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DRC-2022-000685

MEMORANDUM

TO: File

THROUGH: Phil Goble, Manager *Phillip Goble* 01/13/2022

FROM: Tom Rushing, P.G. *Thomas Rushing* 01/13/2022
Thomas Rushing li (Jan 13, 2022 06 25 MST)

DATE: January 12, 2022

SUBJECT: Review of the Energy Fuels Resources (USA) Inc. (EFR), White Mesa Uranium Mill, Blanding, Utah September 7, 2021, Source Assessment Report for Uranium in Monitoring Well MW-29
Ground Water Discharge Permit No. UGW370004 (Permit)

Summary

A September 7, 2021, Source Assessment Report ("SAR") for uranium in Monitoring Well MW-29 at the White Mesa Uranium Mill (Mill) was submitted to the Director by Energy Fuels Resources (USA) Inc. ("EFR") and received by the Utah Division of Waste Management and Radiation Control on September 9, 2021. The SAR was submitted for review and approval of source assessment investigation findings and a proposed revised Ground Water Compliance Limit (GWCL) for uranium in the monitoring well.

Monitoring well MW-29 is located on the southern berm of the Mill Tailings Cell 2 and is hydraulically downgradient from portions of Cell 1, Cell 2 and from the Mill processing and storage areas.

Monitoring well MW-29 has not been subject to any GWCL modifications since the submission of the comprehensive sitewide 2012 SAR (Dated 10/10/2012) which only included a modification of pH. No other constituents have required source assessment since that time.

Per the SAR, MW-29 is downgradient from the nitrate/chloride plume, however, geochemical influences do not appear to be impacting MW-29 groundwater chemistry. Per the EFR recent nitrate plume monitoring reports, the plume margins are not delineated to have impacted MW-29.

Per the review summarized below, there is not evidence to relate slow rising concentrations of uranium in MW-29 with impacts from tailings solution or other Mill impacts. The uranium trend became apparent with improved laboratory method and analysis which is reflected in the historical

data review and data plots. State and Federal guidance, as well as Mill specific agreements support the modification of the uranium GWCL in MW-29 according to data review and statistical evaluation per the approved statistical decision flow chart agreed upon for evaluation of groundwater data.

SAR Review

The SAR is broken up into four primary sections: 1. Categories and approach for analysis; 2. Results of the analysis; 3. Statistical evaluation and calculation of revised GWCL's for trending constituents, and; 4. Conclusions and recommendations.

The figure below depicts the time/concentration plot for uranium in monitoring well MW-29 (data through the 3rd Quarter 2021).

Figure – Uranium Data Plot of Historical Data at MW-29



Per the EFR SAR findings, the GWCL exceedances and data trends are not found to be caused by Mill activities (leakage from the tailings impoundments), and based on the increasing trends, EFR is proposing that a modified approach (background x 1.5) of a post July 2020 data set be used as a basis for the uranium GWCL. Per the plot, it does appear that the post July 2020 data represents a data inflection (steepening and new data distribution which appears more representative than previous data). EFR statistical review finds that the data within this period shows a normal distribution and justifies the use of the modified data set based on that finding and the finding that the increasing trend was previously identified and studied. The EFR proposal is consistent with the Director approved statistical flow chart and Environmental Protection Agency Guidance (EPA 2009) which allows consideration of a modified approach if a significant trend is evident. DWMRC review findings regarding the SAR, sitewide concentration comparisons, and the EFR proposed revised GWCL's is discussed below.

DWMRC Review of Compliance Data and Trends

Uranium – Uranium concentrations in MW-29 are comparable to other monitoring wells at the site including wells upgradient and far downgradient which are not impacted by Mill activities. Although it is noted that large variability in uranium concentrations is measured across the area, the concentrations in MW-29 are well within lower background range, similar to sitewide concentrations and considerably lower than upgradient monitoring well MW-18 and far downgradient monitoring wells MW-20 and MW-03A. The upward trend in MW-29 appears to be a slow minimal increase consistent with natural variation in the Dakota/ Burro Canyon aquifer.

