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DRC-2019-006423

TECHNICAL MEMORANDUM

To: **Kathy Weinel, EFRI**

From: **Angela Persico, INTERA**

Date: **June 28, 2019**

Re: **Reanalysis of uranium data for the calculation of a groundwater compliance limit in MW-30**

1.0 INTRODUCTION

A Source Assessment Report ("SAR") for uranium in MW-30 was submitted to the Division of Waste Management and Radiation Control ("DWMRC") on January 15, 2019. The SAR concludes that (1) increasing concentrations of uranium are likely the result of site-wide decreases in pH; (2) with the exception of chloride, concentrations of indicator parameters in MW-30 have not changed significantly since the time of the New Wells Background Report; and (3) MW-30 is not being impacted by potential tailings system seepage. Therefore, a revised groundwater compliance limit ("GWCL") for uranium was proposed. A GWCL of 11 micrograms per liter ("µg/L"), which is the highest historical value of the data set, was proposed in accordance with the DWMRC-approved Flowsheet.

The 11 µg/L value was measured and reported by Energy Laboratories in 2008 and is an outlier relative to the complete data set. Most uranium concentrations from that time were approximately 7 µg/L (Figure 1). The Flowsheet directs the analyst to only remove extreme outliers, while outliers are to remain in the dataset[1]. Since 11 µg/L is not an extreme outlier, the value was retained for analysis and, in accordance with the Flowsheet, selected as the GWCL for a dataset that is not normally distributed and contains 100 percent detected values.

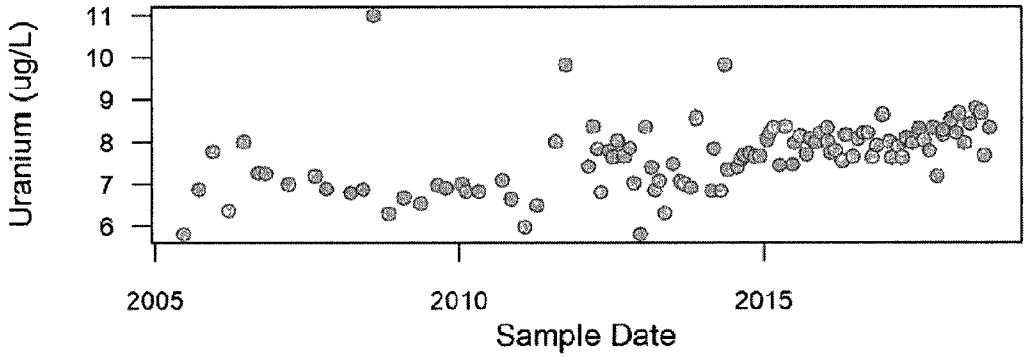


Figure 1: Time series plot of uranium concentrations in MW-30 using all data

[1] Extreme outliers are values greater than the third quartile plus three times the interquartile range or values less than the first quartile minus three times the interquartile range. Outliers are values greater than the third quartile plus 1.5 times the interquartile range or values less than the first quartile minus 1.5 times the interquartile range.

During a preliminary discussion with DWMRC regarding their concern over using this historical data point generated by the previous laboratory as a GWCL, EFRI proposed reanalyzing the uranium data in MW-30 to identify a more representative GWCL.

In the fourth quarter of 2012, EFRI switched laboratories from Energy Laboratories to American West Analytical Laboratory ("AWAL"). This analytical change resulted in more variability in uranium concentrations due to increased sensitivity of the measurement methods. The analytical change provides a temporal point of inflection that may be used to create a subset of more recent and more reliable data. Therefore, although outliers are appropriate to retain in the dataset in accordance with the Flowsheet, the 11 µg/L data point, and all data collected prior to the fourth quarter of 2012, have been excluded from this reanalysis.

1.1 Modified Approach to Calculating a GWCL for Uranium in MW-30

Since uranium is exhibiting a significantly increasing trend, a modified approach should be considered for determining a GWCL. Data collected after the laboratory change in October 2012 were used as a subset of data for reanalysis and revision of the proposed GWCL for uranium in MW-30. Figure 2 is a time series plot of uranium data in MW-30 from October 2012 to the present.

