC-HMS model stored in a DVD for an amended Reclamation Plan. The HEC-HMS model is labelled as "NECR_95_HMS4.2.1." The model, NECR_95_HMS4.2.1," has been reviewed by the staff. It is found that some input parameters and data assigned to the model are not consistent with the data shown in Attachment I.1 to Appendix I, MILL SITE STROMWATER CONTROLS. The inconsistencies are summarized in the below table.

Items	The licensee's parameter values used in the "NECR_95_HMS4.2.1" model are inconsistent with the values presented in the LAR application report. The tables in the report relevant to the inconsistencies are shown in the third column of	Attachment I.1 in Volume I report of the LAR application
1	Sub-watershed areas	Tables A2 and A5 of Attachment A to Attachment I.1
2	Existing Condition Rainfall Loss for watershed IDs, 19, 22, and 35.	Table C1 of Attachment C to Attachment
3	Maximum Storage	Tables C4 and C5 of Attachment C to Attachment I.1
4	Pond Surface Areas	Table F6 of Attachment F to Attachment
5	Area-weighted Averaged PMP Depth in the Pipeline Arroyo watershed is 6.543 inches for 6-hour duration.	Table 4 of Attachment I.1 presents 6.47 inches
6	Trapezoid Channel Bottom Widths	Table E3 of Attachment E to Attachment
7	Channel Lengths	Table E3 of Attachment E to Attachment

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criterion 1, Criterion 4(a), Criterion 6(1) and Criterion 12 are met.

RESPONSE: *Stantec reviewed the modeling input data and found that the majority of the inconsistencies identified by the reviewer were due to miss-reporting the input values in Attachment I.1 and the values input to the HEC-HMS model (NECR_95_HMS4.2.1) were accurate. Exceptions to this are Table C.1 and Table*

C.4. The values reported in these tables in Attachment I.1 were accurate and the HEC-HMS model has been updated. The change in flow rates resulting from these updates are insignificant to the closure design as the maximum change to the discharge results for points of interest to the closure design is less than 0.5 cfs.

The following tables have been updated in response to this comment:

Table A2: Pipeline Arroyo, Post-RA Condition Watershed Areas
Table A5: Watersheds to Size Temporary Haul Road Stormwater Controls
Table C4: Mine Site, RA-Phase 3 Construction Rainfall Loss Parameters
Table C5: Temporary Haul Road, Rainfall Loss Parameters
Table E3: Channel Routing Parameters for Mill Site, Post-RA Condition Model
Table F6: Stage-Area-Storage for Temporary Plug at Pond 3

Stantec confirmed that these values match the values in the HEC-HMS model. An updated version of Attachment I.1 is included as Attachment 3 to this submittal. The updated HEC-HMS files are included as Attachment 4 to this submittal.

RAI 4.2-5 Flooding Determinations

Please provide a corrected file of “NECR_95_HMS4.2.1” that can be executed by the NRC staff to check the consistency between Attachment G and the “NECR_95_HMS4.2.1” modeling results.

The model, “NECR_95_HMS4.2.1,” has been reviewed by the staff. It found that some output data from “NECR_95_HMS4.2.1” model are not consistent with the data shown in Attachments G1 through G16 of Attachment G of Attachment I.1 to Appendix I MILL SITE STROMWATER CONTROLS. NUREG-1620, Section 3.2.3 directs the staff to verify that model input parameters and computational methods are accurate.

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criterion 1, Criterion 4(a), Criterion 6(1) and Criterion 12 are met.

RESPONSE: *The following results tables were updated to correct the inconsistencies noted in the comment:*

- *Table G4: HEC-HMS Model Results for Pipeline Arroyo, Post-RA Condition 1-Hour PMP*
- *Table G5: HEC-HMS Model Results for Pipeline Arroyo, Post-RA Condition 10,000-Year, 24-Hour Storm*
- *Table G6: HEC-HMS Model Results for Pipeline Arroyo, Post-RA Condition 1,000-Year, 24-Hour Storm*
- *Table G7: HEC-HMS Model Results for Pipeline Arroyo, Post-RA Condition 200-Year, 24-Hour Storm*
- *Table G8: HEC-HMS Model Results for Pipeline Arroyo, Post-RA Condition 100-Year, 24-Hour Storm*
- *Table G9: HEC-HMS Model Results for Pipeline Arroyo, Post-RA Condition 10-Year, 24-Hour Storm*
- *Table G10: HEC-HMS Model Results for Pipeline Arroyo, Post-RA Condition*

