

December 14, 2018

Mr. Paul Davis
Project Manager
Oklahoma Department of Environmental Quality
707 North Robinson
Oklahoma City, OK 73102

Re: Cimarron Environmental Response Trust
Uranium in Sediment in the 1206 Drainage

Dear Mr. Davis:

During a November 30, 2018 telephone conversation, you questioned the validity of uranium *mass* concentration values, calculated from uranium *activity* concentration values, presented in a letter submitted to the Oklahoma Department of Environmental Quality (DEQ) on June 18, 2018. The purpose of the uranium concentration calculations was to estimate the mass concentration of uranium in sediment that will be excavated from the 1206 Drainage during site remediation activities. The conversion method used to calculate the mass concentration values presented in the June 18 letter assumed all activity measured in soil samples collected from the 1206 drainage was attributable to the U-238 isotope. Your concern was based on the premise that converting all uranium activity to U-238 mass would result in unrealistically high concentration values was justified. Based upon our discussion, EPM has reevaluated the conversion from activity concentration to mass concentration. The results of this reevaluation are provided in this letter.

The June 18 letter presented uranium activity concentration data for soil samples that had been analyzed in the mid-1990s during the final status survey for Subarea H. The soil samples had been analyzed on-site using the gamma spectrum analyzer that was utilized for all final status survey samples. The gamma spectrum analyzer reported the total uranium activity concentration; the output from the instrument did not include the activity concentration for each isotope.

The conversion method used to calculate the mass concentration values presented in the June 18 letter (i.e., assuming all activity measured in the soil samples was attributed to U-238) was extremely conservative. The intent of this method was to provide a uranium mass concentration for the 1206 sediment that was not underestimated; however, upon further consideration, EPM has concluded that this method was excessively conservative. This method used the specific activity of U-238 to convert the total uranium activity concentration values to total uranium mass concentration. Since the U-238 isotope is only responsible for approximately 20 to 45 percent (%) of total uranium activity (assuming the U-235 enrichment is between 1 and 3 weight percent (wt %) enrichment), this significantly increased the uranium mass concentration values above those that would have been calculated had the actual distribution of uranium isotopes been considered.

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Attachment 1 provides several tables showing the conversion from total activity concentration to isotopic activity concentration, and then from isotopic activity concentration to isotopic and total uranium mass concentration. Table A lists the percent of the total uranium activity among uranium isotopes U-234, U-235, and U-238 for U-235 enrichment values of 1, 2, 3, and 4 wt %. This data was presented in the technical memorandum *Determination of Conservative U-235 Enrichment Levels for Groundwater at Cimarron Site Utilizing ICP-MS Data Collected December 2016 Through 2nd Quarter 2017*, submitted to the NRC and the DEQ on August 17, 2018. Table B lists the specific activities of U-234, U-235, and U-238. This table was taken from *Radiological Health Handbook (1970)*.

The first column in Tables C and D present the average and maximum total uranium activity concentration values (in picoCuries per gram, or pCi/g) for soil samples collected from the 1206 Drainage during the Subarea H final status survey. Although the enrichment of uranium in these samples cannot be determined from data presented in the final status survey report, the primary source of uranium to 1206 sediment is Burial Area #3. Groundwater samples obtained from Burial Area #3 typically yield U-235 enrichment values between 1% and 3%.

Table C presents the results of calculations assuming U-235 enrichment values of 1%, 2%, and 3%. The activity concentrations for each isotope, calculated by multiplying the average and maximum total uranium activity concentration values by the percent of total activity for each isotope (from Table A), are presented in the third, fourth, and fifth columns of Table C. Dividing these isotopic activity concentrations (pCi per gram of soil) by the specific activity (pCi per gram of uranium) for each isotope yields the isotopic mass concentration in milligrams uranium per kilogram of soil (mg/kg) [after unit conversion]. The isotopic mass concentration values are presented in the sixth, seventh, and eighth columns of Table C. Summing the mass concentrations for all three isotopes then yields the total uranium mass concentrations presented in the ninth column of Table C.

The total uranium mass concentrations presented in the June 18 letter for 1206 sediment, based on the assumption that all activity was attributed to the U-238 isotope, ranged from a minimum of 0.0 mg/kg to a maximum of 72.7 mg/kg. The maximum value of 72.7 mg/kg is more than 4 times the EPA residential screening level for uranium of 16 mg/kg. The average mass concentration cited in the June 18 letter was 29.4 mg/kg, nearly twice the residential screening level.

