To: Mr. James Smith, USNRC

From: Stephen F Dwyer, PhD, PE, Dwyer Engineering, LLC

Date: 7-31-20

Re: UNC Response to USNRC's June 26, 2020 Clarification Request on the November 18, 2019 Supplemental Submittal to the Application for Amendment of USNRC Source Material License SUA-1475 for the United Nuclear Corporation Mill Site, McKinley County, New Mexico.

Message:

The United Nuclear Corporation and the General Electric Company (UNC/GE) submitted a supplemental submittal to the Application for Amendment of *USNRC Source Material License SUA-1475 for the United Nuclear Corporation Mill Site* on November 18, 2019 for the USNRC's review to support use of the jetty excavation soils as cover material. Included with the submittal were the 2018 Northeast Church Rock Jetty Investigation Report that was finalized after the application was submitted, along with revised Appendices A (General Design Information), G (Mine Waste Repository Design), and H (Borrow Areas), and revised drawing Sections 07 and 09. A revised Appendix Y (Consolidation and Groundwater Evaluation Report) was not included with the submittal.

During a conference call with USNRC on June 26, 2020 and in an email dated July 22, 2020, USNRC requested that UNC provide:

1. Clarification on the consolidation modeling scenarios evaluated for Appendix Y and how the scenarios would be impacted by effects of using the soil excavated from the jetty as borrow material for the Repository cover system and increasing the ET Cover thickness from 4 to 4.5-ft.
2. Characteristics of the alluvium underlying the tailings impoundment.
3. Clarification of the revised cover design based on use of Jetty material.

This memo, provided on behalf of UNC/GE, addresses USNRC's clarification request.

1. Clarification on Consolidation Modeling

Appendix Y includes a lengthy and detailed set of analyses that evaluate consolidation of multiple profiles across the footprint of the proposed Repository after placement of the mine spoils. The profiles were developed from the material property and geotechnical parameters collected from borings installed at various locations within the tailings impoundments across the footprint of the proposed repository. The profiles evaluated a total repository thickness ranging from 28.6-ft (Profile B2, Appendix Y, Figure 8) to 68.2-ft (Profile B10, Appendix Y, Figure 10) based on the estimated volume of mine spoils that includes a 30% contingency. The 0.5-ft additional cover thickness is less than the thickness provided by the 30% contingency, except for Profile B11 where only 9 inches of mine spoils will be placed under the ET cover.

Four profiles were evaluated including Profile B11 in Borrow Pit 2 and Profiles B10 and B8 in Borrow Pit 1 which showed the highest degree of saturation due to consolidation after construction of the repository. Appendix Y also evaluated a typical cross section designated as Profile B2 - this profile is representative of most of the Repository footprint. The analysis shows that Profiles B2 and B11 never reach saturation within the profile after consolidation. Profiles B8 and B10 (both in Borrow Pit 1) do have saturation in some or all the fine-grained tailings. Borrow Pit 1 is the area with the deepest layer of fine-grained tailings and previous modeling showed it had the highest degree of saturation of all the profiles that were evaluated. Profile B8 was the worst-case profile because the fine-grained tailings layers were the only layers in any of the profiles calculated to reach full saturation (100% degree of saturation) after placement of the mine spoils and ET Cover. The initial degree of saturation weighted average for these fine-grained tailings layers was 93.7%. This was an increase in saturation of 6.3% based on 0.65-ft of total settlement in the fine-grained tailings. Profile B10 was close to full saturation (98.5%) after placement of the mine spoils and ET Cover. The upper fine-grained tailings layer was at about 95% saturation while the remaining underlying fine-grained layers were at 100% saturation. The initial weighted average degree of saturation of the B10 fine-grained tailings layers was 91.4%. This was an increase in saturation of 7.1% based on 0.93-ft of total settlement in the fine-grained tailings.