5-Year, 24-Hour Storm

- *Table G11: HEC-HMS Model Results for Pipeline Arroyo, Post-RA Condition 2-Year, 24-Hour Storm*
- *Table G12: HEC-HMS Model Results for Mill Site, Post-RA Condition 1-Hour PMP*
- *Table G13: HEC-HMS Model Results for Mill Site, Post-RA Condition 10-Year, 24-Hour Storm*
- *Table G14: HEC-HMS Model Results for Mill Site, Post-RA Condition 2-Year, 24-Hour Storm*
- *Table G15: HEC-HMS Model Results for Mine Site, RA-Phase 3 Construction 2-Year, 24-Hour Storm*
- *Table G16: HEC-HMS Model Results for the Temporary Haul Road Stormwater Controls 10-Year, 24-Hour Storm*

Additionally, four tables for the existing conditions Pipeline Arroyo model parameters and results were updated to correct inconsistencies:

- *Table D1: Pipeline Arroyo, Existing Condition Clark Unit Hydrograph Parameters*
- *Table G1: HEC-HMS Model Results for Pipeline Arroyo, Existing Condition 1-Hour PMP*
- *Table G2: HEC-HMS Model Results for Pipeline Arroyo, Existing Condition 100-Year, 24-Hour Storm*
- *Table G3: HEC-HMS Model Results for Pipeline Arroyo, Existing Condition 2-Year, 24-Hour Storm*

An updated version of Attachment I.1 to Appendix I is included as Attachment 3 to this submittal. The updated HMS files are included as Attachment 4 to this submittal.

RAI 4.2-6 Flooding Determinations

Please correct the apparent inconsistencies as indicated in the table below. In reviewing the LAR, Appendix I, the NRC staff identified several apparent inconsistencies. The NRC staff provides the table below to show the inconsistencies in the LAR Volume I report. NUREG-1620, Section 3.2.3 directs the staff to verify that computational methods are accurate. With these inconsistencies, the NRC staff is not able to confirm the accuracy of the computational methods.

	Inconsistencies found by comparing		
Items	Place One	Place Two	Inconsistency
1	Table 10 of Attachment I.1 shows PMF, 26,764 cfs. for	Table G1 of Attachment G to Attachment I.1 shows PMF, 26,443.5	PMF values
2	Table 10 of Attachment I.1 shows peak flow for a 100-year flood is 4,766 cfs.	Table G2 of Attachment G to Attachment I.1 shows 4,826.2 cfs.	100-year peak flood

3	Table 10 of Attachment I.1 shows peak flows for Temporal Culverts 11 through 16.	Tables G10 and G13 of Attachment G to Attachment I.1 show different peak flows when compared to	10-year peak flood
4	On page 2-2, Section 2.4.3 of Volume I, the licensee shows 1-hour	Table 2.9-1 of Volume 1 shows the PMP. That is	1-hour PMP depth
5	Table G1 of Attachment G to Attachment I.1 shows that a runoff volume is 31.302 inches for the model element "J-R16ds." This runoff volume is	Table 4 of Attachment I.1 shows that 1-hour PMP depth is 6.14 inches.	Runoff volume

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criterion 1, Criterion 4(a), Criterion 6(1) and Criterion 12 are met.

RESPONSE: _Item 1_
The PMF value computed in the HEC-HMS model (26,758.5 cfs) is the correct value and the values reported in Table 10 of Attachment I.1 and Table G1 of Attachment G of Attachment I.1 were updated accordingly. An updated version of Attachment I.1 to Appendix I is included as Attachment 3 to this submittal.

Item 2
The 100-year peak discharge value computed in the HEC-HMS model (4,766 cfs) was accurate. Table G2 of Attachment G of Attachment I.1 was updated accordingly. An updated version of Attachment I.1 to Appendix I is included as Attachment 3 to this submittal.

Item 3
The flows reported for temporal culverts 11 through 16 were updated to match the model values. An updated version of Attachment I.1 to Appendix I is included as Attachment 3 to this submittal.

Item 4
The value for the 1-hr PMP depth in Section 2.4.3 of Volume 1 was updated to the correct value of 6.14 inches. The updated LAR, Volume 1 is included as Attachment 2 to this submittal.

Item 5
The runoff volume of 31.302 inches for element J-R16ds highlights a limitation in the HEC-HMS software. This output is generated due to the connection to the upgradient pond structures being coded as an "auxiliary connection". The model computes inches of runoff by first computing the runoff volume passing through the model element then dividing the volume by the contribution area. The model did not consider the area above the auxiliary connections as contributing to the element.