Monitoring Well No.	Location Relative to Tailings Cells	Highest Historic Measured Uranium Value (µg/L)	Average Uranium Concentration (Complete Data Set) (µg/L)
MW-29	Downgradient Cell 2	16.9	13.14
MW-1	Upgradient	10.7	1.08
MW-18	Upgradient	49	38.5
MW-19	Upgradient	12.8	7.0
MW-20	Far Downgradient	34.6	7.45
MW-03A	Far Downgradient	35.2	20.2

EFR Review of Groundwater in Monitoring Well MW-29

Per section 3.2 of the SAR it is noted that when the MW-29 uranium GWCL was originally calculated there was a minimal statistical data set of eight data points. Since that time there has been additional data collected (current 40 data points) and laboratory methods used for analysis have been improved. Per the SAR the additional data *“provides a more robust understanding of the water quality and behavior of MW-29.”*

Section 3.2 also discusses the long-term transient conditions of groundwater resulting from groundwater mounding due to the northern wildlife ponds which may potentially be impacting the chemistry of MW-29 groundwater specifically per the SAR *“changes in saturated thicknesses and rates of groundwater flow can result in changes in concentrations of dissolved constituents (or pH) for many reasons.”* The SAR further discusses that the newly saturated portions of the aquifer may have a different chemical composition, creating long-term changes and trends for impacted constituents.

An increased data set, better reflecting the groundwater chemistry of MW-29 and potential newly saturated areas of the aquifer due to dissipation of groundwater mounding from the northern wildlife pond are proposed as the primary causes of the uranium GWCL exceedances at MW-29. The SAR discusses further studies completed to eliminate the Mill as the cause of the uranium exceedances.

1. Discussion of Tailings Solution Groundwater Indicator Parameters at Monitoring Well MW-29

The SAR Section 3.3 discusses four primary indicator parameters (Chloride, Fluoride, Sulfate and Uranium) which would be detected in ground water in the event of discharge from the Mill tailings cells (early arrival). Additionally, SAR appendices include times series plots of data and linear regressions for the indicator parameters (Appendix C-7); Time series plots with events (Appendix C-8); and Present descriptive statistics for indicator parameters (Appendix A-1 and A-2).

DWMRC plots of indicator parameter data and discussion are below:

Chloride

Chloride concentrations in MW-29 have remained stable. No data trends are apparent. If tailings wastewater were discharged to the groundwater large rises in chloride concentrations would be expected due to extremely high concentrations of chloride in the tailings wastewater source and fast transport to the groundwater. The flat trend in chloride is a strong indicator that the rising uranium concentrations are not due to tailings wastewater, and also confirms that MW-29 chloride concentrations are not yet impacted by the nitrate/chloride plume.



Fluoride

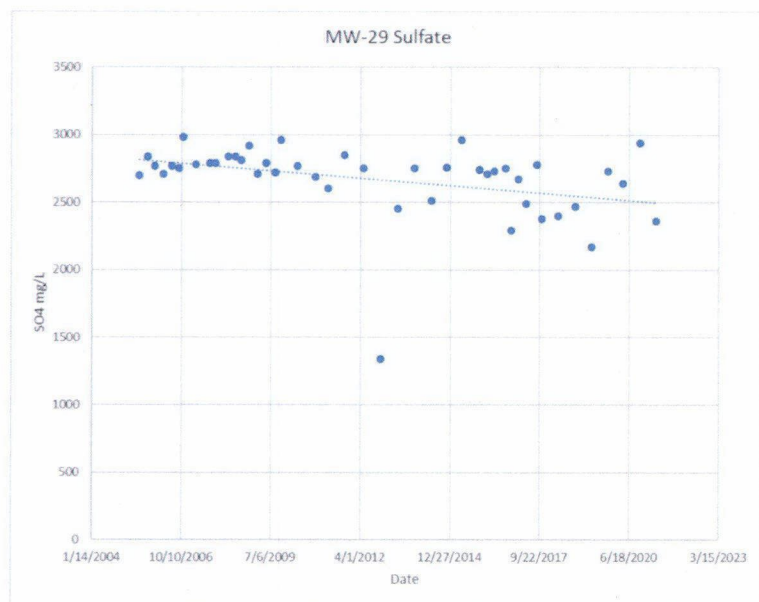
Fluoride is highly concentrated in tailings wastewater and per literature and mill groundwater transport modeling has been shown to be highly mobile in the vadose zone and groundwater beneath the tailing impoundments. Per the figure below, fluoride is showing a decreasing concentration trend in MW-29.

Figure – Fluoride Plot of Historical Data at MW-29 – Decreasing Trend



Sulfate

The relatively low concentration of sulfate in MW-29 and downward concentration trend indicates that tailings solution is not being discharged to groundwater.



Uranium

Uranium concentrations in monitoring well MW-29, as discussed above are low and within range of background concentrations.

Indicator Parameter Summary

Indicator parameters are seen to have low site wide concentrations and except for uranium show flat or decreasing concentration trends. Per SAR evaluations of ratios of the mobile contaminants in groundwater with the tailings wastewater concentrations, it appears that the source of the mobile contaminants is due to causes other than tailings wastewater.