The fine-grained tailings in Borrow Pit 2 (Profile B11) did not reach saturation (degree of saturation was 96.6%) after placement of the mine spoils and ET Cover. The fine-grained tailings in this area was relatively thin compared to Borrow Pit 1. The initial weighted average degree of saturation of the B11 fine-grained tailings layers was 95.3%. This was an increase in saturation of 1.3% based on 0.1-ft of total settlement in the fine-grained tailings. The following tables provide a summary of related details for profiles B8, B10, and B11.

Table 1. Profile B8 Existing Conditions: Soil Layer Input Parameters

Soil Layer	Depth BGS	Data Sample (MWH 2014)	Ks (cm/sec)	Initial Saturation	van Genuchten parameters				Initial Suction[a] (-cm)	Final Saturation	Settlement (ft)
					θs	θr	α	n			
Cover – rock/soil	0 to 0.5’	Loamy sand (Carsel & Parrish 1998)	$4.10x10^{-3}$	30%	0.41	0.057	0.124	2.28	29.2		
Cover - soil	0.5’ –2’	EB-B6-03	$3.60 x10^{-5}$	30%	0.50926	0	0.01399	1.26891	6272.7		
Fill	2’ – 7’	Use B11-03	$2.50 x10^{-5}$	30%	0.30331	0	0.01632	1.06655	4.41E9[b]		
Coarse Tailings	7’ – 26.5’	B8-02	$3.60 x10^{-4}$	38.4%	0.41023	0	0.47787	1.16163	779.9		
Fine Tailings	26.5’ – 31’	Use B8-9	$3.00 x10^{-8}$	96.9%	0.56534	0	0.00446	1.15784	70.0	100%	0.17
Fine Tailings	31’ – 35’	Use B8-9	$3.00 x10^{-8}$	92%	0.56534	0	0.00446	1.15784	193.6	100%	0.17
Coarse/Fine Tailings	35’ - 35.5’	B8-06	$1.60 x10^{-5}$	46%	0.48373	0	0.0009	1.37788	8299.9	100%	0.01
Coarse/Fine Tailings	35.5’ – 36’	B8-06	$1.60E^{-5}$	51.20%	0.48373	0	0.0009	1.37788	6115.2	100%	0.01
Fine Tailings	36’ – 41.5’	Use B8-9	$3.00E^{-8}$	100.2%	0.56534	0	0.00446	1.15784	0.0	100%	0.21
Coarse/Fine Tailings	41.5’ – 42’	B8-08	$1.30 x10^{-7}$	90.5%	0.4272	0	1.87772	1.16882	0.5	100%	0.01
Coarse/Fine Tailings	42’ – 44.5’	B8-08	$1.30 x10^{-7}$	94.9%	0.4272	0	1.87772	1.16882	0.3	100%	0.06
Fine Tailings	44.5’ – 45’	Use B8-9	$3.00 x10^{-8}$	96.2%	0.56534	0	0.00446	1.15784	85.8	100%	0.02
				93.7% [c]						**100%** [d]	**0.65 ft** [e]
Alluvium	45’ – 63’	Use B1-13A	$1.70 x10^{-6}$	50.6%	0.4951	0.0398	0.43246	1.20486	98.5		

[a] Initial suction values for each soil layer were computed utilizing the acquired van Genuchten parameters and measured moisture content (MWH 2014).

[b] It appears large, but this value was calculated from its degree of saturation.

[c] Weighted average of initial saturation for fine grained tailings layers.

[d] Weighted average of final saturation for fine grained tailings layers.

[e] Total settlement in fine grained tailings due to addition of mine spoils and final ET Cover system.