The following calculation table shows that if the model used the total upstream drainage area of 0.520563 mi^2 rather than 0.037395 mi^2 the runoff volume would *be 2.2 inches, which is lower than the PMP depth of 6.14 inches.*

A more appropriate way to report the runoff volumes in this case would be in units of acre-feet rather than inches. Stantec updated Tables G1 to G16 of Attachment G to Attachment I.1 to report volumes in acre-feet. An updated version of Attachment I.1 to Appendix I is included as Attachment 3 to this submittal.

HMS Element J-R16ds Results 1-hr PMP	
Runoff Volume (acre-ft)	62.429
Reported Upstream Drainage Area (mi^2)	0.037395
Reported Runoff Volume (inches)	31.3
Reported Volume/Reported Area (inches)	31.3
Actual Upstream Drainage Area (mi^2)	0.520563
Actual Volume (inches)	2.2

RAI 4.2-7 Flooding Determinations

Please add embankment elevations in Table 9 of Attachment I.1 of the LAR.

Table 9 of Attachment I.1, Pond Outlets Specified for Hydrologic Modeling, shows the crest elevations of auxiliary spillways for Ponds 1 through 4. The embankment top elevations of those ponds are not described. These unknown elevations need to be included so that the staff can compare the pond embankment elevations with maximum pond levels for a PMP event to ensure that overtopping flows would not appear in hydrologic simulations. NUREG-1620, Section 3.2.3 directs the staff to verify that model input parameters are accurate.

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criteria 1, 4(a), 6(1) and 12 are met.

RESPONSE: *The top elevations of the ponds were included in an updated Table 9 of Attachment I.1 (included as Attachment 3 to this submittal). These "ponds" are legacy mine features left behind by historical mining activity and are not engineered structures, but rather large depressions below the existing terrain. Stantec considered them as ponds in the hydrologic model to explicitly account for the water stored in these topographic depressions. These "ponds" are at the Mine Site (not the Mill Site) and are only pertinent to the Mill Site design so far as they affect flow rate at the Mill Site features.*

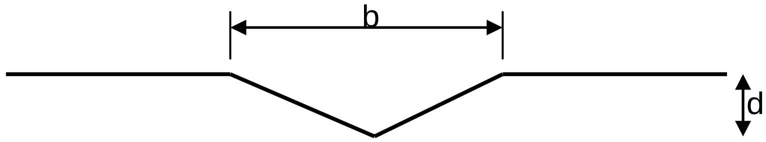
RAI 4.3-1 Water Surface Profiles, Channel Velocities, and Shear Stresses

In Attachment G.7, Tables 5 and 7, please explain how the term 'dh' is calculated. Alternatively, please provide a copy of these tables in a format such that the NRC staff can verify the equations used in the calculation. The NRC staff was not able to locate an explanation or source for this number.

NUREG-1620, Section 3.2.3 directs the staff to verify that model input parameters are accurate. Tables 5 and 7 in Attachment G are used in the calculation of the shear stresses for the design of the admixture of the final cover system. During its review, the NRC staff was not able to verify how this number was calculated.

This information is required for the NRC staff to determine whether 10 CFR Part 40 Appendix A, Criteria 1, 4(a), 6(1) and 12 are met.

RESPONSE: Response from Dwyer Engineering: *Assuming a 'V' shaped erosion channel;*



Channel Geometry
the width of the channel is determined by:

$b = 37\ (Q_m^{0.38} / M^{0.39})$

Where:

b = width of flow (ft)
Q_m = mean annual flow (cfs)
M = percentage of silts and clays in soils

The mean annual flow (Q_m) is assumed to be between 10 to 20 percent of the peak rate of run-off (Q); 10 percent was used. The fines content (M) is known. For the given discharge point of geometry, the hydraulic depth (d_h) is defined as the flow cross-sectional area divided by the width of water surface (b) and is half of the gully depth (d).

For flows at the critical slope:

$b = 0.5\ F^{0.6}\ F_r^{-0.4} Q^{0.4}$

Where:
F = width to depth ratio = b/dh
F_r = Froude Number ≈ 1.0

Thus, the hydraulic depth (d_h) can be solved for. Solving,
$d_h = (1/12.03) * M^{0.2597} * Q_m^{0.4136}$

RAI 4.3-2 Water Surface Profiles, Channel Velocities, and Shear Stresses

This is related to the hydraulic jump length in the sunken basin at the bottom of the riprap chute and has two parts (see item a and b below). Please either provide a justification for the licensee's calculated hydraulic jump length or provide corrected hydraulic jump lengths indicating that the hydraulic jump lengths of PMF and other floods (e.g. 200-yr and 1000-yr floods) are controlled within the sunken basin. Additionally, please either provide velocity distributions or warrant the submerged hydraulic jump within the sunken basin under various tailwater conditions to indicate that the submerged hydraulic jump condition is always in low flow velocity condition without riprap rock protection for the sunken basin.