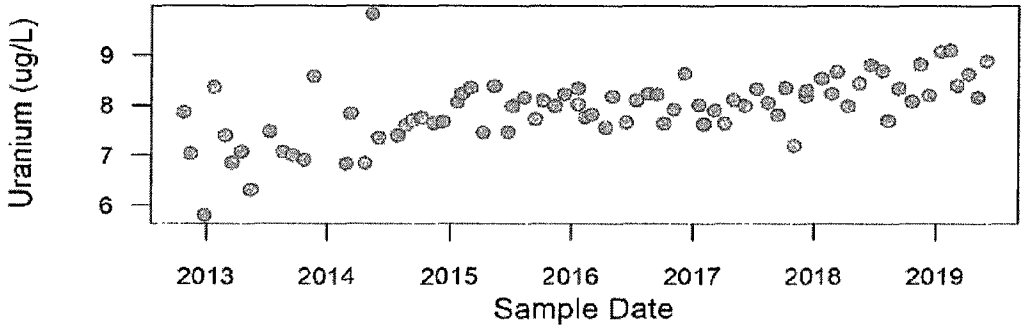


Figure 2: Time series plot of uranium concentrations in MW-30 using data from October 2012 to the present

The October 2012 dataset is representative of current conditions in MW-30. These data have been collected and analyzed in accordance with the Mill's Quality Assurance Plan ("QAP") and are considered more reliable than data collected prior to the laboratory change in 2012. Therefore, a revised GWCL has been calculated using data collected from October 2012 to the present. Table 1 is a summary of statistical results and a revised GWCL using the subset of data collected from October 2012 to the present.

Table 1. Proposed revised GWCL for uranium in MW-30

Parameter	Current GWCL	Modified Approach Revised GWCL	Modified Approach Rationale
Uranium (µg/L)	8.32	9.82	Highest historical value of dataset from Oct. 2012 to present

The proposed revised GWCL for uranium in MW-30 is 9.82 µg/L, which is the highest historical value from the data analyzed after the analytical change in October 2012. This GWCL was determined using a modified approach for trending constituents in accordance with the DWMRC-approved Flowsheet.

APPENDIX A

Statistical Summary of Uranium in MW-30 from October 2012 to the Present

APPENDIX A-1
MW-30 Data Used for Statistical Analysis

Dataset	Units	N	% Non-Detected Values	Mean	Standard Deviation (SD)	Shapiro-Wilk Test for Normality		Normally or Lognormally Distributed?	Mann Kendall Trend Analysis		Linear P	Significant Trend	Highest Historical Value (HHV)	Current GWCL	Proposed Modified Approach GWCL	Modified Approach GWCL Rationale
						W	p		S	p						
2012-present	µg/L	80	0%	7.9	0.64	0.96	7.54E-03	Not normal	1457	7.25E-10	NA	Increasing	9.82	8.32	9.82	Highest Historical Value

Notes:

%ND = percent of non-detected values
mg/L = milligrams per liter
µg/L = micrograms per liter
s.u. = standard units
N = number of valid data points
p = probability
W = Shapiro Wilk test value
S = Mann-Kendall statistic

Distribution = Distribution as determined by the Shapiro-Wilk distribution test for constituents with % Detect > 50% and N>8
Mean = The arithmatic mean as determined for normally or log-normally distributed constituents with % Detect > 50%
Standard Deviation = The standard deviation as determined for normally or log-normally distributed constituents with % Detect > 85%
Highest Historical Value = The highest observed value for constituents with % Detect < 50%