Table 2. Profile B10 Existing Conditions: Soil Layer Input Parameters

Soil Layer	Depth BGS	Data Sample (MWH 2014)	Ks (cm/sec)	Initial Saturation	van Genuchten parameters				Initial Suction[a] (-cm)	Final Saturation	Settlement (ft)
					θ_s	θ_r	α	n			
Cover – rock/soil	0 to 0.5'	Loamy sand (Carsel & Parrish 1998)	4.10×10^{-3}	30%	0.41	0.057	0.124	2.28	29.2		
Cover - soil	0.5' – 2.0'	EB-B6-03	3.60×10^{-5}	30%	0.50926	0	0.01399	1.26891	6272.7		
Fill	2' – 7'	Use B11-03	2.50×10^{-5}	30%	0.30331	0	0.01632	1.06655	4.41E9[b]		
Coarse Tailings	7' – 12'	B10-02	4.30×10^{-4}	34%	0.3481	0	0.67277	1.13662	3994.5		
Coarse Tailings	12' – 17.5'	B10-03	6.70×10^{-5}	30.40%	0.4272	0	1.87772	1.16882	615.8		
Coarse/Fine Tailings	17.5' – 25'	Use B8-08	1.30×10^{-7}	87.70%	0.44786	0	0.00129	1.29116	645.6	95.0%	0.22
Fine Tailing	25' – 26'	Use B10	3.00×10^{-8}	83.50%	0.58891	0	0.0011	1.16727	2006.5	100.0%	0.05
Fine Tailing	26' – 28'	Use B10	3.00×10^{-8}	93.50%	0.58891	0	0.0011	1.16727	585.5	100.0%	0.09
Fine Tailing	28' - 32'	Use B10	3.00×10^{-8}	92.30%	0.58891	0	0.0011	1.16727	709.8	100.0%	0.19
Coarse Tailings	32' – 33'	B8-08	6.70×10^{-5}	61.80%	0.4272	0	1.87772	1.16882	8.9	100.0%	0.02
Fine Tailings	33' – 35.5'	B8-08	3.00×10^{-8}	95.20%	0.58891	0	0.0011	1.16727	423.1	100.0%	0.10
Fine Tailings	35.5' – 36'	Use B8-9	3.00×10^{-8}	83.80%	0.58891	0	0.0011	1.16727	1947.0	100.0%	0.02
Coarse/Fine Tailings	36' – 37'	B10-03	1.30×10^{-7}	93.80%	0.44786	0	0.00129	1.29116	327.1	100.0%	0.02
Fine Tailings	37' – 41'	Use B10	3.00×10^{-8}	100.10%	0.58891	0	0.0011	1.16727	0.0	100.0%	0.16
Fine Tailings	41' – 43'	Use B10	3.00×10^{-8}	98.80%	0.58891	0	0.0011	1.16727	113.2	100.0%	0.07
				91.4% [c]						**98.5%** [d]	**0.93 ft** [e]
Alluvium	43' – 62'	B10-18	2.40×10^{-5}	48.86%	0.40301	0.00829	0.54078	1.1191	911.3		

[a]Initial suction values for each soil layer were computed utilizing the acquired van Genuchten parameters and measured moisture content (MWH 2014).

[b]It appears large, but this value was calculated from its degree of saturation.

[c] Weighted average of initial saturation for fine grained tailings layers.

[d] Weighted average of final saturation for fine grained tailings layers.

[e] Total settlement in fine grained tailings due to addition of mine spoils and final ET Cover system.

Table 3. Profile B11 Existing Conditions: Soil Layer Input Parameters

Soil Layer	Depth BGS	Data Sample (MWH 2014)	Ks (cm/sec)	Initial Saturation	van Genuchten parameters				Initial Suction[a] (-cm)	Final Saturation	Settlement (ft)
					θ_s	θ_r	α	n			
Cover – rock/soil	0 to 0.5’	Loamy sand (Carsel & Parrish 1998)	$4.10\text{x}10^{-3}$	30%	0.41	0.057	0.124	2.28	29.2		
Cover - soil	0.5’ –2’	EB-B6-03	$3.60\ \text{x}10^{-5}$	30%	0.50926	0	0.01399	1.26891	6272.7		
Fill	2’ – 15’	Use B11-03	$2.50\ \text{x}10^{-5}$	29.3%	0.30331	0	0.01632	1.06655	6.28E9[b]		
	15’ – 20’			42.9%	0.30331	0	0.01632	1.06655	2.04E7[b]		
	20’ – 30’			59.8%	0.30331	0	0.01632	1.06655	138843.8[2]		
	30’ – 42.5’			75.7%	0.30331	0	0.01632	1.06655	3974.6		
Fine Tailings	42.5’ – 54’	B8-09	$3.00\ \text{x}10^{-8}$	**95.3%**[c]	0.56534	0	0.00446	1.15784	106.8	**96.6%**[d]	**0.1 ft**[e]
Alluvium	54' - 90'	B11-10	$5.60\ \text{x}10^{-4}$	50.1%	0.45752	0.06145	0.13956	1.31247	109.7		