NUREG-1620, review procedure (4) in SRP section 3.4.2 directs the staff to evaluate the outlet areas of channels to verify that the discharge area is adequately protected. In Section I.7.3 of Appendix I, the licensee stated, "*The sunken riprap basin is designed at the toe of the chute. The basin has a depth of 2 feet and a length of about 100 feet. The hydraulic modeling shows that the hydraulic jump on the chute will be a submerged jump and controlled by the downstream constriction (see Attachment I.7). Therefore, the jump length will not be influenced by the outlet basin length. To account for potential changes in downstream conditions, the length of the outlet basin was designed by assuming that a free jump would form at the toe of the chute and have a length of six times the sequent flow depth (Chow, 1959) for the PMF, approximately 15 feet.*"

a) The licensee calculated hydraulic jump length based on a free jump, which is six times the sequent flow depth. NRC staff independently calculated the hydraulic jump length and determined the length was 120 feet. The licensee's calculated short hydraulic jump length may be incorrect and not provide enough design length (100 feet) for the sunken basin. Please correct the 100 feet of the basin length shown on Design Drawing 09-11 that should not include the sloping riprap chute length. The Design Drawing 9-11 shows that the riprap rock protection length of outlet apron of the basin is 50 ft and the basin length is 65 feet. Please justify or correct the licensee's computed hydraulic jump length to be confined within the design length (65 ft) of the basin plus the outlet apron length (50 ft).

b) The tailwater at the downstream location can affect the hydraulic jump location and length. Revise or provide additional information or analysis showing that the sunken basin length is sufficient to cover the lengths of hydraulic jump due to lower flows other than the PMF. The licensee may check other flows less than PMF with multiple tailwater conditions, not only a PMF condition. The licensee's design should encompass different hydraulic jump lengths in low flow conditions that are expected and controlled within the licensee's property boundary and the sunken basin.

This information is required for NRC staff to determine if the requirements in 10 CFR Part 40, Appendix A, Criteria 1, 6(1), and 12 are met.

RESPONSE: *Stantec will provide a response with the second submittal of responses for the Group 2 RAIs. The response will address the length of the hydraulic jump length and the design drawings. An updated version of Appendix I will be provided with the second submittal of responses for the RAI Group 2.*

RAI 4.3-3 Water Surface Profiles, Channel Velocities, and Shear Stresses

This RAI is related to the riprap chute design and has three parts.

Please either provide a justification as to why the significant variations of the depth- averaged flow velocity at the cross-section A-A exist in a uniform flow depth or provide changes to the modeling result with the corrected input parameters where applicable.

Please either provide a justification as to why the maximum flow velocity of 27 ft/sec is located near the west bank and not near the centerline of the channel or provide changes to the corrected maximum flow velocity and the relevant modeling parameters where applicable.

Please provide a sediment transport calculation to justify the sediment transport in the design channel of the Pipeline Arroyo between the upstream and downstream of the sunken basin limit to be in a natural balance regime. Please provide information to demonstrate that the design of the downstream channel at the sunken basin outlet can convey the sediment without a sediment deposition to migrate the channel alignment.

In Figure 2 of Attachment I.7, the licensee indicated a maximum depth-averaged flow velocity of 27 ft/sec near the west bank. In Figure 3, the licensee showed that the velocities varied from 27 ft/s to 5 ft/sec within a uniform flow depth of approximately 6 feet. The staff has the following questions about these hydraulic modeling results:

a) Figure 3 shows velocities in a trapezoid channel at cross-section A-A. The staff asks if the significant velocity change (27 ft/sec to 5 ft/sec) at the cross-section A- A of a straight channel is physically reasonable. The staff expects the prismatic channel cross section A-A should produce uniform velocity distribution. Please provide the licensee's rationale and technical basis for the significant velocity change in the cross-section A-A.

b) The licensee did not provide support for having the maximum velocity (27 ft/sec) near the west bank (see Figure 2). In general, a curved channel has a maximum velocity near the outer bank, but the licensee's design channel is not a curved. Please provide additional information to support the model results.

c) The sediment transport between the inlet and outlet of the sunken basin should be in balance after the new rock chute is installed in the Pipeline Arroyo or the accumulated sediment could create sand bars to block the narrow stream flow outlet if the sediment transport in the channel is not designed to meet a natural regime. Without calculating the proposed sediment transport, the license cannot have an estimated sediment deposit in and downstream of the sunken basin. The sediment may accumulate in the downstream riprap rock channel after a hydraulic jump in the sunken basin.

