



State of Utah

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF WASTE MANAGEMENT
AND RADIATION CONTROL
Scott T. Anderson
Director

MEMORANDUM

TO: File

THROUGH: Phil Goble, Manager *PRG 12/15/16*

FROM: Tom Rushing, P.G. *JR 12-15-16*

DATE: December 15, 2016

SUBJECT: Review of the November 17, 2016 Energy Fuels Resources (USA) Inc. Transmittal of Revised Statistical Analysis for Cadmium and Thallium in MW-24 Ground Water Permit No. UGW370004

DRC-2016-012281

I. Review Summary:

The following Energy Fuels Resources (EFR) document was reviewed:

1. Energy Fuels Resources (USA) Inc., November 17, 2016, *Transmittal of Revised Statistical Analysis for Cadmium and Thallium in MW-24, White Mesa Mill Groundwater Discharge Permit UGW370004* (Report)

This document was submitted by EFR in response to a September 14, 2016 Division of Waste Management and Radiation Control (DWMRC) Request for Information Letter (RFI). The RFI was regarding review of an EFR June 24, 2016 Source Assessment Report (SAR) which included statistical analysis for cadmium and thallium in monitoring well MW-24. In the SAR, EFR proposed to set revised GWCL's for these parameters by a modified approach (highest historical value), which was considered appropriate by EFR since the cadmium and thallium data sets showed upward trends and were not normally or log-normally distributed.

The RFI specifically requested, "*Per DWMRC review of the cadmium and thallium data sets it was noted that a large number of non-detects are included in the early time data, and that after 2009, the concentrations begin increasing. EFR attributes these increases as associated with declining pH due to pyrite oxidation in groundwater. For comparison it would be helpful for EFR to provide a separate analysis of the data sets as was provided in the December 9, 2015 SAR (Monitoring Well MW-31) using a divided data set based on an identified point of inflection in the data. Specifically, a data inflection is noted at approximately 2009 for cadmium and thallium in monitoring well MW-24. This comparison test is useful in that it may provide a normalized data set and a comparable and representative determination of mean + 2 σ .*"

EFR Statistics – Adjusted Data Set based on a Point of Inflection

Attachment 2 of the Report provides a table of descriptive statistics for the original cadmium and thallium data sets, and the adjusted post inflection data sets. It was noted that the post inflection data sets included data from August 2009 through September 2016 and culled all data earlier than August 2009. This is consistent with the DWMRC findings during review of the SAR and resulting RFI. It was noted that the modified data sets included 29 data points for both cadmium and thallium and that essentially all of the culled data point were non-detects. Both modified data sets were normally distributed and still show increasing trends, although increasing trends are much less significant. Based on DWMRC review of the modified data sets it appears that the modifications were appropriate and allow for calculation of a representative modified GWCL for cadmium and thallium in monitoring well MW-24. DWMRC notes that modifying a data set because of an identified point of inflection is discussed and condoned according to the 2009 EPA Unified Statistical Guidance. Attachment 2 of the Report is below:

Table 1: Attachment 2 of the EFR Report

Data Set	ALL Data		ALL Data	
	Post-Inflection	Cadmium	Post-Inflection	Thallium
Analyte	Cadmium	Cadmium	Thallium	Thallium
Units	µg/L	µg/L	µg/L	µg/L
% Non-Detects	0	31	0.034	36
N	29	46	29	46
Normal or Lognormal?	Yes	No	Yes	No
Mean	£.50	£.0£	1.00	0.071
Min. Conc.	1.06	0.5	0.5	0.5
Max. Conc.	6.72	6.72	2.1	2.1
Std. Dev.	1.72	1.79	0.46	0.447
Range	5.66	6.22	1.6	1.6
Geometric Mean	2.55	1.41	1.00	0.781
Skewness	0.87	1.30	0.68	1.27
Q25	1.50	0.51	0.70	0.5
Median	2.61	1.41	0.96	0.69
Q75	3.97	2.74	0.37	1.09

EFR Proposed Modified Approach – 95% Upper Tolerance Limit

EFR additionally calculated proposed GWCLs using the 95% Upper Tolerance Limit (UTL). This was proposed as a potential solution for data which shows a significant increasing trend. Per DRC review of the proposed GWCLs using the 95% UTL it was noted that the GWCL for cadmium is unreasonably high (9.06 µg/L) in comparison with historical data, even when considering a significant increasing trend. This issue was discussed during a conference call amongst DWMRC, EFR and Intera on November 9, 2016. Per the conference call it appeared that the calculations used for the 95% UTL were not well understood, and that it was not clear why such a high result was given for cadmium. Given this abnormally high cadmium value and confusion regarding the statistical method, GWCL calculated by the proposed 95% UTL were not considered appropriate by the DWMRC.

