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Moab UMTRA Project
Groundwater and Surface Water Monitoring Report
January through June 2021

Revision 0

January 2022

U.S. Department of Energy

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Review and Approval

1/12/2022

X James Ritchey

James Ritchey
TAC Groundwater Technician
Signed by: JAMES RITCHEY (Affiliate)

1/12/2022

X Elizabeth Moran

Elizabeth Moran
TAC Environmental Manager
Signed by: ELIZABETH MORAN (Affiliate)

1/12/2022

X Thomas D. Bachtell

Thomas D. Bachtell
TAC Senior Program Manager
Signed by: THOMAS BACHTELL (Affiliate)

Revision History

Revision	Date	Reason for Revision
0	January 2022	Initial issue.

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Acronyms and Abbreviations

bgs	below ground surface
CCB	continuing calibration blank
CCV	continuing calibration verification
CF	Configuration
cfs	cubic feet per second
CFR	Code of Federal Regulations
cm	centimeter
COC	chain-of-custody
CRI	reporting limit verification
DOE	U.S. Department of Energy
EB	equipment blank
EIS	Environmental Impact Statement
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ft	feet or foot
ICP	inductively coupled plasma
ICV	initial calibration verification
IDL	instrument detection limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
µmhos	micro mhos
MB	method blank
MDL	method detection limit
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
PCOC	Potential Contaminant of Concern
QC	quality control
r^2	correlation coefficient
RIN	report identification number
RL	reporting limit
RPD	relative percent difference
SD	serial dilution
SDG	sample data group
UMTRA	Uranium Mill Tailings Remedial Action

1.0 Introduction

1.1 Purpose

The purpose of this semi-annual report is to present the results and provide interpretation of the data associated with groundwater and surface water samples collected from the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site during the first half of calendar year 2021. The results of the data validation process are also presented.

Three sampling events were completed during this time frame. The first event was associated with Matheson Wetland Preserve (Figure 1) sampling in March 2021.

The second event included the collection of samples in May 2021 from the Interim Action Well Field (Configuration (CF) 4 monitoring wells, CF5 groundwater extraction wells). These locations are shown on Figure 2.

The site wide sampling event took place from May through July 2021. Samples were collected from site-wide groundwater and surface water locations shown on Figures 3 and 4, respectively. Site-wide groundwater sampling was conducted to assess any changes and trends in water quality. The surface water samples associated with this event were collected to assess surface water quality adjacent to the site compared to up- and down-stream water quality.

1.2 Scope

This report presents the summary of sampling events and data assessments, including a summary of the anomalous data generated by the validation process and results for these events. Sampling and analyses were conducted in accordance with the *Moab UMTRA Project Surface Water/Groundwater Sampling and Analysis Plan* (DOE-EM/GJTAC1830). All data validation follows criteria in the *Moab UMTRA Project Standard Practice for Validation of Laboratory Data* (DOE-EM/GJTAC1855). The Site Wide Sampling event was validated to Level 3 and the Matheson Wetlands and Interim Action Samples were validated to Level 2.

Appendix A includes the Water Sampling Field Activities Verification and the trip report associated with the March 2021 Matheson Wetland Preserve sampling event. Appendix B provides similar documentation for the May 2021 CF4 and CF5 sampling event and the documentation associated with the May through July 2021 site-wide sampling event is provided in Appendix C.

All Colorado River flows discussed in this document were measured from the U.S. Geological Survey Cisco gaging station number 09180500. River elevation data were collected adjacent to the site, and river flows are reported as cubic feet per second (cfs).

The Minimums and Maximums analyses were generated by the Moab Environmental Sampling (MESa) database to determine if the applicable data were within a normal statistical range. The new data set was compared to the historical data to determine if the new data fall outside the historical range. The results are not considered anomalous if: (1) identified low concentrations are the result of low detection limits, (2) the concentration detected is less or more than 50 percent of historical minimum or maximum values, or (3) there were fewer than five historical samples for comparison. Anomalous results are provided in tables in the "Data Assessment" section for each sampling event.

Figure 1. Matheson Wetlands Sampling Locations

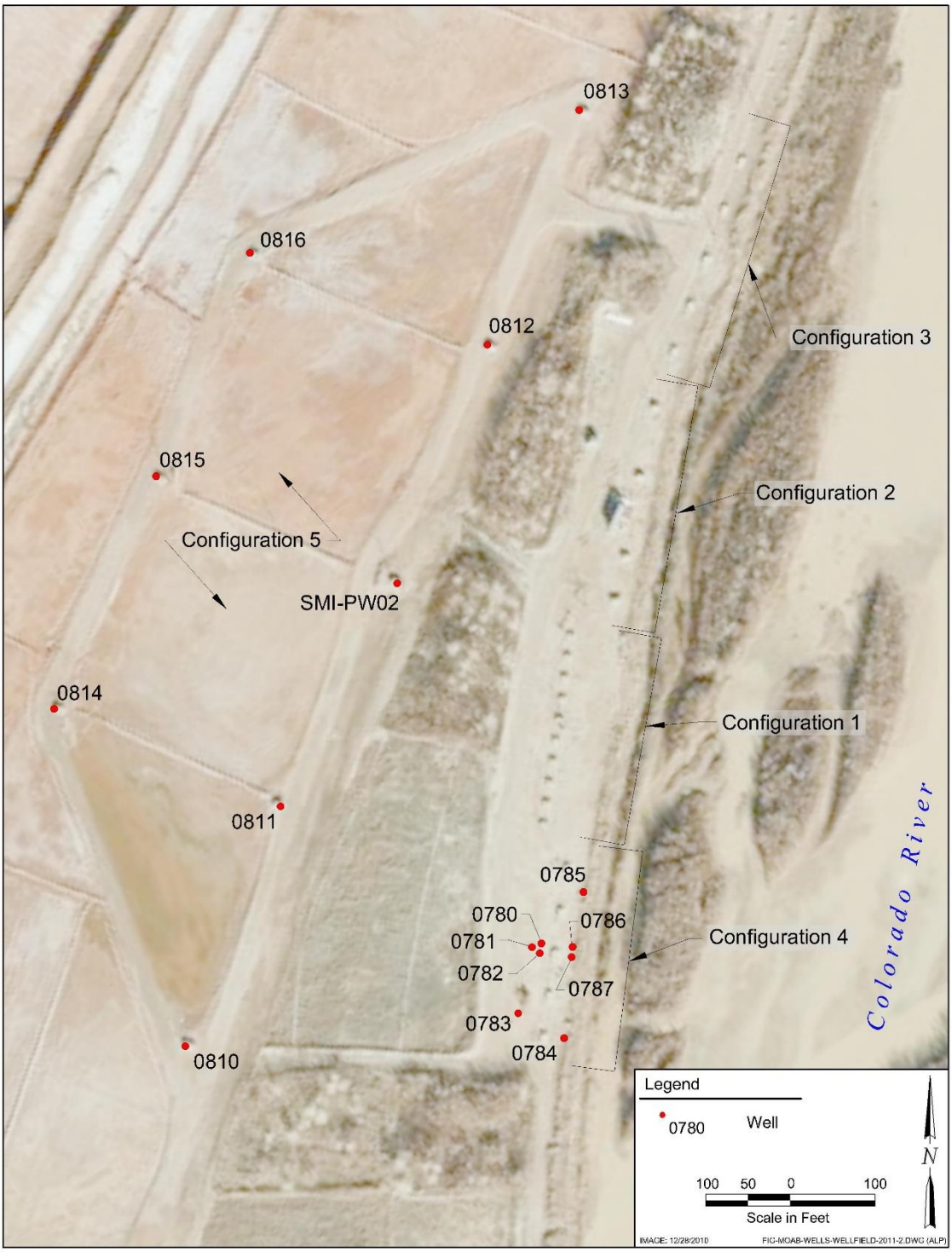

Figure 2.First Half 2021 CF4 and CF5 Groundwater Sampling Locations

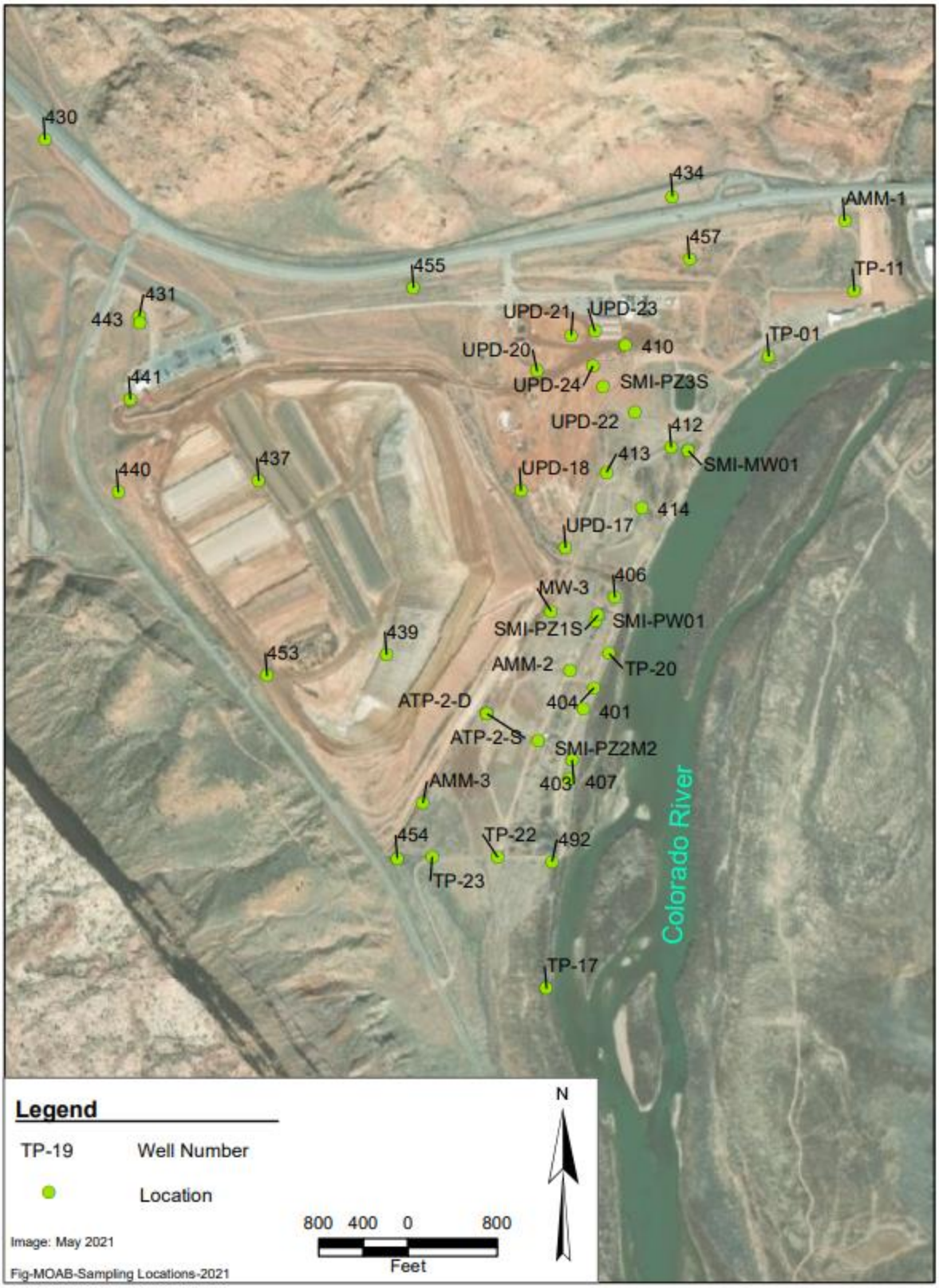

Figure 3. May Through July 2021 Site-wide Groundwater Sampling Locations

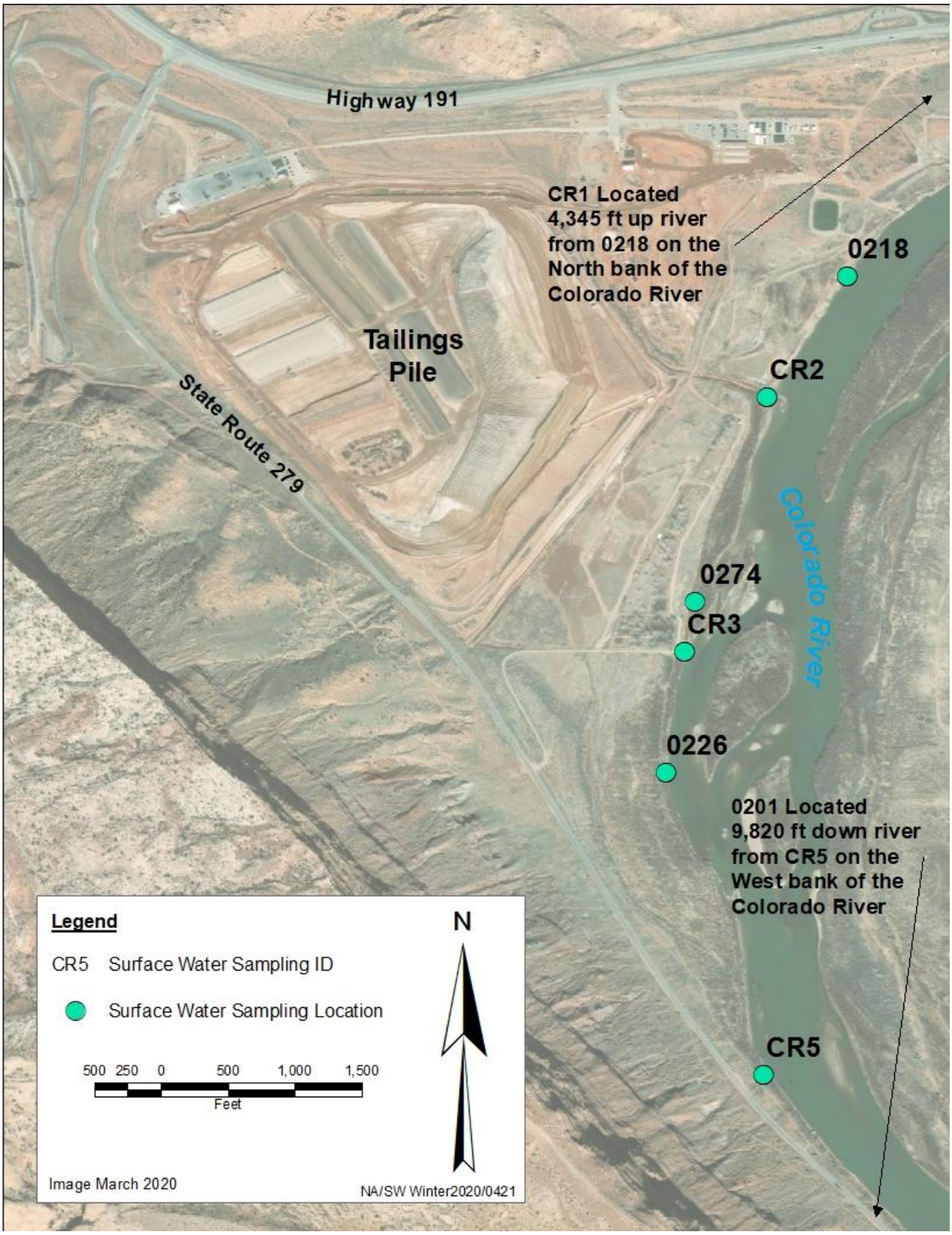

Figure 4. May Through July 2021 Surface Water Sampling Locations

1.3 Data Validation Definitions

The following definitions are associated with the data validation process and apply to Section 3.0. Data validation details are provided in the following sections of this report for the individual sampling events.

Laboratory Instrument Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure the instrument is capable of producing acceptable qualitative and quantitative data for all analytes. Initial calibration demonstrates the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear curve. Compliance requirements for continuing calibration checks are established to ensure the instrument continues to produce acceptable qualitative and quantitative data.

Method and Calibration Blanks
Method blanks (MBs) are analyzed to assess any contamination that may have occurred during sample preparation. Both initial calibration blanks and continuing calibration blanks (CCBs) are analyzed to assess instrument contamination before and during sample analysis. Depending on method requirements, detected sample results greater than the method detection limit (MDL) or instrument detection limit (IDL) are qualified "J" when the detections are less than five times the blank concentration. Non-detects are not qualified.

Equipment Blanks
An equipment blank (EB) is a sample of analyte-free media collected from a rinse of non-dedicated sampling equipment used to sample surface water. EBs are collected to document adequate decontamination of non-dedicated equipment.

Laboratory Control Sample Duplicates
Laboratory Control Sample Duplicates (LCSDs) that contain known concentrations of the analyte of interest are prepared in the laboratory. Matrix spike (MS) samples may not be generated due to a limited sample volume. Instead, laboratory control sample duplicates LCSDs are performed. The results are used to demonstrate the laboratory is in control of the preparation and analysis of samples.

Matrix Spike and Replicate Analysis
MS sample analysis, performed at a frequency of one per 20 samples unless otherwise noted, is a measure of the ability to recover analytes in a particular matrix. The MS sample results are required to be within the recovery limits.

Laboratory Replicate Analysis
The laboratory replicate results demonstrate acceptable laboratory precision. The relative percent difference (RPD) values for the reported matrix spike duplicate (MSD) results for all other analytes should be less than 20 percent for results greater than five times the RL.

Field Duplicate Analysis
Field duplicate samples are collected and analyzed as an indication of the overall precision of the measurement process. The precision observed includes both field and laboratory precision and has more variability than laboratory replicates, which measure only laboratory performance. The duplicate results must meet the U.S. Environmental Protection Agency (EPA)-recommended laboratory duplicate criteria of less than 20 RPD for results that are greater than five times the RL.

Laboratory Control Samples
LCSs provide information on the accuracy of the analytical method and the overall laboratory performance, including sample preparation. Per national environmental laboratory accreditation requirements provided by the National Environmental Laboratory Accreditation Institute, a MS may be used in place of an LCS provided the acceptance criteria are as stringent.

Metals Serial Dilution
Serial dilution (SD) samples are prepared and analyzed for the metals analyses to monitor chemical or physical interferences in the sample matrix.

Detection Limits/Dilutions
Dilutions are prepared in a consistent and acceptable manner when they are required. CRIs are re-run at the beginning of each analytical run as a measure of accuracy near the RL. CRIs were made at the required frequency to verify the linearity of the calibration curve near the RL.

2.0 March 2021 Matheson Wetland Preserve Sampling Event

2.1 March 2021 Matheson Wetland Preserve Data Assessment

Groundwater samples were collected from the Matheson Wetlands Preserve to measure the ammonia and uranium concentrations in groundwater wells across from the Colorado River from the Moab Site. This event represents the first time samples were collected from these locations since 2015. Monitoring the groundwater at the Preserve is performed periodically to assess any changes in site conditions.

This event also included some samples for the previous site wide sampling event (RIN 2012124) for ammonia, uranium, arsenic, and selenium analysis.

2.1.1 Laboratory Performance Assessment
This validation was performed according to *Standard Practice for Validation of Laboratory Data*. The procedure was applied at Level 2, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

RIN	2103125
Laboratory:	ALS Analytics, Fort Collins, Colorado
SDG Numbers:	2103312
Analysis:	Inorganics, Metals
Validator:	James Ritchey
Review Date:	December 2021

The samples were prepared and analyzed using accepted procedures as shown in Table 1.

Table 1. March 2021 Matheson Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N, NH3-N	EPA 350.1	EPA 350.1
Uranium	SW-846 3005A	SW-846 6020A
Arsenic	SW-846 3005A	ICP-MS 6020B
Selenium	SW-846 3005A	ICP-MS 6020B

Data Qualifier Summary

Analytical results were qualified as listed in Table 2. Refer to Table 3 for an explanation of the data qualifiers applied.

Table 2. March 2021 Matheson Wetlands Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
SDG 2103312 -1 through -30	All in SDG 2103312	Ammonia	J	MS-2, MSD-1
SDG 2103312 -1 through -30	All in SDG 2103312	Uranium	J	MS-1, MSD-1
SDG 2103312 -1 through -30	All in SDG 2103312	Arsenic	J	MS-1, MSD-1
SDG 2103312 -1 through -30	All in SDG 2103312	Selenium	J	MS-1, MSD-1

Notes: “J” indicates results are estimated; it becomes “UJ” for analytical results lower than the detection limit.

Table 3. March 2021 Matheson Wetlands Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-Detects)	Explanation
MS-1	J	UJ	The MS sample chosen was from another client.
MS-2	J	UJ	The MS failed due to a low percent recovery.
MSD-1	J	UJ	No MSD data was included in the narrative.
MSD-2	J	UJ	The MSD sample chosen from another client.

Notes: “J” indicates results are estimated; it becomes “UJ” for analytical results lower than the detection limit. U indicates the result is below the detection limit.

Sample Shipping/Receiving

ALS Analytics in Fort Collins, Colorado, received 30 samples for RIN 2103125 in a shipment of one cooler. The shipment (SDG 2103312) contained ground water samples from twelve observation wells from the Matheson Wetland Preserve. Three wells from the Moab UMTRA site were also sampled in a continuation of the December 2020 Site Wide Event (RIN 2012124). The temperature of the cooler was 3.1°C and it arrived on March 16, 2021 (Tracking number 1Z5W1Y510197349600).

The COC forms were checked to confirm that all of the samples were listed on the form with sample collection dates and times, and signatures and dates were present indicating sample relinquishment and receipt. The sample submittal documents, including the COC forms and the sample tickets, had no errors or omissions.

Preservation and Holding Times
The samples were received in the correct container types and had been preserved correctly for the requested analyses. All samples were analyzed within the applicable holding time.

Case Narratives
The case narratives were reviewed, and all detects where found to be within quality-control procedures.