This information is required for NRC staff to determine if the requirements in 10 CFR Part 40, Appendix A, Criteria 1, 6(1), and 12 are met.

RESPONSE: *Stantec will provide a response later as an update. The response will address the hydraulic effects of an asymmetric contraction on velocity distributions in the sunken basin. The response will also address the concern for sedimentation downstream of the basin. An updated version of Appendix I will be provided with the second submittal of responses for the RAI Group 2.*

RAI 4.4-1 Design of Erosion Protection

Please either provide a justification as to why the riprap rock protection was not designed for an extension near the downstream narrow channel or provide the extension of the riprap rock zone at the downstream narrow channel between

Stations 15+80 and 21+00 shown on the Design Drawing 9-09 of Volume II. Please either provide the design flow velocity at the constriction flow area at the end of sunken riprap basin or provide riprap rock layers for erosion protection. Although Figure 3 of Attachment I.7 shows depth-averaged velocity distribution of Flow-3D modeling results, please provide the similar figures for the constriction flow area at the downstream channel near the outlet of sunken basin, (Stations 16+00 and 22+00). Figure 1 of Attachment I.7 of Appendix I shows the plan view of riprap chute. Design Drawings 9-09, 9-10, and 9-11 of Volume II show details for the riprap chute. This is related to the riprap chute design. Please provide technical documentation supporting the licensee's assumption using 12-inch roughness height for the channel surface to simulate flows in the Flow-3D model.

Lack of scour protection design is observed in the downstream channel at the sunken riprap basin outlet (Approximately at Station 15+80, Design Drawing 9-10 of Volume II).

The contraction flow at the constriction section (Station18+00, Design Drawing 9-09 of Volume II) near the end of the riprap chute can create concentration forces that cause erosion and scouring on the downstream narrow stream banks. The NRC staff observes that the recommended flow velocity for a vegetated channel in NUREG-1623 is 2.5 to 3 ft/sec maximum. NUREG-1620, review procedure (4) in SRP section 3.4.2 directs the staff to evaluate the outlet areas of channels to verify that the discharge area is adequately protected.

This information is required for NRC staff to determine if the requirements in 10 CFR Part 40, Appendix A, Criteria 1, 6(1), and 12 are met.

RESPONSE: *Stantec will provide a response later as an update. This response will update Design Drawing 9-09 of Volume II to provide adequate erosion protection at the downstream channel near the outlet of the sunken basin and provide technical support for the assumption of 12-inch relative roughness. An updated version of Appendix I will be provided with the second submittal of responses for the RAI Group 2.*

RAI 4.4-2 Design of Erosion Protection

Please evaluate the sediment transport capacity of the channels around the mine waste repository or justify why sedimentation of the channels is not expected to impact transport.

The NRC staff observes that sediment transport of the east repository channel is addressed in Attachment I.4 of the LAR. However, only a brief mention of the potential sedimentation in the North diversion channel is made in Attachment I.5 and it does not appear that potential sedimentation was considered for other drainage features on or adjacent to the mine waste repository. NUREG-1620, review procedure (4) in SRP section 3.4.2 directs the staff to consider potential sedimentation in drainage features.

This information is required for NRC staff to determine if the requirements in 10 CFR Part 40, Appendix A, Criteria 1, 6(1), and 12 are met.

RESPONSE: *Stantec will provide a response later as an update. This comment will be* *addressed through a sedimentation analysis as described in NUREG-1623 for sedimentation of the repository channels and North Diversion Channel. An updated version of Appendix I will be provided with the second submittal of responses for the RAI Group 2.*

RAI 4.4-3 Design of Erosion Protection

Please demonstrate that the lack of a riprap apron where the mine waste cover system meets the existing ground surface will not result in damage to the cover system. Alternatively, the design could be modified to include a riprap apron. The NRC staff's request should be considered for where the 2 percent, 5 percent, and 20 percent slopes meet the existing ground surface.

During its review of the engineering drawings and calculations in Attachment I, the NRC staff was not able to identify the presence of a riprap apron where the cover system over the mine waste repository meets the existing ground surface. The SRP directs the NRC staff to verify that the design follows the guidance that is available in Appendix D of NUREG 1623. The NRC staff observes that NUREG-1623 discusses riprap sizing at the toe of embankment slopes to minimize the potential for damage to the cover system. NUREG-1623 contains recommendations on the size of the rock that should be considered in a riprap apron, as well as the lateral distance the apron should extend from the toe of the slope.