2. pH Analysis

Section 3.1 of the SAR includes a summary of site-wide decreasing pH and refers specifically to the discussion of “Site-Wide Decreasing pH,” due to pyrite oxidation, Per the SAR it was noted that between the time of installation and 2012 the pH at MW-29 was trending downward after which time it has stabilized and is showing recent upward trend. Per the DWMRC pH plot for MW-29 below it can be seen that the trends are evident but slight. The finding of slight trends and of trend reversal are not what would be expected if the pH changes were caused by the introduction of tailings wastewater which is highly acidic and would likely cause a marked decrease with an associated increase in indicator parameter concentrations. Therefore, per review of the pH data, findings are not consistent with a tailings source and may support findings of the previous and ongoing EFR pH and pyrite investigations.

Figure – pH in monitoring well MW-29



3. Mass Balance

The SAR section 3.4 discusses the mass balance evaluation for MW-29. It is noted that ground water levels in MW-29 have risen by approximately 4.5 feet, and therefore the saturated thickness has increased approximately 25%. The tailings wastewater contains chloride at an average concentration exceeding 23,000 mg/L and chloride is a conservative tracer (non-reactive with minerals and transporting with water at high concentrations). Therefore, if the water level

increases were caused by tailings wastewater and a mixture containing 20% wastewater with groundwater then the chloride concentrations in the MW-29 groundwater would exceed 4,500 mg/L. Current chloride concentrations are measured at less than 40 mg/L. The SAR discusses that the water level is not caused by potential tailings wastewater seepage.

The SAR (Section 3.4 and Appendix D) discuss an evaluation of mass balance for the indicator parameters chloride, fluoride sulfate and uranium which would be expected to all be increasing in the case of a tailings wastewater source, however, chloride, fluoride and sulfate are stable to decreasing and only uranium (the least conservative of the indicator parameters) is showing a slight increase.

The SAR Appendix D also includes mass balance based on expected dilution factors for the indicator parameters uranium, chloride, and sulfate and the expected associated concentrations of fluoride. Predicted concentration of fluoride is higher in association to modeled uranium and lower in association with modeled chloride and sulfate. Findings do not support a tailings wastewater source for the uranium exceedances.

Additional mass balance calculations were provided for predicted uranium concentrations using dilution factors for fluoride, chloride, and sulfate. For all cases, the measured uranium concentrations are much lower than would be predicted for a tailings wastewater source.

4. University of Utah Study

The University of Utah study conducted at the White Mesa Uranium Mill during 2007 (Final Report of Study Findings Dated May 2008) is discussed in section 2.3 of the SAR. In general the results of the study found that groundwater in monitoring wells predated the Mill, showing no discharge, or contained varying percentage mixing with more recent water infiltrated from the wildlife ponds. The Final Report concluded that *“in general, the data collected in this study do not provide evidence that tailings cell leakage is leading to contamination of groundwater in the area around the White Mesa Mill. Evidence of old water in the majority of wells, and significantly different isotopic fingerprints between wells with the highest concentrations of trace metals and surface water sites, supports this conclusion.”*

5. Source Assessment Conclusions

Per Section 3.5 of the SAR, EFRI has concluded that current changes in groundwater chemistry and uranium OOC at monitoring well MW-29 are due to groundwater background variation and not due to Mill impacts. Section 3.5 discusses that the slight increasing uranium trend at MW-29 *“is attributable to mobilization of naturally occurring uranium from the formations hosting perched groundwater due to 1) conditions that are increasingly oxidizing at MW-29 and 2) increases in bicarbonate concentrations at MW-29.”*

The SAR further supports that the source of uranium in MW-29 is not the tailings management system with other information, including: 1. Findings discussed in the Mill groundwater background reports, 2. Mass balance calculations which demonstrate that MW-29 uranium

concentrations are consistent with background conditions and not with a tailings source, 3. Indicator parameter analysis, 4. Review of increasing groundwater elevations due to infiltration and dissipation of water from the former wildlife pond and associated evaluation of chloride concentrations and 6. Data review of uranium concentrations in MW-29 with sitewide background comparison.

Per Division review of the SAR and historical data for MW-29, the out-of-compliance status for uranium in monitoring well MW-29 does not appear to be associated with contamination from Mill activities. Based on these findings it is appropriate to adjust the uranium Permit groundwater compliance limit for uranium in MW-29, consistent with the currently Division approved groundwater data statistical process flow chart for the Mill and associated guidance.

EFR Proposed Modified GWCL Statistical Evaluation of Data:

Based on DWMRC review of the SAR statistical analysis it was noted that analysis was conducted for the complete historic data set for MW-29 and for a post 2011 data set. DWMRC notes that per the MW-29 uranium historical data plot there is a slight shift starting in 2011 indicating rising concentration. Per above the rising uranium concentrations is associated with natural background (no corresponding changes indicate a Mill source). The complete data set and the post 2011 data set both show normal uranium (The uranium trend is slightly increasing post 2011).