Matrix Spike and Replicate Analysis
Sample locations 2103321-1 (0410), 2103321-8 (BL1-D), and 2103321-26 (BL3-S) were chosen for the ammonia matrix spike analysis. The correct amount of matrix spikes were analyzed for the amount of samples. However, all three failed with a low recovery and sample results are flagged "J" for reason MS-2. A MSD sample was not analyzed and all ammonia data had to be flagged "J" for reason MSD-1.

For the uranium SDG, the MS sample that was selected for QC analysis was from another client and the information was not included in the analysis. Therefore, all of the uranium data was flagged "J" for reasons MS-2 and MSD-2.

Completeness
Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable File
The EDD files arrived on March 24, 2021. The contents of the EDD were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package.

2.1.2 Minimums and Maximums Report and Anomalous Data Review

There were four anomalous data points that lay outside of the historical result range (Table 4). Based on the uranium results in the samples collected from well BL2-S, BL3-D, BL3-M, and N3-8.3 which were below the historical minimums.

Table 4. Anomalous Data Associated with the March 2021 Matheson Wetland Preserve Sampling Event

Location	Sample Date	Analyte	Concentration (pCi/L)	Historical Minimum (mg/L)	Historical Maximum (mg/L)	Disposition
BL2-S	3/4/2021	Uranium	0.001	0.0025	0.0032	These data represent historically low concentrations associated with uranium analyses.
BL3-D	3/4/2021		0.00002	0.00015	0.000058	
BL3-M	3/4/2021		0.00007	0.00015	0.0003	
N3-8.3	3/4/2021		0.01	0.03	0.054	

2.2 March 2021 Matheson Wetlands Sampling Event Results

Ammonia and uranium concentration results from the Matheson Wetlands sampling event primarily decreased or stayed consistent with previous results. Table 5 depicts historical concentration sampling events back until December of 2005. All results from March 2021 were lower than when

last sampled in Nov 2015 with the exception of two ammonia concentrations in wells BL1-D (1.8mg/L) and N3-8.3 (0.2mg/L). The ammonia result for BL1-D was still consistent with past results. Also, Table 4 shows all uranium concentrations outside of the historical maximums and minimums were lower than historical minimum results.

Table 5. Matheson Wetlands Analyte Concentrations from 2005 to 2021

Location	Sample Depth (ft btoc)	Analyte	Dec 2005 (mg/L)	May 2006 (mg/L)	June 2006 (mg/L)	April 2010 (mg/L)	Nov 2015 (mg/L)	March 2021 (mg/L)
BL1-S	55	NH_3-N	0.51	0.37	0.49	0.23	0.62	0.24
		U	0.007	0.0062	0.0078	0.011	0.0053	0.004
BL1-M	99	NH_3-N	0.66	0.63	0.62	0.59	0.88	0.73
		U	0.002	0.0024	0.0023	0.0034	0.0031	0.0017
BL1-D	140	NH_3-N	2.2	2.2	2.3	2.3	2.9	1.9
		U	0.0011	0.0012	0.0011	0.0023	0.0019	0.00089
BL2-S	57	NH_3-N	2.1	2.1	2	1.9	1.7	1.8
		U	0.0027	0.0032	0.003	0.0029	0.0025	0.001
BL2-M	100	NH_3-N	2.9	2.8	2.7	2.9	3.9	2.4
		U	0.003	0.003	0.0031	0.0049	0.0038	0.0016
BL2-D	142	NH_3-N	3.1	3.1	3	3.2	4.2	2.6
		U	0.0028	0.0029	0.0029	0.0039	0.0035	0.0014
BL3-M	47	NH_3-N	2.4	2.3	2.5	2.5	4	2.4
		U	0.00016	0.00015	0.00023	0.0003	0.00022	0.00007
BL3-D	100	NH_3-N	3.6	3.5	3.5	3.7	8.9	2.8
		U	0.000058	0.000068	0.00015	0.000096	0.00008	0.00002
N3-8.3	24	NH_3-N	0.1 [1]	0.1[2]	0.1[2]	0.1[2]	0.11	0.2[2]
		U	0.045 [1]	0.048	0.054	0.047	0.03	0.010
N6-6.4	12	NH_3-N	0.1	0.1	0.1	N/A	0.26	0.2[2]
		U	0.0066	0.0072	0.0065	N/A	0.0095	0.005

Notes: 1 = Samples collected in January 2006
2 = At or below the detection limit

3.0 May 2021 CF4 and CF5 Sampling Event

3.1 Summary

Groundwater samples were collected from the seven CF5 extraction wells to determine mass removal calculations for ammonia and uranium concentrations and to assess well field performance.

Groundwater samples were also collected from the eight CF4 monitoring wells to determine the impact of the freshwater injection system on the shallow aquifer. These ground water samples were collected to determine how long the freshwater injection system impacts shallow zone ammonia concentrations, particularly downgradient of the CF4 injection wells.

3.2 May 2020 CF4 and CF5 Data Assessment

3.2.1 Laboratory Performance Assessment

This validation was performed according to *Standard Practice for Validation of Laboratory Data*. The procedure was applied at Level 2, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

RIN 2105127
Laboratory: ALS Analytics, Fort Collins, Colorado
SDG Number: 2105274 and 2108493
Analysis: Metals and Inorganics
Validator: James Ritchey
Review Date: December 2021

The samples were prepared and analyzed using accepted procedures as shown in Table 6.

Table 6. May 2021 CF4 and CF5 Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N, NH_3-N	EPA 350.1	EPA 350.1
Uranium	SW-846- 3005A	SW-846 6020A

Data Qualifier Summary

Analytical results were qualified as listed in Table 7. Refer to Table 8 for an explanation of the data qualifiers applied.

Table 7. May 2021 CF4 and CF5 Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
SDG 2105274-2, -3, -5, -7, -10, -11, -14, -15, -18, -20, -22, -24, -26, -27, -9, and -31	All in SDG 2105274	Ammonia	J	MSD-1
SDG 2108493-18, -20, -27, -29, and -31	All in SDG 2108493	Ammonia	J	MSD-1
SDG 2105274-1, -4, -6, -8, -9, -12, -13, -16, -17, -19, -21, -23, -25, -28, -30, and -32	All in SDG 2105274	Uranium	J	MS-1 MSD-1
SDG 2108493-21, -23, -28, and -30	All in SDG 2108493	Uranium	J	MS-1, MSD-1

Notes: “J” indicates results are estimated; it becomes “UJ” for analytical results lower than the detection limit.

Table 8. May 2021 CF4 and CF5 Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
MS-1	J	UJ	The MS sample chosen was from another client.
MSD-1	J	UJ	No MSD data was included in the narrative.

Notes: “J” indicates results are estimated; it becomes “UJ” for analytical results lower than the detection limit. U indicates the result is below the detection limit.

Sample Shipping/Receiving

ALS Analytics in Fort Collins, Colorado received a total of 32 samples from 16 locations for RIN 2105127 in one shipment; tracking number 1Z5W1Y510192597888 on 5/13/21.

The sample data group (SDG) was accompanied by a Chain of Custody (COC) form. The COC form was checked to confirm that all of the samples were listed on the form with sample collection dates and times, and that signatures and dates were present indicating sample relinquishment and receipt.

Preservation and Holding Times
SDG 2105274 was received intact with a temperature of 0.9°C. All samples were received in the correct container types and all samples were analyzed within the applicable holding times.

Case Narratives
The case narratives were reviewed, and all detects where found to be within quality-control procedures except for the following:

Field Duplicate Analysis
Field duplicate samples are collected and analyzed as an indication of overall precision of the measurement process. The precision observed includes both field and laboratory precision and has more variability than laboratory replicates, which measure only laboratory performance. A duplicate sample (2105274-25 and -26) was collected from location 0813. The duplicate results met the U.S. Environmental Protection Agency (EPA) recommended laboratory duplicate criteria of less than 20 percent relative difference (RPD) for results that are greater than 5 times the RL. However, due to the difference being significant and atypical, the field samples were reanalyzed for uranium and achieved a lower result (1.7 mg/L from 2.7 mg/L). This new result significantly increased the relative difference of the duplicate and is outside of the EPA duplicate criteria.

Completeness
Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable Files
The Electronic Data Deliverable (EDD) files for SDG 2105274 arrived June 19, 2021. Files for SDG 2108493 were received on November 1, 2021. The contents of the EDD were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package

3.2.2 Minimums and Maximums Report and Anomalous Data Review
Based on the results, most concentrations are within the historical range. Table 9 shows the sample results that were less than 10% off of the historical range.

Table 9. Anomalous Data Associated with the CF4 and CF5 Sampling Event

Location	Sample Date	Analyte	Concentration (mg/L)	Historical Minimum (mg/L)	Historical Maximum (mg/L)	Disposition
0812	5/11/2021	Ammonia Total as N	310	330	620	These concentrations are within less than 10% of historical values. These locations will continue to be monitored to determine the general trend in concentration.
0813	5/11/2021	Uranium	3.2	0.91	3.1	
SMI-PW02	5/11/2021	Ammonia Total as N	370	380	4400	

3.3 May 2021 CF4 and CF5 Sampling Event Results

CF4 Sampling

The eight monitoring wells surrounding the CF4 freshwater injection wells (Figure 5) were sampled in May 2021. These same wells were also sampled in January 2021, and these results are presented in this Section for comparison purposes. The May samples were collected after the system injected more than 2.5 mil gal of freshwater into the CF4 wells since the January sampling event. Operation of the system was limited between late February and early April due to the injection system pump replacement.

The CF4 wells are screened and deliver fresh water into the subsurface from 15 to 35 ft below ground surface (bgs). May 2021 ammonia concentrations associated with the downgradient samples collected from a depth less than 20 ft bgs (wells 0784 and 0785) had concentrations that were below 1 mg/L, indicating the injection system operations impact this shallow subsurface zone. The sample from the upgradient shallow zone (from well 0783) was below 50 mg/L. Samples collected from wells 0780 and 0786 (28 ft bgs) and well 0782 (33 ft bgs) had ammonia concentrations ranging from 3.6 to 100 mg/L. From a depth of 36 to 46 ft bgs, the ammonia concentrations ranged from 440 to 850 mg/L (wells 0787 and 0781).

January and May 2021 ammonia concentrations are presented in Table 10, with the May 2021 concentrations displayed in Figure 5. Baseline concentrations represent sample results from January 2019, when limited freshwater was injected (less than 750,000 gal) for the six months leading up to the sample collection.

Table 10. CF4 Monitoring Well Ammonia Concentrations, January and May 2021

Location	Sample Depth (ft bgs)	Upgradient or Downgradient of Injection Wells	Baseline* Concentration (mg/L)	January 2021 Ammonia Concentration (mg/L)	May 2021 Ammonia Concentration (mg/L)
0780	28	Upgradient	330	250	26
0781	46	Upgradient	1,900	1,200	850
0782	33	Upgradient	1,100	290	100
0783	18	Upgradient	20	60	41
0784	18	Downgradient	1.1	5.1	0.2

Table 10. CF4 Monitoring Well Ammonia Concentrations, January and May 2021 (continued)

0785	18	Downgradient	17	88	0.8
0786	28	Downgradient	480	450	3.6
0787	36	Downgradient	2,100	1,200	440

Notes: * = Baseline concentrations taken from samples collected August 2010, prior to when the CF4 wells were used exclusively for injection purposes.

Figure 6 displays the ammonia concentrations in samples collected down gradient from a depth of 18 ft bgs (wells 0784 and 0785) since 2016, along with the CF4 weekly injected volume. As the plot displays, consistent injection continues to significantly decrease the shallow groundwater system ammonia concentrations downgradient of the injection wells.

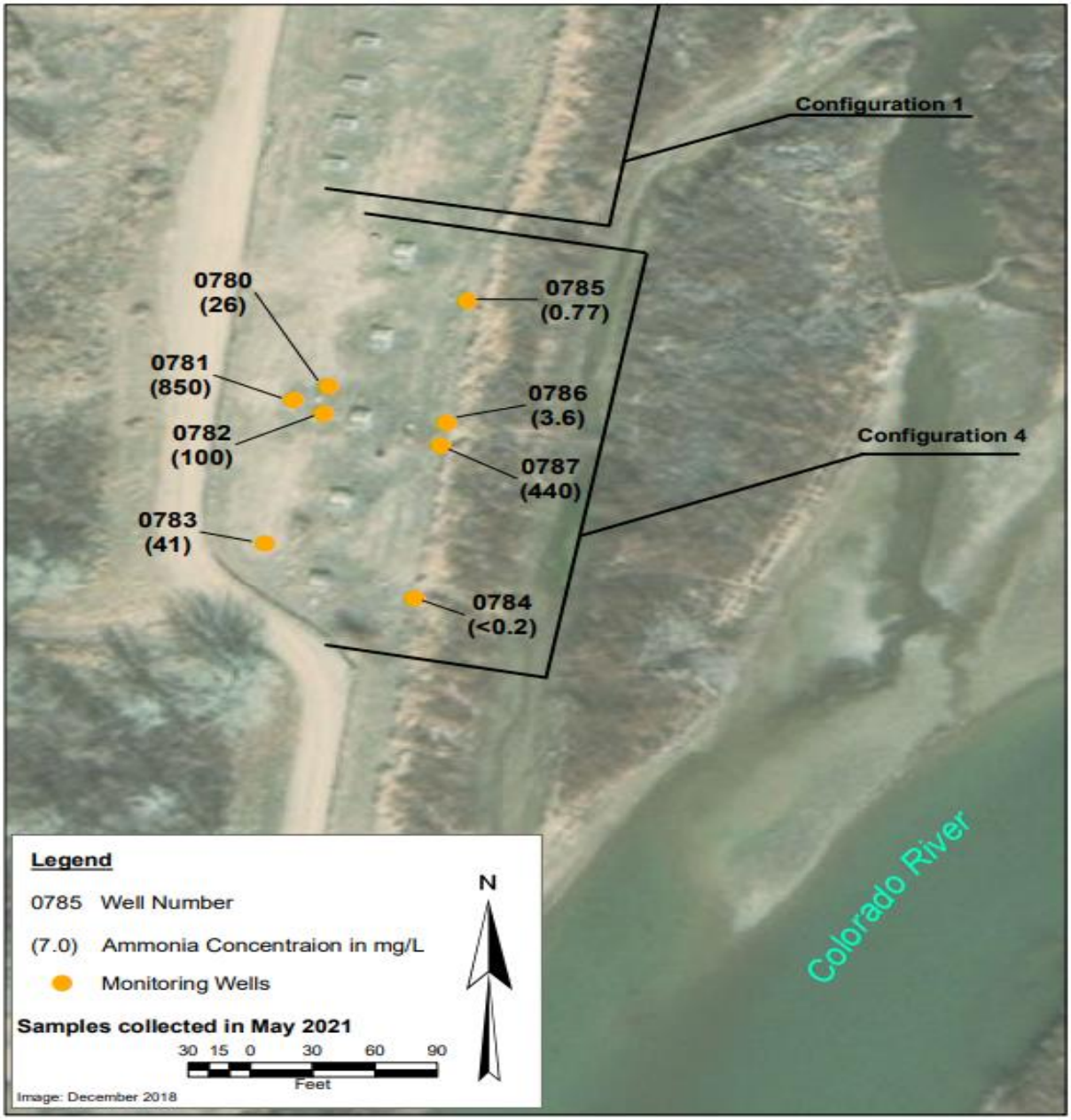

Figure 5. May 2021 CF4 Ammonia Groundwater Concentrations

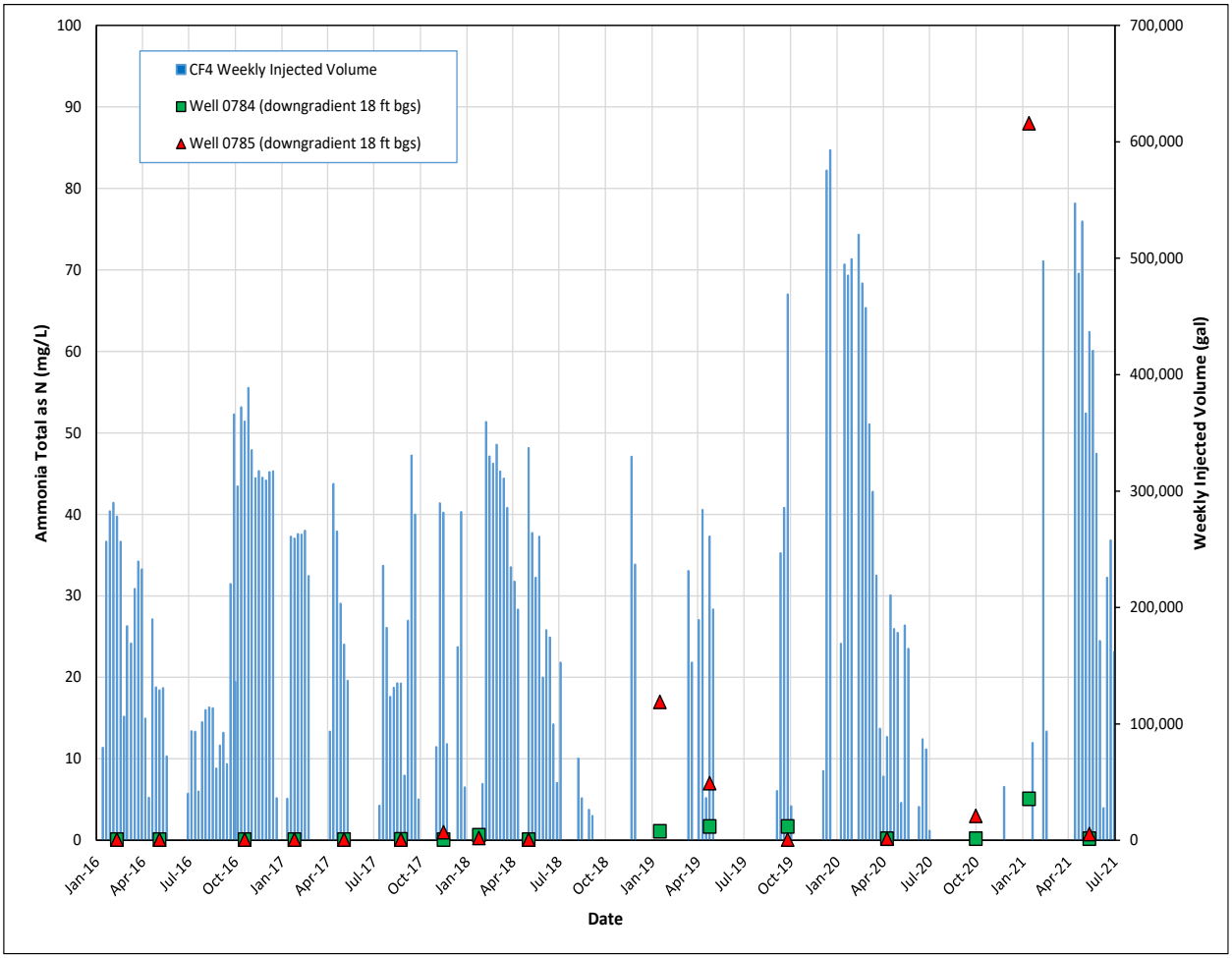

Figure 6. January 2016 through July 2021 CF4 Shallow Zone Ammonia Groundwater Concentrations in Response to Freshwater Injection

CF5 Sampling

Groundwater samples were also collected from the CF5 extraction wells (locations shown on Figure 2) in May 2021. The extraction system had been consistently operational for approximately two months prior to the sample collection, with more than 2.2 mil gal of groundwater removed from the groundwater system during that time. It was not possible to collect any samples from well 0815 due to submersible pump issues. CF5 extraction well ammonia and uranium concentrations associated with this sampling event are displayed on Figure 7. Time versus concentration plots (Figures 8 through 11) were also generated to display the CF5 extraction well ammonia and uranium concentrations measured since July 2010. This nearly covers the timeframe these wells have been utilized to extract groundwater (they were brought online starting in April 2010). Trend lines are also included in these plots.