Cadmium (µg/L)	Thallium (µg/L)	Approach
2.5	1	* Original GWCL; Fractional
4.28	1.57	† DWMRC Approved GWCL; HHV
6.72	2.1	‡ All Data Flowsheet- Revised GWCL; HHV
3.61	2.04	§ All Data 95% UTL
6.43	2.01	* Recent data Flowsheet GWCL; Mean + 2σ
9.06	2.55	† Recent Data 95% UTL

Conclusion

The table below summarizes the EFR proposed GWCL's, calculated by various statistical methods and which considers both the full historical data set and the adjusted data set (according to a point of inflection). The table also includes a column summarizing the DRC findings regarding the original SAR and revised Report, and recommends that the mean + 2 α using the adjusted data set appears to be the most appropriate.

1. Well Number	2. Parameter	3. Location	4. Current GWCL ug/L	5. Approved 2012 Modified GWCL ug/L	6. Highest Historic Value ug/L	7. Calculated Mean + 2 α Entire Data Set (non normal or log normal distribution) ug/L	8. Calculated Mean + 2 α Adjusted Data Set (normal distribution) ug/L	9. Proposed Modified Approach 95% UTL ug/L	10. DRC Finding – Is Proposed Revised GWCL in Conformance with the Statistical Flow Chart?
MW-24	Cadmium	Down Gradient	2.5	4.28	6.72	5.59	6.43	9.06	Per the flow chart 0-15 Percent Non Detects, and normally distributed data, GWCLs may be set by Mean + 2 α (or modified approach if an upward trend is apparent). Proposed modified approach (95% UTL) is proposed, however, the analysis has not been vetted and calculation results seem unreasonably high. GWCL's will be set based on Mean + 2 α of the adjusted data set, column 8 (6.43 mg/L). This concentration is slightly lower, but within the range of the highest historic value.
MW-24	Thallium	Down Gradient	1	1.57	2.1	1.76	2.01	2.55	Per the flow chart 0-15 Percent Non Detects, and normally distributed data, GWCLs may be set by Mean + 2 α (or modified approach if an upward trend is apparent). Proposed modified approach (95% UTL) is proposed, however, the analysis has not been vetted and calculation results seem unreasonably high. GWCL's will be set based on Mean + 2 α column 8 (2.01 mg/L). This concentration is slightly lower, but within the range of the highest historic value.

Based on review of the revised statistical calculations, as summarized on the table above, DWMRC staff recommends that the GWCL's for cadmium and thallium in monitoring well MW-24 be modified as follows:

Well Number	Parameter	Current GWCL	Modified GWCL	Method of Analysis
MW-24	Cadmium	2.5 ug/L	6.43 ug/L	Mean + 2 α
MW-24	Thallium	1 ug/L	2.01 ug/L	Mean + 2 α

II. References

¹ Energy Fuels Resources (USA) Inc., June 24, 2016, *Source Assessment Report for MW-18 and MW-24*, Prepared by Intera

² Energy Fuels Resources (USA) Inc., June 6, 2012, *White Mesa Uranium Mill Ground Water Monitoring Quality Assurance Plan (QAP), Revision 7.2*.

³ Energy Fuels Resources (USA) Inc., November 17, 2016, *Transmittal of Revised Statistical Analysis for Cadmium and Thallium in MW-24, White Mesa Mill Groundwater Discharge Permit UGW370004*

⁴ United States Environmental Protection Agency (USEPA), 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, EPA 530/R-09-007*

⁵ INTERA Incorporated, 2007, *Revised Background Groundwater Quality Report: Existing Wells for Denison Mines (USA) Corp.'s White Mesa Uranium Mill Site, San Juan County, Utah*.

⁶ INTERA Incorporated, 2007, *Background Groundwater Quality Report: New Wells for Denison Mines (USA) Corp.'s White Mesa Uranium Mill Site, San Juan County, Utah*.

⁷ INTERA Incorporated, 2012, *pH Report White Mesa Uranium Mill*

⁸ Hurst, T.G., and Solomon, D.K., 2008. *Summary of Work Completed, Data Results, Interpretations and Recommendations for the July 2007 Sampling Event at the Denison Mines, USA, White Mesa Uranium Mill located near Blanding Utah*. Prepared by the University of Utah Department of Geology and Geophysics.

⁹ Utah Department of Environmental Quality, August 24, 2012, *Utah Ground Water Discharge Permit, Permit No. UGW370004 issued for the Energy Fuels Resources (USA) Inc. White Mesa Uranium Mill*.