Using the more appropriate and accurate method for calculating uranium mass concentration described herein, the *maximum* uranium mass concentration for 1206 sediment varies from 15.4 mg/kg (at 3% enrichment) to 30.9 mg/kg (at 1% enrichment). The *average* uranium mass

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concentration for 1206 sediment varies from 6.2 mg/kg (at 3% enrichment) to 12.5 mg/kg (at 1% enrichment). All of the average uranium mass concentrations are less than the residential screening level for uranium in soil established by the US Environmental Protection Agency (USEPA).

The same overestimation of uranium mass concentration described above occurred when calculating the range of uranium mass concentration in background soils cited in the June 18 letter. The total uranium activity concentration for background soil varies from 2.3 to 6.6 pCi/g, with a mean activity concentration of 4 pCi/g. Using the distribution of isotopic activity values for natural uranium taken from the *Radiological Health Handbook*, the mass concentration of uranium varies from 3.4 to 9.7 mg/kg, with a mean mass concentration of 5.9 mg/kg.

Both the 1206 Drainage remediation plan submitted April 2, 2018 and the June 18 letter proposed to combine the excavated sediment with excess spoils that will be generated while excavating injection trenches for groundwater remediation. This will result in material with a still lower average concentration of uranium. The more accurate uranium mass concentration calculations presented herein provide confidence that even without combining the sediment with excavated material, the sediment will not exceed the USEPA residential screening level.

During our November 30 conversation, you expressed a concern related to the leaching of uranium from 1206 Drainage sediments blended with excavated material and left on-site. Note that the exposure pathway used by the USEPA to develop residential screening levels for soil includes the potential leaching of contaminants from the soil into groundwater. Also consider that the exposure scenario utilized in the development of residential soil screening levels is far more conservative than could be reasonably expected in the area this blended material will be placed.

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EPM requests DEQ approval to manage the sediment as described in the April 2018 remediation plan. Please contact me at 405-642-5152 or at jlux@envpm.com if you desire explanation or clarification. Thank you.

Sincerely,



Jeff Lux, P.E.
Project Manager

Attachment

cc: Michael Broderick, DEQ
Ken Kalman, US Nuclear Regulatory Commission
Martha Poston-Brown, US Nuclear Regulatory Commission, Region IV



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**ATTACHMENT 1
TABLES A, B, AND C**

ATTACHMENT 1
Conversion of Uranium Isotopic Activity to Isotopic Mass
for 1206 Drainage Sediment Remediation

TABLE A			
Enrichment (% U-235 by mass)	Percent of Total Activity		
	U-234	U-235	U-238
1	54.8	2.8	42.5
2	68.3	3.7	28.1
3	75.1	4.1	20.8
5	82.1	4.5	13.4

TABLE B								
Isotope		N	Half-Life		Specific Activity			
			Time	Units	(Ci/g)	(pCi/g)	(Bq/g)	(pCi/g/ppm)
U	234	2.57E+21	2.47E+05	years	6.19E-03	6.19E+09	2.23E+08	6.19E+03
U	235	2.56E+21	7.10E+08	years	2.14E-06	2.14E+06	7.74E+04	2.14E+00
U	238	2.53E+21	4.51E+09	years	3.33E-07	3.33E+05	1.20E+04	3.33E-01

TABLE C									
Uranium Activity / Concentration Data for 1206 Drainage Sediment									
		Total Uranium Activity (pCi/g)	Isotopic Activity Concentration (pCi/g)			Isotopic Mass Concentration (mg/kg)			Total U Mass Concentration (mg/kg)
			U-234	U-235	U-238	U-234	U-235	U-238	
1%	Average	9.7	5.32	0.27	4.12	8.59E-04	1.27E-01	1.24E+01	12.5
	Maximum	24	13.15	0.67	10.20	2.12E-03	3.13E-01	3.06E+01	30.9
2%	Average	9.7	6.63	0.36	2.73	1.07E-03	1.67E-01	8.18E+00	8.3
	Maximum	24	16.39	0.89	6.74	2.65E-03	4.14E-01	2.02E+01	20.6
3%	Average	9.7	7.28	0.40	2.02	1.18E-03	1.85E-01	6.05E+00	6.2
	Maximum	24	18.02	0.98	4.99	2.91E-03	4.59E-01	1.50E+01	15.4