This information is required for the NRC staff to determine if the regulations in 10 CFR Part 40, Appendix A, Criteria 1, 4(c), 4(d), 6(1), and 12 are met.

RESPONSE: *The repository slopes do not transition directly to natural ground. In all cases the cover will transition to either an armored channel or the existing erosion-protected cover. The 20 percent slope drains directly into the East Repository Channel which is lined with riprap. The 5 percent slopes drain into the North Cell Drainage Channel (on the north side), the Runoff Control Ditch/West Apron with added erosion protection (on the west side), and Branch Swale C (on the southeast side). Revised Section 7 Drawings (Sheets 7-08 to 7-10) were submitted with the Group 1 RAI responses, and show details of how each slope ties in to the existing cover or into the drainage channel. The area on the southwest side of the Repository transitions to the existing cover; however, the 5 percent Repository slope transitioning to the existing 1.2 percent rock cover system does not present an abrupt enough slope transition to require additional apron rock.*

RAI 4.4-4 Design of Erosion Protection

Please revise the LAR to include the results of a petrographic evaluation of the basalt rock considered as a potential rock source. Additionally, please describe the experience and qualifications of the individual who performed the petrographic analysis.

During its review of the rock durability results in Attachment I.8 of the LAR, the NRC staff observed that a petrographic analysis was performed for the Tampico Pit limestone and the Page pit granite. However, the NRC staff was not able to locate the results of petrographic analysis for the basalt rock source. Additionally, the LAR does not appear to describe the background, qualifications, or experience of the individual who performed the petrographic analysis for all of the rock durability test results. The guidance in NUREG-1623, Appendix D suggests that a petrographic analysis should be performed for all potential rock sources and that the evaluation should be performed by a geologist or engineer experienced in this type of analysis.

This information is required for the NRC staff to determine if the regulations in 10 CFR Part 40, Appendix A, Criterion 1, Criterion 4(c), Criterion 4(d), Criterion 4(f), Criterion 6(1), and Criterion 12 are met.

RESPONSE: *Durability testing was previously conducted on basalt samples from the Prewitt Pit for another UNC project. These results are included in Appendix H, Attachment H.1. Because of the longer haul distance, this source is considered a third option to the limestone sources. Stantec removed the basalt source from the riprap options described in the text in lieu of performing petrographic analyses on the source to keep it as a formal option. An updated version of Appendix I will be provided with the second submittal of responses for the RAI Group 2.*

The petrographic analyses on the limestone were conducted by Ken Esposito, a professional geologist at INTERA Inc. (previously with Stantec). Ken has over 30 years of experience and has conducted numerous petrographic analysis during his career for mining projects and focused on petrographic analysis during his ten years with the USGS.

RAI 4.4-5 Design of Erosion Protection

Please revise the technical specifications included with the LAR to include: (1) a methodology and testing frequency for gradation of the riprap and cover soils; and (2) a methodology and testing frequency for layer thickness testing. Alternatively, please describe to the NRC staff where or how the existing technical specifications address these issues.

During its review of the proposed technical specifications included in Appendix J of the LAR (specifically specification 02200 for earthwork and 02273 for riprap), the NRC staff was not able to identify the specifications for the gradation for the materials used in the cover system and riprap used in the channel linings and Pipeline Arroyo. Additionally, the NRC staff was not able to locate where the specifications addressed verification of the in-place thicknesses of the cover system soils or the rip rap placed in channel linings around the mine waste repository (and Pipeline Arroyo). The review procedures in Section 3.4.2 of the SRP direct the NRC staff to consider construction considerations of the proposed activities. Without this information, the NRC staff is unable to verify that the licensee will be able to construct the mine waste repository in a manner that is consistent with the proposed design.

This information is required for the NRC staff to determine if the regulations in 10 CFR Part 40, Appendix A, Criterion 1, Criterion 4(c), Criterion 4(d), Criterion 4(f), Criterion 6(1), and Criterion 12 are met.

RESPONSE: *For the riprap material (channels), the specifications for the gradation of the riprap materials is included in Specification 02273 Section 2.1.B.1 through 2.1.B.6. The specification reads:*

"Control of gradation shall be by visual inspection. The CONTRACTOR shall furnish a sample of the proposed gradation of at least 5 tons or 10 percent of the total riprap weight, whichever is less. If approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap."

For riprap gradation testing, specification section 02273.2.1.F was modified as follows: "Control of gradation shall be by ASTM D5519 or other method, approved by the ENGINEER. The CONTRACTOR shall furnish results for each required gradation. Once approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap."