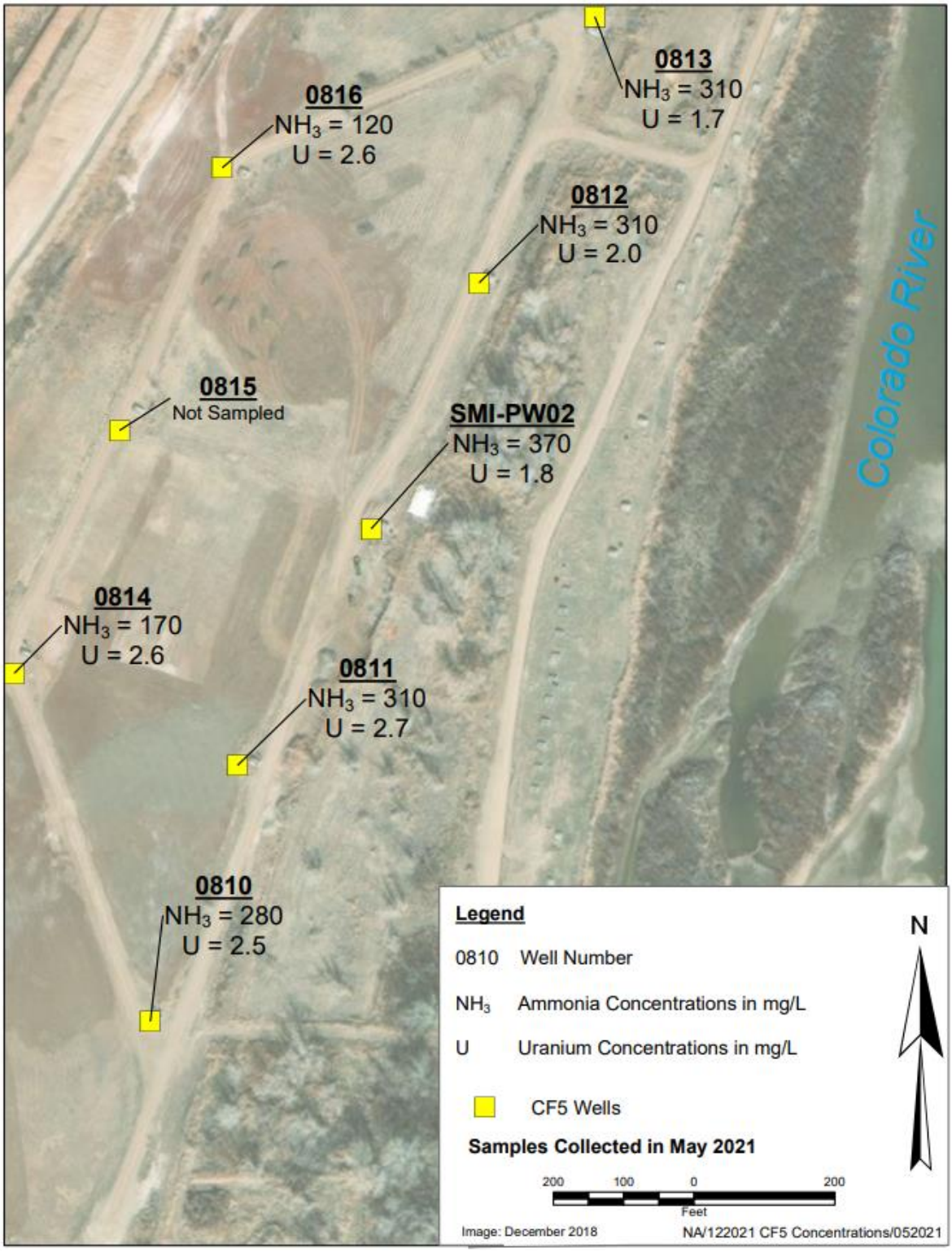

Figure 7. May 2021 CF5 Ammonia and Uranium Groundwater Concentrations

Table 11 provides the geometric mean, standard deviation, 95% confidence interval, and the change in ammonia concentration based on the linear trend line for the CF5 extraction wells since 2010. The trend lines applied to data collected since June 2010 from CF5 extraction wells indicate that, with the exception of the samples collected from well 0813, on average the ammonia concentrations are decreasing at a rate ranging from 3.9 to 21.0 mg/L/yr. As of 2021, the CF5 extraction well geometric mean ammonia concentrations range from 166 to 456 mg/L.

Table 11. Statistical Data for CF5 Extraction Well Ammonia Data, 2010 through 2021

Ammonia Concentrations (2010 – 2021)	CF5 Extraction Well						
	0810	0811	0812	0813	0814	0816	PW02
Geometric Mean (mg/L)	320.0	400.6	415.1	327.7	188.4	165.6	456.1
Standard Deviation (mg/L)	31.7	58.2	66.2	89.0	46.4	30.4	54.0
95% Confidence Interval (mg/L)	13.9	26.2	29.0	39.0	20.9	14.1	23.1
Change in Concentration (mg/L/yr)	-3.9	-11.6	-5.9	+6.9	-11.4	-8.2	-13.5

The trend line associated with data collected from well 0813 indicates concentrations have been increasing over the past 10 years, at a rate of 6.9 mg/L/yr. This increase is a function of the historical low concentrations (measured after the 2011 flooding event) impacting the data set. Only taking into account the ammonia analytical results since 2013, the concentrations decrease on average 11.3 mg/L/yr.

Statistical data for the uranium results since 2010 are presented in Table 12. Trend lines applied to the uranium results over the past 11 years for all CF5 wells indicate four wells on average are decreasing as much as 0.04 mg/L/yr, three wells on average are increasing of up to 0.06 mg/L/yr, and one well has not changed. The wells associated with the highest increases (wells 0813 and 0816 increased on average 0.06 and 0.02 mg/L/yr, respectively) are located at the northern end of CF5. These minimal increases of the uranium concentrations are associated with the periodic influx of oxygenated water and its impact on the subsurface geochemical conditions.

Table 12. Statistical Data for CF5 Extraction Well Uranium Data, 2010 through 2021

Uranium Concentrations (2010 – 2021)	CF5 Extraction Well						
	0810	0811	0812	0813	0814	0816	PW02
Geometric Mean (mg/L)	3.01	2.65	2.06	1.52	2.82	2.50	3.22
Standard Deviation (mg/L)	0.49	0.42	0.30	0.42	0.18	0.17	0.43
95% Confidence Interval (mg/L)	0.22	0.19	0.13	0.18	0.08	0.08	0.18
Change in Concentration (mg/L/yr)	-0.04	+0.01	-0.01	+0.06	0.00	+0.02	-0.03

Figure 8 is the time versus ammonia concentration plot for extraction wells 0810 through 0813 and SMI-PW02, all of which are located along the CF5 southeastern boundary. Figure 9 displays a time versus uranium concentration plot for the same set of wells. Figures 10 and 11 are the time versus ammonia and uranium concentration plots, respectively, for CF5 wells 0814 through 0816 (which are located closer to the base of the tailings pile).

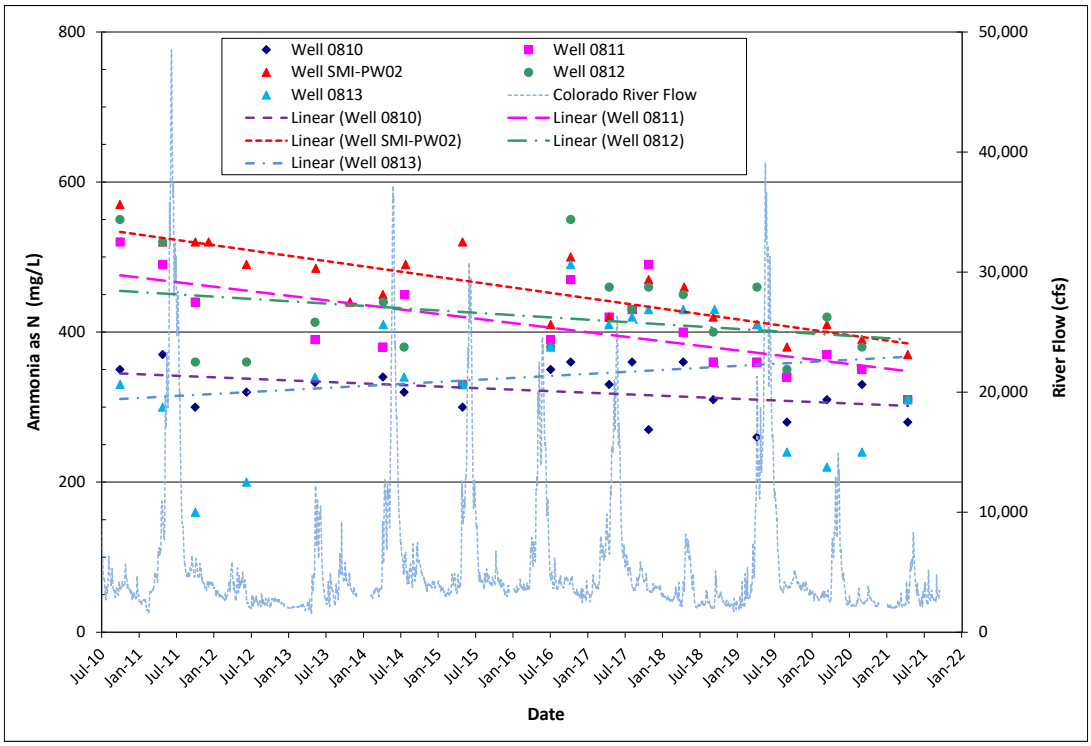

Figure 8. CF5 Extraction Wells 0810, 0811, 0812, 0813, and SMI-PW02 Time versus Ammonia Concentration Plot

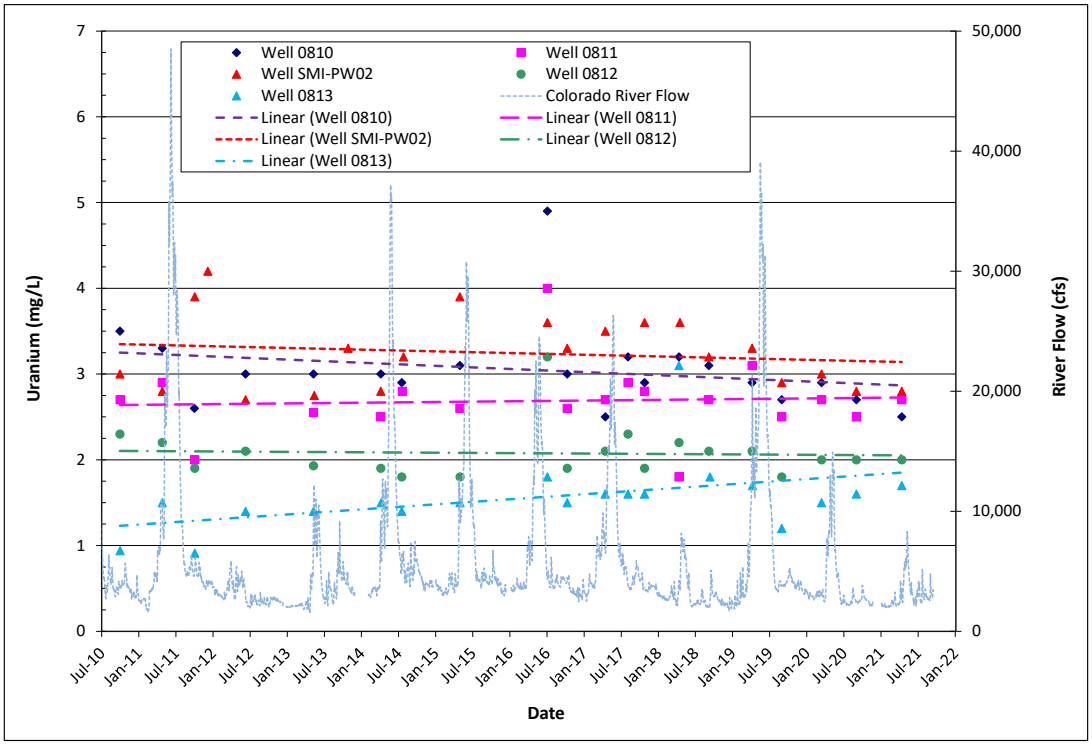

Figure 9. CF5 Extraction Wells 0810, 0811, 0812, 0813, and SMI-PW02 Time versus Uranium Concentration Plot

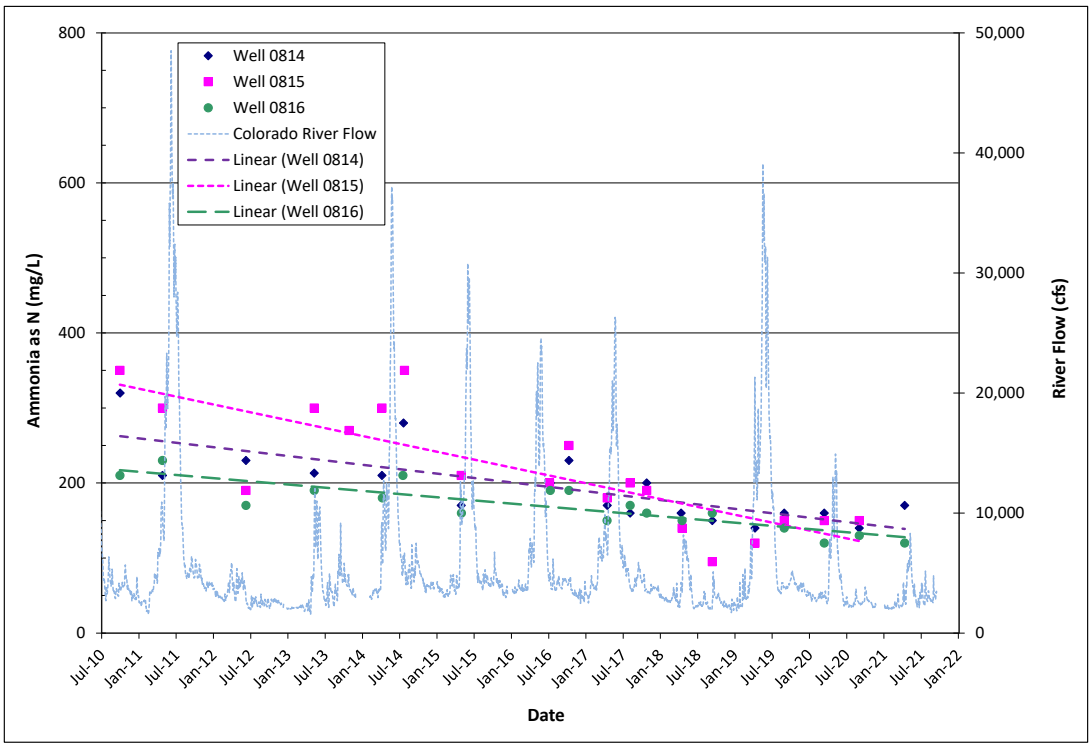

Figure 10. CF5 Extraction Wells 0814, 0815, and 0816 Time versus Ammonia Concentration Plot

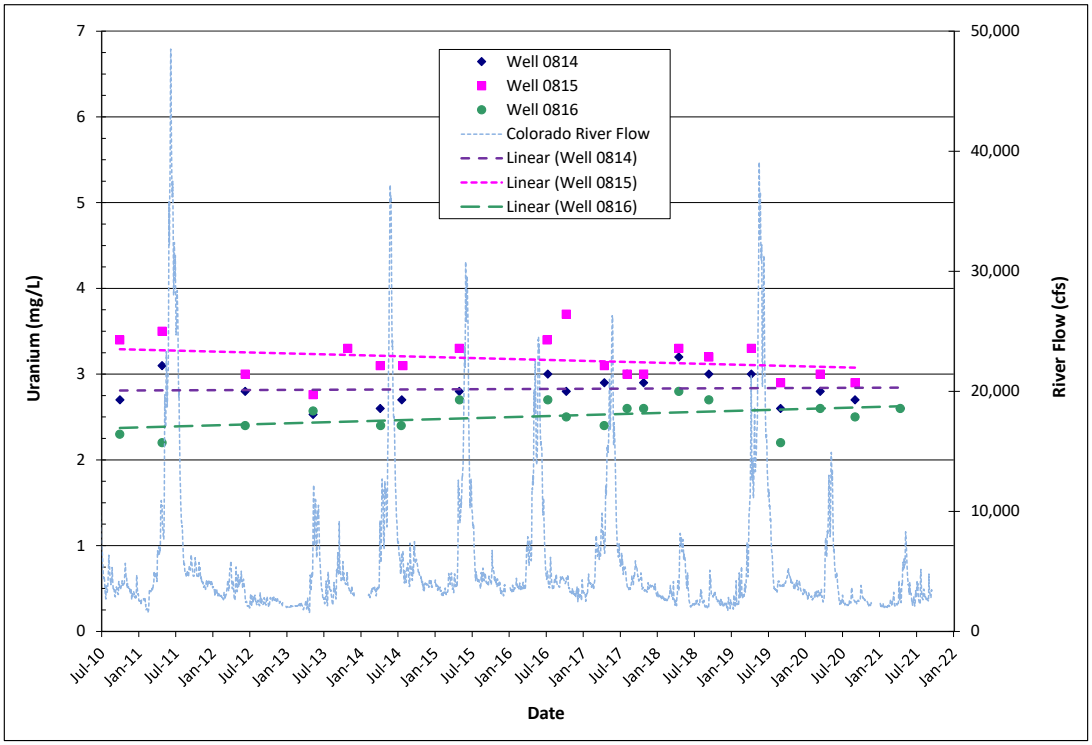

Figure 11. CF5 Extraction Wells 0814, 0815, and 0816 Time versus Uranium Concentration Plot

4.0 May through July 2021 Site-wide Sampling Event

4.1 Summary

Fifty-eight groundwater and surface water samples (including QA samples) were collected as part of the site-wide event. This event is conducted when the Colorado River is at base flow conditions. All samples were submitted to ALS Global Laboratory for ammonia and uranium analysis. Samples from select locations (based on historical results) were also analyzed for arsenic, selenium, copper, and manganese.

4.2 May through July 2021 Site-wide Sampling Event Data Assessment

4.2.1 Laboratory Performance Assessment

This validation was performed according to *Standard Practice for Validation of Laboratory Data*. The procedure was applied at Level 3, Data Deliverables Examination. All analyses were successfully completed.

General Information and Validation Results

RIN	2105128
Laboratory:	ALS Analytics, Fort Collins, Colorado
SDG Numbers:	2106323, 2106610, 2107186
Analysis:	Metals and Inorganics
Validator:	James Ritchey
Review Date:	December 2021

The samples were prepared and analyzed using accepted procedures as shown in Table 13. Analytical results were qualified as listed in Table 14. Refer to Table 15 for an explanation of the data qualifiers applied.

Table 13. May 2021 Site-wide Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N, NH3-N	EPA 350.1	EPA 350.1
Uranium	SW-846 3005A	SW-846 6020A
Arsenic	SW-846 3005A	ICP-MS 6020B
Copper	SW-846 3005A	SW-846 6020B
Manganese	SW-846 3005A	SW-846 6020B
Selenium	SW-846 3005A	ICP-MS 6020B
Sulfate	EPA 300.0	EPA 300.0

Table 14. May 2021 Site-wide Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
22106323-1 through 57 2106610 -1 through 54 2107186 -1 through 54	All in each metals SDG	Metals (Arsenic, Copper, Manganese, Selenium, and Uranium)	J	MS-1, MSD-1,
22106323-1 through 57 2106610 -1 through 54 2107186 -1 through 54	All in each inorganics SDG	Ammonia	J	MS-2, MSD-1
22106323-1 through 57 2106610 -1 through 54 2107186 -1 through 54	All in each inorganics SDG	Sulfate	J	MS-2, MSD-1 MS-2, MSD-1 MSD-1

Notes: "J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit.

Table 15. May 2021 Site-wide Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
MS-1	J	U	No MS data was included in narrative.
MSD-1	J	U	No MSD data was included in the narrative.
MS-2	J	U	The MS failed due to a low percent recovery.

Notes: "J" indicates results are estimated and becomes "UJ" for analytical results lower than the detection limit. U indicates the result is below the detection limit.

Sample Shipping/Receiving

ALS Analytics in Fort Collins, Colorado, received a total of 58 samples for RIN 2105128 in three shipments.

The three SDGs were accompanied by a Chain of Custody (COC) form. The COC form was checked to confirm that all of the samples were listed on the form with sample collection dates and times, and that signatures and dates were present indicating sample relinquishment and receipt. The sample submittal documents, including the COC forms and the sample tickets, had no errors or omissions.

Preservation and Holding Times

All of the SDGs were received intact. SDG 2106323 was received with a temperature of 3.4°C, SDG 2106610 was received with a temperature of 3.1°C, and SDG 2107186 was received with a temperature of 4.0°C. All four SDGs were received with compliant temperatures. All samples were received in the correct container types. All samples were analyzed within the applicable holding times.

Case Narratives

The case narratives were reviewed, and all detects where found to be within quality control procedures except for the following:

Laboratory Instrument Calibration

Method SW-846 6020A, Uranium

The initial calibrations were all performed using four calibration standards and one blank, resulting in calibration curves with correlation coefficient (r^2) values greater than 0.995. The values of the calibration curve intercepts for uranium were positive and less than 3 times the IDL.

Initial calibration verification (ICV) and continuing calibration verification (CCV) checks were made at the required frequency. All calibration checks met the acceptance criteria.

Internal standard recoveries were stable and within acceptable ranges.

Method ICP-MS 6020B, Arsenic, Copper, Manganese, and Selenium

The initial calibrations were all performed using four calibration standards and one blank, resulting in calibration curves with correlation coefficient (r^2) values greater than 0.995. The values of the calibration curve intercepts for arsenic, and selenium were positive and less than 3 times the IDL.

Initial calibration verification (ICV) and continuing calibration verification (CCV) checks were made at the required frequency. All calibration checks met the acceptance criteria.

Internal standard recoveries were stable and within acceptable ranges.

EPA 350.1, Ammonia as N

Initial calibrations for ammonia as N on all SDGs were performed using five calibration standards and one blank. The calibration curve had a correlation coefficient (r^2) value greater than 0.995 in SDGs 2106610 and 2107186. SDG 2106323 had value a below the acceptable limit and the results are flagged "J".

ICV and CCV checks were made at the required frequency. All calibration check results for all SDGs were within the acceptance criteria.

EPA 300.0, Sulfate

Initial calibrations for sulfate on all SDGs were performed using five calibration standards and one blank. The calibration curve had a correlation coefficient (r^2) value greater than 0.995 in SDGs 2106323 and 2106610. SDG 2107186 had a value below acceptable limit and the results are flagged "J".

ICV and CCV checks were made at the required frequency. All calibration check results for all SDGs were within the acceptance criteria.

Method and Calibration Blanks

Method blanks (MBs) are analyzed to assess any contamination that may have occurred during sample preparation. Both initial calibration blanks (ICB) and continuing calibration blanks (CCBs) are analyzed to assess instrument contamination prior to and during sample analysis.

All initial calibration ICBs and CCBs were checked for each requested analyte and were found to be at or below the detection limit, and so no blanks were flagged.

Equipment Blanks

An equipment blank (EB) is a sample of analyte-free media collected from a rinse of non-dedicated sampling equipment used to sample surface water. EBs are collected to document adequate decontamination of non-dedicated equipment. One EB should be prepared with each preparation batch.

One equipment blank (Location 2001) was collected after the surface water tubing was decontaminated. The ammonia result was 2 mg/L (which is the reporting limit) and all the surface water samples also had either 2 mg/L of ammonia or greater so none were flagged. The uranium result for the blank was 0.0013 mg/L and was greater than the reporting limit but lower than the other surface water results.