[a]Initial suction values for each soil layer were computed utilizing the acquired van Genuchten parameters and measured moisture content (MWH 2014).

[b]It appears large, but this value was calculated from its degree of saturation.

[c] Weighted average of initial saturation for fine grained tailings layers.

[d] Weighted average of final saturation for fine grained tailings layers.

[e] Total settlement in fine grained tailings due to addition of mine spoils and final ET Cover system.

The depth of ET Cover and mine spoils, depth of tailings, and initial degree of saturation in the fine-grained tailings all are sensitive to the respective final degree of saturation. A key assumption in the computation of the final degree of saturation is that the amount of initial water within the fine-grained tailings is the same before as after the placement of the mine spoils and ET cover. Thus, the saturation increase is due to the water spread through a thinner layer after settlement. Another key assumption is that water squeezed out of a thinner layer (excess water after 100% saturation is achieved) within the overall fine-grained tailings profile moves into an adjacent unsaturated layer increasing the water in that adjacent layer and thus increasing its degree of saturation.

Preliminary results from evaluating a 6-inch increase in the final cover and overall repository thickness indicates that the small increase in consolidation will not significantly increase the degree of saturation of the tailings. However, since the B8 profile was at full saturation, a small amount of water will likely move up into the overlying coarse tailings layer directly above the fine-grained tailings. This coarse layer will remain below full saturation as its initial degree of saturation is only 53.7%. Should the analysis be performed, the consolidation would be computed on this layer to determine the degree of saturation after consolidation and the layer's initial matric potential would be adjusted accordingly before the groundwater analyses are performed. It is not expected to have any significant change on the groundwater since the bottom layer of the fine-grained tailings layer is controlling the rate of drainage though it.

2. Characteristics for the alluvium underlying the tailings impoundment.

The following information related to the alluvium soil included in the simulations is included below at the request of the USNRC. The moisture characteristic curve data used for the alluvium soil for Profile B8 was derived from soil sample B1-13A. The respective curve is shown in Figure 1. The initial soil conditions for the alluvium in the profile B8 simulations was set at a matric potential of -98.5 cm.