The larger riprap material is too large for standard sieve analysis. Photo-gradation has been used effectively to verify gradations and can be used in conjunction with modified ASTM D 5519, method C or D, Particle Size Analysis of Natural and Man-Made Riprap Materials which outlines visual methods for gradation. Gradation verification has also been added for riprap under 02273 Section 2.6:

Gradation (Riprap)

a. One photo-gradation verification per 500 lineal feet of channel to include a minimum of one photo-gradation on the channel bottom paired with one photo-gradation on the side slope from each location; using representative sample areas based on the size of the material.

Riprap in-place thickness shall be confirmed by survey measurement. The following has been added to Specification 02273 Section 2.5.D: "Riprap thickness shall be confirmed by survey measurement of the completed layers by comparison with the top of the underlying surface (tolerance of -20% to +40% thickness of the design layer) and approved by the ENGINEER prior to placement of the next layer."

Soil Cover in-place thickness shall be confirmed by survey measurement. The following was added to Specification 02200 Section 2.2.D.2: "Soil cover thickness shall be confirmed by survey measurement of the completed layers by comparison with the top of the underlying surface (tolerance of 0% to +5% thickness of the design layer) and approved by the ENGINEER prior to placement of the next layer."

Cover Admixture layer thickness was already included in Specification 02200 Section 2.2.E.5.a.

Specification 02200 Section 2.2.D and 2.2.E states that "Soil Cover shall consist of suitable materials from the approved borrow areas…" There is no requirement for testing gradations of soil cover. If the soil is from one of the approved borrow areas, it is acceptable.

The following has been added to Specification 02200 Section 3.17.1 Gradation:
e. Cover Rock: One test per 3,000 cubic yards of each size material, imported or stockpiled or, in the determination of the ENGINEER, as source materials change.

Updated Specifications 02200 and 02273 are included as Attachment 5to this response document.

RAI 4.5-1 Design of Erosion Protection Covers

Please either clarify that the analyses related to erosion control in the Attachments G.7, G.8, I.1 (for the mill site post-RA conditions), I.2, I.3, I.4, I.5 are based on the cover and associated drainage features for the mine waste repository in an optimal condition or whether the analyses reflect a degraded scenario. The NRC staff recognizes that a degraded scenario could occur either when no vegetation is present on the cover system, potentially leading to higher peak flows; or when vegetation is present in the repository drainage channels, potentially leading to decreased flow capacity. Alternatively, revise the LAR to include an analysis of the erosion control aspects of the cover system that reflect potential changes.

In reviewing the calculations in Attachments G and I of Appendices G and H of the LAR, it appears that the licensee has only considered a situation where the cover is functioning as intended. However, Section 3.5.2 of the SRP provides that the NRC staff evaluate the shear stresses and permissible flow velocities over the cover with potential changes that could occur in the long term. Examples of this would include: lack of vegetation; vegetation succession; or general cover degradation. The NRC staff understands that the licensee has designed the mine waste repository to not require active maintenance. The NRC staff observes that the lack of vegetation on the cover system could result in significantly higher peak flows over the cover system and in the drainage features surrounding the mine waste repository than would otherwise occur assuming normal cover performance.

This information is required for the NRC staff to determine if the regulations in 10 CFR Part 40, Appendix A, Criterion 1, Criterion 4(b), Criterion 4(c), Criterion 6(1), and Criterion 12 are met.

RESPONSE: *Calculations for the 20 percent slope in Appendix G.8 do not assume vegetation for stability. The rock was sized for the design flows and would consist of rock appropriately durable or upsized to account for its durability. Soil was added to the 20 percent slope so that the surface could be vegetated, but the vegetation is not relied on for stability.*

Stantec will reevaluate the Appendix I hydraulics calculations for a degraded condition in the channels to include invasive vegetation and check capacity as well as erosion in these conditions. Stantec will provide a response later as an update regarding performance under degraded conditions for the channels. An updated version of Appendix I will be provided with the second submittal of responses for the RAI Group 2.

Response from Dwyer Engineering: *A rock/soil surface admixture was designed for the cover to minimize erosion and mitigate gully or rill formation. The designed system was found to produce a long-term stable slope per NUREG-1623. Vegetation is not part of the calculations.*

Section 5 - Protecting Water Resources

RAI 5.1 Protecting Water Resources

Please revise the application to include a groundwater monitoring program to detect additional contaminant seepage from the tailings as a result of the overlying weight of the mine spoils and compaction of the tailings.