Matrix Spike Analysis

For all of the uranium, arsenic, copper, manganese, and selenium SDGs, the MS sample that was selected for QC analysis was from another client and the information was not included in the analysis. Therefore, all of the metals data on was flagged "J' for reason MS-1.

All three SDGs experienced low recovery failures in at least one of the matrix spike samples during ammonia analysis. Therefore, all of the ammonia data has been flagged "J" for reason MS-2.

For sulfate analysis, two SDG's (22106323 and 2106610) experienced low MS recovery and are flagged "J" for reason MS-2.

No matrix spike duplicates were included in the analysis narratives and all results were flagged for reason MSD-1.

Laboratory Replicate Analysis

The laboratory replicate results demonstrate acceptable laboratory precision. The relative percent difference (RPD) values for the reported matrix spike duplicate (MSD) results for all other analytes should be less than 20 percent for results greater than 5 times the RL.

The metals SDGs did not contain an MS or MSD sample. Therefore all of the uranium, arsenic, copper, manganese, and selenium data is flagged "J" for reason MS-1 and MSD-1.
For Ammonia and sulfate, there were no matrix spike duplicates run for any of the SDGs so all samples were flagged for MSD-1; lack of matrix spike duplicates.

Field Duplicate Analysis

Field duplicate samples are collected and analyzed as an indication of overall precision of the measurement process. The precision observed includes both field and laboratory precision and has more variability than laboratory replicates, which measure only laboratory performance. Duplicate samples were collected from locations 0413, 0407, and SMI-PZ3S. The duplicate results met the U.S. Environmental Protection Agency (EPA) recommended laboratory duplicate criteria of less than 20 percent relative difference (RPD) for results that are greater than 5 times the RL.

Laboratory Control Samples
Laboratory control samples (LCS) provide information on the accuracy of the analytical method and the overall laboratory performance, including sample preparation. LCS results were acceptable for ammonia analyses. Per national environmental laboratory accreditation requirements provided by the National Environmental Laboratory Accreditation Conference Institute, an MS may be used in place of an LCS provided the acceptance criteria are as stringent. Since no MSs were run for uranium, arsenic, or selenium from our samples all SDGs were flagged MS-1 and could also not be used instead of the LCS.

Metals Serial Dilution
Since no serial dilution samples were run on the uranium, arsenic, or selenium samples in any of the SDGs, all the metals samples were flagged "J" for reason SD-1.

Detection Limits/Dilutions
Dilutions were prepared in a consistent and acceptable manner when they were required. The required detection limits were achieved for all analytes.

Completeness
Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable Files
The Electronic Data Deliverable (EDD) files arrived July 31, September 29, and September 28, 2021, respectively, for SDGs 2106323, 2106610, and 2107186. The contents of the EDD were manually examined to ensure all and only the requested data were delivered in compliance with requirements and that the sample results accurately reflected the data contained in the sample data package.

4.2.2 Minimums and Maximums Report and Anomalous Data Review
Based on the definition of an anomalous data point, there were four anomalous data points associated with this event (Table 16). Well 0414 had a selenium concentration 50% below the historical minimum, and well ATP-1-D had an ammonia concentration that was 50% above the historical maximum. In addition, surface water sampled from location CR-1 contained ammonia and uranium concentrations 50% above the historical maximums.

It was noted that the laboratory was having equipment issues and high employee turnover when this data was analyzed. They did not see any errors in their data validation process, however, many of these numbers are far outside of the historical range. These sample locations will be sampled again in spring 2022 and groundwater personnel will use the analytical data to determine whether the current numbers reflect a changing trend in concentrations or a laboratory error.

Table 16. Anomalous Data Associated with the May *Site-wide Sampling Event*

Location	Sample Date	Concentration (mg/L)	Historical Min (mg/L)	Historical Max (mg/L)	Disposition
Ammonia Total as N					
0201	6/10/2021	2	0.0659	1	All of these ammonia concentrations represent historical highs for each location, except for ATP-2-S, which had abnormally low ammonia concentration. Many of these samples had an ammonia concentration within the 13 to 17 mg/L range, which is an odd coincidence. The laboratory was notified of the abnormally high results and upon reviewing the quality controls of the data, no issues were identified. These samples will be collected again in spring 2022 and the results will be used to determine if the data in this table is indicative of a trend or anomalous lab data.
0226	6/10/2021	4	0.1	1	
0410	6/29/2021	16	0.0125	1	
0430	6/28/2021	13	0.003	1	
0431	7/08/2021	15	0.0262	2	
0434	6/30/2021	13	0.0854	1.1	
0440	7/7/2021	13	0.0507	3	
0441	6/30/2021	13	0.1	1	
0443	7/8/2021	13	0.003	2.5	
0455	6/30/2021	15	0.003	1	
0492	6/14/2021	300	0.1	250	
ATP-2-S	6/1/2021	3.4	56	1130	
CR5	6/10/2021	2	0.07	1	
SMI-PZ3S	6/29/2021	17	1.7	11.49	
UPD-20	6/29/2021	14	0.1	1	
UPD-24	6/29/2021	14	0.8	2.9	
Copper					
0401	6/21/2021	0.0034	0.0035	0.014	These copper concentrations are lower than historical results.
AMM-2	6/1/2021	0.0025	0.0062	0.1	
TP-17	6/10/2021	0.0068	0.017	0.06	
Manganese					
0404	6/21/2021	0.045	5.5	1.1	Most of these manganese results represent historically low concentrations. These samples will be collected again in spring 2022 and the results will be used to determine if the data in this table is indicative of a trend or anomalous lab data.
0406	5/27/2021	0.0076	0.26	3.4	
0413	5/27/2021	0.062	0.1	0.437	
0414	5/27/2021	0.2	0.0395	0.13	
0430	6/28/2021	0.0032	0.04	1.04	
0431	7/8/2021	0.15	0.41	0.961	
0434	6/30/2021	0.48	0.83	2.89	
0437	7/6/2021	0.24	0.49	5.14	
0439	7/7/2021	0.27	0.765	52.6	
0440	7/7/2021	0.00016	0.0036	1.89	
AMM-2	6/1/2021	0.39	5	9.14	
ATP-2-S	6/1/2021	0.04	0.12	6.62	
SMI-PW01	6/14/2021	0.009	3.2	7.56	
SMI-PZ1S	5/27/2021	0.56	2.36	5.9	
SMI-PZ3S	6/29/2021	0.047	0.02	0.0335	
Selenium					
0440	7/7/2021	0.07	0.034	0.067	The sample result is close to the previous historic maximum.

Table 16. Anomalous Data Associated with the May *Site-wide Sampling Event (continued)*

Sulfate					
0406	5/27/2021	2300	3700	7616	These sample results represent a mix of anomalously high and low sulfate concentrations. Most of these locations have been sampled less than 10x, so the numbers may represent a variation in concentration over time. These samples will be collected again in spring 2022 and the results will be used to determine if the data in this table is indicative of a trend, or anomalous lab data.
0412	5/26/2021	340	880	1390	
0413	5/27/2021	2100	550	940	
0414	5/27/2021	2000	925	1300	
0430	6/28/2021	170	122	160	
0443	7/8/2021	490	173	449	
AMM-3	6/1/2021	11000	1110	10000	
SMI-MW01	5/26/2021	810	860	4760	
SMI-PW01	6/14/2021	4000	5800	14569	
SMI-PZ1S	5/27/2021	1200	4600	9500	
SMI-PZ3S	6/29/2021	750	970	1300	
TP-17	6/10/2021	50	1300	6000	
TP-20	6/9/2021	2300	4730	5520	
Uranium					
0434	6/30/2021	0.029	0.0149	0.028	The anomalous uranium data does not represent a large change in concentrations. These four locations had results that are just outside of the historical range.
0813	05/11/2021	3.2	0.91	3.1	
SMI-MW01	5/26/2021	2.3	2.5	17.6	
SMI-PZ3S	6/29/2021	0.63	0.76	3.24	

4.3 May through July 2021 Site-wide Sampling Event Results

In addition to ammonia and uranium, during the recent site-wide event samples were also analyzed for the five other potential contaminants of concern (PCOCs) (arsenic, copper, manganese, selenium, and sulfate) that were identified in the screening process and presented in Appendix A-2 of the EIS. While samples collected during previous sampling events have historically been analyzed for ammonia and uranium (and recently arsenic and selenium), copper, magnesium, and sulfate have not been analyzed since 2009. The groundwater system underlying the site is not a drinking water source, and these analyses were for informational purposes only. Results for each of these PCOCs are discussed individually below.

Ammonia

Samples have been analyzed for ammonia consistently since initial characterization of the site because it is one of the two primary (the other being uranium) site contaminants. There are no regulatory groundwater ammonia standards; however, provided in the EIS is a proposed standard of 3 mg/L for the site based on dilution factors and surface water impacts. With the exception of upgradient and other locations beyond the extent of the ammonia plume, groundwater samples collected across the majority of the site exceed this 3 mg/L ammonia concentration. More detailed information regarding the ammonia results are provided below.

Arsenic

Since 2019 samples collected from select locations (based on historical results) have been analyzed for arsenic. During this most recent event the samples from 10 locations included arsenic analysis, with six having concentrations that exceeded the 40 CFR 192 Sub A, Table 1 standard of 0.01 mg/L. Table 17 presents the locations, sample depths, and results of the arsenic analysis.

Table 17. May through July 2021 Groundwater Locations Exceeding the Arsenic 0.01 mg/L 40 CFR 192 Sub A Standard

Well Number	Date	Location	Sample Depth (ft bgs)	Arsenic Concentration (mg/L)
0413	5/27/2021	NE Uranium Plume Area	10	0.041
0414	5/27/2021	NE Uranium Plume Area	7.5	0.016
SMI-PZ3S	6/29/2021	NE Uranium Plume Area	25	0.021
UPD-17	6/29/2021	NE Uranium Plume Area	14	0.018
UPD-18	6/29/2021	NE Uranium Plume Area	13	0.019
UPD-24	6/29/2021	NE Uranium Plume Area	27	0.21

Copper

The only applicable groundwater standard for copper is the EPA Action Level of 1.3 mg/L. Samples were collected from 30 locations (based on historical results), and the concentrations ranged from 0.00066 (the detection limit) to 0.0078 mg/L. Therefore, none of these exceeded this action level.

Manganese

The only applicable groundwater standard for manganese is an EPA Secondary Drinking Water Regulation of 0.05 mg/L. Samples were collected from 46 locations during this recent event, and 30 were above the 0.05 mg/L concentration. Table 18 provides the locations, sample depths, and associated results.

Table 18. May through July 2021 Groundwater Locations Exceeding the Manganese 0.05 mg/L EPA Secondary Drinking Water Regulation

Well Number	Date	Location	Sample Depth (ft bgs)	Manganese Concentration (mg/L)
0401	6/21/2021	CF2	18	4.5
0403	6/14/2021	CF1	18	2.6
0407	6/14/2021	CF1	18	0.19
0413	5/27/2021	NE Uranium Plume Area	10	0.062
0414	5/27/2021	NE Uranium Plume Area	7.5	0.2
0431	7/8/2021	N of Queue	91	0.15
0434	6/30/2021	Upgradient of site	80	0.48
0437	7/6/2021	On Tailings Pile	NA	0.24
0439	7/7/2021	On Tailings Pile	NA	0.27
0453	7/6/2021	Along SW Site Boundary	80	0.11
0454	6/9/2021	Along SW Site Boundary	13	1.7
0455	6/30/2021	Upgradient of site	46	0.078
0457	5/26/2021	Upgradient of site	29	0.59
0492	6/14/2021	Along S Site Boundary	18	6.8
AMM-2	6/1/2021	Near CF5	48	0.39
AMM-3	6/1/2021	Base of tailings pile	48	2.9

Table 18. May through July 2021 Groundwater Locations Exceeding the Manganese 0.05 mg/L EPA Secondary Drinking Water Regulation (continued)

ATP-2-D	6/1/2021	Base of tailings pile	88	1.1
MW-3	5/27/2021	Near CF5	44	8.3
SMI-MW01	5/26/2021	NE Uranium Plume Area	16	0.54
SMI-PZ1S	5/27/2021	CF5 Vicinity	18	0.56
SMI-PZ2M2	6/1/2021	CF5 Vicinity	56	7.5
TP-01	5/26/2021	NE Uranium Plume Area	22	0.6
TP-11	5/26/2021	E edge of site	30	1.9
TP-17	6/10/2021	NE Uranium Plume Area	17	2.6
TP-20	6/9/2021	CF5 Vicinity	32	0.17
TP-23	6/9/2021	NE Uranium Plume Area	25	4
UPD-17	6/29/2021	NE Uranium Plume Area	14	0.68
UPD-20	6/29/2021	NE Uranium Plume Area	17	0.51
UPD-22	5/27/2021	NE Uranium Plume Area	9	0.077
UPD-24	6/29/2021	NE Uranium Plume Area	27	0.11

Selenium

Similar to the samples collected for arsenic analysis, since 2019 samples from select locations were analyzed for selenium. Of the nine samples collected, five had selenium concentrations above the 0.05 mg/L standard (40 CFR 192 Sub A, Table 1). These results presented in Table 19.

Table 19. May through July 2021 Groundwater Locations Exceeding the Selenium 0.05 mg/L 40 CFR 192 Sub A Standard

Well Number	Date	Location	Sample Depth (ft bgs)	Selenium Concentration (mg/L)
0413	5/27/2021	NE Uranium Plume Area	10	0.13
0440	7/7/2021	Along NW Site Boundary	117	0.07
UPD-17	6/29/2021	NE Uranium Plume Area	14	0.12
UPD-18	6/29/2021	NE Uranium Plume Area	13	0.074
UPD-24	6/29/2021	NE Uranium Plume Area	27	0.091

Sulfate

Similar to manganese, there is only an EPA Secondary Drinking Water Regulation for sulfate, which is 250 mg/L. Of the 46 locations sampled, 43 exceeded this standard. The sulfate concentration ranged from the detection limit of 1 to 16,000 mg/L, with a geometric mean of 1,527 mg/L. The high concentrations can be attributed to the presence of the naturally occurring brine within the groundwater system.

Uranium

All samples collected during this event were analyzed for uranium. Table 20 presents all locations sampled that exceeded the 0.044 mg/L uranium groundwater standard. This standard is based on Table 1 in *Title 40 Code of Federal Regulations Part 192 (40 CFR 192) "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Subpart A, Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites*," assuming uranium-234 and uranium-238 activities are in equilibrium. Table 20 also includes the results of samples collected from locations 0410 and 0412 in March 2021 and the 2021 CF4/CF5 sampling results that exceeded this concentration.

Table 20. May through July 2021 Sampling Events, Groundwater Locations Exceeding the 0.044 mg/L UMTRA Uranium Groundwater Standard

Well Number	Date	Location	Sample Depth (ft bgs)	Uranium Concentration (mg/L)
0401	6/21/2021	CF2	18	2
0403	6/14/2021	CF1	18	1.2
0404	6/21/2021	CF3	18	1.8
0406	5/27/2021	CF1	18	0.81
0407	6/14/2021	CF1	18	0.33
0410	3/10/2021	NE Uranium Plume Area	23.5	0.55
0410	6/29/2021	NE Uranium Plume Area	23.5	0.41
0412	3/10/2021	NE Uranium Plume Area	9.5	3.6
0412	5/26/2021	NE Uranium Plume Area	9.5	3.1
0413	5/27/2021	NE Uranium Plume Area	10	2.5
0414	5/27/2021	NE Uranium Plume Area	7.5	2.7
0437	7/6/2021	On Tailings Pile	NA	2.4
0439	7/7/2021	On Tailings Pile	NA	1.7
0441	6/30/2021	Along SW Site Boundary	53	0.053
0453	7/6/2021	Along SW Site Boundary	80	1.6
0454	6/9/2021	Along SW Site Boundary	13	1.4
0492	6/14/2021	Along S Site Boundary	18	3.1
0780	5/10/2021	CF4	28	0.19
0781	5/10/2021	CF4	48	3.4
0782	5/10/2021	CF4	33	0.44
0783	5/10/2021	CF4	18	0.27
0786	5/11/2021	CF4	28	0.065
0787	5/11/2021	CF4	36	2.5
0810	5/11/2021	CF5 Extraction Well	10 to 40	2.5
0811	5/11/2021	CF5 Extraction Well	9 to 39	2.7
0812	5/11/2021	CF5 Extraction Well	14 to 44	2
0813	5/11/2021	CF5 Extraction Well	14 to 44	1.7
0814	5/11/2021	CF5 Extraction Well	12 to 42	2.6
MW-3	5/27/2021	Near CF5	44	3
SMI-MW01	5/26/2021	NE Uranium Plume Area	16	2.3
SMI-PW01	6/14/2021	CF5 Vicinity	40	2
SMI-PW02	5/11/2021	CF5 Extraction Well	20 to 60	1.8
SMI-PZ1S	5/27/2021	CF5 Vicinity	18	0.6
SMI-PZ2M2	6/1/2021	CF5 Vicinity	56	2
SMI-PZ3S	6/29/2021	NE Uranium Plume Area	25	0.63
TP-01	5/26/2021	NE Uranium Plume Area	22	0.045
TP-22	6/1/2021	NE Uranium Plume Area	17	0.4
TP-23	6/9/2021	NE Uranium Plume Area	25	2.5
UPD-17	6/29/2021	NE Uranium Plume Area	14	1.5
UPD-18	6/29/2021	NE Uranium Plume Area	13	0.85
UPD-20	6/29/2021	NE Uranium Plume Area	17	0.064

Table 20. May through July 2021 Sampling Events, Groundwater Locations Exceeding the 0.044 mg/L UMTRA Uranium Groundwater Standard (continued)

UPD-21	6/29/2021	NE Uranium Plume Area	25	6.4
UPD-22	5/27/2021	NE Uranium Plume Area	9	2.7
UPD-23	6/22/2021	NE Uranium Plume Area	26	0.8
UPD-24	6/29/2021	NE Uranium Plume Area	27	5.8

Notes: NE = northeastern; SW = southwestern

To more easily present the trends observed in the water chemistry for the site-wide locations, the site was divided into six areas. These include:

- The Northeastern Base of the Tailings Pile
- The Northeastern Edge of Uranium Plume Area
- The Southeastern Base of the Tailings Pile
- The Southwestern Site Boundary
- The Site Boundary along the Colorado River
- The Southern and Off-site Areas

Also included is a response to CF5 extraction system activity on nearby monitoring wells SMI-PZ2M2 and AMM-2. All results since 2010 are plotted against the Colorado River flow to determine if the river stage may impact the concentrations. Refer to Figure 3 for the site-wide groundwater sampling locations.

4.3.1 Northeastern Base of Tailings Pile

Figures 12 and 13 are time versus ammonia and uranium concentration plots, respectively, for locations UPD-17 and UPD-18. Because of these location's proximity to the Colorado River and Moab Wash (in which the Colorado River tends to flood during peak runoff), prior to 2019 ammonia concentrations (Figure 12) have displayed a general trend of higher ammonia concentrations during river base flows and, conversely, lower concentrations during the spring runoff (or higher flows). Since 2019 the ammonia concentrations have not followed this trend, and most recently the concentrations have increased at both locations, but are still within the historical range. Overall the ammonia concentrations have been gradually decreasing at approximately the same rate.