APPENDIX A-2
MW-30 Data Used for Statistical Analysis

Well ID	Date Sampled	Parameter	Result	Units	Qualifer
MW-30	10/23/2012	Uranium	7.86	ug/L	
MW-30	11/13/2012	Uranium	7.03	ug/L	
MW-30	12/26/2012	Uranium	5.80	ug/L	
MW-30	1/23/2013	Uranium	8.36	ug/L	
MW-30	2/26/2013	Uranium	7.40	ug/L	
MW-30	3/20/2013	Uranium	6.85	ug/L	
MW-30	4/17/2013	Uranium	7.08	ug/L	
MW-30	5/15/2013	Uranium	6.31	ug/L	
MW-30	7/10/2013	Uranium	7.48	ug/L	
MW-30	8/20/2013	Uranium	7.07	ug/L	
MW-30	9/18/2013	Uranium	7.00	ug/L	
MW-30	10/22/2013	Uranium	6.91	ug/L	
MW-30	11/20/2013	Uranium	8.57	ug/L	
MW-30	2/25/2014	Uranium	6.83	ug/L	
MW-30	3/11/2014	Uranium	7.84	ug/L	
MW-30	4/23/2014	Uranium	6.84	ug/L	
MW-30	5/14/2014	Uranium	9.82	ug/L	
MW-30	6/3/2014	Uranium	7.35	ug/L	
MW-30	7/29/2014	Uranium	7.40	ug/L	
MW-30	8/20/2014	Uranium	7.60	ug/L	
MW-30	9/9/2014	Uranium	7.70	ug/L	
MW-30	10/7/2014	Uranium	7.76	ug/L	
MW-30	11/10/2014	Uranium	7.65	ug/L	
MW-30	12/10/2014	Uranium	7.67	ug/L	
MW-30	1/21/2015	Uranium	8.06	ug/L	
MW-30	2/4/2015	Uranium	8.23	ug/L	
MW-30	3/3/2015	Uranium	8.35	ug/L	
MW-30	4/8/2015	Uranium	7.45	ug/L	
MW-30	5/12/2015	Uranium	8.38	ug/L	
MW-30	6/24/2015	Uranium	7.46	ug/L	
MW-30	7/7/2015	Uranium	7.98	ug/L	
MW-30	8/11/2015	Uranium	8.16	ug/L	
MW-30	9/15/2015	Uranium	7.72	ug/L	
MW-30	10/7/2015	Uranium	8.10	ug/L	
MW-30	11/11/2015	Uranium	7.99	ug/L	
MW-30	12/9/2015	Uranium	8.22	ug/L	
MW-30	1/20/2016	Uranium	8.02	ug/L	
MW-30	1/20/2016	Uranium	8.34	ug/L	
MW-30	2/10/2016	Uranium	7.76	ug/L	
MW-30	3/2/2016	Uranium	7.82	ug/L	
MW-30	4/13/2016	Uranium	7.55	ug/L	
MW-30	5/4/2016	Uranium	8.18	ug/L	
MW-30	6/14/2016	Uranium	7.66	ug/L	

APPENDIX A-2
MW-30 Data Used for Statistical Analysis

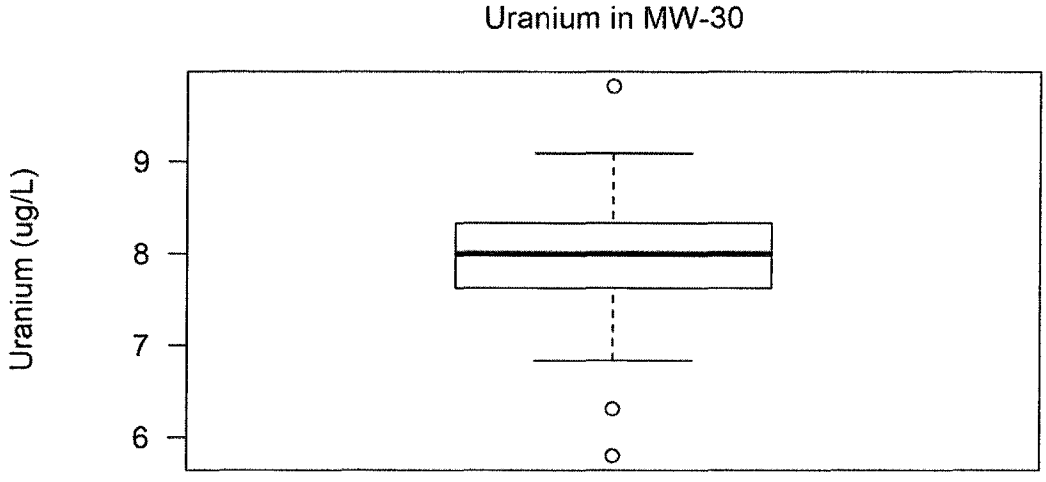
Well ID	Date Sampled	Parameter	Result	Units	Qualifer
MW-30	7/13/2016	Uranium	8.10	ug/L	
MW-30	8/18/2016	Uranium	8.23	ug/L	
MW-30	9/14/2016	Uranium	8.22	ug/L	
MW-30	10/5/2016	Uranium	7.64	ug/L	
MW-30	11/3/2016	Uranium	7.92	ug/L	
MW-30	12/6/2016	Uranium	8.63	ug/L	
MW-30	1/18/2017	Uranium	8.01	ug/L	
MW-30	2/2/2017	Uranium	7.62	ug/L	
MW-30	3/7/2017	Uranium	7.89	ug/L	
MW-30	4/5/2017	Uranium	7.63	ug/L	
MW-30	5/2/2017	Uranium	8.11	ug/L	
MW-30	6/5/2017	Uranium	7.98	ug/L	
MW-30	7/11/2017	Uranium	8.33	ug/L	
MW-30	8/14/2017	Uranium	8.05	ug/L	
MW-30	9/12/2017	Uranium	7.80	ug/L	
MW-30	10/5/2017	Uranium	8.35	ug/L	
MW-30	11/1/2017	Uranium	7.19	ug/L	
MW-30	12/6/2017	Uranium	8.18	ug/L	
MW-30	12/6/2017	Uranium	8.29	ug/L	
MW-30	1/23/2018	Uranium	8.53	ug/L	
MW-30	2/22/2018	Uranium	8.23	ug/L	
MW-30	3/8/2018	Uranium	8.66	ug/L	
MW-30	4/12/2018	Uranium	7.98	ug/L	
MW-30	5/15/2018	Uranium	8.44	ug/L	
MW-30	6/19/2018	Uranium	8.80	ug/L	
MW-30	7/24/2018	Uranium	8.69	ug/L	
MW-30	8/10/2018	Uranium	7.69	ug/L	
MW-30	9/11/2018	Uranium	8.34	ug/L	
MW-30	10/22/2018	Uranium	8.08	ug/L	
MW-30	11/14/2018	Uranium	8.81	ug/L	
MW-30	12/11/2018	Uranium	8.20	ug/L	
MW-30	1/16/2019	Uranium	9.07	ug/L	
MW-30	2/13/2019	Uranium	9.09	ug/L	
MW-30	3/6/2019	Uranium	8.39	ug/L	
MW-30	4/9/2019	Uranium	8.62	ug/L	
MW-30	5/7/2019	Uranium	8.15	ug/L	
MW-30	6/3/2019	Uranium	8.88	ug/L	