The results of Consolidation and Groundwater Evaluation Report (Dwyer Engineering, 2018) concluded that the estimated amount of consolidation and reduction in porosity in the tailings due to added weight from placement of the mine spoils and ET Cover on the existing impoundment will not result in an increase in groundwater flux into the underlying groundwater from the tailings impoundment. The analysis, however, involved certain assumptions (e.g., constant permeability in the tailings, and time-invariant relationship between void ratio and effective stress among others) that were not fully supported in the LAR. The report also stated that any drainage from the tailings will be captured within the underlying alluvium, but no further detailed analysis was provided.

The staff notes that the water holding capacity of the unsaturated alluvium material below the tailings may also be reduced during consolidation due to the weight of mine spoils. In addition, the significance of capturing the drainage in the alluvium beneath the mill tailings material may be questionable because the alluvium is not consistently present beneath the mill tailings. For example, mill tailings located in the north and east of the North Cell were placed directly on the Zone 3 outcrop and Borrow Pit No. 2 was excavated into the Zone 1 subcrop (Canonie Environmental, 1987).

Other evidence of mill tailings seepage directly migrating into Zone 3 includes persistently low pH values observed in the groundwater just downgradient of North Cell due to lack of alluvial materials that have significant amount of acid-buffering capacity whereas Zone 3 itself has little acid-buffering capacity (Hatch Chester, 2019; Canonie Environmental, 1991). Given the large uncertainties and inconclusive aspects of the consolidation analysis with regards to assessing additional water flux and associated contaminant transport from the future impoundment to the groundwater, and given that the groundwater (with seepage from mill tailings) in Zone 3, for example, had historically followed different flow paths (Canonie Environmental, 1987), the current site groundwater monitoring program needs to be re-evaluated and modified if necessary to be able to verify impacts on the groundwater and to assess the performance of the ET Cover after mine spoil disposal and ET Cover completion.

The licensee could propose a groundwater monitoring program, including a monitoring well network (number of monitoring wells, well depths, and locations), and sampling schedule and monitoring parameters. The proposed groundwater monitoring program would account for the geologic and hydrogeologic features near the tailings impoundment. The geometry of mine spoils placement and the contacts with the alluvium materials and Gallup Sandstone may have significant influence on future groundwater flow and contaminant migration possibly to the SW Alluvium, Zone 1 or Zone 3 if release of additional groundwater from the mill tailings occurs.

UNC needs to evaluate and determine whether the current groundwater monitoring network for the mill tailings impoundment is adequate or needs to be modified in order to monitor the potential groundwater impact possibly resulting from the placement of mine spoils and ET Cover in the mill tailings impoundment.

This information is required for the NRC staff to determine if the regulations in 10 CFR Part 40, Appendix A, Criterion 7.

RESPONSE: *The application does not contemplate modifying the currently-licensed groundwater monitoring program because the additional mine spoils weight and compaction of tailings will produce less contaminant seepage when the ET Cover System is constructed than at any other time in the history of mill tailings management, and because the existing monitoring well network can be used to monitor changes to the groundwater regime, following construction.*

The request to consider modifying the groundwater monitoring program is based on:

- *certain assumptions that "were not fully supported" in the LAR*
- *the absence of alluvial materials in some places with seepage directly to Zone 3 or Zone 1*
- *the geometry of mine spoils placement and the contacts with the alluvium materials and Gallup Sandstone that may have significant influence on future groundwater flow and contaminant migration*

With respect to uncertainties in material properties, the parameter values underwent thorough sensitivity analyses and were chosen to be very conservative to eliminate those uncertainties. The assumptions were not only supported but were chosen to represent worst-case conditions. The RAI points to the assumption of constant permeability in the tailings as one such shortcoming; however, this was a conscious decision to be conservative because permeability will decrease over time due to consolidation, and that would lessen seepage rates.

With respect to an absence of alluvium or the geometry of the repository and underlying geology, it is essential to consider that the design described in the LAR will not change any of these conditions from their present state. Future groundwater flow and contaminant migration are not going to change because of the modifications proposed in this LAR. Moreover, the analyses performed in Appendix Y, Section 5 compared long-term fluxes between the existing licensed reclamation plan, and the proposed repository for a wide range of profiles. In each case, seepage is reduced with the LAR compared to existing conditions. This means that the currently-licensed monitoring program will be more than adequate to monitor future seepage-impacts. Should UNC wish to request changes to the groundwater monitoring program in the future, it will be for reasons driven by results of on-going data collection. Groundwater flow and contaminant migration at the site are well understood based on decades of monitoring.

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