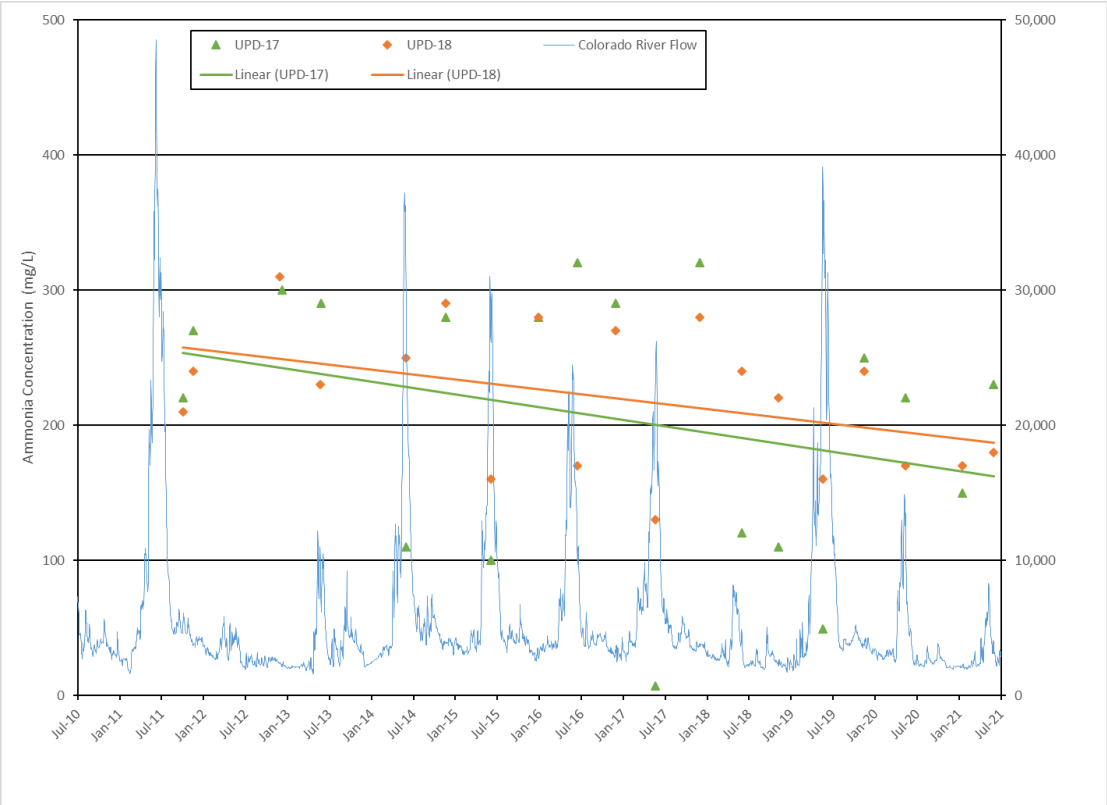

Figure 12. Wells UPD-17 and UPD-18 Time versus Ammonia Concentration Plot

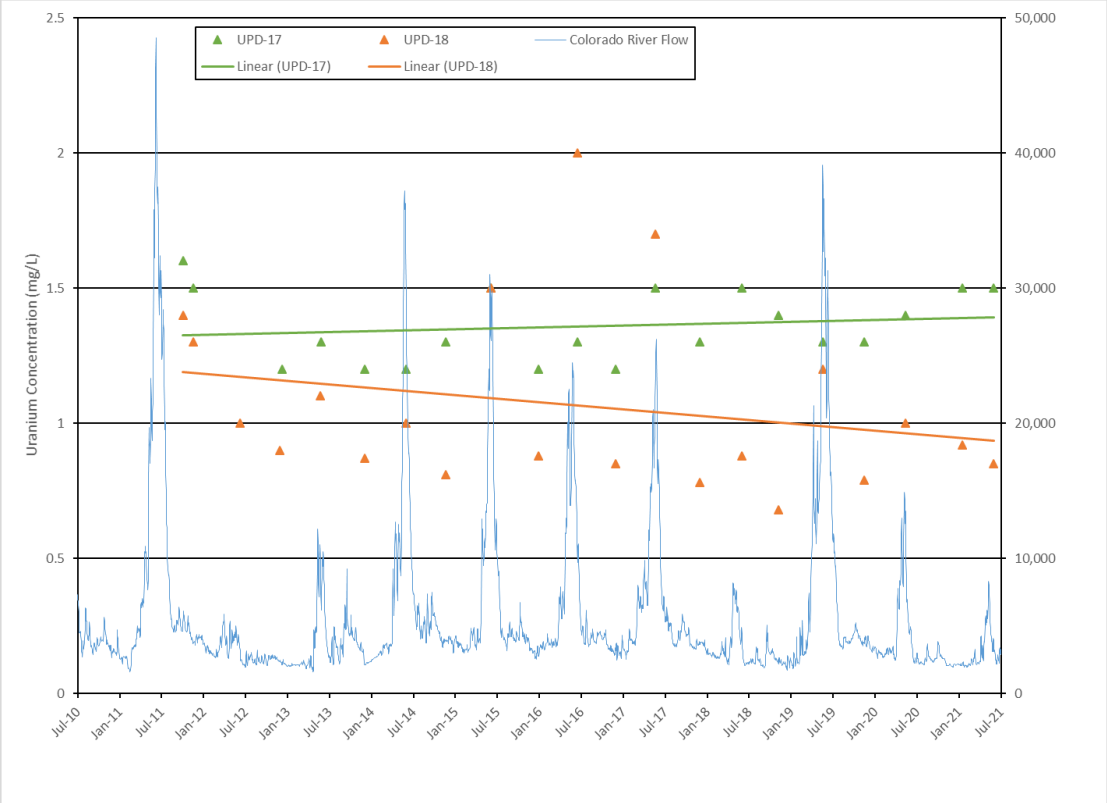

Figure 13. Wells UPD-17 and UPD-18 Time versus Uranium Concentration Plot

Uranium concentrations (Figure 13) tend to increase during higher river stages, where oxygenated water enters the subsurface and increases the uranium solubility. This geochemical reaction is especially evident in the samples collected from well UPD-18. In the past 10 years the uranium concentrations in samples collected from UPD-17 have slightly increased, and the concentrations have slightly decreased in the samples collected from UPD-18.

4.3.2 Northeastern Uranium Plume Area

Due to the number of wells associated with the northeastern uranium plume, this area of the site was further subdivided into the center of the plume, the vicinity of the Atlas building, and the northeastern edge of the plume area.

Center of Northeastern Uranium Plume Area

Figures 14 and 15 are the time versus ammonia and uranium concentration plots, respectively, for the center of the northeastern uranium plume area, which includes locations UPD-20, 0411, 0413, and 0414 (listed from upgradient to downgradient). It was not possible to collect a sample from 0411 over the past year, and the ammonia results associated with location UPD-20 are considered suspect based on historical data, and were not taken into consideration.

Well 0413 is approximately 650 ft from the Colorado River, and the ammonia concentrations (Figure 16) collected from this location are have been consistently higher since 2011 compared to the samples collected from well 0414. Well 0413 is less susceptible to impacts of the river stage compared to well 0414 (located only 250 ft from the river) when this area is not flooded. Trendlines indicate ammonia concentrations over the past 10 years have steadily increased.

The uranium concentration (Figure 15) in the sample collected from well UPD-20 was again just above the 0.044 mg/L standard (as it has been since this well was installed in 2011), with a concentration of 0.071 mg/L. Since 2012 the concentration has ranged from 0.056 to 0.095 mg/L. The uranium concentrations in samples collected from wells 0413 and 0414 have generally been similar since June 2013, with 0414 concentrations only 0.2 mg/L higher than 0413. By the most recent event, the trendlines suggest the uranium concentrations in the samples collected from 0413 have generally increased and in 0414 decreased over the past 10 years.

Vicinity of the Atlas Building

The ammonia and uranium concentrations associated with samples collected from locations in the vicinity of the Atlas building are displayed in Figures 16 and 17, respectively. These wells include 0410, UPD-21, UPD-23, and UPD-24, all of which were sampled at a depth of approximately 25 ft bgs. Based on data validation and historical ranges, the samples collected from locations 0410 and UPD-24 for ammonia analysis are considered suspect and are not presented in these plots.

As shown in Figure 16, the ammonia concentrations in samples collected from UPD-21 and UPD-23 during this site-wide event were less than 5 mg/L. Historically this area of the site has had the highest uranium concentrations (Figure 17) in groundwater, particularly in wells UPD-21 and -24. The uranium concentrations in samples collected from wells 0410 and UPD-23 remain lower than 1.0 mg/L and have not significantly changed since 2012, suggesting the uranium plume has not extended to the north/northeast during this time. The trendlines displayed in Figure 17 suggests that the UPD-21 and UPD-24 concentrations have decreased at a similar rate over the past 10 years.

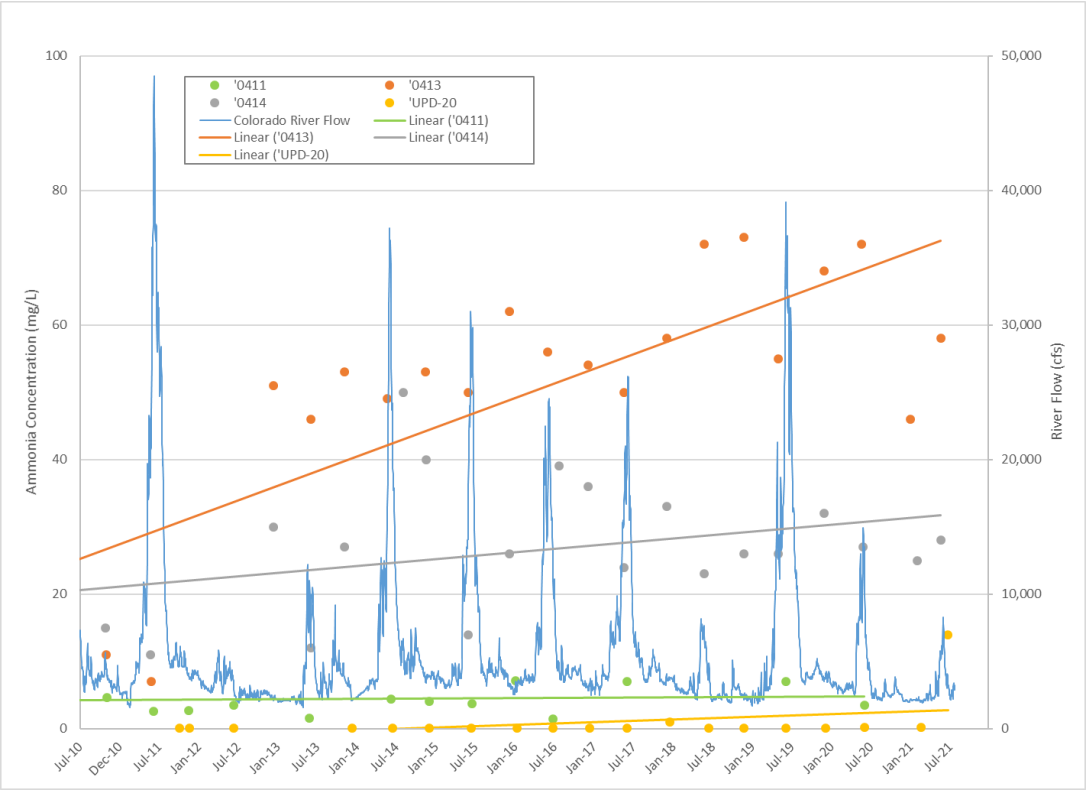

Figure 14. Center of Northeastern Uranium Plume Area Observation Wells 0411, 0413, 0414, and UPD-20 Time versus Ammonia Concentration Plot

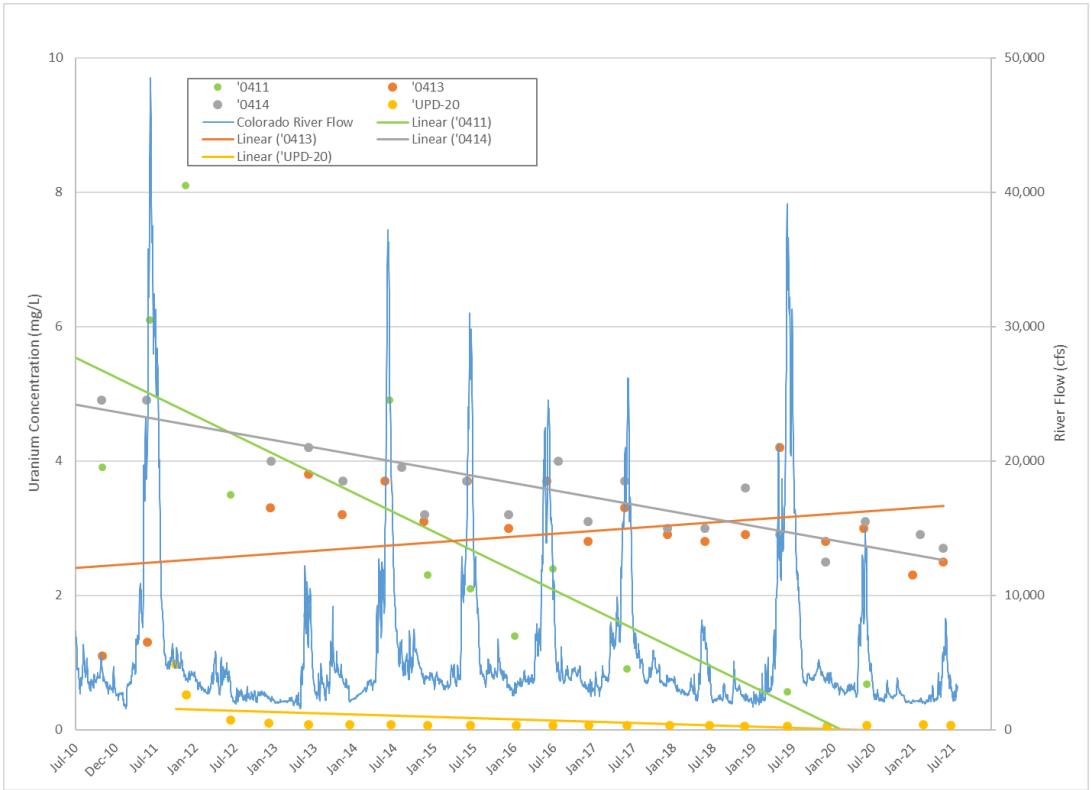

Figure 15. Center of Northeastern Uranium Plume Area Observation Wells 0411, 0413, 0414, and UPD-20 Time versus Uranium Concentration Plot

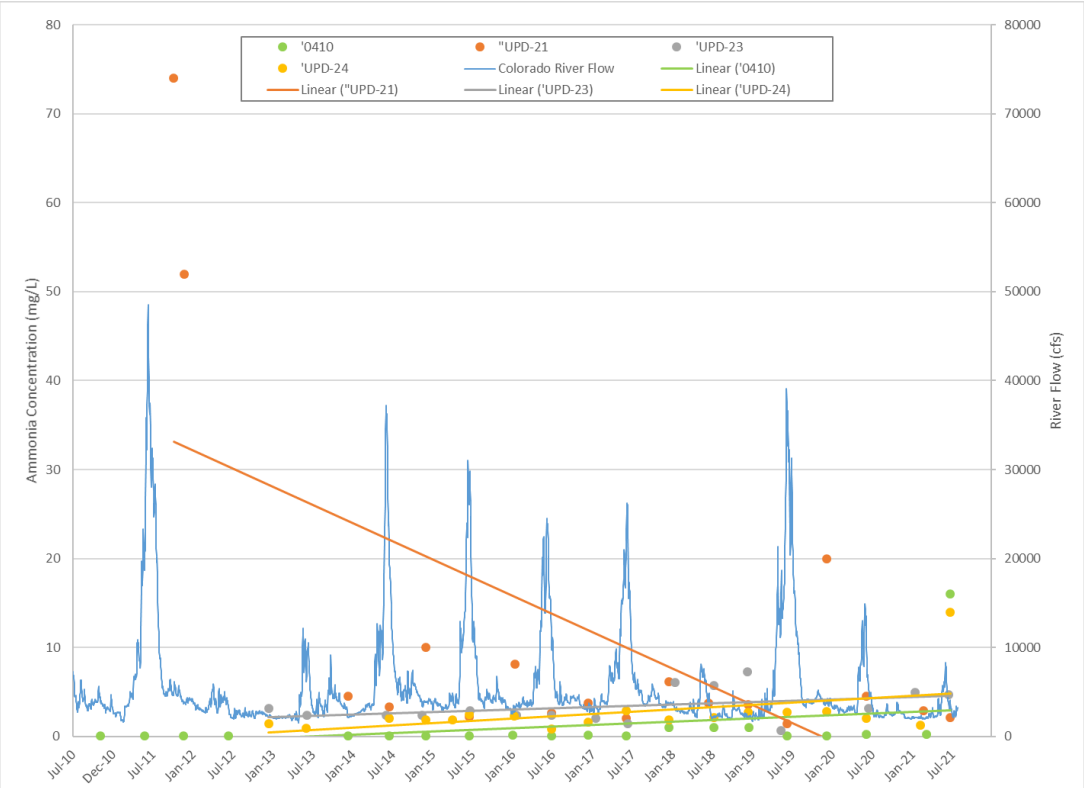

Figure 16. Vicinity of Atlas Building Observation Wells 0410, UPD-21, UPD-23, and UPD-24 Time versus Ammonia Concentration Plot

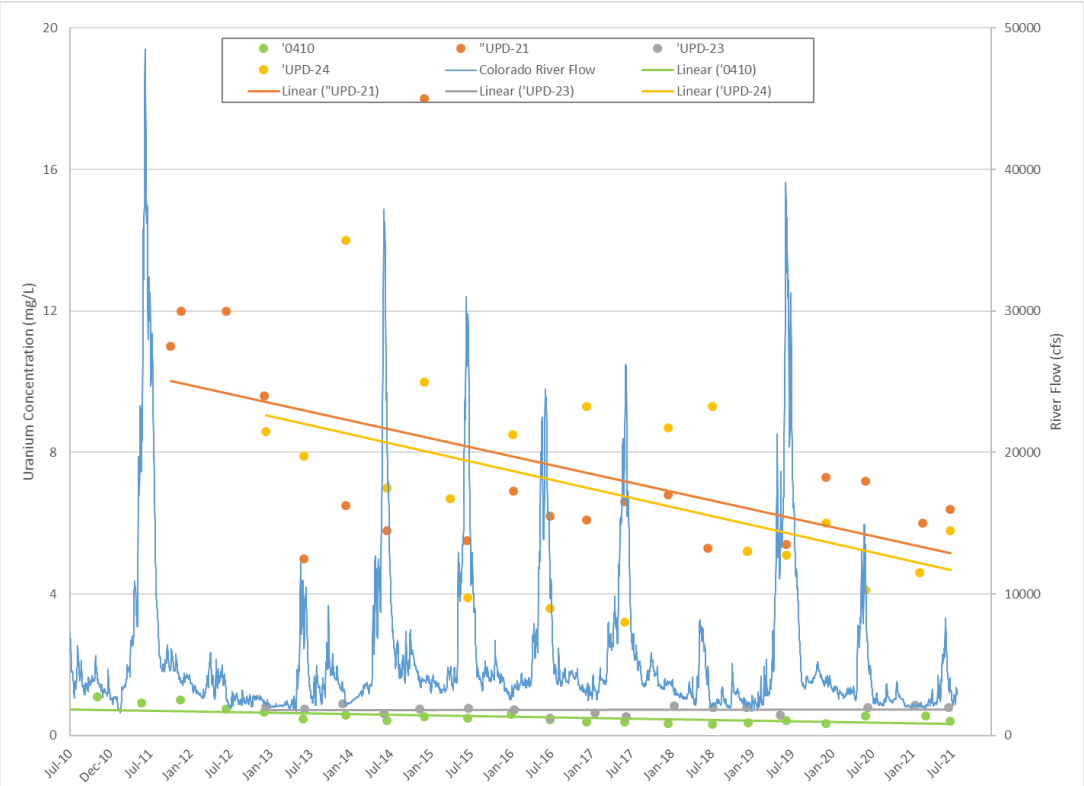

Figure 17. Vicinity of Atlas Building Observation Wells 0410, UPD-21, UPD-23, and UPD-24 Time versus Uranium Concentration Plot

Northeastern Edge of Uranium Plume Area

Figures 18 and 19 display ammonia and uranium concentration data for the wells located in the vicinity of the northeastern edge of the plume area. This includes wells SMI-PZ3S, UPD-22, 0412 and SMI-MW01 (listed from upgradient to downgradient). Well SMI-PZ3S is located approximately 850 ft from the river bank, and SMI-MW01 is only 50 ft off the bank. Well 0412 is near SMI-MW01, approximately 60 ft upgradient, but sampled at different depths (11 and 16 ft bgs, respectively). The ammonia analysis associated with the sample collected from location SMI-PZ3S provided a suspect result (based on data validation), and was not included in this discussion.

As Figure 18 exhibits, the ammonia concentrations associated with the sampling of these wells increases moving away from the river bank. The fluctuations displayed in the concentrations associated with 0412 are a function of detection limits. The concentrations measured in the samples collected from SMI-MW01 and 0412 have remained below 3 mg/L since 2010, suggesting this area is close to the edge of the ammonia plume. Through 2015 the concentrations measured in samples collected from well UPD-22 were below 5 mg/L, increased to nearly 10 mg/L in 2017 and have gradually decreased suggesting some minimal plume movement.

With this set of wells located downgradient of the Atlas Building and former processing area, the uranium concentrations are impacted by the upgradient conditions. However, consistently the uranium concentrations measured in the samples collected from the well closest to the Atlas Building cluster (SMI-PZ3S) are the lowest of this set of wells. Additionally well SMI-PZ3S is near UPD-24, approximately 200 ft downgradient, but the concentrations are significantly different (0.63 and 5.8 mg/L, respectively) during this most recent event even though the sample depths are similar (25 and 27 ft bgs). As shown in Figure 19, moving in the southeast (downgradient) direction concentrations generally increase, with the highest associated with the sample collected from well 0412. The concentration increase in the downgradient direction suggests the uranium plume is being impacted by another source, possibly the remnants of the berm that was in place during mill site operations through 2011.