Notes:

U = Not detected above method detection limit

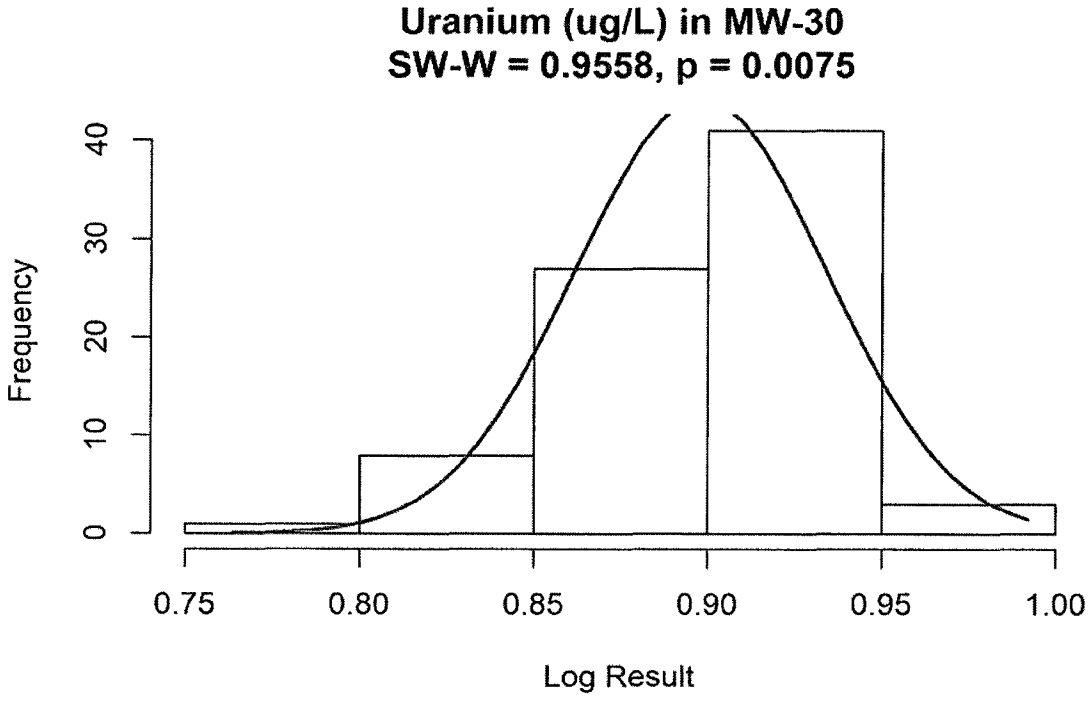
µg/L = micrograms per liter

APPENDIX A-3
Box Plot of Uranium in MW-30



Percent nondetect: 0%
Min: 5.8, Mean: 7.93, Max: 9.82, Std Dev: 0.64
Upper extreme threshold (Q75 + 3xH): 10.4475
Lower extreme threshold (Q25 - 3xH): 5.5125

APPENDIX A-4
Histogram of Uranium in MW-30



APPENDIX A-5
Time Series Plot of Uranium in MW-30