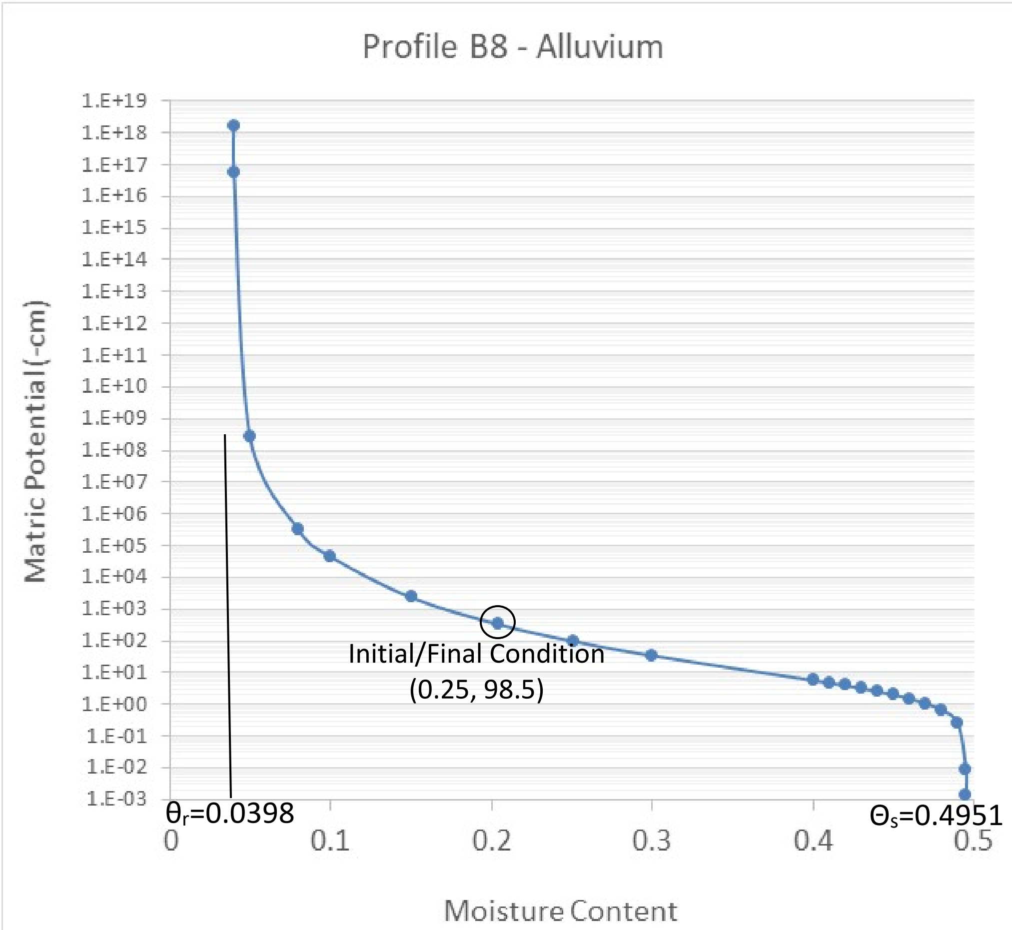

Figure 1. MCC for Alluvium at Base of Profile B8

The following Figure 2 (Figure 22 from Appendix Y report) shows that this initial matric potential condition was unchanged for most of the alluvium profile through the entire long-term modeling period. This reveals there is no significant drainage from the tailings while the entire profile is moving toward a steady state condition. When comparing Figures 21 (existing profile) and 22 (profile with mine spoils and ET Cover) from Appendix Y; Figure 21, Appendix Y shows there is some recharge with the existing cover system allowing for moisture to be added to the profile. However, with the addition of mine spoils and new ET Cover (Figure 22, Appendix Y), moisture is being removed from the system upward via ET.