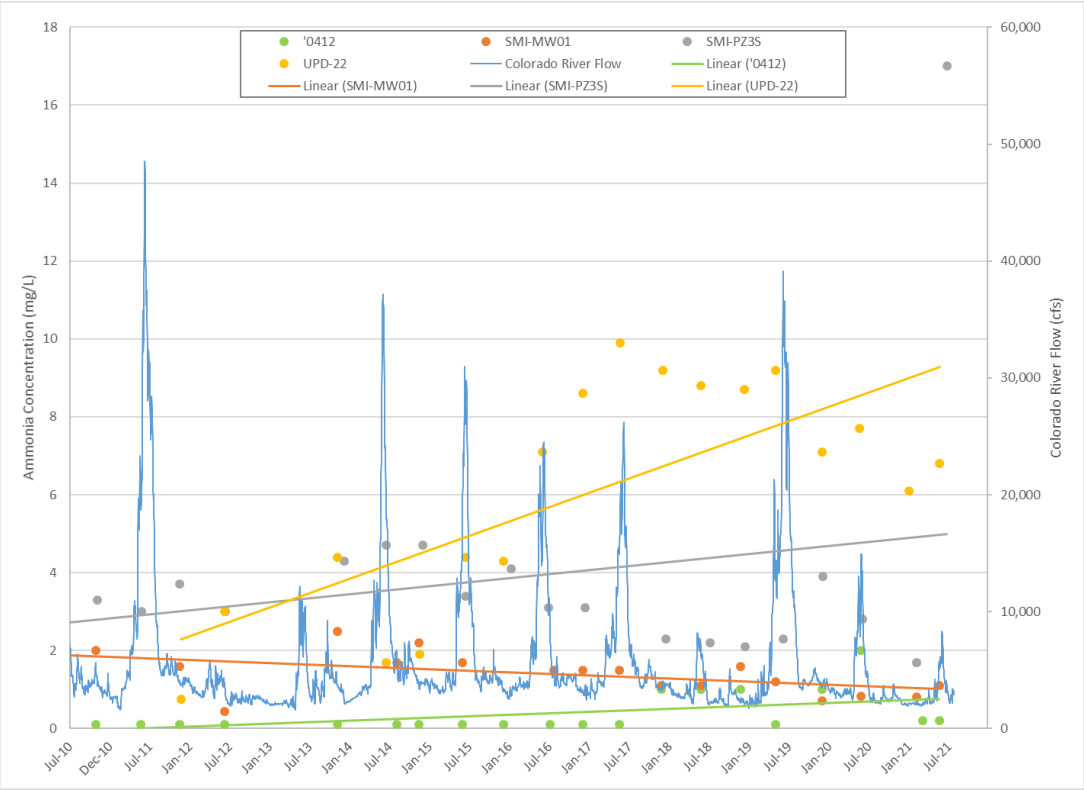

Figure 18. Northeastern Edge of Uranium Plume Area Observation Wells 0412, SMI-MW01, SMI-PZ3S, and UPD-22 Time versus Ammonia Concentration Plot

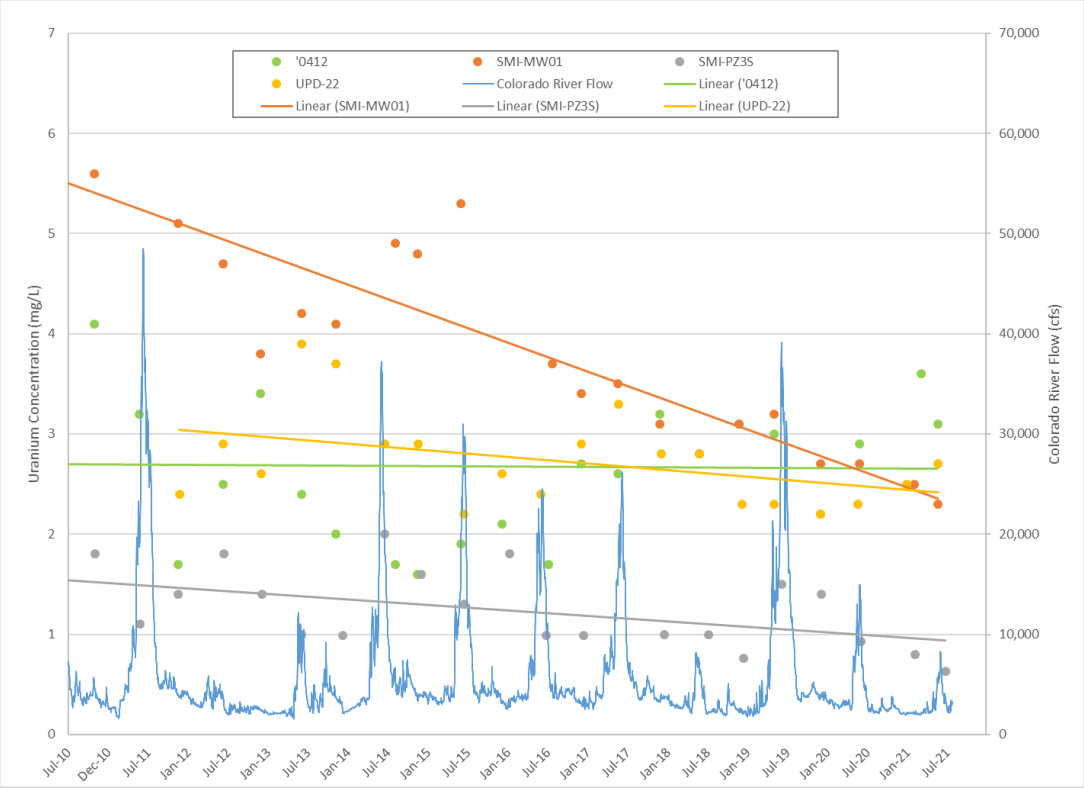

Figure 19. Northeastern Edge of Uranium Plume Area Observation Wells 0412, SMI-MW01, SMI-PZ3S, and UPD-22 Time versus Uranium Concentration Plot

4.3.3 Southeastern Base of Tailings Pile

The time versus ammonia and uranium concentration plots for the area near the base of the tailings pile are presented in Figures 20 and 21 for wells 0454, AMM-3, ATP-2-S, ATP-2-D, and MW-3 (listed from south to north). These wells are sampled over a variety of depths, ranging from 13 to 88 ft bgs. They are also located at approximately the same ground surface elevation.

Starting from the southern corner of the base of the pile, the samples collected 13 ft bgs from well 0454 provide ammonia concentrations in the shallowest zone. Figure 20 displays how this zone of the plume is impacted by the river stage, with a significant decrease when the river is experiencing spring runoff flows. Because this well is located in a slight depression off the southern tip of the pile, it is susceptible to being submerged during flood events (most recently in 2019). Between July 2017 and January 2019 ammonia concentrations were comparable to those in samples collected from other wells along the tailings pile base, approximately 400 mg/L. The concentration decreased to 55 mg/L during the 2019 flood, and has continued to rebound and, based on the recent event, has increased in a similar fashion as AMM-3 and MW-3.

Wells ATP-2-S and ATP-2-D are contained within a well cluster that is located near the center of the tailings pile base. Since 2010 ammonia concentrations have been similar from depths of 25 and 88 ft bgs. This not only provides a general idea of the depth of the plume, but also suggests there is minimal impact from the river stage on the ammonia plume down to a depth of at least 25 ft bgs. However, starting with the June 2020 sampling event, the ATP-2-S ammonia concentration decreased significantly and remained low during the most recent event. During this same time frame the ATP-2-D concentration remained within the historical range, suggesting this portion of the plume was diluted while the deeper zone was not impacted. Well MW-3 is located near the northeastern end of the plume, and ammonia concentrations in samples collected at this location are similar and tend to mimic those associated with the ATP-2-D.

Well 0454 displays the impact of the river stage on the uranium concentration in the shallowest zone (Figure 21), where uranium concentrations tend to decrease in response to high river flows. However, with the low flows during the 2021 runoff, the uranium concentrations in AMM-3 and MW-3 increased during this most recent event. The samples collected from well MW-3 have had the highest uranium concentration of this group of wells consistently since 2011, while concentrations in wells ATP-2-S and ATP-2-D have all been less than 0.015 mg/L since 2010. One would expect the ATP well concentrations to be higher, especially in the sample associated with ATP-2-S (from 25 ft bgs), since the samples collected along the base of the tailings between 13 (0454) and 44 ft bgs (MW-3) range from 1.4 to 3.0 mg/L.

4.3.4 Southwestern Site Boundary

Figures 22 and 23 are time versus concentration plots for ammonia and uranium, respectively, for locations 0441, 0440, 0453, and 0454 (listed from northwest to southeast). These locations are all along the furthest western extent of the alluvial aquifer. Due to the varying topography along this boundary, sample depths range from 13 to 117 ft bgs. The results associated with well 0454 are again presented in this section because in addition to being located along the base of the tailings pile, it is also along this site boundary.

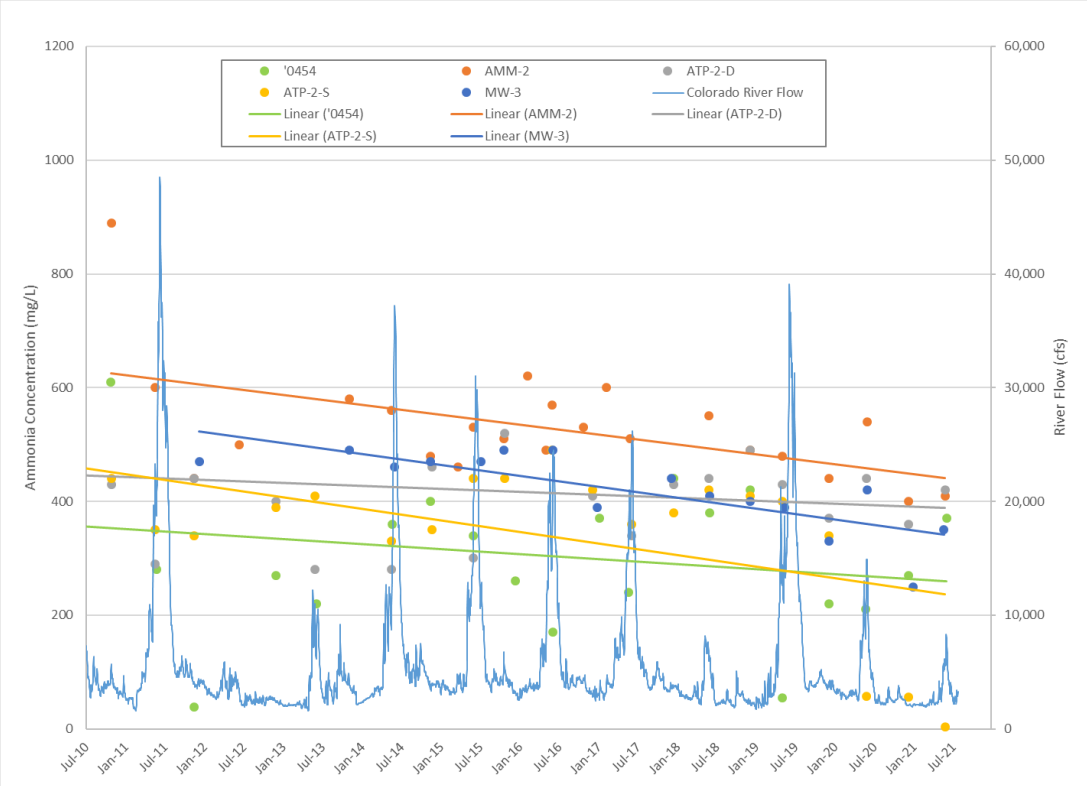

Figure 20. Base of Tailings Pile Observation Wells 0454, AMM-3, ATP-2-S, ATP-2-D, and MW-3 Time versus Ammonia Concentration Plot

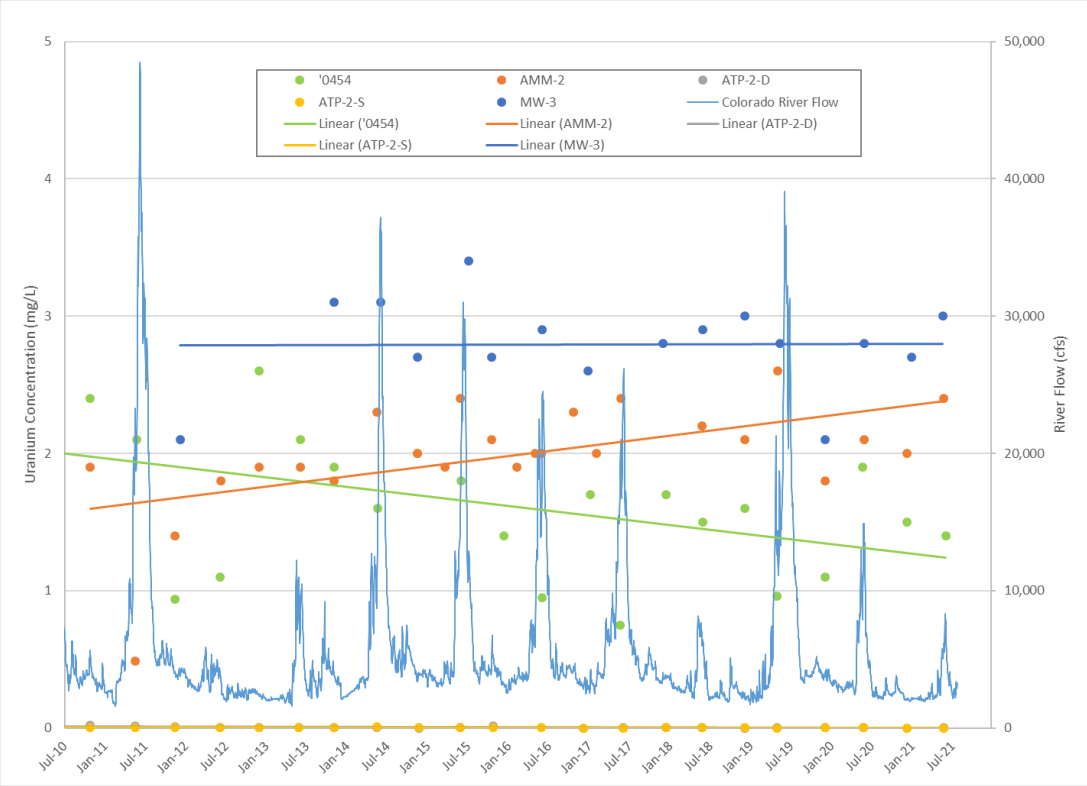

Figure 21. Base of Tailings Pile Observation Wells 0454, AMM-3, ATP-2-S, ATP-2-D, and MW-3 Time versus Uranium Concentration Plot

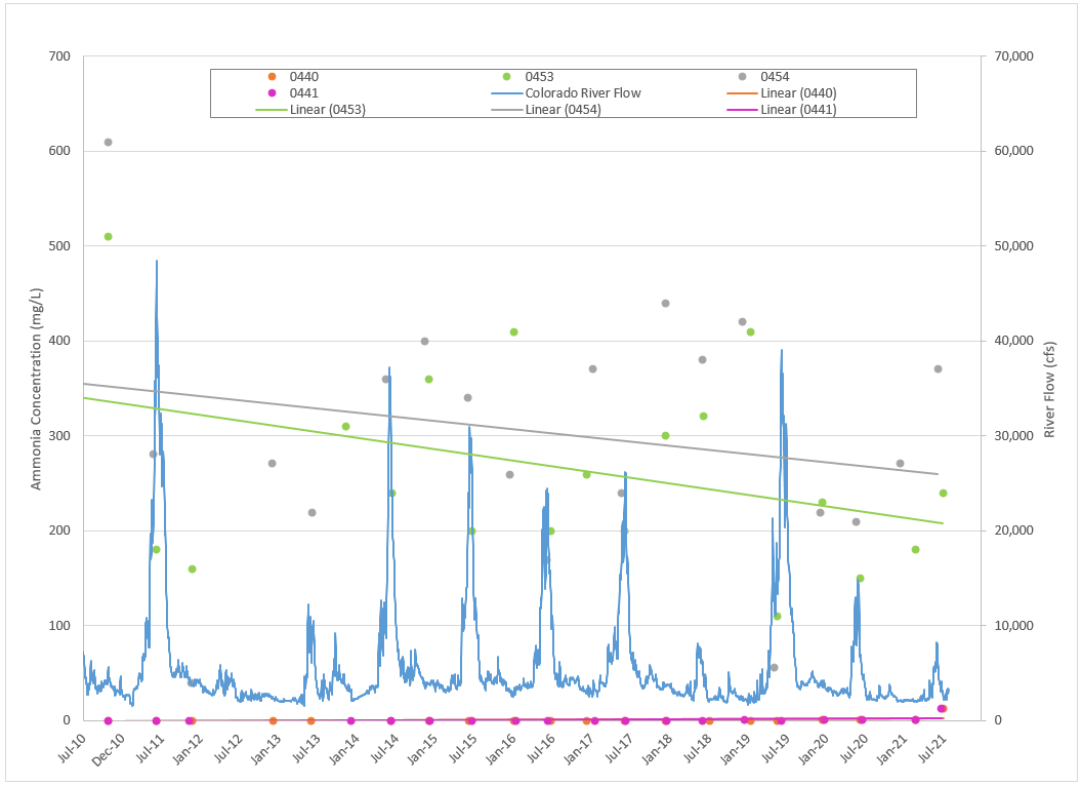

Figure 22. Southwestern Boundary Observation Wells 0453, 0454, 0440, and 0441 Time versus Ammonia Concentration Plot

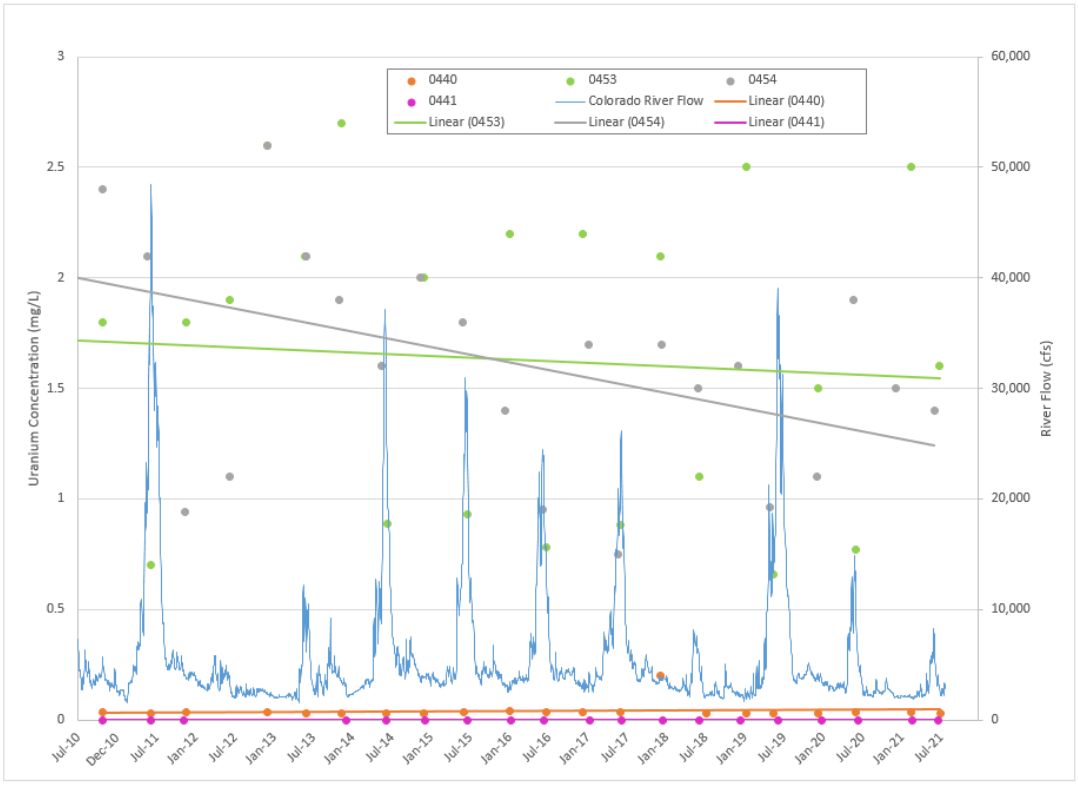

Figure 23. Southwestern Boundary Observation Wells 0453, 0454, 0440, and 0441 Time versus Uranium Concentration Plot

Data validation indicated that the samples collected from wells 0441 and 0440 for ammonia analysis produced suspect results, and are not discussed in this analysis. Ammonia concentrations and fluctuations are similar in the samples collected from 0453 and 0454 (Figure 22). The low 2021 river flows in response to the drought resulted in the 453 and 454 ammonia concentrations to continue to increase during the recent event.

Wells 0453 and 0454 uranium concentrations (Figure 23) display significant seasonal fluctuations similar to those displayed by ammonia concentrations, with lower concentrations during the peak river flows and increased concentrations during river base flows. The sample collected from well 0440 (0.031 mg/L) is below the 0.044 mg/L uranium UMTRA standard, and the 0441 concentration measured from the sample collected during this most recent event is above the standard (0.053 mg/L). These data suggests there has been minimal change in the northwest corner of the plume.

4.3.5 Site Boundary along the Colorado River

Figures 24 and 25 are the time versus ammonia and uranium concentration plots, respectively, for the locations sampled along the riverbank. Wells TP-17, 0492, 0407, 0401, 0404, SMI-MW01, and TP-01 (listed from the south to the north) were sampled from depths ranging from 17 to 28 ft bgs. Because these wells are located along the riverbank, the water chemistry has historically been heavily influenced by the Colorado River stage fluctuations.

The results presented in Figure 24 suggest the ammonia plume continues migrating to the south since 2017, based on the sample data collected from well 0492. Between November 2011 and January 2017 the ammonia concentrations associated with this location were below 10 mg/L. Since that time the concentrations have ranged from 16 to 300 mg/L. It is possible that this increase is in response to low river stages between August 2017 and April 2019 (and after 2019), allowing for uninhibited migration from the upgradient plume source. Ammonia concentration increases also occurred in the samples collected from wells 0401, 0407, and especially well 0404, which increased from 380 to 670 mg/L during this same timeframe. Ammonia concentrations have gradually decreased since the December 2018 peak in the samples from well 0404, with the most recent event having a concentration of 250 mg/L. The lowest ammonia concentrations were associated with the samples collected from the wells TP-17, SMI-MW01, and TP-01. The data suggests the plume is contained within the area bounded to the south by TP-17 and between SMI-MW01 and TP-01 to the north.

As displayed in Figure 25, the uranium concentration in the sample from 0492 continued to increase during the most recent event with 3.1 mg/L, the highest concentration detected since 2006. The uranium concentrations in samples collected from 0401 and 0404 have remained consistent over the past five years (both between 1 and 2 mg/L), suggesting no significant plume migration in this area of the plume. Uranium concentrations associated with SMI-MW01 (located downgradient of the northeast uranium plume) have continued to decrease over the past 10 years.