EFR Statistical methods used in the SAR included: 1. Descriptive statistics for the complete and modified data sets; 2. Mean and Standard Deviation Calculation; 3. Shapiro-Wilk Test for normality; and 4. Mann-Kendall Trend Analysis (non-normally distributed data sets). Proposed GWCL's were calculated based on Mean + 2 σ of the complete and post 2011 data set, Highest Historical Value, Fraction of the Groundwater Quality Standard, and Mean X 1.5. The calculations and findings are summarized on a table in the SAR (Appendix B-1 of the SAR).

Per the SAR Section 4.2, EFR proposed that GWCL's be adjusted according to 1.5 times the uranium background (Mean X 1.5) for the post 2011 data set. The DWMRC approved statistical flow chart for the White Mesa Mill groundwater monitoring wells clarifies that if an upward trend is apparent for a constituent, then a modified approach should be considered. The modified approach should allow for a GWCL which considers the increasing concentrations.

The table below summarizes the EFR calculations and background rationale for the proposed modified GWCL's.

Table of EFR Proposed Revised GWCL's for Monitoring Well MW-29:

Well Number	Parameter	Current GWCL	EFR Proposed GWCL Revision	Method to Determine GWCL	DWMRC Finding – Is Proposed GWCL in Conformance with the Statistical Flow Chart?	DWMRC Recommended Modified GWCL Based on SAR Review
MW-29	Uranium	15 µg/L	20.2 µg/L	1.5 X Background of the Post April 2011 Data Set for MW-29	Increasing Trend allows for modified approach on Flow Chart. Per UAC 317-6, Class III water is allowed to be calculated by 1.5 X Background. Per DWMRC Review of the Uranium Data the modified approach appears appropriate. The post April 2011 data set is appropriate since data in that range shows a normal distribution but is below the GWQS and within range of site background concentrations per comparisons with upgradient and far downgradient monitoring wells at the White Mesa Mill. Per the approved statistical flow chart, a modified approach to setting the GWCL is allowed when an upward trend is apparent.	20.2 µg/L

Conclusions:

Based on DWMRC review of the background statistics and findings that the uranium OOC is not shown to be caused by the Mill, it is appropriate to set GWCL for uranium at 1.5 X Background (Utah Administrative Code (UAC) R317-6 for Class III Groundwater) for the modified data set. This review is consistent with the Director approved statistical flowchart and EPA Statistical Guidance⁹ since the data set shows an inflection at the 2011 data set point and since the data shows an increasing trend at that inflection.

Therefore, the uranium GWCL will be modified in the White Mesa Uranium Mill Ground Water Permit for monitoring well MW-29 uranium as summarized on the table below:

Well Number	Parameter	Current GWCL	Modified GWCL	Method of Analysis
MW-29	Uranium	15 µg/L	20.2 µg/L	1.5 X Background

*Based on 1.5 X background of the uranium background data mean of the post April 2011 data set for MW-29

A letter will be sent to EFR which notes that the modified GWCL's will not be effective until future issuance of a modified Permit, and that the modifications will be subject to formal public notice and public participation requirements. These Permit modifications are anticipated to be made during calendar year 2022.

References

¹ Energy Fuels Resources (USA) Inc., October 12, 2012, *Source Assessment Report*, Prepared by Intera

² Energy Fuels Resources (USA) Inc., November 9, 2012, *pH Report*, Prepared by Intera

³ Energy Fuels Resources (USA) Inc., August 15, 2017, *White Mesa Uranium Mill Ground Water Monitoring Quality Assurance Plan (QAP), Revision 7.4*

⁴ Energy Fuels Resources (USA) Inc., September 7, 2021, *Transmittal of Source Assessment Report for MW-29 White Mesa Mill Groundwater Discharge Permit UGW370004*

⁵ United States Environmental Protection Agency. 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance*. EPA 530/R-09-007.

⁶ Hurst, T.G., and Solomon, D.K. University of Utah, 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 Near Blanding*, Utah, Prepared by Department of Geology and Geophysics

⁷ Hydro Geo Chem, December 7, 2012, *Pyrite Investigation Report*

⁸ Intera, 2007, *Groundwater Data Preparation and Statistical Process Flow for Calculating Groundwater Protection Standards, White Mesa Mill Site, San Juan County, Utah*

⁹ United States Environmental Protection Agency, 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance EPA530/R-09-007*

¹⁰ Utah Department of Environmental Quality, January 19, 2018, Modified on March 8, 2021, *Utah Division of Radiation Control, Ground Water Discharge Permit, Permit No. UGW370004, Energy Fuels Resources (USA) Inc.*