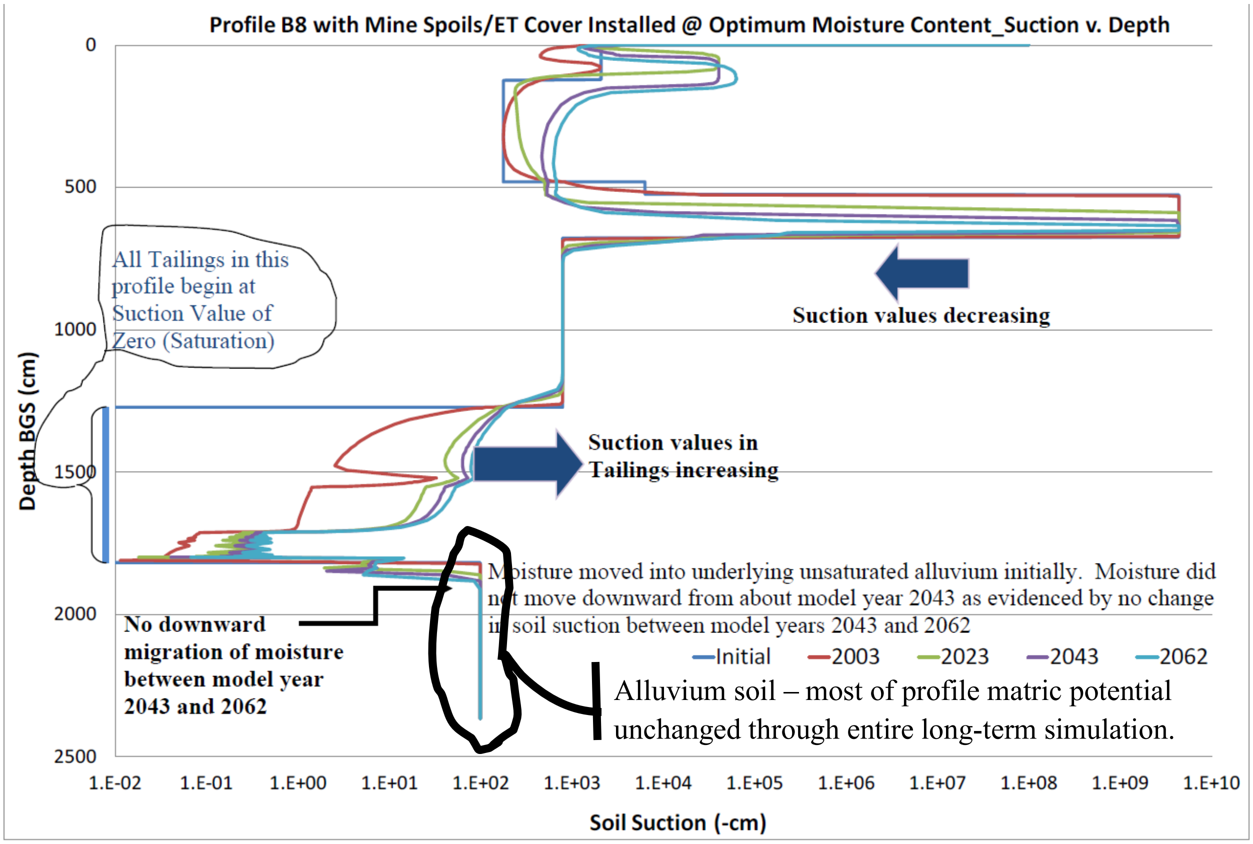

Figure 2. Suction Values v. Time for Profile B8

The moisture characteristic curves used for the alluvium soil for Profiles B10 (derived from soil sample B10-18) and B11 (derived from soil sample B11-10) are shown below in Figures 3 and 4 for information only per the request of the USNRC. Long-term simulations were not performed on these profiles.