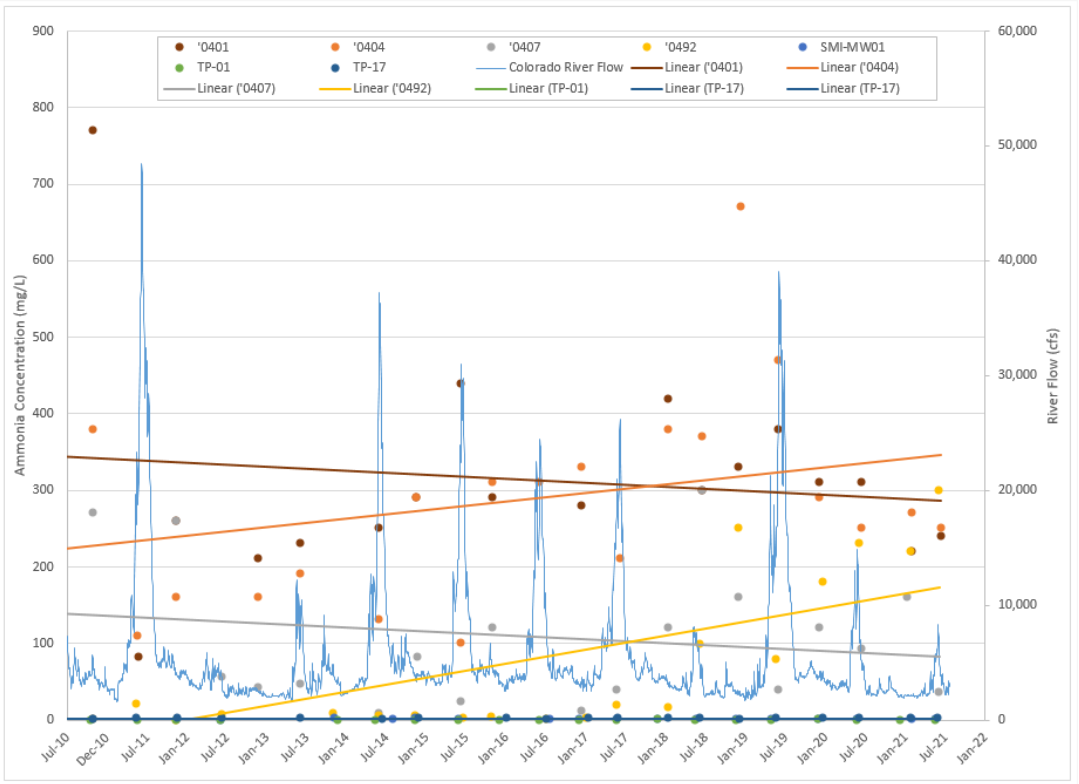

Figure 24. Riverbank Observation Wells TP-17, 0492, 0407, 0401, 0404, SMI-MW01, and TP-01 Time versus Ammonia Concentration Plot

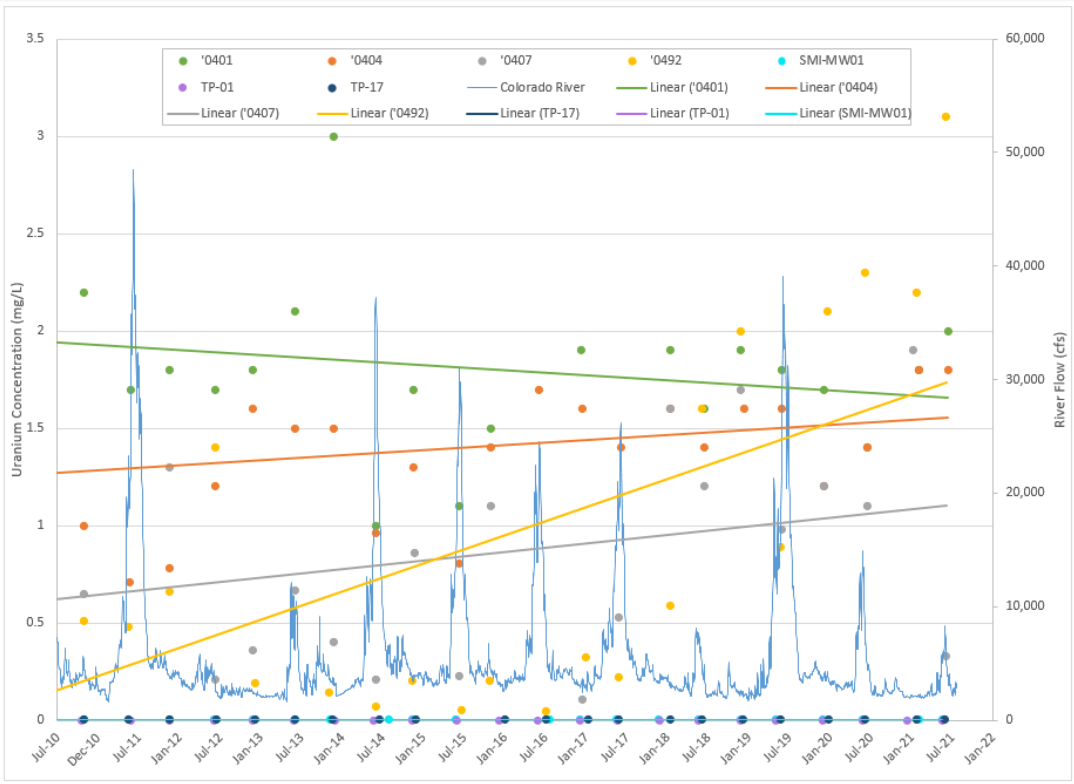

Figure 25. Riverbank Observation Wells TP-17, 0492, 0407, 0401, 0404, SMI-MW01, and TP-01 Time versus Uranium Concentration Plot

The results also suggest the uranium plume is bounded to the south near the location of well TP-17, where uranium concentrations have ranged from 0.012 to 0.037 since 2009. To the north, the results indicate the plume extent is in the vicinity of well TP-01, where the uranium concentrations have been below 0.1 mg/L since 2013 and above or just below the 0.044 mg/L UMTRA standard. During this most recent event the TP-01 concentration was 0.045 mg/L. These data indicate the uranium plume has not significantly migrated to the north or south in the past 10 years.

4.3.6 Southern and Off-site Areas

Figures 26 and 27 are the plots for four locations sampled at the southern end of the site, wells TP-17, TP-20, TP-23, and 0454. Well TP-17 is located along the riverbank, TP-20 is located approximately 500 ft off the riverbank, and TP-23 and 0454 are located closer to the toe of the tailings pile. Sample depths range from 13 ft bgs (well 0454) to 32 ft bgs (TP-20).

Ammonia concentrations (Figure 26) in samples collected from wells TP-17 and TP-20 have consistently been below 5 mg/L since 2000, suggesting the ammonia plume has not significantly migrated past these locations during this time period. Groundwater flow is likely impeded by groundwater density differences related to the presence of the high density brine unit. During December 2020 specific conductance values were above 105,000 micro ohms per centimeter (µmhos/cm) at a depth of just 28 ft bgs and more than 134,000 µmhos/cm at a depth 32 ft bgs for wells TP-17 and -20 (respectively). These values suggest the brine unit is near the groundwater surface in this area of the site.

Ammonia concentrations in samples collected from well 0454 are impacted by flood events, as evidenced by the significant decrease observed in 2019. The specific conductance during this recent sampling event was more than 72,000 µmhos/cm at a depth of only 13 ft bgs, near the southwestern boundary of the groundwater system. Likewise, the sample from TP-23 was collected with a specific conductance of more than 45,000 µmhos/cm at a depth of 25 ft bgs. Well TP-23 is located 225 ft directly east of 0454, and the results from these samples provides insight into the ammonia concentration vertical differences in this portion of the ammonia plume. Samples collected from both have increased over the past year.

Similar to the ammonia concentration results, uranium concentrations measured from wells TP-17 and TP-20 (Figure 27) suggest no uranium plume migration in this area of the site, likely for the same reason (presence of brine in near the groundwater surface). The sample collected from well TP-17 continues to be below the 0.044 mg/L UMTRA standard (since 2008), while the concentrations in samples from location TP-20 have been at or below this standard since 1997. Trendlines presented in Figure 27 indicate the uranium concentrations have decreased over the past 10 years.

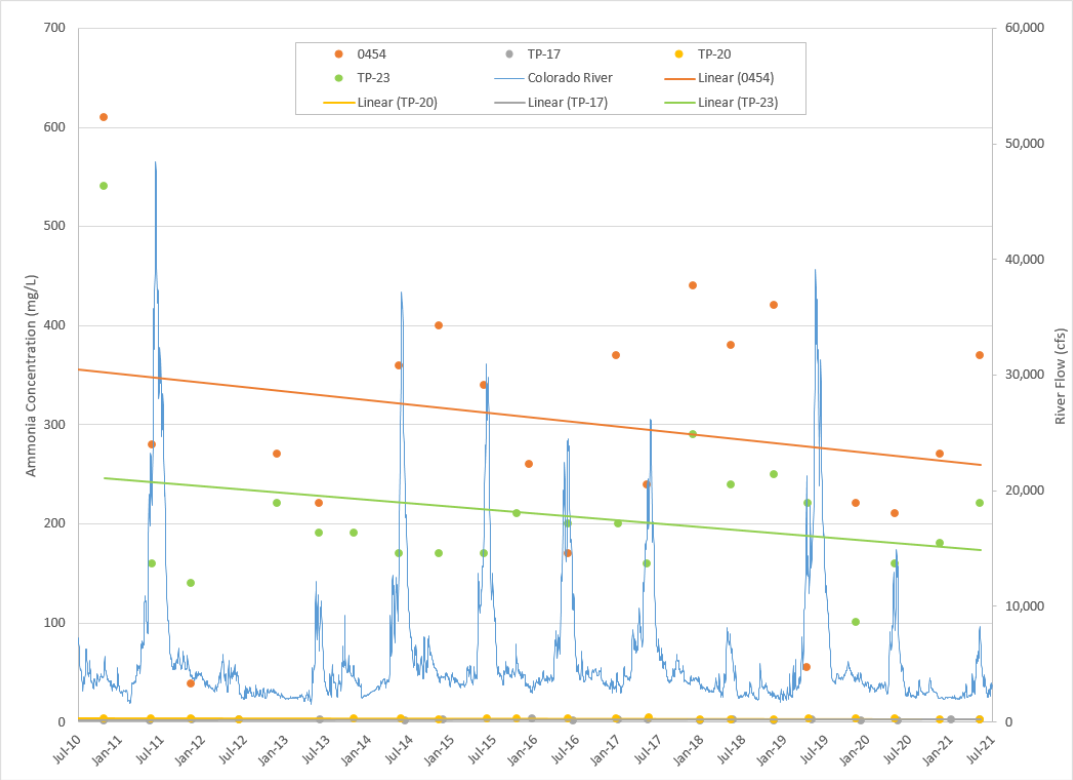

Figure 26. South of Site Observation Wells TP-17, TP-20, TP-23, and 0454 Time versus Ammonia Concentration Plot

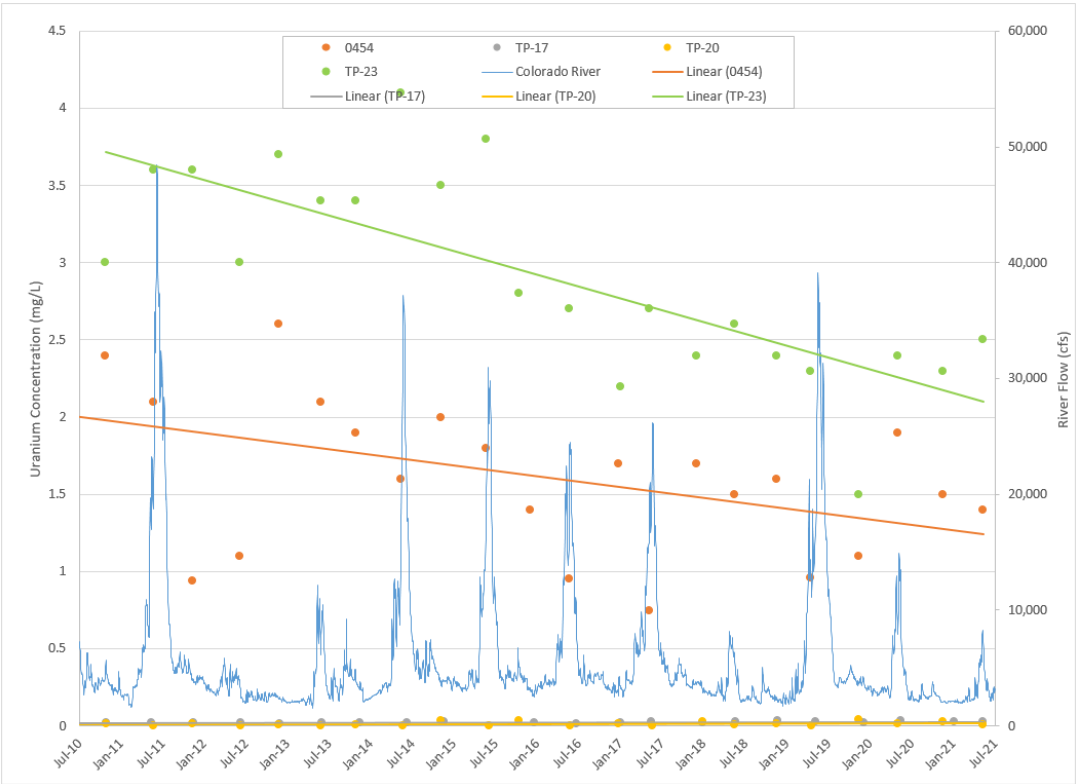

Figure 27. South of Site Observation Wells TP-17, TP-20, TP-23, and 0454 Time versus Uranium Concentration Plot

4.3.7 Response to CF5 Extraction

The sampling of wells AMM-2 and SMI-PZ2M2 provide some insight on how the CF5 extraction wells are impacting the groundwater system. Results from these monitoring wells are presented with the data collected from nearby extraction wells.

Monitoring well AMM-2 is located approximately 100 ft off extraction well 0813, and samples were collected from a depth of 48 ft bgs. Figures 28 and 29 present the ammonia and uranium concentrations (respectively), along with trend lines (linear) associated with the data collected from well AMM-2 and 0813. Figure 30 displays how the concentration fluctuations from the two wells generally are similar since 2009/2010, with the concentrations consistently higher in well AMM-2. Trend line data associated with the AMM-2 data set indicates the ammonia concentrations have on average decreased 13.4 mg/L per year since 2009, while extraction well 0813 has increased on average 6.9 mg/L per year (Figure 28). Well field 2011 flooding in addition to the fact that monitoring well AMM-2 samples are collected below the screen interval of extraction well 0813 may explain this difference.

Figure 31 displays the uranium concentrations from both wells, and with the exception of the sample collected in May 2018, the AMM-2 concentrations are in general 0.5 mg/L higher compared to 0813. The trend line generated from the AMM-2 data set results in a uranium concentration increase of 0.05 mg/L per year on average, while the 0813 trend line indicates an increase of 0.06 mg/L per year (Table 12).

Monitoring well SMI-PZ2M2 is within the SMI-PW02 well cluster (less than 20 ft away), and samples were collected from a depth of 56 ft bgs. Figures 32 and 33 presents the ammonia and uranium concentrations (respectively) measured from samples collected from extraction well SMI-PW02 and monitoring well SMI-PZ2M2. Also provided on the plot is the linear trend line associated with the SMI-PZ2M2 data set. The results indicate ammonia concentrations (Figure 30) from both locations have gradually decreased since 2009, with SMI-PZ2M2 generally having the higher concentration. The trend line associated with well SMI-PZ2M2 ammonia concentrations exhibits a decrease in the ammonia concentration of 44.2 mg/L per year, while extraction well SMI-PW02 has decreased on average 13.5 mg/L per year (Table 11).

Figure 31 is a plot of the uranium concentrations for these locations. Results associated with the sampling from these locations indicate the SMI-PW02 the uranium concentrations are consistently higher compared to the SMI-PZ2M2 concentrations. The trend line associated with the SMI-PZ2M2 data set suggests the uranium concentration has increased on average 0.11 mg/L per year, while the SMI-PW02 concentration on average has not changed significantly (only decreasing 0.03 mg/L per year, as shown in Table 12).

Results from both these monitoring well locations indicate the CF5 extraction appears to impact the groundwater system close to the extraction wells, especially regarding ammonia concentrations. Results indicate ammonia concentrations have been gradually decreasing in the samples collected from these monitoring wells, a trend that is not apparent in wells located in areas outside of the influence of the CF5 extraction wells. Uranium concentrations, likely due to geochemical processes, have not displayed the same decrease over time. This trend is also displayed in the extraction well results (Table 12).

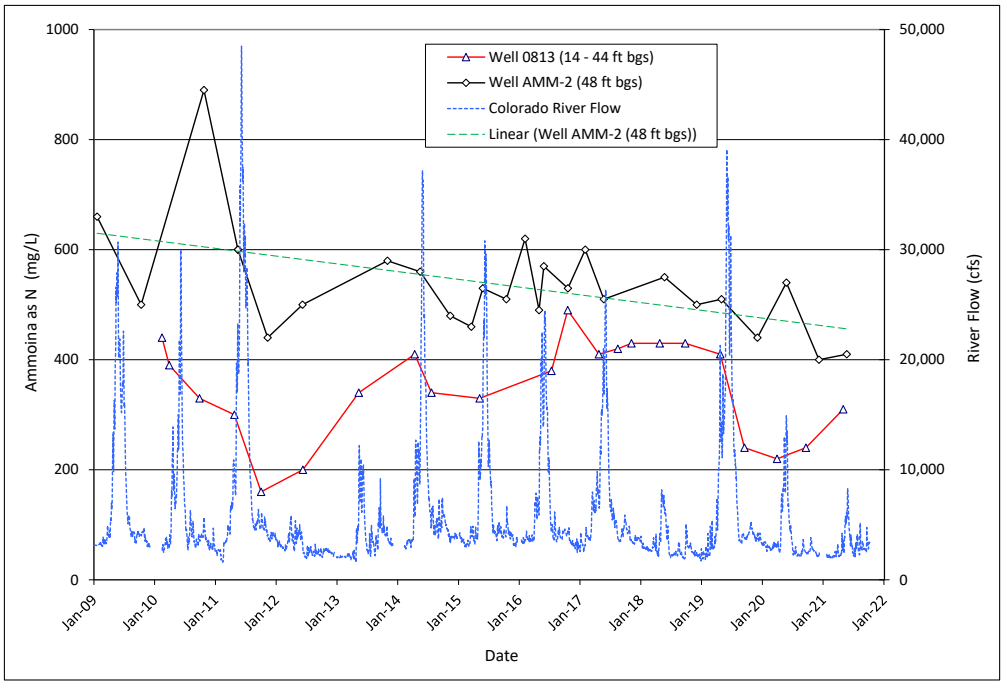

Figure 28. Monitoring Well AMM-2 and Extraction well 0813 Time versus Ammonia Concentration Plot and Trend Line

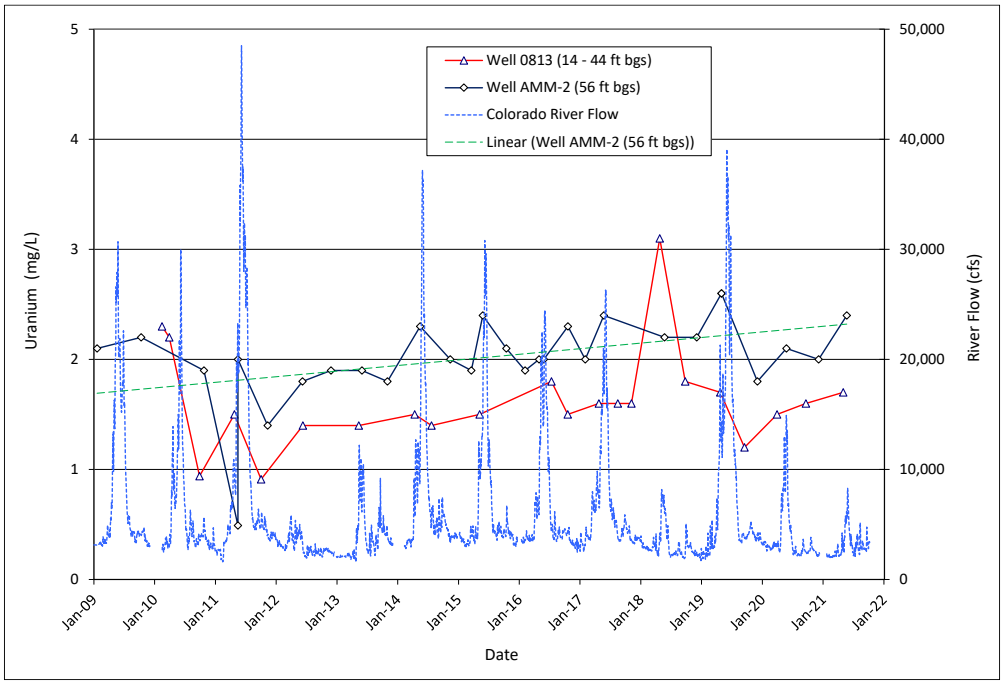

Figure 29. Monitoring Well AMM-2 and Extraction well 0813 Time versus Uranium Concentration Plot and Trend Line