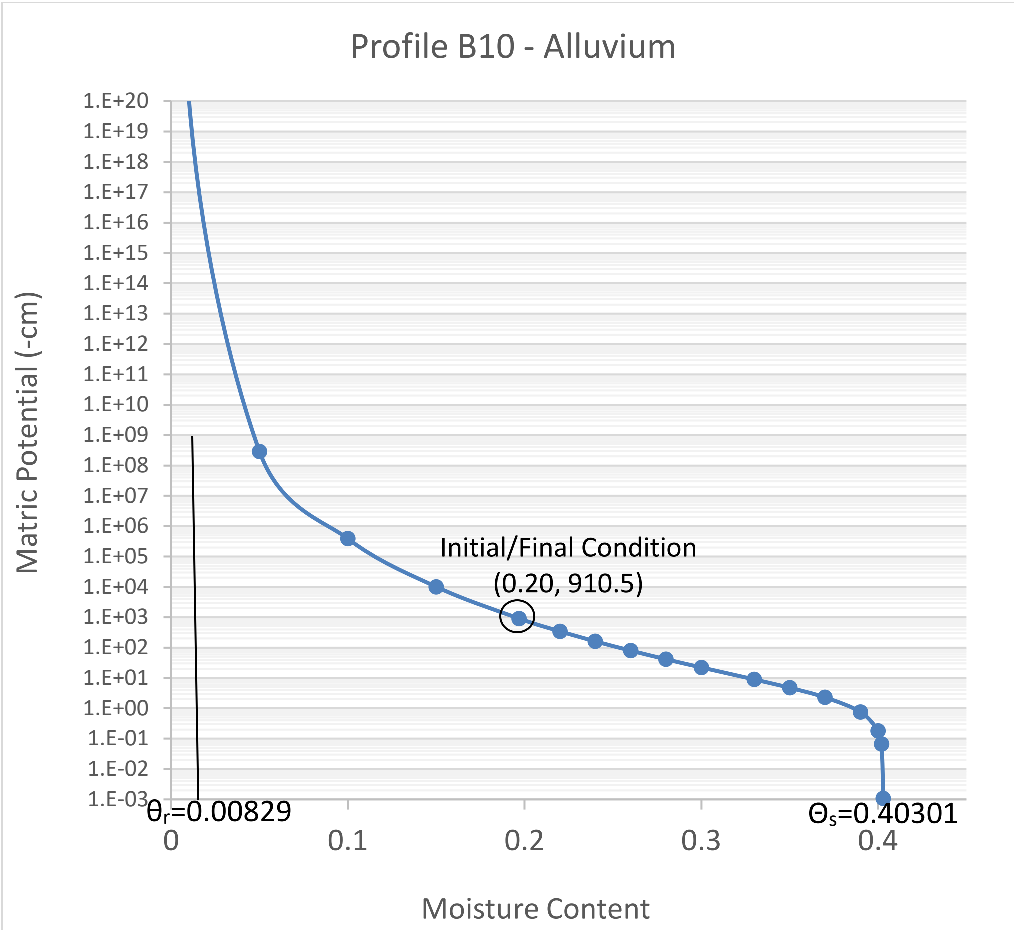

Figure 3. MCC for Alluvium at Base of Profile B10

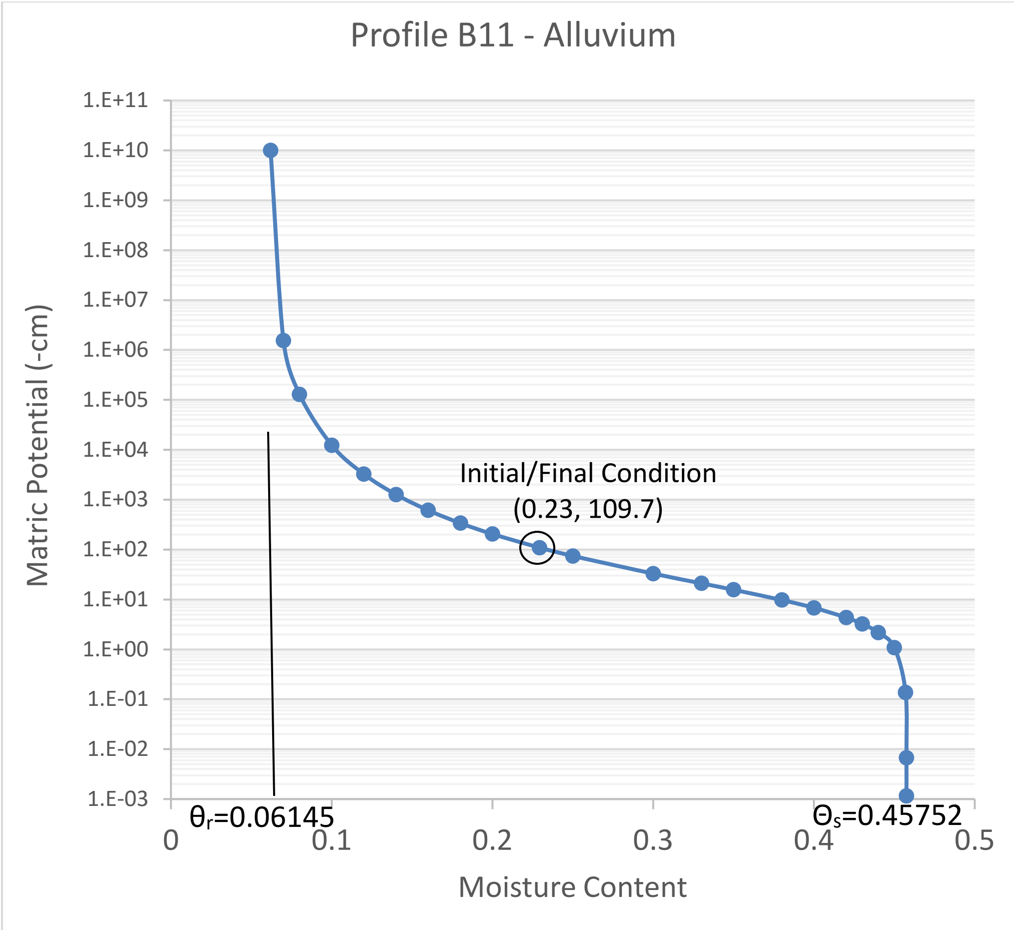

Figure 4. MCC for Alluvium at Base of Profile B11

3. Clarification of Revised Cover Design Based on Use of Jetty Material

The USNRC requested information on how the revised cover design contained in the Addendum to the Cover System Design Report (Addendum) accounted for the higher fines content in the Jetty soil compared to the other approved borrow sources. The Addendum was submitted to allow for the use of soil to be excavated from the Jetty area as the primary borrow source for cover material. Modeling sensitivity simulations evaluated the myriad of samples tested. The soil sample with the highest clay content (53.9%) and fines content (96.5%) turned out to be the worst case requiring the cover thickness be increased from 4-ft to 4.5-ft (see Addendum for detail).

The potential for higher fines content in the Jetty soil sample also required adjustments to the surface rock/soil admixture layer. Fines are more erodible and are sensitive input parameters for the admixture design as are slope and slope length. The admixture design evaluated the worst-case soil (most fines content) for various slope lengths along the 5% slope. All designs regardless of slope and slope length include a mixture of 33% rock to 67% soil by volume. Because smaller rock is preferable from a cost and constructability standpoint, the admixture design was developed whereby smaller rock were included near the top with the biggest rock included toward the bottom of the 5% slope. The 2% slope, 1.5-inch rock was uniformly used along the entire slope length since there is significant available 1.5-inch rock. The admixture design required smaller than 1.5-inch rock along the 2% slope; but 1.5-inch rock was