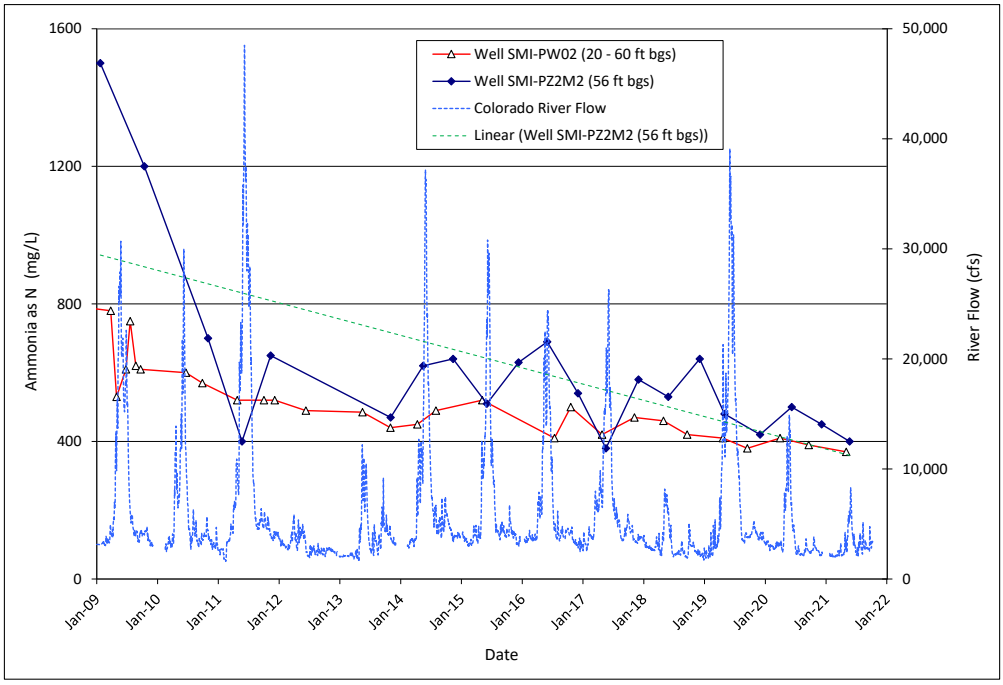

Figure 30. Monitoring Well SMI-PZ2M2 and Extraction well SMI-PW02 Time versus Ammonia Concentration Plot and Trend Line

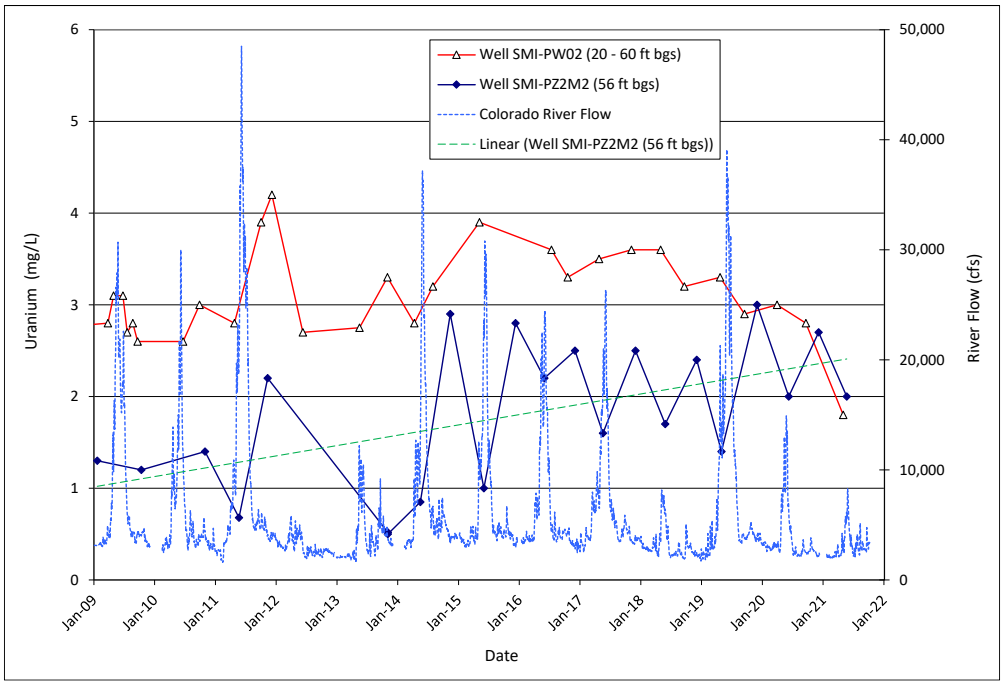

Figure 31. Monitoring Well SMI-PZ2M2 and Extraction well SMI-PW02 Time versus Uranium Concentration Plot and Trend Line

4.3.8 Surface Water Sampling Results

Table 21 presents the ammonia results from the surface water samples collected in January/February 2021 from locations 0201, 0218, 0226, CR1, CR2, CR3, and CR5 (as shown in Figure 4). The ammonia results are used along with the temperature and pH data to derive applicable EPA criteria for both acute and chronic levels. These criteria are presented with the ammonia results in Table 25 and represent a snapshot at the time the samples were collected. Appendix A details how these instantaneous criteria are used to derive monthly averages for habitat management.

Table 21. May Through July 2021 Site-wide Surface Water Ammonia Concentrations and Comparisons to EPA Acute and Chronic Criteria

Location	Date	Temp (°C)	pH	June 2021 Ammonia as N (mg/L)	EPA - Acute Total as N (mg/L)*	EPA - Chronic Total as N (mg/L)**
0201	6/10/2021	20.72	7.4	<2	9.8	1.4
0218	6/10/2021	20.83	7.54	<2	8.5	1.3
0226	6/10/2021	24.33	8.32	4	1.6	0.38
0274	6/10/2021	25.70	8.08	<100	2.0	0.46
CR1	6/10/2021	21.34	7.47	<2	8.5	1.3
CR2	6/10/2021	21.59	7.62	<2	6.7	1.1
CR3	6/10/2021	23.86	7.76	<0.2	4.0	0.79
CR5	6/10/2021	21.77	7.49	<2	7.8	1.2

Notes: *U.S. EPA Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater State (Effective April 2013), Table N.4. Temperature and pH-Dependent Values, Acute Concentration of Total Ammonia as N (mg/L)
**U.S. EPA Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater State (Effective April 2013), Table 6. Temperature and pH-Dependent Values, Chronic Concentration of Total Ammonia as N (mg/L)

Due to analytical laboratory issues, the typical 0.2 mg/L detection limit for surface water samples unfortunately was applied to the sample collected from only one location. Five other samples were analyzed with a detection limit of 2 mg/L, and another was analyzed using a detection limit of 100 mg/L. The sample collected from location 0274, just downgradient of CF4 had an ammonia concentration of 4 mg/L, which exceeded both the acute and chronic criteria. However, it should be noted that there were no dead fish present in this location, and subsequent habitat sampling resulted in a number of samples that had ammonia concentrations below 1 mg/L.

4.4 Groundwater Surface Elevations

Water level data to generate the groundwater surface contour map were collected in May 2021. The Colorado River mean daily flows during this time period ranged from 2,030 to 2,240 cfs, which translates into a river surface elevation at the southern end of the site of only 3,953.0 to 3,953.1 feet above mean sea level. These flows were significantly below normal (the average mean daily flows for these dates ranged from 3,340 to 3,500 cfs) in response to continued drought conditions experienced in this region.

Because river elevations fluctuated only 0.1 ft during this time period, it was possible to use this water level data collected during this time frame to generate the groundwater surface contour map displayed in Figure 32. This contour map displays how the site groundwater

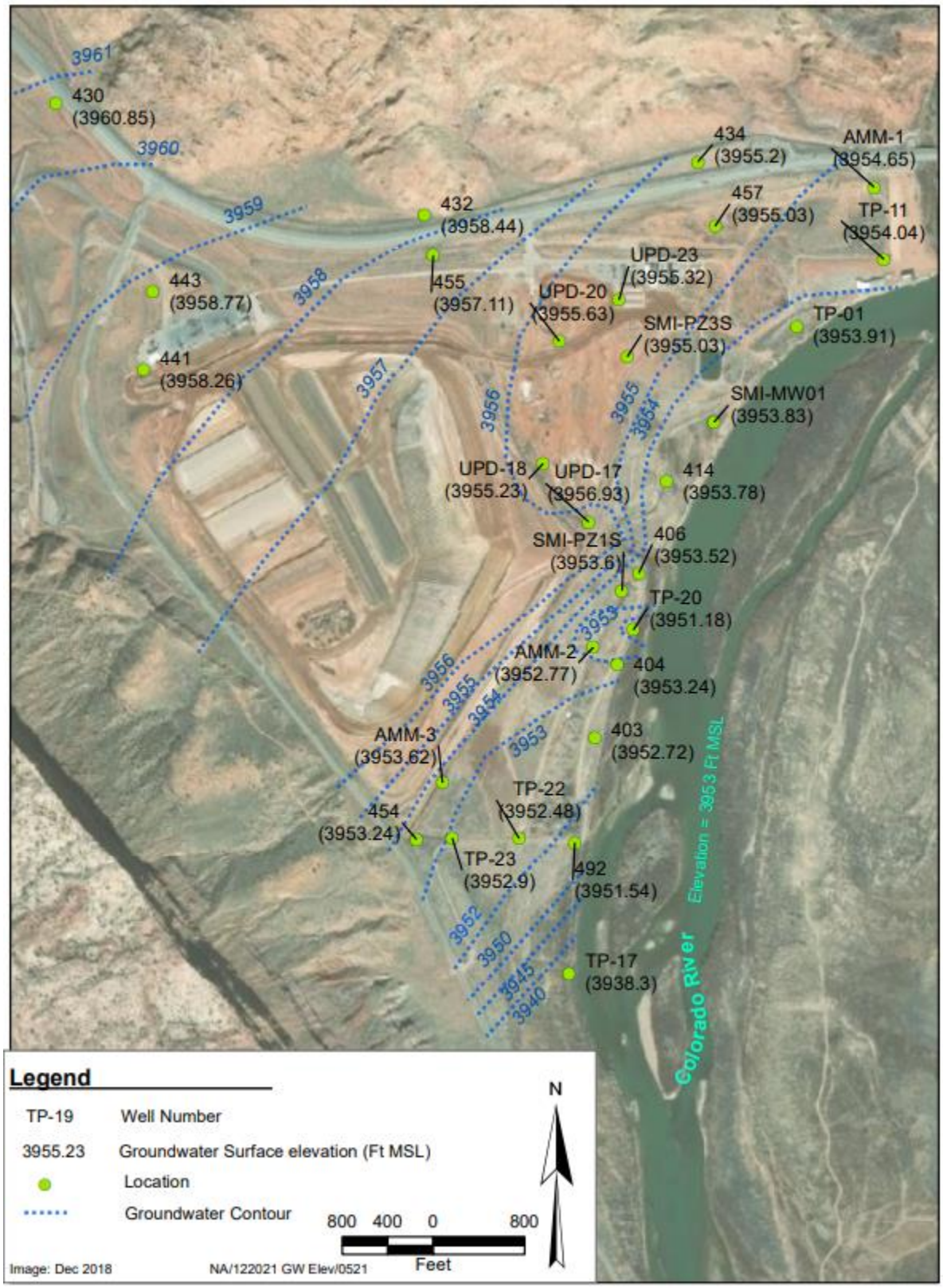

Figure 32. Site-wide Groundwater Elevations, May through June 2021

system responds to the river during primarily gaining conditions, when groundwater discharges into the river. Groundwater flow direction and the gradient displayed in this contour map are comparable to historical contour maps generated using groundwater data collected during river base flow conditions.

4.5 Contaminant Distribution

Figures 33 and 34 are maps showing shallow groundwater ammonia and uranium plumes, respectively, using data collected during the May through July 2021 site-wide event. Data collected typically from less than 50 ft bgs were used to generate these plume maps.

During river base flows, contaminant concentrations tend to rebound after being diluted during spring runoff peak flows. Minimal plume migration has occurred since the previous site-wide event, as discussed in Sections 4.3.4, 4.3.5, and 4.3.6. In general, the plume maps are comparable to previous plume maps generated using data collected during the river base flows.

5.0 Conclusions

5.1 March 2021 Matheson Wetlands Sampling Event

Ground water samples were collected from eleven Matheson Wetlands locations March 2021. This represents the first time samples had been collected from this area located across the Colorado River from the Moab site since November 2015. The ammonia and uranium concentrations have not significantly changed when compared to the previous sampling results. All sample results were lower than or consistent with previous results.

5.2 May 2021 CF4 and CF5 Sampling Event

The collection of groundwater samples from observation wells surrounding the CF4 injection wells in May 2021 was to determine how the effectiveness of freshwater injection into the CF4 wells. Despite limited injection during February through April due to pump replacement, 2.5 million gallons were injection into the wells. The analytical results indicate a significant reduction in ammonia concentrations in the both downgradient and upgradient wells. The peak flow of the Colorado River during this time was also lower than average and had less of an impact on concentrations.

Seven CF5 wells were sampled to monitor contaminant concentration trends over time and update the contaminant concentrations used for the mass removal calculations. Statistical analysis of the data collected from the CF5 wells during the past ten years indicates the ammonia concentrations on average have decreased 7 mg/L/yr, while during the same time period, uranium concentrations continue to show little change.

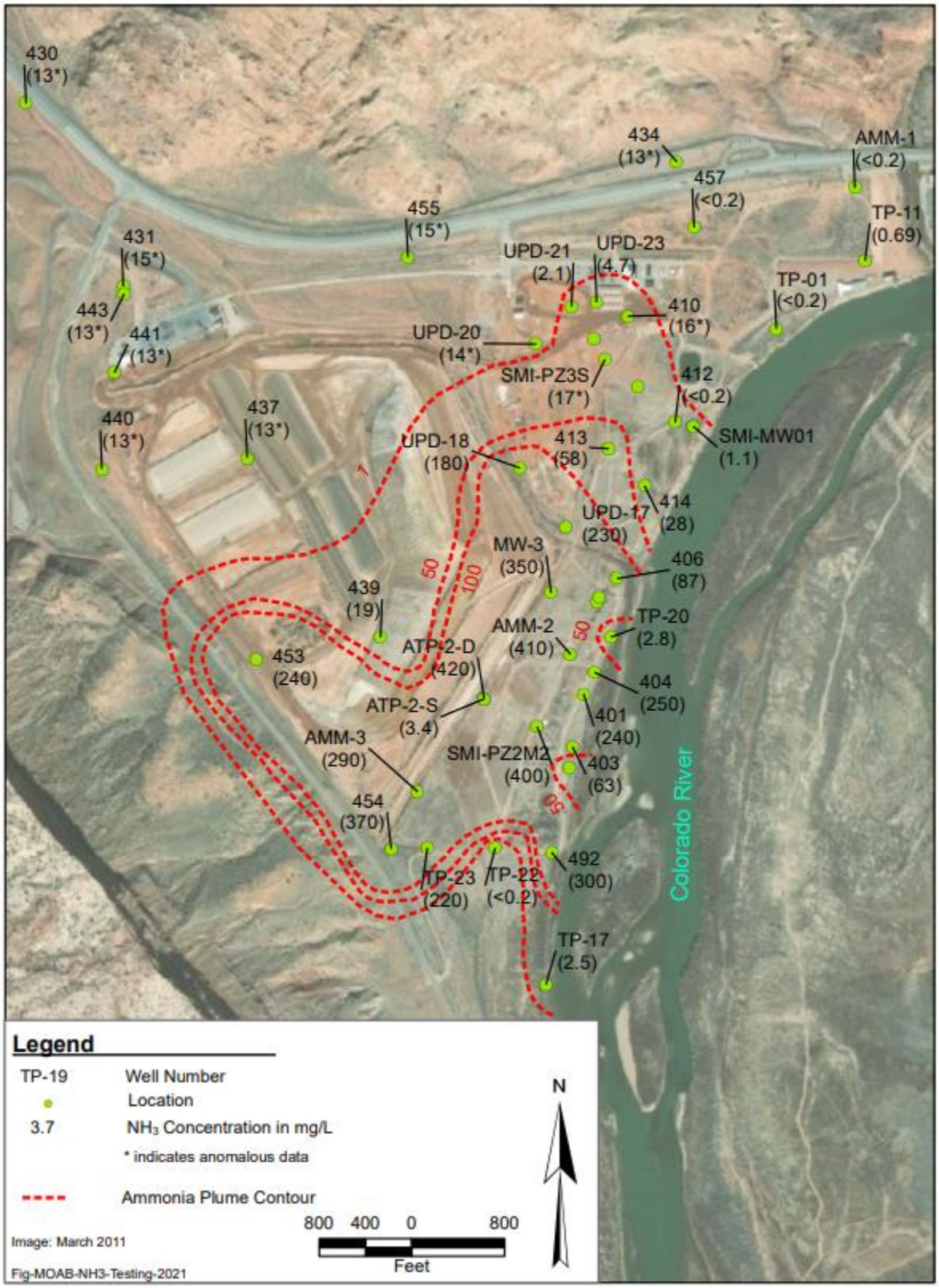

Figure 33. Ammonia Plume in Shallow Groundwater, May - June 2021

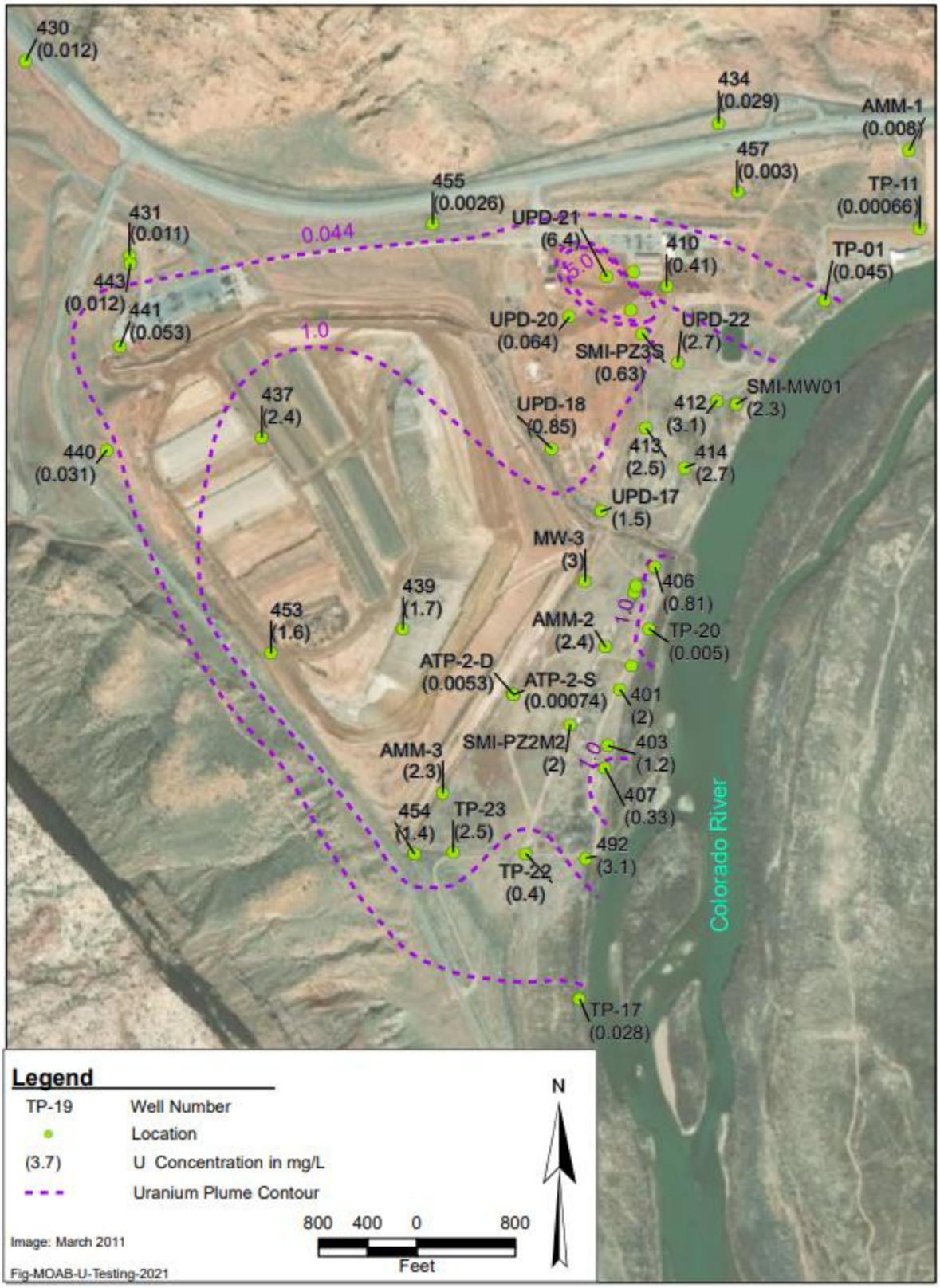

Figure 34. Uranium Plume in Shallow Groundwater, May through June 2021

5.3 May-July 2021 Site-wide Sampling Event

The rationale for conducting the May through July 2021 site-wide sampling event was to collect data from the site during Colorado River base flows and to assess any changes in the contaminant plume migration or trends in the groundwater system water chemistry. Five additional PCOCS were sampled for select locations. Three of these (arsenic, manganese, and selenium) did have results exceeding 40 CFR 192 Sub A standards.

The river flows were lower than average due to continued drought conditions this region has been experiencing. Surface water sampling was also conducted to assess surface water quality adjacent to the site compared to upstream and downstream water quality.

In general, there was minimal plume migration based on the samples collected from wells located along the plume boundaries. Ammonia concentrations from the seven surface water samples collected during this sampling event were primarily non-detect with the exception of one location that had a higher result above the applicable EPA criteria (for a suitable habitat) for both acute and chronic concentrations. Laboratory dilution factors were considerably higher than previous analyses causing a doubt in the accuracy of the results. Also, several upgradient locations had ammonia results uncharacteristic from previous results. These locations will be further investigated in the next site-wide sampling event to determine accuracy.

6.0 References

40 CFR 192A (Code of Federal Regulations) Subpart A, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites."

DOE (U.S. Department of Energy), *Characterization of Groundwater Brine Zones at the Moab Project Site (Phase 1)* (GJO-2002-333-TAR, GJO-MOA 19.1.2-3).

DOE (U.S. Department of Energy), *Moab UMTRA Project Standard Practice for Validation of Laboratory Data* (DOE-EM/GJTAC1855).

DOE (U.S. Department of Energy), *Moab UMTRA Project Surface Water/Groundwater Sampling and Analysis Plan* (DOE-EM/GJTAC1830).