included in the design because of the available 1.5-inch rock on-site. In the 95% Design report, the rock size and admixture depth were computed along the slope length developing three different profiles (1.5-inch rock/14-inches deep with slope length 400-ft and less, 2-inch rock/18-inches deep with slope lengths from 400 to 525-ft, and 3-inch rock 27-inches deep for slope lengths longer than 525-ft). In the Addendum, the admixture design was redone with the worst-case Jetty soil (most fines) which resulted in some modifications to the previous design included in the 95% Design Report. The changes resulted in four different profiles (1.5-inch rock/14-inches deep for slope lengths less than 350-ft, 2-inch rock/18-inches deep for slope lengths from 350 to 525-ft, 3-inch rock 27-inches deep for slope lengths from 525-ft to 900-ft, and 3.5-icnh rock for slope lengths greater than 900-ft). Refer to the Addendum for additional detail.

The fines content regarding radon attenuation did not affect the outcome in the 95% Design report or the Addendum to this report as the criteria was easily satisfied in each case. The thicker cover improved the attenuation by reducing the expected radon flux from 13.73 pCi/m^2 for the 4-ft cover with applicable soil properties to 6.23 pCi/m^2 with the adjusted soil properties.

Modeling in the Addendum was not performed for a five-year period without vegetation as was done in the 95% Design Report submittal. The modeling without vegetation was an exercise performed at the request of the EPA to provide additional sensitivity analyses but was not used to dictate the design of the cover profile other than to show that only a de minimis amount of flux occurs given no vegetation. With the Jetty soils, the flux is expected to be similar at a 4.5-ft depth, no significant flux is expected.